SYSTEMATIC STUDIES OF SOME PSEUDOSCORPIONS

(ARACHNIDA: PSEUDOSCORPIONIDA) FROM THE

SOUTHEASTERN UNITED STATES

by

James Everett Lawson, B.S., M.A.

Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute

in candidacy for the degree of

DOCTOR OF PHILOSOPHY

in

Zoology

APPROVED:

Chairman, Dr. Perry C. Holt

Dr. Richard L. Hoffman

Dr. Michael Kosztarab

Dr. C. Duke Wilder

Dr. Richard W. Rhoades

August, 1967

Blacksburg, Virginia

ERRATA

Page 47. Top line to be included as the bottom line of page 46.

Page 61. Delete "comb-like" and insert "pectinate".

Page 184. "have been discussed above" should read "have been discussed on page 129".

Page 219 and 2nd page of abstract. Delete "ecology" and insert "habitat".

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I. ACKNOWLEDGMENTS

I am indebted to many persons for their assistance during the course of this study, but I should like to specifically thank Dr. Perry C. Holt, who directed the research and has rendered many helpful suggestions in the preparation of this paper. My appreciation is extended to Dr. R. L. Hoffman, Dr. M. Kosztarab, Dr. R. Rhoades, and Dr. C. D. Wilder who have served as members of my graduate committee.

Very special thanks are due Dr. T. P. Copeland of East Tennessee State University for many of the pseudoscorpions used in this study and for his personal interest and encouragement.

I am grateful to the following individuals for the loan of types and identified material used in this study: Dr. Willis J. Gertsch of the American Museum of Natural History; Dr. H. W. Levi of the Museum of Comparative Zoology; Dr. D. R. Malcolm of Portland State College; Dr. W. E. Muchmore of the University of Rochester; Dr. L. L. Pechuman of Cornell University; Dr. J. D. Unzicker of the Illinois Natural History Survey.

I wish to acknowledge the National Science Foundation for its financial assistance in the form of a Science Faculty Fellowship.

Finally, I would like to express sincere appreciation to my wife, , for her patience and understanding during the years of graduate study.

II. INTRODUCTION

The pseudoscorpions are chelicerate arthropods belonging to the Class Arachnida, Order Pseudoscorpionida. They have a body size ranging from 0.8 mm. to 6.0 mm., and the body is divided into two tagmata, the prosoma and opisthosoma. Unlike that of the scorpion, the opisthosoma is entire and not divisible into a mesosoma and metasoma. These animals are superficially similar to diminutive scorpions, however, in the manner in which the pedipalps are carried by the animal.

In addition to scorpions and pseudoscorpions, the Class Arachnida embraces such well known forms as spiders, ticks, mites, harvestmen, and other less well known animals: the amblypygids, uropygids, palpigrades, solpugids, and ricinuleids. In the United States, some species are widespread, while others are restricted in distribution to more limited regions such as the southern, western, and southwestern United States.

The habitats of the pseudoscorpions are quite diverse and include leaf mold, rotting tree trunks, the flaking bark of trees, rodent and bird nests, and caves. One species, *Chelifer cancroides*, is associated with human habitations. Because of their inconspicuous habitats and the difficulty of collection, the biology and systematics of these animals have not been extensively studied.

Pseudoscorpions are found in all areas of the world, except in the arctic and antarctic region. Savory (1964) has constructed a table, using Chamberlin's monograph on the order as his source, which gives a summary of the world-wide distribution of the families. This table indicates that some families are localized, some cosmopolitan, but the greater number are tropicopolitan. This degree of localization of distribution does not preclude the possibility of species of some genera of tropicopolitan families being found outside the tropics. For example, the heterosphyronid family Tridenchthoniidae and the monosphyronid family Atemnidae are considered circumtropical in their distribution but a few species of each family have been found in the United States, particularly some atemnids in subtropical Florida and some tridenchthoniid species in the southeastern states. The implication is that most groups have a wide geographical range (Hoff, 1949).

The possible means of dispersal employed by pseudoscorpions are inadequately known. Chamberlin (1939) has discussed several ways in which dispersal could occur. Firstly, small forms may be carried by air currents as are spiders and other small arthropods. Secondly, many forms could be transported by insects, mammals, and birds. Thirdly, some forms may be transported by commerce, as indicated by the distribution of *Chelifer cancroides* and by the number of pseudoscorpions taken from incoming shipments at quarantine stations in Boston and New York. Because of the ease with which pseudoscorpions can be transported, Chamberlin (1939) doubts the possibility of true endemism. Hoff (1949) supports Chamberlin's suggestions on the dispersal of pseudoscorpions, but points out that the successful establishment of these man-introduced species is not known.

Pseudoscorpions have been found attached to the appendages and bodies of large flying insects. This phoretic habit of pseudoscorpions is not ectoparasitism and serves only as a dispersal mechnaism (Chamberlin, 1931a). Vachon (*fide*, Savory, 1964) has not accepted the role of phoresy as a purely mechanical one for dispersal, but has proposed an alternate explanation. He was able to show that phoresy is not prevalent at all times, but occurs at frequent intervals throughout the year. During one of these periods, Vachon collected several pseudoscorpions from the legs of harvestmen and all but one were females. This preponderance of females led Vachon to conclude that phoresy has no relation to the dispersal of young, but rather was associated with the dispersal of adults. All these females had just left the brood chamber after rearing and feeding their offspring, or they had recently been fertilized. In either case, there was a limited food supply and hunger had made them attach to the harvestmen, the result being that they reached areas where food was plentiful. This idea has not been generally accepted, but Vachon (1953) continues to report new instances of pseudoscorpions being found on various insects.

The apparent ease with which pseudoscorpions are dispersed, either actively or passively, must be considered carefully in attempting to explain the distribution of any species. Further, the present knowledge of the distribution and taxonomy of the order is insufficient for zoogeographical purposes because the pseudoscorpion fauna of many areas of the world has been partially or wholly neglected.

The fossil record of pseudoscorpions is limited to the Cenozoic era.

Some species collected in Baltic amber have been described and placed in the Oligocene and Recent epochs. One species from Burma is of the Miocene epoch. It is of interest that one fossil specimen has been found attached to the leg of an insect, which indicated the occurrence of phoresy during those times as well (Savory, 1964).

Eighteen fossil specimens have been assigned to nine of the eighteen families of living pseudoscorpions. Moreover, some specimens have been assigned to recent genera (Savory, 1964).

Chamberlin (1931a) and Beier (1932c) have presented phylogenetic schemes for the families and higher taxa of the Pseudoscorpionida. An examination of these diagrams shows that the schemes are, for the most part, in agreement, but differ in the treatment of the superfamily Feaelloidea. Chamberlin (1931a) considers the Feaelloidea and its included families to be of the suborder Monosphyronida, while Beier (1932c) believes the correct assignment is to the suborder Diplosphyronida. A discussion of this point is presented in another position in this paper.

The relationship of the pseudoscorpions to other arachnids has not been established as many workers have associated them with several arachnid orders (fide, Chamberlin, 1931a). Shipley in tabulating Lankester's system, placed the pseudoscorpions between the solpugids and ricinuleids. Warburton allied them with solpugids on the basis of structure. Pocock placed them between the palpigrades and phalangids. Daiber included them with the scorpions, solpugids, amblypygids, phalangids, and ricinuleids, which he separated from the spiders. Comstock placed them between the spiders and phalangids. Simon placed them between the spiders and solpugids, but did not imply a relationship. Hansen and Sørensen grouped the pseudoscorpions with the scorpions, solpugids, and opilionids. Chamberlin related them to the spiders and amblypygids.

From Chamberlin's review just presented it should be evident that the problem of pseudoscorpion relationships is far from being solved. According to Vachon (1949), the difficulties encountered in attempting to show relationships are because of the diverse opinions of different authors being based on various criteria. The arguments for particular viewpoints are based on embryology, anatomy, or comparative morphology, and the conclusions drawn have led to the confusion of pseudoscorpion affinities.

The objective of this study is to present the results of systematic investigations of some of the pseudoscorpions commonly found in leaf mold of deciduous forests of the eastern United States. The opportunity is taken to redescribe and sufficiently illustrate several species by descriptions based on a series of specimens. Originally, the geographic limits for this investigation were to be the Great Smoky Mountains National Park and the adjacent area of East Tennessee, but additional specimens from other areas have been included. It is hoped that this study will stimulate further research on the taxonomy of pseudoscorpions which will serve as a foundation for understanding the ecology, distribution, and evolution of these animals.

III. REVIEW OF THE LITERATURE

Our written knowledge of the order dates back to the time of Aristotle, but the taxonomic history of the pseudoscorpions begins with Linnaeus, who in 1758 recognized two species, *Phalangium cancroides* and *P. americanus*. Geoffroy, in erecting the genus *Chelifer* in 1762, separated these two forms from the other arachnids (*fide*, Chamberlin, 1931a).

The genus *Obisium*, with *Chelifer cancroides* as its only included species, was proposed by Illiger in 1798. Despite the synonymy involved, Leach used *Obisium* for a group of species not congeneric with *cancroides* and this usage was maintained until Chamberlin (1929b) replaced it with the genus *Neobisium*.

The first systematic account of pseudoscorpions was published in 1804 by J. F. Hermann. He was able to list six species divisible into two groups (*fide*, Chamberlin, 1931a). This work preceded a later division by Balzan into two suborders which were equal to Hermann's groups.

In addition to those contributions mentioned above, others of this time were of relatively little importance in giving status to pseudoscorpion taxonomy, although a number of new genera were erected and new species named.

Modern pseudoscorpion classification began with Eugene Simon, who in 1879, attempted to classify the French pseudoscorpion fauna on the basis of characters of the chelicerae and legs (With, 1906). In this scheme Simon recognized one family, the Cheliferidae, and three subfamilies, the Cheliferinae, Garypinae and Obisiinae. It is noteworthy that, in his system, Simon disregarded several recognized genera because the use of criteria other than eye characters, which was the basis for earlier schemes, proved to be more constant. This arrangement was accepted by most authors except Daday and Tömösváry, who promoted Simon's three subfamilies to full family rank. Daday, in his description of the genus Garypinus, extended Simon's system to include another subfamily, the Garypininae (Chamberlin, 1931a).

Luigi Balzan, in 1890, (fide, Chamberlin, 1931a) set forth a system based on chelicera characters. These features of the chelicerae and the consideration of leg segmentation represented the basis of a new system which he formulated in 1891. In this last endeavor, Balzan raised the two families of his previous scheme to suborders and gave them the names Panctenodactyli and Hemictenodactyli. In this attempt, however, Balzan had followed Simon in the interpretation of the segmentation of pseudoscorpion legs and did not realize that there are differences in the number of podomeres. Consequently, he proposed what can only be regarded now as an artificial system. This system was accepted and utilized until 1894 when Hansen was able to demonstrate intermediate forms when using Simon's chelicerae characters. The basis for the revision, which represents Hansen's greatest contribution, was the correct interpretation of the femoral and tarsal segments. In this system Hansen characterized the suborder Hemictenodactyli as having the tarsus of the first two pairs of legs two-jointed and the suborder Panctenodactyli as having a tarsus comprised of a single segment.

This system has virtually remained unchanged with the exception of a few modifications.

With (1906) accepted Hansen's classification and did not make any significant changes but was able to recognize that there are important differences among the members of Hansen's subfamily Cheliferinae. This important study of With's helped pave the way for the erection of three new families, the Chernetidae, Atemnidae, and Cheliferidae.

Changes in the system, first laid down by Balzan and with subsequent revisions and additions by Hansen and With, have been primarily in the elevation of particular taxa and in the description of new forms. A conspectus of this scheme is outlined below and represents the culmination of efforts by Balzan, With, and Hansen (*fide*, Chamberlin, 1931a).

- Order Chelonethi (Pseudoscorpiones)
  - Suborder Hemictenodactyli
    - Family Chthoniidae
      - Subfamily Chthoniinae
      - Subfamily Tridenchthoniinae
    - Family Obisiidae
      - Subfamily Obisiinae
      - Subfamily Pseudobisiinae
  - Suborder Panctenodactyli
    - Family Garypidae
    - Family Feaellidae
      - Subfamily Pseudogarypinae

Subfamily Feaellinae

Family Cheliferidae

Subfamily Pseudocheiridiinae

Subfamily Cheiridiinae

Subfamily Sternophorinae

Subfamily Cheliferinae

A revision of the Balzan-Hansen-With scheme in which the order is subjected to a thorough taxonomic and morphological inspection was published by Chamberlin (1929a, 1930, 1931a). In his revision, Chamberlin utilized the number of podomeres for division of the order into three suborders. Further, he gave superfamily status to families of the Balzan-Hansen-With classification.

In 1932 Max Beier, Chamberlin's contemporary, undertook the task of revising the taxonomy of the order. He also made use of the femur and tibia as the characters used for separating the suborders. This work is elaborate in illustrations and descriptions of species (Beier, 1932a, 1932b). Like Chamberlin, Beier retained three suborders and six superfamilies. A conspectus of both schemes is offered later as part of the discussion of the order.

Chamberlin and Chamberlin (1945) questioned the validity of Beier's suborders and superfamilies since they are in strict synonymy with J. C. Chamberlin's (1931a) monograph. Their objection has no standing in nomenclatural disputation, yet, ignoring for now J. C. Chamberlin's (1931a) "groups", I shall follow his usage since it is more familiar to

American workers. Beier's work, however, has much to offer in keys, descriptions of new genera or species, and illustrations and because of these values it shall not be disregarded.

The workers of the past three decades have been quite productive in the erection of new genera and the description of new species. Beier has been the prinicipal worker in Europe and as recently as 1963, has published a treatise on certain families of the order. In the United States, C. C. Hoff has been a major contributor to the taxonomy of the group, and has published taxonomic treatments on the pseudoscorpions of Illinois, New Mexico, Colorado, and other geographical areas.

Roewer (1940) has given an excellent account of the morphology of the pseudoscorpions. His systematic treatment is a condensation of Beier's. In many ways this work complements Chamberlin's earlier monograph which includes an excellent anatomical account.

Another European worker, M. Vachon, should be mentioned for his contributions to our knowledge of the taxonomy, embryology, and distribution of the pseudoscorpions, particularly the cavernicolous species of Europe. W. B. Muchmore (1963, 1965) has recently devoted considerable attention to the cavernicolous pseudoscorpions of North America.

IV. MATERIALS AND METHODS

The material for this study was obtained from over 700 samples of leaf mold from deciduous forests. Some sampled material also included the debris from rotting logs and the flaking bark of trees. These collections came from the Great Smoky Mountains National Park; the counties of East Tennessee, and various state parks of Middle and West Tennessee; Mt. Mitchell, North Carolina; Greenville Co., South Carolina; Breaks Interstate Park, Virginia; Blue Ridge Parkway, Floyd Co., Virginia; Mt. Lake, Virginia; and Plummer's Isle, Maryland. The samples of leaf mold were brought into the laboratory in dark plastic bags. A battery of twenty Berlese funnels was used to process the samples. Hoff (1949) has illustrated and discussed the feasibility of using the Berlese apparatus for the collection of soil animals. The material to be sampled was processed through the Berlese apparatus and the animals were collected in 70% ethyl alcohol after being driven out of the detritus by heat and light from 40 watt electic bulbs or by fumes from naphthalene flakes. The use of naphthalene flakes proved to be as effective as the heat from the light bulbs. The material being sampled was left in the Berlese apparatus for a period of twenty-four hours, after which the collected pseudoscorpions were removed with the aid of a binocular dissecting microscope and placed in a vial of 70% alcohol for storage until mounted on slides.

The preparation of material for mounting was patterned after the method employed by Hoff (1949), in which both chelicerae, the two palps, and one of the first and one of the fourth legs were dissected from the body. These appendages were left in 70% alcohol while the body and remaining pedal appendages were treated further. The treatment accorded the body and attached appendages was that used by Dr. Michael Kosztarab of the Entomology Department, Virginia Polytechnic Institute, for scale insects. This technique is a modification of one used by taxonomists of the United States Department of Agriculture for mounting scale insects and aphids. The procedure is as follows: The material is taken from 70% ethyl alcohol and placed in a small dish containing 10% potassium hydroxide. For quicker results, the dish containing the potassium hydroxide solution is heated on a warming table for ten minutes or more. The exact amount of time needed will depend upon the size and sclerotization of the specimen. The purpose of this step is to dissolve all body contents in order to make the exoskeleton transparent. To facilitate this step, a small incision is made in the pleural membrane of the abdomen through which the body contents can be removed. The use of a flat or blunt instrument to alternately press and release the abdomen is helpful in inducing the removal of the disintegrated material. Once the body contents have been removed and the bleaching action of the potassium hydroxide has been effective, the specimen is removed to acetic acid alcohol (20 cc of glacial acetic acid; 45 cc of distilled water; 50 cc of 95% ethyl alcohol) for twenty minutes or more. This solution serves to neutralize the potassium hydroxide remaining in the cleared body. The use of acetic acid alcohol is a time saving step because Hoff (1949), in his procedure, left the specimens in water for a day to remove the potassium hydroxide. If desired, staining can be done at this time, but staining was not necessary for the specimens used in this study. The material is passed through 70%, 95%, and into 100% ethyl alcohol. The dissected appendages are carried through these same concentrations and are placed in absolute alcohol with the body. All body parts are then transferred to clove oil for ten minutes or more for clearing, after which they are ready for mounting in Canada balsam. In mounting, the body is placed ventral side up with the attached appendages not folded under or upon the body but positioned away from the body. The two pedipalps are mounted with the body. One palp is mounted in its entirety with the dorsal side uppermost. The chela is removed from the remaining pedipalp and the fingers are spread apart. The chela and the remaining palpal podomeres are then positioned so that the lateral side is uppermost. Frequently, it is necessary to add short pieces of glass slivers or finely drawn glass rods to support the coverslip. The chelicerae and legs I and II are mounted on the same slide with the lateral surface uppermost but under a separate cover glass. As soon as the mounts are made they are placed in an oven, cured for two or three days at 50-55° C., and then removed and placed flat in slide boxes for several more days to allow the balsam to dry. By allowing the slides to "age" in this way, the structures are fixed in the proper attitude for study. Altogether, more than two-thousand slides were prepared by this method. The use of this procedure drastically reduces the amount of time necessary for preparing each slide to about 40 minutes rather than the mimimum of at least one day as employed by Hoff (1949).

The examination of material was done with the aid of a Bausch and

Lomb Flat Field Zoom microscope. The 4X, 10X, and 40X objectives were calibrated with a stage micrometer and an ocular disc on both the standard and maximum Zoom magnifications. Oil immersion was used only for detail. The original drawings were made with the aid of a Bausch and Lomb Speedmatic microprojector, except those of the internal male genitalia, and then all illustrations were reduced in size when photographed. The preliminary drawings of the male genitalia were done with the microprojector, but the distance required to enlarge the genitalia to ample size was too great and failed to include the finer details. Therefore, for completeness, the illustrations were finished by using a compound microscope without the projector.

The use of measurements is important for species determinations. All measurements given in the species descriptions are the ranges of the measurements obtained from the specimens studied. Chamberlin (1931a) has emphasized the necessity of accurate measurements and the importance of having fixed reference points for taking these data. I have utilized the reference points suggested by Chamberlin in taking the dimensions of the various structures. The data for each specimen were recorded on a mimeographed sheet which listed those structures to be measured. Chamberlin and Chamberlin (1945) omitted measurements of the coxae, the pedal trochanters, and the chelicerae in species description. Further, they simplified the method of reporting the dimensions of the pedal femora. Previously, the length and depth was given for both the pars basalis and pars tibialis of the femur, but the system employed by Chamberlin and Chamberlin (1945) depended upon the interfemoral articulation. If the articulation was symphytic, the total length of the femur was recorded together with the greatest depth. Where the interfemoral articulation was ginglymous the length and depth of each subsegment was measured.

The length-width ratios and actual measurements of the various palpal segments, so important in identifications, are obtained from measurements taken of properly oriented pedipalps and are listed in the descriptions as proportions for the various palpal segments. In the recording of these data, the differences in the ratios of a measured structure are given as a range, and the range of the dimensions of each structure are given in the subheading, "Measurements". The ratios and measurements of the podomeres of the first and fourth walking legs are treated in the same manner as the pedipalp. The use of measurements and ratios of pedal segments follows that of With (1906). The recording of numerical data is important as a part of the description of the variability of a species and for a comparison with similar information of past, present, and future descriptions.

In the present study, I did not usually measure the pedal coxae, but occasionally the dimensions of the pedal trochanters and of the chelicerae are reported. The recording of cheliceral dimensions is presented for the purpose of comparison with other species. Measurements of the carapace were not taken by me, since they are difficult to do accurately and widely overlap between members of taxa of all categories.

The characters used in the diagnoses of the higher taxa are established in the literature, particularly in the works of Chamberlin (1929a, 1930, 1931a), Beier (1932a, 1932b), and Hoff (1949). Where adequate, many of the diagnoses in this paper are paraphrased from an earlier treatment by these authors.

The types of the species reported on in this paper are deposited in several museums, but the curators of most of these collections are reluctant to loan them. In some instances, however, types were loaned to me directly or through Dr. Holt after a personal plea for assistance. The identification of many species did not require types, however, and the identifications were made from identified material on loan from various museums or individuals with the exception of one (Dactylochelifer copiosus). The material on loan had been identified by the author of the original description or by individuals who had done revisions or emendations of the species being studied.

The locality data for the material examined are based on collections made by me as well as other collectors who have donated their specimens for this study. In reporting of these data, each collection site is given as well as my collection number denoted by the prefix JEL within parentheses.

Because many species records are based on reports written more than 25 years ago, and in some instances as much as 50 years ago, the accuracy of many of the published locality records for the various species has been questioned by Hoff (1958). For the distribution of species in the United States Hoff (1958) has given a list of states where each species has been reported. I have gone further and have searched the literature, listing as precise a location as possible for each species.

During the course of this study a bibliography of over 700 titles was prepared. Many of these publications were of the eighteenth and nineteenth centuries, making their acquisition difficult. Constructing a complete synonymy from these works would be a monumental task. Therefore, the synonymy given for each taxon begins with the revision of the order by Chamberlin (1929b, 1930). For references to earlier taxonomic papers, Beier's (1932a, 1932b) monograph of the order should be consulted. A general bibliography for the order is found in the works of Chamberlin (1931a), Beier (1932a, 1932b, 1963), and Roewer (1936).

V. CHARACTERS OF SYSTEMATIC IMPORTANCE

The taxonomy of the pseudoscorpions is based on a number of external morphological features. The brief discussions of the external morphology which follow are presented as a basis for the following taxonomic treatments. For a more extensive treatment of the order Pseudoscorpionida, reference is made to the monographs of Chamberlin (1931a), Beier (1932), and Roewer (1940).

The body of a pseudoscorpion is divided into two tagmata, the prosoma or cephalothorax and opisthosoma or abdomen. The prosoma bears six pairs of segmented appendages. The first pair, the chelicerae, are two-segmented and chelate. The presence of silk glands in this pair of appendages makes the order unique among the arachnids. The second pair of appendages, the pedipalps, are six-segmented and terminally chelate. The remaining four pairs of appendages, the legs, have an ambulatory function. In descriptions of species, the legs, or their respective segments, are designated by Roman numerals from anterior to posterior, i.e., legs I, II, III, IV, and coxae I, II, III, IV. In addition to having appendages, the prosoma bears a carapace which covers the cephalothorax dorsally. The eyes, when present, are located anterio-laterally on the carapace and are sessile.

The abdomen consists of 12 segments, the last of which is reduced to a circumanal plate. Each segment is covered dorsally by a tergite and ventrally by a sternite. The abdomen bears ventrally the genitalic and respiratory openings. The genitalia are located in the region of the second and third abdominal segments and the second sternite forms the main part of the genital operculum. Respiratory spiracles occur laterally and near the posterior border of the third and fourth abdominal sternites. In species descriptions, abdominal segments are referred to by Arabic numerals.

Setae.

Tactile setae. These are extremely slender and elongate setae which are inserted in areoles. For the most part they are confined to the pedipalps and chelicerae. Their occurrence, however, on leg podomeres is not unusual. The tactile setae are important in taxonomy because much of the current classification is based on chaetotaxy.

Vestitural setae. The typical vestitural seta is an elongate hair which is inserted in an areole of the derm. This type of seta is shorter than a typical tactile seta and has a smaller areole.

The setal form varies considerably throughout the order. Because variation in setal shape is great, the exact shape will be given with the species descriptions.

Carapace.

Form. The form of the carapace varies from an almost quadrate plate, as is typical in the families Chthoniidae and Neobisiidae, to a sub-triangular shape in certain genera of the family Chernetidae. In those specimens with a quadrate carapace, the sides are more or less sub-parallel but slightly converge posteriorly, as in the Chthoniidae, or slightly diverge posteriorly, as is typical of the Cheliferoidea.

Epistomal process. The anterior margin of the carapace may be truncate, produced, or emarginate, and this margin may be smooth, dentate, or serrate. In the Chthoniidae the margin is more or less serrate, but medially, the margin is produced into a dentate process called the epistomal process. The Neobisiidae have a single toothlike epistomal process and the remainder of the margin is smooth. In the suborder Monosphyronida the anterior margin is truncate and without an epistomal process. The family Tridenchthoniidae has an emarginate anterior carapacal margin (Fig. 4).

Eyes. Pseudoscorpions may have none, one or two pairs of eyes. The eyes are located on the anteriolateral margins of the carapace. When four eyes are present, the posterior pair is never more than two ocular diameters removed posteriorly from the anterior pair.

Chaetotaxy. The formula used for expressing the number of setae is one in which the total number of setae on the anterior margin of the carapace is recorded, followed by the number of border setae on the posterior margin. Then a total number for the entire carapace is given with this last figure recorded within parentheses. Thus, the formula might appear in a species description as 6-4 (22). This formula allows for the inclusion of those setae scattered over the surface. In the description of *Chthonius tetrachelatus* an exception is made to this formula because, here, the setae are linearly arranged in five rows. In this instance the number of setae per row is recorded and then the total number of setae is given.

Chelicerae.

Form. The general form is constant throughout the order, but varies in size throughout the group. In the chthonioids and neobisioids the chelicerae are large and, distally, the fingers cross. The fingers possess marginal teeth and a sub-apical lobe is absent. The galea is small or absent. The chelicerae in the Monosphyronida are small, but the fingers never cross when closed. The sub-apical lobe is present and the galea is conspicuous and well developed.

Flagellum. The flagellum is located on the inner face of the palm near the base of the movable finger and consists of a few to several blades. As found in the Chthonioidea, it is composed of six to eight unilaterally pinnate blades, all of equal size. In the Neobisiidae the blades are simple or unilaterally serrate with the posterior blades reduced in size. With a few possible exceptions (Chamberlin, 1931a), the flagella of the Monosphyronida are represented by three or four blades.

Spinneret. The spinneret or "galea" is located on the outer apical curve near the tip of the movable finger. Basically, it is of two types, The first type is a sclerotic tubercle and is characteristic of the Chthonioidea. The second type is the form in which the spinneret (the "typical galea") consists of translucent branches. This second type is characteristic of the suborder Monosphyronida. In the suborder Diplosphyronida, the "typical galea" is present only in the subfamily Ideobisiinae of the family Neobisiidae.

Chaetotaxy. Figure 5 shows the location of setae on the cheliceral hand and movable finger. Occasionally, an additional seta, the laminal seta, may be found paired with the interior seta. Further, the Chthonioidea and most of the Neobisioidea have other setae on the palm which are called accessory setae. The use of these accessory setae in systematics has been to note their presence by indicating the number of setae present.

Marginal teeth. In those forms where both fingers have marginal teeth, the teeth of the movable finger are protrorse and those of the fixed finger, generally, retrorse.

The denticles of the fingers are relatively numerous in the Chthonioidea and Neobisioidea. In the Monosphyronida and Garypoidea the fixed finger has relatively few denticles and the movable finger has only a subapical lobe and a terminal tooth.

Coxal Area.

Coxal spines. These structures are found only on some members of the Heterosphyronida, with one possible exception, a species of the genus *Pseudogarypus* of the suborder Monosphyronida. In *Pseudogarypus hesperus* Chamberlin the derm of coxae I has developed into finger-like projections that have tentatively been called spines (Chamberlin, 1931a).

These spines are located on the medial portions of the first to third coxae. They never occur on more than two pairs of coxae and, in many instances, are found only on a single pair. Figures 6, 12, 19 illustrate these spines on different species of the Heterosphyronida.

Intercoxal tubercle. A small tubercle is located medially at the intersection of coxae III and coxae IV. It is small and possesses one or two setae. Like the coxal spines, this structure is found only in the Heterosphyronida.

Coxal chaetotaxy. The setae of the pedal and palpal coxae on one side of the body are recorded in a formula. The coxal formula is constructed by recording the number of apical setae, followed by the number of setae that border the trochanteral foramen, and concluded by the number occurring on the body of the coxa. This method is used for each coxa and the chaetotaxy of the palpal coxa is the first series of numbers. Coxal spines are denoted by attaching the letters CS to the coxa or coxae which have them. I have added to the conventional formula the microsetae of coxa I and have indicated their presence by the use of the letter ms without indicating the number. As an example, the following formula includes all aspects just discussed: 2-2-1:2-1-0-ms: 2-4-CS:2-5:2-5.

Pedipalp.

Segmentation. The podomeres of the palp are coxa, trochanter, femur, tibia, metatarsus, and telotarsus. The last two segments form the chela, making a total of six segments for the entire pedipalp. The trochanter is always the shortest segment, the femur is generally longer than the tibia, and the chela is strongly developed.

Chamberlin (1931a) used the term maxilla instead of palpal coxa because he believed it necessary to distinguish between the palpal and pedal coxae and that the failure to do so implies the presence of nonexistent homologies. Chamberlin further pointed out that the use of the term in connection with pseudoscorpions does not mean that the structure so designated is homologous with the maxillae of the mandibulata. In my opinion, the term maxilla should be discontinued and the basal segment of the pedipalp referred to as the palpal coxa. This practice would eliminate any implication of an homology with the maxilla of the mandibulate arthropods and, thus, would identify the coxa as being a segment of the pedipalp. Because the shape, dimensions, and chaetotaxy of palpal segments are used in systematic studies, all terms should be clear and well defined. By identifying the basal segment of the basal segment of the pedipalp in the manner suggested, the palpal coxa is delimited from the pedal coxae of the walking legs.

On many palpal coxae, the antero-medial apical region forms a lobe which is bordered by setae. The number of setae investing this lobe is used to separate some genera of the family Neobisiidae. Chamberlin (1930, 1931a) described this area as the apical curve of the maxilla. Since then, the term maxillaris apicalis has evolved to denote the apical region of the palpal coxae. As was suggested for the maxilla, this term should be discontinued for the same reasons and the term, apical lobe of the palpal coxa, adopted.

Venom apparatus. This structure is located in the chela and, according to Chamberlin (1931a), is of simple structure. It is a mass of glandular tissue which surrounds sac-like reservoirs which narrow into tubular ducts and unite distally on the finger into a large duct that carries the venom to the terminal tooth or venedens. The junction of the many small ducts from the reservoirs to from the large duct is referred to as the nodus ramosus.

The use of the nodus ramosus in systematic work is important. Its location is usually given by reference to the number of the marginal tooth of the chela opposite it or by reference to the nearest tactile seta.

In the order, Pseudoscorpionida, the venom apparatus may be found in both fingers, in the fixed finger only, in the movable finger only, or may be absent altogether. Chamberlin (1931a) has given a summary of the distribution of the venom apparatus in the different families. Of those families included in this paper, the venom apparatus is absent in the Chthoniidae and Tridenchthoniidae. The Neobisiidae has the apparatus developed only in the fixed finger, while in the Chernetidae it occurs in the movable finger. Finally, it is present in both the fixed and movable fingers in the family Cheliferidae.

Chaetotaxy of chela. The typical chela bears 12 tactile setae, in three series of four setae. One series is on the exterior face of each finger and one is on the inner face of the fixed finger. The setae designation of each series begins at the apical end of the finger and proceeds basally. The setae are referred to as terminal, subterminal, subbasal, and basal setae. The preceeding terms are used for the setae on the movable finger, and according to their location on the fixed finger, the terms interior or exterior are used to designate the series group, i.e., interior basal, exterior basal. Figures 28 and 68 show the location of the tactile setae of the chela, and in the explanation of these figures, the abbreviations used for identifying and labelling these setae are listed.

Although the usual number of tactile setae is 12, some forms have more or less than this number. The adults of the genus Microbisium have only ten setae, the subbasal and interior subbasal setae being absent (Chamberlin, 1931a). The genus Menthus, family Menthidae, is cited by Chamberlin (1931a) as an example of a form having more than 12 tactile setae on the chela. In this case there are fifteen variously disposed setae, and the interpolated setae are lettered a, b, c by Chamberlin.

Other than the genus Microbisium and the superfamily Chthonioidea, all pseudoscorpions examined for this paper had the normal number of setae. Microbisium is discussed above and in the Chthonioidea, a pair of setae occurs near the exterior tip of the fixed finger. These setae are not considered to be interpolated but are assumed to be accessary setae. It appears that they have their origin from two contiguous areolès and, because of their difference from the typical tactile setae, they have been called double setae. Figure 28, with the abbreviation DS, illustrates their position on the finger.

Dentition of the chela. The marginal teeth vary widely in shape. In most forms the tooth is an acute cone, but sometimes it may be rounded or truncate. It is also common to find the marginal teeth of one finger strongly developed and those of the opposing finger weakly developed into a low, rounded series. Specific shapes of teeth are given under the species descriptions.

It is not possible to draw generalizations from the character of the dentition since different forms within the order are very diverse in this respect. The dentition may be spaced, contiguous, well developed, or poorly developed.

The family Chernetidae is unique in possessing true accessory teeth (Fig. 88). These accessory teeth, which may be large or small, are conical and are parallel to the marginal teeth. Further, these accessory teeth are arranged linearly and are well spaced.

Legs.

Segmentation. Typically, the legs are composed of seven segments. These are the coxa, trochanter, femur I, femur II, tibia, metatarsus, and telotarsus. The pretarsus, regarded by some as an eighth segment, is present. There is no patella. The number of pedal podomeres is frequently reduced by fusions of the metatarsus and telotarsus resulting in a single tarsus. When such fusions occur, only six segments are recognizable. In regard to femur I and femur II, the practice of earlier workers has been to refer to these segments as pars basalis and pars tibialis, respectively. But, I follow Chamberlin (1952) and most workers in using the terms basifemur and telofemur for the two segments of the femur.

The number of pedal podomeres is the basis for separating the order into three suborders. In the suborder Heterosphyronida, the first and second legs have a single tarsal segment, while the third and fourth legs have two tarsal segments. Therefore, the first two pairs of legs are composed of six segments and the last two pairs of legs have seven segments. The suborder Diplosphyronida is characterized by each leg having a metatarsus and telotarsus and, therefore, seven segments. In the suborder Monosphyronida, each leg has only six podomeres because of the fusion of the metatarsus and telotarsus of each.

Chaetotaxy. On the tarsus of leg IV are tactile setae which are longer than other setae and are arranged at right angles to the longitudinal axis of the segment. In the Monosphyronida, the presence and relative position of these setae are used for some generic determinations.

Abdomen.

Tergites and sternites. In most forms, the tergites and sternites extend across a single segment of the abdomen. In other forms these dorsal and ventral sclerites are secondarily divided into two halves by the development of a membranous suture-like stripe.

The systematic usefulness of these sclerites is concerned primarily with the chaetotaxy and dermal sculpturing. The derm is described as being smooth, papillate, reticulate, granulate, or scale-like. Most Chthonioidea and most Neobisioidea have a non-sculptured derm. The greatest degree of dermal marking occurs in the Monosphyronida. In this suborder the tubercles on the sclerites, as well as other types of dermal sculpturing, are pronounced.

The chaetotaxal formula, as given in the species descriptions, denotes the total number of setae on each sclerite. The chaetotaxy for tergites and sternites are listed separately. In constructing the formula for tergites, the number of setae on the first tergite is recorded and is then followed by the number of setae on each of the succeeding tergites. Beginning with the fifth sternite, the chaetotaxy for sternites is similar to the method employed for tergites. The first four sternites are treated differently, however, since the setae surrounding the genitalia and the respiratory spiracles are modified, but they are included in the complete formula. The chaetotaxy of these four sclerites will be treated under the discussion of the genitalia.

Usually, the tergites and sternites have one row of setae on the posterior margin of each sclerite. But, occasionally, there are more than a single row. When more than one row is found, the number is recorded in fractional form rather than as a whole number. For example, if a single tergite has 17 setae, with seven forming an anterior row and ten in a posterior marginal series, the notation would be 7/10 for that tergite.

With one exception, the chaetotaxy of the tergites and sternites used in this paper has not differentiated between what is referred to by Chamberlin (1931a) as normal setae, semitactile setae, tactile setae, and microsetae. Numbers have been used for normal setae, while the letters S, T, and m have been used for semitactile, tactile, and microsetae, respectively. The basis for distinguishing among these setae has been their relative size. This practice was found not to be of systematic value. Hence, all abdominal setae in the following descriptions are recorded in numerical form. The one exception to this has been the designation of the setae of the anal plate as microsetae by using the abbreviation m. These microsetae are used only to indicate the last abdominal segment.

Genitalia. Although Chamberlin (1931a) has listed several workers who have contributed to a knowledge of the morphology of the male and female reproductive systems, a general treatment of the genitalia of both sexes has been neglected. The morphology of the genitalia cannot be worked out from ordinary systematic preparations. Serial sections of carefully prepared specimens will be necessary in order to understand the structure of the reproductive systems.

The illustrations of the male genitalia included in this paper do not solve the morphological problems they present, but if used in a comparative sense, can show that their internal sclerotic elements have a fundamental plan. Any attempt to conclusively identify those sclerotized structures is beyond the scope of this paper and, if attempted, could lead to a gross misunderstanding of the whole reproductive complex. This author follows Chamberlin (1929b, 1930, 1931a, 1939, 1949, 1952, 1962), Chamberlin and Chamberlin (1945), and Malcolm and Chamberlin (1961) in presenting illustrations of the male genitalia as a supplement to descriptions and for reasons of comparison rather than for the identification of morphological elements.

The suborders of the Pseudoscorpionida are quite diverse in their genitalic anatomy and the morphology can be understood only after careful dissections and serial sections have been made. The use of the genitalia as taxonomic characters can be employed only after these structures have been studied species by species for the pseudoscorpion genera.

This last point is accentuated later in this paper under the descriptions and discussion of two species of the genus Kleptochthonius. I was able to demonstrate an obvious difference in the male genitalia of these two species and have used this dissimilarity as one of the diagnostic characters for the separation of species. Similar attempts with other genera, however, did not produce any evidence to support the use of the male genitalia for species characters. For this reason a careful examination of all the species within a genus is required. Until such work has been done, the illustrations given by me and by other workers will be useful only in the determination of species. The following description of the male and female reproductive structures is taken from Chamberlin (1931a) and is primarily concerned with the features of the external genitalia.

Male. The genital opening of the male is on the second abdominal segment. The sternites of the second and third abdominal segments form the respective anterior and posterior genital opercula. These opercula are sclerotic plates that surround the genital slit. The anterior operculum may be transverse, as in the Neobisioidea, or triangular, as in the Chthonioidea. Members of the suborder Monosphyronida have the greatest opercular modifications, particularly those of the subfamily Cheliferinae where the operculum is modified in conjunction with extrusible genital sacs, the so-called "ramshorn organs". The posterior operculum, like the anterior operculum, is generally a transverse plate, but also shows some modifications. It is deeply incised, medially, in members of the Chthonioidea, while in the Cheliferoidea it is strongly sclerotic.

The chaetotaxy of the genital area is recorded with the chaetotaxy of the sternites. If fact, the chaetotaxy of the genital area forms the first part of the formula. Since the genital setae are variable in number and placement, the following formulae and explanations from the different suborders are given for a general understanding of the involved chaetotaxy:

1. Heterosphyronida: $\frac{4:}{9}$ (4-4):(3) $\frac{8\text{-}9}{8}$ (3):(3)8(3).

This is interpretated to mean that on the anterior genital operculum there are four setae on the face and nine along the margin. It is acceptable, however, to record this by a total number, 13 in this instance, when it is difficult to distinguish between the setae of the face and margin. The next figures represent internal guard setae. It was found in the preparations examined in this study that these are not setae but thin-walled ducts. For the purpose of an aid to identification, I have retained them in the chaetotaxal formula. Further work is necessary to understand their function. The third group of figures indicates the presence of eight setae and nine setae on the lips of the posterior operculum and eight setae along the margin of the third sternite. Further, the figure, "3", enclosed in parentheses is the number of guard setae surrounding the spiracle of respiration. The setae surrounding the spiracle may be recorded with the marginal setae, or its notation may be on both sides of the fractional form. There are eight setae along the posterior margin of the fourth sternite and three guard setae associated with each spiracle.

2. Diplosphyronida: $9:(4\text{-}4):\dfrac{7}{(3)9(3)}:(3)9(3)$.

This formula is very similar to the one just given. The first sternite has nine setae, which are not arranged in divisible groups, surrounding the anterior operculum. The second sternite has four internal guard setae on each side of the genital slit. In this order and in the following order these are true setae. The third group of figures indicates that there are seven setae near the transverse plate of the posterior operculum and a marginal row of nine setae which are bordered on both sides by guard setae of the spiracles. The fourth sternite has nine setae in the marginal series and there are three setae near the spiracle.

3. Monosphyronida: 36:(0-0):(3)24(3):(2)11(2).

The chaetotaxy used here shows that the first sternite has 36 setae; the second sternite is devoid of any internal setae; the third sternite has 24 setae on the marginal row and three guard setae near the spiracle; the fourth sternite is similar to the third, differing only in the number of setae.

Female. The modifications of the genital area are slight and the opercular sternites are very similar to other abdominal sternites. The genital area has cribriform plates which are variously modified throughout the order. In the Chthoniidae the plates are not easily discernible but a cribriform area is present. The Neobisiidae have a large cribriform area occurring medially. The Monosphyronida have well developed lateral and medial plates. The use of these cribriform plates in systematics has not been utilized because of their membranous nature and the consequent difficulty of studying them in the usually used preparations. As in the male, very little research has been directed towards an understanding of the reproductive system.

The method of recording the chaetotaxy of the genitalia is like that of the male, but is less involved. The only differences are that no internal setae need to be accounted for on the second sternite, and the first or second sternite may be devoid of marginal setae.

VI. SYSTEMATIC TREATMENT

ORDER PSEUDOSCORPIONIDA BANKS, 1895

Pseudoscorpionidea, Beier, 1929, p. 445; Chelonethida, Chamberlin, 1929, p. 56; Pseudoscorpions, Hadzi, 1930, p. 65; Chelonethida, Chamberlin, 1931, p. 206; Chelonethida or Pseudoskorpione, Roewer, 1940, p. 1; Pseudoscorpionida or Chelonethida, Hoff, 1949, p. 427.

Diagnosis: A sharply defined group of arachnids in which the opisthosoma lacks a telson, whip, or an accessory appendage of any type; carapace quadrate or triangular in shape, if bearing eyes, they are laterally placed and may be two to four in number; opisthosoma typically of twelve segments, each with distinct tergite and sternite, the last tergite and sternite reduced to circumanal ring; chelicerae two segmented and chelate; movable finger of chelicerae with galea which exudes silk; pedipalpi six-segmented and chelate; chela typically provided with twelve sensory setae, principally located on the fingers; venom glands, when present, open near venedens; legs of five to seven segments depending on suborder; pretarsus provided with two claws and suctorial arolium; two pairs of spiracles located latero-ventrally on third and fourth abdominal segments (Chamberlin, 1931a).

Discussion: In his monograph of 1931 and in earlier papers, Chamberlin used the name Chelonethida Thorell for the order because it had greater brevity, significance, and distinctiveness than the clumsy term, Pseudoscorpionida. The name is distinct and significant because it means the chelicerae bear silk glands. I prefer the name Pseudoscorpionida, however, because it associates the common name with its proper zoological nomenclature. Also the name Pseudoscorpionida is preferred in current Invertebrate Zoology texts. Finally, the name is the same as used by Beier (1932a), except for the idea ending, in his monograph.

As indicated earlier, Chamberlin (1929b) divided the order into two groups and three suborders. In subsequent work (Chamberlin, 1930, 1931a) he maintained this arrangement and offered keys for the identification of the groups, suborders, superfamilies, families, and genera. In addition to Chamberlin, Hoff (1949, 1958) has constructed keys to the higher categories which are acceptable for this study, but I have constructed the keys to the species studied for this paper.

The outlines which follow are intended as a comparison of the two major schemes now employed for the classification of the pseudoscorpions. Both schemes are similar in dividing the order into three suborders. On the family level, Chamberlin (1931a) has listed 18 families while Beier (1932a, 1932b) divides the order into 16 separate families. This variation occurs because Beier prefers a subfamily status for some members to which Chamberlin gives family rank. Other differences are noted throughout this paper and explanations offered to make them agree in context.

Classification of the Pseudoscorpionida as Proposed by Chamberlin (1931a)

Order Chelonethida

Group Heterosphyronida

Suborder Heterosphyronida

Superfamily Chthonioidea

Family Tridenchthoniidae (Dithidae)

Family Chthoniidae

Group Homosphyronida

Suborder Diplosphyronida

Superfamily Neobisioidea

Family Neobisiidae

Family Syarinidae

Family Hyidae

Family Ideoroncidae

Superfamily Garypoidea

Family Menthidae

Family Olpiidae

Family Garypidae

Suborder Monosphyronida

Superfamily Feaelloidea

Family Pseudogarypidae

Family Feaellidae

Superfamily Cheiridioidea

Family Pseudocheiridiidae

Family Cheiridiidae

Family Sternophoridae

Superfamily Cheliferoidea

Family Myromochernetidae

Family Chernetidae

Family Atemnidae

Family Cheliferidae

Classification of the Pseudoscorpionida as Proposed by Beier (1932a, 1932b)

Order Pseudoscorpionidea

Suborder Chthoniinea

Family Chthoniidae

Family Dithidae

Suborder Neobisiinea

Superfamily Neobisiides

Family Neobisiidae

Subfamily Neobisiinae

Subfamily Ideobisiinae

Family Syarinidae

Subfamily Syarininae

Subfamily Chitrellinae

Family Ideoroncidae

Subfamily Hyinae

Subfamily Bochicinae

Subfamily Ideoroncinae

Superfamily Garypides

Family Menthidae

Family Olpiidae

Subfamily Olpiinae

Subfamily Garypininae

Family Garypidae

Subfamily Garypinae

Subfamily Geogarypinae

Superfamily Feaellides

Family Synsphyronidae

Family Pseudogarypidae

Family Feaellidae

Suborder Cheliferinea

Superfamily Cheiridiides

Family Cheiridiidae

Subfamily Pseudocheiridiinae

Subfamily Cheiridiinae

Family Sternophoridae

Superfamily Cheliferides

Family Atemnidae

Subfamily Atemninae

Subfamily Miratemninae

Family Chernetidae

Subfamily Lamprochernetinae

Subfamily Chernetinae

Subfamily Goniochernetinae

Family Myrmochernetidae

Family Cheliferidae

Subfamily Withiinae

Subfamily Cheliferinae

A selection between the two schemes just presented is left to the discretion of the investigator. In the United States, Chamberlin's scheme is preferred, while Beier's is preferred in Europe. I have selected the scheme proposed by Chamberlin (1931a) because it precedes Beier's (1932a, 1932b) monograph. The names used in both schemes are essentially parallel and the diagnostic characters of the higher categories, when different, differ slightly but not significantly. A minor reason for selecting Chamberlin's system is for the previously mentioned reason that other workers in the United States, past and present, have employed this system in their investigations. Therefore, the reporting of my results is in keeping with the form used by others in this country.

Key to the suborders of the Order Pseudoscorpionida:

1. (a) Tarsus of first leg of one segment; tarsus of third and fourth leg of two segments; the anterior two pairs of legs with six segments, the posterior two pairs with seven segments............Suborder Heterosphyronida

   (b) All legs with same number of segments and all tarsi similar...2

2. (a) Each leg with seven segments; tarsi of two segments.... ....Suborder Diplosphyronida

   (b) Each leg with six segments; tarsi undivided........... ....Suborder Monosphyronida

Suborder Heterosphyronida Chamberlin, 1929

Heterosphyronida, Chamberlin, 1929, p. 57; Heterosphyronida, Chamberlin, 1931, p. 208; Chthoniinea, Beier, 1932, p. 22; Chthoniinea, Roewer, 1937, p. 232; Heterosphyronida, Hoff, 1949, p. 429; Chthoniinea, Beier, 1963, p. 17.

Diagnosis: Tarsi of first and second legs of single segment, of third and fourth legs of two; chelal fingers without venom apparatus (Hoff, 1949).

Discussion: The members of this suborder have an undivided tarsus on the first two pairs of pedal appendages and a tarsus divided into a metatarsus and telotarsus on the third and fourth pairs of pedal appendages. Since these animals exhibit a heterotarsate condition, Chamberlin (1931a) has interpreted the single tarsal segment as being a fused condition of the metatarsus and telotarsus and collectively calls this segment the miotarsus. The use of this term has not been adopted in the literature and for clarity should not be employed, as its retention may imply an evolutionary trend contrary to the unknown actual one.

A typical structure occurring on these animals is the coxal spines on the medial portion of the first, second, and third coxae. As far as is known, these spines never occur on more than two pairs of coxae and are frequently found on a single pair. As indicated earlier they are of different shapes.

The number of eyes is generally four, but some forms may have only two while others are eyeless. Their location is marginal in that the first pair is placed close to the anterior carapacal margin while the posterior pair is never removed more than twice the diameter of an eye from the margin. This marginal position of the eyes was quite evident in all specimens examined.

The intercoxal tubercle, when present, is located at the junction of the third and fourth pedal coxae. In its most characteristic form the tubercle is raised and contains two setae, but some members, particularly the genus Compsadith of the family Tridenchthoniidae, have a monosetose intercoxal tubercle. The presence or absence of this character is of systematic importance in separating the genera of the suborder.

The genitalia of the male are strongly sclerotized. Because of this and the striking modifications apparent in the opisthosomal sternites, the male genitalia are pronounced and recognizable. The posterior operculum is deeply notched medially. The female genitalia are inconspicuous and, except for the presence of sclerotized cribriform plates, difficult to distinguish from the late stages of a tritonymph. The opisthosomal sternites are only slightly modified. One exception to this general condition of the female reproductive structure is the presence of a highly sclerotized genital area found in some genera of the family Tridenchthoniidae which is quite pronounced and exposes the internal features in properly mounted specimens.

The suborder Heterosphyronida is, in part, the same as the suborder Emictenodactyli (Chamberlin, 1931a, believes this is a misprint for

Hemictenodactyli and treats it as such) as erected by Balzan in 1891 and later accepted by Hansen and With with a few addenda. Some of the characters used by these authors for the separation of the suborders are still maintained in current schemes. In the suborder Hemictenodactyli, Balzan encompassed not only the now recognized families Chthoniidae and Tridenchthoniidae, but also included the families Neobisiidae and Ideoroncidae. Chamberlin (1929b), in his revision of the order, recognized differences between the walking legs within the order and was able to exclude the last two families mentioned above from the suborder and to place them in the newly erected suborder, Diplosphyronida, along with other well defined families.

The two families included in the Heterosphyronida are represented in the collections examined.

Key to families:

1. (a) Spiracles of third and fourth abdominal sternites obliquely oriented and with guard sclerites; spines on coxa I and II.........Family Tridenchthoniidae

   (b) Spiracles of third and fourth abdominal sternites transverseely placed and without smaller guard sclerites; spines on coxa I, on coxa II, or on coxae II and III..............Family Chthoniidae

Family Tridenchthoniidae Balzan, 1891

Dithinae + Tridenchthoniinae, Chamberlin, 1929, p. 58; Dithidae + Tridenchthoniinae, Chamberlin, 1931, p. 209; Dithinae, Beier, 1932,

p. 24; Dithidae, Beier, 1932, p. 181; Dithidae, Roewer, 1937, p. 233; Dithinae, Mello-Leitao, 1939, p. 115; Tridenchthoniidae, Chamberlin and Chamberlin, 1945, p. 6.

Diagnosis: Well-differentiated guard sclerites and obliquely oriented spiracles; chela with setae IB and ISB placed subbasally to submedially on dorsum of the hand; coxal spines on coxae I and II of three to six blades which may or may not be incised; abdominal segments with double row of short setae; body and palps very setose and granular. (Chamberlin and Chamberlin, 1945)

Discussion: *Verrucaditha spinosa* is the only species of this family found in the United States. In an excellent account of all included genera and species, Chamberlin and Chamberlin (1945) have given this family a thorough taxonomic investigation. Generally, the above diagnosis is adequate for the determination of any included member, but for a better understanding of the family the following information is intended to extend the diagnosis and include other characteristics of importance.

Chamberlin (1931a) believes the original respiratory spiracle was a simple transverse slit located postero-laterally to the corresponding sternite, and it was the border of this sternite which served to support the stigmatic opening. This is the type of spiracle found in the Chthoniidae. The Tridenchthoniidae, however, have a different type of spiracle, apparently derived from the original type, making this family unique among the heterosphyronid pseudoscorpions. In this group the spiracles are oriented obliquely rather than transversely and each spiracle is partially surrounded anteriorly and laterally by a small sclerite, termed the stigmatic plate or guard sclerite. According to Chamberlin (1931a), this guard sclerite was formed when a small portion of the sternite separated from the main body and thus came to form an independent plate, and like its counterpart in the Chthoniidae, the border of the sternite functions in a supporting role. The position, form, and chaetotaxy of this structure are considered in systematic work within the family.

Frequently, it may not be possible to use the above character because the spiracle may be obscured in mounting or perhaps the amount of pigment removed in the preparation was too slight. In either case, an alternative character is available for specimens collected in the United States. All specimens, of presently known species, have the anterior border of the carapace strongly emarginate. It should be made clear that this condition is not a family character, but is confined to a few species, one of which is *Verrucaditha spinosa*.

The carapace of tridenchthoniids is modified dorsally to receive the chelicerae when not extended, and the consequence is a dorsally arched condition which forms a longitudinal furrow extending from the anterior carapacal margin to a point slightly caudad to the eyes. The texture of the carapace is rugose and heavily invested with setae which have their origin in small raised tubercles. The number of setae and their displacement are of some taxonomic importance. Generally, the shape of these setae is lanceolate or acuminate, but the setae are always conspicuous.

The abdomen is about the same size as the prosoma and broadly joined to the latter. Abdominal setae form two, more or less, regular rows. Chaetotaxy of the abdomen is discussed under the species descriptions. The intrafemoral articulation of the legs is characteristic for the suborder in that legs I and II possess a freely mobile intrafemoral joint and legs III and IV have a semimobile oblique symphysis. The first pedal coxae are characterized by a small, forward projecting, spine-like process on their anterior mesal margin.

The family Tridenchthoniidae was first proposed by Balzan in 1891 (*fide*, Chamberlin and Chamberlin, 1945) and its only included species was defined as a chthoniid possessing a triple galea. Since then, it has been shown by Beier that the galeate condition is a nymphal character and is not present on adults. For a number of years the status of this family was unsettled until Chamberlin (1929b) defined the group, assigning the included species to the subfamily Dithinae. Two years later (Chamberlin, 1931a) raised them to family status. Beier (1932a) reduced the group to subfamily status (Dithinae) without giving any reasons to justify the change, but shortly thereafter recognized it as a valid family. Chamberlin and Chamberlin (1945) have emended the family description and given the group a thorough systematic treatment.

Type genus: *Tridenchthonius* Balzan, 1887

Genus *Verrucaditha* Chamberlin, 1929

Verrucaditha, Chamberlin, 1929, p. 59; *Verrucaditha*, Beier, 1932, p. 31;

Verrucaditha, Roewer, 1937, p. 235; *Verrucaditha*, Chamberlin and Chamberlin, 1945, p. 22.

Type Species: *Verrucaditha spinosa* (Banks, 1893)

Diagnosis: Small pseudoscorpions with anterior border of carapace distinctly emarginate; body heavily invested with stout setae which arise from conspicuous granules; carapace with about 80-100 lanceolate setae; tergites with two rows of setae with six to 12 in discal series and 14 to 18 in marginal series; palps granular; fixed finger of chela with widely spaced, acute marginal teeth, which become smaller and contiguous basally; movable finger with large, rounded and contiguous teeth directed basally; coxal spines on coxae I and II small with minute terminal incisions; usual number of coxal spines four; intercoxal tubercle absent (Chamberlin and Chamberlin, 1945).

Discussion: The two previously described species, *V. spinosa* (Banks, 1893) and *V. megaloptera* (Chamberlin, 1929), have been shown to be synonymous (Chamberlin and Chamberlin, 1945), thus making *Verrucaditha* a monotypic genus.

Verrucaditha spinosa (Banks, 1893)

PLATE I, FIG. 1, 2, 3; PLATE II, FIG. 4, 5, 6

Verrucaditha spinosa, Chamberlin, 1929, p. 59; *Verrucaditha spinosa*, *V. megaloptera*, Chamberlin, 1931, p. 177; *Verrucaditha spinosa*, *V. megaloptera*, Beier, 1932, p. 31; *Verrucaditha spinosa*, *V. megaloptera*, Roewer, 1937, p. 235; *Verrucaditha spinosa*, Chamberlin and Chamberlin, 1945, p. 24; *Verrucaditha spinosa*, Hoff, 1951, p. 534; *Verrucaditha* spinosa, Hoff and Bolsterli, 1956, p. 160.

Type Specimen: The types were collected from Citrus County, Florida, and have been deposited in the collections of the Museum of Comparative Zoology at Cambridge, Massachusetts.

Material Examined: A single specimen collected from Chickasaw State Park, Chester Co., Tennessee, June 1964, T. P. Copeland (JEL 418).

Diagnosis: Same as for genus.

Description: Male. This specimen agrees with the characters given under the diagnosis of the genus. It is a small pseudoscorpion with a body length of about 1.11 mm. The posterior appendages quite obviously extend beyond the tip of the abdomen.

The carapace is quadrate in shape and markedly granular. The granulations are obvious on the posterior pair of eyes. The anterior border of the carapace is distinctly emarginate giving the appearance of being bilobed (Fig. 4). The setae, which heavily invest this structure, number about 80, and have their origin in the raised tubercles. The derm of the carapace is markedly hispid as well as granular.

The abdomen is broadly joined to the prosoma. The tergal and sternal chaetotaxy is difficult to ascertain but it appears to be different from the formula given by Chamberlin and Chamberlin (1945). Obviously, there is a variation in the number of setae present on the tergites and sternites. The genital area is as shown in Fig. 3. The coxal area is as described by Chamberlin and Chamberlin (1945), and there are spines on coxae I and II (Fig. 6). The terminal ends of these coxal spines are incised.

The chelicera is typical of the suborder (Fig. 5). Length about 1.7 times as long as broad. The palm has one more accessory seta than the usual number. The derm appears smooth but hispid tubercles are present on the palm. The flagellum is of six blades, all of which are unilaterally branched. The movable finger bears five small teeth and one larger tooth located distally to the smaller teeth. The fixed finger has seven denticles one of which is larger than the others. A galeal knob is absent.

The palps are as shown in Fig. 1. Palpal proportions: trochanter 1.56, femur 4.36, tibia 2.03 times as long as broad, chela, indeterminable.

The chaetotaxy and dentition of chela is as illustrated in Fig. 2. The fixed finger has a marginal row of 32 teeth. Distally these denticles are well-spaced and acute, but basally they become contiguous and rounded. The movable finger has 27 denticles which are all contiguous and more or less directed basally.

Female. None collected.

Measurements (in millimeters): Total length 1.11. Palps: trochanter 0.161 by 0.087; femur 0.475 by 0.113; tibia 0.220 by 0.101; chela 0.680 by indeterminable; hand, indeterminable; finger 0.403 long.

Distribution: Banks (1893) noted this species as being common in Florida, but it appears to be rare in the southern Appalachians as I have seen only one specimen. The collection of *V. spinosa* from

Chickasaw State Park, Chester Co., Tennessee is a new record. The previously known distribution is from the following localities:

FLORIDA: Citrus Co.; Lake Poinsette; Dunedin; Ancilla; Gainesville.

ILLINOIS: Edgar Co.

INDIANA: Bloomington; Winona Lake; Evansville.

LOUISIANA: Norco; Chalmette.

MISSISSIPPI: Lucedale.

MISSOURI: Sam A. Baker State Park.

NORTH CAROLINA: Durham.

OHIO: Cambridge.

Disposition of Material: The single specimen will remain in the author's collection.

Discussion: Chamberlin and Chamberlin (1945) have shown that nearly all the characters upon which *V. megaloptera* was based are bridged by intermediates with *V. spinosa* and as a result have deemed it necessary to combine *V. megaloptera* and *V. spinosa* into one species. In this publication they further noted that the appendicular measurements and proportions of the legs are uniform throughout the family and their usefulness is limited in the identification of species. Therefore, this information was not included in the description presented above.

Family Chthoniidae Hansen, 1894

Chthoniidae, Chamberlin, 1929b, p. 57; Chthoniidae, Chamberlin; 1931a, p. 211; Chthoniidae, Beier, 1932a, p. 23; Chthoniidae, Hoff, 1949, p. 431.

Diagnosis: Abdominal tergites with single row of acuminate setae across each segment; respiratory spiracles transversely oriented and without guard sclerite; body and palps weakly granular; carapace only sparsely beset by setae (Chamberlin, 1931a).

Discussion: This is a well-recognized family which is represented by several genera with essentially a cosmopolitan distribution. The diagnosis above serves to delimit this family, and additional features, which are characteristic of the group and aid in separating it from the other family of the suborder, are now offered.

The setae in most cases are acuminate, moderately long, and few in number. The tergites and sternites of the abdomen bear a single posterior marginal row of setae. The number may vary with the genus, but the more common number is four. The carapace is sparsely furnished with about 18-24 acuminate setae which are similar to the abdominal setae.

The carapace is characteristic in that the sides are sub-parallel and typically diverge posteriorly. This structure bears two pairs of eyes which are located on the latero-anterior portion. The anterior pair of eyes are slightly larger than the posterior pair. The derm is smooth with the exception of a slightly hispid nature on the lateral surface. This condition is also observed on the lateral margins of the carapace and appears to be a continuation of the serrate condition of the anterior carapacal margin. As indicated, the anterior carapacal margin is practically always more or less serrate and is medially produced into an irregularly dentate or serrate epistomal process. In the genus Mundochthonius the shape of the epistome is of great systematic value in separating species, but in the other genera it is more uniform and of little systematic importance. Considered alone, the carapace offers enough features to sufficiently separate the Chthoniidae from the Tridenchthoniidae and other families.

The chelicerae are large, and, generally, are slightly withdrawn beneath the anterior margin of the carapace. These appendages, as well as those in the Tridenchthoniidae, exhibit accessory setae on the palm of the chela. Another feature of the chthoniid chela is the presence of small lyrifissures scattered on the external surface of the palm, in addition to the two normally present in pseudoscorpions.

The interfemoral articulation of the legs is similar to that of other members of the suborder. The intercoxal tubercle may be present or absent. When present, it always has two setae. Coxal spines are present on coxae I; coxae II; or coxae II and III.

The genitalia are highly sclerotized in the male. The female reproductive structures are represented by small and slightly sclerotized cribriform plates, which are not clearly differentiated, thus making for an indefinite transverse cribriform area. The male genitalia have a distinct posterior operculum which exposes the internal elements.

The pleural membrane, with the exception of the tribe Lechytini, is smooth and usually minutely papillate.

Historically, it is possible to trace the genus Chthonius back to C. L. Koch, who in 1843 erected four genera. The Chthoniidae was considered as a genus of the subfamily Obisiinae by E. Simon in 1879. Balzan in 1891 recognized the diversity of included forms of the Obisiinae and raised the genus to subfamily rank. This subfamily, Chthoniinae, also embraced the now recognized family Tridenchthoniidae (*fide*, Chamberlin, 1931a). Family status was finally proposed by Hansen in 1894, whose scheme was supported by With (1906). Since then, the family Chthoniidae has been recognized as a distinct group by students of the pseudoscorpions.

All the genera included in this study belong to the subfamily Chthoniinae, tribe Chthoniini. Members of this tribe possess two tactile setae, IB and ISB, on the dorsum of each chelal hand. All specimens studied have coxal spines variously disposed.

Type genus: *Chthonius* C. L. Koch, 1843

Key to genera:

1. (a) Intercoxal tubercle, bearing two small setae, present between bases of third and fourth pedal coxae; coxal spines not acuminate and never found on mesal portion of first pedal coxa......................2

   (b) Intercoxal tubercle absent; coxal spines acuminate and confined to the mesal portion of the first pedal coxa.....................................3

2. (a) Coxal spines in comb-like row confined to mesal portion of the second pedal coxa.........*Mundochthonius*

   (b) Coxal spines on mesal portion of the second and third pedal coxae.................................4

3. (a) Marginal teeth of chelal fingers small and contiguous.. ....Apochthonius

(b) Marginal teeth of chelal fingers well-spaced, at least distally..............................Kleptochthonius

4. (a) Marginal teeth of chelal fingers contiguous and blunt.. ....Kewochthonius

(b) Marginal teeth of fixed chelal finger acute and spaced distally.....................................Chthonius

Genus Mundochthonius Chamberlin, 1929

Mundochthonius, Chamberlin, 1929b, p. 64; Mundochthonius, Chamberlin, 1931a, p. 212; Mundochthonius, Beier, 1932a, p. 36; Mundochthonius, Roewer, 1937, p. 238; Mundochthonius, Hoff, 1949, p. 436; Mundochthonius, Hoff, 1956a, p. 10; Mundochthonius, Hoff, 1961, p. 420; Mundochthonius, Beier, 1963, p. 18.

Type Species: Mundochthonius erosidens Chamberlin, 1929

Diagnosis: Coxal spines serrated or deeply incised blades on medio-anterior portion of coxa of each second leg; chelal fingers with simple and contiguous teeth; intercoxal tubercle present; epistome distinctly developed, triangular or subtriangular, with serrated edge.

Discussion: The characteristic feature of this genus is the presence of a serrated or comb-like blade on the mesal portion of coxae II. This structure is homologous to the coxal spines of other genera and is treated as such in the coxal chaetotaxy. These comb-like blades may be deeply incised, giving the appearance of being separate entities, but they are still attached to each other basally, or they may have a slight degree of incision, thus appearing symmetrical. In either case the shape of these coxal spines are diagnostic of the species.

The epistome of this genus is much larger than that of other members of the suborder. It consists of an enlargement having a serrate edge. The degree of these serrations appears to be different for members of the same species. This variability is obvious when a series of specimens is examined. Hoff (1949) was able to show significant variations in the serration of the epistomes of the species he described. Except for this sort of intraspecific variability, the epistomes of the members of the genus are all very similar.

The chela is small and the setae IB and ISB are located on the dorsum of the hand. The chaetotaxy is similar to other members of the tribe Chthoniini. The marginal teeth are contiguous on both fingers. The movable finger has a slight protuberance near the marginal teeth on about the same level as the subterminal seta. This protuberance has no known function, nor has it been treated in the literature.

Chamberlin (1929b), in the erection of this genus, included three species which he described at that time. These species, *M. erosidens*, *M. montanus*, and *M. magnus*, were separated on the basis of the incisions of the coxal spines and the tergal chaetotaxy. The information given by Chamberlin in the original descriptions was inadequate, but a comparison of these descriptions with the specimens collected show that these species are distinct.

Hoff (1949) added the species *M. sandersoni* and *M. rossi* to the genus. Of these two species only the former was found within the geographic limits of this paper, and for the most part, these specimens agree with the original description. Hoff's measurements, however, do not reveal the real differences among specimens of *M. sandersoni*. The extension of these ranges of measurable characters is not great enough to confuse *M. sandersoni* with *M. rossi* since *M. rossi* remains distinct by virtue of its deeply incised coxal spines and larger podomeres.

M. rossi is included in the key to species because the comparison of identified *M. rossi* with *M. sandersoni* indicate similarities in both appearance and structure.

Key to species:

(a) Length of palpal femur greater than 0.3 mm.; chela exceeds 0.5 mm.; coxa II with coxal spines in form of a comb with teeth irregularly joined at base........ ....*M. rossi*

(b) Length of palpal femur less than 0.3 mm.; chela less than 0.5 mm. in length; coxal spines of second pedal coxa comb-like and fused basally, without deep terminal incisions....................*M. sandersoni*

Mundochthonius sandersoni Hoff, 1949

PLATE III, FIG. 7, 8, 9; PLATE IV, FIG. 10, 11, 12, 13, 14

Mundochthonius sandersoni, Hoff, 1949, p. 440; *Mundochthonius sandersoni*, Hoff and Bolsterli, 1956, p. 158.

Type Specimen: All types were collected at Herod, Illinois and are deposited in the Illinois Natural History Survey at Urbana, Illinois.

Material Examined: One hundred specimens collected from the following localities:

MARYLAND: Montgomery Co.: Plummer's Isle, November 1963, T. P. Copeland (JEL 340).

NORTH CAROLINA: Swain Co.: Great Smoky Mountains National Park, Clingman's Dome, October 1966, J. E. Lawson (JEL 699). Yancy Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 3, 5, 8, 9, 20, 21, 26, 27, 30, 31, 32, 33, 34, 39, 46, 54, 62, 63, 68, 74, 75, 79).

TENNESSEE: Carter Co.: Roan Mt., July 1953, T. P. Copeland (JEL 176). Cocke Co.: Great Smoky Mountains National Park, Cosby Rd., October 1966, J. E. Lawson (JEL 712, 713, 715). Sevier Co.: Dupont Mt., April 1952, T. P. Copeland (JEL 195).

VIRGINIA: Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 565, 569, 570, 582, 584, 585, 591, 595, 596, 599, 601, 602, 603, 604, 605, 607, 609, 610, 612, 613, 614, 615, 616, 618, 622, 624, 629, 637, 638, 642, 647, 650).

Diagnosis: Palpal femur always shorter than 0.3 mm.; chela less than 0.53 mm.; length of chela always less than 4.3 times its width; coxal spines of coxa II comb-like and joined basally; epistome distinct with serrated edge.

Description: Male. These are small pseudoscorpions with moderately short bodies and appendages. The range of body length is

0.81-1.00 mm.

The carapace is almost square in outline, but slightly wider than long. The sides are more or less subparallel. The derm is smooth but reticulate markings which are without spinules are on the lateral surface. The anterior carapacal margin is smooth with a distinct epistome which is conspicuously serrate. Eyes are wanting. Setae are acuminate and the chaetotaxy is 4-2 (20). Some specimens, however, have only 18 setae on the carapace, but setae of the anterior and posterior margins remain 4-2, respectively.

The abdomen is slightly constricted anteriorly at its junction with the prosoma. Abdominal setae are relatively few in number and are acuminate in shape. Netlike markings are not apparent on the sternites and tergites, resulting in a smooth condition of the derm. Tergal chaetotaxy: 4:4:6:6:6:6:6:6:6:6:?:0. Sternal chaetotaxy: $\frac{4}{9}$: $\frac{15\text{-}13}{(4)8(4)}$: (4)8(4):10:10:8:8:8:?:?:mm. The genital area has numerous setae surrounding both the anterior and posterior opercula. The internal features appear to be constant for all specimens examined (Fig. 9). The coxae have a chaetotaxy of 2-2-1:2-1-0-ms:2-4-CS:2-5:2-5. Three microsetae are located on the mesal portion of each coxa I. Coxal spines are on each second coxa in the form of a single comb-like blade (Fig. 12). Basally, this blade is entire but the terminal ends are moderately incised giving a symmetrical comb-like appearance (Fig. 13, 14).

In relation to body size, the chelicerae are large as indicated by the measurements given at the end of this section. The length ranges from 1.3 to 1.5 times the depth. The flagellum consists of nine unilaterally pinnate blades. The palm has six setae. The surface appears smooth but the dorsal and ventral margins are sparsely invested with small scalelike protrusions. The fixed finger has 10-12 acute denticles; the distal tooth is the largest of the series. The second most distal tooth is much smaller than the others and is either a small protrusion from the first or part of a bifid condition of the third denticle. The teeth, after the third one, become progressively reduced in size and acuteness toward the base. The movable finger possesses galeal setae inserted near the midpoint of the finger. Marginal teeth of the movable finger are seven in number; the distal tooth is separate from the remaining six and placed about midway toward the apex of the finger. The galeal knob is conspicuous and slightly proximal to the distal end of the finger.

A pedipalp is illustrated in Fig. 7. Range of palpal proportions: trochanter 1.50-1.83, femur 2.93-4.06, tibia 1.45-1.90, chela 3.50-4.25 times as long as broad; finger 1.89-2.13 times as long as hand, and 1.11-1.22 times as long as femur; chela 1.36-1.48 times as long as finger.

The arrangement of tactile setae and dentition of the chela are as illustrated in Fig. 8. Both chelal fingers have 43-57 marginal teeth of two shapes. The distal teeth are more or less acute and have a cusp on the proximal corner while the basal teeth are blunt and without a cusp.

Legs are of the general shape for the suborder (Fig. 10, 11), except that the tibia of leg IV has its flexor margin weakly S-shaped with the greatest depth on the distal one-third. Tarsal claws are simple. Proportions of leg I: basifemur 2.60-3.26, telofemur 1.57-1.79, tibia 1.97-2.65, tarsus 4.93-6.10; leg IV: entire femur 1.91-2.28, tibia 2.73-3.33, metatarsus 1.58-1.84, telotarsus 4.39-5.15 times as long as deep.

Female. The female is essentially like the male in external features. The body length is slightly larger with a range of 0.88-1.13 mm.

The carapace has a chaetotaxy of 4-2 (18). The epistome has a distinct serrated edge. As in the male, the shape is almost square and the lateral margins are subparallel.

The abdomen is weakly ovate and lightly invested with setae. Tergal chaetotaxy: 4:4:6:6:6:6:6:6:6:6:?:0. Sternal chaetotaxy: 11:(4)9(4):(4)6(4):9:9:10:8:6:6:mm. The cribriform area is lightly sclerotized but apparently not unlike other members of the family. Coxal chaetotaxy: 2-2-1:2-1-0-ms:2-4-CS:2-5:2-5. Three microsetae are on the mesal portion of coxa I and the coxal spine is in the shape of a symmetrical blade with terminal incisions. Chelicerae are as in the male, but slightly larger. Length is about 1.36 to 1.53 times the depth.

Palpal proportions: trochanter 1.48-1.85, femur 3.12-4.33, tibia 1.50-1.90, chela 3.42-4.15 times as long as broad; finger 1.77-2.06 times as long as hand, and 1.08-1.17 times as long as femur; chela 1.39-1.51 times as long as femur.

Proportions of leg I: basifemur 2.76-3.30, telofemur 1.54-1.88, tibia 2.29-2.82, tarsus 4.69-6.00 times as long as deep; leg IV: entire femur 1.92-2.39, tibia 2.75-3.23, metatarsus 1.37-1.94, telotarsus 4.27-5.07 times as long as deep.

<u>Measurements</u> (<u>in</u> <u>millimeters</u>): Male. Body length 0.81-1.00; chelicera 0.200-0.244 by 0.115-0.163; Palp: trochanter 0.120-0.144 by 0.070-0.088, femur 0.245-0.300 by 0.064-0.087, tibia 0.137-0.175 by 0.078-0.102, chela 0.403-0.500 by 0.102-0.120, chela hand 0.141-0.169 long, chela finger 0.285-0.347; Leg I: basifemur 0.125-0.183 by 0.045-0.056, telofemur 0.068-0.095 by 0.045-0.056, tibia 0.075-0.113 by 0.034-0.045, tarsus 0.150-0.208 by 0.028-0.038; Leg IV: entire femur 0.237-0.275 by 0.107-0.128, tibia 0.165-0.214 by 0.055-0.065, metatarsus 0.068-0.092 by 0.040-0.050, telotarsus 0.142-0.179 by 0.030-0.038. Female. Body length 0.88-1.13; chelicera 0.219-0.281 by 0.163-0.175; Palp: trochanter 0.131-0.163 by 0.075-0.097, femur 0.260-0.300 by 0.069-0.095, tibia 0.148-0.188 by 0.086-0.119, chela 0.408-0.525 by 0.113-0.128, chela hand 0.153-0.188 long, chela finger 0.281-0.344; Leg I: basifemur 0.138-0.175 by 0.046-0.058, telofemur 0.075-0.088 by 0.043-0.055, tibia 0.085-0.110 by 0.037-0.040, tarsus 0.150-0.200 by 0.030-0.038; Leg IV: entire femur 0.225-0.306 by 0.100-0.145, tibia 0.173-0.225 by 0.055-0.075, metatarsus 0.073-0.097 by 0.043-0.055, telotarsus 0.141-0.200 by 0.033-0.040.

<u>Distribution</u>: <u>M</u>. <u>sandersoni</u> has been reported only from Illinois, and the specimens examined in this study represent new records that extend considerably the known geographic range for the species. Because of its small size, perhaps, <u>M</u>. <u>sandersoni</u> may have been overlooked in Berlese samples or considered a nymph when selecting specimens to be mounted. In any case, <u>M</u>. <u>sandersoni</u> is much more common in leaf litter than is indicated by its previously known geographical range.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Hoff (1949) referred to the chelal teeth as varying in structure from the distal subquadrate ones with a cusp on the proximal point to the proximal rounded, acuspid teeth. The distinction here is slight and insignificant since the original teeth are believed to be all subquadrate in form and with a cusp. Due to feeding habits and the normal use of the chelal fingers, however, the more proximal teeth have simply worn away resulting in this blunt acuspid condition. An examination of the nymphal stages gives credence to this idea since they show the proximal teeth as somewhat broader but less blunt and with a cuspid on the proximal corner of the denticle. Perhaps this is a minor point, but a species or subspecies being described on the basis of the teeth being essentially alike along the entire length of the finger, should immediately be questioned.

Hoff (1949) measured only 11 specimens. The measurements recorded here of 100 specimens reveal a greater amount of variability in size than Hoff realized existed. Even though the variability is size is great, the ratios obtained by Hoff are altered only slightly if at all. The measurements given by Hoff (1949) for the width of the chelicera are much less than those presented by me. The reason is that Hoff measured the base of the chelicera while I used the middle of the palm as my reference point, as suggested by Chamberlin (1931a).

Hoff (1949) reports that the spines borne on the second coxa are distinctly different in *M. sandersoni* and *M. rossi*. These spines, referred to as blades, are joined at the base, but terminally, the margin is irregular as a result of shallow to deep incisions. These incisions were seen in all specimens examined of _M. sandersoni_ (Fig. 12, 13, 14), but the blade is more slender than that of those illustrated by Hoff (1949). _M. sandersoni_ is characterized by having these blades fused symmetrically at the base to form a fanshaped structure, while _M. rossi_ has the base irregularly fused giving the appearance of several blades. The general shape may vary; but it is the degree of fusion which is constant for a species.

Genus _Apochthonius_ Chamberlin, 1929

Apochthonius, Chamberlin, 1929b, p. 66; _Apochthonius_, Chamberlin, 1929a, p. 152; _Apochthonius_, Chamberlin, 1931a, p. 213; _Apochthonius_, Beier, 1932a, p. 41; _Apochthonius_, Roewer, 1937, p. 238; _Apochthonius_, Hoff, 1956a, p. 2; _Apochthonius_, Hoff, 1958, p. 6.

Type Species: _Chthonius moestus_ Banks, 1891, by monotypy, Chamberlin, 1929.

Diagnosis: Coxa I with three coxal spines; intercoxal tubercle absent; marginal teeth of chelal fingers small, contiguous, occupying nearly full length of finger; carapace with 22 setae; eyes four (Chamberlin, 1929b).

Discussion: In 1929, Chamberlin erected the tribe Kewochthonini and separated it from the tribe Chthonini on the basis of the marginal teeth of the chela being contiguous rather than well spaced. In this newly erected tribe he included several known genera, one of which was the newly described genus Apochthonius. Chamberlin characterized this genus on the basis of three coxal spines, each with an associated cleft present on coxa I, and assigned Chthonius moestus Banks to it as the only species. Shortly thereafter, Chamberlin discovered a new species which had the characteristic coxal spines of the genus and widely spaced chelal denticles. It was thought by Chamberlin (1929b) that this new species represented an intergradation between the tribes Kewochthonini and Chthonini and on this basis he separated the genus into two subgenera, Apochthonius and Heterochthonius. This new species Apochthonius crosbyi, he placed in the subgenus Heterochthonius. Since the original description of this species and the erection of this subgenus, it has been shown that Heterochthonius is deserving of generic rank (Hoff, 1945a). The present generic name is Kleptochthonius since Chamberlin realized the homonymy involved with a genus of oribatid mites. The use of the subgenus Apochthonius has been dropped and the genera of the tribe Kewochthonini have been incorporated into the tribe Chthonini.

The present status of Apochthonius is that of a genus of five species undivided into subgenera or species groups.

In the key below, three species, A. intermedius Chamberlin, A. occidentalis Chamberlin, and A. magnanimus Hoff have been excluded since they have only been taken west of the Mississippi and were not represented in these collections. A. moestus (Banks), a common species of the eastern states, and A. barbarae sp. n. are included in the key and are treated in the text of this paper. In the construction of the key, an attempt has been made to keep it restrictive and as limited as possible by using measurements of the palpal femur and chela but, unfortunately, these measurements may overlap among the above mentioned species. When using this key, it is suggested that one also refer to the descriptions given in the text or to the original descriptions for each species.

Key to species:

(a) Palpal femur shorter than 0.5 mm. (occasional specimens may slightly exceed this figure); length of chela less than 0.8 mm., generally between 0.6 and 0.7 mm. Eastern states............................*A. moestus*

(b) Length of palpal femur greater than 0.6 mm.; chela length greater than 0.9 mm. (occasional specimens may slightly be less, but greater than 0.87 mm.).... ....*A. barbarae*, sp. n.

Apochthonius moestus (Banks, 1891) Chamberlin, 1929

PLATE V, FIG. 15, 16; PLATE VI, FIG. 17, 18; PLATE VII, FIG. 19, 20

Apochthonius moestus, Chamberlin, 1929b, p. 67; *Apochthonius (Apochthonius) moestus*, Chamberlin, 1929a, p. 153; *Apochthonius (Apochthonius) moestus*, Beier, 1932a, p. 41; *Apochthonius moestus*, Roewer, 1937, p. 238; *Apochthonius moestus*, Hoff, 1944, p. 125; *Apochthonius moestus*, Hoff, 1945a, p. 311; *Apochthonius moestus*, Hoff, 1951b, p. 4; *Apochthonius moestus*, Hoff, 1956a, p. 2; *Apochthonius moestus*, Hoff and Bolsterli, 1956, p. 158.

Type Specimen: Types were collected at Ithaca, New York and according to Chamberlin (1929b) are deposited in the United States National Museum or the Museum of Comparative Zoology at Cambridge, Massachusetts.

Material Examined: Ninety specimens collected from the following localities:

NORTH CAROLINA: Swain Co.: Great Smoky Mountains National Park, Clingman's Dome, October 1966, J. E. Lawson (JEL 669); Cherokee Road, October 1966, J. E. Lawson (JEL 675, 676, 684, 687); Cherokee Reservation, October 1966, J. E. Lawson (JEL 722, 723, 750). Yancey Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 9, 18, 19, 28, 29, 32, 34, 40, 61, 72, 76, 77, 86).

SOUTH CAROLINA: Greenville Co.: Paris Mountain State Park, September 1962, T. P. Copeland (JEL 128).

TENNESSEE: Cocke Co.: Great Smoky Mountains National Park, Cosby Rd., October 1966, J. E. Lawson (JEL 704). Greene Co.: Tusculum, Tulip Garden Rd., July 1953, T. P. Copeland (JEL 174). Sevier Co.: Dupont Mt., April 1952, A. C. Cole (JEL 195); Great Smoky Mountains National Park, Indian Gap, October 1959, T. P. Copeland (JEL 273, 278).

VIRGINIA: Floyd Co.: Blue Ridge Pkwy., October 1962, J. E. Lawson (JEL 102, 104, 106, 114). Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 563, 564, 565, 566, 570, 571, 572, 575, 577, 578, 579, 580, 581, 585, 586, 588, 589, 590, 592, 597, 606, 609, 624, 625, 628, 636, 637, 638, 641). Montgomery Co.: near Riner, September 1963, J. E. Lawson (JEL 315).

Diagnosis: Carapace with 22 setae; three coxal spines on coxa I; marginal teeth of chelal finger small and contiguous; intercoxal tubercle absent.

Description: Male. Males of *A. moestus* are relatively small animals with a range in body length of 1.20 to 1.47 mm.

The carapace is slightly wider than long and bears two pairs of eyes. The eyes of the posterior pair are smaller than those of the anterior pair. The derm of the carapace is smooth except for the area near the appendages which is reticulate. Spinules are not present on this reticulate surface as in members of other genera. The anterior margin of the carapace is truncate and smooth with a small medially placed epistome consisting of three protrusions, one large and two smaller ones laterad, but confluent on each side. Chaetotaxy: 8-4 (22).

The abdomen is of usual facies for the family. The dermis is smooth without any obvious sculpturing. Setae are acuminate and relatively few in number on tergites and sternites. Tergal chaetotaxy: 4:4:6:7:7:9:9:9:9:?:?:0. Setae are more numerous on sternites and the chaetotaxy is as follows: $\frac{2}{11}$: (4-4): $\frac{7\text{-}9}{(2)8(2)}$: (3)8(3):10:9:9:10:10:?:mm. The genital area has many setae (Fig. 20), as indicated in the above expression, and the internal features, from all indications, are typical for the genus. The coxal area is characteristic with a 2-2-1:3-0-CS:2-2: 2-3:3-3 chaetotaxy. Coxal spines are always three and are arranged in a more or less linear series on the mesal portion of the first pair of coxae (Fig. 19). The intercoxal tubercle is absent.

Chelicerae are large with a length of 1.51 to 1.53 times the depth.

The palm has seven setae, and the movable finger has the single characteristic galeal setae. The derm of the chelicerae possesses hispid scales and small spinules, but this condition is more pronounced on the dorsal and ventral margins. The flagellum consists of six unilaterally pinnate blades and arises from an oval areole. The galeal tubercle is wanting and internal ducts are not observable. The fixed finger has eight denticles arranged in a linear series, the most apical teeth are the largest and the teeth become progressively reduced in size toward the base. The movable finger also possesses eight teeth arranged in a series similar to the fixed finger, but about midway between these teeth and the apex of the finger is a single denticle positioned so that the tip is directed distally.

The pedipalp is as shown in Fig. 15. Palpal proportions (the figures given represent the ranges of the material examined): trochanter 1.63-1.88, femur 3.65-4.34, tibia 1.54-1.82, chela 3.74-4.30 times as long as broad; finger 1.92-2.04 times as long as hand, and 1.00-1.08 times as long as femur; chela 1.38-1.48 times as long as finger.

The chaetotaxy and dentition of the chela are as illustrated in Fig. 16. The fixed finger has about 60-70 contiguous marginal denticles which extend the length of the finger. The shape of these teeth are quadrangular and blunt. The movable finger has about 50-55 teeth, distally the shape is similar to teeth of the fixed finger but the basal 15 or so are short and rounded.

The legs are typical (Fig. 17, 18), as in the suborder. The derm appears smooth, but careful study reveals the presence of minute scale-like spinules. The trochanter of all legs exhibits two setae near the junction with the femur. Tactile setae are present. Tarsal claws are simple. Proportions of leg I: basifemur 3.76-4.46, telofemur 1.92-2.12, tibia 2.71-3.56, tarsus 6.11-7.39 times as long as deep. Leg IV: entire femur 2.17-2.38, tibia 3.27-3.51, metatarsus 1.98-2.20, telotarsus 5.42-6.84 times as long as broad.

Female. Generally, the female is larger than the male. The range of total body length is 1.11 to 1.70 mm., but the depth is about equal in both sexes.

The carapace is much like that of the male with acuminate setae and a chaetotaxy of 8-4 (22). The epistome is not nearly as obvious as in the male and is difficult to demonstrate, but when viewed, consists of three small protrusions of equal size. The derm is smooth dorsally with a lateral reticulation as in the male. Two pairs of eyes are present.

Setae of the abdomen are similar in shape on both tergites and sternites. Tergal chaetotaxy: 4:4:7:8:8:9:9:8:8:8:?:0. Sternal chaetotaxy: $\frac{2}{6}$:(2)8(2):(3)8(3):12:12:13:13:9:9:?:mm. The cribriform area is not unusual and has the expected type of sclerotic elements forming a "U" shaped structure with the bottom detached. Coxal chaetotaxy: 2-2-1:3-0-CS:2-2:2-3:2-3. Three coxal spines are on each coxa I and are linearly arranged.

Chelicerae are similar to those of the male, with seven setae on the palm, denticles, flagellum of six blades, and hispid tubercles.

The only difference noted, other than size, is the presence of additional basal denticles on the fingers. Length is 1.30 to 1.58 times depth.

The range of palpal podomeres in proportions: trochanter 1.63-1.88, femur 3.44-4.25, tibia 1.40-1.81, chela 3.27-4.25 times as long as broad; finger 1.77-2.14 times as long as hand, and 1.00-1.10 times as long as femur; chela 1.38-1.52 times as long as finger.

The chaetotaxy and dentition of the chela are as in the male except the chela is larger and possesses more denticles because of the increase in size.

Proportions of leg I: basifemur 3.41-4.13, telofemur 1.68-2.26, tibia 2.58-3.41, tarsus 5.45-7.35 times as long as deep. Leg IV: entire femur 2.06-2.54, tibia 3.25-3.87, metatarsus 1.98-2.40, telotarsus 5.42-6.57 times as long as deep. Other appendicular structures and their placement are similar to those in the male.

<u>Measurements (in millimeters)</u>: Male. Body length 1.20-1.47; chelicera 0.313-0.352 long by 0.219-0.229; Palp: trochanter 0.180-0.210 by 0.100-0.119, femur 0.400-0.494 by 0.095-0.118, tibia 0.207-0.240 by 0.125-0.150, chela 0.617-0.736 by 0.156-0.175; chela hand 0.219-0.250, finger 0.431-0.506; Leg I: basifemur 0.225-0.281 by 0.055-0.068, telofemur 0.119-0.138 by 0.058-0.065, tibia 0.131-0.178 by 0.045-0.053, tarsus 0.269-0.291 by 0.038-0.045; Leg IV: entire femur 0.375-0.439 by 0.160-0.187, tibia 0.250-0.321 by 0.076-0.090, metatarsus 0.119-0.143 by 0.058-0.063, telotarsus 0.231-0.260 by 0.038-0.045. Female: Body length 1.11-1.70; chelicera 0.263-0.400 by 0.229-0.256; Palp: trochanter

0.163-0.223 by 0.093-0.133, femur 0.344-0.519 by 0.088-0.138, tibia 0.198-0.256 by 0.123-0.156, chela 0.519-0.794 by 0.145-0.219, chelal hand 0.169-0.300, finger 0.363-0.573; Leg I: basifemur 0.188-0.294 by 0.053-0.075, telofemur 0.093-0.144 by 0.050-0.070, tibia 0.120-0.181 by 0.040-0.058, tarsus 0.218-0.313 by 0.035-0.048; Leg IV: entire femur 0.325-0.469 by 0.150-0.194, tibia 0.244-0.325 by 0.063-0.090, metatarsus 0.113-0.156 by 0.050-0.070, telotarsus 0.206-0.289 by 0.038-0.048.

Distribution: *A. moestus* has a widespread geographic distribution in most eastern states and is considered a common inhabitant of leaf litter. Hoff (1951b, 1956a) reports it from Texas and New Mexico. The specimens from Greenville Co., South Carolina studied for this paper constitutes a new state record.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: The description of this species by Chamberlin (1929b) was grossly inadequate and indicated a narrow range for the length-width palpal proportions. This work was apparently copied by Beier (1932a), since he did not extend Chamberlin's measurements or add to the description. Hoff (1945a), in an attempt to give recognition to the variations shown by the palpal podomeres, subjected the measurements from a series of 40 males and females from Illinois and North Carolina to a statistical analysis. The results obtained indicated a greater degree of variation than was reported by Chamberlin, with significant differences in the palpal proportions of both sexes, and that the information given by Beier and Chamberlin was inaccurate because the arithmetical mean obtained could not be included in their measurements. The measurements taken by me fall within the limits given by Hoff (1945a), but nearer the upper one.

Chamberlin (1929b) attached taxonomic significance to the ventral and dorsal Y-shaped apodemes of the male genitalia. In A. moestus the arms of the dorsal apodeme are shorter than those of the ventral apodeme and are not basally flaring. Also, the dorsal apodeme is positioned so that the angle is slightly obtuse to the body. Using these criteria, Chamberlin (1929b) described the species A. occidentalis, which had similar measurements, and could be distinguished by the greater length of the arms of the dorsal apodeme and the flared base of the arms of the ventral apodeme. Hoff (1945a) found that the treatment of specimens with potassium hydroxide solution altered the length of the arms of both Y-shaped apodemes. It appears that the ends of the arms are destroyed by treating specimens with this solution and, as a result, the lengths of the arms are unreliable characters in potassium hydroxide treated material. Unfortunately, Hoff did not question the validity of this species and it remains in the literature as a species closely related to A. moestus, although if the specimens upon which it is based were treated with potassium hydroxide, it must be regarded as questionable.

The remaining two species of the genus, A. intermedius and A. magnanimus are characteristically different in size and in length-width proportions of the palpal podomeres. Confusion of the two with A. moestus is unlikely.

Hoff (1956) has indicated an altitudinal restriction for those specimens of A. moestus from New Mexico, but I could not establish any such relationship with the material examined. Presently, A. moestus is considered a distinct species commonly found among leaf litter in most eastern states and, until now, was the only species of this strictly North American genus found east of the Mississippi. A new species A. barbarae, recently discovered by me, is described in the following account.

Apochthonius barbarae sp. n.

PLATE VIII, FIG. 21, 22; PLATE IX, FIG. 23, 24; PLATE X, FIG. 25, 26

Type Specimen: Holotype male (JEL 335) and allotype (JEL 337) collected from Plummer's Isle, Montgomery Co., Maryland by T. P. Copeland, November 1963. The holotype, allotype, and four paratypes will be deposited in the American Museum of Natural History, New York.

Material Examined: Sixty-two specimens collected from the following locality:

MARYLAND: Montgomery Co.: Plummer's Isle, November 1963, T. P. Copeland (JEL 326, 327, 329, 330, 331, 332, 333, 334, 335, 336, 337, 339, 340, 341, 342, 343, 344, 345).

Description: The numerical data given in the following description for the holotype and allotype, the first figure is for the type and those figures in parentheses are the ranges of all specimens examined. Holotype male. The body length of the holotype is 1.82 mm.

The carapace is wider than long and the lateral margins are more or less subparallel. Two pairs of eyes are present, the anterior pair are located about one ocular diameter from the anterior carapacal margin, and the posterior pair approximately two-thirds an ocular diameter from the first pair. Posteriorly, the carapace is constricted and closely associated with the first tergite of the abdomen. Laterally, the derm on the posterior of the carapace region appears folded or at least overlapping, creating a condition which makes it difficult to discern the limits of the carapace and the first tergite. The lateral sides of the carapace are reticulate ventrally. This reticulation passes posteriorly giving rise to a folded condition of the derm. The truncate anterior margin is smooth and possesses a medially placed epistome consisting of six small protrusions of equal size. Setae are acuminate and are variously disposed in an arrangement offering a chaetotaxy of 8-4 (22).

The abdomen is broadly joined to the prosoma and moderately invested with acuminate setae. The anterior tergites are lightly reticulate, especially the first, but the derm of the last six or seven tergites is smooth. Tergal chaetotaxy: 4:4:4:6:6:8:8:8:8:?:?:0. Sternites are without any reticulate markings and exhibit a chaetotaxy of: $\frac{2}{13}$: $\frac{12\text{-}12}{(3)8(3)}$:(3)8(3):9:11:11:11:9:6:?:mm. The genitalia (Fig. 25) appear to be typical and possess many setae variously disposed around the anterior apertures (Fig. 26). Some variation was noted in the number of setae lining the anterior aperture. In the holotype this number was eight, but in some of the other specimens there were six setae. The coxal area is typical of the suborder with a 2-2-1:1-2-0-CS: 2-2:2-3:2-3 chaetotaxy and each coxa of the first pair has three coxal spines.

The chelicerae are large with a length approximately 1.49 times their depth. The general facies of this structure is similar to that of other species of the genus and, like other members, there are seven setae on the palm, and one, the galeal seta, on the movable finger. Also present is a flagellum of seven unilaterally pinnate blades and hispid tubercles on both the dorsal and ventral margins of the hand. The movable finger possesses ten denticles, nine of which form a series and one distally removed from this group which is located midway from the tip of the finger. This tooth is low-lying and its apex is directed toward the distal end of the finger. The galeal tubercle is wanting. Beginning at the distal end of the fixed finger, there are 11 marginal denticles and four much smaller denticles which are arranged in a linear series with the apical teeth being the largest and the remaining teeth becoming progressively reduced in size toward the base of the finger.

Figure 21 illustrates a pedipalp of the holotype. Palpal proportions: trochanter 1.73 (1.62-1.81), femur 4.75 (4.00-4.84), tibia 1.79 (1.55-1.96), chela 4.67 (3.96-4.96) times as long as broad; finger 1.83 (1.70-1.92) times as long as hand, and 0.93 (0.91-0.99) times as long as femur; chela 1.58 (1.47-1.62) times as long as finger.

The chaetotaxy and dentition of the chela are as illustrated (Fig. 22). The fixed finger has 70 contiguous teeth. Distally these denticles are quadrangular and blunt but basally the teeth are slightly triangular in shape. The movable finger possesses 40 teeth similar in shape to those of the fixed finger, but the basal 18 teeth are low and rounded.

The legs are of apochthoniine appearance and have the characteristic tactile setae and simple tarsal claws. Proportions of leg I: basifemur 4.41 (4.11-4.66), telofemur 2.10 (1.98-2.33), tibia 3.75 (3.26-3.76), tarsus 7.54 (7.50-8.38); Leg IV: entire femur 2.47 (2.04-2.51), tibia 4.10 (3.53-4.14), metatarsus 2.28 (2.08-2.57), telotarsus 7.50 (7.17-7.77) times as long as deep.

Allotype female. The body length is essentially equal to the male, but the appendages are slightly larger. Body length of the allotype is 1.71 mm. with other specimens having a range of 1.45-1.78 mm.

The carapace is like the male's in shape, size, and chaetotaxy of 8-4 (22). The epistome has five small protrusions. The pattern of derm on the lateral surface is reticulate with a folded condition laterally on the posterior margin.

Anterior tergites are slightly reticulate on their lateral margins. Tergal chaetotaxy: 4:4:6:6:5:7:7:7:8:6:5:0. Sternal chaetotaxy: $\frac{2}{6}$:(3)6(3):(3)7(3):8:8:11:11:11:9:?:mm. The cribriform area is not unusual and is similar to that of members of other genera of this family. Coxal chaetotaxy: 2-2-1:1-2-0-CS:2-2:2-3:2-3. Three coxal spines are present on coxa I.

Other than size, the chelicerae are similar to the male and possess seven setae on the palm, a flagellum of seven blades which are unilaterally pinnate, tubercles on both the dorsal and ventral margins of the hand, and a similar dentition of both fingers. The length is about 1.50-1.56 times its depth.

Palpal proportions: trochanter 1.77 (1.57-1.83), femur 4.51 (4.16-4.64), tibia 1.88 (1.53-1.88), chela 4.58 (3.67-4.58) times as long as broad; finger 1.67 (1.67-1.90) times as long as hand, and 0.94 (0.92-0.98) times as long as femur; chela 1.53 (1.48-1.56) times as long as femur.

Proportions of leg I: basifemur 4.12 (4.04-4.47), telofemur 2.26 (1.85-2.32), tibia 3.47 (3.17-3.87), tarsus 7.43 (7.32-8.12) times as long as deep. Leg IV: entire femur 2.49 (2.26-2.57), tibia 3.87 (3.50-4.19), metatarsus 2.35 (2.21-2.66), telotarsus 7.12 (6.60-7.50) times as long as deep.

<u>Measurements</u> <u>(in</u> <u>millimeters)</u>: (The first figures represent the type, and those in parentheses are the ranges of all specimens examined): Male. Body length 1.82 (1.47-1.82); chelicera 0.456 (0.406-0.459) long by indeterminable (0.285-0.363); Palp: trochanter 0.250 (0.238-0.281) by 0.144 (0.137-0.169), femur 0.680 (0.600-0.681) by 0.143 (0.128-0.155), tibia 0.321 (0.288-0.331) by 0.179 (0.156-0.200), chela 1.00 (0.882-1.00) by 0.213 (0.188-0.229), chela hand 0.344 (0.313-0.356) long, chela finger 0.630 (0.563-0.630); Leg I: basifemur 0.375 (0.331-0.375) by 0.085 (0.075-0.085), telofemur 0.175 (0.150-0.175) by 0.083 (0.073-0.085), tibia 0.225 (0.198-0.225) by 0.060 (0.055-0.065), tarsus 0.400 (0.367-0.419) by 0.053 (0.048-0.053); Leg IV: entire femur 0.619 (0.500-0.619) by 0.250 (0.219-0.256), tibia 0.431 (0.388-0.431) by 0.105 (0.095-0.113), metatarsus 0.194 (0.156-0.194) by 0.085 (0.073-0.085), telotarsus 0.375 (0.338-0.388) by 0.050 (0.045-0.050). Female. Body length 1.71 (1.45-1.78); chelicera indeterminable (0.425-0.481) by indeterminable

(indeterminable); Palp: trochanter 0.256 (0.250-0.269) by 0.144 (0.138-0.163), femur 0.655 (0.619-0.670) by 0.145 (0.138-0.163), tibia 0.319 (0.294-0.325) by 0.169 (0.169-0.200), chela 0.945 (0.895-0.982) by 0.206 (0.206-0.256), chelal hand 0.368 (0.331-0.356) long, movable chelal finger 0.617 (0.594-0.655) long; Leg I: basifemur 0.363 (0.340-0.375) by 0.088 (0.080-0.090), telofemur 0.181 (0.156-0.188) by 0.080 (0.075-0.088), tibia 0.219 (0.206-0.238) by 0.063 (0.058-0.065), tarsus 0.394 (0.369-0.406) by 0.053 (0.048-0.053); Leg IV: entire femur 0.594 (0.550-0.600) by 0.238 (0.231-0.256), tibia 0.418 (0.375-0.431) by 0.108 (0.100-0.115), metatarsus 0.200 (0.181-0.200) by 0.085 (0.075-0.088), telotarsus 0.356 (0.338-0.369) by 0.050 (0.048-0.055).

Distribution: Known only from the type locality.

Disposition of Material: The types mentioned above will be deposited in the American Museum of Natural History; the remainder, including four additional paratypes, will remain in the author's collection.

Discussion: This is the fifth species of the genus and differs from the other four by its longer palpal and pedal podomeres. A comparison with the holotype of *A. occidentalis*, identified material of *A. intermedius* on loan from Chamberlin's collections, and a study of the original descriptions of both species show that *A. barbarae* has more slender palps and legs. The measurements obtained from these podomeres in *A. barbarae*, especially of the pedipalp, indicate a larger size than is characteristic of *A. occidentalis* and *A. intermedius*. *A. barbarae* also differs from *A. moestus* and *A. magnanimus* in this respect, but because of distributional records, other similarities, and size of the appendages, these two species need further comment.

Hoff (1956a) in his description of A. magnanimus noted that the larger size of the palpal segments and dentition of the chela were sufficient to separate it from A. moestus. Using both of these characters for comparison, A. barbarae is quite distinct in that the marginal teeth of the chela are quadrangular and blunt, as in A. moestus, and not triangular and apically acute with denticles of two different sizes as Hoff reports for A. magnanimus. By means of an examination of the allotype, and by using the measurements given for the holotype, it is possible to show that A. barbarae exceeds in all measurements of those of the types of A. magnanimus. The above information and the type locality of A. magnanimus in New Mexico, substantiates a separation of these species.

A. moestus, a closely related species, is the only other member of the genus reported east of the Mississippi, and because of similar anatomical features the distinction may be somewhat obscure. However, a comparison of the lengths of the palpal and pedal segments and the male genitalia offers enough evidence to separate these two forms.

The chaetotaxy of the anterior operculum of the male is slightly different in that A. barbarae has eight setae lining its border while A. moestus has six setae on this border. Also the setae on the posterior border are less in number on A. moestus.

The measurements taken of A. barbarae indicate that both the pedal and palpal podomeres are longer than those of A. moestus which gives the appendages a more slender appearance. In the material examined the smallest measurements obtained from the palpal femur and chela of A. barbarae was 0.60 mm. in the male and 0.62 mm. in the female for the femur, and 0.882 mm. and 0.895 mm., respectively, for the chela. A comparison of these figures with those obtained from A. moestus shows a difference in length of 0.1 mm. When these measurements are plotted on a scattergram, the results are quite obvious because there is a distinct separation without any intermediate forms.

To give further credence to A. barbarae as a species, those measurements given by Hoff (1945, 1956) for A. moestus also show this difference in length of at least 0.1 mm., and does not overlap with any specimens of A. barbarae.

Currently, the best characters for the separation of A. barbarae from A. moestus are the differences in length of the palpal femur and chela. Until other specimens are found, total variability of A. barbarae will remain undetermined because all specimens upon which this species is based came from one area and represent a single population. Hoff and Bolsterli (1956), however, report a single female from Canyon State Park, Indiana with a palpal femur 0.63 mm. long and a chela 0.93 mm. in length. They felt this to be a new species, but in the absence of other material did not deem it advisable to describe it as such. These measurements fall within the range obtained for A. barbarae and would indicate its presence in the Canyon State Park.

This species is dedicated to my wife Barbara.

Genus Kleptochthonius Chamberlin, 1949

Apochthonius (*Heterochthonius*), Chamberlin, 1929a, p. 153; *Apochthonius* (*Heterochthonius*), Beier, 1932a, p. 42; *Heterochthonius*, Hoff, 1945a, pp. 313-314; *Heterochthonius*, Hoff, 1949, p. 434; *Kleptochthonius*, Chamberlin, 1949, p. 4; *Kleptochthonius*, Malcolm and Chamberlin, 1961, p. 2.

Type Species: *Kleptochthonius crosbyi* (Chamberlin, 1929)

Diagnosis: Marginal teeth of chela well separated; denticles of chela typically of two sizes at least on fixed finger; generally two pairs of eyes; troglobitic species with two pairs, one pair, or eyeless; galea missing but galeal knob generally present, at least in females; palm of chelicera with four basic setae and a variable number of accessory setae; coxa I with three to six coxal spines.

Discussion: Chamberlin (1929) originally placed these pseudoscorpions in the genus *Apochthonius*, and erected the subgenus *Heterochthonius* to encompass the single species *Apochthonius* (*Heterochthonius*) *crosbyi* because the marginal teeth of the chela were typically composed of alternating large and small denticles. Hoff (1945) later raised the subgenus to generic rank when he described a second species, *Heterochthonius multispinosus*, with similar marginal teeth. Because of this type of dentition, Hoff considered these species as being a natural group separate from the genus *Apochthonius*. The current generic name resulted when Chamberlin (1949) discovered *Heterochthonius* was a homonym for a genus of oribatid mites and, consequently, proposed the name *Kleptochthonius*.

Characteristic of the genus is the presence of coxal spines on the mesal portion of coxa I which vary in number from three to six on each coxa. The structure of these coxal spines has been mentioned earlier in a discussion of systematic characters.

The nature of the marginal teeth of the palpal chela, which was the basis for the erection of this genus, has been shown to vary from the typical alternating macro and microdenticles. Malcolm and Chamberlin (1961) have assigned two species to the genus with homo-dentition. There are other variations in the chelal denticles but, for the most part, these differences have been noted in cavernicolous forms.

Malcolm and Chamberlin (1961) considered the genus Chamberlinochthonius Vachon (1952) as a subgenus of Kleptochthonius because its included species are cave forms. The inclusion of this genus as a subgenus of Kleptochthonius was a convenience in separating cave forms from epigean forms (subgenus Kleptochthonius). There is a precedent, however, because the subgenus Blothrus is, similarly, an aggregate of modified cave species of the genus Neobisium, suborder Diplosphyronida (Malcolm and Chamberlin, 1961). In this work, there has not been an attempt to collect or include troglobitic forms, but the subgenus seems to be composed of a distinct group of species and is, therefore, included in the key. A short discussion of the group is given thereafter.

Key to subgenera and species:

1. (a) Four well-developed eyes; generally smaller animals; epigean forms..........Subgenus Kleptochthonius...2

(b) Eyeless or two to four eyes, when four eyed anterior pair large, the posterior pair much smaller; cave forms; large animals...Subgenus Chamberlinochthonius

2. (a) Both chelal fingers distinctly heterodentate, smaller microdenticles alternating with spaced macrodenticles; coxal spines three..................*K.* (*K.*) *crosbyi*

(b) Movable finger of chela essentially homodentate (microdenticles, if present, greatly reduced in size and inconspicuous); fixed finger heterodentate; coxal spines three to six.............*K.* (*K.*) *multispinosus*

Subgenus *Chamberlinochthonius* Vachon, 1952

Chamberlinochthonius, Vachon, 1952, pp. 105-106 (considered as a genus); *Chamberlinochthonius*, Malcolm and Chamberlin, 1961, p. 16; *Chamberlinochthonius*, Muchmore, 1965, p. 1.

Diagnosis: Eyeless, two-eyed, or four-eyed; large species with palpal femur 0.9 to 1.5 mm. long; palp long and slender with the femur and chela more than six times as long as broad; entire femur of leg IV 3.2 to 4.2 times as long as deep; cave forms.

Discussion: As mentioned earlier, Vachon (1952) considered this group to be a genus, but Malcolm and Chamberlin (1961), as well as Muchmore (1963, 1965), treated these forms as a subgenus. When Malcolm and Chamberlin initiated this change in rank, the included species were characterized as being two-eyed or eyeless. Muchmore (1965) has since emended this diagnosis, however, when he pointed out that some forms possess four eyes, the posterior pair being much smaller than the anterior two. According to Muchmore (1965) members of this subgenus are larger species with attenuated appendages and fewer vestitural setae. The presence of these characters, in addition to those given in the diagnosis for the subgenus should be sufficient to delimit these from the subgenus *Kleptochthonius*.

Subgenus *Kleptochthonius* Malcolm and Chamberlin, 1961

Kleptochthonius, Malcolm and Chamberlin, 1961, p. 5.

Diagnosis: Four well developed eyes of nearly equal size; palpal femur 0.5 to 0.8 mm. long; entire femur of leg IV 2.4 to 3.1 times as long as broad; epigean species (Chamberlin and Malcolm, 1961).

Discussion: The characters mentioned in the diagnoses are sufficient to separate the subgenera. It should be made clear that this group is an artificial one, separated from the other subgenus on the basis of habitat, rather than a natural assemblage.

The subgenus contains four species. Two of these are widely represented in the pseudoscorpion fauna of the eastern United States, while the other two have been reported from the Pacific Coast by Malcolm and Chamberlin (1961). The latter two species *K.* (*K.*) *oregonus* and *K.* (*K.*) *geophilus*, are characterized by homodentate chelal fingers with spaced macrodenticles only, and are separated by additional characters. These two species are mentioned here to give a more complete account of the subgenus, but are not treated in the species descriptions.

Kleptochthonius (*Kleptochthonius*) *crosbyi* (Chamberlin, 1929)

PLATE XI, FIG. 27, 28; PLATE XII, FIG. 29, 30, 31, 32

Apochthonius (*Heterochthonius*) *crosbyi*, Chamberlin, 1929a, p. 153; *Apochthonius* (*Heterochthonius*) *crosbyi*, Chamberlin, 1931a, p. 213; *Apochthonius* (*Heterochthonius*) *crosbyi*, Beier, 1932a, p. 42; *Heterochthonius* *crosbyi*, Hoff, 1945a, pp. 313, 318; *Heterochthonius* *crosbyi*, Hoff, 1949, p. 436; *Kleptochthonius* *crosbyi*, Chamberlin, 1949, p. 4; *Kleptochthonius* *crosbyi*, Hoff, 1958, p. 7; *Kleptochthonius* (*Kleptochthonius*) *crosbyi*, Malcolm and Chamberlin, 1961, p. 11.

Type Specimen: The male holotype was collected from Mt. Mitchell, North Carolina, and is deposited in the Cornell University collections.

Material Examined: Seventy-three specimens collected from the following localities:

NORTH CAROLINA: Swain Co.: Mingus Creek, October 1966, J. E. Lawson (JEL 691); Cherokee Reservation, October 1966, J. E. Lawson (JEL 727); Big Cove Rd., October 1966, J. E. Lawson (JEL 735, 736). Yancey Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 5, 7, 10, 11, 12, 15, 16, 19, 21, 22, 23, 27, 38, 41, 56, 76, 79).

SOUTH CAROLINA: Greenville Co.: Paris Mountain State Park, September 1962, T. P. Copeland (JEL 128); Greenville watershed, September 1962, T. P. Copeland (JEL 129).

TENNESSEE: Bledsoe Co.: Walden's Ridge, July 1953, T. P. Copeland (JEL 241, 249). Blount Co.: Maryville-Gatlinberg Hwy., June 1953, T. P. Copeland (JEL 158); near Fontana Lake, June 1953, T. P. Copeland (JEL 190);

Great Smoky Mountains National Park, Cades Cove Rd., July 1953, T. P. Copeland (JEL 354). Carter Co.: Roan Mt. July 1953, T. P. Copeland (JEL 154, 159, 165, 220, 246, 259). Cocke Co.: near French Broad River and Cosby Rd., October 1959, T. P. Copeland (JEL 293); Great Smoky Mountains National Park, Cosby campground, October 1966, J. E. Lawson (JEL 709). Cumberland Co.: Cumberland Mt. State Park, October 1962, T. P. Copeland (JEL 90). Hamilton Co.: Signal Mt., July 1953, T. P. Copeland (JEL 221). Rhea Co.: July 1953, T. P. Copeland (JEL 243). Roane Co.: Rockwood, July 1953, T. P. Copeland (JEL 242). Sequatchie Co.: July 1953, T. P. Copeland (JEL 236, 252). Sevier Co.: Great Smoky Mountains National Park, Newfound Gap Rd., July 1953, T. P. Copeland (JEL 142, 170, 210); Knoxville-Sevierville Hwy., July 1953, T. P. Copeland (JEL 149); Dupont Mt., April 1952, A. C. Cole (JEL 189). Unicoi Co.: Unaca Mt., July 1953, T. P. Copeland (JEL 186).

VIRGINIA: Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 570, 599, 613, 644). Floyd Co.: Blue Ridge Pkwy., October 1962, J. E. Lawson (JEL 100). Dickenson Co.: Breaks Interstate Park, August 1963, Charlie White (JEL 321, 324, 461, 463, 466, 471, 483, 493, 499, 505, 519).

Diagnosis: Three coxal spines on each coxa I; both chelal fingers distinctly heterodentate; accessory structure of male genitalia present; carapacal chaetotaxy 10-4 (24).

Description: Male. This is an epigean species of small animals. The body length of the animals examined ranged from 1.20 to 1.63 mm.

The carapace is of the usual shape for the genus, about as long as broad and partially constricted posteriorly giving an appearance of being slim-waisted to the animals. Two pairs of corneate eyes with the anterior pair near the anterior carapacal margin are present. The anterior margin of the carapace is truncate and slightly serrulated laterally. In some specimens a slight median elevation is present which suggests an epistome. The derm is smooth except for the hispid nature of the lateral surface. The lateral margin has a few widely spaced denticulate spinules. Reticular markings are present on the sides of the carapace. Chaetotaxy 10-4 (24).

The abdomen is typical. The anterior tergites have reticulate sculpturing on the lateral margins. Tergal chaetotaxy: 4:4:7:7:7:9:9:10:10:10:?:0. Sternal chaetotaxy: $\frac{3}{12}$:(4-4):$\frac{12\text{-}13}{(3)8(3)}$:(3)10(3):11:11:12:9:9:8:mm. The genital area is typical and as illustrated in Fig. 31, 32. Chaetotaxy of coxae: 2-2-1:1-2-0-CS:2-2:2-3:2-3. Coxal spines are with the associated clefts and never exceed three in number on each coxa.

The chelicerae are characteristic of the subgenus. Their length is 1.30 to 1.69 times their depth. The flagellum has six or, more commonly, seven unilaterally branched blades. The derm is smooth, but low scale-like projections are apparent on the medial aspect of the palm. The movable finger has at least six denticles, the distal one set apart from the remaining five. The fixed finger has a series of seven to ten denticles, the basal three much smaller and not as distinct, the distal tooth distinct and much larger than the remaining members of the series. Three accessory setae are present on the palm. The galeal tubercle is inconspicuous but, nevertheless, present.

The palp is typical of the genus (Fig. 27). Palpal proportions: trochanter 1.59-1.94, femur 3.68-5.16, tibia 1.42-1.96, chela 2.91-4.96 times as long as broad; finger 1.69-2.10 times as long as hand, and 0.98-1.11 times as long as femur; chela 1.40-1.57 times as long as finger.

The chela is as illustrated in Fig. 28 showing the chaetotaxy and dentition. The fixed finger has a marginal row of 14-15 spaced macrodenticles and 10-12 microdenticles. The movable finger has seven to nine spaced macrodenticles and ten microdenticles. Basal to these sclerotized denticles are a group of eight to ten low, rounded, contiguous teeth which lack the typical sclerotized appearance.

The legs (Fig. 29, 30) are typical for the suborder. The derm is essentially smooth on all legs, but legs III and IV have small spines on certain areas of the trochanter, entire femur, and tibia. Proportions of leg I: basifemur 3.58-4.97, telofemur 1.74-2.29, tibia 3.00-3.77, tarsus 7.29-8.75 times as long as deep. Leg IV: entire femur 2.42-3.11, tibia 3.62-4.88, metatarsus 2.30-3.50, telotarsus 7.27-9.44 times as long as deep.

Female. The females are similar to the males but are slightly larger and have more slender appendages. Body length ranges from 1.36 to 1.89 mm.

The denticulate condition of the anterior carapacal margin is about the same as that of the male, but this condition is not as obvious on the lateral margins. Laterally, and on a few anterior tergites, the derm is reticulate, otherwise it is smooth. Carapacal chaetotaxy: 10-4 (24).

Coxal chaetotaxy: 2-2-1:2-1-0-CS:2-2:2-3:2-3. Three coxal spines are on coxa I.

Tergal chaetotaxy: 4:4:4:7:9:9:10:10:10:6:?:0. Sternal chaetotaxy: $\frac{3}{6}$:(4)9(4):(4)9(4):11:16:14:15:16:?:?:?:mm. The genital area is typical for the genus. The cribriform area is modestly sclerotized.

Dentition and chaetotaxy of the chelicerae are similar to that of the male, but the galeal tubercle is represented by a distinct protuberance.

The palpal chela is distinctly heterodentate and with essentially the same number of denticles as in the male.

Palpal proportions: trochanter 1.60-2.12, femur 3.84-5.14, tibia 1.43-1.90, chela 3.44-4.42 times as long as broad; finger 1.68-1.93 times as long as hand, and 1.00-1.14 times as long as femur; chela 1.38-1.57 times as long as finger.

The legs are moderately robust and of typical facies. Proportion of leg I: basifemur 3.82-4.74, telofemur 1.89-2.40, tibia 3.07-4.12, tarsus 7.04-8.78 times as long as deep; Leg IV: entire femur 2.42-3.00, tibia 3.44-4.89, metatarsus 2.34-2.98, telotarsus 7.16-9.12 times as long as deep.

Measurements (in millimeters): (The two figures given for each structure and separated by a hyphen represent the ranges observed in the material examined.) Male. Total length 1.20-1.63; chelicera 0.263-0.331 by 0.188-0.281; Palp: trochanter 0.169-0.219 by 0.100-0.131, femur 0.506-0.619 by 0.103-0.168, tibia 0.213-0.256 by 0.115-0.163, chela 0.793-0.945 by 0.168-0.235; chelal hand 0.275-0.378 long; finger 0.525-

0.642 long; Leg I: basifemur 0.275-0.356 by 0.063-0.075; telofemur 0.125-0.156 by 0.060-0.075, tibia 0.150-0.231 by 0.038-0.058, tarsus 0.306-0.369 by 0.038-0.050; Leg IV: entire femur 0.450-0.531 by 0.158-0.213, tibia 0.300-0.368 by 0.073-0.093, metatarsus 0.138-0.188 by 0.050-0.068, telotarsus 0.306-0.406 by 0.038-0.045. Female. Total length 1.36-1.89; chelicera 0.331-0.394 by 0.190-0.263; Palp: trochanter 0.213-0.300 by 0.106-0.150, femur 0.554-0.680 by 0.125-0.160, tibia 0.238-0.281 by 0.138-0.175, chela 0.869-1.060 by 0.219-0.281; hand 0.313-0.388 long; finger 0.579-0.705 long; Leg I: basifemur 0.306-0.369 by 0.070-0.085, telofemur 0.138-0.175 by 0.063-0.080, tibia 0.175-0.225 by 0.048-0.063, tarsus 0.338-0.406 by 0.042-0.050; Leg IV: entire femur 0.456-0.581 by 0.156-0.230, tibia 0.313-0.394 by 0.075-0.100, metatarsus 0.169-0.219 by 0.058-0.078, telotarsus 0.335-0.394 by 0.038-0.050.

Distribution: *K. crosbyi* was found frequently in my collections, but an examination of identified material on loan from the Illinois Natural History Survey showed that some specimens of *K. crosbyi* had been mistakenly identified as *K. multispinosus*. This error in identification invalidates any previous distribution data, therefore, the localities given in the material examined section for this species will constitute known distribution. Previously known locality records which must be considered suspect are from Mt. Mitchell, North Carolina and Quicksand, Kentucky. Further comments and discussion on the criteria for separating *K. crosbyi* and *K. multispinosus* will be given as a part of the discussion of *K. multispinosus*.

Discussion: Characteristic of *K. crosbyi*, as well as other species of the genus, is the slightly constricted posterior margin of the carapace which gives the junctions between the prosoma and the opisthosoma a "slim-waisted" appearance.

Malcolm and Chamberlin (1961) described the flagellum of the chelicera as consisting of six denticulate blades. All specimens examined by me show a strong unilaterally pinnate condition of the flagellum, however, in most instances it consists of seven blades. Chamberlin (1931a) has illustrated this structure for the family and has described it as arising from a circular or ovate areole. My observations support Chamberlin's (1931a) figures and descriptions of the flagellum. It is believed by me that the flagellum exhibits denticulate incisions on the blades, but this reflects age and shrinkage of the type specimen rather than a normal occurrence. This supposition is further supported by Hoff (1949) and Malcolm and Chamberlin (1961) who reported the body length as being 1.3 mm. which is contrary to the 1.5 mm. as indicated by Chamberlin (1929a) in the original description. These variations, as noted, makes me suppose that the measurements of the type material has become useless as a tool in species identification.

The length of the body in all material examined ranged from 1.20 to 1.57 mm., with the greater majority of the specimens having a total body length of 1.40 mm. The lower end of this range was represented by a single specimen which could have been a recently molted tritonymph. Because of the condition of the holotype, of which many measurements were not possible, Malcolm and Chamberlin (1961) described an allotype female to supplement the data not available on the holotype.

Since the discovery of this species by Chamberlin (1929a), one additional species _K. multispinosus_, was described by Hoff (1945a) in which the separation of the two species was based largely on the length-width ratio of the palpal femur. The reliability of this character in keeping the two forms distinct is hereby questioned. A discussion of the status of _K. crosbyi_ is deferred, and it will be treated in the discussion of _K. multispinosus_.

Kleptochthonius (_Kleptochthonius_) _multispinosus_ (Hoff, 1945)

PLATE XIII, FIG. 33, 34; PLATE XIV, FIG. 35, 36, 37, 38

Heterochthonius multispinosus, Hoff, 1945a, p. 314; _Heterochthonius multispinosus_, Hoff, 1949, p. 434; _Kleptochthonius multispinosus_, Hoff, 1951b, p. 5; _Kleptochthonius multispinosus_, Hoff and Bolsterli, 1956, p. 159; _Kleptochthonius multispinosus_, Hoff, 1958, p. 7; _Kleptochthonius_ (_Kleptochthonius_) _multispinosus_, Malcolm and Chamberlin, 1961, p. 14.

Type Specimen: All types were taken from the Duke Forest, Durham, North Carolina and are deposited in the American Museum of Natural History, New York.

Material Examined: Forty-four specimens collected from the following localities:

NORTH CAROLINA: Swain Co.: Cherokee Reservation, October 1966, J. E. Lawson (JEL 721, 730, 743). Yancey Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 7, 11, 18, 29, 45, 52, 58, 77, 81).

SOUTH CAROLINA: Greenville Co.: Greenville watershed, September 1962, T. P. Copeland (JEL 129).

TENNESSEE: Bledsoe Co.: Fall Creek Falls State Park, October 1962, T. P. Copeland (JEL 91). Cocke Co.: bank of French Broad River, October 1959, T. P. Copeland (JEL 292); Great Smoky Mountains National Park, Cosby Rd., October 1966, J. E. Lawson (JEL 702, 705, 711, 715). Greene Co.: Tusculum, Tulip Garden Rd., July 1953, T. P. Copeland (JEL 196). Overton Co.: Standing Stove State Park, October 1962, T. P. Copeland (JEL 93). Sevier Co.: Great Smoky Mountains National Park, Chimney camping area, July 1953, T. P. Copeland (JEL 137); near Park headquarters, October 1959, T. P. Copeland (JEL 277, 298). Unicoi Co.: Limestone Cove Rd., near Unicoi, July 1953, T. P. Copeland (JEL 148); Unaka Mt., July 1953, T. P. Copeland (JEL 230).

VIRGINIA: Dickenson Co.: Breaks Interstate Park, August 1963, Charlie White (JEL 489, 497, 507, 512, 522). Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 568, 576, 596, 626).

Diagnosis: Three to six coxal spines on each coxa I; movable chelal finger weakly heterodentate; accessory structure of the male genitalia absent; carapacal chaetotaxy 6-4 (20).

Description: Male. The males of *K. multispinosus* are small to moderately large, similar in general facies to other members of the subgenus.

The carapace is about as long as broad and two pairs of eyes are located dorsally and near the lateral margin of it. The derm of the dorsal surface is smooth, while, laterally, the derm is distinctly reticulate and interspersed with small spines. Ventral and anterior margins of the carapace are obscurely denticulate. A well-defined epistome is lacking but a slight elevation is present. Chaetotaxy 6-4 (20).

The abdomen is typical. Lyrifissures are located along the marginal setae of the tergites and sternites while microlyrifissures are abundant and scattered on the last three or four segments. The lateral border of the anterior tergites have markings similar to those found on the carapace. Tergal chaetotaxy: 4:4:6:6:6:7:9:8:7:6:7:0. Sternites are without any obvious sculpturing. Sternal chaetotaxy: $\frac{3}{10}$:(4-4):(3) $\frac{12\text{-}13}{6}$ (3):(3)8(3):12:10:11:9:10:8:2:mm. The genital area is typical (Fig. 38). The external genital area is of kleptochthoniine facies but the genitalia differ internally from *K. crosbyi* in lacking the accessory structure. The characteristic genital features showing the location of the accessory structure are illustrated in Fig. 32. The coxal area is characteristic and shows the following chaetotaxy: 2-2-1: 1-2-0-CS:2-2(or 3):2-3(or 4):2-3. The usual number of coxal spines is three on each coxa, but it is not unusual to find four, five or six. One specimen had four spines on one coxa and three on the other.

The chelicerae are of typical appearance for the subgenus. Their length is 1.20 to 1.71 times their width. The palm has seven long and acuminate setae. The derm is slightly sculptured, scalelike in appearance. Dorsally and medially, however, this texture is disrupted by the presence of about six or more small hispid tubercles. The flagellum consists of seven unilaterally branched blades. The movable finger has eight denticles, the most distal one being located between the tip of the finger and the remainder of the denticles which are grouped together into one continuous series. Of these denticles, the basal two are short, slightly rounded, and poorly defined, while the remaining five are distinct and deeply incised. The galeal knob is represented by a superficial elevation, while the galeal seta is located slightly distad from the midpoint of the finger with its length seldom extending beyond the tip of the finger. The fixed finger has nine denticles; the basal three, low, rounded, and poorly defined and the remaining six pointed and well defined.

Palps are similar in shape and outline (Fig. 33) to those of other members of the subgenus. Palpal proportions: trochanter 1.44-1.96, femur 4.33-5.56, tibia 1.36-2.09, chela 3.51-5.12 times as long as broad; finger 1.36-1.62 times as long as hand and 0.84-0.91 times as long as the femur; chela 1.56-1.72 times as long as finger.

Chaetotaxy and dentition of chela are as illustrated in Fig. 34. The fixed finger has a marginal row of 19-20 well spaced and sharply pointed macrodenticles, 9-11 smaller obtund microdenticles, and two much smaller denticles located at the base of the finger. The movable finger is essentially homodentate with 9-11 macrodenticles, 0-3 inconspicuous microdenticles, and 5-10 low, rounded, membranous, contiguous teeth located basal to the other denticles.

The legs are slender to moderately robust (Fig. 35, 36). The derm of legs I and II is smooth, while legs III and IV have small spines on the trochanter, femur, and tibia. Tarsal claws are simple. Proportions of leg I: basifemur 3.83-5.65, telofemur 2.08-2.50, tibia 3.67-4.50, tarsus 8.20-10.47 times as long as broad. Leg IV: entire femur

2.20-3.04, tibia 3.81-5.21, metatarsus 2.82-3.56, telotarsus 8.33-10.62 times as long as broad.

Female. In general the female is similar to the male, but slightly larger. The denticulate nature of the carapacal margins is more prominent than in the male. Carapacal setae 6-4 (20). Coxal chaetotaxy: 2-2-1:1-2-0-CS:2-3:2-3:2-3. Generally, there are three, but typically for the species there are four, five, or six spines on each coxa I. Chaetotaxy of tergites: 4:4:6:6:6:8:9:8:8:9:?:0. Sternal chaetotaxy: $\frac{3}{6}$:(3)8(3):(4)7(4):14:14:14:14:12:14:?:mm. Cribriform plates of the genital area appear typical.

Chelicerae are similar to those of the male but with the galeal prominence more distinct.

Palps are like those of the male. The chela exhibits a wide range of dentition. The fixed finger has 17-27 macrodenticles, 9-15 microdenticles, and two smaller basal denticles. The movable finger has 8-12 macrodenticles, 2-11 microdenticles, and 10-14 rounded, contiguous enlargements. As in the male, the microdenticles, when present, always occur singly between macrodenticles. Palpal proportions: trochanter 1.66-1.90, femur 4.43-5.26, tibia 1.85-2.00, chela 3.62-4.58 times as long as broad; finger 1.31-1.50 times as long as hand and 0.86-0.92 times as long as femur, chela 1.54-1.72 times as long as finger.

Proportions of leg I: basifemur 4.76-5.26, telofemur 2.05-2.40, tibia 3.77-4.65, tarsus 8.50-9.64 times as long as broad; Leg IV: entire femur 2.37-2.65, tibia 3.61-4.44, metatarsus 2.96-3.33, telotarsus 9.25-10.42 times as long as broad.

Measurements (in millimeters): Male. Body length 1.42-2.07; chelicerae 0.300-0.375 by 0.218-0.263 broad; Palp: trochanter 0.200-0.263 long by 0.113-0.138; femur 0.613-0.806 long by 0.115-0.160, tibia 0.231-0.313 by 0.131-0.169, chela 0.882-1.150 by 0.185-0.250, hand 0.350-0.469 long, movable finger 0.563-0.703 long; Leg I: basifemur 0.338-0.444 by 0.065-0.098, telofemur 0.144-0.188 by 0.063-0.075, tibia 0.194-0.256 by 0.048-0.058, tarsus 0.381-0.504 by 0.040-0.050; Leg IV: entire femur 0.550-0.693 by 0.203-0.243, tibia 0.369-0.469 by 0.080-0.100, metatarsus 0.194-0.250 by 0.052-0.073, telotarsus 0.381-0.488 by 0.038-0.048. Female. Body length 1.72-2.20; chelicerae, indeterminable; Palp: trochanter 0.250-0.294 by 0.138-0.163, femur 0.756-0.894 by 0.153-0.175, tibia 0.313-0.375 by 0.156-0.200, chela 1.10-1.33 by 0.250-0.306, hand 0.466-0.500 long, finger 0.655-0.806 long; Leg I: basifemur 0.400-0.469 by 0.083-0.089, telofemur 0.175-0.200 by 0.075-0.085, tibia 0.219-0.281 by 0.055-0.063, tarsus 0.425-0.519 by 0.048-0.058; Leg IV: entire femur 0.625-0.756 by 0.250-0.300, tibia 0.438-0.531 by 0.100-0.115, metatarsus 0.231-0.275 by 0.070-0.083, telotarsus 0.444-0.519 by 0.045-0.050.

Distribution: The discovery that some specimens of *K. crosbyi* were misidentified as *K. multispinosus* nullifies for the present the value of the previous distributional records for these two species. It is necessary for all specimens in the various museums, private collections, and other sources where specimens have been deposited to be properly identified and new distributional records published. Such a task is beyond the scope of this paper. The following list of known locales is given for *K. multispinosus*, but it is based on uncorrected distributional data, and some of the citations may refer to K. crosbyi.

ALABAMA: Monte Sano, Madison Co; Tuskegee, Macon Co.; Marshall Co.

ILLINOIS: Hardin, Pope, and Cangamon Cos.

KENTUCKY: Bowan; Quicksand.

MISSISSIPPI: Bolivar and Pike Cos.

MISSOURI: Iron and Wayne Cos.

NORTH CAROLINA: Great Smoky Mountains National Park, Newfound Gap; Hillsboro; Mt. Pisgah; Oteen; Raleigh; Blowing Rock; Duke Forest, Durham.

TENNESSEE: Franklin, Sevier, and Sumner Cos.

VIRGINIA: Alberta.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: K. multispinosus differs from other members of the subgenus by the nature of the dentition of the chela and by the absence of or modifications in certain reproductive structures in the male.

Both fingers of the chela in K. multispinosus are weakly heterodentate. Frequently, however, and especially in the males, the microdenticles of the movable finger are absent or greatly reduced in size and number. Malcolm and Chamberlin's (1961) two species, K. oregonus and K. geophilus described from the Pacific coast, possess only macrodenticles on the chelal fingers which are referred to as being homodentate. Chamberlin (1929b) and Hoff (1945a), in their diagnosis of K. crosbyi and K. multispinosus, have indicated a distinctly heterodentate condition of both chelal fingers. As illustrated in Fig. 34, K. multispinosus differs from these dentate conditions by having the fixed finger weakly heterodentate and a movable finger essentially homodentate to lightly heterodentate. Further, it should be noted that each macrodenticle always alternates with a single microdenticle. This is not the case in K. crosbyi since groups of two to three microdenticles interposed between macrodenticles are frequently found along the length of the chelal teeth, and, as a result, the number of macrodenticles are fewer in number and the microdenticles are greater in number than that found in K. multispinosus.

Figure 32 illustrates the male genitalia of K. crosbyi which is much like Chamberlin's (1931a) illustration for the type species of the genus. A study of the male genitalia of K. multispinosus (Fig. 37) demonstrates that at least one internal element, the accessory structure, is absent. The absence of this structure is quite evident in all specimens examined, and suggests that, perhaps, other softer elements of the genitalia may be different, but can not be demonstrated because the procedure used in mounting may have destroyed them. A comparison of Fig. 32 with Fig. 37 implies other differences, particularly in the size and shape of various structures. It should be pointed out, however, that because of a lack of terminology, except for that offered by Chamberlin (1931a), it is difficult to ascertain or to assign anatomical terms and functions to these structures.

Hoff (1951b) has indicated that K. multispinosus is more variable, particularly in the dimensions of the palpal podomeres, than was previously noted. According to Hoff, these differences are great enough to approach the size of the palpal podomeres of K. crosbyi. I, however, believe that _K. crosbyi_ is the organism with the greatest variability and that its podomeres closely approximate the size of the less variable _K. multispinosus_. Evidence to support this opposite opinion comes from the identified material of _K. multispinosus_ on loan from the Illinois Natural History Survey, which was deposited there by C. C. Hoff and by C. C. Hoff and J. E. Bolsterli. This material contains male specimens which possess the before mentioned accessory structure, and other male specimens which lack this structure. Further, the dentition of the chelal fingers is weakly heterodentate on those which lack the accessory structure, while those possessing this structure have distinctly heterodentate dentition. It is difficult to believe that these specimens represent a single species. The procedure followed in this paper is to assign those specimens with the accessory structure and a distinct heterodentate chelal finger to _K. crosbyi_ and those lacking the accessory structure and having essentially homodentate dentition on the movable chelal finger to _K. multispinosus_. Additional material of _K. multispinosus_ on loan from the American Museum of Natural History and from J. C. Chamberlin's collection, as well as those from the Illinois Natural History Survey, was compared with the holotype of _K. crosbyi_ and this comparison supports the action taken by me for the redefinition of _K. crosbyi_ and _K. multispinosus_.

Part of the difficulty regarding these two species has been the use of length-width ratios of the palpal femur. Previously _K. crosbyi_ has been characterized as having a ratio of 3.8 to 4.0, and _K. multispinosus_ as having a ratio of 4.7 to 5.5 for the palpal femur

(Malcolm and Chamberlin, 1961). As shown in the descriptions just completed, the ratio of the palpal femur in K. crosbyi can be as great as 5.16, and as low as 4.33 for K. multispinosus. Obviously, the use of such ratios is of no taxonomic value and should be discontinued since other characters, already mentioned, are of greater importance.

Genus Kewochthonius Chamberlin, 1929

Kewochthonius, Chamberlin, 1929b, p. 65; Neochthonius, Chamberlin, 1929b, p. 66; Kewochthonius, Chamberlin, 1931a, p. 212; Chthonius (Neochthonius), Beier, 1932a, p. 46; Kewochthonius, Hoff, 1951b, p. 4; Chthonius (Neochthonius), Beier, 1963, p. 20.

Type Species: Kewochthonius halberti (Kew, 1916)

Diagnosis: Coxal spines present on coxae II and III; marginal teeth of movable finger of chela much reduced in comparison with those of fixed finger; marginal teeth of both chelal fingers contiguous; intercoxal tubercle present; five setae on palm of chelicerae; galeal knob conspicuous.

Discussion: The genus Chthonius is partly characterized by the marginal teeth of the chela being widely spaced, at least distally. Chamberlin (1929b) noticed the contiguous marginal teeth of Chthonius halberti Kew, and erected the genus Kewochthonius. Furthermore, Chamberlin assumed the intercoxal tubercle to be absent since Kew had not mentioned it in his description of Chthonius halberti. Because of this supposed absence of the intercoxal tubercle in Kewochthonius, Chamberlin (1929b) created a second genus, Neochthonius, whose included members possessed the intercoxal tubercle. To this genus he assigned two species, _N. stanfordianus_ and _N. paludis_. Inasmuch as Chamberlin had not seen the type series, he acknowledged the possibility that _Kewochthonius halberti_ may possess the intercoxal tubercle, and if this could be shown, then _Neochthonius_ would be a synonym of _Kewochthonius_.

Hoff (1951b) indicated that Chamberlin had acquired specimens of _Kewochthonius halberti_ which did possess an intercoxal tubercle. As a result, _Neochthonius_ became a synonym of _Kewochthonius_, since the latter had priority by pagination.

Beier (1932a) has considered _Neochthonius_ as a subgenus of _Chthonius_, but Hoff (1951b) has suggested, apparently on the basis of a personal communication from Chamberlin, that _Kewochthonius_ be considered a separate genus differing from _Chthonius_ in the arrangement of the chelal teeth which are contiguous rather than spaced. Beier (1963) has retained the subgenus _Neochthonius_ for his work on the European fauna. In examining the limited material available, I agree with Hoff (1951b) that the genus is distinct and is deserving of generic rank.

The two species, _K. stanfordianus_ and _K. paludis_, are the only members found in the United States, and only one of these, _K. paludis_, is represented in these collections.

A further discussion of the anatomy of this genus is presented in the discussion following the description of _K. paludis_.

Kewochthonius paludis (Chamberlin, 1929)

PLATE XV, FIG. 39, 40; PLATE XVI, FIG. 41, 42

Neochthonius paludis, Chamberlin, 1929b, p. 66; Chthonius (Neochthonius) paludis, Beier, 1932a, p. 46; Chthonius (Chthonius) pearsei, Hoff, 1945a, p. 319; Kewochthonius paludis, Hoff, 1951b, p. 4; Kewochthonius paludis, Hoff and Bolsterli, 1956, p. 157.

Type Specimen: The holotype was collected at Billy's Island, Okefinokee Swamp, Georgia, and is deposited in the Cornell University collections.

Material Examined: Seventeen specimens collected from the following localities:

TENNESSEE: Bledsoe Co.: July 1953, T. P. Copeland (JEL 250). Blount Co.: near Fontana Lake, July 1953, T. P. Copeland (JEL 141). Campbell Co.: Jacksboro, July 1953, T. P. Copeland (JEL 218). Claiborne Co.: July 1953, T. P. Copeland (JEL 216). Rhea Co.: Glen Alice, July 1953, T. P. Copeland (JEL 219, 243, 248). Sequatchie Co.: July 1953, T. P. Copeland (JEL 235). Sevier Co.: Great Smoky Mountains National Park, Newfound Gap, July 1953, T. P. Copeland (JEL 170). Union Co.: July 1953, T. P. Copeland (JEL 227, 244).

SOUTH CAROLINA: Greenville Co.: Paris Mountain State Park, September 1962, T. P. Copeland (JEL 128).

Diagnosis: Marginal teeth of chelal fingers contiguous, those of movable finger much smaller than those of fixed finger; coxal spines on coxae II and III; intercoxal tubercle present; galeal protuberance conspicuous.

Description: The males are small animals with a moderately stout body and long slender appendages. The range of body length is 0.92 to 1.27 mm.

The carapace is almost rectangular in shape and lightly invested with setae. The chaetotaxy is 4-2 or 4 (18 or 20). A small epistome with a serrated margin is present. The anterior margin of the carapace, laterad to the epistome, is dentate. The derm of tha carapace is smooth except for the reticulate markings on the lateral side which are interspersed with spinules. Two pairs of eyes are present with the anterior pair strongly developed and conspicuous and the posterior pair weakly developed and difficult to demonstrate.

The abdomen is more or less ovate in shape and slightly longer than the prosoma. The anterior half of each tergite is slightly sculptured with reticulate markings, the degree of these netlike impressions diminishing on the more posterior segments. Tergal chaetotaxy: 4:4:4:6:6:6:6:6:4:4:2:0. The sternites are without any obvious markings and with a chaetotaxy of: $\frac{3}{6}:\frac{8\text{-}6}{(2)8(2)}$:(2)6(2):6:6:6:6: 6:6:?:mm. The genital area appears to be typical. The setae of the margin of the anterior operculum are widely spaced and scattered. The coxae have three microsetae on the first pair of pedal coxae, eight coxal spines on the second pedal coxa, and four on the third. The coxal spines are separate and are not fused basally. Under higher magnifications (oil immersion), the coxal spines appear pinnate with very small lateral branches along the entire length of the spine. Coxal chaetotaxy: 2-2-1:2-1-ms:2-2-CS:1-4-CS:1-6.

The chelicerae are of typical facies for the genus. Their length is about 1.7 times the width. The palm has five setae. The movable finger has the galeal seta inserted about midway along its length as well as a prominent galeal tubercle. The flagellum possesses six unilateral pinnate blades. Denticles of the movable finger are large, acute, and arranged in a series of six teeth plus one additional tooth distally placed at about the level of the galeal tubercle. The fixed finger has eight to ten marginal teeth with the distal teeth larger than the basal teeth.

Figure 39 illustrates the palpus. Palpal proportions: trochanter 1.42-1.97, femur 4.38-4.47, tibia 1.66-1.71, chela 4.44-4.56 times as long as broad; finger 1.71-2.09 times as long as hand, and 0.91-1.00 times as long as femur; chela 1.53-1.58 times as long as finger.

The chaetotaxy and dentition of the chela are as illustrated in Fig. 40. The fixed finger has 47 denticles along the marginal row which extend nearly to the base and have cusps directed basally. The movable finger has 37 denticles which differ in shape from the teeth of the fixed finger (inset of Fig. 40).

The legs are slender to moderately robust (Fig. 41, 42). The surface of the podomeres is smooth. The tarsal claws are simple. Proportions of leg I: basifemur 4.04-4.16, telofemur 2.06-2.18, tibia 3.22-3.57, tarsus 7.64-9.03; leg IV: entire femur 2.12-2.36, tibia 3.46-3.90, metatarsus 2.43-2.60, telotarsus 9.20-9.82 times as long as broad.

Female. None collected.

<u>Measurements</u> (<u>in millimeters</u>): Male. Body length 0.92-1.27;

chelicera 0.213-0.250 by 0.117-0.125; Palp: trochanter 0.113-0.148 by 0.070-0.083, femur 0.338-0.363 by 0.073-0.083, tibia 0.135-0.168 by 0.083-0.098, chela 0.506-0.556 by 0.100-0.125, chelal hand 0.163-0.219 long, chelal finger 0.331-0.375 long; Leg I: basifemur 0.225-0.255 by 0.051-0.063, telofemur 0.093-0.107 by 0.045-0.051, tibia 0.125-0.143 by 0.035-0.040, tarsus 0.237-0.280 by 0.030-0.031; Leg IV: entire femur 0.375-0.423 by 0.163-0.199, tibia 0.250-0.281 by 0.064-0.081, metatarsus 0.128-0.143 by 0.050-0.055, telotarsus 0.275-0.291 by 0.028-0.030.

Distribution: The previously known distribution of *K. paludis* is given in the list below. Moreover the material studied from Greenville Co., South Carolina and the several Tennessee counties represent new records.

GEORGIA: Billy's Island, Okefinokee Swamp.

NORTH CAROLINA: Concord; Duke Forest; Pittsboro; Yanceyville.

MISSISSIPPI: Ocean Springs, Jackson Co.

TENNESSEE: Reelfoot Lake.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Chamberlin (1929b) placed this species in the newly erected genus *Neochthonius* on the basis of the presence of an intercoxal tubercle between the third and fourth pedal coxae. Subsequent investigations (Hoff, 1951b) have shown this genus to be a synonym of *Kewochthonius*, and its included species were accordingly transferred. Beier (1932a, 1963) has not accepted *Kewochthonius* as a distinct genus and has treated *K. paludis* as a species of the genus *Chthonius*, subgenus

Neochthonius.

Hoff (1945a) reported a new species _Chthonius_ (_Chthonius_) _pearsei_ from the Duke Forest in North Carolina. Later, Hoff (1951b) considered _C_. _pearsei_ a synonym of _K_. _paludis_ without explanation.

The measurements and ratios of the examined material agree with the description given by Hoff (1945a) for _C_. _pearsei_ and Chamberlin (1929b) for _Neochthonius_ _paludis_. In some instances the reported ranges for these numerical data were extended, but these changes were not great enough to be considered significant. Moreover, it should be pointed out that the condition of my specimens were poor and could perhaps reflect inaccurate measurements.

The inset of Fig. 40 illustrates the marginal teeth of the chela. The difference in shape between the denticles of the two fingers is obvious. The teeth of the movable finger are modified by being slightly wider and not nearly as long as those on the opposing finger.

The number of setae of the carapace differs from that reported by Chamberlin (1929b) and Hoff (1945a). Both authors have indicated four setae on the posterior margin. This number (four) was found on identified material on loan, however, it was possible to demonstrate only two setae on the posterior carapacal margin of the other specimens studied. This difference in setal number of the carapace does not imply a species distinction but, rather, shows a variation in the number of setae present on the posterior margin. One source of error, mentioned earlier, is the condition of the specimens used for comparison. The chaetotaxy of the carapace given in the description allows for two or four setae on the posterior margin.

The tergal chaetotaxy of the abdomen, as reported by Chamberlin (1929b) and confirmed by me, differs from the 2:2:2:2:3:3:3:3:3:mm. arrangement given by Hoff (1945a). Perhaps there is much more variation in the setal number than is realized, or Hoff has simply reported only those setae found on each half of a tergite. If this is the case, he did not indicate this method in his original description. Regardless of how Hoff arrived at the tergal chaetotaxy, the number of setae on the sternites and genitalia of the material studied compare favorably with the figures given by Hoff (1945a).

The discrepancies noted above are intended to describe the variability which apparently exists in this species. _K. paludis_ can easily be confused with _Chthonius_ (_Chthonius_) _ischnocheles_, but the information given above and in the description should serve to delimit and separate these two species.

Genus _Chthonius_ Koch, 1843

Chthonius, Chamberlin, 1929b, p. 69; _Chthonius_, Beier, 1932a, p. 43; _Chthonius_, Hoff, 1949, p. 432; _Chthonius_, Beier, 1963, p. 19.

Type Species: _Chthonius orthodactylum_ (Leach, 1817)

Diagnosis: Body length ranging from 1.0 to 2.5 mm.; carapace with about 20 setae; intercoxal tubercle present; coxal spines present on mesal portion of second and third pedal coxae; marginal teeth of fixed chelal finger, acute and distinctly spaced, those of movable finger, variable.

Discussion: The characters given in the diagnosis should serve for identification, but the coxal spines are short, feathered ones which are well spaced. In addition to this character, the specimens studied have two tactile setae, IB and ISB, on the dorsum of the hand which is also typical for the tribe Chthonini.

The genus has been separated into several subgenera but only one, Ephippiochthonius, is represented in the collections studied here. Characteristically the subgenus displays a depression between the tactile setae of the dorsum of the hand and the base of the finger. The marginal teeth of the chela are long, acute, and well separated.

Several species of this genus have been reported in the United States, but only one, Chthonius (Ephippiochthonius) tetrachelatus has been collected within the geographic limits of this paper.

Chthonius (Ephippiochthonius) tetrachelatus (Preyssler, 1790)

PLATE XVII, FIG. 43, 44, 45; PLATE XVIII, FIG. 46, 47, 48

Chthonius tetrachelatus, Chamberlin, 1929b, p. 72; Chthonius tetrachelatus, Chamberlin, 1931a, p. 128; Chthonius tetrachelatus, Beier, 1932a, p. 56; Chthonius tetrachelatus, Roewer, 1937, p. 239; Chthonius tetrachelatus, Vachon, 1941, pp. 442-449; Chthonius (Ephippiochthonius) tetrachelatus, Hoff, 1951b, p. 2; Chthonius (Ephippiochthonius) tetrachelatus, Hoff and Bolsterli, 1956, p. 157; Chthonius (Ephippiochthonius) tetrachelatus, Hoff, 1958, p. 3; Chthonius tetrachelatus, Gabbutt and Vachon, 1963, p. 75; Chthonius (Ephippiochthonius) tetrachelatus, Beier, 1963, p. 57.

Type Specimen: Chamberlin (1929b) believes the type is not extant and his determinations were based on common repute. Type locality is not known.

Material Examined: Sixty-eight specimens collected from the following localities:

MARYLAND: Montgomery Co.: Plummer's Isle, November 1963, T. P. Copeland (JEL 326, 327, 328, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345).

NORTH CAROLINA: Swain Co.: Great Smoky Mountains National Park, Deep Creek Camp grounds, October 1966, J. E. Lawson (JEL 739).

TENNESSEE: Sevier Co.: Great Smoky Mountains National Park, October 1959, T. P. Copeland (JEL 268).

VIRGINIA: Floyd Co.: Blue Ridge Pkwy., October 1962, J. E. Lawson (JEL 95, 97, 106). Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 621, 648, 655, 657, 659, 660).

Diagnosis: Teeth of inner margins of chelal fingers well separated, long, and acute; an obvious depression just proximal from base of fixed finger; coxal spines on mesal portion of coxae II and III; intercoxal tubercle present.

Description: Male. The males are small pseudoscorpions similar to other members of the subgenus.

The carapace is sparsely invested with a few stout setae which are disposed in five, more or less, linear rows giving a chaetotaxy of 4-6-4-2-2 or 4 = 18 or 20. In many instances, the posterior row has four setae, the outermost two small and the inner two much larger and lanceolate. The eyes are four in number. The anterior margin is truncate and has an epistome which is serrate medially and dentate laterally. The derm is distinctly reticulate anteriorly and laterally; the lateral surface bears a large number of spinules.

The shape of the abdomen is typical of the subgenus. Both tergites and sternites have reticular markings which are more pronounced on the lateral margins. Like the carapace, the abdomen is sparsely invested with setae. Tergal setae are lanceolate and have the following chaetotaxy: 4:4:4:4:6:6:6:6:6:6:?:0. The setae of the sternites are acuminate and are more numerous than those on the tergites. Sternal chaetotaxy: $\frac{4}{6}$: $\frac{7\text{-}7}{(2)9)2)}$:(2)9(2):7:4:4:5:4:4:?:mm. The genital area is illustrated in Fig. 48. Coxal chaetotaxy: 2-2-1:1-2-1-ms:2-2-CS:1-2-CS: 1-5. Coxa I has, on its mesal portion, three microsetae which are included in the above formula by the letters ms. The number of spines on coxa II range from 9-11 and on coxa III from 4-6. The shape of these coxal spines are similar on both coxa II and coxa III in that they are short and feathered. Intercoxal tubercles are bisetose.

The chelicerae are large in relation to body size. The length is 1.48 to 1.76 times as deep. The galeal tubercle is pronounced and slightly proximal from the apical curve of the finger. Internal galeal ducts are present but inconspicuous. A few small hispid tubercles are present on the medial portion of the palm, but they are inconspicuous and difficult to demonstrate. The flagellum is typical of the family and consists of six unilaterally branched blades. The branches of each blade seem to be fewer in number than observed in other genera of the family Chthoniidae.

Seven to ten denticles form a continuous series on the movable finger. The distal tooth is, by far, the largest of the group. Frequently, this denticle is incised at the tip and has a bifid appearance. The marginal teeth of the fixed finger number seven to nine and they are arranged in a series. Distally, these denticles are large and conspicuous. In addition to these larger teeth, there are four small dentate protrusions which are basal to them. The galeal seta is located on the midpoint of the movable finger and it never extends beyond the limits of the finger. The palm has three accessory setae in addition to the normal complement. Two of these accessory setae are microsetae and are located ventrally and medially on the hand, while the other accessory seta is normal in size and is located basally and laterally. The subbasal seta is much larger and longer than the others, making it more conspicuous.

The pedipalp is illustrated in Fig. 43. Palpal proportions: (the figures listed represent the ranges of the material examined): trochanter 1.51-1.77, femur 5.44-6.17, tibia 1.83-2.32, chela 4.41-5.33 times as long as broad; finger 1.18-1.39 times as long as hand, and 0.73-0.82 times as long as femur; chela 1.72-1.83 times as long as finger.

Characteristic for this species is the depression found on the dorsum of the chela hand. Figure 44 shows this depression beginning distad to the tactile setae and reaching its greatest depth about the level of the fixed finger. The dentition and chaetotaxy are also shown in this figure. The denticles of the fixed finger are large, pointed, and well separated, but distally the distance between denticles is not as great as medially. At the apex of the marginal denticles the first tooth is out of series and is placed laterad on the finger. The number of teeth range from 14-17. The movable finger possesses 8-11 large teeth and some obtund protrusions, whose exact number was difficult to ascertain. At the junction of the chelal fingers a highly sclerotized area is present and has been called an apodeme by Chamberlin (1929b).

The legs are typical (Fig. 46, 47). The derm is smooth. Tarsal claws are simple. Proportions of leg I: basifemur 4.33-5.52, telofemur 2.33-3.00, tibia 3.90-4.27, tarsus 8.05-9.84 times as long as broad. Leg IV: entire femur 2.10-2.39, tibia 3.46-4.25, metatarsus 2.36-3.67, telotarsus 7.18-11.03 times as long as broad.

Female. The female is larger than the male and has more slender appendages.

The carapace has lanceolate setae arranged as in the male. The chaetotaxy is 4-6-4-2-2 or 4 = 18 or 20. The anterior carapacal margin is distinctly serrate medially and dentate laterally. The epistome is represented by a low elevation. The derm, like that of the male, is reticulate and with small spines. Two pairs of eyes are present.

The abdomen has reticulate margins on the anterior tergites and sternites. Posteriorly these markings are confined to the lateral margins of these plates. Tergal chaetotaxy: 4:4:4:4:6:6:6:6:6:?:0. Sternal chaetotaxy: 10:(4)9(4):(2)8(2):9:6:6:6:6:4:4:mm. The cribriform area is of typical facies. Coxal chaetotaxy: 2-2-1:1-2-0-ms:2-2-CS:1-4-CS:1-5. Three microsetae are on the mesal portion of coxa I. The number of spines on coxa II is 9-12 and on coxa III, 4-6.

The chelicera has a length of 1.51 to 1.76 times depth. The derm is reticulate and with small spines. The galeal tubercle is obvious. Flagellum is of six unilaterally branched blades. Denticles are similar to those of the male: fixed finger 7-9, movable finger 7-10. The palm has three accessory setae similarly disposed as those in the male.

Proportions of palpal podomeres: trochanter 1.47-1.77, femur 4.92-5.95, tibia 1.75-2.17, chela 4.22-4.95 times as long as broad; finger 1.15-1.37 times as long as hand, and 0.71-0.79 times as long as femur; chela 1.71-1.84 times as long as finger.

The depression on the dorsum of the chelal hand is not as greatly accented as in the male because of the greater depth of the chelal hand (Fig. 45). Dentition of chela: fixed finger 15-18; movable finger 8-11. The teeth on both fingers are similar to those of the male. A heavily sclerotized area is also present at the base of the movable finger.

Proportions of leg I: basifemur 3.98-4.86, telofemur 2.16-2.81, tibia 3.83-4.52, tarsus 8.05-9.52 times as long as broad. Leg IV: entire femur 2.13-2.44, tibia 3.63-4.68, metatarsus 2.50-2.76, telotarsus 8.39-10.21 times as long as broad.

Measurements (in millimeters): Male. Body length 1.21-1.60; chelicera 0.250-0.311 by 0.148-0.204; Palp: trochanter 0.138-0.169 by 0.087-0.100; femur 0.488-0.575 by 0.080-0.100; tibia 0.181-0.231 by 0.092-0.119; chela 0.655-0.781 by 0.128-0.163; hand 0.288-0.344 long; finger 0.375-0.438 long; Leg I: basifemur 0.265-0.321 by 0.060-0.070; telofemur 0.133-0.168 by 0.053-0.063; tibia 0.158-0.189 by 0.040-0.046; tarsus 0.291-0.347 by 0.033-0.039; Leg IV: entire femur 0.438-0.569 by

0.188-0.238; tibia 0.275-0.344 by 0.069-0.088; metatarsus 0.143-0.188 by 0.056-0.069; telotarsus 0.281-0.375 by 0.031-0.044. Female. Body length 1.23-1.80; chelicera 0.296-0.352 by 0.181-0.219; Palp: trochanter 0.156-0.188 by 0.094-0.117; femur 0.517-0.630 by 0.090-0.113; tibia 0.219-0.265 by 0.102-0.131; chela 0.718-0.856 by 0.153-0.188; hand 0.321-0.375 long; finger 0.403-0.469 long; Leg I: basifemur 0.268-0.342 by 0.064-0.083; telofemur 0.142-0.179 by 0.055-0.068; tibia 0.173-0.207 by 0.043-0.060; tarsus 0.306-0.362 by 0.036-0.040; Leg IV: entire femur 0.474-0.569 by 0.194-0.256; tibia 0.301-0.363 by 0.075-0.092; metatarsus 0.165-0.204 by 0.061-0.070; telotarsus 0.316-0.388 by 0.033-0.040.

Distribution: Beier (1932a) has given Europe and North America for the distribution of C. (E.) tetrachelatus. Chamberlin (1929b) examined material from France and Sweden, but did not give general distributional data for that continent. C. (E.) tetrachelatus has been reported previously from the following localities in the United States:

CONNECTICUT: New Haven; Rowayton; Rawson Park.

GEORGIA: Gainesville.

ILLINOIS: Hardin, Lawrence, Pike, Quincy, Richland, and Scott Cos.

INDIANA: Bloomington; Montgomery Co.

KENTUCKY: Lexington.

MAINE: State record only.

MARYLAND: State record only.

MASSACHUSETTS: State record only.

NEW JERSEY: Cape May.

NEW YORK: Ithaca; Long Island; Sea Cliff; Sound Beach.

NORTH CAROLINA: State record only.

OHIO: Clark Co.; Mariemont.

PENNSYLVANIA: Telford.

WASHINGTON, D. C.: Rock Creek Park.

VIRGINIA: State record only.

Great Smoky Mountains National Park, Sevier Co., Tennessee is a new record for C. tetrachelatus. Material examined from Maryland, North Carolina, and Virginia may be new records but cannot be recorded as such because C. tetrachelatus has been reported from these states.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Chamberlin (1929b) believed this species included several forms which, subsequently, would be recognized as subspecies as more specimens were examined. C. (E.) tetrachelatus, however, has defied all attempts at separation into groups or subgroups. This pseudoscorpion is an extremely variable species, as indicated in the measurements given. Hoff (1951b) recognized a high degree of individual variation but noted, particularly, the sexual dimorphism in the hand of the chela. He reported the depth of the chelal hand in males ranged from 0.125 to 0.155 mm. and in females 0.160 to 0.190 mm. These figures fall within the limits reported by me in the description and because of the wide range in the dimensions reported the possibility of exceeding these limits, particularly those for the chela of both sexes, would be remote.

One closely related species, Chthonius (Globochthonius) virginicus, reported by Chamberlin (1929b), should now be questioned. In his original description Chamberlin reported the distinctive characteristics of _C._ (_G._) _virginicus_, as four setae on the posterior row of the carapace, a pedicellate chela, and length-width palpal proportions of 5.3 for the femur, 1.7 for the tibia and 4.6 for the chela. When compared with the palpal proportions given earlier for _C._ (_E._) _tetrachelatus_, these dimensions of _C._ (_G._) _virginicus_ fall within the middle of the reported ranges, with the exception of the tibia which is at the lower end of the range. Certainly these measurements are not adequate for the separation of species because Beier (1932a), in his diagnosis of _C._ (_E._) _tetrachelatus_, lists figures which overlap and are similar to those reported by Hoff and me.

Vachon (1941a, 1941b) and Gabbutt and Vachon (1963) reported that _C._ (_E._) _tetrachelatus_ has only two setae on the posterior row, while Chamberlin (1929b) has reported four on _C._ (_G._) _virginicus_, consisting of two normal sized and two laterally placed smaller setae. Apparently, Chamberlin believed this to be a new species on the basis of this difference in chaetal number. Hoff (1951b), however, reported that in his collections he found some individuals with two setae and others with four on the posterior row. In the specimens with four setae, Hoff has included the smaller setae but has not made an effort to distinguish between setae of the carapace on the basis of size. If this is correct, since Hoff makes no mention of microsetae in his work, then the number of setae on the posterior row may be two or four. This complements my observations since some specimens possess only two medially placed setae while others have four. Material identified by Hoff of C. (E.) tetrachelatus on loan from the American Museum of Natural History also shows a specimen with four setae on the posterior row.

The other character used by Chamberlin as diagnostic of C. (G.) virginicus is the more pedicellate condition of the palpal chela. When two specimens are described as similar except for a slight difference in length, the use of such a character becomes vague and invites disagreement. The material upon which Chamberlin based his description of this species was composed of females and, as mentioned earlier, C. (E.) tetrachelatus has a high degree of individual variability and sexual dimorphism. Inasmuch as males were not available for the original description, Chamberlin was not able to observe the dimorphism of the sexes. Chamberlin placed C. (G.) virginicus in the subgenus Globochthonius which is characterized by a swelling of the basal portion of the chela. This assignment has been doubted by Hoff (1958) since he placed a question mark after the subgenus in his listing of species in the United States. A small amount of such swelling is seen in females of C. (E.) tetrachelatus, however, because of the greater depth of the hand, the degree of the swelling does not approximate that of any of the species of the subgenus Globochthonius.

The small setae or microsetae of the carapace have been considered. In this connection, the microsetae of the chelicerae and coxa I need to be discussed and their disposition described.

The normal number of setae on the cheliceral hand is five, but some genera exhibit additional setae, however, which are termed accessory setae. Gabbutt and Vachon (1963) have listed the number of cheliceral setae as 1 + 6, meaning one setae on the movable finger and six, including the accessory setae, on the cheliceral palm. This method is acceptable because all these setae are located on the lateral surface and are easily counted. Close observation of the ventral and basal margin of the palm, however, locates two microsetae not included in the above expression. It is believed their presence should be recognized in the chaetotaxy. Otherwise, if excluded, they could present some problems if not mentioned and specifically located. It is suggested that these microsetae be considered as accessory setae and included in the total number of setae on the chelal hand.

The mesal portion of each coxa I displays three microsetae which, like those on the carapace, have not been included in the coxal formula. The presence of setae on the first coxa is suggestive of coxal spines of other genera and, perhaps, could indicate a phylogenetic affinity. This would be difficult to prove but, nevertheless, the presence of these setae and their occupying essentially the same position as coxal spines deserves mention. The intent here is to include these setae in the coxal chaetotaxy. The method of identifying these is similar to the manner in which coxal spines are indicated. In this instance, however, the letters ms are added to that portion of the formula identifying coxa I. Then the size, number, and position are given in the description.

The need for the inclusion of the microsetae of the carapace, coxa I, and the chelicera in the chaetotaxal formula is obvious. The term "micro" is relative and the exclusion of setae because of size certainly may lead to confusion. The investigator could easily misinterpret size and, on this basis, erect new species or subspecies.

It would seem that the discussion presented supports an earlier statement that the validity of *C. virginicus* is in question since it appears to be a synonym of *C. tetrachelatus*.

Suborder Diplosphyronida Chamberlin, 1929

Homosphyronida (in part.) + Diplosphyronida, Chamberlin, 1929b, p. 56, 78; Diplosphyronida, Chamberlin, 1930, p. 6; Diplosphyronida, Chamberlin, 1931a, p. 213; Neobisiinea, Beier, 1932a, p. 74; Neobisiinea, Roewer, 1937, p. 242; Diplosphyronida, Hoff, 1949, p. 443; Neobisiinea, Beier, 1963, p. 80.

Diagnosis: Medium to large sized pseudoscorpions with body length of 1.5 to 5.0 mm.; all pedal appendages with six segments, exclusive of the coxa; tarsus of each leg divided into metatarsus and telotarsus (Chamberlin, 1930).

Discussion: Pseudoscorpions of this suborder can be recognized by the two-segmented pedal tarsi. The genus *Synsphyronus* of the family Garypidae, however, has only one tarsal segment on the pedal appendages. This genus is not found in the United States, and for this reason, the keys used herein are not affected.

Chamberlin (1930) has divided the suborder into two superfamilies, the Neobisioidea and Garypoidea. Both superfamilies reflect the earlier Balzan-Hansen-With classificatory scheme mentioned earlier in this paper. Chamberlin's revision was based primarily on the number of tarsal segments and this newer scheme resulted in the reassignment of many families and genera.

In his monograph, Beier (1932a), a contemporary of Chamberlin, renamed the suborders and superfamilies proposed by Chamberlin in 1931 without making any significant changes in the concept of the categories so considered. Thus, the suborder Diplosphyronida became the suborder

Neobisiinea. In the case of superfamilies, he changed Chamberlin's endings of -oidea to -ides and, in this way, erected supposedly new superfamilies. This obvious synonymy was considered earlier.

Beier (1932a) not only included in this suborder the superfamilies Neobisioidea Chamberlin (Neobisiides Beier) and Garypoidea Chamberlin (Garypides Beier). Chamberlin (1931a) classified this last superfamily in the suborder Monosphyronida because of the one-segmented tarsus and the similarities between legs I and IV. In doing this, the genus *Synsphyronus* of the family Garypidae was retained in the suborder Diplosphyronida because of the dissimilarities between legs I and IV. Beier (1932a), on the other hand, raised *Synsphyronus* to family rank and included it in the superfamily Feaelloidea. Rather than considering this genus as an exception and relying on other characters to support its being placed in the family Garypidae, Beier was, in effect, destroying the concept of the suborder. By including the Feaelloidea in the Diplosphyronida and to justify its presence there, Beier indicated in his diagnosis the tarsi as being two-segmented or, rarely, one-segmented. If one-segmented, four eyes will also be present. This will allow for the feaelloids to be classified with the diplosphyronids. It is believed that Chamberlin (1943) showed sufficient evidence when he compared the superfamilies Garypoidea and Feaelloidea, pointing out the dissimilarities involved and how these superfamilies could not be of the same suborder. Unfortunately, the status of the Feaelloidea remains unsettled. This is of no real concern here, however, since members of this superfamily are not found within the geographical limits of this paper.

Key to superfamilies:

(a) Movable finger of the chelicera with a single subapical tooth which may be secondarily divided into two or three lobes............................Garypoidea

(b) Movable finger of the chelicera with denticles along at least one-fifth of inner margin.........Neobisioidea

Superfamily Garypoidea Chamberlin, 1930

Garypoidea, Chamberlin, 1930, p. 585; Garypoidea, Chamberlin, 1931a, p. 222; Garypides, Beier, 1932a, p. 176; Garypides, Roewer, 1937, p. 257; Garypoidea, Hoff, 1949, p. 446; Garypoidea, Hoff, 1956, p. 26.

Diagnosis: Inner margin of movable finger of chelicera with single subapical tooth which may or may not be secondarily divided into two or three lobes; basal plates of serrula interior fused; serrula exterior fused to movable finger; subterminal setae of tarsus simple and acute; flagellum of from one to four blades; suture between basifemur and telofemur strongly to slightly oblique to longitudinal axis of femur (Chamberlin, 1931a).

Discussion: Of the three families found in the United States, only one, the family Garypidae, has been reported from the eastern states. This family, represented by a single species, *Larca granulata*, was not found in any of the collections. It has been reported from Tennessee (Hoff and Bolsterli, 1956), however, but only in connection with rodent nests. Since the material used for this paper came from leaf mold, the presence of this species was not expected.

The characteristics given in the diagnosis are adequate for the recognition of members of the superfamily. It is suggested, however, that Chamberlin (1930, 1931a), Beier (1932a), and Hoff (1949, 1956b) be consulted for a more intensive treatment of the families, genera, and species.

Superfamily Neobisioidea Chamberlin, 1930

Neobisioidea, Chamberlin, 1930, p. 9; Neobisioidea, Chamberlin, 1931a, p. 215; Neobisiides, Beier, 1932a, p. 75; Neobisiides, Roewer, 1937, p. 243; Neobisioidea, Hoff, 1949, p. 443; Neobisioidea, Hoff, 1956b, p. 2; Neobisioidea, Hoff, 1958, p. 7.

Diagnosis: Movable finger of chelicera toothed along inner margin; subterminal setae of pedal tarsus forked or dentate (Chamberlin, 1930).

Discussion: The form of the carapace in this superfamily is quite similar to the chthonioids in being quadrate in shape and having subparallel sides. Also, the carapacal furrows are lacking which results in an uninterrupted dorsal surface. The anterior carapacal margin is characteristically provided with a single medial epistomal process. Its use in a diagnostic sense, however, is unreliable because within a single genus it may vary from a sharply pointed structure to nothing more than a shallow elevation.

The chelicerae are relatively large when compared to those of the suborder Monosphyronida but are smaller than those of the chthonioids.

The fingers cross when closed and, for this reason, the serrula exterior is free distally. The galea is either absent or, if present, small. Generally, the palm will have at least one accessory seta, which is of little systematic value, but is of supplementary importance in confirming and supporting the classification based upon other characters.

The Neobisioidea is represented in the United States by three families. Ideoroncidae is found only in the southwest, while Syarinidae is found in the Pacific Coast and the Rocky Mountain area. The third family, Neobisiidae, is well represented in the area from which the collections for this paper were taken.

The key below includes the three families mentioned, but subsequent discussion is concerned only with the family Neobisiidae.

Key to families:

1. (a) Venom apparatus developed in both chelal fingers... Ideoroncidae
   (b) Venom apparatus developed only in the fixed chelal finger.... 2
2. (a) Pleural membrane of abdomen smoothly and longitudinally plicate; suture separating basifemur and telofemur of femur IV slightly oblique to the longitudinal axis of the femur.....................................Syarinidae
   (b) Pleural membrane of abdomen granulate, never smooth; suture between basifemur and telofemur of femur IV perpendicular to the longitudinal axis of the femur.......Neobisiidae

Family Neobisiidae Chamberlin, 1930

Neobisiidae, Chamberlin, 1930, p. 9; Neobisiidae, Chamberlin, 1931a, p. 244; Neobisiidae, Beier, 1932a, p. 76; Neobisiidae, Hoff, 1949, p. 444; Neobisiidae, Hoff, 1956b, p. 2; Neobisiidae, Beier, 1963, p. 80.

Diagnosis: Venom apparatus in fixed finger of chela; pleural membrane of abdomen granulate, never striated or longitudinally plicate; suture between basifemur and telofemur of legs III and IV at right angles to longitudinal axis of femur (Chamberlin, 1930).

Discussion: The vertical symphysis on the femur of the third and fourth pedal appendages is diagnostic for the family. The interpretation of this joint is easily confused, and for this reason, other characters need to be emphasized.

The granular condition of the abdominal pleural membrane is characteristic and delimits the Neobisiidae from the Syarinidae and Ideoroncidae. There are, however, variations in which the granules are small or quite large, reaching a papillose condition. Regardless of the size of the granules, it is obvious that the pleural membrane is never smooth, strictly striated, or plicate. The arenaceous pleural membrane is diagnostic of the family.

Another feature of systematic value is the subterminal setae of the telotarsus. These setae are found on all pedal appendages and occur in pairs with each member of a pair on opposite sides of the tarsus. Their location is just dorsal to the claws. Setae that are distinctly forked and not merely dentate or with short side branches are characteristic of the Neobisiidae. This feature is of systematic interest since other families exhibit various shapes of setae which are quite different from the forked condition of the Neobisiidae.

Historically, the family Neobisiidae was once considered part of the subfamily Obisiinae, as defined by Simon in 1897. Also included within this subfamily were pseudoscorpions which make up the now recognized suborder Heterosphyronida. Simon's scheme consisted of three subfamilies, the Obisiinae included, under the single family Cheliferidae. In 1891, Balzan erected new families and subfamilies in his revision of the classificatory scheme. In this scheme the Neobisiidae and the suborder Heterosphyronida were again included under a single family, the Obisiidae. This did not do much in separating the Neobisiidae from the Heterosphyronida, but Balzan did recognize the dissimilarities involved and erected two subfamilies, the Obisiinae and the Chthoniinae. The former contained the Neobisiidae and the latter included the Heterosphyronida. By erecting several families and separating them into subfamilies, Balzan extended the classificatory scheme and made it less encompassing. The point here is that the scheme for classifying pseudoscorpions was being questioned as more and more animals were found. Later, Hansen, in 1894, revised the classification and included the Neobisiidae under the family Obisiidae, thus separating the family from the heterosphyronid pseudoscorpions and making the time right for a revision of the order (Chamberlin, 1931a).

Chamberlin (1930, 1931a) in his revision, maintained the separation of the neobisids and heterosphyronids primarily on the basis of the segmentation of the pedal appendages. Here, for the first time, the status of the Neobisiidae was stabilized, and its present name was assigned at the expense of the older name, Obisiidae, which was discarded. Further, Chamberlin erected new superfamilies and gave family rank to several subfamilies which strengthened his scheme by giving a more orderly arrangement to the diverse forms. Once this rearrangement was accomplished, subfamily categories were necessary to give consistence to Chamberlin's revised scheme. Currently, the family Neobisiidae consists of two subfamilies, the Neobisiinae and the Ideobisiinae, both of which have representatives within the geographical area considered in this paper.

Type genus: Neobisium Chamberlin 1930

Key to subfamilies:

(a) Cheliceral galea, if present, a sclerotized knob.... .... Neobisiinae

(b) Cheliceral galea present and represented by one or more transparent galeal processes........... Ideobisiinae

Subfamily Neobisiinae Chamberlin, 1930

Neobisiinae, Chamberlin, 1930, p. 9; Neobisiinae, Beier, 1932a, p. 7; Neobisiinae, Roewer, 1937, p. 244; Neobisiinae, Hoff, 1949, p. 444; Neobisiinae, Hoff, 1956b, p. 2; Neobisiinae, Beier, 1963, p. 80.

Diagnosis: Typical galeae on movable finger of the chelicerae absent and represented by a sclerotic knob.

Discussion: Chamberlin (1962) gave generic rank to the former subgenus *Parobisium*. With the erection of this genus, there are now three genera of the Neobisiinae found in the United States. The remaining two, *Neobisium* and *Microbisium*, are represented in my collections. *Parobisium* is a western genus, and is not included in the key to genera.

Key to genera:

(a) Adults with three tactile setae on the movable chelal finger and seven on the fixed chelal finger..........*Microbisium*

(b) Adults with four tactile setae on the movable chelal finger and eight on the fixed chelal finger..........*Neobisium*

Genus *Microbisium* Chamberlin, 1930

Microbisium, Chamberlin, 1930, p. 20; *Microbisium* Chamberlin, 1931a, p. 217; *Microbisium*, Beier, 1932a, p. 136; *Microbisium*, Roewer, 1937, p. 249; *Microbisium*, Hoff, 1946, pp. 493-494; *Microbisium*, Hoff, 1949, p. 444; *Microbisium*, Hoff, 1958, p. 8; *Microbisium*, Hoff, 1961, p. 431; *Microbisium*, Beier, 1963, p. 202.

Type Species: *Microbisium brunneum* (Hagen, 1869)

Diagnosis: Adults with three tactile setae on the movable finger of the chela, and seven on the fixed finger; movable finger without a galea; pleural membrane granulate; apical lobe of palpal coxa with three border setae (Chamberlin, 1930).

Discussion: Microbisium is a distinct genus among the pseudoscorpions, but considerable confusion has been apparent in the treatment of the American species. This discomfiture resulted because of the inadequate original descriptions of *Obisium brunneum* Hagen and *Obisium parvulum* Banks, the uncertainty of the type locality of *M. parvulum*, and the misidentification of *M. brunneum* as a type of *M. parvulum* (Hoff, 1946). Hoff (1946) attempted to clarify the status of these two species, and in so doing found and described a third species, *M. confusum*. In this work, Hoff was able to give a more detailed account of all three species. Unfortunately, the characters used, which consist mainly of extended measurements of the palpal podomeres, are not infallible, but are of importance when comparing species. In subsequent work (Hoff, 1949, 1956b, 1961; Hoff and Bolsterli, 1956), more data in the form of measurements and distribution have been compiled.

M. confusum was the only species found in the collections taken for this paper. This is expected since *M. parvulum* is a western species and *M. brunneum* is found in northern states. According to Hoff (1958) the records of *M. brunneum* from Georgia, Virginia, and the District of Columbia are of doubtful validity because the determinations are based on nymphs. Further, the reported presence of *M. brunneum* in Utah and Arkansas is probably due to a misidentification. In fact, Hoff and Bolsterli (1956) reexamined the specimens from Arkansas, reported by Hoff in an earlier paper, and showed that they should be referred to *M. confusum*.

Previously, all workers have indicated that the genus _Microbisium_ probably reproduces parthenogentically, since males had not been found. However, a single male is among the specimens studied here and it will be described in the species description of _M. confusum_.

Microbisium confusum Hoff, 1946

PLATE XIX, FIG. 49, 50, 51, 52; PLATE XX, FIG. 53, 54;

PLATE XXI, FIG. 55, 56, 57

Microbisium brunneum, Hoff (_non_ Hagen), 1945b, p. 34; _Microbisium confusum_, Hoff, 1946, p. 496; _Microbisium confusum_, Hoff, 1949, p. 446; _Microbisium confusum_, Hoff and Bolsterli, 1956, p. 160; _Microbisium confusum_, Hoff, 1958, p. 9; _Microbisium confusum_, Hoff, 1961, p. 432; _Microbisium confusum_, Hoff, 1963, p. 2.

Type specimen: Types were collected from a tamarack bog near Antioch, Illinois, and are deposited in the Illinois Natural History Survey, Urbana, Illinois.

Material Examined: One-hundred and six specimens collected from the following localities:

MARYLAND: Montgomery Co.; Plummer's Isle, November 1963, T.P. Copeland (JEL 326, 327, 332, 336, 340).

NORTH CAROLINA: Swain Co.: Great Smoky Mountains National Park, near Newfound Gap, April 1963, T.P. Copeland (JEL 318); Great Smoky Mountains National Park, Cherokee Rd., October 1966, J.E. Lawson (JEL 678, 679, 681, 690, 692, 693, 698); Cherokee Reservation, October 1966, J.E. Lawson (JEL 717, 720, 727, 736, 744, 748, 749). Yancey Co.: Mt.

Mitchell, July 1962, R. A. Durey (JEL 11, 14, 45, 83).

SOUTH CAROLINA: Greenville Co.: Paris Mountain State Park, September 1962, T. P. Copeland (JEL 128).

TENNESSEE: Blount Co.: Great Smoky Mountains National Park, near Cades Cove, July 1953, T. P. Copeland (JEL 131, 201, 352, 354). Carter Co.: Roan Mt., July 1953, T. P. Copeland (JEL 145, 165, 191, 225, 257, 271, 280). Chester Co.: Chickasaw State Park, June 1964, T. P. Copeland (JEL 422, 427, 433). Cocke Co.: Newport-Greeneville Hwy., July 1953, T. P. Copeland (JEL 178); Great Smoky Mountains National Park, Cosby campground, October 1966, J. E. Lawson (JEL 708, 709, 713, 716). Cumberland Co.: Cumberland Mt. State Park, October 1962, T. P. Copeland (JEL 90). Hamilton Co.: Signal Mt., July 1953, T. P. Copeland (JEL 221, 222). Henderson Co.: Natchez Trace State Park, June 1964, T. P. Copeland (JEL 391, 402, 406). Jefferson Co.: near Dandridge, July 1953, T. P. Copeland (JEL 205). Polk Co.: Ocoee Dam, May 1954, T. P. Copeland (JEL 297). Sevier Co.: Great Smoky Mountains National Park, Chimney's camping area, July 1953, T. P. Copeland (JEL 192, 210); Dupont Mt., April 1952, A. C. Cole (JEL 195). Union Co.: near Maynardville, July 1953, T. P. Copeland (JEL 188, 227, 232). Washington Co.: East Tennessee State University, July 1953, T. P. Copeland (JEL 152). Wilson Co.: Cedars of Lebanon State Park, October 1962, T. P. Copeland (JEL 92).

VIRGINIA: Dickenson Co.: Breaks Interstate Park, August 1963, Charlie White (JEL 322, 461, 468, 477, 490, 495, 507). Floyd Co.: Blue Ridge Pkwy., October 1962, J. E. Lawson (JEL 95, 106, 114, 314); Rocky Knob, September 1963, J. E. Lawson (JEL 533). Giles Co.: Mt. Lake, July

1965, T.P. Copeland (JEL 575, 595, 602, 607, 621, 623, 624, 625, 626, 638, 652, 654). Montgomery Co.: near Riner, September 1963, J.E. Lawson (JEL 315).

Diagnosis: Length of palpal femur less than 0.4 mm.; length-width ratio of palpal femur 2.06 to 3.04 .

Description: Male. A single specimen with a body length of 1.37 mm. The abdomen is robust and oval in shape and its length is more than twice that of the carapace.

The carapace is slightly broader than long. Four well developed eyes are present; the anterior pair about two ocular diameters removed from the anterior carapacal margin. The posterior pair of eyes are only about one-third an ocular diameter from the first pair. The derm of the carapace is smooth. The chaetotaxy is 4-6 (20). The epistome is prominent.

The abdomen is ovate in shape and its width is greater than the width of the carapace. The pleural membrane is granulate. Tergites and sternites are smooth and entire, with the following chaetotaxy:
Tergites 6:6:6:6:8:8:8:8:7:5:?:mm; Sternites 7:(2-2):$\frac{12}{(2)8(2)}$:(2)6(2): 11:10-12:10-12:10-12:8:3-6:mm.

The genital area is shown in Fig. 57. The three setae of the apical lobe of the palpal coxa are attenuate. In close proximity with these setae is the condylar seta which is of the same size and length. The smaller setae of the coxae are usually five in number.

The chelicerae are small and have a length of 0.183 mm. The length-width ratio is not given because the hand of the chelicera was broken making it impossible to obtain an accurate measurement. The flagellum is composed of five blades in which each blade appears to be smooth and not serrate. The palm has five setae. The galea is absent and represented by an enlarged sclerotic knob on the apex of the movable finger. The movable finger has ten acute teeth with the central denticles much larger and more conspicuous. The galeal seta is inserted distally on the movable finger. The denticles of the fixed finger are small, acute, low-lying, directed basally and number about 13 in the marginal row.

The palp (Fig. 53) is uniformly yellowish in pigmentation. The surface of all palpal podomeres is smooth and without any trace of granules. The femur has a lateral projection toward the proximal end. The tibia has a robust pedicel and body.

Palpal proportions: trochanter 1.65, femur 2.87, tibia 1.85, chela (excluding pedicel) 2.70 times as long as deep, finger 1.07 times as long as hand, and 0.93 times as long as femur; chela 1.76 times as long as finger.

The chaetotaxy of the palp is as shown in Fig. 54. The fixed finger has 30 teeth which are closely spaced, at least distally, and they are absent from the basal one-third of the finger. The movable finger has 32 denticles which cover the entire marginal length. The inset of Fig. 49 illustrates the difference in shape of the teeth on the two fingers. The last ten or so teeth of both fingers are reduced in size and are low and truncate. The position of the nodus ramosus on the fixed finger is difficult to identify but it appears to be on the same level as the third marginal tooth.

The legs are of typical facies (Fig. 55, 56). The subterminal tarsal seta is equally bifurcate, and is not denticulate.

Pedal proportions: Leg I: basifemur 2.58, telofemur 1.91, tibia 2.87, metatarsus 1.74, telotarsus 3.27; Leg IV: entire femur 2.87, tibia 4.09, metatarsus 1.72, telotarsus 3.55.

Female. The female is larger than the male and has stouter appendages. The range for the observed body lengths is 1.08 to 1.60 mm.

The lateral area of the carapace is definitely reticulate, and the lateral margins are papillose. The chaetotaxy of the carapace is 4-6 (20).

The abdomen is similar to that of the male. Tergal chaetotaxy: 6:7:8:10:10:9:8:8:9:9:?:mm. Sternal chaetotaxy: $0{:}2{:}(2)7(2){:}(2)6(2){:}\frac{2}{10}{:}\frac{2}{10}{:}\frac{2}{9}{:}\frac{2}{8}{:}11{:}3{:}6{:}$mm. Sternites five through eight exhibit two discal setae located medially which are indicated in the above expression.

Chelicerae are similar to those of the male. Cheliceral proportions range from 1.33 to 1.44 times as long as deep.

The palp (Fig. 50) is larger and stouter than the male pedipalp. Range of palpal proportions: trochanter 1.52-1.85, femur 2.06-3.04, tibia 1.70-2.00, chela (less pedicel) 2.43-2.85; finger 1.00-1.34 times as long as hand and 0.84-1.02 times as long as femur; chela 1.66-1.83 times as long as finger.

Legs are similar to those of the male (Fig. 51, 52). Pedal proportions: Leg I: basifemur 2.03-2.57, telofemur 1.43-1.72, tibia 2.42-3.33, metatarsus 1.62-2.00, telotarsus 2.90-3.76; Leg IV: trochanter 1.36-1.80, entire femur 2.38-2.96, tibia 3.37-4.32, metatarsus 1.58-2.01, telotarsus 3.39-4.08.

<u>Measurements</u> (<u>in</u> <u>millimeters</u>): Male. Body length 1.37; chelicera 0.183; palp: trochanter 0.179 by 0.108, femur 0.311 by 0.108, tibia 0.260 by 0.140, chela (excluding pedicel) 0.513 by 0.190; chela hand 0.270 long, movable finger 0.291 long; Leg I: basifemur 0.163 by 0.063, telofemur 0.115 by 0.060, tibia 0.138 by 0.048, metatarsus 0.068 by 0.039, telotarsus 0.118 by 0.036; Leg IV: entire femur 0.313 by 0.109, tibia 0.250 by 0.061, metatarsus 0.083 by 0.048, telotarsus 0.153 by 0.043. Female. Body length 1.08-1.60; chelicera 0.165-0.240 by 0.125-0.168; palp: trochanter 0.175-0.238 by 0.105-0.135, femur 0.306-0.394 by 0.110-0.138, tibia 0.250-0.313 by 0.135-0.175, chela (excluding pedicel) 0.525-0.656 by 0.193-0.243, chela hand 0.238-0.338 long, movable finger 0.294-0.375 long; Leg I: basifemur 0.155-0.195 by 0.063-0.090, telofemur 0.108-0.133 by 0.058-0.086, tibia 0.138-0.173 by 0.045-0.061, metatarsus 0.063-0.088 by 0.038-0.048, telotarsus 0.118-0.145 by 0.035-0.048; Leg IV: trochanter 0.135-0.163 by 0.075-0.113, entire femur 0.311-0.395 by 0.105-0.155, tibia 0.250-0.311 by 0.061-0.086, metatarsus 0.088-0.110 by 0.048-0.066, telotarsus 0.155-0.188 by 0.043-0.051.

<u>Distribution</u>: <u>M</u>. <u>confusum</u> appears to be a common species found in the Mississippi River Valley, the eastern United States, and has been reported from several states west of the Mississippi River. Previously known distribution for the species is given below.

ARKANSAS: White River, Washington Co.; Carroll Co.

COLORADO: Boulder, Gilpin, Larimer, Las Animas, Routt Cos.

ILLINOIS: Adams and Alexander Cos.; Alhambra; Alto Pass; Antioch; Apple River Canyon State Park; Astoria; Aurora; Bensenville; Brownfield

Woods; Browning; Burksville; Burton; Calhoun, Carrol, Champaign, Clark, Clinton, Cook, and Crawford Cos.; Cadiz; Caledonia; Charleston; Clarksville; Collinsville; Danville; DeKalb Co.; Dixon Springs; Dolson; Elgin; Enfield; Fayette Co.; Fountain Bluff; Fox Ridge State Park; Freeport; Galena; Gallatin Co.; Geff; Giant City State Park; Grafton; Halfday; Hancock, Hardin and Henry Cos.; Havana; Herod; Highland Lake; Ivanhoe; Jackson, Jo Daviess, Johnson, Kane, and Knox Cos.; Kampsville; Kell; Kellerville; Lake, La Salle, Lawrence, and Lee Cos.; La Grange; Lake Glendale; Lake Zurich; La Rue; Lincoln; Logan; McHenry, McLean, Madison, and Mason Cos.; Magnolia; Makanda; Marshall; Mascoutah; Monticello; Mound City; New Windsor; Oakwood; Ogle, Pike, Platt, and Pope Cos.; Palestine; Palisades State Park; Paloma; Palos Park; Peoria; Pochaontas; Quincy; Richland and Rock Island Cos.; Ruma; Sangamon and Scott Cos.; Seymour; Sherman; Siloam; Starved Rock State Park; Summit; Troy; Urbana; Ursa; Vermilion Co.; Vienna; Volo; Washington Co.; Wauconda; Waukegan; White Pines Forest State Park; Winthrop Harbor; Zion.

INDIANA: Montgomery and Harrison Cos.

IOWA: Howard Co.

KANSAS: Douglas Co.

KENTUCKY: Edmonson Co.

MISSOURI: Iron and Wayne Cos.

NEBRASKA: Pierce Co.

NEW YORK and NORTH CAROLINA: Reference is made to state only.

NORTH DAKOTA: Grand Forks, Ramsey and Walsh Cos.

OHIO: Miami and Prable Cos.

SOUTH DAKOTA: Custer, Lawrence, and Pennington Cos.

TENNESSEE: Franklin, Grundy, and Sevier Cos.

WISCONSIN: Adams, Barron, Douglas, Fond du Lac, Forest, Manitowoc, Marathon, Portage, Sauk, Walworth, Washburn, Waukesha, and Waushara Cos.

The localities as given for the material examined constitutes new records for *M. confusum*, but those specimens studied from North Carolina should not be considered as new records because Wray (1950) reports this species as occurring throughout the state.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: All female specimens examined agree well with previous information (Hoff, 1946, 1949, 196?; Hoff and Bolsterli, 1956) and, in every instance, the male included, were easily separated from identified material on loan of *M. parvulum* and *M. brunneum*. Particularly, the short palpal femur (less than 0.4 mm. in length) is distinctive for the species and this measurement, along with careful comparisons of other structures and their ratios, were employed for the determinations.

The description of *M. confusum* just completed is the first attempt to give measurements and chaetotaxy of structures which heretofore have been neglected.

The single male reported is the only male found in more than 300 mounted slides of adults and nymphs of the genus *Microbisium*. Figure 57 illustrates the genital structure of the internal sclerotized features, and this figure also includes some of the setae surrounding the posterior operculum. A comparison of the internal features of this figure with Fig. 80 shows a relationship of this genus to the genus *Microcreagris*. Further, but not illustrated, the genitalic comples is similar to the genus *Neobisium*. The similarities of the male genitalia among these genera are obvious and are significant in that they support subfamily and generic relationships.

The discovery of a male in a genus which had previously been considered parthenogenetic is important because it not only shows *M. confusum* to be bisexual, but it also implies that males of the other two American species, *M. parvulum* and *M. brunneum*, probably exist.

Genus *Neobisium* Chamberlin, 1930

Neobisium, Chamberlin, 1930, p. 11; *Neobisium*, Chamberlin, 1931a, p. 217; *Neobisium*, Beier, 1932a, p. 78; *Neobisium*, Roewer, 1937, p. 245; *Neobisium*, Hoff, 1949, p. 444; *Neobisium*, Hoff, 1961, p. 427; *Neobisium*, Chamberlin, 1962, p. 324, *Neobisium*, Beier, 1963, p. 81.

Type Species: *Obisium muscorum* Leach, 1817

Diagnosis: With four eyes or none; apical lobe of palpal coxa with three, four, or five setae; eight tactile setae on fixed chelal finger and four on movable chelal finger; tactile setae of fixed finger in two distinct groups, one group with three or four setae within distal one-half of finger and remaining setae grouped basally.

Discussion: As mentioned earlier in this paper, the genus *Obisium* has existed in synonymy with the genus *Chelifer* Geoffroy since 1798 when

Illiger proposed the name Obisium and included Chelifer cancroides (Linn.) as its only species. Leach, in 1817, adopted the name Obisium for use with the species Obisium muscorum. Chamberlin (1930) recognized the synonymy involved and proposed the name Neobisium to include those species previously listed under the genus Obisium.

The genus Neobisium has been separated into several subgenera, but only one, the subgenus Neobisium, has been reported from the United States, and of this subgenus only three species have been described. In Europe, the genus Neobisium is well represented. According to Beier (1963), there are 61 species assigned to the subgenus Neobisium. The total number of species for the genus found in Europe is 122 and this figure does not include the several subspecies (Beier, 1963).

Chamberlin (1962) has thoroughly treated the species of the genus found in the United States. He included a description of a new species, N. ingratum, while separating N. carolinense and N. carolinense tenue into two distinct species rather than considering tenue a subspecies of N. carolinense. N. ingratum is not included in the key to species since it was not found in the collections taken for this paper, but a new species, N. holti, is included and will be described shortly.

Key to species:

1. (a) Inner surface of all palpal podomeres granulate..........
 .... N. holti sp.n.

   (b) Inner surface of palpal femur granulate, but derm of other
 podomeres smooth.................................. 2

2. (a) Range of the length-width ratio of the palpal tibia 2.47-

2.59; width of palpal femur generally greater than 0.275 mm.; marginal teeth of movable chelal finger well developed along entire length..............*N. carolinense*

(b) Range of the length-width ratio of the palpal tibia 2.66-2.85; width of palpal femur generally less than 0.275 mm.; marginal teeth of movable chelal finger reduced or absent basally...*N. tenue*

Neobisium carolinense (Banks, 1895)

PLATE XXII, FIG. 58, 59; PLATE XXIII, FIG. 60, 61, 62

Neobisium carolinensis, Chamberlin, 1930, p. 15; *Neobisium carolinense*, Beier, 1932a, p. 91; *Neobisium carolinense*, Roewer, 1937, p. 246; *Neobisium carolinense*, Chamberlin, 1962, p. 325.

Type Specimen: The types as designated by Banks were collected from Retreat, North Carolina and Lee County, Virginia (Chamberlin, 1962), and are deposited in the American Museum of Natural History, New York.

Material Examined: Twenty-three specimens collected from the following localities:

NORTH CAROLINA: Yancey Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 13, 28, 39, 64, 71, 83).

TENNESSEE: Carter Co.: Roan Mt., October 1959, T. P. Copeland (JEL 253, 255). Sevier Co.: Great Smoky Mountains National Park, October 1959, T. P. Copeland (JEL 270). Unicoi Co.: Unaka Mt., July 1953, T. P. Copeland (JEL 230).

<u>Diagnosis</u>: Palpal femur 3.7 to 4.2; tibia 2.47 to 2.59 times as long as broad; width of palpal tibia greater than 0.275mm.; marginal teeth of movable finger of chela well developed along entire length of finger.

<u>Description</u>: Male. Large pseudoscorpions with a body length ranging between 2.62-3.06 mm. The palpal podomeres are robust and of a reddish-brown color. The abdomen is of a light to dark brown color.

The carapace is subquadrate and longer than wide. The derm of the dorsal surface is smooth, but the sides have reticulate markings and a rugose lateral margin. The epistome is pronounced and of a triangular shape. Four prominent eyes are present and are of the usual placement. All setae are acuminate. The chaetotaxy of the carapace is 4-6 (22).

The abdomen is of usual shape for the family. The pleural membrane is conspicuously granulate. Tergites and sternites are smooth and entire. Chaetotaxy of the tergites is 6:6:8:11:11:9:9:9:9:9:3:mm. Sternal chaetotaxy: 22:(3-3):$\frac{10}{(3)16(3)}$:(3)12(3):12:12:13:13:13:10:3:mm. The genital area is typical for the genus and is illustrated by Chamberlin (1931a).

The apical lobe of the palpal coxa is rounded and has five acuminate border setae. The condylar seta of the palpal coxa is of usual placement. The palpal coxae are sculptured with reticulate markings similar to those on the lateral surface of the carapace. Pedal coxae and chaetotaxy are as for other members of the genus.

The chelicerae are moderately large with a range in the length-width ratio of 1.49 to 1.87. The spinneret is a rounded sclerotic knob on the movable finger. The movable finger has about 13 protrose teeth of which three or four of the medial denticles form an enlarged crest opposite to the galeal seta. The fixed finger has about 18 teeth along the marginal length. The distal denticles are usually broken or eroded away giving a truncate appearance, while the remaining teeth have an acute apex. The flagellum consists of eight blades. The six setae of the palm are long and acuminate.

The palp (Fig. 58) is robust and of a reddish-brown color. The derm of all palpal podomeres is smooth except for the derm of the femur, which is finely granulate on the flexor margin. The pedicel of the tibia is short and robust.

Palpal proportions: trochanter 1.86-2.05, femur 3.45-4.16, tibia 2.47-2.59, chela (less pedicel) 3.31-3.61 times as long as broad; finger 1.20-1.46 times as long as hand, and 0.97-1.12 times as long as femur; chela 1.53-1.69 times as long as finger.

The chaetotaxy and dentition of the chela are as illustrated in Fig. 59, 62. The marginal teeth of the fixed finger are well developed and retroconical in shape. The movable finger has 47-55 truncately, rounded denticles and 12-13 distal teeth which are acute. The nodus ramosus is found opposite the second marginal tooth.

The legs (Fig. 60, 61) are of typical neobisiid shape and structure. Tarsal claws are simple. The subterminal seta of the tarsus is unequally branched and has subdenticulate protrusions.

Pedal proportions: Leg I: basifemur 3.98-4.58, telofemur 2.58-2.96, tibia 4.46-5.14, metatarsus 3.01-3.44, telotarsus 4.41-5.42; Leg IV: trochanter 1.73-2.13, entire femur 3.14-3.25, tibia 5.29-5.75, metatarsus 2.77-3.03, telotarsus 5.04-6.09.

Female. The female is similar to the male except slightly larger. The range of the observed body lengths is 2.61-3.47. Carapacal chaetotaxy: 4-6 (22). The abdomen is longer and more slender than that of the male. Tergal chaetotaxy: 6:7:7:10:10:9:11:12:9:9:6:mm. Sternal chaetotaxy: 5:(0):(3)22(3):(3)11(3):12:17:15:15:15:13:?:mm.

The chelicera is 1.46-1.67 times as long as deep. Other features are similar to those of the male.

Palpal podomeres are slightly shorter than those of the male. Palpal proportions: trochanter 1.82-2.13, femur 3.49-4.27, tibia 2.24-2.78, chela (less pedicel) 3.03-3.78 times as long as broad or deep; finger 1.25-1.53 times as long as hand, and 0.95-1.19 times as long as femur; chela 1.46-1.68 times as long as finger.

Legs are similar to those of the male. Pedal proportions; Leg I: basifemur 3.84-4.68, telofemur 1.92-3.57, tibia 4.42-5.10, metatarsus 3.12-3.60, telotarsus 4.74-5.79; Leg IV: trochanter 1.62-2.08, entire femur 2.87-3.66, tibia 4.86-5.82, metatarsus 2.70-3.15, telotarsus 4.94-6.11.

Measurements (in millimeters): Male. Body length 2.62-3.06; chelicera 0.438-0.500 by 0.321; Palp: trochanter 0.453-0.529 by 0.240-0.275, femur 0.970-1.02 by 0.240-0.281, tibia 0.718-0.756 by 0.277-0.306, chela (excluding pedicel) 1.60-1.73 by 0.466-0.494; chela hand 0.743-0.819 long, movable finger 0.945-1.11 long; Leg I: basifemur 0.513-0.556 by 0.120-0.138, telofemur 0.338-0.350 by 0.120-0.133, tibia 0.431-0.463 by 0.088-0.098, metatarsus 0.250-0.269 by

0.075-0.078, telotarsus 0.338-0.369 by 0.068-0.078. Female. Body length 2.61-3.47; chelicera 0.463-0.575 by 0.256-0.344; Palp: trochanter 0.466-0.592 by 0.250-0.306, femur 0.983-1.12 by 0.250-0.301, tibia 0.718-0.856 by 0.281-0.338, chela (excluding pedicel) 1.61-1.92 by 0.463-0.573, chela hand 0.756-0.907 long, movable finger 0.98-1.22 long; Leg I: basifemur 0.506-0.606 by 0.120-0.148, telofemur 0.275-0.438 by 0.105-0.143, tibia 0.438-0.563 by 0.085-0.110, metatarsus 0.244-0.300 by 0.075-0.090, telotarsus 0.350-0.413 by 0.068-0.083; Leg IV: trochanter 0.394-0.481 by 0.213-0.250, entire femur 0.932-1.12 by 0.263-0.337, tibia 0.844-0.970 by 0.138-0.168, metatarsus 0.288-0.375 by 0.100-0.133, telotarsus 0.488-0.619 by 0.088-0.110.

Distribution: *Neobisium carolinense* is a species of relatively large pseudoscorpions which is confined to the mountainous area composed of western North Carolina, eastern Tennessee, northern Georgia, and apparently, southwest Virginia. All specimens collected of this species were found in samples taken from the first two states mentioned above.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: The restricted distribution discussed above is real, because collections from other areas do not reveal this species, nor its closely related form, *N. tenue*. One possible reason for not finding *N. carolinense* in adjacent mountainous terrain is habitat preference. Collection data show that all specimens on hand were taken from and around decaying logs. It may be that when samples were taken elsewhere, decaying logs were not available, but this seems unlikely since an effort was made to sample uniformly and equally.

Chamberlin (1930) proposed two alternatives for the treatment of N. carolinense: (1) the species is quite variable, and (2) the form includes two or three species which cannot be separated. Of the two alternatives, Chamberlin selected the former for his treatment of the species and listed one variety, N. carolinense tenue. Subsequently, Hoff and Bolsterli (1956) influenced the acceptance of N. carolinense tenue as a distinct species which Chamberlin (1962) then described and to which he gave species status.

The measurements, and particularly the ratios obtained from the limited material available for study, agree with those given by Chamberlin (1962) for N. carolinense. The measured structures of the specimens examined are not as large as those reported by Chamberlin (1962) for the species, but the length-width ratios are similar.

Variation of external structures is apparent in N. carolinense, suggesting the possibility of several species being involved. Particularly, the arrangement and number of setae on the tergites and sternites are variable, which both Chamberlin (1962) and I have noted. In addition to the chaetotaxy, other structures show variation in their measurements except for the palpal tibia which remained fairly constant in its measured width.

The constancy of the tibial width and the nature of the dentition (Fig. 62) of the movable chelal finger are diagnostic for the species. The width of the tibia was always greater than 0.275 mm. and did not overlap the measurements of the palpal tibia of N. tenue. The measurements of other palpal podomeres did overlap with those of N. tenue. This overlapping is evident in Chamberlin's data of the two species.

The marginal teeth of the movable finger of the chela are as discussed in the description, but of greater importance, these denticles are all of similar shape and extend the full length of the finger (Fig. 62). This is not the case in N. tenue as the marginal denticles become progressively smaller until they are wanting or vestigal near the base of the fingers.

Currently, the status of N. carolinense as a distinct species rests on the dentition of the movable finger of the chela and the constancy of the tibial width. For this species, variation is the theme, and because of this, a series of specimens are required for an intensive treatment to determine if several species are involved or if there is only a single species involved.

During the time the final editing of this paper was underway, W. B. Muchmore has sent me a manuscript in which he proposes to change the generic name of the American species of Neobisium to Novobisium. In making this separation from the European species, Muchmore relies on the cheliceral flagellum and the chaetotaxy of the male genital opercula as the diagnostic characters for distinguishing between the two genera. This proposed change was not included in this paper because I have not had time to compare my specimens with Muchmore's description of the new genus.

Neobisium tenue Chamberlin, 1962

PLATE XXIV, FIG. 63, 64; PLATE XXV, FIG. 65, 66, 67

Neobisium carolinensis, var. tenuis, Chamberlin, 1930, p. 16; Neobisium carolinense tenue, Beier, 1932a, p. 92; Neobisium carolinense tenue, Hoff and Bolsterli, 1956, p. 161; Neobisium tenue, Chamberlin, 1962, pp. 328-330.

Type Specimen: Types were collected from Mt. Leconte, Tennessee, and are deposited in the Cornell University collections.

Material Examined: Thirty-two specimens collected from the following localities:

NORTH CAROLINA: Swain Co.: Great Smoky Mountains National Park, October 1959, T.P. Copeland (JEL 275); Great Smoky Mountains National Park, Smoky Mount Camp, April 1963, T.P. Copeland (JEL 316, 318); Great Smoky Mountains National Park, Cherokee Rd., October 1966, J.E. Lawson (JEL 675, 677, 680); Great Smoky Mountains National Park, near Heintooga Overlook, October 1966, J.E. Lawson (JEL 693, 694, 695, 696, 697); Cherokee Reservation, Cooper Creek Rd., October 1966, J. E. Lawson (JEL 745).

TENNESSEE: Bledsoe Co.: Fall Creek Falls State Park, October 1962, T. P. Copeland (JEL 91). Carter Co.: Roan Mt., October 1959, T. P. Copeland (JEL 304). Cocke Co.: near French Broad River, October 1959, T. P. Copeland (JEL 290, 293); near Parrottsville, October 1959, T. P. Copeland (JEL 295); Great Smoky Mountains National Park, Cosby campgrounds, October 1966, J. E. Lawson (JEL 708, 710, 714). Cumberland Co.: Cumberland Mt. State Park, October 1962, T. P. Copeland (JEL 90).

Sevier Co.: Great Smoky Mountains National Park, Indian Gap, October 1959, T. P. Copeland (JEL 273, 276); Great Smoky Mountains National Park, Newfound Gap Rd., October 1959, T. P. Copeland (JEL 284, 294, 300, 301, 302, 303, 309, 351); Great Smoky Mountains National Park, Clingman's Dome Rd., October 1959, T. P. Copeland (JEL 296, 299, 308, 350).

Diagnosis: Palpal femur 3.78-4.48; tibia 2.66-2.85 times as long as broad; width of palpal femur generally less than 0.275 mm.; marginal teeth of movable finger of chela reduced on basal half of finger.

Description: The following description pertains to both sexes unless otherwise noted because the male and female of *N. tenue* are similar to one another as well as being similar to those of *N. carolinense*. Carapacal chaetotaxy: 4-6 (22); tergal chaetotaxy for both sexes: 6:6:6:8:8:9:8-11:8-11:9-11:7-9:3mm.; sternal chaetotaxy of male: 19:(4-4):(3) $\frac{13\text{-}16}{12}$ (3):(4)11(4):13:15:13:13:13:11:8:mm., of female: 4:(0):(4)18(4):(3or4)13(3or4):14:12:13:13:9:9:?:mm.; palpal (Fig. 63) proportions: trochanter 1.79-2.11, femur 3.78-4.48, tibia 2.66-2.85, chela (excluding pedicel) 3.49-3.72, finger 1.18-1.45 times as long as hand and 1.00-1.11 times as long as femur, chela 1.53-1.72 times as long as finger.

The chela is as illustrated in Fig. 64; the teeth of the movable finger are reduced in size or are absent basally and number about 50; the fixed finger has about 63 acute teeth.

The legs (Fig. 65, 66) are of neobisiid facies. Pedal proportions: Leg I: basifemur 3.74-4.42; telofemur 2.34-2.87, tibia 4.18-4.97, metatarsus 3.12-3.57, telotarsus 4.32-5.60 times as long as deep; Leg IV:

trochanter 1.54-2.08, entire femur 2.66-3.40, tibia 4.73-5.75, metatarsus 2.55-3.22, telotarsus 5.04-6.09 times as long as deep.

Measurements (in millimeters): Male. Body length 2.42-2.77; chelicera 0.356-0.453 by 0.253-0.294; palp: trochanter 0.403-0.510 by 0.225-0.250, femur 0.920-1.01 by 0.219-0.238, tibia 0.643-0.718 by 0.225-0.263, chela (excluding pedicel) 1.41-1.64 by 0.381-0.444; chela hand 0.668-0.730 long, movable finger 0.882-1.03 long; Leg I: basifemur 0.500-0.531 by 0.125-0.133, telofemur 0.300-0.344 by 0.115-0.123, tibia 0.419-0.438 by 0.080-0.090, metatarsus 0.231-0.263 by Q070-0.075, telotarsus 0.344-0.363 by 0.060-0.070; Leg IV: trochanter 0.338-0.400 by 0.219-0.231, entire femur 0.856-0.959 by 0.263-0.331, tibia 0.699-0.794 by 0.125-0.158, metatarsus 0.281-0.319 by 0.093-0.105, telotarsus 0.456-0.500 by 0.080-0.093. Female. Body length 2.71-3.21; chelicera 0.494-0.542 by 0.256-0.294; Palp: trochanter 0.428-0.516 by 0.278-0.244, femur 0.894-1.09 by 0.238-0.255, tibia 0.617-0.743 by 0.263-0.269, chela (excluding pedicel) 1.41-1.61 by 0.466-0.478, chela hand 0.693-0.730 long, movable finger 0.819-1.05 long; Leg I: basifemur 0.438-0.538 by 0.117-0.128, telofemur 0.288-0.344 by 0.113-0.125, tibia 0.356-0.438 by 0.085-0.098, metatarsus 0.219-0.269 by 0.070-0.083, telotarsus 0.281-0.381 by 0.065-0.075; Leg IV: trochanter 0.344-0.456 by 0.213-0.244, entire femur 0.806-0.932 by 0.250-0.281, tibia 0.655-0.756 by 0.133-0.147, metatarsus 0.263-0.289 by 0.100-0.105, telotarsus 0.506-0.538 by 0.085-0.090.

Distribution: N. tenue has been reported from the mountainous region of western North Carolina and eastern Tennessee (Chamberlin, 1930). Hoff and Bolsterli (1956) reported a single tritonymph from Quicksand, Breathitt Co., Kentucky. This is a dubious record. The material studied for this paper does not extend the known geographical range for *N. tenue*.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: All specimens studied agree well with previously published data by Chamberlin (1930, 1962) and Hoff and Bolsterli (1956). As mentioned in the discussion of *N. carolinense*, the diagnostic features of the width of the palpal tibia and the nature of the marginal denticles of the movable finger of the chela (Fig. 67) are constant. The width of the palpal tibia in *N. tenue* is somewhat less than 0.275 mm., and this podomere has a range in the length-width ratio of 2.66 to 2.85. Other features, such as a range of length-width ratios from 3.78-4.22 for the palpal femur and the teeth of the movable finger reduced or wanting basally, are diagnostic for the species.

The diagnosis given earlier (Chamberlin (1930) for *N. tenue* is very similar to that for *N. carolinense* and, only recently (Chamberlin, 1962), has *N. tenue* been given species status. The smaller size, the more slender podomeres, and the length-width ratios of the podomeres serve to separate this species from the closely related form, *N. carolinense*. This author agrees with Chamberlin's raising of *N. tenue* to species status.

Neobisium holti sp. n.

PLATE XXVI, FIG. 68, 69; PLATE XXVII, FIG. 70, 71, 72

Type Specimen: Holotype male collected from the Great Smoky

Mountains National Park, Heintooga Overlook, Swain Co., North Carolina. The holotype will be deposited in the American Museum of Natural History, New York.

Material Examined: A single male collected from the type locality October 1966, J.E. Lawson (JEL 699).

Diagnosis: Palpal trochanter, femur, tibia, and chela coarsely granulate on the flexor margins; apical lobe of pedal coxae I with small spinules; basal and subbasal setae of chelal movable finger about five areolar diameters apart.

Description: Male. This is a moderately large pseudoscorpion with a body length of 3.38 mm. Palps and carapace are of a reddish brown color and the abdomen and pedal appendages of a lighter brownish tone.

The carapace is subquadrate in shape but slightly longer than broad. Dorsally, the derm of the carapace is smooth, but laterally, the surface shows reticulate markings. The lateral margin of the carapace has denticulate protrusions which are sparse, posteriorly, but become larger and more numerous, approaching a dentate condition, anteriorly. Two pairs of eyes are present; the anterior pair is about one ocular diameter removed from the anterior carapacal margin. The epistomal process is pronounced and triangular in shape. The setae are acuminate and have a chaetotaxy of 4-8 (22).

The abdomen is greater than twice as long as and slightly wider than the carapace. The pleural membrane is strongly granulate. Both the tergites and sternites are entire and smooth, with the exception of the third and fourth sternites. These two sternites have minute spinules near the spiracles. All setae of the abdomen are acuminate. The chaetotaxy of the tergites: 6:6:6:8:9:8:8:10:10:7:mm.; of the sternites: 32:(3-3): $\frac{13}{(2)19(2)}$:(2)12(2):14:14:14:14:13:10:4:mm. The genital area is of the usual neobisiid facies. The apical lobe of the palpal coxa is rounded and possesses five border setae. Basal to these border setae is the single condylar seta. The pedal coxae are of usual shape, except for the first pair, which has numerous small spines on the apical lobe and mesal portions.

The chelicera is of typical shape and is 1.43 times as long as broad. The flagellum consists of eight blades on some of which minute serrations are present unilaterally. The palm has six acuminate setae while the movable finger has a galeal seta inserted distal to the midpoint of the finger. The teeth of the movable finger number 14. Distally and basally these denticles are small, but medially, the teeth are enlarged to form a dental crest. The denticles of the fixed finger are sawlike with a large tooth alternating with a smaller one. The total number of teeth on the fixed finger is 25. The nodus ramosus is located opposite to the third marginal tooth.

The palp (Fig. 69) is large and moderately robust. The inner surface of the trochanter, femur, tibia and chela are distinctly granulate. The tibia has a short, stout pedicel. Palpal proportions: trochanter 2.09, femur 4.18, tibia 2.86, chela (less pedicel) 3.49 times as long as broad; finger 1.29 times as long as hand, and 0.98 times as long as femur, chela 1.62 times as long as finger.

Chaetotaxy and dentition of the chela are as illustrated in Fig. 68.

Marginal teeth of the fixed finger are retroconical in shape and well developed along the entire length. The denticles of the fixed finger are low and truncately rounded, except for the distal eight, which are acute. The teeth number 62 on the movable and 72 on the fixed finger. The two terminal teeth of the movable finger form the receptor venedentis. No more than five areolar diameters separate the basal and subbasal setae. The subbasal seta is located opposite to the third and fourth basal teeth (Fig. 72).

Legs (Figs. 70, 71) are of neobisiid structure. The subterminal tarsal seta is almost equally furcate and each branch is minutely subdenticulated. Pedal proportions: Leg I: basifemur 4.30, telofemur 2.89, tibia 4.83, metatarsus 3.78, telotarsus 5.72 times as long as deep; Leg IV: trochanter 1.85, entire femur 3.40, tibia 5.89, metatarsus 3.20, telotarsus 5.62 times as long as deep.

Female. None collected.

Measurements (in Millimeters): Male. Body length 3.38; chelicera 0.541 by 0.378; Palp: trochanter 0.630 by 0.301, femur 1.28 by 0.306, tibia 1.01 by 0.352, chela (excluding pedicel) 2.05 by 0.592; chela hand 0.970 long, movable finger 1.26 long; Leg I: basifemur 0.680 by 0.158, telofemur 0.428 by 0.148, tibia 0.542 by 0.112, metatarsus 0.328 by 0.092, telotarsus 0.441 by 0.077; Leg IV: trochanter 0.491 by 0.265, entire femur 1.18 by 0.347, tibia 1.02 by 0.173, metatarsus 0.391 by 0.122, telotarsus 0.630 by 0.112.

Distribution: Known only from type locality.

Disposition of Material: The holotype will be deposited in the

American Museum of Natural History.

Discussion: The discovery of *N. holti* brings the total number of species of the genus in the United States to four. Two of these species have already been discussed and the third, *N. ingratum*, was not represented in my collections.

N. holti differs from all previously described species in possessing a granulated derm on the flexor margins of the palpal trochanter, tibia, and chela, and by the arrangement of the tactile setae on the movable finger of the chela. The granular condition of the palpal podomeres (Fig. 69) is conspicuous and offers sufficient evidence for separating *N. holti* from *N. carolinense* and *N. tenue*, which exhibit granules only on the palpal femur. The subbasal seta is much nearer to the basal seta than it is in the other forms. The position and relationship of the tactile setae are illustrated in Fig. 72. A comparison of Figs. 62 and 67 with Fig. 72 shows this shorter distance between the two tactile setae. In both *N. carolinense* and *N. tenue* the subbasal seta is located distally to the first marginal tooth, while *N. holti* has the subbasal seta located opposite to the third and fourth teeth.

Because of its larger size and the possession of teeth extending the full length on the movable finger of the chela, *N. holti* is closely related to *N. carolinense* and *N. tenue*. All three species are similar in many respects and, for the present, it is not possible to draw conclusions about any real relationships between them.

This species is dedicated to Dr. Perry C. Holt.

Subfamily Ideobisiinae Chamberlin, 1930

Ideobisiinae, Chamberlin, 1930, p. 22; Ideobisiinae, Chamberlin, 1931a, p. 217; Ideobisiinae, Beier, 1932a, p. 141; Ideobisiinae, Roewer, 1937, p. 250; Ideobisiinae, Hoff, 1949, p. 444; Ideobisiinae, Hoff, 1956, p. 4.

Diagnosis: As for family, except for presence of one or more branched cheliceral galeae.

Discussion: Of the three genera assigned to the subfamily, *Halobisium*, *Microcreagris* and *Ideobisium*, only the first two have been reported from the United States. *Halobisium* has been reported from the Pacific Coast and *Microcreagris* is well represented in the eastern states.

Chamberlin (1930) changed the older subfamily name of Pseudobisiinae to Ideobisiinae because there was not a genus *Pseudobisium*.

Since *Halobisium* was not found in the author's collections, a key to genera is not included. However, the separation of genera is based on the number of tactile setae on the distal one-third of the fixed chelal finger and the number of galeae on the spinnerets (Chamberlin, 1930).

Genus *Microcreagris* Balzan, 1891

Microcreagris, Chamberlin, 1930, p. 23; *Microcreagris*, Beier, 1932a, p. 143; *Microcreagris*, Roewer, 1937, p. 251; *Microcreagris*, Hoff, 1956b, p. 4; *Microcreagris*, Chamberlin, 1962, p. 333; *Microcreagris*, Beier, 1963, p. 80.

Type Species: *Microcreagris gigas* Balzan, 1891

Diagnosis: Movable cheliceral finger with simple or weakly branched galea; at least one tactile seta on distal third of fixed palpal finger; movable chelal finger with setae distributed along entire length and not clumped basally; apical lobe of palpal coxa with three to five setae.

Discussion: Balzan divided the family Pseudobissidae into two subfamilies, the Pseudobisiinae and the Microcreaginae, and separated them on the basis of the presence of a simple galea in the former and a distally divided galea in the latter. In the scheme of classification he presented in 1893, Hansen did not accept this separation and retained these pseudoscorpions under the subfamily Pseudobisiinae. Ellingsen, in 1901, supported Hansen's decision because he was able to show that some forms of the Pseudobisiinae, as defined by Balzan, possessed distally divided galea, and because of this, the use of the subfamily Microcreaginae was rejected (*fide*, With, 1906). The genus *Microcreagris* of the subfamily Microcreaginae was regarded as valid by With (1906), who did not present any evidence for its acceptance, and the name has remained.

Chamberlin (1930), in his revision of the suborder Diplosphyronida, included in the genus *Microcreagris* most of the previously described species of the genus *Ideobisium*. This change was necessary because many of the species of *Ideobisium* have a cheliceral galea which is similar in shape to the one found in species of *Microcreagris*. Because of the similarities of the galea in the two genera, Chamberlin had to use other characters for their separation. Briefly, the characters used for separating Ideobisium are an apical lobe of the palpal coxa with two setae and the T, ST, and SB tactile setae of the movable chelal finger clustered basally. The genus Microcreagris has three to five setae on the apical lobe of the palpal coxa and the tactile setae of the movable chelal finger are evenly distributed. When these characters are employed, many species formerly in the genus Ideobisium are placed in the genus Microcreagris.

It is interesting to note that the genus Microcreagris is well represented in this country and in the orient but is relatively rare in most parts of Europe. The common genera of the suborder in Europe are Neobisium and Roncus, while these two genera are poorly represented in the United States.

Key to species:

1. (a) Palpal femur smooth; apical lobe of palpal coxa with four border setae............................. M. atlantica

   (b) Palpal femur and inner face of chelal hand granulate; apical lobe of palpal coxa with three border setae... 2

2. (a) Palpal femur greater than 0.85 mm. in length; tibia slenderly pedicellate (Fig. 83)............. M. rufula

   (b) Palpal femur less than 0.85 mm. in length; pedicel of tibia more robust (Fig. 83)................. M. lata

Microcreagris atlantica Chamberlin, 1930

PLATE XXVIII, FIG. 73, 74, 75

Microcreagris atlantica, Chamberlin, 1930, p. 29; *Microcreagris atlantica*, Beier, 1932a, p. 148; *Microcreagris atlantica*, Roewer, 1937, p. 252; *Microcreagris atlantica*, Hoff and Bolsterli, 1956, p. 163; *Microcreagris atlantica*, Chamberlin, 1962, p. 338.

Type Specimen: The original specimens were found in an unlabeled vial included in a general collection from the eastern United States which was probably from Asheville, North Carolina (Chamberlin, 1930). The types are deposited in the American Museum of Natural History, New York.

Material Examined: Thirty-nine specimens collected from the following localities:

NORTH CAROLINA: Swain Co.: Cherokee Reservation, Big Cove Road, October 1966, J. E. Lawson (JEL 728, 734, 735); Great Smoky Mountains National Park, Smoky Mount Camp, April 1963, J. E. Lawson (JEL 316). Yancey Co.: Mt. Mitchell, July 1962, R. A. Durey (JEL 5, 24).

SOUTH CAROLINA: Greenville Co.: Paris Mt. State Park, September 1962, T. P. Copeland (JEL 128); Greenville watershed, September 1962, T. P. Copeland (JEL 129).

TENNESSEE: Blount Co.: Great Smoky Mountains National Park, Old Cades Cove Rd., July 1953, T. P. Copeland (JEL 144); near Fontana Village, June 1953, T. P. Copeland (JEL 197). Cocke Co.: French Broad River bank, July 1953, T. P. Copeland (JEL 161, 178, 184); Great Smoky Mountains National Park, Cosby Rd., October 1966, J. E. Lawson (JEL 702, 712). Henderson Co.: Natchez Trace State Park, June 1964, T. P. Copeland (JEL 398). Jefferson Co.: near Dandridge, July 1953, T. P.

Copeland (JEL 182). Monroe Co.: near Fontana Dam, June 1953, T. P. Copeland (JEL 138). Sequatchie Co.: July 1953, T. P. Copeland (JEL 228). Sevier Co.: Great Smoky Mountains National Park, Newfound Gap Rd., July 1953, T. P. Copeland (JEL 143, 175). Wilson Co.: Cedars of Lebanon State Park, October 1962, T. P. Copeland (JEL 92).

VIRGINIA: Floyd Co.: Blue Ridge Pkwy., October 1962, J. E. Lawson (JEL 108, 112). Giles Co.: Mt. Lake, July 1965, T. P. Copeland (JEL 630, 639). Montgomery Co.: near Riner, September 1963, J. E. Lawson (JEL 315).

Diagnosis: Relatively small pseudoscorpions; range of body size 1.93 to 2.65 mm.; palpal femur smooth; apical lobe of palpal coxa with four setae.

Description: Male. A relatively small pseudoscorpion with a body length ranging in size from 1.93 to 2.65 mm. The abdomen is more or less slender and elongate, and is more than twice as long as the prosoma.

The carapace is longer than broad and has subparallel lateral margins. Four well-developed eyes are present, the anterior pair being slightly removed from the anterior margin of the carapace, and the second pair being about one-third to one-half an ocular distance away. The lateral surface of the carapace is reticulate and, dorsally, the derm is smooth and moderately invested with acuminate setae. Chaetotaxy of the carapace is 4-6 (26). An epistome is present, but it is relatively small and rounded.

The abdomen is elongate and not much wider than the carapace. The pleural membrane is granulate. Tergites and sternites are smooth and entire. Tergal chaetotaxy: 7:9:11:10:10:10:10:9:7:6:?:mm. Sternal chaetotaxy: $9{:}(4\text{-}4){:}\dfrac{7}{(3)9(3)}{:}(3)9(3){:}12{:}12{:}12{:}12{:}12{:}9{:}7{:}mm$. The genital area is of typical form. The apical lobe of the palpal coxa is bordered by four setae. Coxal setae, especially near the condylar rim, are attenuate, but other setae are generally much shorter and have a smaller areole. Coxa IV has, on its posterior condylar rim, three setae which are clumped together.

Chelicerae are relatively small and 1.44 to 1.52 times as long as deep. The flagellum consists of seven contiguous blades which may or may not be minutely serrated. Six setae are on the palm, but some specimens may have seven setae. However, there were not any other discernible differences noted in the chelicera of those with seven setae. The galea is a small stylet without any noticeable branches. The movable finger has about 11-13 sawlike marginal teeth, while the fixed finger has 15-20 small denticles, the smallest located apically and the others increasing in size basally.

The palp (Fig. 73) is uniformly pigmented a reddish brown. The derm of all segments is smooth without any trace of granulations. The tibia is strongly pedicellate and robust.

Palpal proportions: trochanter 1.53-1.99, femur 2.93-3.40, tibia 2.05-2.30, chela (excluding pedicel) 2.68-3.16 times as long as broad or deep; finger 1.20-1.40 times as long as hand and 0.89-1.02 times as long as femur; chela 1.60-1.68 times as long as finger.

The chaetotaxy and dentition are as shown in Fig. 74. Both fingers have 49 rounded and well-developed denticles. The nodus ramosus of the fixed finger is on the same level as the third marginal tooth of the fixed finger.

The legs are of typical appearance of the suborder. The subterminal tarsal setae are unequally branched and each branch is lightly denticulate.

Pedal proportions: Leg I: basifemur 2.34-2.69, telofemur 1.99-2.39, tibia 3.18-4.02, metatarsus 2.30-2.66, telotarsus 4.36-4.90; Leg IV (Fig. 75): trochanter 1.47-1.81, entire femur 2.57-2.99, tibia 4.06-4.92, metatarsus 2.63-2.95, telotarsus 3.61-4.44.

Female. The female is very similar to the male, but slightly larger and with more robust appendages.

Chaetotaxy of carapace: 4-6 (26); Tergal chaetotaxy: 8:10:11:11:12: 12:12:12:8:9:7:mm; Sternal chaetotaxy: 6:(0):(4)9(4):(4)7(4):11:11:12: 12:10:11:7:mm.; Chelicera 1.67 times as long as deep; Palpal proportions: trochanter 1.73-2.30, femur 2.13-3.26, tibia 1.98-2.25, chela (excluding pedicel) 2.64-3.19 times as long as broad or deep; finger 1.26-1.50 times as long as hand, and 0.96-1.02 times as long as femur; chela 1.61-1.71 times as long as finger; Pedal proportions: Leg I: basifemur 2.24-2.50, telofemur 1.95-2.15, tibia 3.47-3.90, metatarsus 2.26-2.50, telotarsus 4.31-5.00; Leg IV: trochanter 1.48-1.61, entire femur 2.46-3.19, tibia 4.20-4.81, metatarsus 2.52-2.73, telotarsus 4.01-4.64.

Measurements (in millimeters): Male. Body length 1.93-2.48; chelicera 0.260-0.332 by 0.204-0.230; Palp: trochanter 0.311-4.28 by 0.158-0.239, femur 0.529-0.718 by 0.173-0.245, tibia 0.466-0.630 by 0.214-0.306, chela (less pedicel) 0.819-1.17 by 0.301-0.423; chela hand 0.406-0.554 long, movable finger 0.488-0.693 long; Leg I: basifemur 0.300-0.372 by 0.125-0.138, telofemur 0.231-0.275 by 0.105-0.125, tibia 0.293-0.347

by 0.080-0.093, metatarsus 0.145-0.172 by 0.060-0.068, telotarsus 0.238-0.286 by 0.053-0.063; Leg IV: trochanter 0.240-0.285 by 0.143-0.189, entire femur 0.556-0.693 by 0.192-0.240, tibia 0.467-0.580 by 0.108-0.123, metatarsus 0.208-0.245 by 0.076-0.093, telotarsus 0.286-0.347 by 0.066-0.083. Female. Body length 2.17-2.65; chelicera 0.342-0.356 by 0.204-0.224; Palp: trochanter 0.326-0.398 by 0.173-0.230, femur 0.580-0.693 by 0.189-0.260, tibia 0.503-0.567 by 0.235-0.286, chela (less pedicel) 0.958-1.13 by 0.332-0.428; chela hand 0.420-0.592 long, movable finger 0.567-0.668 long; Leg I: basifemur 0.296-0.342 by 0.125-0.148, telofemur 0.230-0.265 by 0.113-0.130, tibia 0.296-0.342 by 0.080-0.088, metatarsus 0.143-0.163 by 0.063-0.068, telotarsus 0.240-0.275 by 0.055-0.058; Leg IV: trochanter 0.240-0.270 by 0.148-0.168, entire femur 0.563-0.655 by 0.184-0.245, tibia 0.463-0.554 by 0.110-0.118, metatarsus 0.205-0.240 by 0.075-0.093, telotarsus 0.281-0.316 by 0.065-0.075.

Distribution: *M. atlantica* had been reported only from its type locality until Hoff and Bolsterli (1956) reported it from Iuka, Tishomingo Co., Mississippi. The localities given for the specimens studied of this species adds further distributional data and represents new records. These localities show a much greater range for *M. atlantica* than was previously thought, and because it was found in several collections taken from various states, it is believed that further collecting will reveal its presence in most eastern states.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Chamberlin (1930), in his original description of

M. atlantica, did not give actual dimensions but listed ratios of certain podomeres which were quiet unsatisfactory for the identification of the species. Later, Chamberlin (1962) redescribed *M. atlantica* on a much sounder basis and this time gave actual measurements.

The data obtained in the present work show a wide variation in dimensions, and when compared with the information given by Chamberlin (1962) for the types, and Hoff and Bolsterli (1956) for the specimens from Mississippi, the specimens agree with both works.

It is interesting to note that the measurements given by Hoff and Bolsterli (1956) approach the lower limits of the observed ranges of *M. atlantica* while Chamberlin's (1962) measurements for the types nearly parallels the dimensions given for the upper limits for those structures measured. Since the efforts of Chamberlin and Hoff and Bolsterli approach the extremes of this current work, it precluded any possibility of naming a new species. That this is a comparison of palpal segments and does not include the pedal appendages should be emphasized. In regard to the pedal podomeres, the measurements given by Chamberlin (1962) for these segments fall near the middle of the observed extremes. Hoff and Bolsterli (1956) did not give measurements for these structures.

A study of the allotype of *M. atlantica* shows a close agreement in most respects with the specimens used for this study but a difference in the size of the chelicerae. This difference is primarily in length rather than in width. An attempt to correlate the larger chelicerae of the allotype with the smaller chelicerae of my specimens did not provide any additional data since both were quite similar in appearance.

Chamberlin (1962) apparently had some difficulty ascertaining the number of guard setae surrounding the spiracles. A careful examination of the material available showed that the males have three and the females have four surrounding each spiracle. This number for the setae has been included in the sternal chaetotaxy for each sex.

The galea on the movable finger of the chelicerae of my material was represented by a small translucent stylet and has no terminal branching as does the allotype. The absence of this terminal branching is believed not to be characteristic for the material studied. Rather, it reflects the fragility of the branches which may be easily broken off when mounted.

Chamberlin (1962) constructed a key to the epigean, troglobitic, and near trogolobitic species of the genus Microcreagris east of the Mississippi River. Until then, M. atlantica was the only species with a smooth palpal femur found in the eastern United States. In this work Chamberlin described a new species, M. subatlantica, which is closely related to M. atlantica but is reported from two caves in Alabama.

Microcreagris rufula (Banks, 1891)

PLATE XXIX, FIG. 76, 77; PLATE XXX, FIG. 78, 79, 80

Microcreagris rufulum, Chamberlin, 1930, p. 30; Microcreagris rufula, Beier, 1932a, p. 152; Microcreagris rufula, Roewer, 1937, p. 252; Microcreagris rufula, Hoff and Bolsterli, 1956, p. 162; Microcreagris rufula, Hoff, 1958, p. 10; Microcreagris rufula, Chamberlin, 1962, p. 333.

Type Specimen: Banks (1891) in his original description of *M. rufula* gave the locality as Washington D.C, but did not indicate where types would be deposited.

Material Examined: Fifteen specimens collected from the following locality:

MARYLAND: Montgomery Co.: Plummer's Isle, November 1963, T.P. Copeland (JEL 326, 330,332, 335, 339, 341, 343, 344).

Diagnosis: Relatively large pseudoscorpions; chela (excluding pedicel) 1.34-1.42 mm. long; femur and inner face of the chelal hand densely granulate; subterminal seta unequally furcate with each branch denticulate.

Description: Male. These are large animals with a body length ranging in size from 2.42 to 3.04 mm. The prosoma is much shorter than the abdomen. The body is a dark reddish-brown in color.

The carapace is slightly longer than broad and slightly narrowed anteriorly and posteriorly. Two pairs of eyes are present. The dorsal surface of the carapace is smooth, but laterally, a striated sculpturing is apparent. The anterior margin is smooth with a single, large, toothlike epistome. The setae of the carapace are moderately numerous and are all acuminate. The chaetotaxy is 6-4 (26).

The abdomen is of usual structure, scarcely wider than the carapace and moderately elongate. The pleural membrane is distinctly granulate. Both tergites and sternites are entire and without any obvious markings. Setae are acuminate. Tergal chaetotaxy: 8:11:11:11:10:10:9:9:8:10:?:mm. Sternal chaetotaxy: 14:(3-3):$\frac{5}{(5)15(5)}$:(5)8(5):12:12:13:11:11:9:3:mm. The genital area is as illustrated (Fig. 80). The apical lobe of the palpal coxa has three terminal setae, and basal to these is a single condylar seta which is quite long. Other coxal setae are much smaller and variously disposed over the coxae. The condylar edge of coxa IV, however, possesses three setae clumped together on the posterior rim. All coxal setae are acuminate.

Chelicerae are moderately large with a length 1.37 to 1.50 times the depth. The flagellum consists of six blades. In the material examined, it appears that one blade is unilaterally branched. The palm has six setae which are long and acuminate. The movable finger has the spinneret removed toward the base from the apex, and the galea consists of a small stylet with two simple terminal branches. The galeal seta is inserted distally to the midpoint of the finger. There are about 16 teeth on the movable finger which are contiguous and appear sawlike, i.e., a large denticle alternates with one or two smaller denticles. Teeth of the fixed finger number about 20, all of which are about the same size but they become progressively smaller toward the base of the finger.

The pedipalp (Fig. 76) is reddish-brown, and the derm is smooth on the tibia and trochanter. The femur and the inner face of the chelal hand is conspicuously granulate. The tibia has a slender and elongate pedicel, and the body of the tibia has two small protrusions which are located laterally.

Palpal proportions: trochanter 2.06-2.08; femur 3.23-3.68; tibia 2.43-2.65; chela 3.10-3.15 (less pedicel) times as long as broad or deep; finger 1.21-1.27 times as long as hand and 0.82-0.95 times as long as femur; chela 1.48-1.65 times as long as finger.

Chaetotaxy, dentition and chelal facies are as illustrated in Fig. 77. The fixed finger has 67 teeth which are contiguous and truncately rounded and the movable finger has 62 similarly shaped denticles. The nodus ramosus is located opposite to the third and fourth marginal teeth of the fixed finger.

The legs are typical of the genus. Leg IV has strongly differentiated tactile setae (Fig. 79). The subterminal seta is furcate and subdenticulate. The tarsal claws are simple.

Pedal proportions: Leg I (Fig. 78): basifemur 2.35-2.68, telofemur 1.89-2.44, tibia 3.88-4.39, metatarsus 2.52-2.77, telotarsus 4.42-4.46 times as long as deep; Leg IV: entire femur 2.80-3.06, tibia 4.43-5.41, metatarsus 2.39-2.67, telotarsus 4.28-4.73 times as long as deep.

Female. None collected.

Measurements (in Millimeters): Male. Body length 2.42-3.04; chelicera 0.372-0.388 by 0.255-0.270; Palp: trochanter 0.479-0.495 by 0.230-0.240, femur 0.857-0.957 by 0.255-0.265, tibia 0.756-0.894 by 0.311-0.337, chela (excluding pedicel) 1.34-1.42 by 0.393-0.454, chela hand 0.655 long, movable finger 0.794-0.832 long; Leg I: basifemur 0.388-0.398 by 0.148-0.165, telofemur 0.280-0.306 by 0.125-0.148, tibia 0.383-0.413 by 0.088-0.100, metatarsus 0.189-0.194 by 0.070-0.075, telotarsus 0.281-0.301 by 0.063-0.068; Leg IV: trochanter 0.306 by 0.163, entire femur 0.730-0.781 by 0.245-0.265, tibia 0.643-0.693 by 0.120-0.145, metatarsus 0.235-0.245 by 0.090-0.098, telotarsus 0.350-0.377 by 0.075-0.088.

Distribution: The specimens collected from Plummer's Isle, Maryland constitute a new record for *M. rufula*, but this locality adds little to the known distribution because the type locality, Washington, D. C., is only a few miles away. Known distribution is given in the list below, but a Texas record by Banks has been omitted because Hoff (1958) believes this record to be based on a misidentification.

KENTUCKY: Mammoth Cave National Park, Edmonson Co.

VIRGINIA: Falls Church; Great Falls.

WASHINGTON, D. C.: No specific location.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Beier (1932) gives the length-width ratio of the palpal femur as 3.7-3.8 and the palpal tibia as 2.6-2.8. The smaller proportions given earlier in this description do not agree with these ratios. Hoff and Bolsterli (1956), however, have reported *M. rufula* from Kentucky, and their measurements agree very well with those obtained from the material examined. It is concluded, therefore, that the specimens studied are of this species.

M. rufula is closely related to *M. lata*, but differs by having appendages of a much greater size. Chamberlin (1962), in his key to the known species east of the Mississippi River, separated *M. rufula* from *M. lata* on the basis of size of the palpal podomeres and of the subterminal seta being unequally furcate on *M. rufula* and almost equally furcate on *M. lata*. The use of this last character invites question because an examination of the holotype and allotype of *M. lata* did not show any significant difference in the subterminal seta of identified material of M. rufula from the J. C. Chamberlin collection. But these two species do differ in the proportions of the palpal podomeres.

Microcreagris lata Hoff, 1945

PLATE XXXI, FIG. 81, 82, 83; PLATE XXXII, FIG. 84, 85

Microcreagris lata, Hoff, 1945a, p. 323; Microcreagris lata, Hoff, 1958, p. 12; Microcreagris lata, Chamberlin, 1962, p. 334.

Type Specimen: All types were collected from Duke Forest, Durham, North Carolina, and are deposited in the American Museum of Natural History, New York.

Material Examined: Two-hundred and sixteen specimens collected from the following localities:

SOUTH CAROLINA: Greenville Co.: Paris Mountain State Park, September 1962, T. P. Copeland (JEL 128).

TENNESSEE: Bledsoe Co.: Fall Creek Falls State Park, October 1962, T. P. Copeland (JEL 91). Campbell Co.: Cove Lake Park, July 1953, T. P. Copeland (JEL 233). Chester Co.: Chickasaw State Park, June 1964, T. P. Copeland (JEL 423). Cocke Co.: Greenville Hwy., July 1953, T. P. Copeland (JEL 184). Cumberland Co.: Cumberland Mt. State Park, October 1962, T. P. Copeland (JEL 90). Henderson Co.: Natchez Trace State Park, June 1964, T. P. Copeland (JEL 405). Overton Co.: Standing Stove State Park, October 1962, T. P. Copeland (JEL 93, 94). Sequatchie Co.: July 1953, T. P. Copeland (JEL 213).

VIRGINIA: Dickenson Co.: Breaks Interstate Park, August 1963, Charlie White (JEL 320, 463, 469, 471, 472, 473, 474, 476, 478, 479, 481, 485, 486, 487, 489, 490, 491, 500, 501, 502, 507, 509, 510, 511, 514, 516, 517, 524). Floyd Co.: Blue Ridge Pkwy., October 1962, T. P. Copeland (JEL 98, 99, 101, 107, 112, 113, 115); Near Floyd, September 1963, J. E. Lawson (JEL 314). Giles Co.: Mt. Lake, August 1965, T. P. Copeland (JEL 646, 651, 664).

Diagnosis: Chela (excluding pedicel) 1.12-1.32 mm. long; palpal femur and inner face of chelal hand granulate; palpal femur less than 0.85 mm. in length.

Description: Male. The body is relatively slender, but occasionally the abdomen is more or less ovate. The palpi are reddish-brown in color while the body and pedal appendages are light yellow. The palpi are stout. The range of the body length is 2.38 to 2.90 mm.

The carapace is slightly longer than broad, slightly constricted anteriorly and posteriorly, and the sides are subparallel. The derm is smooth medially, but laterally, reticulate markings are obvious. A single protrusion, the epistome, is present on the anterior margin. Two pairs of eyes of typical placement are present. Setae are acuminate and with a 4-6 (26) chaetotaxy.

The abdomen is slenderly ovate in shape and is about twice as long as broad. The pleural membrane is granulate. Tergites and sternites are entire and without any markings. The second abdominal segment appears to be slightly constricted anteriorly, giving a "slim-waisted" appearance. Tergal chaetotaxy: 8:11:12:12:12:12:12:10:

11:10:6:mm. Sternal chaetotaxy: 12:(3-3):$\frac{5}{(3)12(3)}$:(3)7(3):9:10:9:9: 9:9:6:mm. The genital area is typical of the genus. The apical lobe of the palpal coxa has three setae and the condylar rim of this coxa has a single seta. Other coxal setae do not appear to offer an arrangement which can be placed into a formula. Coxa IV, however, has two large acuminate setae on the posterior margin of the condylar rim and one additional seta placed basally.

The chelicerae are moderately large with a length 1.33 to 1.57 times their depth. The palm has six setae which are long and acuminate. The flagellum consists of six minutely serrated blades. The spinneret of the movable finger has a terminally bifurcated galea. The galeal seta is inserted near the center of the row of marginal teeth and reaches just beyond the distal end of the galea. There are about twelve acute teeth located along the margin. The fixed finger has about 20 marginal teeth arranged along the entire inner margin of the finger.

A palp is illustrated in Fig. 81. The derm of the femur and portions of the chela are granulate, while the tibia and trochanter have a smooth derm. The tibial pedicel is short and robust. Two protrusions on the lateral surface are present but are difficult to demonstrate unless the podomere is in the proper attitude.

Palpal proportions: trochanter 1.65-2.07, femur 3.03-3.61, tibia 2.26-2.56, chela 3.09-3.43 (less pedicel) times as long as broad or deep; finger 1.17-1.33 times as long as hand, and 0.87-1.01 as long as femur; chela 1.57-1.81 times as long as finger.

Chaetotaxy and dentition of chela are illustrated in Fig. 82. The marginal teeth of the chelal fingers are contiguous, blunt and rounded, about as high as wide, and extend nearly the full length on each finger. The movable finger has about 60 teeth and the fixed finger about 55. The nodus ramosus of the fixed finger is on the same level as the first apical tooth.

The legs are of typical appearance for the genus and are moderately slender (Fig. 84, 85). Femoral podomeres and the tibia of the third leg are marked by weak and minute papilliform spines. The tarsal claws are simple. The subterminal seta is branched distally into two, more or less, equal arms with each arm having a few denticulate protrusions.

Pedal proportions: Leg I: basifemur 2.47-2.90, telofemur 2.08-2.39, tibia 3.70-4.42, metatarsus 2.29-3.07, telotarsus 4.25-4.85; Leg IV: trochanter 1.49-1.84, entire femur 2.42-3.18, tibia 4.64-5.93, metatarsus 2.31-2.76, telotarsus 4.06-4.91.

Female. The female is very similar to the male, but slightly larger. The range of the observed body lengths is 2.33-3.15 mm. Chaetotaxy of the carapace is 4-6 (26).

The abdomen is more ovate than in the male. Tergal chaetotaxy: 8:10:12:12:12:12:12:12:10:6:?:mm. Sternal chaetotaxy: 6:(4)10(4):(4)10(4):12:12:12:10:10:10:6:6:mm.

The chelicera is 1.49 to 1.51 times as long as deep. All other cheliceral features are like those of the male.

The podomeres of the palpus are slightly stouter in the female. Palpal proportions: trochanter 1.73-1.98, femur 3.01-3.32, tibia 2.16-2.41, chela 2.87-3.20 (less pedicel) times as long as broad or deep; finger 1.11-1.21 times as long as hand, and 0.88-1.00 times as long as femur; chela 1.57-1.82 times as long as finger.

Legs are similar to those of the male. Pedal proportions: Leg I: basifemur 2.35-2.88, telofemur 1.95-2.30, tibia 3.35-4.27, metatarsus 2.30-2.93, telotarsus 4.15-4.68; Leg IV: trochanter 1.50-1.81, entire femur 2.73-3.12, tibia 4.42-5.45, metatarsus 2.13-2.61, telotarsus 3.75-4.52.

Measurements (in Millimeters): Male. Body length 2.38-2.90; chelicera 0.321-0.363 by 0.219-0.260; Palp: trochanter 0.382-0.459 by 0.204-0.235, femur 0.693-0.794 by 0.204-0.250, tibia 0.617-0.756 by 0.255-0.306, chela (excluding pedicel) 1.12-1.30 by 0.342-0.398; chela hand 0.529-0.592 long, movable finger 0.643-0.756 long; Leg I: basifemur 0.342-0.388 by 0.125-0.143, telofemur 0.245-0.294 by 0.108-0.128, tibia 0.321-0.369 by 0.083-0.090, metatarsus 0.163-0.209 by 0.063-0.078, telotarsus 0.255-0.301 by 0.055-0.065; Leg IV: trochanter 0.255-0.306 by 0.153-0.184, entire femur 0.630-0.743 by 0.199-0.275, tibia 0.542-0.668 by 0.110-0.125, metatarsus 0.214-0.245 by 0.083-0.093, telotarsus 0.326-0.383 by 0.073-0.083. Female. Body length 2.33-3.15; chelicera 0.352-0.388 by 0.235-0.256; Palp: trochanter 0.388-0.454 by 0.209-0.238, femur 0.743-0.819 by 0.235-0.255, tibia 0.668-0.743 by 0.281-0.316, chela (excluding pedicel) 1.17-1.32 by 0.362-0.459, chela hand 0.567-0.668 long, movable finger 0.668-0.769 long; Leg I: basifemur 0.342-0.383 by 0.138-0.168, telofemur 0.250-0.286 by 0.115-0.128, tibia 0.332-0.367 by 0.085-0.108, metatarsus 0.158-0.188 by 0.065-0.075, telotarsus 0.275-0.291 by 0.060-0.070; Leg IV: trochanter 0.296-0.300

by 0.163-0.199, entire femur 0.668-0.730 by 0.223-0.275, tibia 0.567-0.617 by 0.120-0.148, metatarsus 0.194-0.240 by 0.090-0.105, telotarsus 0.342-0.357 by 0.080-0.095.

Distribution: Previously known distribution for *M. lata* has been the type locality. The localities given, herein, for the material examined are all new records, thus extending considerably the geographical range for this species.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Hoff (1945), in his original description of *M. lata*, gave measurements for the holotype and allotype but did not give any ranges for the measured structures. The ranges offered in the above description indicate a wide variation for this species. I, however, was not able to show reliable characters which would separate the extreme ranges into two categories. As a matter of fact, when a scatter diagram was employed on the length-width measurements of the palpal femur, there was no separation. Moreover, specimens from the same collection were frequently of large and small sizes which prohibited any presumption of geographical variation. The measurements given by Hoff (1945a) fall near the median of those reported here.

M. lata is absent from Mt. Mitchell, North Carolina, and the Great Smoky Mountains National Park. An attempt to correlate this absence with altitude was fruitless since *M. lata* has been found to inhabit the Mountain Lake, Virginia, region. Therefore, the conclusion drawn was that the time of collecting varied from middle summer at Mt. Lake to late summer and early fall at the other two sites. Habitat preference was tested in connection with altitude. This approach was invalidated, however, when it became obvious that M. lata was found in many collections regardless of the type of litter collected.

M. lata seems closely related to M. rufula but differs by having much smaller palpal and pedal podomeres. The broken line in Fig. 83 represents an outline of the palpal tibia of M. rufula which is superimposed over the palpal tibia of M. lata. From this figure the size difference is obvious. Further, M. rufula has a tibial pedicel which is longer and more slender than that of M. lata. The sternal chaetotaxy is further evidence of the distinctiveness of each species, since M. rufula has more setae on the sternites and the guard setae around the spiracles are greater than those found on M. lata.

Chamberlin (1962) has proposed that M. fallax, a new species which he described in 1962, is closely related to M. lata. Its affinities to M. lata, and even to the subfamily, should be questioned, however, because the transparent galea, which is so characteristic for the subfamily, is absent. Chamberlin did not attempt to resolve this problem but suggested that the study of additional material, including juveniles, would be necessary before the status of this form could be resolved. In any case he placed M. fallax in the subfamily Ideobisiinae and attributed the apparent lack of a galea to its loss in mounting. A final disposition of M. fallax is necessary because, if this is a true ideobisiinin, the galeate condition is of minor importance and should not be used in the separation of subfamilies.

Suborder Monosphyronida Chamberlin, 1929

Monosphyronida, Chamberlin, 1929b, p. 56, 78; Monosphyronida, Chamberlin, 1931a, p. 228; Cheliferinea, Beier, 1932b, p. 1; Cheliferinea, Roewer, 1937, p. 272; Monosphyronida, Hoff, 1949, p. 449; Monosphyronida, Hoff, 1956c, p. 2; Cheliferinea, Beier, 1963, p. 243.

Diagnosis: Each leg with five segments, excluding coxa; tarsus of a single segment; two-eyed or blind; always galeate.

Discussion: Of the three suborders, the Monosphyronida contains the greatest number of described genera and species. In the United States, however, most of the species have been found in the southwest and far west. Few species of this suborder have been found in the southern Appalachians.

Historically, the members of this suborder have been recognized as being distinct, but most authors have included the now recognized superfamily Garypoidea of the suborder Diplosphyronida in the Monosphyronida. Chamberlin (1931a) was able to separate the Garypoidea from the Monosphyronida. In this endeavor, Chamberlin erected three superfamilies for the suborder.

The three superfamilies, Feaelloidea, Cheiridioidea, and Cheliferiodea, are found in the United States. The first two are poorly known and are represented by a few species. All specimens of the suborder collected for this paper belong to the superfamily Cheliferoidea.

The genus *Synsphyronus* and the reasons for assigning the Feaelloidea to the Monosphyronida have been discussed above.

Superfamily Cheliferoidea Chamberlin, 1931

Cheliferoidea, Chamberlin, 1931a, p. 239; Cheliferides, Beier, 1932b, p. 19; Cheliferides, Roewer, 1937, p. 278; Cheliferoidea, Hoff, 1949, p. 449; Cheliferoidea, Hoff, 1956d, p. 4.

Diagnosis: Eyes two or none; femoral articulation of legs I and II dissimilar from the femoral articulation of legs III and IV (Fig. 86, 89).

Discussion: Chamberlin (1931a) gave With (1906) credit for correctly separating the old genus *Chelifer* into the currently recognized families of the Cheliferoidea, leaving many species to go into other families. Currently, the superfamily is subdivided into three valid families. A fourth family, Myrmochernetidae, is considered of doubtful validity and is confined to Africa (Hoff, 1956c). The families Atemnidae, Chernetidae, and Cheliferidae are cosmopolitan in distribution and include the greater number of pseudoscorpion species. The Chernetidae and Cheliferidae are represented in the collections taken for this paper. The Atemnidae are scarce in this country and are represented by a single genus containing a single species, *Paratemnus elongatus* (Banks) from Florida (Hoff, 1964).

The diagnosis used by Banks for the genus *Chelanops* was so inclusive that it applied to many species. By such a loose application of general characters, the genus encompassed those families, genera, and species now assigned to the superfamily Cheliferoidea. Hoff (1947) redescribed those species of *Chelanops* described by Banks, thus giving stability to the classification of the superfamily.

Key to families:

(a) Accessory teeth present on the chelal fingers; venom apparatus developed on movable finger of the chela..... Chernetidae

(b) Accessory teeth absent; both chelal fingers with a venom apparatus.................................. Cheliferidae

Family Chernetidae Menge, 1855

Chernetidae, Chamberlin, 1931a, p. 241; Chernetidae, Beier, 1932b, p. 80; Chernetidae, Roewer, 1937, p. 287; Chernetidae, Hoff, 1949, p. 449; Chernetidae, Hoff, 1956c, p. 4.

Diagnosis: Venom apparatus developed only in movable finger of chela; in addition to marginal teeth, accessory teeth always present; flagellum consist of three or four blades.

Type Genus: *Chernes* Menge, 1855

Discussion: In 1891, Balzan classified the presently recognized family Chernetidae as the subgenus *Chernes* of the genus *Chelifer*. As mentioned earlier, With (1908) recognized the diversity of forms placed in this subgenus, and accordingly, questioned their inclusion. With's work was invaluable in the erection of the family Chernetidae from a group of species previously classified as *Chelifer cimicoides* (Chamberlin, 1932).

The chelal fingers have accessory teeth in addition to the marginal denticles. These accessory teeth may be few in number or relatively numerous. The accessory teeth, which are widely spaced, are in a more or less linear series and parallel the marginal denticles.

The family is divided into two subfamilies, the Lamprochernetinae and the Chernetinae. The former was not found in the fauna of this area. The latter subfamily was represented by two species of separate genera. Characteristically, the Lamprochernetinae are characterized by the presence of only acuminate setae, while the Chernetinae have plumose, feathered, or denticulate setae on the body and palps.

Subfamily Chernetinae Beier, 1932

Chernetinae, Beier, 1932b, p. 105; Chernetinae, Beier, 1933, p. 520; Chernetinae, Hoff, 1949, p. 455; Chernetinae, Hoff, 1956c, p. 12; Chernetinae, Beier, 1963, p. 249.

Diagnosis: Palps and body invested with short, thickened to clavate setae; cheliceral flagellum of two, three or four blades; tarsus of leg IV with or without tactile setae, and if present, always inserted at midpoint or more distad on tarsus.

Discussion: Chamberlin (1931a) and Hoff (1949) have adequately illustrated the genera and species of this subfamily. For a more detailed and inclusive taxonomic treatment of the subfamily, the reader is referred to Hoff (1949, 1956c).

Key to genera:

(a) Cheliceral flagellum of three blades; tactile seta present on the tarsus of leg IV....................*Pselaphochernes*

(b) Cheliceral flagellum of four blades; tactile seta absent on the tarsus of leg IV....................*Illinichernes*

Genus Pselaphochernes Beier, 1932

Pselaphochernes, Beier, 1932b, p. 130; Pselaphochernes, Roewer, 1937, p. 296; Pselaphochernes, Hoff, 1949, p. 461; Pselaphochernes, Hoff, 1958, p. 41; Pselaphochernes, Beier, 1963, p. 253.

Type Species: Chelifer scorpioides Hermann, 1804

Diagnosis: Tactile setae of fixed chelal finger evenly distributed and not basally clustered; tactile seta on tarsus of leg IV inserted less than 0.6 the total distance of the tarsus from its proximal end.

Discussion: The genus is represented in Europe by nine species (Beier, 1963), but only three species have been reported in the United States (Hoff, 1958). One of these three, P. becki Hoff and Clawson, is from rodent nests. The remaining two, P. scorpioides and P. parvus, are from the eastern states. The differences between P. scorpioides and P. parvus will be treated under the discussion of P. parvus.

Pselaphochernes parvus Hoff, 1945

PLATE XXXIII, FIG. 86, 87, 88, 89

Pselaphochernes parvus, Hoff, 1945b, p. 38; Pselaphochernes parvus, Hoff, 1949, p. 461; Pselaphochernes parvus, Hoff and Bolsterli, 1956, p. 168; Pselaphochernes parvus, Hoff, 1958, p. 31.

Type Specimen: A female holotype and female paratype collected from Lake Wedington Wildlife Area, Washington Co., Arkansas. These types are deposited in the Illinois Natural History Survey at Urbana, Illinois.

Material Examined: Two specimens collected from Chickasaw State Park, Chester Co., Tennessee, June 1964, T.P. Copeland (JEL 429).

Diagnosis: Cheliceral flagellum of three blades; tactile seta present on the tarsus of leg IV; a single internal accessory tooth on each chela finger.

Description: Because the male and female of *P. parvus* are similar to one another and I have only a single specimen of each sex, the following description pertains to both sexes unless otherwise noted.

Chaetotaxy of carapace, about 40 clavate setae; tergal chaetotaxy of male: 9:11:12:16:14:15:15:13:12:12:6:2; of female: 10:10:12:11:11:12:14:12:12:14:6:2; sternal chaetotaxy of male: 18:(2-2):$\frac{(3)10(3)}{9}$:(2)7(2):22:22:22:22:19:15:8:2; of female: 0:14:(2)0(2): (2)4(2):15:24:23:20:20:17:9:2; the arrangement of setae on the coxae cannot be given as a formula.

Figure 87 illustrates the palp: palpal proportions of male: trochanter 1.58, femur 2.28, tibia 2.46, chela (less pedicel) 3.15 times as long as broad or deep; finger 1.07 times as long as hand, and 0.96 times as long as femur; chela 1.86 times as long as finger; palpal proportions of female: trochanter 1.81, femur 2.46, tibia 2.47, chela 3.09 times as long as broad or deep; finger 1.07 times as long as hand, and 0.94 times as long as femur; chela 1.94 times as long as finger.

Figure 88 illustrates the dentition and arrangement of tactile setae on the chela. There are a single interior accessory tooth on each finger; seven to nine exterior accessory teeth on each finger; marginal teeth numbering 40 on the fixed finger and 45 on the movable finger; and a nodus ramosus about midway between tactile setae T and ST.

The legs are of typical facies for the genus: Pedal proportions of male: Leg I (Fig. 89): entire femur 2.53, tibia 2.94, tarsus 4.75; Leg IV (Fig. 86): entire femur 3.12, tibia 3.10, tarsus 4.12 times as long as deep; Pedal proportions of female: Leg I: entire femur 2.74, tibia 3.38, tarsus 5.50; Leg IV: entire femur 3.29, tibia 3.75, tarsus 5.18 times as long as deep.

Measurements (in millimeters): Male. Body length 1.88; chelicera 0.188 by 0.143; Palp: trochanter 0.316 by 0.199, femur 0.456 by 0.200, tibia 0.433 by 0.198, chela (less pedicel) 0.819 by 0.260; chela hand 0.408 long, movable finger 0.439 long; Leg I: entire femur 0.377 by 0.133, tibia 0.250 by 0.085, tarsus 0.275 by 0.058; Leg IV: entire femur 0.469 by 0.150, tibia 0.326 by 0.108, tarsus 0.301 by 0.073. Female. Body length 2.14; chelicera 0.245 by 0.160; Palp: trochanter 0.363 by 0.200, femur 0.531 by 0.215, tibia 0.544 by 0.220, chela (less pedicel) 0.970 by 0.313; chela hand 0.463 long, movable finger 0.500 long; Leg I: entire femur 0.406 by 0.148, tibia 0.288 by 0.085, tarsus 0.319 by 0.058; Leg IV: entire femur 0.544 by 0.165, tibia 0.406 by 0.108, tarsus 0.363 by 0.070.

Distribution: Known from the type locality, most of the state of Illinois, Gibson Co., Tennessee and Dane Co., Wisconsin. The material collected from Chickasaw State Park, Chester Co., Tennessee, is a new record but not a state record.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: The two specimens collected from Chickasaw State Park agree with data previously published by Hoff (1945b, 1949). The information in the description is intended to supplement published descriptions. The chaetotaxal formula, not previously reported, is introduced for the purpose of presenting the number of setae in a concise form. This method is also employed in the diagnosis of other species of the suborder Monosphyronida, when the number of specimens available for study are few in number. Note, however, that the number of setae represents the total number of setae for each tergite and sternite and does not discriminate between the anteriorly placed lateral setae on each half of a sclerite and the setae of the marginal row.

The closest related species to P. parvus is P. scorpioides which Hoff and Bolsterli (1956) have reported from Fayette Co., Kentucky.

Hoff (1949) distinguishes P. parvus from P. scorpioides on the basis of the length-width ratio of the palpal chela. As reported by Hoff (1949), the female of P. parvus has a length-width ratio of 2.9 to 3.15 for the chela. The similar ratio for the male is 3.1 to 3.2. The length-width ratio for the chela in P. scorpioides is 2.7 in the female and 2.9 in the male. The same ratios for the chela of my two specimens of P. parvus are 3.09 for the female and 3.15 for the male. These ratios agree closely with those mentioned above for P. parvus. Further, Hoff (1949) has noticed a difference in the curvature of the outer margin of the chelal hand. As illustrated by Beier (1932b), P. scorpioides has a chelal hand which is more rounded than my specimens of P. parvus (Fig. 87) which have a slightly flattened exterior margin of the chelal hand.

Genus *Illinichernes* Hoff, 1949

Illinichernes, Hoff, 1949, p. 481.

Type Species: *Illinichernes distinctus* Hoff, 1949

Diagnosis: Flagellum of four blades; basal seta of chelicera acuminate; setae of palps and tergites large, conspicuous, and leaflike; setae of sternites clavate, except those surrounding genitalia and on more anterior segments which are acuminate; tactile seta absent on tarsus of leg IV.

Discussion: Characteristic for the genus are the stout setae on the body and palps which are leaflike and bilaterally feathered. Hoff (1949), in his original diagnosis of the genus, has amply illustrated these setae. The leaflike shape of the setae is obvious and does not present any problems for a generic determination.

Illinichernes appears closely related to the genus *Hesperochernes* but differs by the large leaflike setae on the body and palps and by the acuminate basal seta of the chelicera (Hoff, 1949).

Illinichernes distinctus Hoff, 1949

PLATE XXXIV, FIG. 90, 91, 92

Illinichernes distinctus, Hoff, 1949, p. 481; *Illinichernes distinctus*, Hoff and Bolsterli, 1956, p. 169.

Type Specimen: Types were collected from Magnolia, Illinois, and are deposited in the Illinois Natural History Survey, Urbana, Illinois.

Material Examined: Six specimens collected from Plummer's Isle, Montgomery Co., Maryland, November 1963, T.P. Copeland (JEL 337, 338, 339).

Diagnosis: As for the genus.

Description: Carapacal chaetotaxy not ascertainable but about 50 leaflike, stout setae; tergal chaetotaxy of male: 14:14:16:18:18:18:18:18: 18:16:7:2; for the female: 13:18:16:20:20:20:18:16:19:17:11:2; sternal chaetotaxy of male: 36:(0-0):(3)24(3):(2)11(2):18:15:16:17:15:10:7:2; of the female: 0:25:(3)14(3):(3)11(3):18:21:17:17:14:11:8:2.

The palp is illustrated in Fig. 91. Palpal proportions of male: trochanter 1.76, femur 3.20, tibia 2.64, chela 2.56 times as long as broad; finger 1.07 times as long as hand, and 0.69 times as long as finger; chela 1.87 times as long as finger; range for females: trochanter 1.58-1.66, femur 3.15-3.25, tibia 2.43-2.61, chela 2.47-2.62 times as long as broad; finger 1.04-1.08 times as long as hand, and 0.64-0.72 times as long as femur; chela 1.76-1.98 times as long as finger.

Tactile setae of the chela with the following arrangement: on the movable finger ST is closer to T than to SB, and on the fixed finger IST is distal to EST; movable finger with four external and two internal accessory teeth; setae of the chelal fingers acuminate, except dorsal surface of fixed finger with three to five clavate setae.

The legs are of typical facies for the subfamily (Figs. 90, 92): Pedal proportions of male: Leg I: entire femur 3.12, tibia 4.08, tarsus 5.93; Leg IV: entire femur 3.85, tibia 4.76, tarsus 5.60 times as long as deep; range of pedal proportions of female: Leg I: entire femur 2.68-3.13, tibia 3.51-3.95, tarsus 5.26-5.95; Leg IV: entire femur 3.57-3.70, tibia 4.47-4.50, tarsus 5.23-5.58 times as long as deep.

Measurements (in millimeters): Male. Body Length 1.75; chelicera 0.177 by 0.113; Palp: trochanter 0.331 by 0.188, femur 0.635 by 0.198, tibia 0.556 by 0.210, chela (less pedicel) 0.832 by 0.325; chela hand 0.413 long, movable finger 0.444 long; Leg I: entire femur 0.400 by 0.128, tibia 0.306 by 0.075, tarsus 0.344 by 0.058; Leg IV: entire femur 0.513 by 0.133, tibia 0.419 by 0.088, tarsus 0.381 by 0.068. Female. Body length 1.98-2.07; chelicera 0.180-0.190 by 0.095-0.125; Palp: trochanter 0.344-0.362 by 0.208-0.228, femur 0.625-0.693 by 0.198-0.213, tibia 0.544- 0.592 by 0.213-0.243, chela (less pedicel) 0.794-0.895 by 0.321-0.357; chela hand 0.413-0.431 long, movable finger 0.500-0.506 long; Leg I: entire femur 0.398-0.438 by 0.130-0.163, tibia 0.301-0.344 by 0.078-0.098, tarsus 0.332-0.375 by 0.060-0.063; Leg IV: entire femur 0.513-0.556 by 0.143-0.150, tibia 0.394-0.450 by 0.088-0.100, tarsus 0.356-0.413 by 0.068-0.075.

Distribution: The range of I. distinctus may be more extensive than was first realized. Other than the type locality of Magnolia, Illinois, it has been reported from Kell, Illinois; White Cloud, Harrison Co., Indiana; and College Park, Maryland. My material is from an area near the locality reported for Maryland.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: All specimens examined agree well with the original description by Hoff (1949). This species is relatively easy to recognize because of the shape of the palpal and body setae. Further, the presence of these leaflike setae on the fixed finger of the chela is peculiar to *I. distinctus*.

The formula for the chaetotaxy, as given in the description, includes the total number of setae for each scuta and does not differentiate a single laterally place seta on the posterior segments. Using such a formula gives the number of setae per tergite or sternite and provides a quick reference for comparison with other tergal and sternal chaetotaxal formulae.

I. distinctus is the only known species of the genus and, as mentioned earlier under the generic discussion, it is closely related to the genus *Hesperochernes*.

Family Cheliferidae Hagen, 1879

Cheliferidae, Chamberlin, 1931a, p. 244; Cheliferidae, Chamberlin, 1931b, p. 289; Cheliferidae, Beier, 1932b, p. 191; Cheliferidae, Roewer, 1937, p. 304; Cheliferidae, Hoff, 1949, p. 485; Cheliferidae, Hoff, 1956d, p. 1; Cheliferidae, Hoff, 1958, p. 46; Cheliferidae, Hoff, 1964, p. 5.

Diagnosis: Marginal teeth only on fingers of chela, accessory teeth absent; both chelal fingers with venom apparatus; flagellum of three or four blades; femoral articulation of leg I different from symphysis of leg IV.

Type Genus: *Chelifer* Geoffroy, 1762

Discussion: The Cheliferidae has had much the same history as the family Chernetidae. Balzan, in his classification of 1891, listed the genus Chelifer and included the subgenus Chelifer. As now recognized, this subgenus is the family Cheliferidae. With (1908) was instrumental in separating the genus Chelifer, as used by Balzan, into several families. The two groups upon which With based the family was Chelifer cancroides and Chelifer subruber, which now represents two subfamilies (fide, Chamberlin, 1931a).

The Cheliferidae is divided into three subfamilies, the Paragoniochernatinae Beier, the Withiinae Chamberlin, and the Cheliferinae Simon. Only this last subfamily is important here since the Paragoniochernatinae is found in Africa and New Zealand and the Withiinae was not collected even though it has been reported from the United States (Hoff, 1958, 1964).

The character which separates the Chernetidae from the Cheliferidae is the presence of accessory teeth on the former and their absence on the latter. Other characters such as the number of blades on the flagellum, and the presence of the venom apparatus in both fingers or only in the movable finger can be confusing and should be applied with caution.

Subfamily Cheliferinae Simon, 1879

Cheliferinae, Chamberlin, 1931b, p. 293; Cheliferinae, Beier, 1932b, p. 226; Cheliferinae, Roewer, 1937, p. 310; Cheliferinae, Hoff, 1949, p. 485; Cheliferinae, Hoff, 1956d, p. 2; Cheliferinae, Hoff, 1958, p. 48; Cheliferinae, Hoff, 1964, p. 5.

Diagnosis: Flagellum of three blades; males with coxal sac present in fourth coxa; tarsal claws and subterminal setae may or may not be toothed or cleft; male with statumen convolutum, ramshorn organs.

Discussion: The presence of well developed genital sacs, the ramshorn organs, are characteristic of the subfamily. These structures are folded and invaginated just beneath the genital cavity and have a reticulate derm which Chamberlin (1931a) believes is of systematic importance. The genital sacs are found in other families and suborders, but they reach their highest development in the Cheliferinae. Chamberlin (1931a) believes they function as display organs during courtship.

Present along with the ramshorn organs of the male are the coxal sacs on the fourth pair of coxae. Their function is not known, but their structure is used in systematics because the shape varies from species to species.

A single tribe, the Dactylocheliferini, was represented in the material collected. Other tribes of the subfamily have been reported from more southern and western states (Hoff, 1958).

Tribe Dactylocheliferini Beier, 1932

Lissocheliferini, Chamberlin, 1932, p. 20; Dactylocheliferini, Beier, 1932b, p. 241; Dactylocheliferini, Roewer, 1937, p. 313; Dactylocheliferini, Hoff, 1949, p. 491; Dactylocheliferini, Hoff, 1956d, p. 28; Dactylocheliferini, Hoff, 1964, p. 30.

Diagnosis: Anterior margin of statumen convolutum rounded and without rod-like structure; coxal sacs of male with distinct medial atrium; female cribriform plates fused into a single plate.

Discussion: The diagnostic character for the tribe is the rounded anterior margin of the statumen convolutum which is never deeply invaginated, nor does it possess a median rod-like process. The rounded margin is obvious when compared with members of the tribe Cheliferini, which have the anterior portion deeply invaginated. The statumen convolutum is of some systematic importance, but unfortunately, males are necessary for generic assignments.

The genus Dactylochelifer was the only member of the tribe found within the geographical limits of this paper. Other genera and species have been reported for the Dactylocheliferini, but these are from Florida and California.

The genus Tyrannochelifer, formerly assigned to the tribe Dactylocheliferini, has been placed by Hoff (1964) in the tribe Cheliferini. This action was taken because females have paired median cribriform plates, thus separating them from the females of the Dactylocheliferini which have a single median cribriform plate. Males have a deeply invaginated statumen convolutum but lack a rod-like process (Hoff, 1964). After relegation of Tyrannochelifer to the tribe Cheliferini, the Dactylocheliferini now consists of three genera, Dactylochelifer, Ellingsenius, and Pugnochelifer.

As mentioned earlier, the genus Dactylochelifer is the only genus of the tribe represented in my collections. Briefly, the Dactylochelifer are separated from the genus Ellingsenius by possessing a single galeal seta on the movable finger of the chelicera rather than three galeal setae, and from the genus Pugnochelifer by the presence of the tactile seta SB on the cheliceral hand which is absent in the genus *Pugnochelifer*.

Genus *Dactylochelifer* Beier, 1932

Ectoceras, Chamberlin, 1932, p. 21; *Dactylochelifer*, Beier, 1932b, p. 253; *Dactylochelifer*, Roewer, 1937, p. 315; *Dactylochelifer*, Hoff, 1949, p. 491; *Dactylochelifer*, Hoff, 1956d, p. 28; *Dactylochelifer*, Hoff, 1961, p. 460; *Dactylochelifer*, Beier, 1963, p. 288; *Dactylochelifer*, Hoff, 1964, p. 31.

Type Species: *Dactylochelifer latreillei* (Leach, 1817).

Diagnosis: Tactile seta IT of fixed chelal finger about halfway between ET and IST; movable finger of chela with tactile seta ST evenly spaced between SB and T or closer to SB; absence of tactile seta on tarsus of leg IV; subterminal setae acuminate; male with modified tarsus on leg I, claws asymmetrical; claws on other legs simple; anterior margin of statumen convolutum never invaginated; coxal sacs with distinct atria.

Discussion: The genus *Dactylochelifer* is represented in the United States by two species. It has been reported that the genus contains a total of 23 species which occur throughout the palearctic region (Hoff, 1964). Of the two species, *D. copiosus* Hoff and *D. silvestris* Hoff, only the former is represented in collections taken for this paper.

Dactylochelifer appears to be confined to the central part of the United States. Specimens of *D. copiosus* were collected from west Tennessee which supports the previous distribution data reported by Hoff and Bolsterli (1956).

<u>Dactylochelifer</u> <u>copiosus</u> Hoff, 1945

PLATE XXXV, FIG. 93, 94, 95; PLATE XXXVI, FIG. 96, 97, 98

<u>Dactylochelifer</u> <u>copiosus</u>, Hoff, 1945b, p. 53; <u>Dactylochelifer</u> <u>copiosus</u>, Hoff 1945c, p. 521; <u>Dactylochelifer</u> <u>copiosus</u>, Hoff, 1949, p. 491; <u>Dactylochelifer</u> <u>copiosus</u>, Hoff and Bolsterli, 1956, p. 178; <u>Dactylochelifer</u> <u>copiosus</u>, Hoff, 1964, p. 31.

<u>Type</u> <u>Specimen</u>: The holotype male and allotype were taken in a collection from Farmington, Washington Co., Arkansas. Types are deposited with the Illinois Natural History Survey, Urbana, Illinois.

<u>Material</u> <u>Examined</u>: Forty-three specimens collected from the following localities:

TENNESSEE: Chester Co.: Chickasaw State Park, June 1964, T.P. Copeland (JEL 413, 417, 418, 420, 422, 425, 426, 429, 430, 435, 436, 439, 444, 445, 446, 447, 450, 456, 457, 458, 459, 460). Cocke Co.: Greeneville Hwy., July 1953, T.P. Copeland (JEL 184). Cumberland Co.: Cumberland Mt. State Park, October 1962, T.P. Copeland (JEL 90). Henderson Co.: Natchez Trace State Park, June 1964, T.P. Copeland (JEL 380, 385, 392, 397, 400). Wilson Co.: Cedars of Lebanon State Park, October 1962, T.P. Copeland (JEL 92).

VIRGINIA: Floyd Co.: Blue Ridge Parkway, October 1962, J.E. Lawson (JEL 105, 108).

<u>Diagnosis</u>: Proportion of palpal femur 3.93 to 4.52; chela hand narrowed towards the finger base.

<u>Description</u>: For both sexes unless otherwise noted. The chaetotaxy

of the carapace is indeterminable since the setae are obscured by the pigment and granular condition of the derm; tergal chaetotaxy for both sexes: 11:11:13:$\frac{6}{10}$:$\frac{6}{10}$:$\frac{6}{11}$:$\frac{6}{12}$:$\frac{9}{12}$:$\frac{8}{12}$:$\frac{7}{10}$:$\frac{2}{7}$:mm; sternal chaetotaxy of male: 35:(2-2):(0)6(0):(1)10(1):14:14:14:13:15:9:mm; of female: 0:14:(0)7(0); (1)8(1):15:13:13:13:14:13:10:mm.

Figure 93 illustrates the general facies of the palp. Palpal proportions of male: trochanter 1.64-1.86, femur 4.02-4.21, tibia 3.13-3.41, chela (excluding pedicel) 4.09-4.31 times as long as broad, finger 1.01-1.22 times as long as hand and 0.79-0.88 times as long as femur, chela 1.80-1.94 times as long as finger; Palpal proportions of female: trochanter 1.61-1.96, femur 3.93-4.52, tibia 3.04-3.65, chela (excluding pedicel) 3.94-4.51 times as long as broad, finger 1.01-1.13 times as long as hand and 0.76-0.89 times as long as femur, chela 1.80-2.05 times as long as finger.

Dentition and chaetotaxy as illustrated in Fig. 94.

The legs are of typical facies for the genus. Pedal proportions of male: Leg I (Fig. 96): entire femur 2.64-3.25; tibia 2.22-2.55, tarsus 3.14-3.21; Leg IV: (Fig. 97) trochanter 1.84-2.36, entire femur 3.10-3.37, tibia 3.69-4.20, tarsus 4.37-4.68 times as long as broad or deep. Pedal proportions of female: Leg I: entire femur 2.94-3.33, tibia 3.27-3.33, tarsus 4.20- 4.44; Leg IV: entire femur 3.13-3.60, tibia 3.71-4.43, tarsus 4.41-4.82 times as long as broad or deep.

Measurements (in millimeters): Male. Body length 2.48-2.76; chelicera 0.208-0.220 by 0.118-0.128; Palp: trochanter 0.416—0.466 by 0.230-0.260, femur 0.781-0.869 by 0.194-0.214, tibia 0.743-0.819 by 0.224-0.245, chela (less pedicel) 1.25-1.36 by 0.291-0.332; chela hand 0.567-0.680 long, movable finger 0.668-0.731 long; Leg I: entire femur 0.481-0.525 by 0.148-0.193, tibia 0.281-0.311 by 0.120-0.135, tarsus 0.363-0.377 by 0.113-0.120; Leg IV: trochanter 0.291-0.301 by 0.123-0.163, entire femur 0.617-0.693 by 0.183-0.223, tibia 0.463-0.504 by 0.110-0.133, tarsus 0.372-0.403 by 0.080-0.088. Female. Body length 2.58—3.19; chelicera 0.217-0.250 by 0.118-0.148; Palp: trochanter 0.403-0.491 by 0.240-0.281, femur 0.819-0.958 by 0.199-0.224, tibia 0.731-0.895 by 0.230-0.255, chela (less pedicel) 1.31-1.50 by 0.316-0.367; chela hand 0.630-0.756 long, movable finger 0.643-0.794 long; Leg I: entire femur 0.494-0.556 by 0.153-0.175, tibia 0.313-0.362 by 0.093-0.105, tarsus 0.352-0.398 by 0.070-0.078; Leg IV: trochanter 0.311-0.357 by 0.133-0.188, entire femur 0.680-0.794 by 0.197-0.235, tibia 0.434-0.554 by 0.110-0.138, tarsus 0.394-0.434 by 0.085-0.098.

Distribution: Present records as shown in the list below indicate that *D. copiosus* has a wide distribution in the central part of the United States. In this paper, the material examined from Tennessee represents new county records and those specimens collected from the Blue Ridge Parkway, Floyd Co., Virginia, constitutes a new state record for the species.

ARKANSAS: Carroll Co.; Farmington, Washington Co.

GEORGIA: Columbus, Muscogee Co.

ILLINOIS: Burksville; Calhoun and Clay Cos.; Edwardsville; Geff; Giant City State Park; Gillespie; Grand Detour (Castle Rock); Hardin Co.; Havana; Herod; Jackson, Jefferson, and Johnson Cos.; Logan;

Macoupin Co.; Makanda; Murphysboro; New Columbia; Pere Marquette State Park; Perry and Pope Cos.; Vienna; Washington Co.

KANSAS: Franklin Co.

KENTUCKY: Edmonson Co.

MISSISSIPPI: Tishomingo Co.

MISSOURI: Cole, Iron, Phelps, St. Louis, Shannon, and Wayne Cos.

TENNESSEE: Franklin and Obion Cos.

Disposition of Material: All specimens will be retained in the author's collection.

Discussion: Hoff (1945), in his original description of *D. copiosus*, accorded this species an excellent treatment. Subsequent work by Hoff (1949) and Hoff and Bolsterli (1956) have added to the original description.

In addition to *D. copiosus*, only one other species, *D. silvestris*, from New Mexico and Colorado, has been reported for the genus in the United States. It is separated from *D. copiosus* by having stouter palpal podomeres. Separation of species can generally be based on the palpal femur. According to published data (Hoff, 1956d, 1961), *D. silvestris* has a range of the length-width palpal femur of 3.42-3.72 for the male and 3.44 to 3.87 for the female. The range for this ratio, taken from examined material of *D. copiosus*, was 4.02-4.21 for the male and 3.93-4.52 for the female. The ratios obtained from the specimens studied of *D. copiosus* agree well with the information given by Hoff (1945, 1949) for this species.

VII. DISCUSSION

Previous taxonomic studies of pseudoscorpions have relied, in the main, upon a very few specimens of the species under consideration. In some instances, a description would be based on only two or three specimens, while other descriptions were based on a slightly larger number. It is conceivable that in earlier descriptions the use of only a few specimens was necessary, but as procedures for collecting and mounting improved, descriptions should have been based on a series of specimens, but, unfortunately, this usually has not been done. Hoff, for example, collected 94 specimens of Mundochthonius sandersoni, yet his description is based on 11 individuals. In my treatment of M. sandersoni, 100 specimens were studied and, as a result, the measurements given by Hoff in the original description of the species are shown to be inadequate to describe the variability of M. sandersoni. Throughout this paper, I have based my descriptions on a series of specimens rather than on a token sample. I must, however, qualify this last statement. First, the number of specimens collected of the suborder Monosphyronida were relatively few, but attention was drawn to this fact when the species were described. Second, the description of a new species, Neobisium holti, is based on a single male. By giving species status to this single specimen, I am, in a sense, opposing my tenet of the necessity of a series of specimens, but when viewed in light of the distinctiveness of N. holti, there is no recourse other than to erect a new species. My main objections to previous taxonomic studies is the usual failure of current workers to adequately describe the variability of the species they identify and their tendency to concentrate upon describing new species and erecting new genera on the basis of a few "key" characters. To emphasize my point, I have heard the following statement in reference to Microbisium confusum, "I have considered this species to be as common as dirt and have not bothered to mount them." Throughout my work, measurements taken of Microbisium confusum were in agreement with previously published data, but in the 300 specimens mounted, I found and described a male of this species which is the first recorded instance of a male of the genus being reported. Previously, all workers had assumed the genus to reproduce parthenogenetically, and no effort to collect males had been made.

In short, I believe that the investigator is primarily responsible for the number of specimens used in species descriptions, and when possible, a large number of specimens should be relied upon for the description. By studying a series of specimens, the worker is more likely to detect greater variability and dissimilarities in structure.

When a series of specimens are used as the basis of a species description, the dimensions of measured structures become a large part of the data accumulated. I utilized these measurements in three ways: One, to extend or show agreement with similarily published data; two, to compare length and width dimensions of various palpal or pedal segments; three, to group the ranges of all measurements under a separate subheading.

Descriptions, as given by earlier workers, were entirely unsatisfactory in many respects, particularly in the neglect of measurements. For example, Banks (1891), in describing Apochthonius moestus (Banks), used such indefinite terms as "femur short," "hand very short," "hind pair of legs short." Chamberlin (1929b), in describing this species, listed only the proportions of the palpal segments. More recent descriptions, however, do include the actual measurements of various structures, but few redescriptions have been done to correct the descriptions of earlier workers. The listing of numerical data is important as a description of variability within a species and as a comparison with similar information of past, present, and future descriptions.

In comparing the measurements taken of particular structures, I found the scatter diagram to be useful as a visual interpretation of the variations recorded in numerical form. When using this method, I began to question the validity of the ratios of the palpal femur in the separation of Kleptochthonius crosbyi and K. multispinosus. The results obtained from this scatter diagram led me to look further because the data did not satisfy my requirements for two distinct species. On the other hand, the erection of the new species, Apochthonius barbarae, rests partially on the distinctiveness it showed when the dimensions of the palpal femur were plotted on the scatter diagram along with the measurements of A. moestus. This method was employed for all species described, but the results were not formally presented in this paper because the use of this method, or a similar one, should be a part of the background study which is done before a description is given.

I have emphasized throughout this paper that the taking and recording of measurements is important. It is true that most workers, myself included, rely heavily upon the dimensions of the palpal segment, particularly of the femur and tibia, as key characters for the identification of species. For the present, this approach appears to be the only one open to the investigator. This type of pseudoscorpion taxonomy is changing, however, because descriptions are becoming more complete. It is for this reason that I, in following others, have set apart from the rest of the description a list of the ranges of the measurements actually taken. The availability of such a list provides a quick and easy reference for purposes of comparison. This list of numerical data should not be considered in terms of an average pseudoscorpion, but rather as information which contributes to the "total" understanding of pseudoscorpion taxonomy.

When this study was first begun, I thought the classification scheme was fairly well established. Throughout my investigation, however, I found myself questioning, more and more, the work of earlier workers and, unfortunately, current investigators. Now, my contention is that the approach of reporting on pseudoscorpions from various geographical areas is the second stage while the first stage should be that of revisionary studies in which the included species of each genus are subjected to a thorough taxonomic treatment. Until such studies are done, the classification system will be considered suspect.

In reading descriptions, keys, diagnoses, etc., one becomes acutely aware of the erection of genera on the slimmest of evidence. The chaetotaxy of the chela becomes all important and genera are separated on the basis of one tactile seta being near or removed from another similar one. For example, the key character for Dendrochernes is the tactile seta ST being closer to SB than to T. If I had applied this type of taxonomy to my new species, Neobisium holti, I would have erected a new genus rather than a new species, because the chaetotaxy of the movable chelal finger is different from other species of the genus. However, I do not believe that the position of tactile setae is the criterion to be used for constructing a classification system of the pseudoscorpions.

The confusion that exists with the present classification scheme has led to an overrefinement of many taxa. When additional studies are done, it may be possible to show that many specimens, now assigned to separate genera, are not this distinct but rather are congeneric. Further, relationships among the higher taxa may be affected as a result of revisionary studies. It must be remembered, however, that the system presently employed is the only one available and changes in this system will come only after efforts have been made to correct and improve the system for the classification of pseudoscorpions.

The systematic characters used for the suborders, superfamilies, families, subfamilies, and some genera appear to be valid for the specimens studied in this investigation and are of taxomonic value in erecting a scheme of classification. In regard to the suborders, the interpretation of the segments of the pedal appendages offers enough evidence to assign them to their proper taxon. It is those characters presently employed for some generic and species identifications which I question.

The systematic characters used in the separation of the genera of the Heterosphyronida and Diplosphyronida appear to be constant. Moreover, these characters are formed morphological elements rather than being the insertion of tactile setae and the proximity of these setae to other similar ones. On the species level, it is unfortunate, but necessary, that measurements and length-width proportions of palpal podomeres are generally the key species characters. If used solely as data for the separation of species, these measurements and proportions can easily lead to misunderstanding of the species being studied. These data are important, but only if used as suggested earlier, with such information being correlated with other types of data.

The taxonomy of the suborder Monosphyronida is the most difficult to understand. In this paper, the suborder Monosphyronida is represented by only a few species, but even this limited contact along with additional reading has led me to question the characters used for the identification of genera within the subfamilies of the suborder. This view is shared by others, but no one has attempted to correct the classification of the suborder. Instead, the practice has been to "build" on an unsound "foundation". The following quotation from Hoff (1949) seems to be the attitude of current workers:

> "The present scheme of classification within the subfamily is entirely unstable and unsatisfactory. In order to circumvent confused concepts of some older genera, the writer has established several new ones even though there is a possibility that one or more of these may later lapse into

synonymy. A comprehensive revision of the entire subfamily is needed."

In this quotation, I particularly agree with the last statement. There was, and still is, a need for revisionary work, but this type of research has been the second choice for most workers.

One point obviously missing from this discussion is the value of chaetotaxy in understanding the lower and higher taxa of pseudoscorpions. In each description presented in this paper, various chaetotaxal formulae were given for various regions of the body. Chaetotaxy must be viewed in two aspects: one, the vestitural setae and, two, the tactile setae.

The arrangement of the vestitural setae is given in the formulae for tergites, sternites, coxae, and carapace. In regard to tergal and sternal chaetotaxy, the number of setae may vary slightly between specimens of the same species and even between sexes. Also, the setae of the carapace and coxae, which appear to be more constant for the species, would also show some variation in their numbers. From my studies, I have found that the use of these chaetotaxal formulae should not be strictly applied, but rather be used as an index for comparison with other specimens being examined. Other workers also employ the use of these formulae in this manner because they appear in their descriptions but never in their diagnoses.

The tactile setae have been used extensively throughout the order for classifying pseudoscorpions, contrary to the case for vestitural setae. As mentioned earlier, the arrangement of the tactile setae on the palpal chela has been a primary character for the determination of genera in the suborder Monosphyronida. Note that the arrangement, and not a grouping or the number of setae present, was questioned as a generic character. Some genera can be characterised on the basis of the number of tactile setae, i.e. the genus Microbisium has 10 setae rather than the normal 12. This lesser number is diagnostic and no other genera in the material studied have a similar condition. In some genera some of the tactile setae of the chela may be in a single group or may form two or more distinct groups.

Chaetotaxy, when applied wisely, can be of great systematic value for the determination of many subordinate categories. At present, its use should be valid only in terms of an index for comparison or as an aid for determining some genera and higher taxa.

In the preparation of material for study, I was continually disturbed with the few specimens I was collecting of the suborder Monosphyronida. I kept questioning my collecting techniques, particularly the size of screen used in sifting the detritus through the Berlese apparatus. An examination of material given to me from Monterrey, Mexico, which was subjected to identical screen size and collecting method, was found to contain monosphyronids outnumbering the other two suborders by 9 to 1. The discovery of a great number of monosphyronids from a much drier climate, leads me to conclude that members of the Monosphyronida are much more prevalent in arid regions. To add substance to the possibility of the monosphyronids being more widely distributed than is realized, Dr. John Holsinger of East Tennessee State University recently showed me some specimens which he collected from the mouth of a cave near Blacksburg, Virginia. These specimens were in a dry area away from the places he usually collects for pseudoscorpions. Tentatively, I have placed these specimens in the family Cheliferidae and they do not belong to any species collected and identified by me from that general area. Only additional study will confirm the presence of monosphyronids pseudoscorpions in the drier habitats of a region where most of the animals are searched for and found in relatively moist places.

There are other important aspects about the ecology of pseudoscorpions, but this subject has been neglected or there has been a lack of data to suggest or substantiate any findings. In my case, collection data was not sufficient for any type of correlation between pseudoscorpion fauna and the surrounding vegetation from which the collections were taken. Only in one instance am I able to offer some evidence for habitat dependency. _Neobisium carolinense_ was collected only from the base of rotting tree trunks and was never found among the debris collected elsewhere. The factor or factors involved in this case cannot be deduced from the information I have at hand. Further, if _N. carolinense_ has a preference for this type of habitat, the closely related form, _N. tenue_, might also show this choice of habitats. Therefore, I did a study of the collection sites from which _N. tenue_ was taken. The results were not encouraging because _N. tenue_ was collected from dead tree trunks, at the base and near trees and shrubs, predominantly evergreen, and from deciduous ground litter. With the present data, I can not predict the type of pseudoscorpion fauna one can expect to find in any given habitat.

The families of pseudoscorpions have a wide geographical range, but some genera are confined to certain areas. In the United States, the genus Neobisium is found only in the mountainous region of the southern Appalachians, while this genus is quite common in Europe. From all evidence available it would seem that Neobisium is endemic to this area in the United States. Collections taken from surrounding areas did not reveal any species of Neobisium. It is concluded from the material at hand that much further study is required before the actual numbers, relations, and distributions of the various forms can be clearly understood, and only then will it be possible to determine the extent of endemism of Neobisium to the Appalachian Mountains.

Some of the genera reported on in this paper are localized in their distribution while other genera have a much greater range. The genera Apochthonius, Kleptochthonius, Illinichernes, and Verrucaditha are found only in certain areas of the United States. Their distribution in this country is indicated with each species description given in this paper.

The genus Chthonius is cosmopolitan in its distribution, but the genera Mundochthonius, Kewochthonius, Microbisium, Neobisium, Microcreagris, Pselaphochernes, and Dactylochelifer are more restricted in the geographical areas they inhabit. The following information, taken from Beier (1963), is a short account of the regions or areas in which these latter genera have been found: Mundochthonius is widespread throughout the holarctic region; Microbisium is found in the holarctic and ethiopian faunal regions; Neobisium is widespread throughout Europe but localized in the southern Appalachians of the United States; Microcreagris is widespread in the palearctic, nearctic, and oriental regions; Pselaphochernes is limited to Europe, North Africa, parts of Asia, and the United States. Dactylochelifer is found throughout the palearctic but localized in the United States; Kewochthonius is found only in the United States and England.

The distribution of genera in the United States is inadequately known. This lack of knowledge about their distribution is the result of a failure to collect throughout the United States. Earlier workers collected and reported on species from the eastern states. Chamberlin was responsible for most of the work done on the pseudoscorpions of the Pacific Coast states. Other areas were wholly neglected until Hoff published on pseudoscorpions from various western, southwestern and midwestern states. This is the type of work necessary before any valid discussion can be presented on the distribution of pseudoscorpions in the United States. This work, in order to be meaningful, however, will have to be postponed until the taxonomy of the group is better known.

The possible means of dispersal for pseudoscorpions, as mentioned earlier in this paper, are by air currents for smaller forms, as a result of phoresy, and by commerce. The possibility of pseudoscorpions, even small ones, being blown about by air currents seems unlikely because their secluded habitat would protect them from high winds. From the evidence available, phoresy appears to be the chief means of transportation. The discovery of pseudoscorpions on the legs of various arthropods and in rodent and bird nests implies that these animals could be carried for small or great distances. It has been suggested that pseudoscorpions found in the nest are in search of food. This may be true, but as a result they might become attached to rodents, mammals, or any other animal and be carried to new ecological areas. Concerning transportation by commerce, it seems feasible that pseudoscorpions could easily be dispersed in this manner. One species, *Chthonius tetrachelatus*, is found in the United States and Europe. Its presence on both continents makes me lean toward the possibility of the introduction and establishment of this species by commercial means. Spatial isolation alone should account for two distinct species, unless that space recently has been bridged by some other factor.

It would appear that pseudoscorpions have the means available for their dispersal, but these means must be considered carefully in attempting to explain the distribution of any group. Our knowledge of distribution and taxonomy of the order is insufficient for zoogeographical purposes because the pseudoscorpion fauna of many areas of the world has been partially or wholly neglected. To emphasize this last statement, pseudoscorpions have not been reported or collected from the states of Delaware, Rhode Island, South Dakota, and, until now, South Carolina. Also, many state records are for only one or two species (Hoff, 1958). Until such records are more complete, it is difficult to show distribution or design any form of zoogeographical pattern.

The study of pseudoscorpions is far from complete. Some research has been done toward behavior, embryology, taxonomy, and distribution. As a result of my study, I believe that the taxonomy of the group is the greatest challenge facing our understanding of the pseudoscorpions, since the taxonomic approach is basic to the understanding of these other studies.

Throughout my study, I found the present system of classification to be questionable and, at best, workable for the species studied. A more refined system is necessary, but before order can come to pseudoscorpion taxonomy, revisionary studies on the genus level are necessary for the establishment of a functional classification.

This study has questioned the value of previous studies of a similar nature. Two monographs are available for reference to a beginner in the study of these animals. However, I found these previous works and other earlier publications to be quite unsatisfactory for a critical study because their descriptions of new species and redescriptions of other species were inadequate. I was surprised that current workers had not questioned these earlier descriptions. Instead they seemed intent upon confusing the taxonomy of the group by describing new genera and species on, what I consider to be, superficial evidence. In reading through this paper, one will find my contributions to be a more intensive and extensive description of species based on the use of a series of specimens rather than on a token number. In doing so, I was able to show a greater variation than was previously known, and was able to uncover some anatomical differences which will have a bearing on future taxonomic work. Further locality data from other works are presented to show the previously known distribution for each species and, from my study, new records are stated. Finally, a discussion is given for each species concerning the variations noted among similar species and closely related species.

VIII. SUMMARY

More than two-thousand slides of pseudoscorpions were prepared from over 700 samples of leaf mold from deciduous forests. These collections came from Plummer's Isle, Maryland; Mt. Mitchell, North Carolina; Greenville Co., South Carolina; several counties of East Tennessee and various state parks from Middle and West Tennessee; Breaks Interstate Park, Virginia; Blue Ridge Parkway, Floyd Co., Virginia; Mt. Lake, Virginia; and the Great Smoky Mountains National Park. Systematic studies of these specimens reveal that 18 species, two of which are new species, of the Order Pseudoscorpionida are present in these collections.

A redescription of each of 16 species and a description of each of the two new species is presented together with a discussion of the systematic position of each species. Species emendations are based on a series of specimens, and the measurements taken of the various structures show a greater range in length-width ratios and dimensions than was indicated in similarly published data for many of the species. With each species description a short synopsis of its distribution is given with the addition of recent collection records.

Several changes in regard to chaetotaxal formulae are proposed and employed in the descriptions. Also, the use of the terms "maxillae" and "maxillaris apicalis" is thought to be incorrect and the abandoment of such usages is urged.

The need for revisionary work, the use of measurements, and the

validity of systematic characters are discussed along with the ecology, distribution, and means of dispersal of pseudoscorpions.

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PLATE I

Fig. 1. Verrucaditha spinosa, palp, 21X.

Fig. 2. V. spinosa, chela, 21X.

Fig. 3. V. spinosa, internal genitalia of male, 43X.

PLATE I

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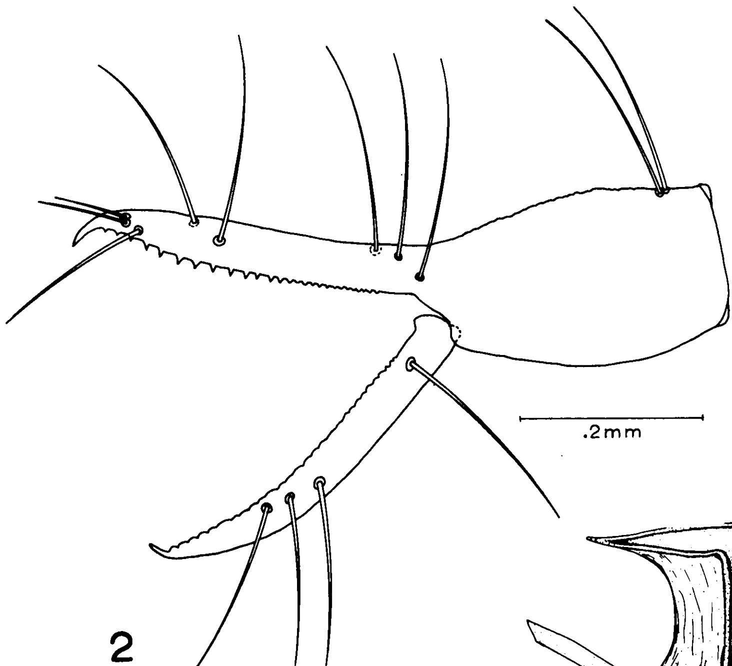

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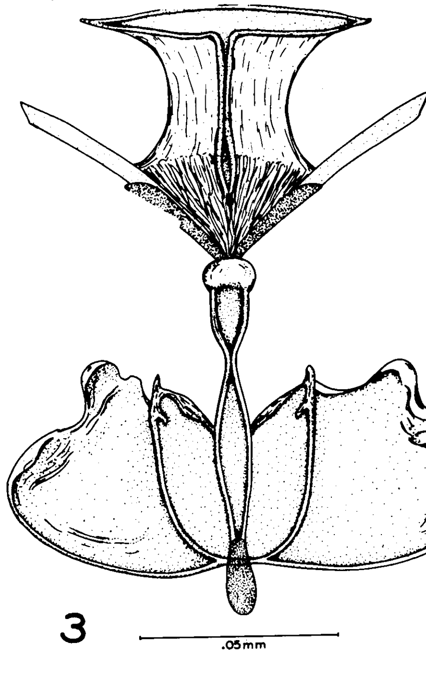

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PLATE II

Fig. 4. *Verrucaditha spinosa*, anterior portion of carapace, 43X.

Fig. 5. *V. spinosa*, chelicera, 43X.

Fig. 6. *V. spinosa*, coxal spines of coxae I and II.

B - basal seta

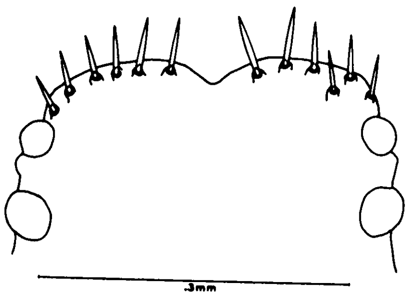
ES - exterior seta

GS - galeal seta

IS - interior seta

SB - subbasal seta

PLATE II



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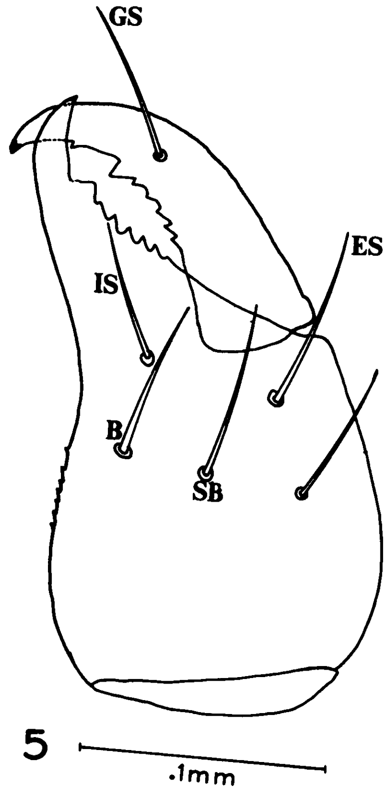

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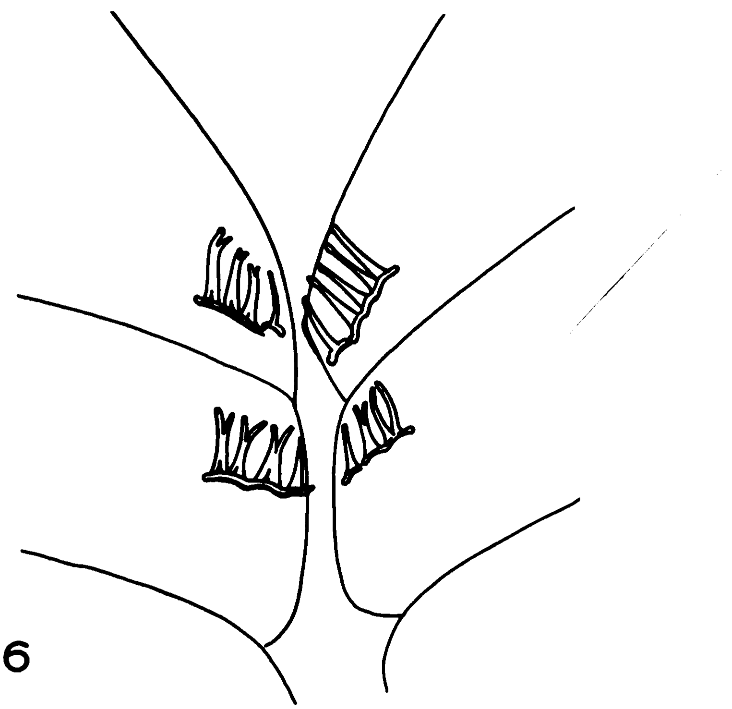

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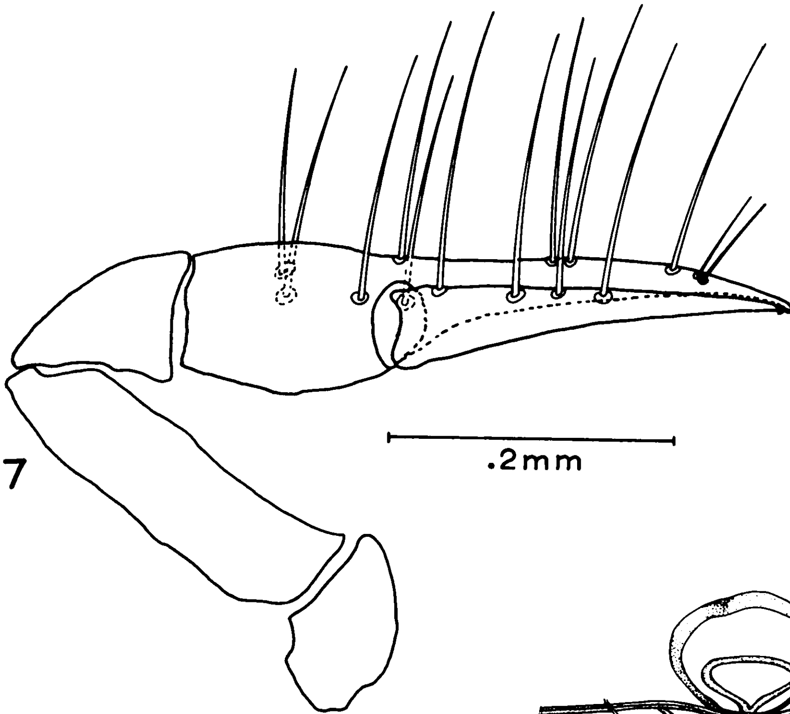
PLATE III

Fig. 7. *Mundochthonius* *sandersoni*, palp, 21X.

Fig. 8. *M*. *sandersoni*, chela, 21X.

Fig. 9. *M*. *sandersoni*, internal genitalia of male, 43X.

PLATE III



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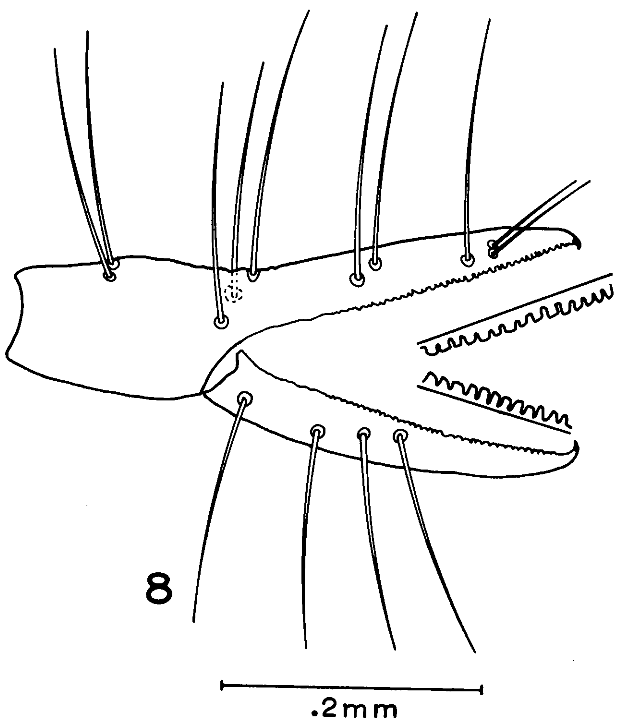

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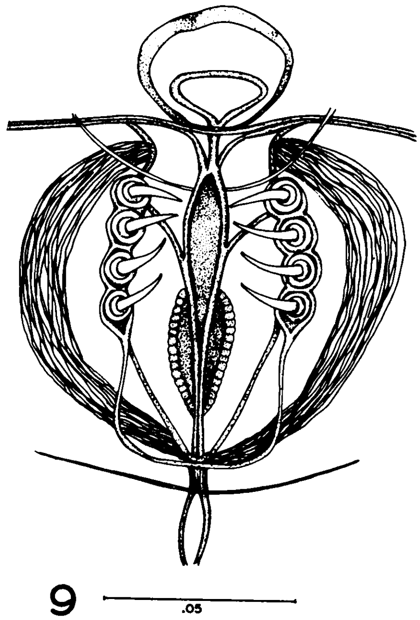

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PLATE IV

Fig. 10. *Mundochthonius sandersoni*, leg IV, 21X.

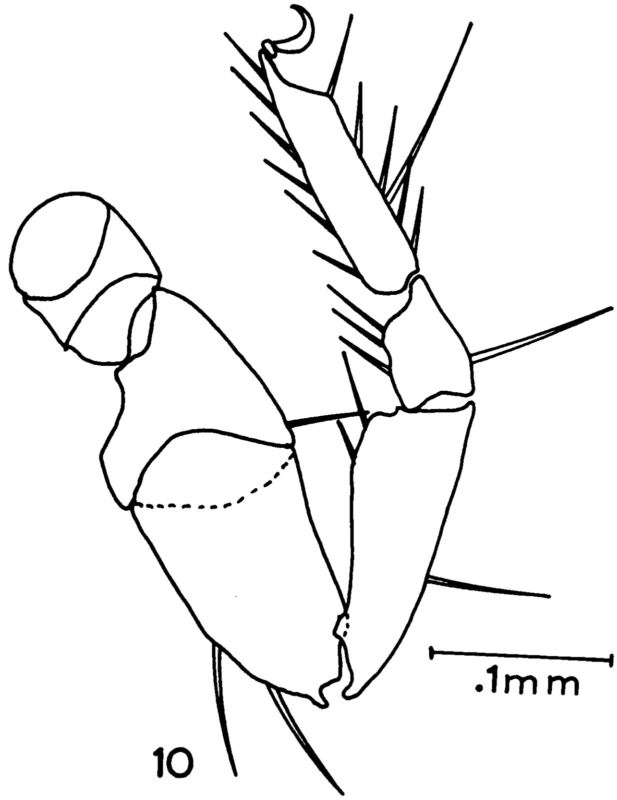
Fig. 11. *M. sandersoni*, leg I, 21X.

Fig. 12. *M. sandersoni*, coxal spines on coxae II.

Fig. 13. *M. sandersoni*, coxal spines showing a type of variation.

Fig. 14. *M. sandersoni*, coxal spine of symmetrical shape.

PLATE IV



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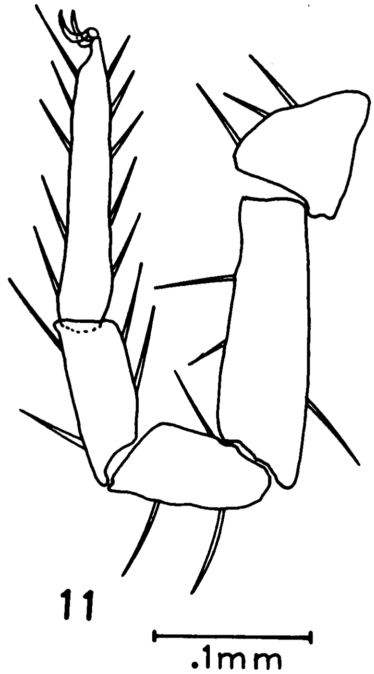

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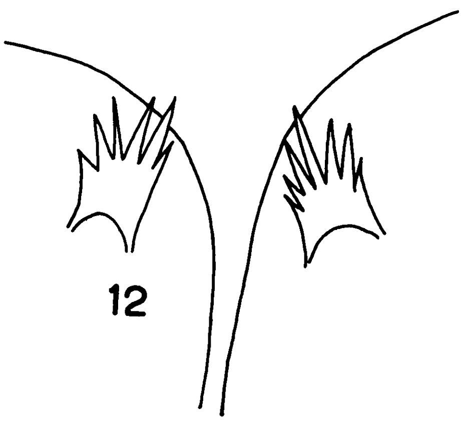

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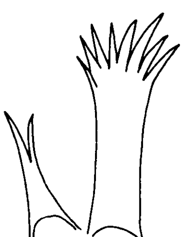

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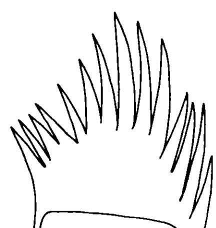

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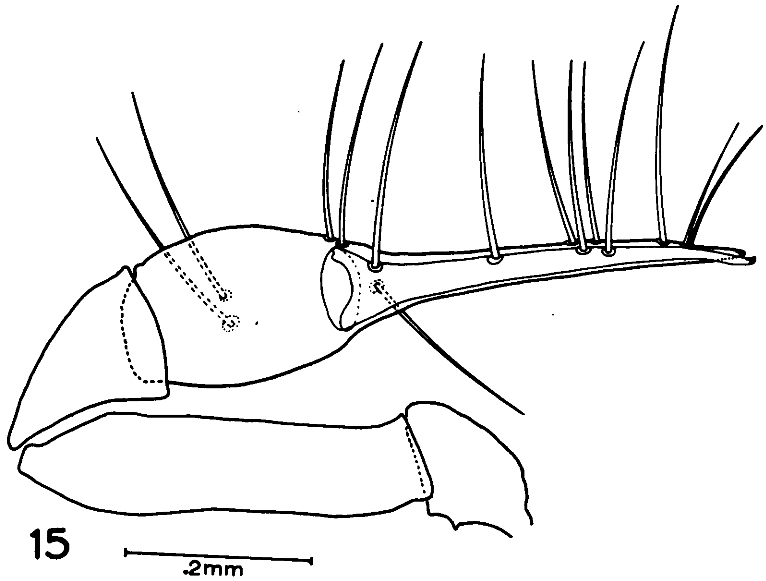
PLATE V

Fig. 15. Apochthonius moestus, palp, 21X.

Fig. 16. A. moestus, chela, 21X.

PLATE V



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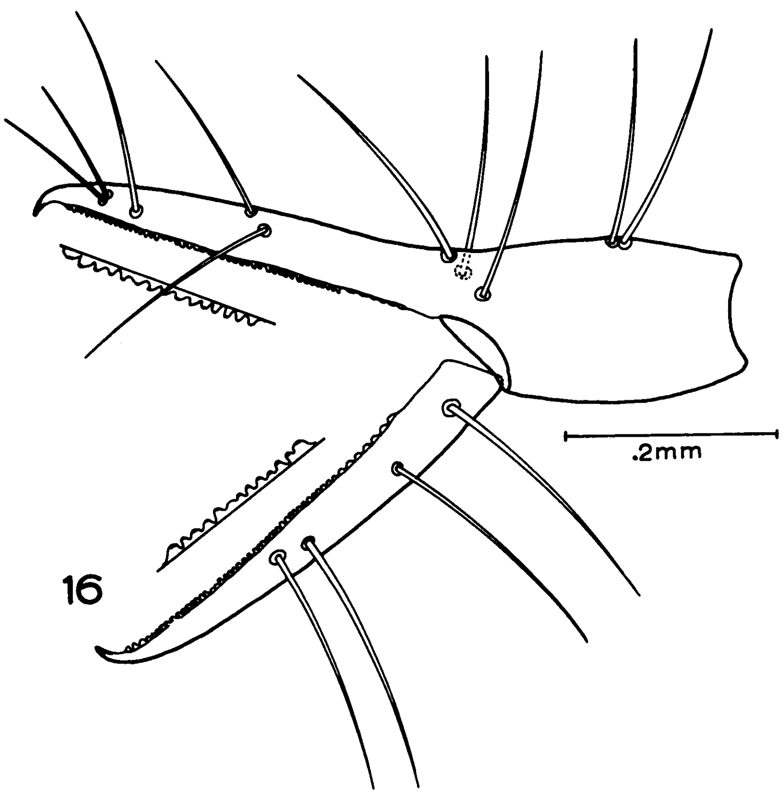

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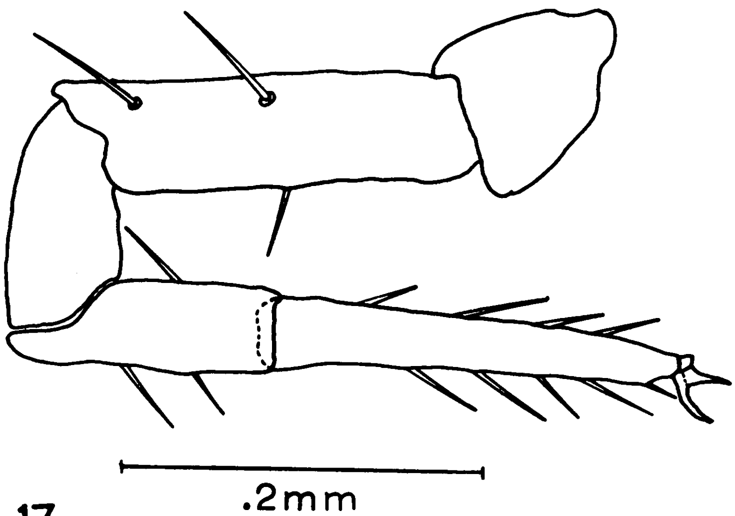
PLATE VI

Fig. 17. Apochthonius moestus, leg I, 21X.

Fig. 18. A. moestus, leg IV, 21X.

PLATE VI



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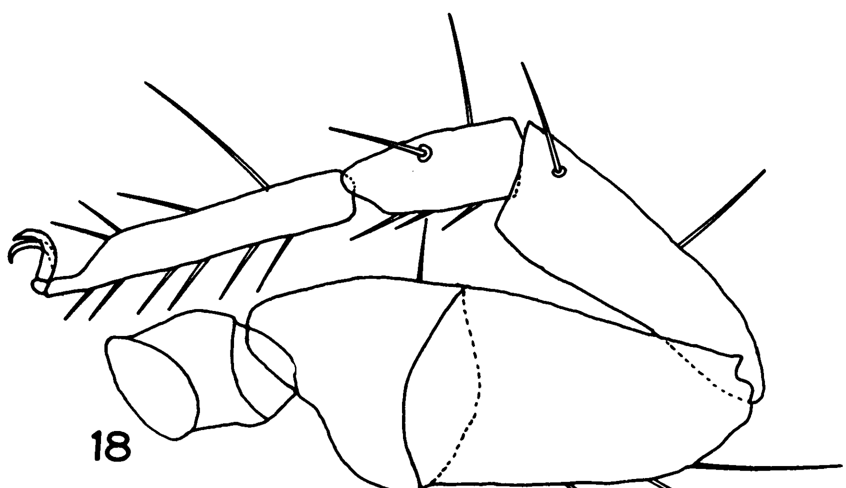

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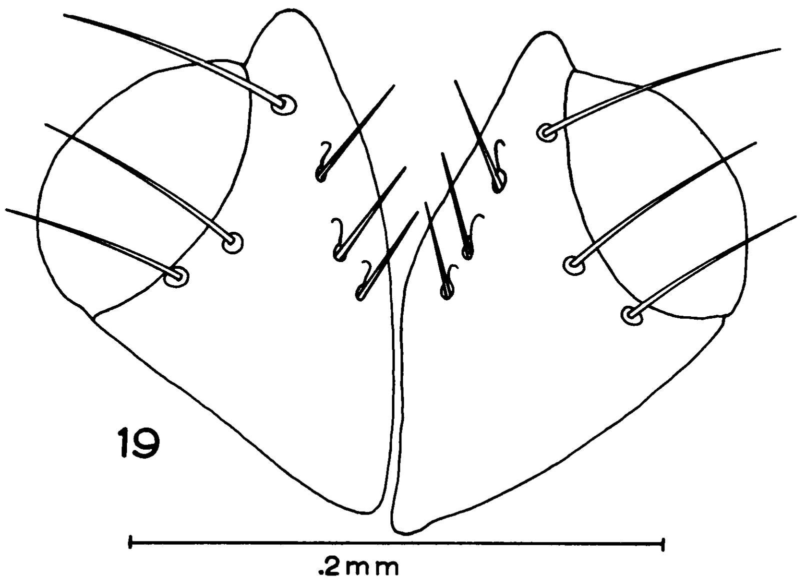
PLATE VII

Fig. 19. *Apochthonius moestus*, coxae I with coxal spines, 43X.

Fig. 20. *A. moestus*, male genital area, 43X.

PLATE VII



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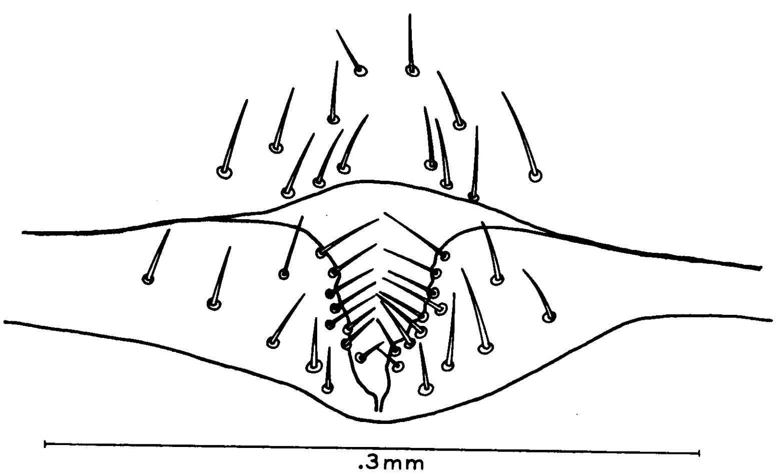

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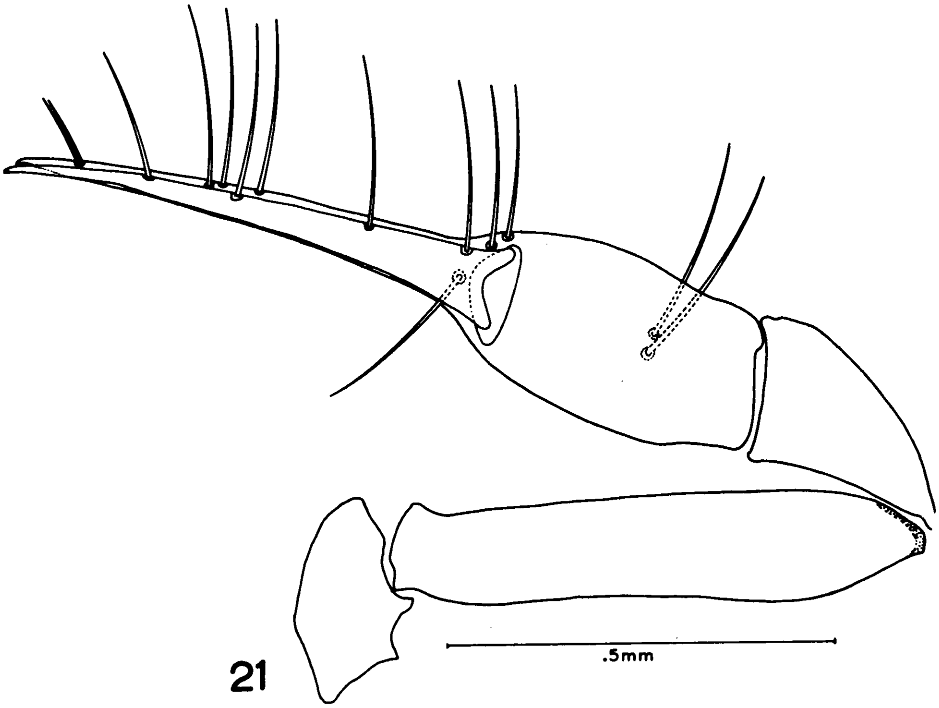
PLATE VIII

Fig. 21. *Apochthonius barbarae* sp. n., male, palp, 21X.

Fig. 22. *A. barbarae* sp. n., chela, male, 21X.

PLATE VIII



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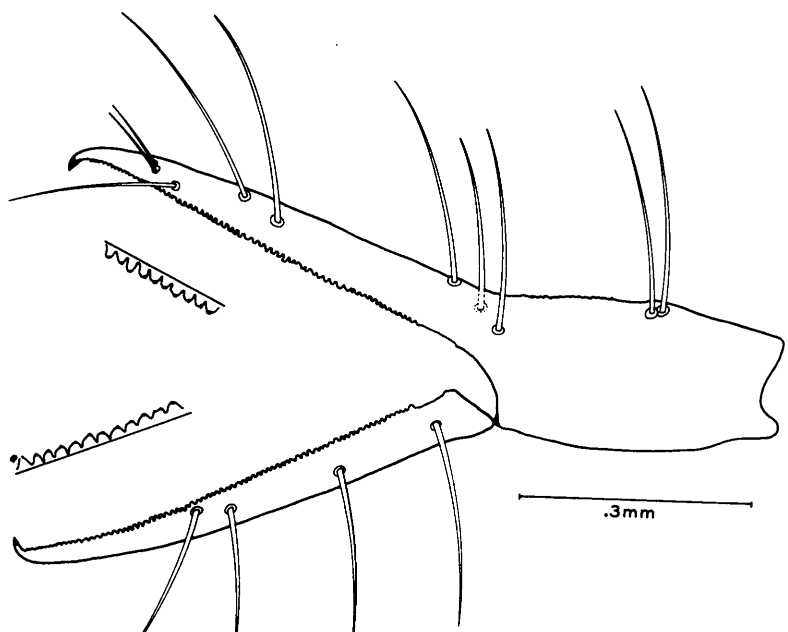

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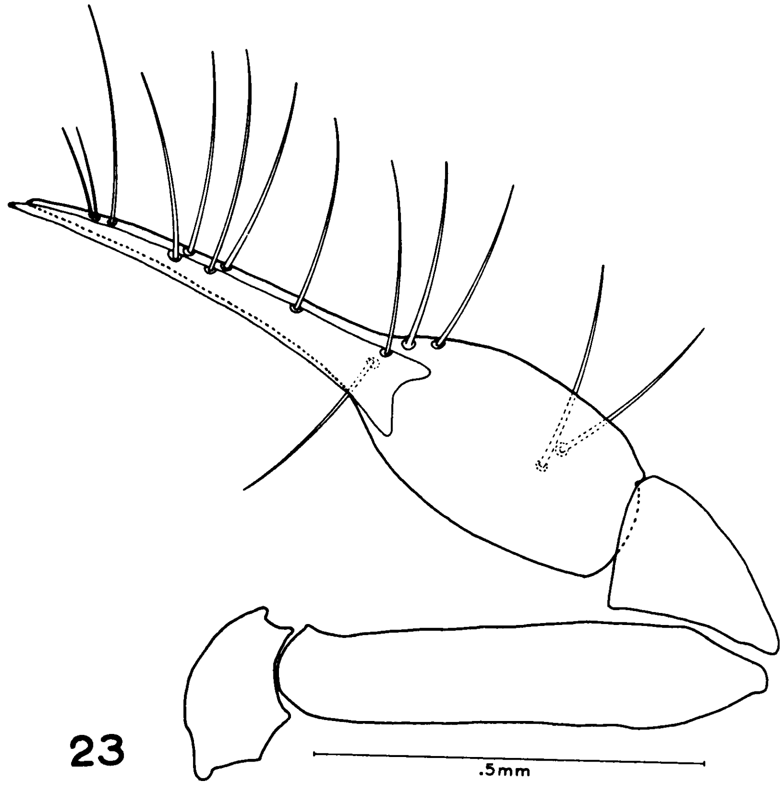
PLATE IX

Fig. 23. *Apochthonius barbarae* sp. n., female, palp, 21X.

Fig. 24. *A. barbarae* sp. n., female, chela, 21X.

PLATE IX



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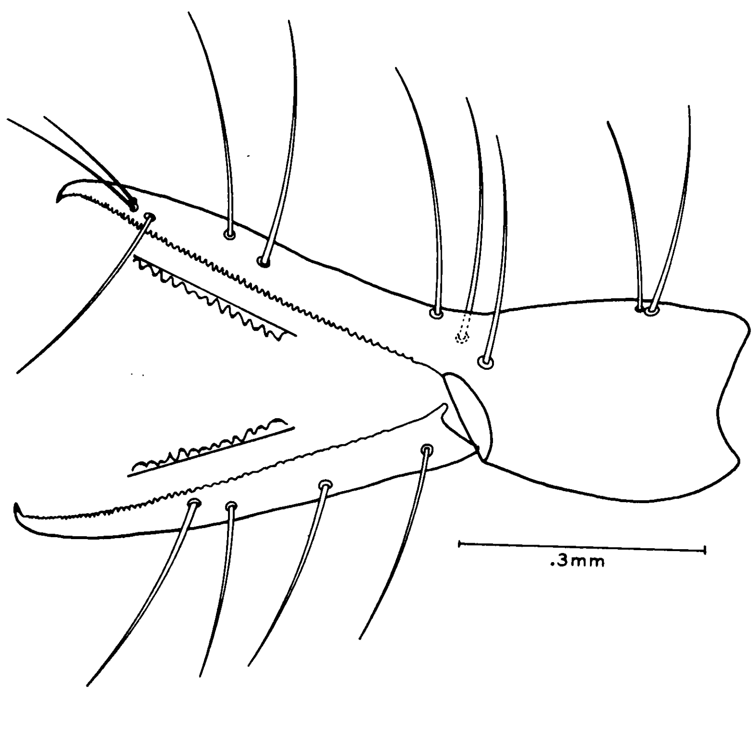

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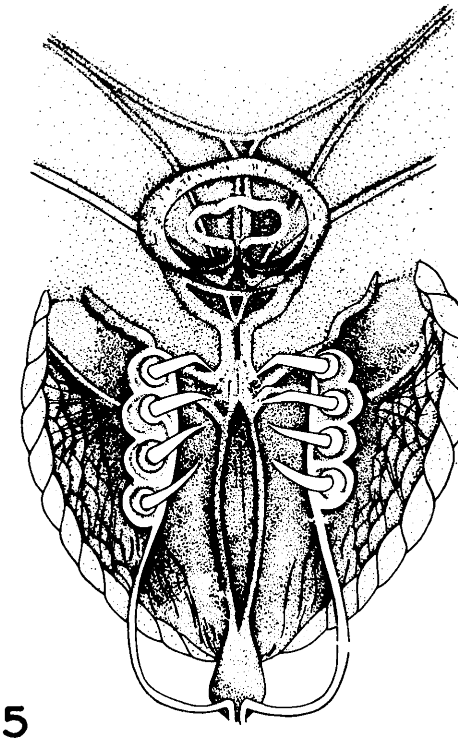
PLATE X

Fig. 25. *Apochthonius barbarae* sp. n., male, internal genitalia, 43X.

Fig. 26. *A. barbarae* sp. n., male, genital area, 43X.

PLATE X



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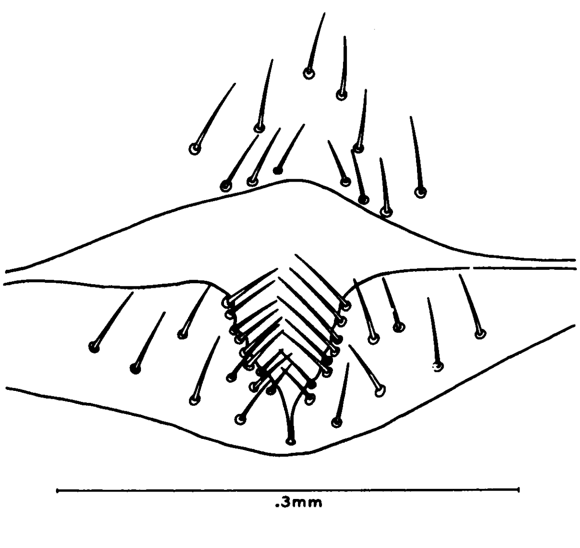

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PLATE XI

Fig. 27. *Kleptochthonius (Kleptochthonius) crosbyi*, palp, 21X.

Fig. 28. *K. crosbyi*, chela, 21X.

B - basal seta

DS - double seta

EB - exterior basal seta

ESB - exterior subbasal seta

EST - exterior subterminal seta

ET - exterior terminal seta*

IB - interior basal seta

ISB - interior subbasal seta

IST - interior subterminal seta

IT - interior terminal seta

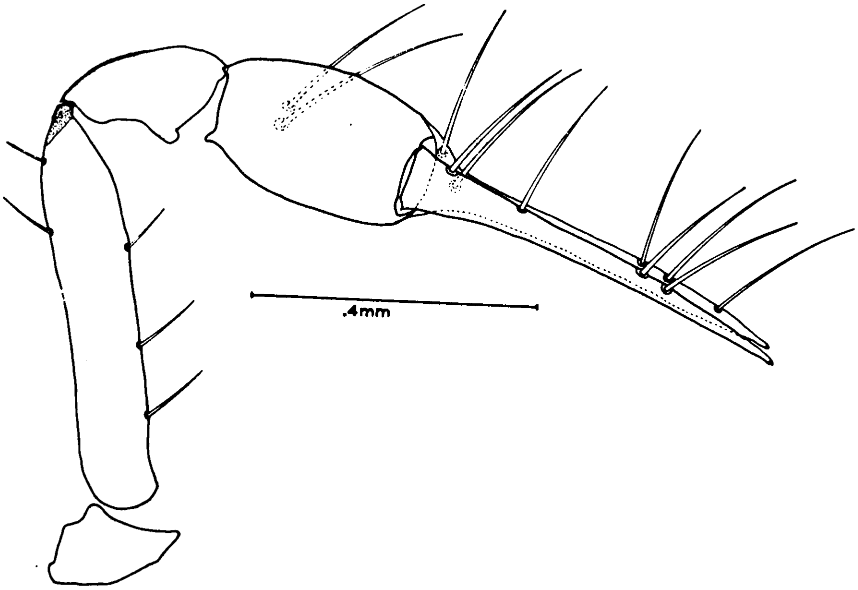
SB - subbasal seta

ST - subterminal seta

T - terminal seta

*Not shown see figure 34.

PLATE XI



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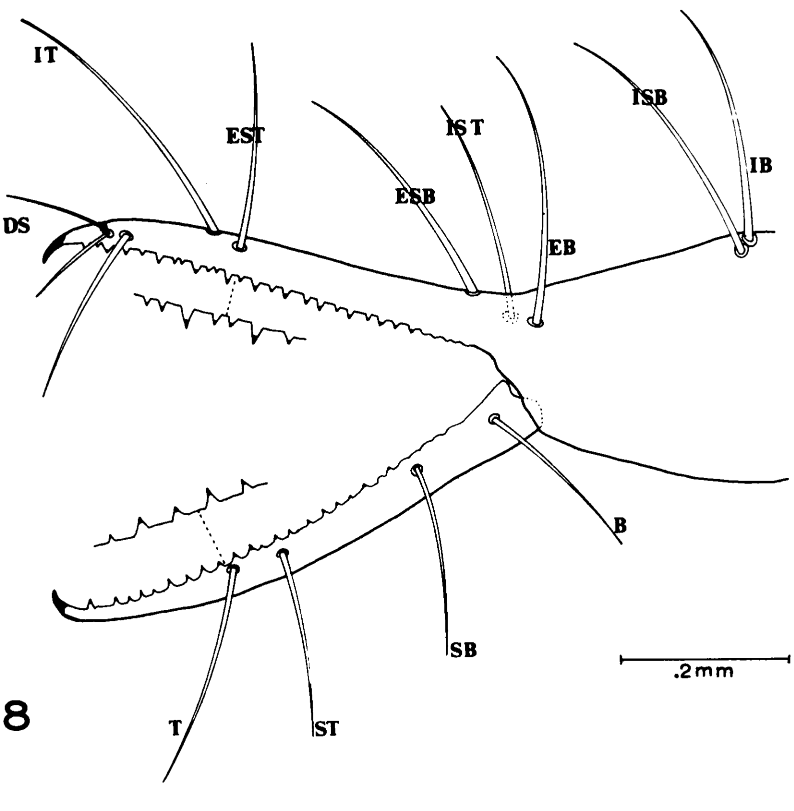

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PLATE XII

Fig. 29. Kleptochthonius (Kleptochthonius) crosbyi, leg I, 21X.

Fig. 30. K. crosbyi, leg IV, 21X.

Fig. 31. K. crosbyi, male genital area, 43X.

Fig. 32. K. crosbyi, internal genitalia of male, 43X.

AC S - accessory structure

PLATE XII

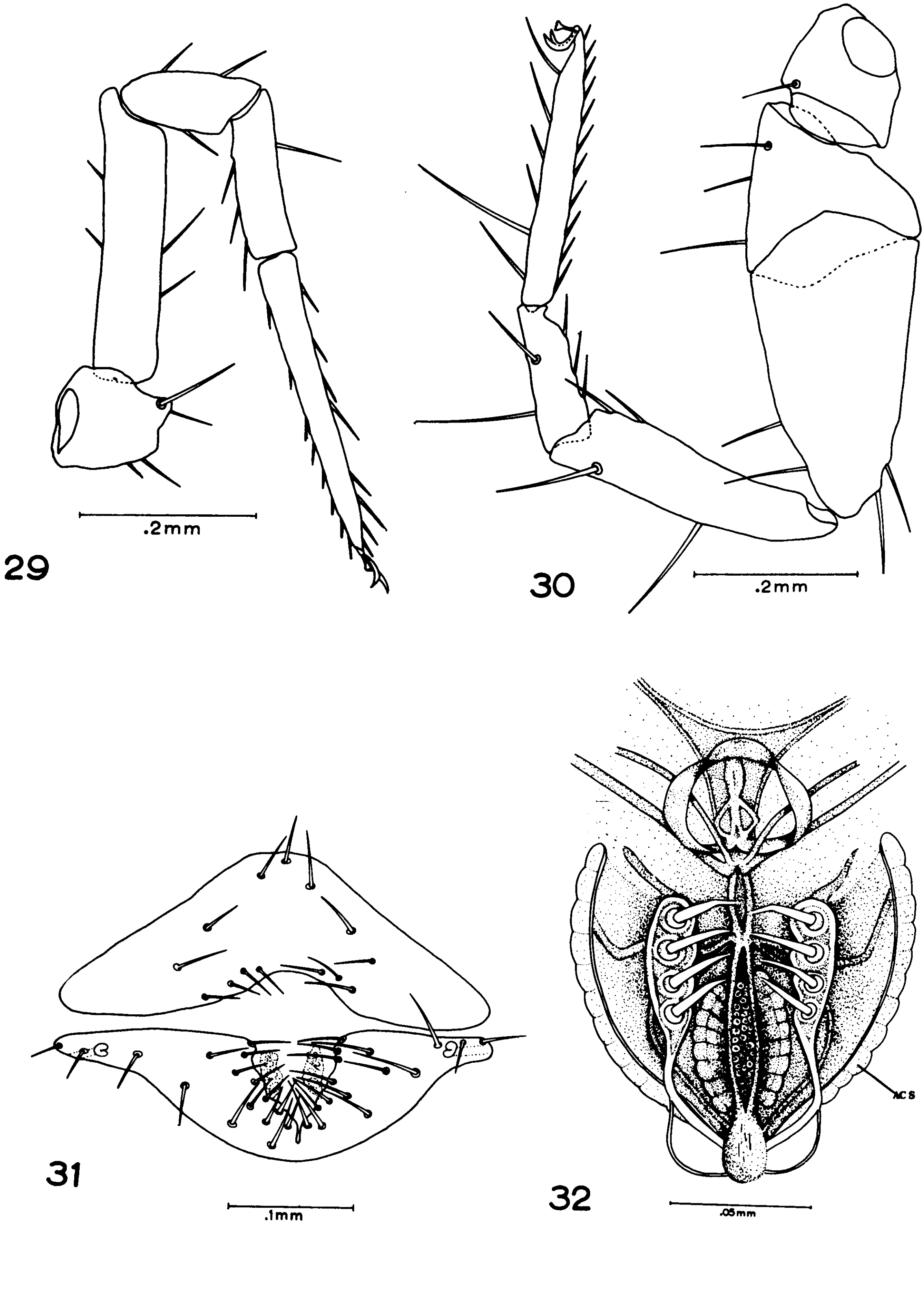


PLATE XIII

Fig. 33. Kleptochthonius (Kleptochthonius) multispinosus, palp, 21X.

Fig. 34. K. multispinosus, chela, 21X.

B - basal seta

DS - double seta

EB - exterior basal seta

ESB - exterior subbasal seta

EST - exterior subterminal seta

ET - exterior terminal seta

IB - interior basal seta

ISB - interior subbasal seta

IST - interior subterminal seta

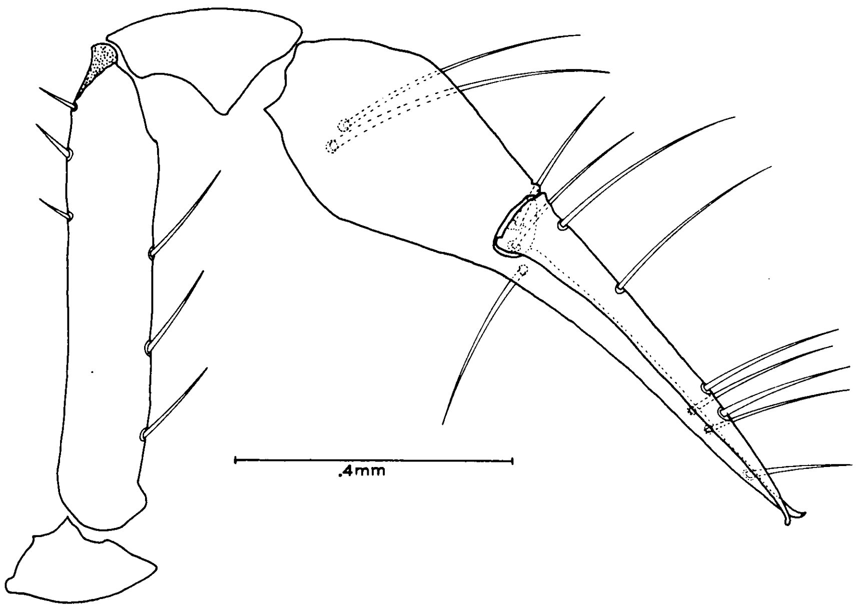
IT - interior terminal seta

SB - subbasal seta

ST - subterminal seta

T - terminal seta

PLATE XIII



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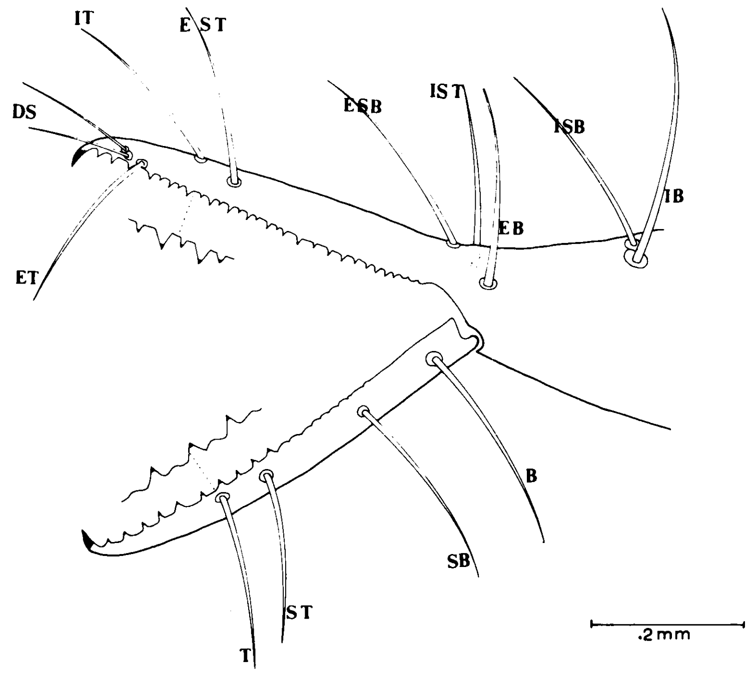


34

PLATE XIV

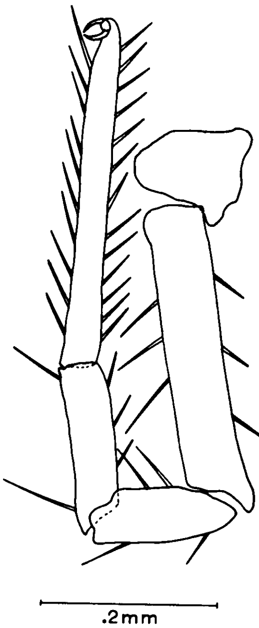
Fig. 35. _Kleptochthonius_ (_Kleptochthonius_) _multispinosus_, leg I, 21X.

Fig. 36. _K. multispinosus_, leg IV, 21X.

Fig. 37. _K. multispinosus_, internal genitalia of male, 43X.

Fig. 38. _K. multispinosus_, genital area of male, 43X.

PLATE XIV



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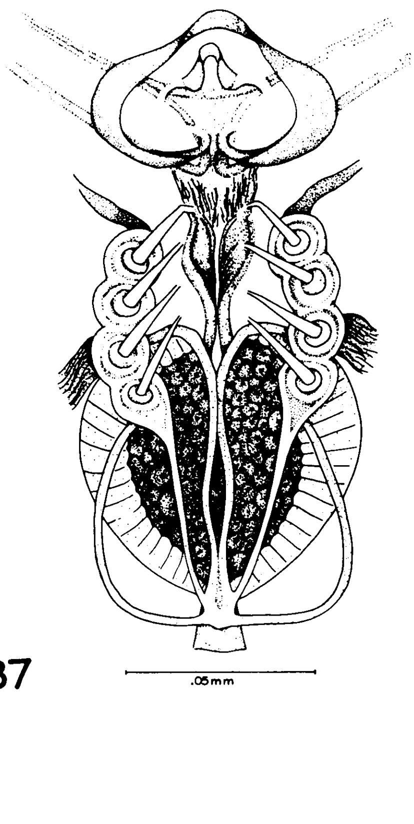

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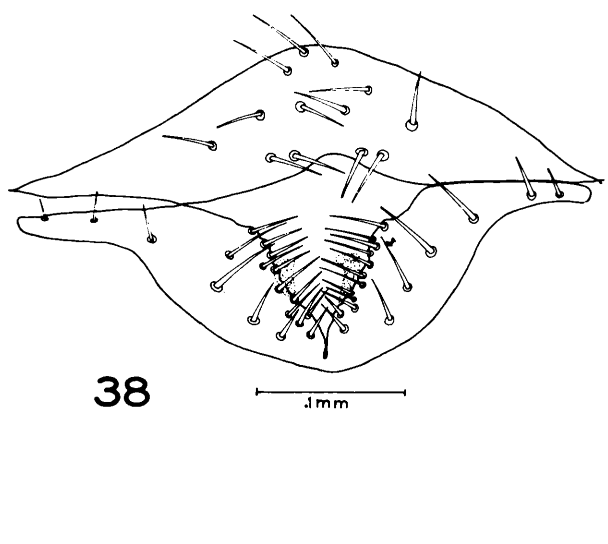


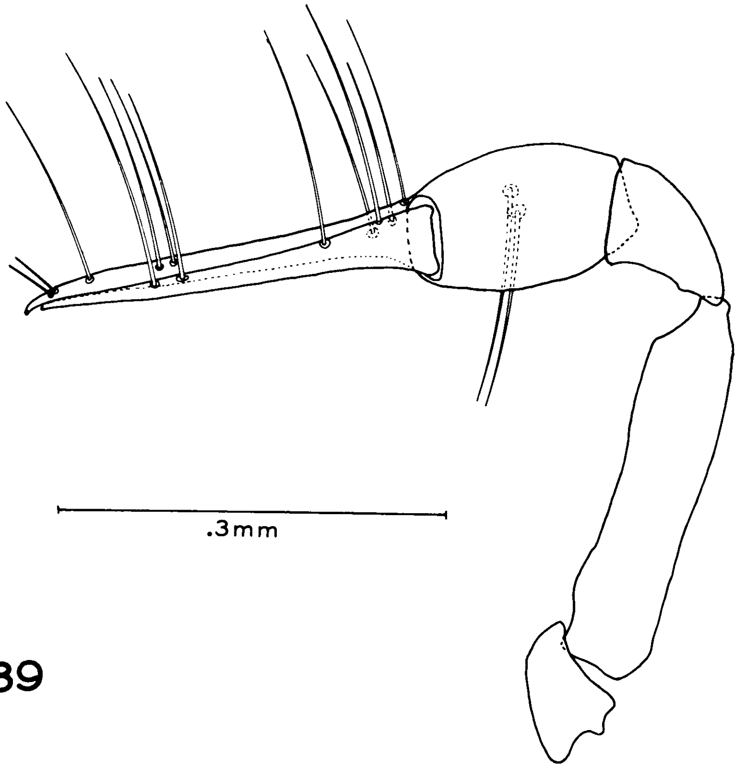
38

PLATE XV

Fig. 39. Kewochthonius paludis, palp, 21X.

Fig. 40. K. paludis, chela, 21X.

PLATE XV



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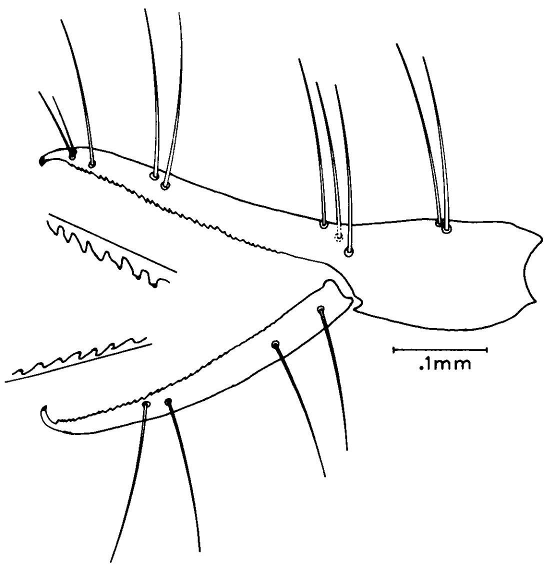

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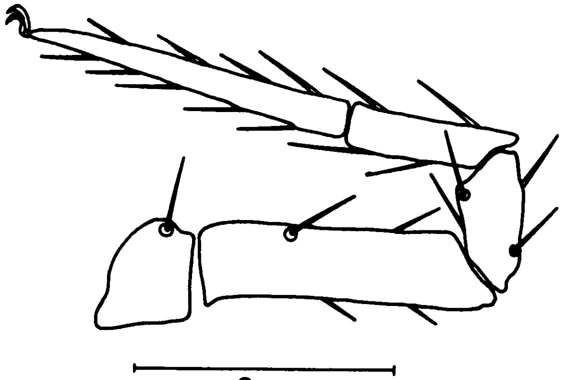
PLATE XVI

Fig. 41. _Kewochthonius paludis_, leg I, 21X.

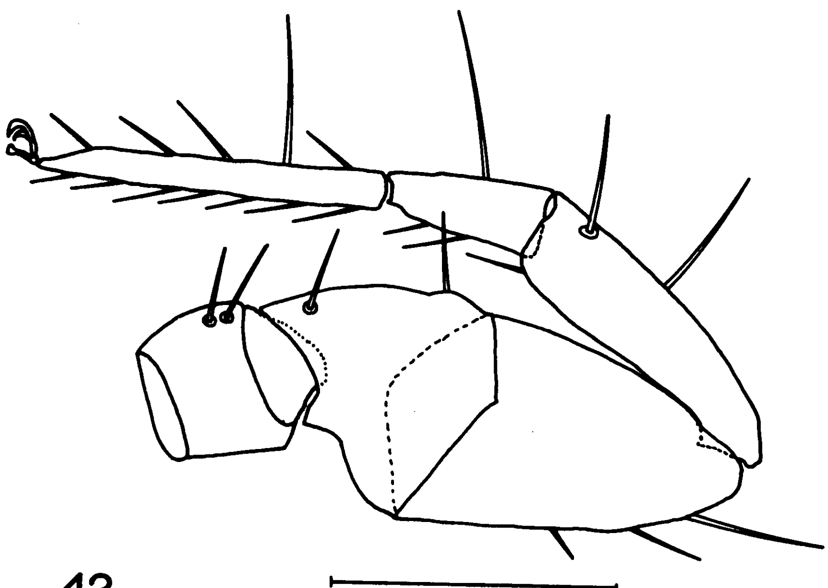
Fig. 42. _K. paludis_, leg IV, 21X.

PLATE XVI



41

.2mm



42

.2mm

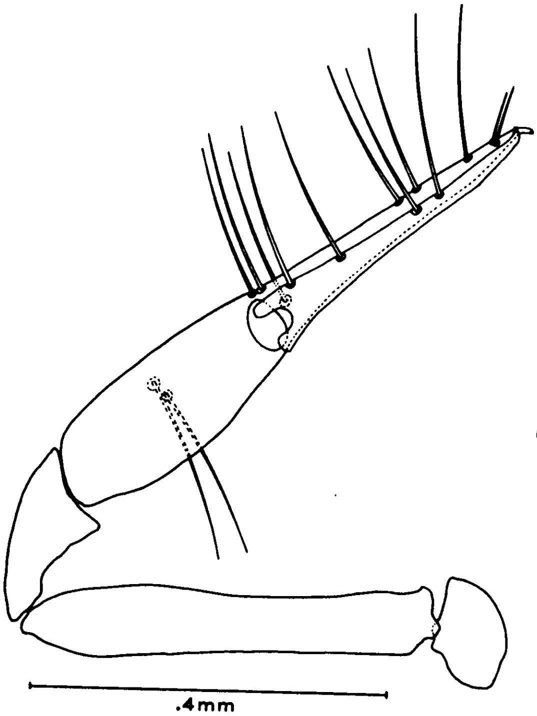
PLATE XVII

Fig. 43. Chthonius tetrachelatus, palp, male, 21X.

Fig. 44. C. tetrachelatus, chela, male, 21X.

Fig. 45. C. tetrachelatus, chela, female, 21X.

PLATE XVII



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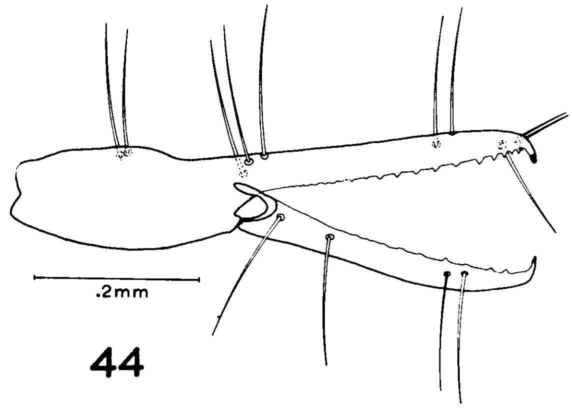

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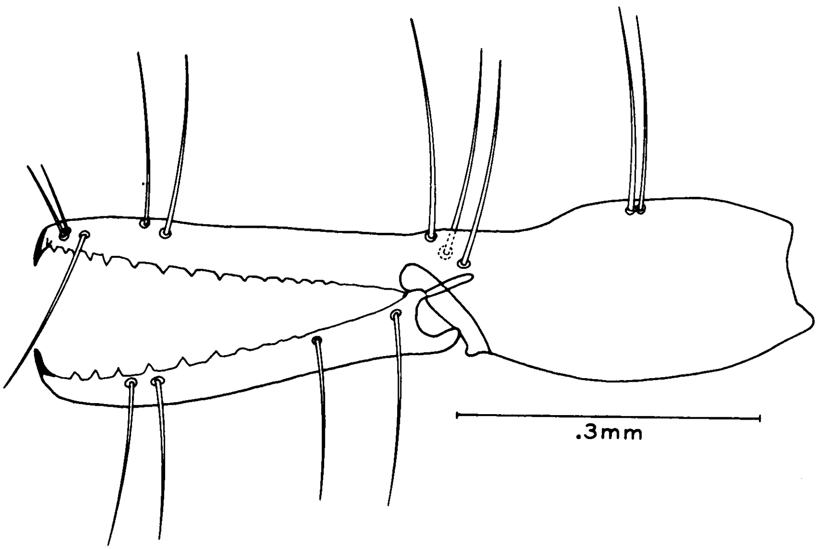

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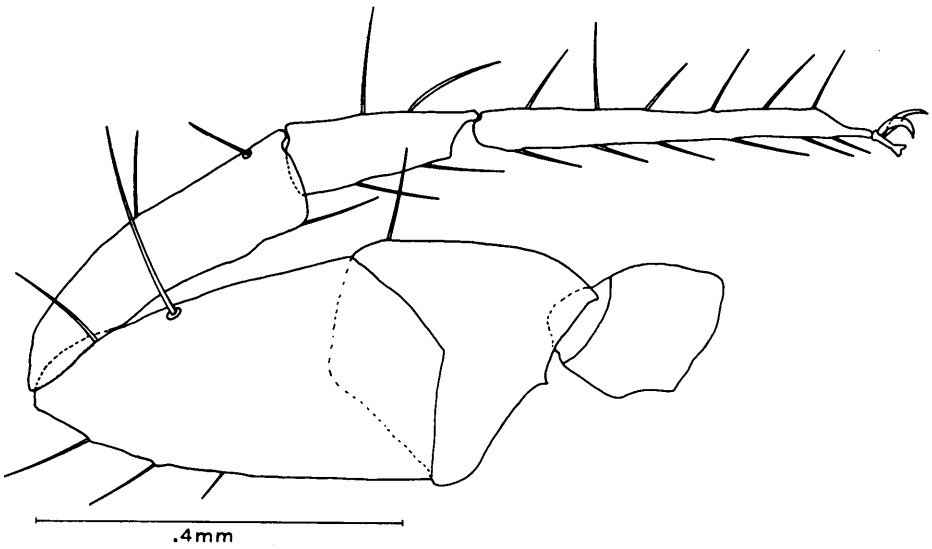
PLATE XVIII

Fig. 46. _Chthonius tetrachelatus_, leg IV, 21X.

Fig. 47. _C. tetrachelatus_, leg I, 21X.

Fig. 48. _C. tetrachelatus_, internal male genitalia, 43X.

PLATE XVIII



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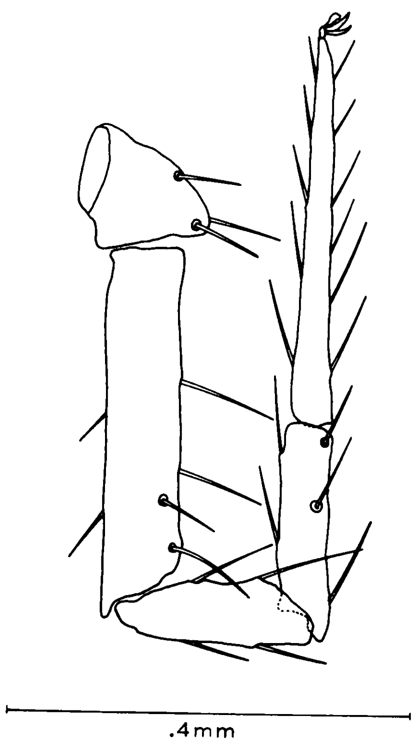

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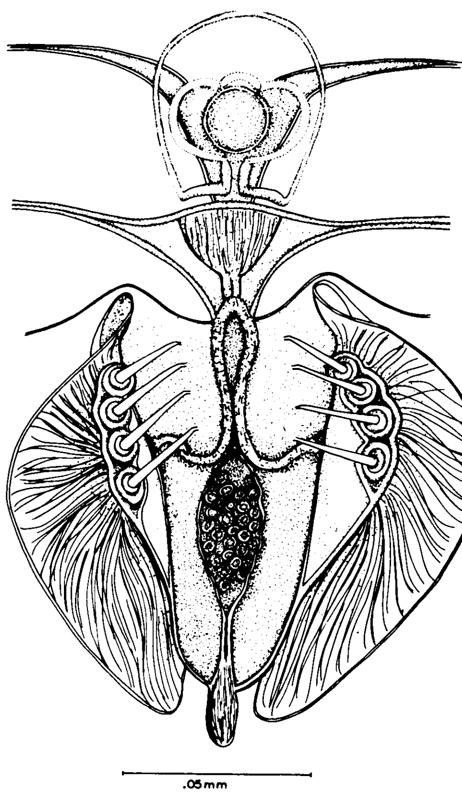

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PLATE XIX

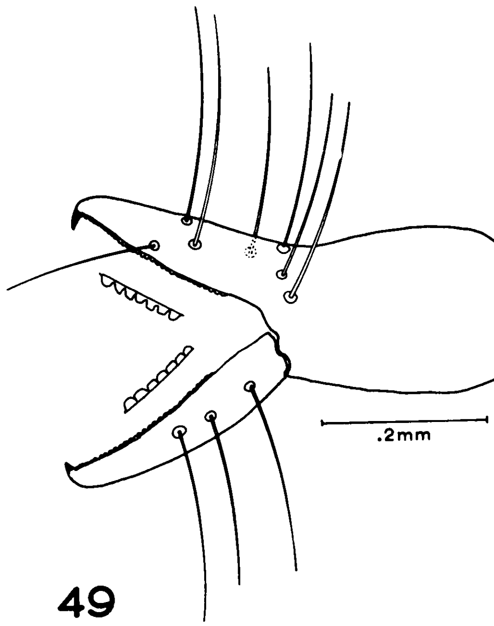
Fig. 49. *Microbisium confusum*, female, chela, 21X.

Fig. 50. *M. confusum*, female, palp, 21X.

Fig. 51. *M. confusum*, female, leg IV, 21X.

Fig. 52. *M. confusum*, female, leg I, 21X.

PLATE XIX



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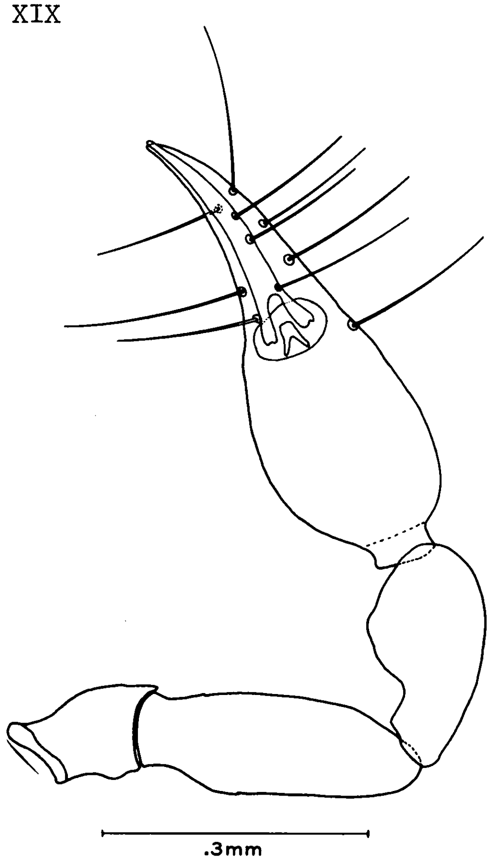

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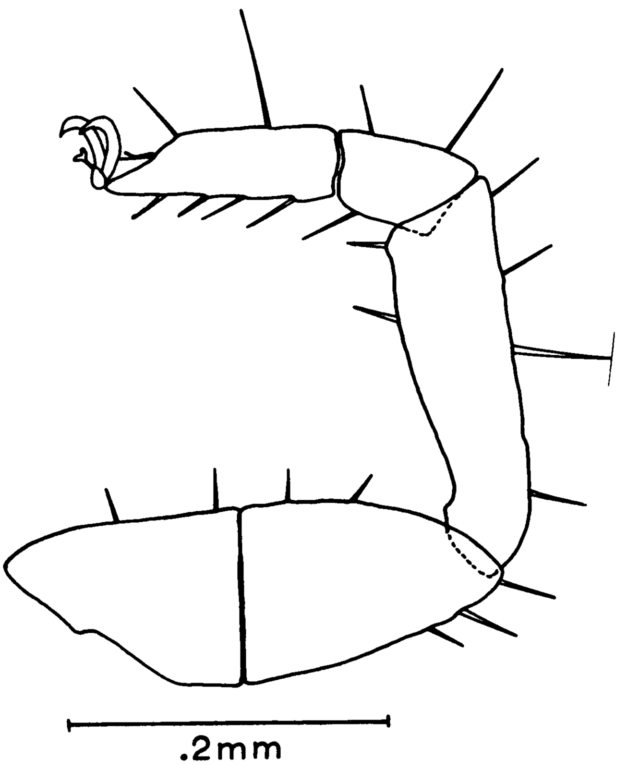

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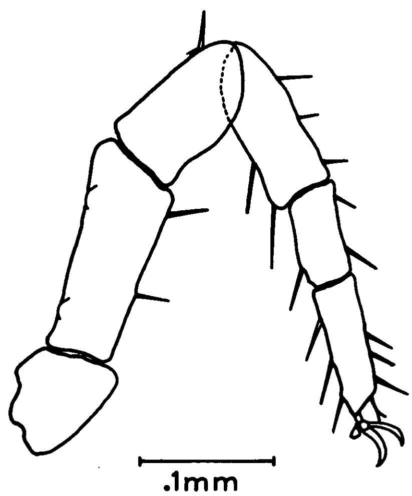

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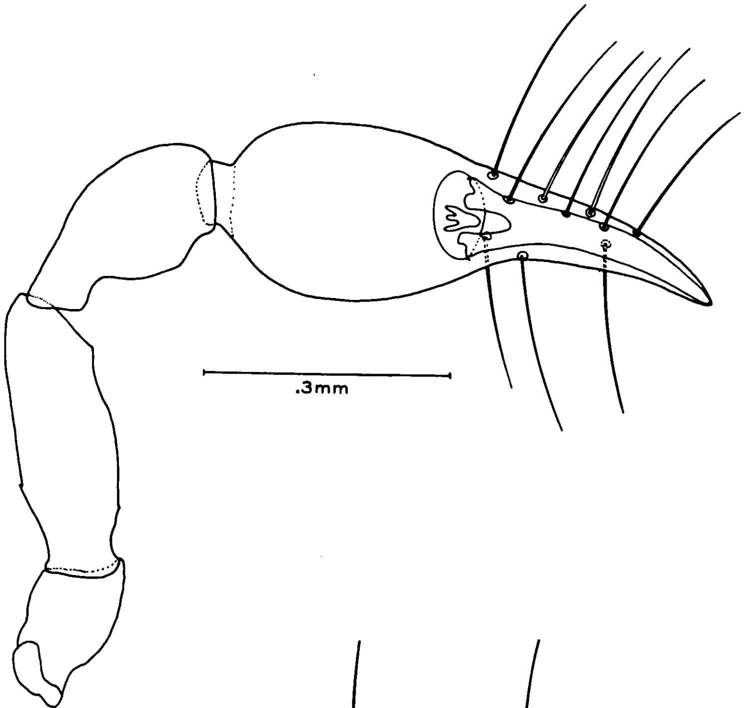
PLATE XX

Fig. 53. Microbisium confusum, male, palp, 21X.

Fig. 54. M. confusum, male chela, 21X.

PLATE XX



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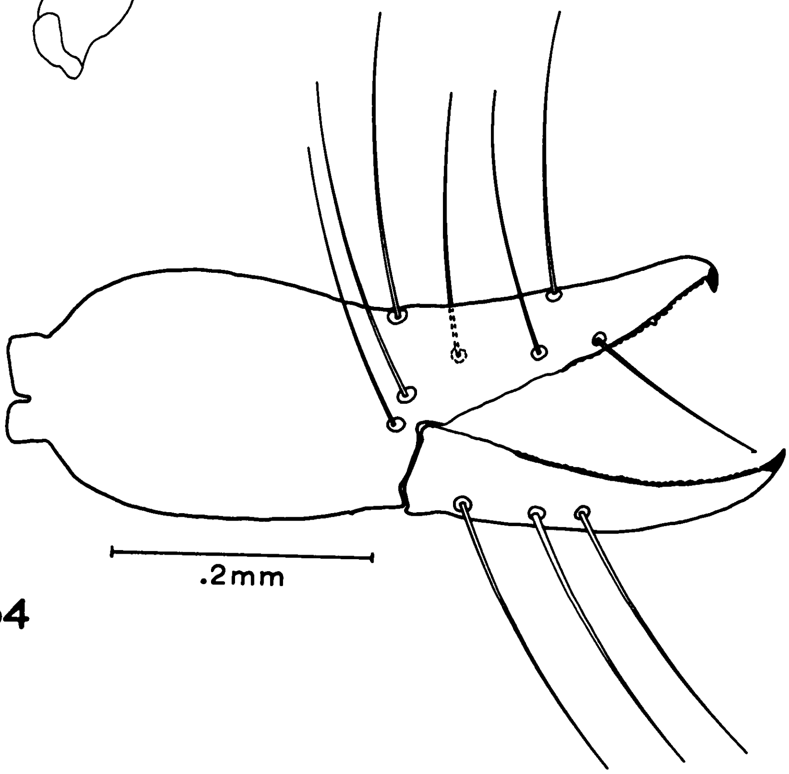

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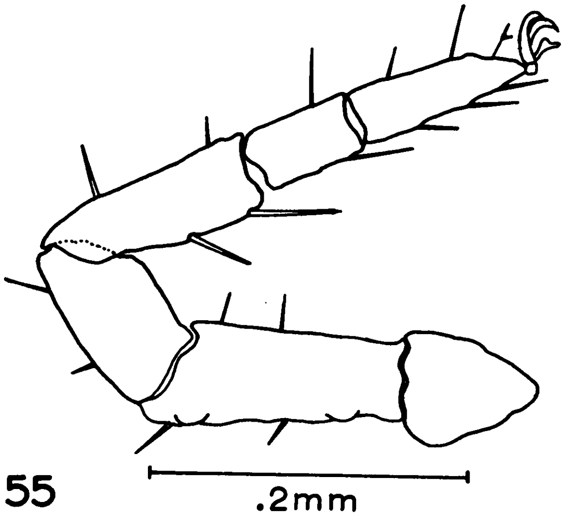
PLATE XXI

Fig. 55. Microbisium confusum, male, leg I, 21X.

Fig. 56. M. confusum, male, leg IV, 21X.

Fig. 57. M. confusum, male internal genitalia with external seta shown.

PLATE XXI



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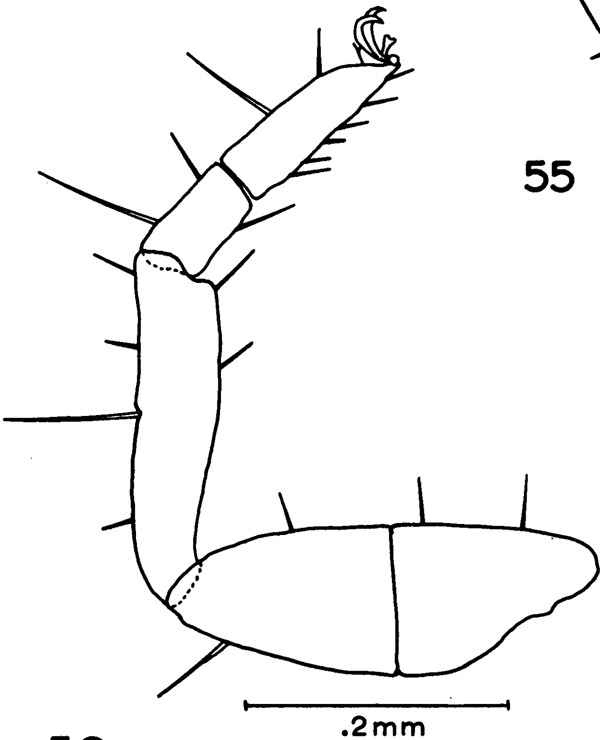

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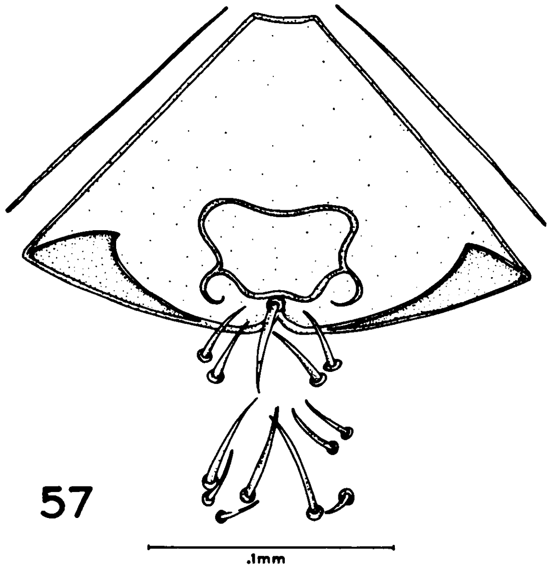


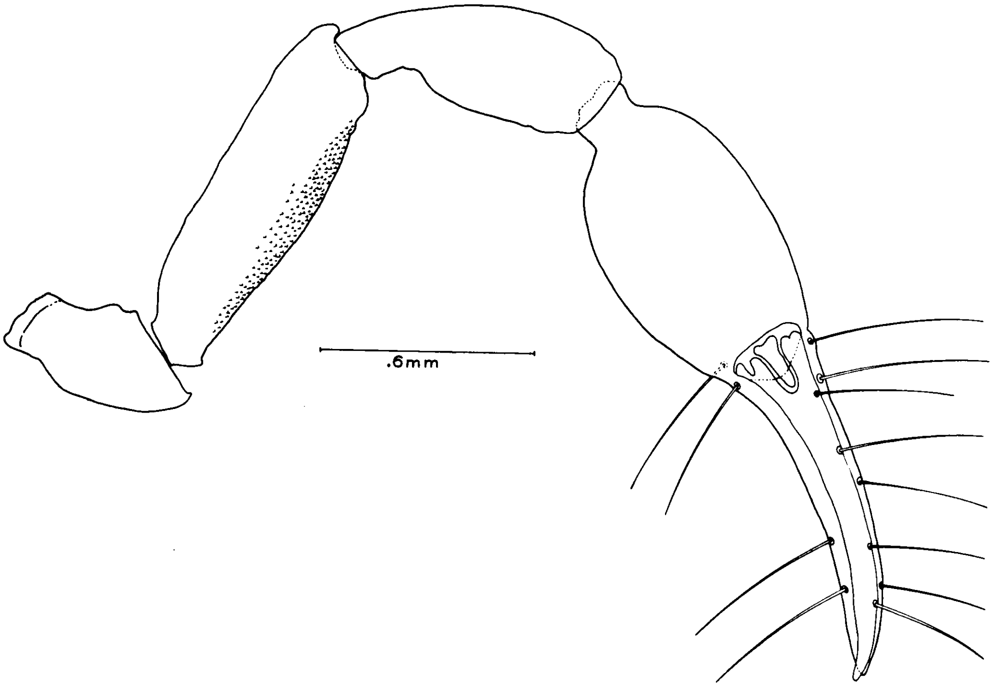
57

PLATE XXII

Fig. 58. _Neobisium carolinense_, palp, 10X.

Fig. 59. _N. carolinense_, chela, 10X.

PLATE XXII



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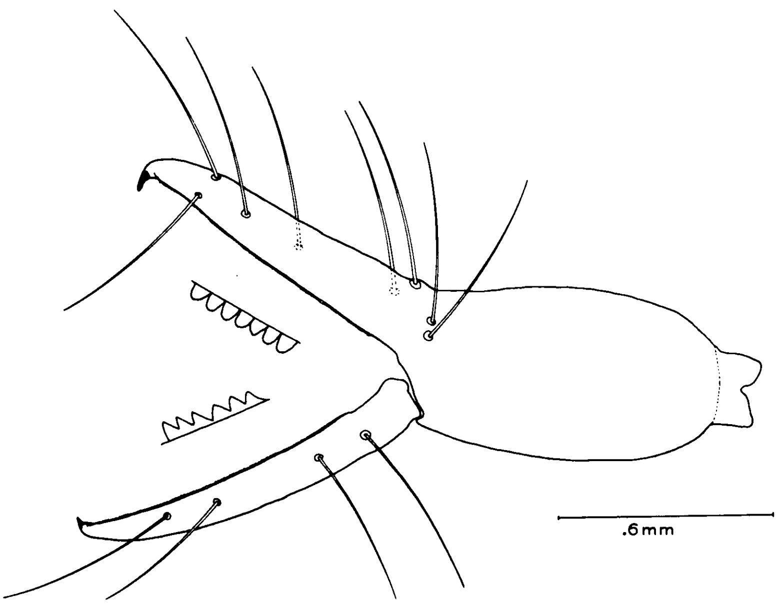

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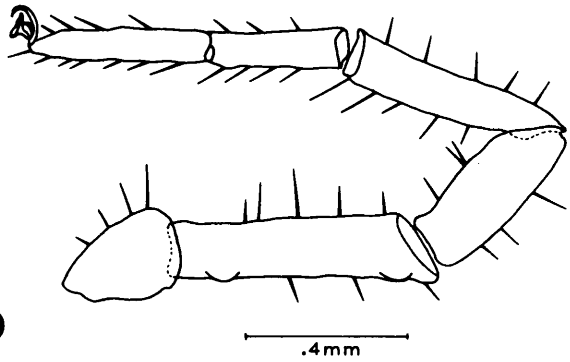
PLATE XXIII

Fig. 60. Neobisium carolinense, leg I, 10X.

Fig. 61. N. carolinense, leg IV, 10X.

Fig. 62. N. carolinense, movable chelal finger, 21X.

PLATE XXIII



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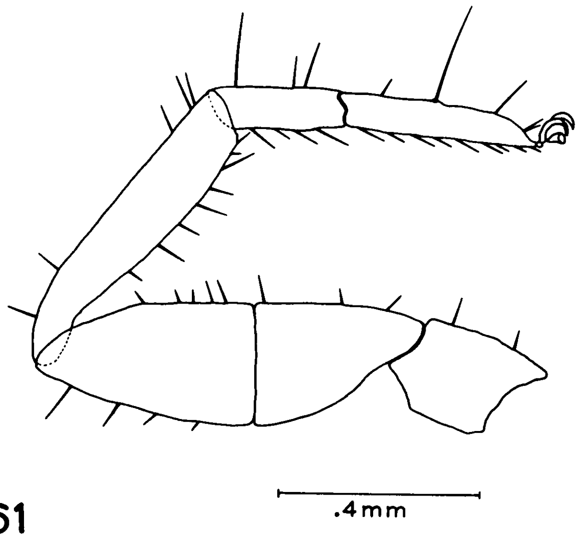

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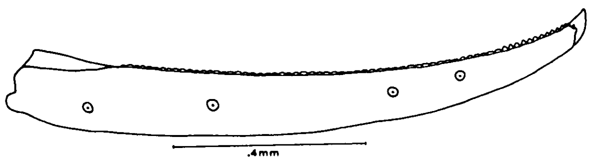


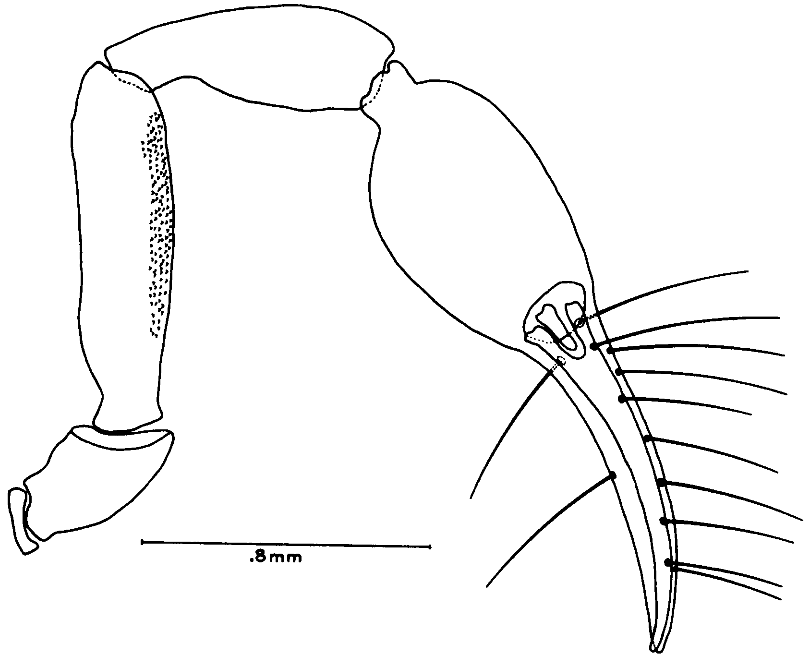
62

PLATE XXIV

Fig. 63. *Neobisium tenue*, palp, 10X.

Fig. 64. *N. tenue*, chela, 10X.

PLATE XXIV



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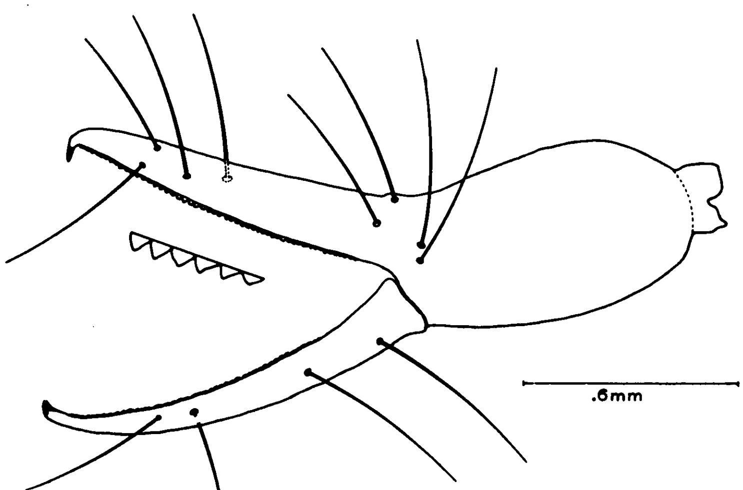


64

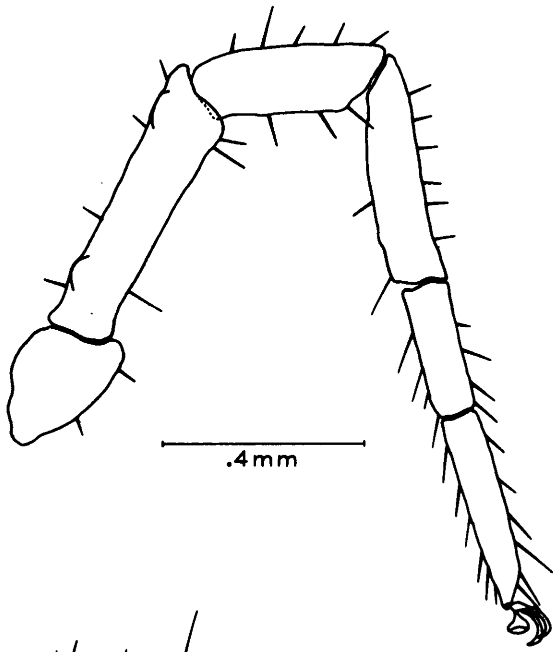
PLATE XXV

Fig. 65. *Neobisium tenue*, leg I, 10X.

Fig. 66. *N. tenue*, leg IV, 10X.

Fig. 67. *N. tenue*, movable chelal finger, 21X.

PLATE XXV



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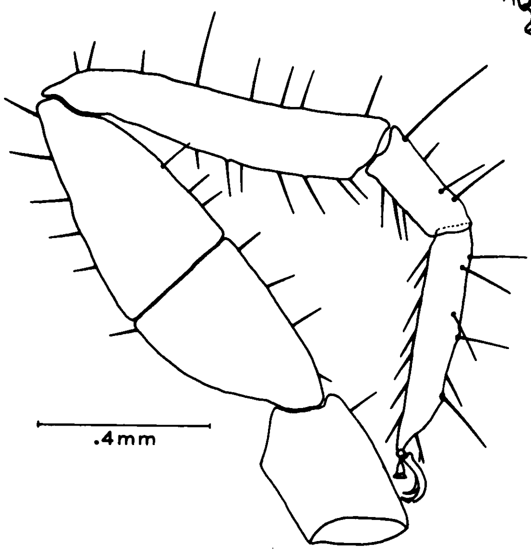

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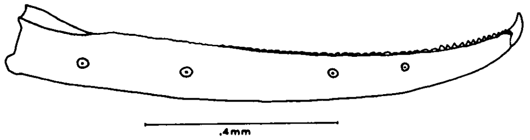

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PLATE XXVI

Fig. 68. Neobisium holti sp. n., chela, 10X.

Fig. 69. N. holti sp. n., palp, 10X.

B - basal seta

EB - exterior basal seta

ESB - exterior subbasal seta

EST - exterior subterminal seta

ET - exterior terminal seta

IB - interior basal seta

ISB - interior subbasal seta

IST - interior subterminal seta

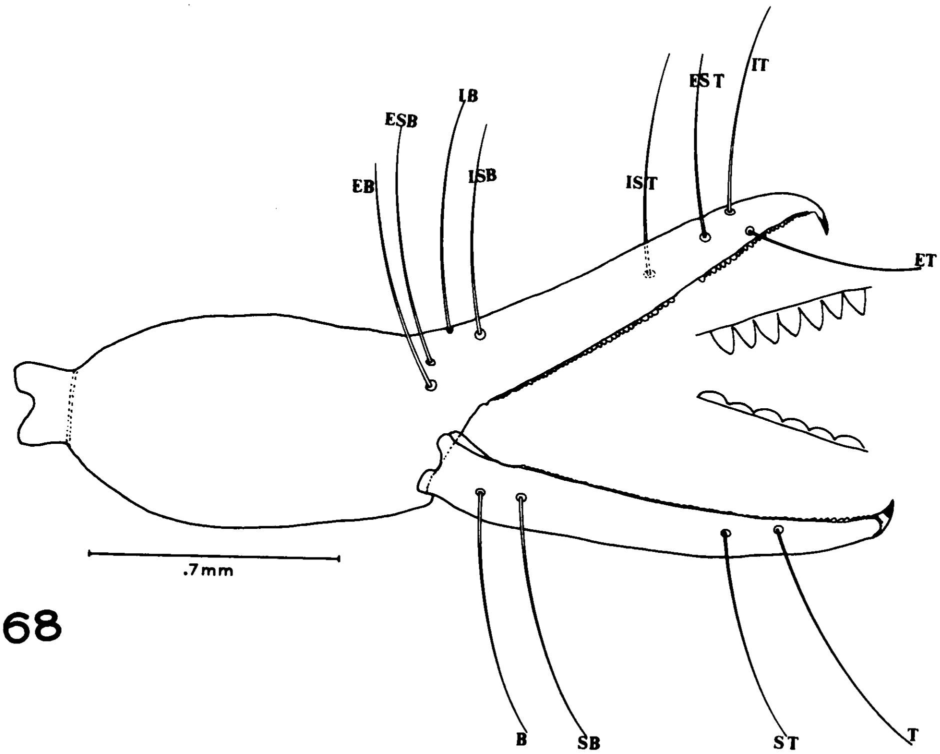
IT - interior terminal seta

SB - subbasal seta

ST - subterminal seta

T - terminal seta

PLATE XXVI



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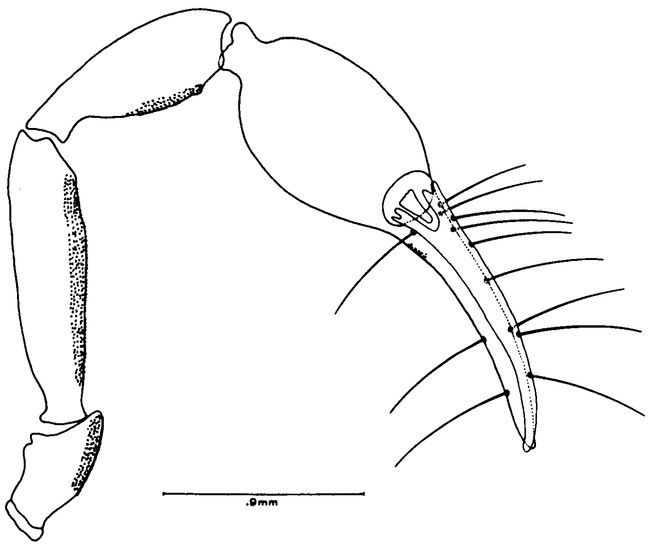

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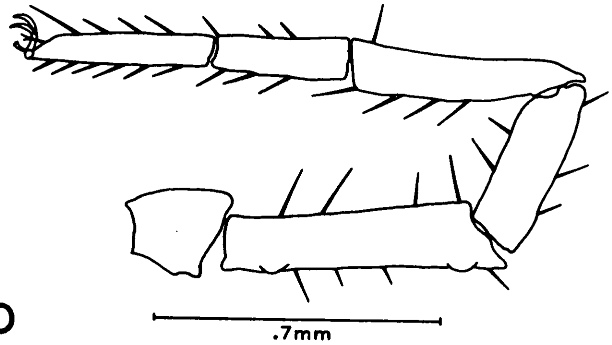
PLATE XXVII

Fig. 70. Neobisium holti sp. n., leg I, 10X.

Fig. 71. N. holti sp. n., leg IV, 10X.

Fig. 72. N. holti sp. n., movable chelal finger, 21X.

PLATE XXVII



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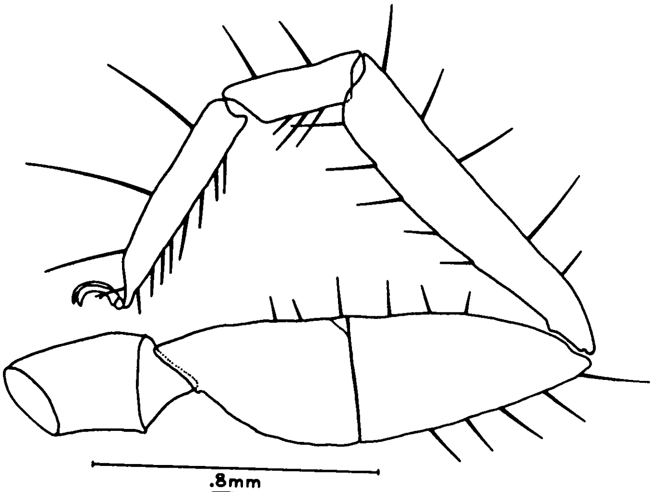

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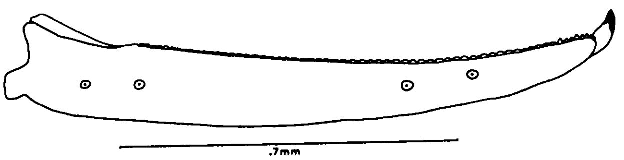

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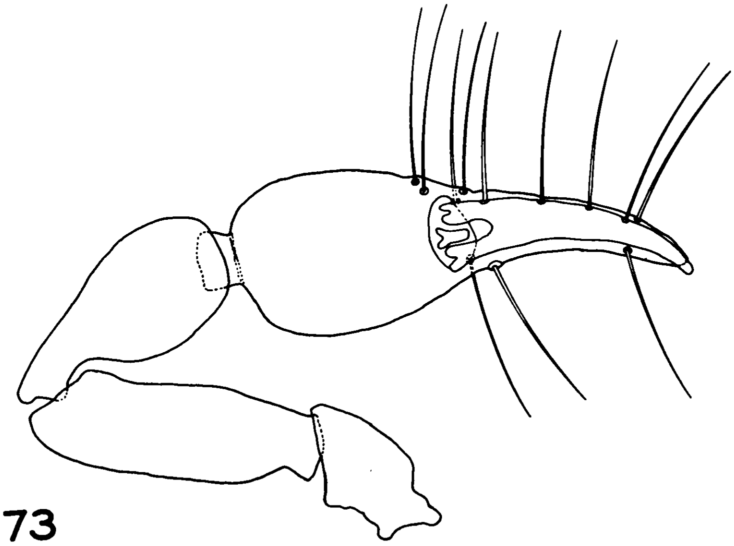
PLATE XXVIII

Fig. 73. *Microcreagris atlantica*, palp, 10X.

Fig. 74. *M. atlantica*, chela, 10X.

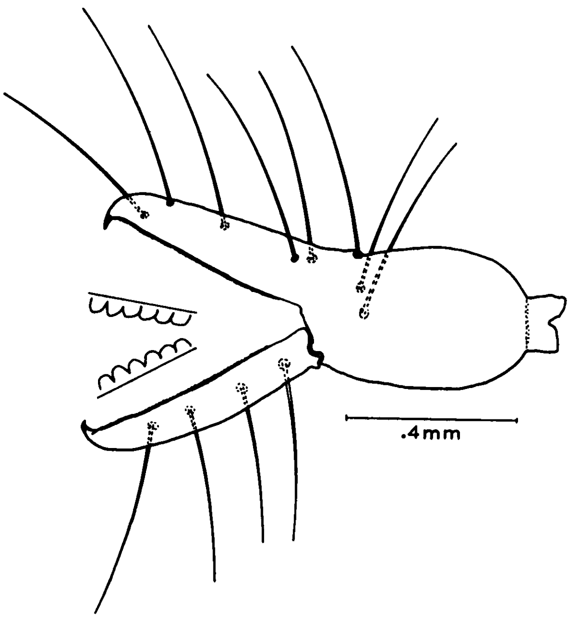
Fig. 75. *M. atlantica*, leg IV, 10X.

PLATE XXVIII



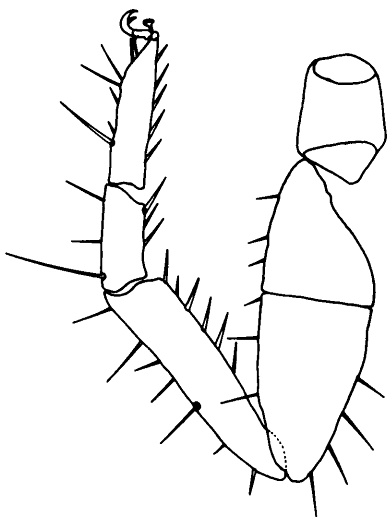
73

.8mm



.4mm

74



75

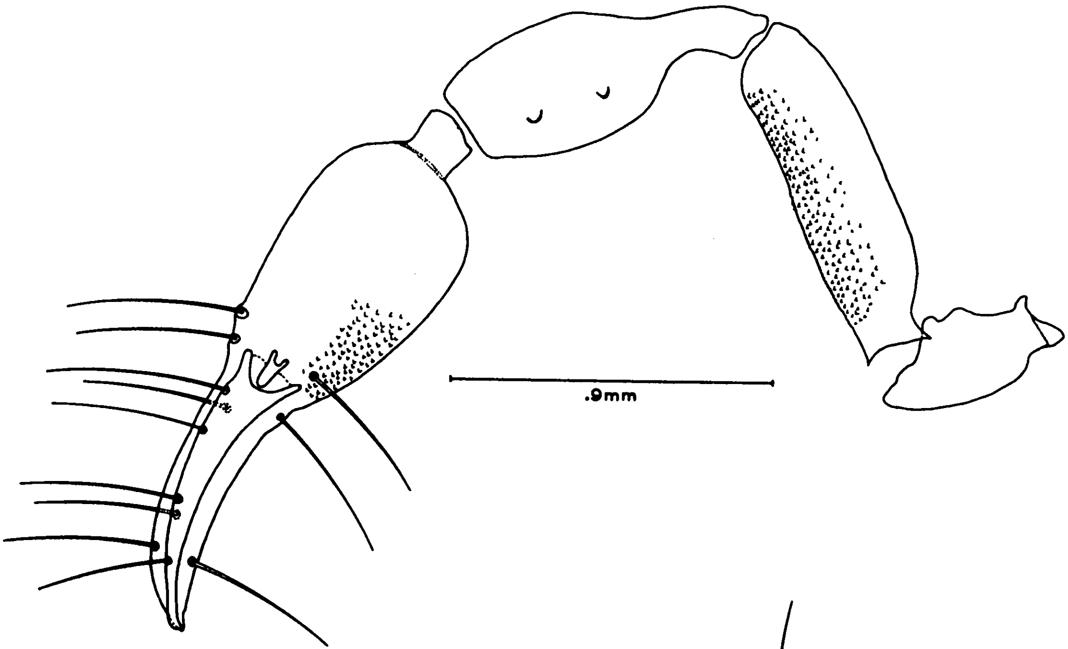
.4mm

PLATE XXIX

Fig. 76. Microcreagris rufula, palp, 10X.

Fig. 77. M. rufula, chela, 10X.

PLATE XXIX



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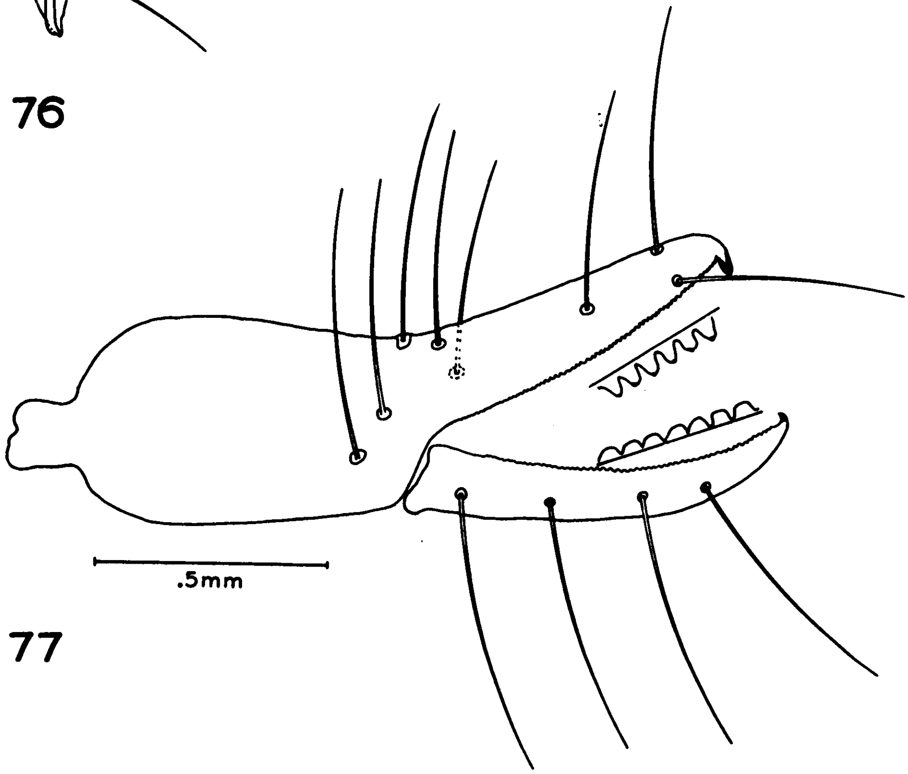

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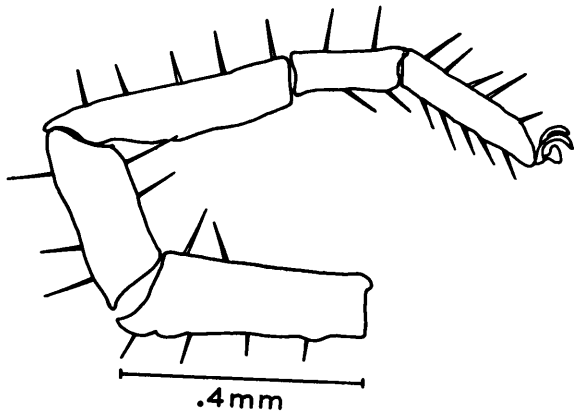
PLATE XXX

Fig. 78. *Microcreagris rufula*, leg I, 10X.

Fig. 79. *M. rufula*, leg IV, 10X.

Fig. 80. *M. rufula*, internal male genitalia, 43X.

PLATE XXX



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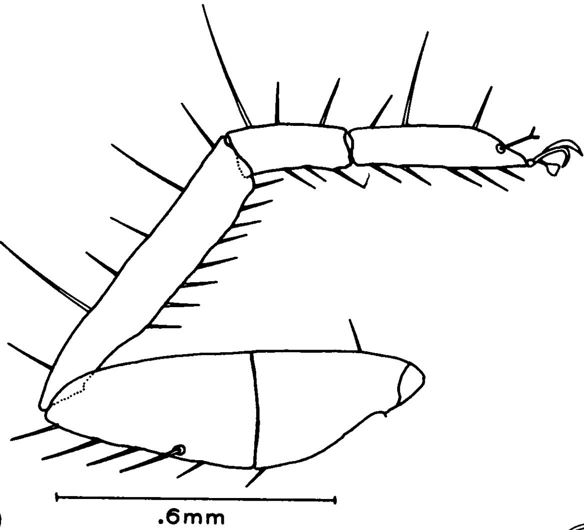

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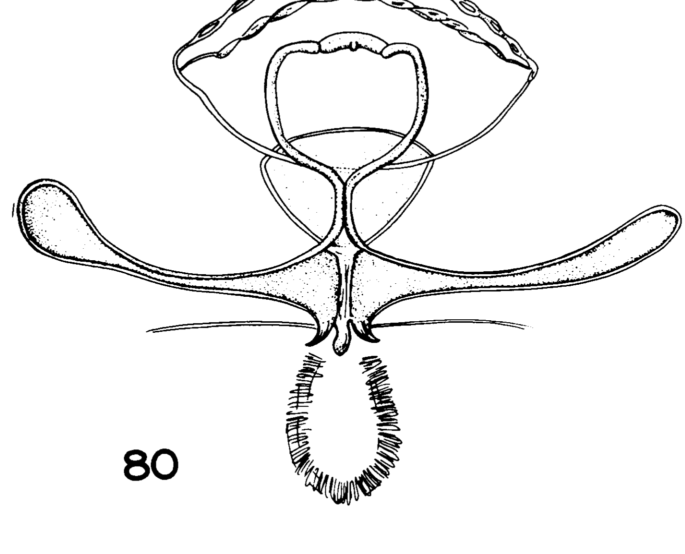

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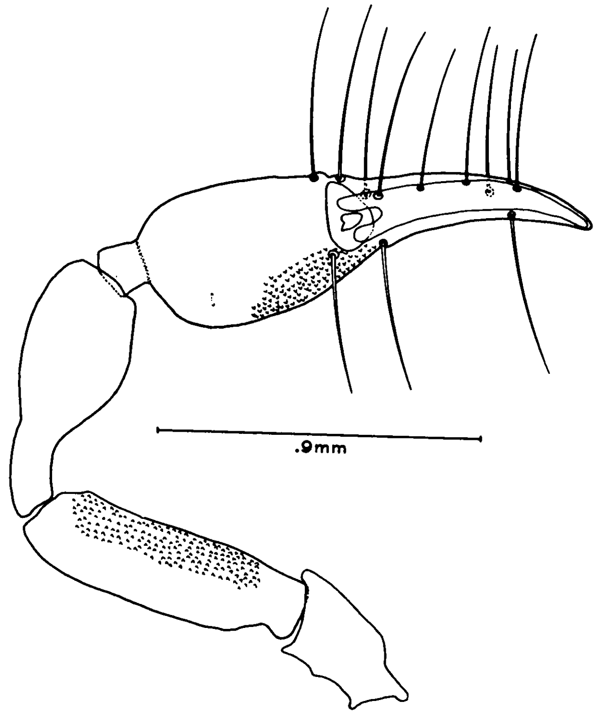
PLATE XXXI

Fig. 81. *Microcreagris lata*, palp, 10X.

Fig. 82. *M. lata*, chela, 10X.

Fig. 83. *M. lata*, palpal tibia (solid line) with outline of palpal tibia of *M. rufula* superimposed, 10X.

PLATE XXXI



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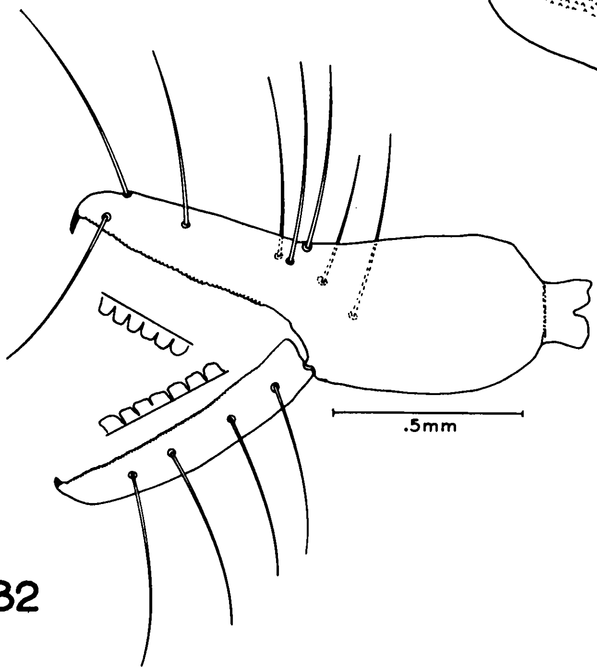

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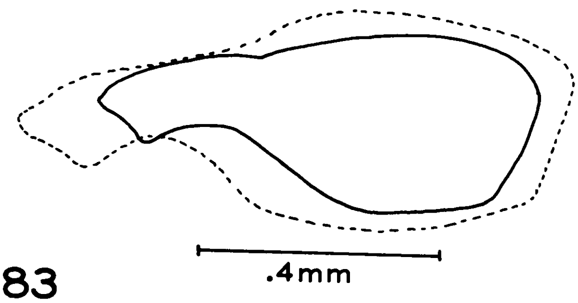

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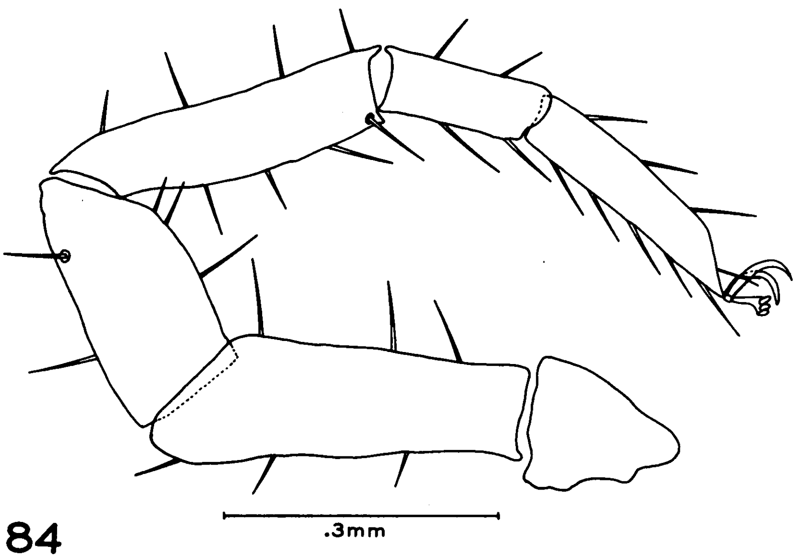
PLATE XXXII

Fig. 84. *Microcreagris lata*, leg I, 21X.

Fig. 85. *M. lata*, leg IV, 21X.

PLATE XXXII



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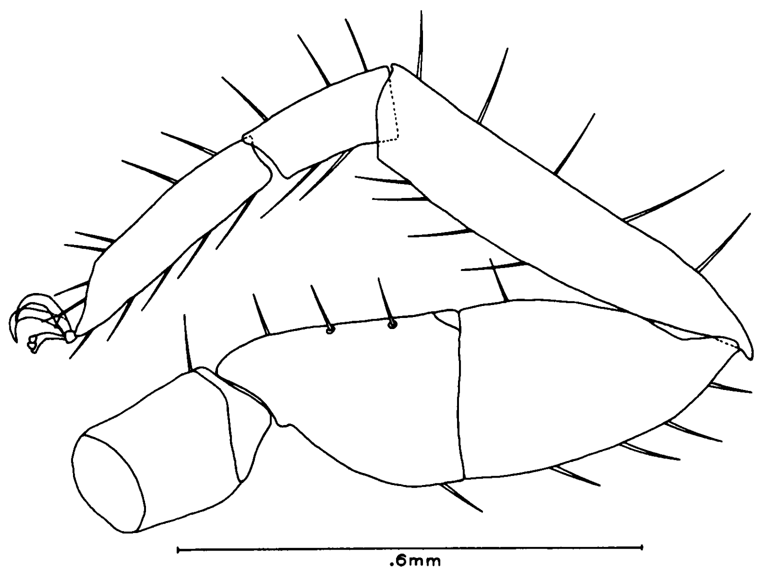

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PLATE XXXIII

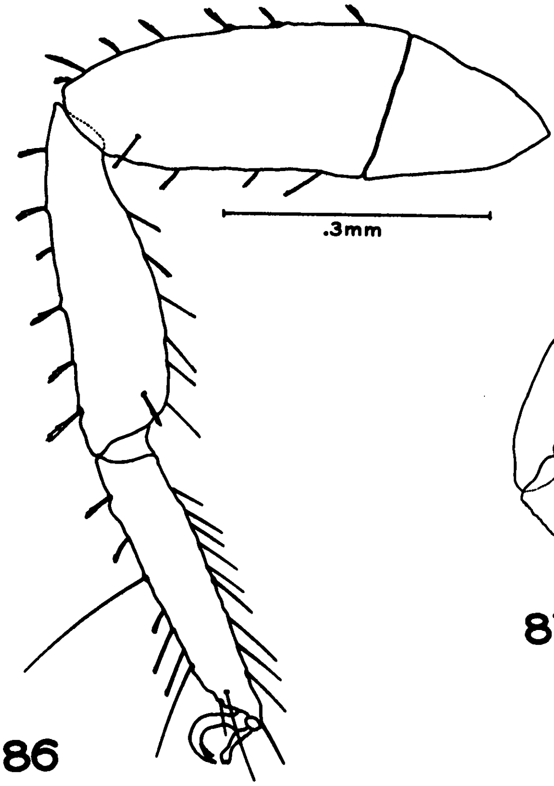
Fig. 86. Pselaphochernes parvus, leg IV, 21X.

Fig. 87. P. parvus, palp, 21X.

Fig. 88. P. parvus, chela, 21X.

Fig. 89. P. parvus, leg I, 21X.

PLATE XXXIII



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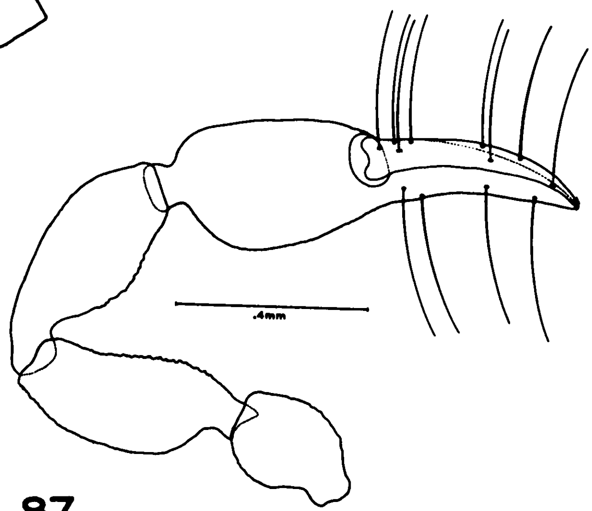

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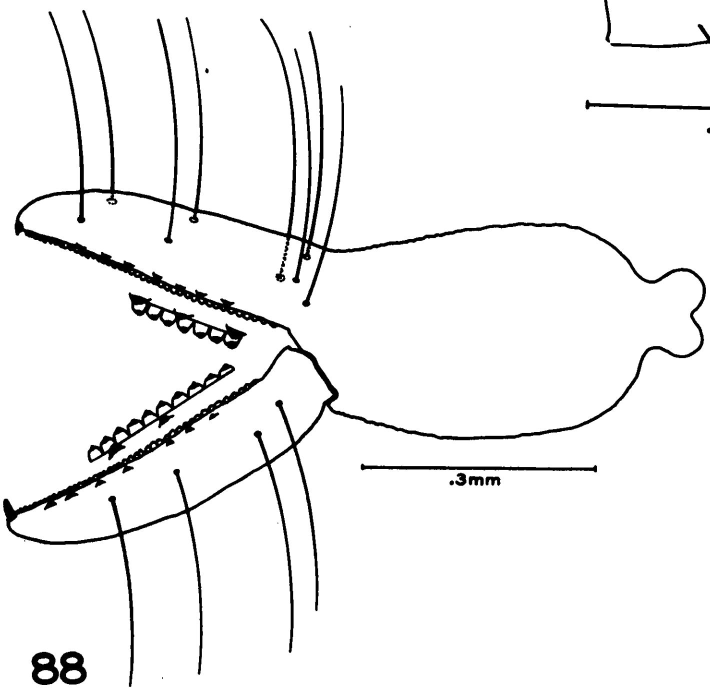

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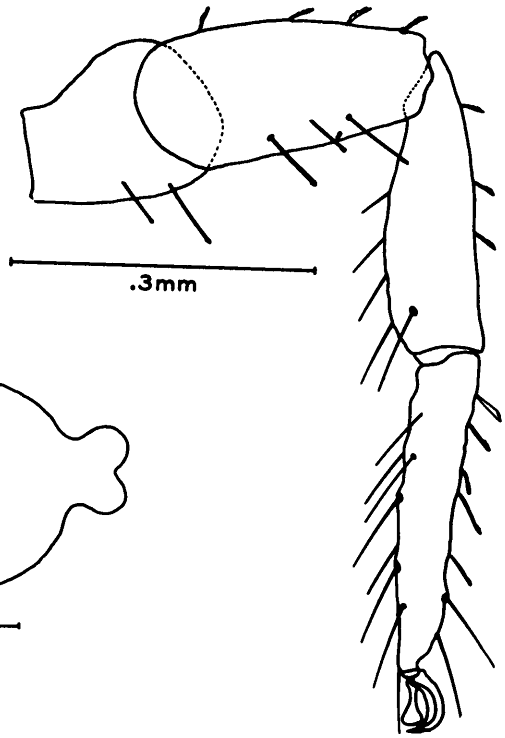

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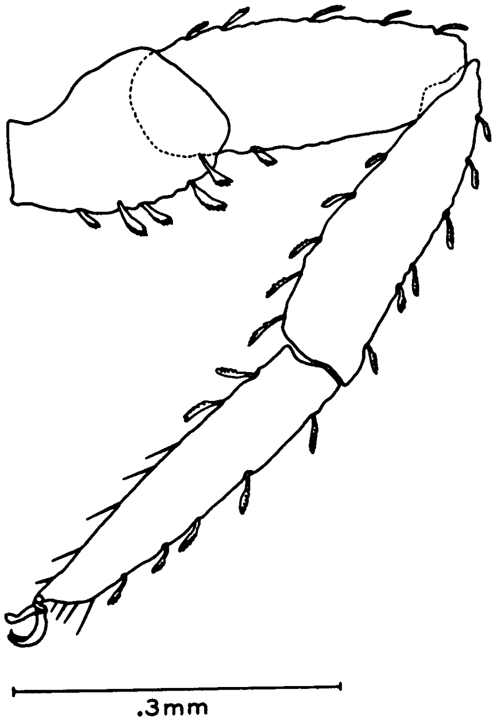
PLATE XXXIV

Fig. 90. *Illinichernes distinctus*, leg I, 10X.

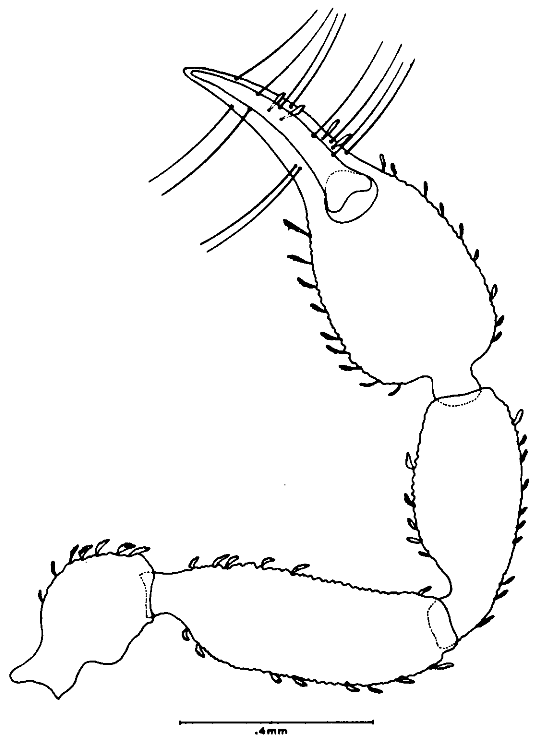
Fig. 91. *I. distinctus*, palp, 21X.

Fig. 92. *I. distinctus*, leg IV, 10X.

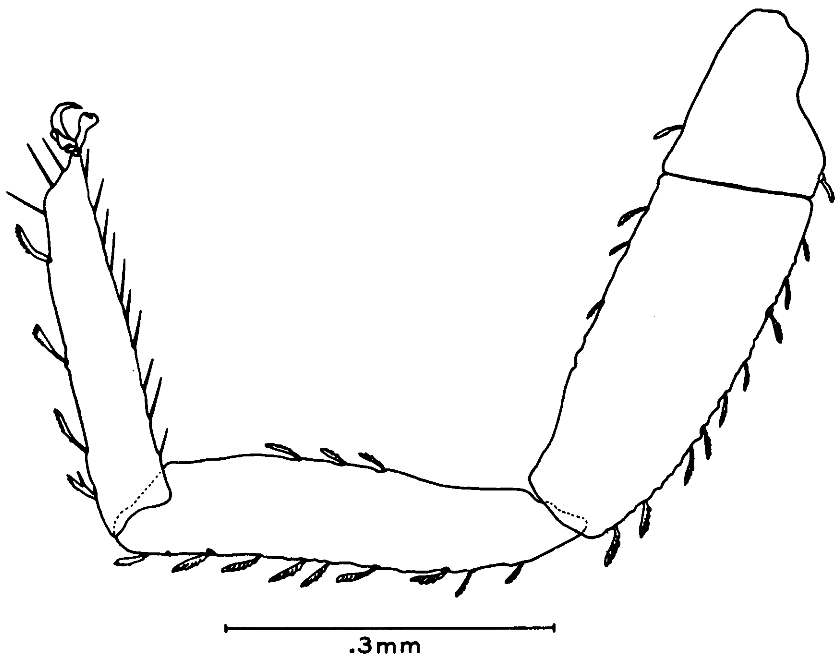
PLATE XXXIV



90



91



92

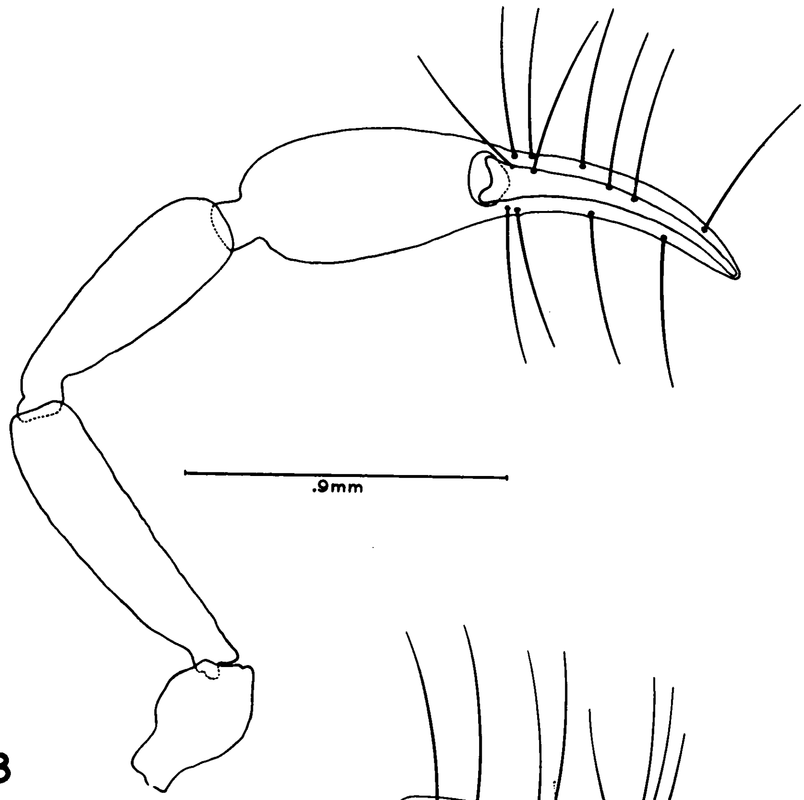
PLATE XXXV

Fig. 93. Dactylochelifer copiosus, palp, 10X.

Fig. 94. D. copiosus, chela, 10X.

Fig. 95. D. copiosus, one-half of a posterior tergite showing setae insertion.

PLATE XXXV



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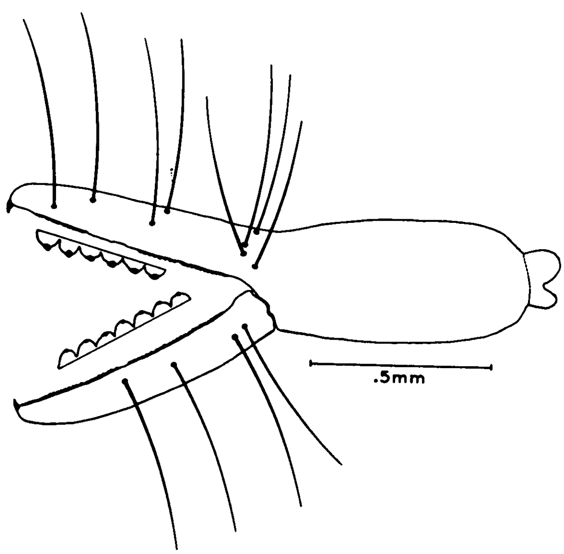

94

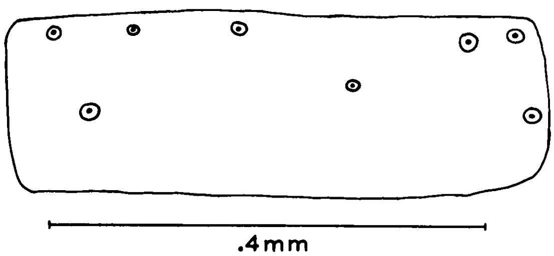

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PLATE XXXVI

Fig. 96. Dactylochelifer copiosus, leg I, 21X.

Fig. 97. D. copiosus, leg IV, 21X.

Fig. 98. D. copiosus, internal male genitalia, 43X.

AT - atrium

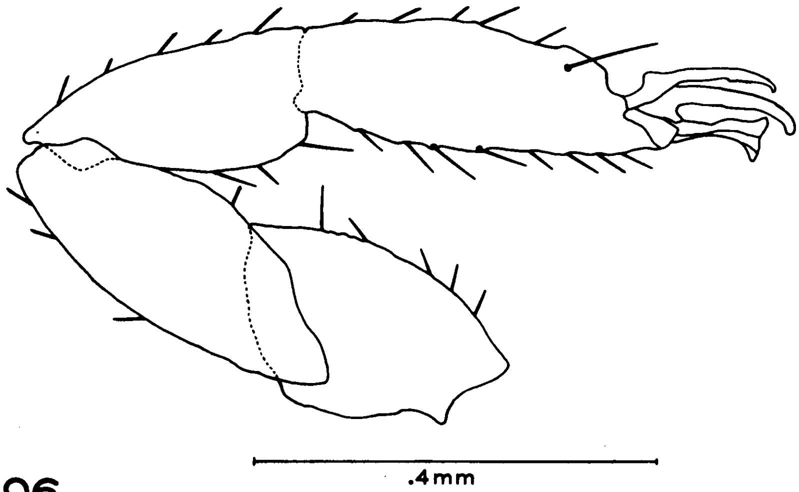
CX IV - coxa four

CX S - coxal sac

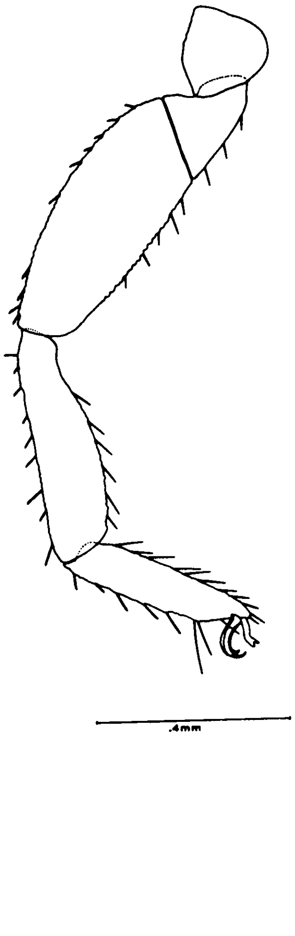
GS - genital sac

ST C - statumen convolutum

PLATE XXXVI



96



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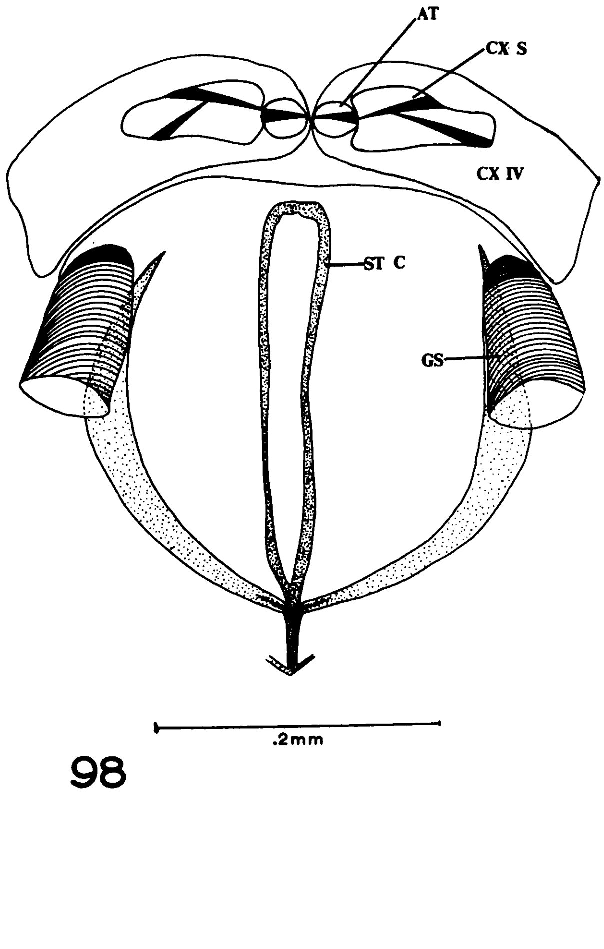

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SYSTEMATIC STUDIES OF SOME PSEUDOSCORPIONS

(ARACHNIDA: PSEUDOSCORPIONIDA) FROM THE

SOUTHEASTERN UNITED STATES

by

James Everett Lawson, B.S., M.A.

ABSTRACT

The pseudoscorpion fauna found in leaf mold of deciduous forests was used in this study and the collections were taken from the following localities: Plummer's Isle, Montgomery Co., Maryland; Mt. Mitchell, Yancey Co., North Carolina; Greenville Co., South Carolina; several counties of East Tennessee and various state parks from Middle and West Tennessee; Breaks Interstate Park, Dickinson Co., Virginia; Blue Ridge Parkway, Floyd Co., Virginia; Mt. Lake, Giles Co., Virginia; and the Great Smoky Mountains National Park. Specimens were obtained from these collections by employing the Berlese apparatus. For mounting the specimens, the procedure utilized was a modification of the method used by Miss Louise M. Russell of the United States Department of Agriculture for mounting scale insects and aphids.

During the course of this investigation, more than two-thousand specimens were studied and the following species were identified: *Verrucaditha spinosa*, *Mundochthonius sandersoni*, *Apochthonius moestus*, *Apochthonius barbarae* sp. n., *Kleptochthonius* (*Kleptochthonius*) *crosbyi*, *Kleptochthonius* (*Kleptochthonius*) *multispinosus*, *Kewochthonius paludis*, *Chthonius* (*Ephippiochthonius*) *tetrachelatus*, *Microbisium confusum*, *Neobisium carolinense*, *Neobisium tenue*, *Neobisium holti* sp. n., *Microcreagris atlantica*, *Microcreagris rufula*, *Microcreagris lata*, *Pselaphochernes parvus*, *Illinichernes distinctus*, and *Dactylochelifer copiosus*.

A redescription of 16 species and descriptions of two new species were presented. In these descriptions an account of a male from a genus previously thought to reproduce parthenogenetically was given. The discovery of a male of _Microbisium confusum_ suggested that other males of the genus might exist. Emendations of species descriptions were based on a series of specimens, and the measurements taken of the various structures showed a greater range in length-width ratios and dimensions than was indicated in similarly published data for many of the species.

Type locality and place of deposit of the type specimen, collection data, previous distribution and new distribution records, and a discussion of the taxonomic status were presented for each species. A synonymy, beginning with the revision of the order by Chamberlin in 1929, was prepared for each taxon.

The possibility of using the male genitalia as taxonomic characters was considered and recommendations were made. Males of two closely related species, _Kleptochthonius crosbyi_ and _Kleptochthonius multispinosus_, were separated on the basis of dissimilar genitalic features.

Tergal and sternal chaetotaxy were found to vary considerably and strict application of these formulae was avoided. The chaetotaxal formulae of the coxae, carapace, and palpi were of systematic impottance and their employment was urged.

Suggestions were made concerning the discarding of such terms as "maxillae" and "apicalis maxillaris" from species descriptions and the adoption of the terms "palpal coxa" and "apical lobe of the palpal coxa," respectively.

The need for revisionary work, the use of measurements, and the value of systematic characters were discussed. The ecology, distribution, and means of dispersal of pseudoscorpions were also mentioned.

Ninety-eight illustrations were presented to accompany species descriptions.