QL
461
.A373X
ENT

MEMOIRS
OF THE
AMERICAN ENTOMOLOGICAL SOCIETY
NUMBER 17

A TAXONOMIC STUDY OF THE MILLIPED FAMILY SPIROBOLIDAE (DIPLOPODA: SPIROBOLIDA)

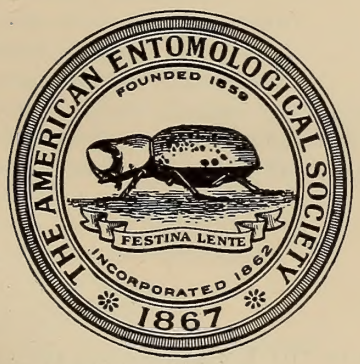
BY
WILLIAM T. KEETON

PUBLISHED BY THE AMERICAN ENTOMOLOGICAL SOCIETY
AT THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA
1960

MEMOIRS
OF THE
AMERICAN ENTOMOLOGICAL SOCIETY
NUMBER 17

A TAXONOMIC STUDY
OF THE
MILLIPED FAMILY SPIROBOLIDAE
(DIPLOPODA: SPIROBOLIDA)

BY
WILLIAM T. KEETON



PUBLISHED BY THE AMERICAN ENTOMOLOGICAL SOCIETY
AT THE ACADEMY OF NATURAL SCIENCES
PHILADELPHIA
1960

(*Issued July 29, 1960*)

PRINTED IN THE UNITED STATES OF AMERICA

WICKERSHAM PRINTING COMPANY
LANCASTER, PENNSYLVANIA

TABLE OF CONTENTS

Introduction 1
Historical Background 4
Morphology and Terminology 8
Biology 15
Classification and Relationships 20
Taxonomy 28
Family Spirobolidae Bollman 28
Subfamily Spirobolinae, new usage 31
Genus *Aztecolus* Chamberlin 33
Aztecolus nigrior Chamberlin 35
Aztecolus pablillo Chamberlin 38
Genus *Chicobolus* Chamberlin 39
Chicobolus spinigerus (Wood) 40
Genus *Spirobolus* Brandt 50
Spirobolus bungii Brandt 54
Spirobolus walkeri Pocock 56
Spirobolus umbobrochus, new species 58
Spirobolus grahami, new species 59
Spirobolus formosae, new species 62
Genus *Narceus* Rafinesque 63
Narceus annularis (Rafinesque) 67
Narceus americanus (Palisot de Beauvois) 87
Narceus gordanus (Chamberlin) 95
Subfamily Tylobolinae, new 97
Genus *Hiltonius* Chamberlin 98
Hiltonius mexicanus (Saussure) 101
Hiltonius fossulifer (Pocock) 103
Hiltonius carpinus Chamberlin 107
Hiltonius carpinus carpinus Chamberlin 107
Hiltonius carpinus vulcan (Chamberlin) 108
Hiltonius pulchrus (Chamberlin) 110
Hiltonius mimus Chamberlin 111
Hiltonius hebes (Bollman) 113
Hiltonius thebanus Chamberlin 114
Nomina inquirenda 115
Genus *Tylobolus* Cook 115
Tylobolus claremontus Chamberlin 122
Tylobolus ergus (Chamberlin) 124
Tylobolus monachus (Chamberlin) 125
Tylobolus deses Cook 127
Tylobolus castaneus Chamberlin 127

SMITHSONIAN
FEB 22 2006
LIBRARIES

Tylobolus uncigerus (Wood) 129
Tylobolus utahensis Chamberlin 132
Tylobolus fredricksoni (Causey) 133
Tylobolus species? 134
Nomen inquirendum 135
Literature Cited 136
Explanation of Figures 139

MEMOIRS
OF THE
AMERICAN ENTOMOLOGICAL SOCIETY
NUMBER 17

A TAXONOMIC STUDY OF THE MILLIPED FAMILY SPIROBOLIDAE (DIPLOPODA: SPIROBOLIDA)[1]

BY WILLIAM T. KEETON
(*Department of Entomology, Cornell University*)

INTRODUCTION

Probably no other millipeds are so commonly encountered in the United States as are the members of the family Spirobolidae. These large diplopods are used as examples of their class in most general biology, invertebrate zoology, and introductory entomology courses in colleges throughout the country. Specimens of "*Spirobolus marginatus*" are on sale at most of the major biological supply houses.

Despite all of this superficial attention, however, the family has remained one of the least studied and most poorly understood groups in the Diplopoda. For years, the main taxonomic attention accorded these animals has been a succession of descriptions of new species. These descriptions have far too often been of such a brief and inaccurate nature that their use is exceedingly limited. Seldom has any attempt been made to compare in an adequate way new species with previously described ones. Only on the rarest occasions have papers been published that have made any attempt at critical synthesis. Thus the list of names in the group has grown longer year by year with

[1] Modified from a thesis presented to the graduate school of Cornell University for the degree of Doctor of Philosophy. The expense of publishing the illustrations in this paper was paid by the Griswold Fund of the Department of Entomology, Cornell University.

little evaluation being made of their zoological (or nomenclatorial) validity. The result has been great confusion, not only for the diplopodologists themselves, but for other scientists as well. One example should serve to indicate the extent of this confusion. The name "*Spirobolus marginatus*" has regularly been applied by both biologists and laymen to specimens representing several genera and species occurring in the United States, despite the fact that no member of the genus *Spirobolus,* as now conceived, is found in North America and that the species name *marginatus* is a junior homonym and hence invalid.

Having criticized the biologists, it is now only fair to shift from them part of the blame for the muddled condition of the taxonomy of the Spirobolidae. In few groups of millipeds are the species so difficult to define and intraspecifically so variable. It is thus easy to understand why so many specimens, actually unusual in one or more characters, have been made the bases for descriptions of "new" species, and why the validity of these species has so long remained in doubt.

This paper is an attempt to bring together and evaluate the existing information on this family of animals and to add new information gained from the study of specimens. Wherever possible the emphasis has been on examination of large series in the hope that the light thus shed on both individual and geographic variation will lead to a better understanding of the species involved. It is one of the shortcomings of the work that adequate series of some groups of species have not been available. My attention has been devoted primarily to determining what species actually occur in nature and to studying those species. To this end, the entire study has been oriented around animals, not names. Specimens have been studied and decisions as to species made before attempting to match the species thus determined with the names available in the literature. Some names, the evaluation of which has been considered impossible until such time as the types are available for examination, have simply been listed as *nomina inquirenda.* If such procedure be deemed unsatisfactory by anyone, I beg to be forgiven on the grounds that I am interested in biology, not in nomenclatorial legalistics.

I do not claim that the picture of the Spirobolidae herein given is

complete and wholly satisfactory. Indeed, many new problems have appeared as the study has progressed and many of these problems have been left unresolved. If, however, my work serves to stimulate further critical inquiries into the biology and classification of these millipeds, it will have accomplished something of value.

The idea of a taxonomic study of the Spirobolidae was first proposed to me by my good friend Richard L. Hoffman to whom I owe many thanks for continued suggestions and encouragement. The work has been done under the advisorship of Dr. Howard E. Evans of the Department of Entomology of Cornell University, and I wish to express to him and to Dr. John G. Franclemont of the same department my appreciation for their support and helpful suggestions. Dr. Henry Dietrich, curator of the insect collections at Cornell, has rendered me constant aid in obtaining information and specimens from collections throughout the world. Special thanks are extended to Dr. R. V. Chamberlin and to Dr. Nell B. Causey, both of whom lent me types and other specimens from their private collections; without these important specimens, my study would have been far less complete. I take this opportunity of expressing to Miss Frances A. McKittrick my sincere gratitude for her generous aid in preparing drawings. Miss McKittrick's name is on the captions for the figures made by her.

I am listing below the various sources of the material used in the preparation of this work. The list is meant to serve both as an acknowledgment and as an indication of the abbreviations (show in parentheses) by which these collections are designated in the body of this paper.

The Academy of Natural Sciences of Philadelphia (ANSP), through Mr. Harold J. Grant, Jr. and Mr. James A. G. Rehn. The California Academy of Sciences (CAS), through Mr. Hugh B. Leech, The Carnegie Museum, Pittsburgh, Pa. (CMP), through Mr. G. K. MacMillan. The Chicago Natural History Museum (CNHM), through Mr. Henry S. Dybas. Cornell University (CU), through Dr. Henry Dietrich. The Los Angeles County Museum (LACM), through Dr. Fred S. Truxal. The Museum of Comparative Zoology, Harvard University (MCZ), through Dr. Herbert W. Levi. The Museum of Natural History of Geneva, Switzerland (MHNG), through Dr. Her-

mann Gisin. The Natural History Museum of Vienna, Austria (NHMV), through Dr. Friedrich Kasy. The Snow Entomological Museum of the University of Kansas (SMUK), through Dr. George W. Byers. The United States National Museum (USNM), through Dr. Ralph E. Crabill, Jr. The private collections of Dr. Herbert W. Levi (HWL), Dr. Nell B. Causey (NBC), Dr. Richard L. Hoffman (RLH), Dr. R. V. Chamberlin (RVC), Dr. Thomas Eisner (TE), Dr. J. F. Hanson (JFH), and of the author (WTK).

Historical Background

The oldest specific name now referred to the family Spirobolidae is that proposed by Palisot de Beauvois in 1817. This species, *americae borealis* or *americanus*, was placed by Palisot in the then all-embracing genus *Julus* of the family Julidae. Save for a very few brief reappearances, this species name immediately sank into oblivion whence it was not fully resurrected until almost 150 years later.

The next appearance in the literature of names now referred to the Spirobolidae suffered from an even more complete disregard. In 1820, the eccentric American naturalist C. S. Rafinesque published in his "Annals of Nature" two new genera, *Narceus* and *Rhexenor,* each with a single new species. Both of these are easily recognizable as spirobolids, yet it was not until 133 years later that either was even considered as a milliped. In the three great indexes, "Nomenclator Animalium" of the Prussian Academy, "Index Animalium" of Sherborn, and "Nomenclator Zoologicus" of Neave, these are actually listed as genera of fish!

The third paper describing a spirobolid (still in the genus *Julus;* Refinesque's generic names already disregarded) appeared in 1821. The new name, *marginatus,* proposed by the noted entomologist Thomas Say, has had a history very different from that of the Palisot and Rafinesque names. Though it is now known to be both a junior homonym and a junior synonym, the name *marginatus* has been used over and over again, and applied to almost every spirobolid species in North America and even to species in China! The name has apparently become for many people almost synonymous with the word "milliped." Inasmuch as "*marginatus*" has been used so indiscriminately in textbooks, check lists, regional faunal lists, and almost every other type of

publication wherein millipeds are mentioned at all, no attempt will be made in this paper to list all of these references in the synonymies of the species treated—in most cases it is impossible to ascertain to which species they actually apply.

A paper of major importance to the future of the taxonomy of the millipeds under consideration was that of J. F. Brandt, published in 1833. The genus *Spirobolus* was described in this work and two new species, *olfersii* from Brasil and *bungii* from China, were included in it. Neither species was designated as the type of the genus. The name *Spirobolus* gained immediate acceptance by workers throughout the world and during the remainder of the nineteenth century hundreds of new species were placed in the genus. During most of this period, the genus was used in much the same sense that the order Spirobolida is used today, but it was still placed in the family Julidae by the majority of workers.

In his " Classification of the Myriapoda " published posthumously in 1893, Charles Harvey Bollman established the first suprageneric category based on *Spirobolus.* He erected the subfamily Spirobolinae in the family Julidae. At the same time, Bollman recognized the division of *Spirobolus* into two subgenera, *Spirobolus* and *Rhinocricus,* as Karsch had proposed in 1881.

Bollman's subfamily was immediately elevated to full family status by many workers, notably K. W. Verhoeff (1893), R. I. Pocock (1893), and O. F. Cook (1895). Cook placed the family Spirobolidae in a separate new order, the Anocheta (including a single suborder, the Spiroboloidea, which was also new). Thus Cook was the first to recognize the ordinal status of the group, but he still included all of the genera (*Spirobolus, Rhinocricus,* and four other genera which had been proposed by that time) in a single family. Later, however, Cook (1897) became the first worker to recognize more than one family in the group; he split the old Spirobolidae into " the true Spirobolidae " and the Pachybolidae.

It was not until 1909 (and 1910) that the fundamental characters of the two major divisions of the Spiroboloidea were explicitly mentioned. At that time Carl Attems established two separate families, the Euspirobolidae and the Trigoniulidae. Attems used as the basis for his division the fact that in the Euspirobolidae the posterior gonopods

of the male are free from each other with no sternum present, and that the basal and distal pieces of these gonopods lie in an approximately straight line. In the Trigoniulidae the posterior gonopods are bound together by a sclerotized sternum and the basal and distal parts of the gonopods lie at right angles to each other. These characters are still considered of basic importance at the present time. It is important to note that Attems' name Euspirobolidae was antedated by Bollman's Spirobolinae (= Spirobolidae) and that, furthermore, the name Euspirobolidae was not based on any generic name as is required by the international rules of zoological nomenclature.

Perhaps the most important single work on the classification of the order is that published in 1914 by Brölemann (who continued to regard the group as a suborder). Brölemann made a study of the structure of the male gonopods and on the basis of his findings elevated Attems' two groups to the rank of "phyla." In the phylum Euspirobolidi, he included the Spirobolidae (used in a new, more restricted sense) and three new families, the Rhinocricidae, the Pseudospirobolellidae, and the Spirobolellidae. In the phylum Trigoniulidi, he included the Trigoniulidae (used in a new sense), the Pachybolidae, and a new family, the Spiromimidae. In his definition of the Spirobolidae, Brölemann accepted Pocock's earlier (1893) designation of *bungii* as the type species of *Spirobolus* and included *olfersii* in the Rhinocricidae. He further argued that inasmuch as *bungii* had remained unknown since its original brief description, the North American species "*Spirobolus marginatus*" should be used as the working type of the genus and therefore of the family Spirobolidae as well. Brölemann's classification has remained the basis for the classifications used by most other workers until the present time.

It is not the purpose of this study to trace in detail the various vicissitudes that the ideas concerning the classification of the Spiroboloidea (or Spirobolida, as the order is most generally designated in the United States) have undergone, particularly in the voluminous works of Attems and Verhoeff. Mention will here be made of only those publications which have played major roles in the history of the family Spirobolidae.

By the year 1918, R. V. Chamberlin had become the leading worker

on diplopods in the United States. It was in that year that Dr. Chamberlin published the first of his many new spirobolid species. It was also in that year that Chamberlin erected a new family, the Atopetholidae, to include certain genera from southwestern United States and Mexico. A brief survey of the confusion that has persisted for many years concerning the relationships between the Atopetholidae and the Spirobolidae will indicate the kinds of problems that have existed in the classification of the order in general.

The family Atopetholidae was erected in 1918 to receive two new genera, *Atopetholus* and *Hesperolus,* and two of Cook's genera, *Eurelus* and *Onychelus.* In the same publication, a new genus called *Hiltonius* was described in the Spirobolidae. In 1941, however, Chamberlin moved *Hiltonius* and *Messicobolus* Brölemann to the Atopetholidae. In a paper published in 1943 he continued this arrangement and added three new genera, including *Aztecolus,* to the Atopetholidae. In a 1947 paper, however, *Aztecolus* was moved to the Spirobolidae while *Hiltonius* and *Messicobolus* were retained in the Atopetholidae. Finally, in a paper " On some western millipeds of the order Spirobolida " published by Chamberlin in 1949, a list of the genera of the Spirobolidae occurring in the United States and Mexico included for the first time all three genera, *Hiltonius, Aztecolus,* and *Messicobolus.* In no instance was any reason given for any of these changes. It is to be hoped that the present paper, together with a revision of the Atopetholidae currently being completed by R. L. Hoffman and B. S. Orcutt, will settle the problem of the correct assignment to family of these much-moved genera.[2]

A few other papers should be mentioned in order to bring this account up to date. These include a work by Hoffman (1951) which effectively revived the use of the name proposed by Palisot de Beauvois, a study by Hoffman and Crabill (1953) which resurrected the work done on myriapods by Rafinesque, a summary by Causey (1955a) of the spirobolids of the United States east of the Rocky Mountains, a study by Hoffman (1957) which clarified the relationships between the common spirobolid millipeds of the eastern United States and the true *Spirobolus* of China, and two papers, one by Loomis (1933) and

[2] The paper by Hoffman and Orcutt (Proc. U. S. Nat. Mus., vol. 111, pp. 95–165. 1960) appeared while this study was in press.

the other by Causey (1955b), which dealt with the life histories of members of the family Spirobolidae.

Morphology and Terminology

It is not the purpose of this paper to present a detailed account of the external morphology of spirobolid millipeds. Admirable as such an endeavor might be, a really adequate morphological study would be a major undertaking in itself. It is intended here only to point out those characters used in the pages that follow and to indicate the terms and abbreviations used to designate them. Likewise, the figures given in this paper are not detailed morphological drawings. Most of them are simple line drawings and some are rather diagrammatic. Their purpose is to facilitate identification, not to give complete pictures of the animals.

The members of this family are all large millipeds. The smallest usually exceed 31 mm. in length and 3.3 mm. in width, while the largest may be 130 mm. long and 13 mm. wide. Both absolute size and relative body proportions are important in distinguishing species. The number used to indicate proportions is the quotient obtained by dividing the length of the specimen by the greatest width of the specimen (L/W). Admittedly measurements of this sort, particularly those of the length of specimens that are often rigidly fixed in bends and coils, are subject to considerable error. Probably no two people would get the same value for the length of a specimen, if for no other reason than that these animals are capable of much telescoping or extension of their bodies. Granting all of these facts, it is nonetheless true that with a little practice one can reach the point where his errors are all of approximately the same magnitude and the results obtained are of use in a comparative manner. The length (L) is customarily measured to the nearest millimeter and the width (W) to the nearest tenth of a millimeter. In the descriptions of species, both the ranges of values observed for these characters and the means are given; the means are shown in parentheses.

Most members of the family are dark brown with lighter legs and often with a band of yellowish-brown or red on the posterior portion of each segment. Many specimens of the genus *Chicobolus* have more contrasting light areas on the sides and underparts than do other spiro-

bolids. Color is a very variable character throughout the family and its use in identification is unsafe in most cases. Most preserved specimens fade badly and under no circumstances should the color of such specimens be used as the basis for the description of a new species or as a major character in a taxonomic key.

The head is usually rounded and smooth with the mouthparts directed ventrally. Most of the visible part of the head is termed the *face.* It is divided into four major regions as shown in figure 1. The posterior (the terms anterior and posterior are used as if the head were prognathous) portion of the face is the *vertex* (V). This area is limited anteriorly by the posterior margins of the eye patches. The portion of the face between the vertex and the anterior margins of the antennal sockets is termed the *frons* (F). Anterior to the frons is the large, broad *clypeus* (C). Laterally, the clypeus extends below and beyond the antennal sockets. The posteriolateral corners of the clypeus are termed the *lateral corners* (lc). The lateral borders of the clypeus run convergently anteriomesad for a distance and then each ends in an abrupt, rounded corner. These anteriolateral corners are termed the *ventral corners* (vc) of the clypeus. The anterior margin of the clypeus has a deep V-shaped mesal emargination. Within this *anterior emargination,* a narrow sclerite, the *labrum* (L), runs along the edge, a pronounced groove separating it from the clypeus. This narrow, often dark colored labrum bears on each side one or more short, blunt teeth. The number and distribution of these *labral teeth* is variable and of no taxonomic value. Running down the center of the face is the *facial suture* (fs), which is usually interrupted on the frons between the levels of the mid-points of the eye patches and the anterior margins of the bases of the antennae. The general shape of the face and its various regions is sometimes of taxonomic value.

As has already been indicated, the frons bears the two large lateral *eye patches* (EP), each made up of many simple eyes (see figure 11). The number of eyes in each patch varies both interspecifically and intraspecifically. A table showing the observed variation in eye number is given for most species treated herein. Each eye patch is counted separately as the two patches seldom contain the same number of eyes and the variation between the patches is not inversely related.

The frons also bears the two, seven-segmented antennae. The second segment of an antenna is always the longest. The last segment bears four small sensory cones on its distal end. At rest, the first two antennal articles lie horizontally in an *antennal groove* (ag), the anterior border of which is formed by the lateral corner of the clypeus. The posterior border is formed by a small triangular sclerite termed the *parietal sclerite* (PS). The apex of this sclerite runs posteriorly along the lateral border of the frons. Both the depth of the antennal groove and the shape of the parietal sclerite are important in species recognition.

Along each side of the anterior border of the clypeus is a line of foveolae each of which bears a moderately long and heavy seta. These setae are called *clypeal setae.* Just below them is another series of setae arising from the base of the labrum and termed the *labral setae.* The number of setae in each of these two series varies both between and within species and is useful in a few cases for species recognition if used with great caution. Commonly there is not the same number of setae on each side of the face. Inasmuch as this is also true of both the eyes and the labral teeth, it appears that bilateral symmetry is not the usual rule in regard to the face (indeed, the most common number of labral teeth is three: two on one side and one on the other). The number of setae on one side seems often to vary inversely as the number on the other side. Hence the total number of setae in each series is the most important count. The observed variation in these counts is given for most species.

Spirobolids, like other diplopods, have only two sets of mouthparts, the mandibles and the gnathochilarium. The mouthparts are remarkably constant throughout the entire order Spirobolida and thus provide very few taxonomic characters within the group. A few important features will be mentioned here, however.

The large mandibles form what appear to be the sides of the head or face and for this reason the parts visible without dissection when the mouthparts are held in the resting position are called the *mandibular cheeks* (figure 11, MC) or simply, the cheeks. Each cheek is divided by a suture opposite the antennal groove into basal and distal portions. The basal portion is the *cardo* (Crd) and the distal is the

stipes (Stip). When the antenna is held at rest, there is an angle between the second and third articles so that the distal segments lie against the stipes of the mandibular cheek. The surface of the cheek is often somewhat concave for the reception of the antenna. Both the degree to which the stipes is concave and the shape of the distal end of the stipes are important taxonomic characters.

The gnathochilarium (figure 7) is essentially the same throughout the Spirobolida and is made up of a basal *hypostoma* (H), a small *prebasilare* (P), two small *cardo* plates (Cd), a very large subtriangular mentum (M) which widely separates two lateral *stipites* (S), and two small plates called the *lingual laminae* (LL). Each lingual lamina bears two long setae. Each stipes bears two distal sensory protuberances and three or more long setae. The number of setae is stabilized at three on each stipes in most genera of the Spirobolinae but is variable in *Chicobolus* and in the two genera of the Tylobolinae.

The *collum* (figure 11, Cl), or first segment of the body, is a large, oblong, hood-like plate extending over the back of the head. The second segment is a more typical circular body segment but its anterior ventrolateral portion on each side is usually produced into a heavy, large protuberance which often considerably surpasses the lateral end of the collum. This portion of the second segment forms a large, anteriorly directed, slightly concave surface, the *cephalic plate* (figure 82, CP) of the second segment, which is held against the cardo of the mandible. This segment is open ventrally.

The ordinary segments of the body are essentially simply rings (figures 8 and 9) made up of the fused tergum (T), pleura (Pl), and sternum (St). The sutures between the sternum and the pleura and between the pleura and the tergum are usually visible, though in dark specimens the latter may be difficult to see. The tergum of each segment is made up of three areas (figure 8), the fore (f), mid (m), and hind (h) *belts* separated by weak lines or sutures. The line between the mid and hind belts is termed the *segmental suture;* the degree to which it is evident is very variable and of no taxonomic importance, despite its frequent use in keys. Lying immediately in front of the segmental suture about midway down on each side of the segment is the *repugnatorial pore* (rp), the opening of the repugnatorial gland.

Repugnatorial pores are present on all segments except the first five and the telson. The sterna of segments three to five each bare a single spiracle; those of all segments behind the fifth, except the telson and the seventh segment of the male, bear two spiracles. The sternum, pleura, fore belt, and lower portions of mid and hind belts are crossed by numerous striae. The extent of this striation on the mid and hind belts is sometimes of taxonomic importance. The entire surface of the tergum (figure 20) is of a very finely reticulate texture (this reticulation can be seen only under high power of the microscope) with irregular, weak rugulae and scattered puncta.

The last segment, the *telson,* bears a hypoproct or *anal scale* (figure 22, Sc) and two large paraprocts or *anal valves* (AV). The two valves meet in a straight line when they are in the resting position. There is often a thickened area, termed the *anal lip* (al), on each valve along the margin of this line. The extent of development of the lips is variable and only rarely of use in species determination; it is more consistent at the generic level. The tergum of the telson (figure 64) is produced caudally and covers part of the valves. The extent of this development is seldom consistent at the species level although it is sometimes, as in *Aztecolus,* reliable as a generic character. The tergum is often crossed by a line or depression which has sometimes been used as a character in keys. This depression is simply a buckling of the sclerite at a point where the underlying support changes, and its presence or absence is a result of the condition of the individual. It is not taxonomically meaningful.

The first pair of legs is suspended from the collum. The Spirobolida are the only order of millipeds in which the collum bears (or appears to bear) legs. The second pair of legs is suspended from the second tergum and usually looks much like the first pair. Both the first and second legs are usually shorter than the other legs and the podomeres are often swollen.

The third segment bears a single pair of legs, as do the fourth and the fifth segments (this is the only diplopod order in which there is only one pair of legs on the fifth segment). The sixth segment bears two pairs of legs. All of these legs (3rd–7th pairs) are like those of the posterior part of the body in that they are attached to the sterna of

their respective segments and are of full length. They differ, however, in that they more commonly have one or more podomeres specially modified. These modifications are sexual and are much more pronounced in the male than in the female. The coxa, or first podomere, is the segment most often modified.

In the adult, there are two pairs of legs on each segment behind the seventh except the telson which is legless. These legs are not so commonly modified as are the pregenital legs and when they are, their modifications are usually different. In two genera, one or more of the podomeres of the male may bear on part or all of its ventral surface a thin, semitransparent area of unknown function called a *ventral pad.* All of the legs (figure 43) are made up of six segments plus a claw (the claw is actually a seventh segment). The lengths of the various podomeres, of the claws, and of the legs themselves are of taxonomic importance in some cases. The number of ventral setae on the various podomeres is sometimes of importance though this is a highly variable character.

The seventh segment of the female is a typical body segment bearing two pairs of legs. In the male, however, the two sets of appendages are highly modified to form intromittant organs or *gonopods.* These gonopods are drawn inside the body when not in use and are not visible externally. The seventh segment of the male thus appears entirely legless. Although the *anterior gonopods* or *coleopods* (figures 23 and 24) are formed from the first pair of appendages together with the sternum, the modifications are so great that it is exceedingly difficult to establish clear homologies. The terms here used to designate the various parts of the gonopods are based on tradition and are not necessarily indicative of morphological derivations. The *sternum* (St) forms a horizontal basal support for the anterior gonopods and bears at either end a sternal *apodeme* (Sta) for muscle attachment. Lateral to the sternum on either end and fused to it are plates called *coxae* (Co) which give rise to large mesally extending anterior plates, the *coxal endites* (Coe), and mesally extending posterior plates, the *posterior coxal bars* (pcb). Distal to each coxa is a separate plate, the telopodite (Tel), which is slightly moveable on the coxa and is supplied with several small muscles.

The *posterior gonopods* or *phallopods* are independent of each other and there is no posterior sternum in this family. Each posterior gonopod (figures 26 and 27) is embraced by the anterior gonopod; by the sternum and coxal endite on the cephalic side, by the coxa and telopodite laterally, and by the posterior coxal bar and the telopodite on the caudal side. Each is made up of a distal segment termed the telopodite (Telp), a coxa (Cox), and a coxal apodeme (Coxp) which not only extends internally far beyond the coxa to form a spatulate area for muscle attachment but also is fused to the inner surface of the coxa and runs through it to hinge with the telopodite. On the inner surface of the telopodite (figure 28) there is a pocket, the *seminal receptacle* (sr), bounded by sclerotized ridges which also form a *seminal canal* (sc) leading from the receptacle to the distal end of the telopodite.

The gonopods are variously modified and provide characters which are among the most important in the family. Three such modifications should be mentioned here. Four genera have a long mesal, ventrally directed process arising near the base of the posterior telopodite and called the *prefemoral endite* (figure 26, PE); the same genera have a distinct ventrally projecting *mesal process* (figure 23, MP) of the anterior sternum. Two genera have an elongate, sclerotized *mesal apodeme* (figure 173, MA) of the posterior telopodite.

The segment ring of the seventh segment of the male is, as would be expected, specially modified. As a result of the migration of the sternum from the ring to form part of the gonopods, the pleura have become elongated mesoventrally and meet on the mid-ventral line behind the gonopods. The rather narrow bar thus formed (figure 29) is termed the *postgenital bar* (Pb). The segment ring is emarginate both anterior to the bar and posterior to it. These two emarginations are here termed respectively the *genital emargination* (gm) and the *postseral* emargination (pm).

The female genitalia (figures 192 and 193), or *cyphopods,* are small sclerotized structures at the posteriolateral bases of the second legs. They are very simple structures made up of a *caudal plate* (Cp), a *cephalic plate* (Cph), and a *basal valve* (Bv). A suture is evident along the lateral surface and sometimes a thin *lateral flange* (lf) is present. Each cyphopod lies in a pocket in the body membrane. The

membrane is attached to the cyphopod on the mesal side only, and the most distal point of attachment delimits two areas of the cyphopod, the distal lobe (dl) and the basal portion (bp). The cyphopods provide excellent generic characters and in some cases are useful for species determination as well.

This brief summary of the morphology of the spirobolids has been far from complete. Snodgrass (1952) used a spirobolid as one of his examples of the Diplopoda and more information may be obtained from this and others of his excellent publications. An old, but important, general work on the morphology of the Diplopoda is that of Silvestri (1903).

Biology

Very little is known about the life histories of most species of the Spirobolidae. The only published works dealing with this subject for members of the family are based on species of *Narceus,* the common genus of the eastern half of the United States. In 1933, H. F. Loomis published a study based on specimens of *Arctobolus marginatus* (= *Narceus annularis*) collected near Washington, D. C. A paper by Causey (1955b) summarized Loomis' findings and added some new data based on observations of specimens of *Narceus tinctorius* (= *Narceus americanus*) collected in Arkansas and Louisiana. My own observations are based primarily on specimens of *Narceus annularis* collected in Giles County, Virginia. The reader must, therefore, bear in mind that most of the facts mentioned in the short summary of the biology of the spirobolids given here apply only to *Narceus.* It is unknown in what respects members of other genera differ and, in fact, little is known concerning possible variations within *Narceus* itself.

These large, cylindrical millipeds are usually found under damp leaves, rocks, logs, or loose bark during the warmer seasons of the year. In very cold or dry weather, they often go deeper into the ground. They are essentially nocturnal animals and are most easily collected on warm, humid summer nights in areas where the ground is covered with rich humus. On nights such as this, the millipeds are often found crawling on the surface of the humus layer or climbing on the trunks of large trees or on the faces of rocky cliffs. On several occasions I have been in areas of southwestern Virginia and eastern

Tennessee and seen hundreds of individuals of *Narceus* crawling on the tree trunks at night. On each such occasion I have noted that large tulip trees (*Liriodendron tulipifera*) had far more millipeds on their trunks than did equally large oaks in the same area. It is possible that the spirobolids were attracted by the aromatic character of *Liriodendron,* though what benefit they gained by their ventures into tree-climbing is unknown to me.

Recent observations on *Narceus gordanus* indicate that this species often occupies a habitat decidedly different from that of its congeners. These animals are commonly, though not always, found in sandy areas where there is little or no leaf-mold. They burrow deep into the sand during the day; the round holes into which they have disappeared are easily located by the observer. The millipeds emerge at night to feed, rotting logs often providing the most ready source of food. Further details on the life history of *Narceus gordanus* will doubtless soon be available as a result of the research of Dr. Thomas Eisner of Cornell University.

A curious phenomenon called " swarming " has been reported in the literature for species in most orders of the Diplopoda. At such times the millipeds forsake their usual secretive habits and in swarms of hundreds or thousands of individuals begin to move along the ground. It is doubtful if they move very far in these " migrations " though there are few data upon which to base definite conclusions. Many of the reported instances of swarming have occurred in bright daylight despite the fact that diplopods normally exhibit a strongly negative phototaxis.

Two instances of swarming of *Chicobolus spinigerus* are here reported. Other than a note by Viosca (1925), these are the first records, so far as I am aware, of this phenomenon being observed in species of the Spirobolidae, though I am sure that it has been seen many times without note of the fact being made in print. The first case is recorded on a label in a vial containing two specimens collected by Ballard at James Island, South Carolina. I quote a note on the label: " Migration? Numbers of these crossing Folly Road from East to West during latter part of August 1928 ". The second case was observed by Dr. H. E. Evans, Dr. Henry Dietrich and Mr. E. G. Mat-

thews on March 22, 1957 at a point 15 miles northeast of Flamingo, Everglades National Park, Florida. These men observed hundreds of the millipeds crossing a road. This was during a period when the area was dryer than it had been for many years. I have examined 58 specimens collected from this swarm and have found that most of them have fully mature genitalia but are considerably smaller than normal adults. The measurements obtained from these specimens are given in the tables included in the discussion of the species. One might postulate that the excessively dry weather reduced the food supply thus causing poor growth and providing the stimulus for "migration". Without many more data on swarming, however, this is little more than a guess.

Spirobolids, like most other diplopods, feed on humus and other decaying organic matter. During warm weather they are voracious feeders and are able to consume large quantities of leaves or rotted wood in a short time. Their role in the economy of the soil must, therefore, be no small one. They are apparently not very selective feeders inasmuch as I have collected them in areas dominated by a great variety of different deciduous plants, upon the old leaves of which the millipeds were living. I have successfully fed captive specimens on the leaves of many different plants and, indeed, have never seen rotted leaves of any deciduous species rejected.

These animals are, therefore, easily kept in captivity. They thrive in large, tightly closed jars if several handfuls of moist humus are added from time to time and if the jars are cleaned occasionally. Adequate moisture is far more critical than oxygen and for this reason I prefer to use closed jars instead of open cages. Near 100% humidity can thus easily be maintained. Even if the jars are not opened more than once a month, the animals get enough oxygen and remain healthy. Fungi are no problem in cultures of these millipeds as most fungal species will not grow in the jars. Apparently the secretions from the repugnatorial glands of the millipeds are toxic to fungi.

The repugnatorial secretions are also an important means of defense against predators. In a series of interesting experiments now being conducted by Dr. Thomas Eisner, the effectiveness of these secretions, together with the ability of predators to learn to avoid the milli-

peds, is being investigated. Published results are eagerly awaited.

One of the most interesting behavioral patterns known in spirobolid millipeds is that of egg laying. The eggs are layed in moist humus or under the loose bark of rotting logs, the latter being the location where they are most easily found. Each egg is enclosed in a hollow spherical pellet composed of regurgitated material. At first glance, the egg pellets closely resemble the large fecal pellets which are characteristic of sites inhabited by these millipeds. Closer examination reveals, however, that the fecal pellets are more cylindrical, coarser grained, and usually slightly darker in color. Loomis (1933) has described the making of the egg pellets in considerable detail; portions of his description are given here. " The first step in the manufacture of one of these egg cases was the regurgitation of a small mass of material by the mother, who curved her head so that the mass was delivered to the legs a short distance behind the head, the eighth to eleventh pairs of legs receiving the moist lump. These legs held the mass while the milliped curved her head around still further and began flattening and spreading the material by repeatedly forcing the smooth, convex front of her head against it, until soon there was formed a thin saucer or shallow bowl, smoothed on the convex [concave?] side by the milliped's head, but with a rough exterior. In the center of this saucer the egg was placed immediately following its ejection from one of the paired oviducts. . . . The actual placing of the egg in the saucer was not observed but probably was accomplished by the mother's bending her body over the saucer and laying the egg directly in it, although it may have been possible to have the egg passed back from the oviduct and placed in the saucer by the legs between the oviduct and those holding the receptacle. As soon as the egg was deposited, the edges of the saucer were brought up and kneaded together by the feet, while the junction was rapidly worked over by the front edge of the head or labrum, and this action of head and feet was continued until an almost perfect sphere, with a slightly roughened surface but without folds or cracks, was formed. The completed pellet was dropped by the mother and she soon began a repetition of the process for the next egg."

It is unknown how long it takes for an egg to hatch, but it is probably a matter of only a few days. The first instar larva is a small, white, grub-like creature with no distinct head or segmentation and

with no appendages. A single indistinct eye spot is present on each side of the head. This entire stage is passed within the pellet.

The second instar larva is also white but a distinct head, with antennae, mouthparts, and one eye of each patch, is present. The collum and next five succeeding segments are evident and the first three pairs of legs are present. Behind the six distinct segments is a short, slightly swollen, unsegmented region, at the end of which are distinct anal valves and an anal scale. This stage, too, is passed within the egg pellet.

The third instar usually has 21 distinct segments (both Loomis and I have seen occasional specimens with 22). The first seven pairs of legs are present, and there are three eyes in each patch. A repugnatorial pore with active gland (visible through the thin integument) is present on each side of the sixth segment. It is during this stage that the young milliped chews a small, round hole in the side of the pellet and emerges. Both Loomis and Causey state that the larva emerges near the end of the third instar, but I have had many specimens remain in this instar as long as a month after emergence.

Beginning with the fourth instar there is considerable difference in the development of various individuals and it becomes more and more difficult to recognize the instars. All specimens of the fourth stage examined by Loomis had either 26 or 27 segments. Causey found some with as few as 24 or 25. Most of the specimens which I examined had either 25 or 26 segments and were 11–11.5 mm. long. Most specimens in this stage have six legless segments, but a few have four, five, or seven. There are usually three rows of eyes in each patch, with three eyes in the posterior row, two in the middle row, and one in the anterior.

Specimens in the fifth stage usually have about ten eyes in each patch, arranged in rows of 4, 3, 2, 1. The number of body segments usually ranges from 29 to 32. Most sixth stage specimens I have seen have had about 15 eyes per patch, arranged in rows of 5, 4, 3, 2, 1. The most common segment count for these specimens has been 35. They have been 13.7–14.5 mm. long and about 2 mm. wide. The usual number of eyes per patch in seventh instar millipeds is 21, arranged in rows of 6, 5, 4, 3, 2, 1. Most specimens I have examined

have had between 39 and 41 segments. In all of these instars there are usually six (occasionally five or seven) legless segments.

Specimens in the eighth and later instars show so much individual variation in size, number of segments, and number of eyes that it is impossible to characterize these stages in any meaningful way. Differences in the amount of available food, for instance, effect both the size and the number of new segments added at any given molt. It is uncertain how many molts a spirobolid undergoes before reaching sexual maturity. As an animal approaches the adult stage, the number of new segments added per molt decreases and sub-adult specimens often have only one or two legless segments in addition to the permanently legless telson. It has generally been supposed that at the final molt legs are added to the previously legless segments and the genitalia attain full size and development. I have seen many specimens, however, with a full complement of segments and only the telson legless, but with immature genitalia and underdeveloped anterior coxae which still retain the setae typical of immature and subadult specimens. It seems likely, therefore, that many individuals must go through at least one additional molt to reach sexual maturity. Inasmuch as newly matured adults are seldom as large as older individuals, I think it probable that even adults continue to molt occasionally.

CLASSIFICATION AND RELATIONSHIPS

In general, the basic division of the order Spirobolida proposed by Attems (1909, 1910) and more clearly defined by Brölemann (1914) is still in use. Thus the group is divided into the Spirobolidea and the Trigoniulidea. It is my opinion that each of these is best accorded suborder rank. Study of the Atopetholidae reveals that they exhibit many characters of the Trigoniulidea, despite their constant confusion with the Spirobolidae.

Most families of the Spirobolidea, the group to which the Spirobolidae belong, are characterized by several features of the posterior gonopods of the males. The sternum of these appendages is usually absent and the two gonopods are connected by only the thin membrane of the body wall. Each posterior gonopod is, therefore, independent of its mate on the other side. Correlated with this is the fact that the

telopodite, coxa (when present), and coxal apodeme are all arranged in a line. The proximal portion of the apodeme may be curved, but the distal end which articulates with the telopodite is always oriented in an essentially vertical plane. The importance of the apodeme's, rather than the coxa itself, forming the major articulating structure for the telopodite is basic. The gonopod is thrust straight out when it is to be used. The leverage mechanism typical of the Trigoniulidea is entirely absent. In the latter suborder, the coxa forms a right angle articulation with the telopodite, and the coxal apodeme makes a right angle articulation with the coxa, thus forming a fulcrum on which the coxa is pivoted by muscles attached to its inner end.

The family Spirobolidae, as used in the present paper, contains only six known genera. In this group the coxa of each posterior gonopod of the male is still present (the coxa has been lost or greatly reduced in most families of the Spirobolidea). The coxal apodeme is long with a spatulate inner end. The distal portion of the apodeme is fused to the inner surface of the coxa. It runs through the entire length of the coxa, curving around to the caudal side distally, and forms at its end a rounded nob on which the telopodite articulates. The telopodite is a relatively short, simple, well-sclerotized structure. The sternum of the anterior gonopods is relatively narrow and is always exceeded ventrally by the coxal endites. Anterior telepodites are always present and distinctly separated from the coxae and posterior coxal bars. There is only one pair of apodemes associated with the anterior gonopods and these are always the sternal apodemes. There is never a free sclerite (termed the "basal sclerite" by Brölemann, 1914) in the membrane between the anterior and posterior gonopods.

On the basis of this definition of the family, several genera that have commonly been associated with the Spirobolidae are excluded. *Microspirobolus* Silvestri and genera related to it have lost the coxae of the posterior gonopods and have developed very complex posterior telopodites. The sternum of the anterior gonopods is much enlarged. These genera are also very distinctive in several nonsexual characters. I, therefore, consider this tropical group a distinct family to which the name Spirobolellidae of Brölemann may be applicable.

Messicobolus Brölemann, *Oxobolus* Chamberlin, and related genera all differ from the Spirobolidae in the basic structure of the male

posterior gonopods and also in several nonsexual characters. I have examined the cyphopods of three species of *Messicobolus* and they are very different from those of all spirobolids (though knowledge of female genitalia is still exceedingly meagre, I anticipate the day when these structures will be considered as important at higher taxonomic levels as are the male gonopods). I feel, therefore, that these genera must be excluded from the Spirobolidae. Until such time as the other families of the Spirobolida are thoroughly studied and redefined, I am at a loss as to the correct family assignment for the group. It may eventually be determined that a separate new family is needed for them.

Causey (1957) has recently described a new genus, *Floridobolus,* from Florida. She assigned this genus to the Spirobolidae. Through the kindness of Dr. Causey, I have been able to examine a paratype of *Floridobolus penneri,* the type species, and have found that this remarkable genus differs in several important respects from the known Spirobolidae (and indeed, from all spiroboloid millipeds known to me). Among these differences are the absence of free anterior telopodites, the presence of a distinct, elongate basal sclerite, and an immense elongation and curvature of the coxal apodemes of the posterior gonopods. In addition, there are differences of legs, mouthparts, and other structures. It seems, therefore, that *Floridobolus* must be excluded from the Spirobolidae. Accordingly, I (1959) have recently erected the familly Floridobolidae for this genus.

As here defined, the Spirobolidae form a compact, very distinct group of millipeds. They not only share certain basic morphological features, but also show a clear unity in their geographical distribution. They are known only from the Palaearctic and Nearctic faunal regions. In areas where their ranges extend far south, as in Central America, they are found only in high mountainous regions. The southernmost record for a member of the family is that for *Hiltonius carpinus vulcan* from southwestern Quatemala. This record is for Volcan Tajumulco, a peak that rises so high that its top is a treeless Boreal life-zone.

Many facts indicate that the Spirobolidae are an ancient, primitive group. The retention of the coxae of the posterior gonopods may be viewed as a primitive character. Indeed, some members of the genus *Hiltonius* show a marked tendency towards reduction of the coxae

and provide a picture of a possible line of derivation for the other more advanced families of the Spirobolidea. These species even have a larger, more triangular anterior sternum than do the Spirobolinae, though this structure is smaller and simpler in all Spirobolidae than in most other members of the suborder. The posterior telopodites, though specialized in some ways, are certainly simpler structures than those found in related families. The absence of apodemes arising from the coxal endites is surely to be regarded as a lack of specialization. In short, practically every feature of the gonopods except the absence of a basal sclerite (a probable homologue of the posterior sternum) appears to be primitive.

Other characters in addition to the genitalic ones attest to the primitive nature of the Spirobolidae. No species of this family has stabilized the number of clypeal setae while several families, such as the Rhinocricidae and Trigoniulidae, with more complex genitalia have done so. There are never more than four antennal sensory cones. The telson never forms a hook or other special structure. The anal valves are not highly modified as they are in some families.

The discontinuous and spotty distribution of the Spirobolidae, together with the restriction to temperate regions of a family in an order that is otherwise almost exclusively tropical, also suggests that this is a relict group which has been unable to withstand the competition of the highly diverse and exceeding numerous members of more advanced families in the tropics.

On the basis of all the available evidence, I regard the Spirobolidae as the most primitive known family of the order Spirobolida. It is a relatively simple matter to derive the genitalia of all other Spirobolidea from those of a hypothetical spirobolid-like ancestor. The complex modifications of the Trigoniulidea indicate that they are a much more advanced group.

Within the Spirobolidae there are two distinct groups of genera to which I have assigned the rank of subfamily. These groups differ in many ways, the more important of which are summarized in Table 1.

Of the two subfamilies, the Spirobolinae are clearly the most primitive. This is indicated particularly by the narrower sternum, the consistently more strongly developed posterior coxae, the open seminal receptacle and canal, and the more uniformly uncinate anterior telopo-

TABLE 1

A COMPARISON OF THE SUBFAMILIES OF SPIROBOLIDAE ON THE BASIS OF SOME IMPORTANT CHARACTERS

STRUCTURE	SPIROBOLINAE	TYLOBOLINAE
prefemoral endite	present	absent
seminal receptacle and canal	widely open	usually with restricted opening
outer surface of posterior telopodite	never spinose	often spinose distally
mesal apodeme of telopodite of posterior gonopods	very short	long
sternum of anterior gonopods	narrow, with a distinct mesal process	triangular, without a mesal process
coxal endite	never papillate	usually papillate mesoventrally (cephalic surface)
anterior telopodite	broad	narrow
3rd coxae of male	never uncinate	always uncinate
3rd podomere of male pregenital legs	often longer than second podomere	often shorter than second podomere
cyphopod	with a thin lateral flange	without a lateral flange
eye patches	narrowly separated	widely separated

dites. The pre-femoral endite may be a specialized character, however.

Four genera are included in the Spirobolinae: one from Mexico, two from eastern North America, and one from China and Formosa.

TABLE 2

A COMPARISON OF THE GENERA OF SPIROBOLINAE ON THE BASIS OF SOME IMPORTANT CHARACTERS

STRUCTURE	Aztecolus	Chicobolus	Spirobolus	Narceus
ventrolateral projection of 2nd segment	absent	weak to moderate	moderate	strong
distal end of mandibular stipes	rounded or square	rounded or square	usually shallowly notched	always deeply notched
face	narrow	narrow	narrow to broad	broad
lateral corners of clypeus	only moderately distinct	indistinct	usually distinct	distinct
stipital setae of gnathochilarium	3	4-11	3	3
ventral setae of legs	few	many	few	few
pregenital coxae 3-7 of male	not modified	strongly modified (3rd least, 7th most)	not or only slightly modified	strongly modified (3rd most, 7th least)
ventral pads of legs of male	present	absent	absent	absent
prefemoral endite	moderately long	moderately long	short	long
teeth, spines, or other specializations of posterior telopodite	present	present	absent	absent

Any attempt arbitrarily to state which of these is most primitive and which most advanced is exceedingly difficult. Each combines some primitive features with some specialized ones. Clearly no one of these genera is directly ancestral to any other. Some of the most important characters of the genera are summarized in Table 2.

It is my opinion that *Aztecolus* is the most primitive. This opinion is based on the only very slightly modified ventrolateral corners of the second segment, the unmodified pregenital coxae of the male, and the usually rounded distal end of the mandibular stipes. The teeth and

spines on the posterior telopodite are regarded as specializations that are probably of relatively recent origin.

Chicobolus appears to be a derivative of an *Aztecolus*-like ancestor which did not have distal modifications of the posterior telopodite. This is indicated most strongly by the shape of the face and the poorly developed lateral corners of the clypeus. The unusually large number of ventral setae on the legs and stipital setae on the ghathochilarium may be a character retained from an ancestral stock living before reduction of the number of setae occurred. An alternative explanation, and the one favored here, is that both of these characters are more recent specializations. The highly modified pregenital coxae of the male are surely very specialized characters.

Spirobolus may possibly also be derived from a pre-*Aztecolus* stock. Some species still retain the narrow face and the unmodified pregenital coxae of the male. The second segment, like that of *Chicobolus,* is only moderately produced ventrolaterally in most instances. I am inclined to feel that the short, but often not uncomplicated, prefemoral endite is probably the result of reduction and is not a primitive trait.

The line leading to *Spirobolus* probably also gave rise to *Narceus.* Indeed, the two genera are very close. Resemblances are seen in the broad face, distinct lateral corners of the clypeus, shape of mandibular stipes, and general features of the posterior telopodite. The modifications of the male pregenital coxae (which are totally unlike those in *Chicobolus*) are regarded as more recent specializations.

The Tylobolinae probably arose from an early stock of the Spirobolinae. It is difficult to say whether this origin occurred before the development of the prefemoral endite in the Spirobolinae, or whether the endite was lost later. *Hiltonius* is probably the more primitive of the two genera in the subfamily and may even be the direct ancestor of *Tylobolus.* It is a relatively simple matter to derive the special modifications of *Tylobolus* from an unspecialized *Hiltonius* species. Some important characters of the two genera are summarized in Table 3.

From these few speculations regarding the relative primitiveness of the various genera of Spirobolidae, one indication of pattern emerges. In each subfamily, the genus deemed most primitive is

TABLE 3

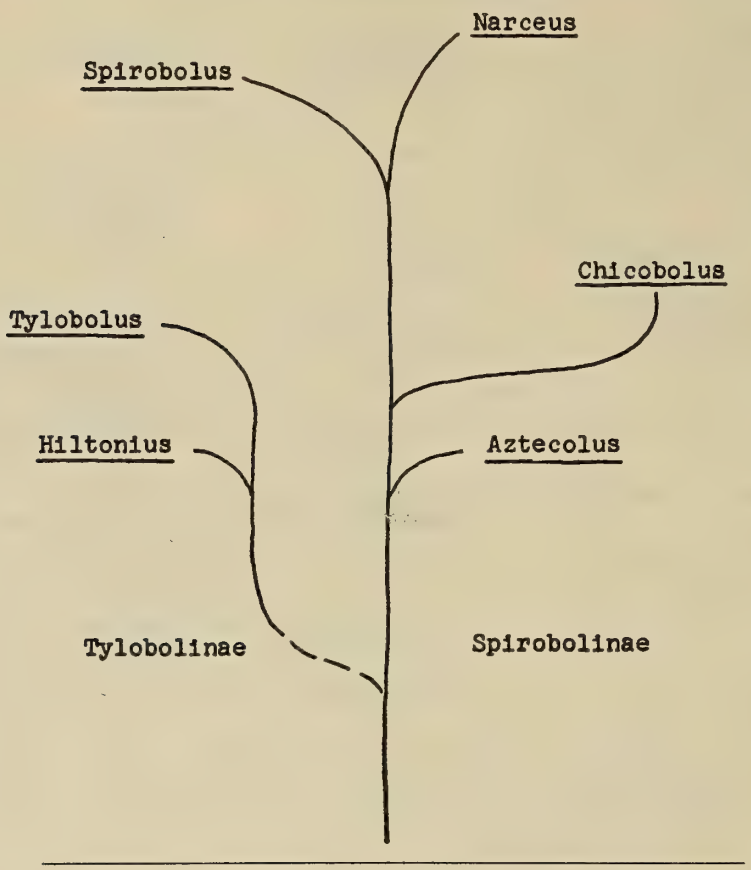
A COMPARISON OF THE GENERA OF TYLOBOLINAE ON THE BASIS OF IMPORTANT CHARACTERS

STRUCTURE	Hiltonius	Tylobolus
ventrodistal corner of mandibular stipes	rounded	sharp
eyes in each patch	fewer	more
anal lips	very weak	moderate to strong
uncinate process of male 3rd coxa	smaller	larger
caudal surface of coxal endite	without prop for posterior telopodite	with well-developed prop for posterior telopodite
coxa of posterior gonopod	often reduced	seldom reduced
posterior telopodite	without a long distal process	with a long distal process
opening of seminal receptical	larger	smaller
coxal endites	always much exceed sternum mesally	often reduced mesally
distal lobe of cyphopod	thin, not papillate	thick, papillate

found primarily in the highlands of Mexico. Thus there arises the possibility that that general area was the center of origin and dispersal for the family. Table 4 shows the hypothetical relationships of the genera. It must be emphasized that such a diagram of phylogeny is based on subjective interpretations and is not to be considered a presentation of fact.

TABLE 4

POSSIBLE RELATIONSHIPS OF THE GENERA OF THE SPIROBOLIDAE



Taxonomy

Family SPIROBOLIDAE Bollman

Spirobolinae Bollman (in part), U. S. Nat. Mus. Bull., no. 46, p. 156. 1893.

Spirobolidae Verhoeff (in part), Zool. Anz., vol. 16, p. 481. 1893.

Spirobolidae Pocock (in part), Journ. Linn. Soc. London, Zool., vol. 24, p. 484. 1893.

Spirobolidae Pocock (in part), *in* Max Weber, Zool. Ergeb. Reise Niederl. Ost.-Ind., vol. 3, p. 388. 1894.

Spirobolidae Cook (in part), Ann. New York Acad. Sci., vol. 9, p. 7. 1895.
Euspirobolidae Attems (in part), Myriopoda, *in* Sjöstedt, Wissen. Ergeb. Schwed. zool. Exped. Kilimandjaro Meru, vol. 19, p. 25. 1909.
Euspirobolidae Attems (in part), Myriopoden, *in* Voltzkow, Reise in Ostafrika, Band 3, p. 89. 1910.
Spirobolidae Brölemann, Bull. Soc. Ent. France, 1913, p. 476. 1913.
Spirobolidae Brölemann, Ann. Soc. Ent. France, vol. 83, p. 29. 1914.
Spirobolidae Attems (in part), Diplopoda, *in* Kükenthal and Krumbach, Handbuch der Zoologie, Band 1, Halfte 1, Insecta 1, pp. 194, 225. 1926.
Spirobolidae Verhoeff (in part), Diplopoda, *in* Bronn, Klassen und Ordnungen des Tierreichs, Band 5, Buch 2, Teil 2, Lief. 11, p. 1683. 1931.
Spirobolidae Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 163. 1949.
Spirobolidae Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 159. 1958.

Family Characters.—Moderately large to large. Body subcylindrical. Usually brown with lighter band on posterior portion of each segment and lighter legs and sterna; color very variable.

Face moderately convex, smooth, with very scattered minute puncta. Vertex short, usually covered by collum. Frons with large, lateral, subtriangular to subcircular eye patches, number of eyes per patch variable, most common number of rows 6. Clypeus large, broad, often with very distinct knob-like lateral corners; anterior margin with V-shaped emargination; a series of foveolae bearing setae along anterior margin, number of setae variable, most common number 4 + 4. Labrum narrow, toothed, the teeth short and blunt, number of teeth variable, most common number 3; a series of setae arising at base of labrum, number of setae variable. Antennae relatively short and stout; second segment longest; segments 3 to 6 subequal; segment 7 short, hirsute, bearing 4 apical sensory cones; when at rest, segments 1 and 2 lie horizontally in antennal groove bordered caudally by subtriangular parietal sclerite and cephalically by lateral corner of clypeus; depth of antennal groove shallow to very deep. Outer surface of mandibular stipes and cardo forming cheek on which distal segments of antenna lie when at rest; details of gnathal portion of mandible typical for order. Gnathochilarium typical for order except for stipital setae; setae stabilized at 3 + 3 in some genera, more and variable in number in other genera.

Collum usually subovoid, anterior border below level of eye patch on each side often somewhat emarginate and with a marginal ridge. Second segment often with anterior ventrolateral corner on each side produced below end of collum, this production together with pleural ventral bar forming on cephalic face a smooth, concave plate pressed against mandibular stipes.

Most body segments with very fine reticulate texture, and usually with scattered minute puncta and regulae. Tergum, pleura, and sternum of each segment fused to form ring; pleurosternal sutures very evident; tergopleural sutures ob-

scure but usually visible; tergum divided by two visible circular sutures into 3 belts, each belt in turn divided by obscure lateral and dorsal sutures into 4 areas; fore belt with fine circular striae over entire surface, mid belt and hind belt with moderately strong striae on ventrolateral areas. Repugnatorial pore on each side just anterior to segmental suture which angles foreward slightly at level of pore; each pore surrounded by small, smooth peritreme.

Telson with tergum produced caudad, its posterior end rounded, valves usually not completely covered. Anal valves moderately compressed, smooth, but with few scattered puncta; anal lips often distinct, set off by shallow depression from rest of valve areas; valves never meeting in reentrant angle. Anal scale broad, posterior end rounded or subtruncate. No legs or repugnatorial pores on telson.

One pair of legs suspended from collum and one pair supended from second segment. All other legs attached to sterna of segment rings; 1 pair each on segments 3, 4, and 5; two pairs each on segments 6 to penultimate except male seventh. Each leg with six segments and curved claw, usually with few ventral setae on some podomeres and 1 dorsal seta at base of claw.

Male anterior gonopods with relatively narrow sternum, this bearing apodemes. Coxal endites exceeding sternum ventrally; endites without apodemes. Anterior telopodites distinct, often uncinate distally. Posterior coxal bars distinct. No basal sclerite. Posterior gonopods without sternum, independent, with distinct coxae. Coxal apodemes spatulate internally, often curved mesad but usually entirely contained in seventh segment; fused to inner surfaces of coxae distally and running length of coxae to form articulating supports for telopodites. Posterior telopodites relatively short, stout, almost completely sclerotized, with simple seminal receptacle and canal, without distinct solenomerite; prefemoral portion forming stout, moderately distinct base for distal portion. Postgenital bar usually flat, sometimes slightly raised to form low ridge; emarginations variable in shape and extent.

Cyphopods moderately large, with large distal lobe; caudal and cephalic plates tightly fused laterally; no distolateral membranous pocket; basal valve musculated, moveable.

Distribution.—In temperate areas: Formosa (probably in mountains), China north of 28° north latitude, North America from southern Canada and United States south in mountains to Mexico and extreme southwestern Guatemala.

The Spirobolidae occur with several other families of the Spirobolida in Mexico. In the United States, however, this is the principle family of the order and, indeed, in most areas of this country it is the only such family. In order to facilitate identification of the spirobolids, I am presenting a key to the families of Spirobolida in the United States.

It must be stressed that the key will work only in North America north of Mexico. The characters used are mostly superficial ones of little phylogenetic importance. They are used in order to avoid the more complicated characters of the genitalia.

Key to the Families of Spirobolida in the United States

1. Clypeal setae almost always 2 + 2 ..... Rhinocricidae
   Clypeal setae at least 3 + 3 2
2. Second segment projecting well below lateral ends of collum 3
   Second segment not projecting below lateral ends of collum .. Atopetholidae
3. Apex of mentum of gnathochilarium swollen to form a large raised convexity between the lingual lamellae ..... Floridobolidae
   Apex of mentum not swollen, the surface of the apex resembling that of the rest of the sclerite ..... Spirobolidae

Of the groups mentioned in the key, both the Rhinocricidae and the Atopetholidae are found in the United States primarily in the southwest. The Floridobolidae are known only from Highlands County, Florida.

Classification.—I recognize two subfamilies of the Spirobolidae. These have already been compared on the basis of some of their most important characters in Table 1 above. The following key may be used to separate the subfamilies.

Key to the Subfamilies of the Spirobolidae

1. Eye patches separated by less than twice the width of a patch (figure 1); coxae of third legs of male either not produced or produced straight ventrad, never uncinate (figure 16); each posterior gonopod with a prefemoral endite; sternum of anterior gonopods with a mesal process (figure 23); cyphopod almost always with a lateral flange ... Spirobolinae
   Eye patches separated by much more than twice the width of a patch (figure 6); coxae of third legs of male always each with a conspicuous anteriorly directed process (figure 18); posterior gonopods without prefemoral endites; sternum of anterior gonopods broad, triangular, without a mesal process (figure 189); cyphopod never with a lateral flange ..... Tylobolinae

Subfamily SPIROBOLINAE, new usage

The characteristics of this subfamily have been summarized in Table 1 and in the key to subfamilies. A somewhat more complete description is given here.

Length of adults 31–130 mm.; width 3.3–12.8 mm.; L/W 7.2–15.0. Segments 45–61.

Shape of face variable. Antennal groove shallow to very deep. Eyes per patch usually numerous, 30–61; patches usually rather acute mesally and separated by a distance equal to less than twice the width of a patch; patches wider than long. Both clypeal and labral setae very variable in number. Mandibular stripes either rounded or notched distally. Stipital setae of gnathochilarium fixed at 3 + 3 in three genera, variable in number in one genus.

Collum almost always broadly rounded laterally; emargination very slight to moderate. Anterior ventrolateral corners of second segment scarcely produced to strongly produced.

Production of tergite of telson very great to moderate. Anal valves compressed, always with distinct lips; anal lips sometimes extremely pronounced.

First and second legs with podomeres somewhat enlarged. Legs 3 to 7 in male often with coxae strongly produced, sometimes not at all produced; coxae of third legs directed straight ventrad when produced, the production never uncinate. Segments of telopodites of male legs 3–7 never strongly swollen; length of segment 3 equal to or greater than that of segment 2. Claws of these and of all other legs in both sexes always shorter than 6th podomere.

Anterior male gonopods with narrow sternum; sternum always bearing a ventrally directed mesal process which may be broadly rounded, truncate, or narrow and acute. Coxal endites prominent, their surface smooth and never papillate; ventral margins of endites often sinuate. Anterior telopodites always broad and always uncinate distally. Posterior coxal bar usually exceeding telopodite mesally. Male posterior gonopods each with distinct, never degenerate coxa. Posterior telopodite always bearing prefemoral endite which may be rounded, oval, or elongate. Prefemoral portion of telopodite heavily sclerotized and enlarged mesally but without long mesal apodeme. Distal portion of telopodite always convex laterally and concave mesally, and always curving mesad; the end never acute; distinct open seminal receptacle and open seminal canal visible on concave mesal surface, these bordered by thin sclerotized ridge which is often darkly pigmented; outer convex surface never papillate. Postgenital bar usually relatively broad, flat, never raised to form a ridge; emarginations very slight to exceedingly pronounced.

Each cyphopod almost always with distinct, thin, sclerotized lateral flange, this rarely almost obsolete; flange toothed or not. Distal portion never papillate.

Distribution.—The eastern half of the United States and extreme southeastern Canada; Mexico; China and Formosa.

Classification.—I recognize four genera in the Spirobolinae. The following key may be used to separate them.

Key to the Genera of the Spirobolinae

1. More than three setae on each stipes of the gnathochilarium; second segment of antenna usually greatly exceeding lateral edge of clypeus (figure 2); leg podomeres with many ventral setae; mandibular stipes rounded or square (figure 103); male 7th coxae enormously produced (figures 19, 62) ..... *Chicobolus*

   Only three setae on each stipes of the gnathochilarium; second segment of antenna exceeding lateral edge of clypeus or not; legs with at most 1 ventral seta on each of the first two podomeres and 2 or 3 on each of the 3rd to 5th; mandibular stipes rounded, square or strongly notched; male 7th coxae at most only slightly produced 2

2. Face narrow, the clypeus much exceeded laterally by the second antennal segment (figure 3); antennal groove very shallow; lateral corners of clypeus not very distinct; mandibular stipes rounded or square (figure 104); second segment not produced at its anterior ventrolateral corners (figure 96); male posterior gonopod with a spined distal prong; female cyphopod with distal portion very thin and with the lateral flange toothed ..... *Aztecolus*

   Face usually broad, the clypeus not or usually only slightly exceeded laterally by the second antennal segment; antennal groove moderately deep to very deep; lateral corners of clypeus usually distinct; mandibular stipes usually notched at least slightly, rarely square; second segment produced at its anterior ventrolateral corners; male posterior gonopod without a spined distal prong; female cyphopod usually moderately thick or very thick distally, rarely thin, the lateral flange toothed or not 3

3. Prefemoral endite of male posterior gonopod short, often twisted or oval or round, much less than half as long as the telopodite; female cyphopod with two or more teeth on the lateral flange ..... *Spirobolus*

   Prefemoral endite much more than half as long as the telopodite, never twisted or oval or round; female cyphopod usually with no teeth on the lateral flange, at most with 1 ..... *Narceus*

Genus **Aztecolus** Chamberlin

Aztecolus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 3, p. 28. 1943.

TYPE SPECIES: *Spirobolus nigrior* Chamberlin, by original designation and monotypy.

Diagnosis.—This genus is easily recognized by the lack of projecting ventrolateral corners of the second segment, by the details of the face and antennal groove, by the presence of ventral pads on some podomeres in the male and the absence of coxal productions, and by

the details of the male and female genitalia. Of the latter characters, the spiny distal prong of the male posterior gonopod is distinctive, as is the combination of a very thin distal lobe with several distinct lateral flange teeth in the female cyphopod. The genus is compared with the other genera of the Spirobolinae in Table 2 above.

Description.—L 31–68 mm.; W 3.3–6.6 mm.; L/W 8.3–12.6. Segments 47–59. Color usually very dark brown or purplish black, sometimes with red or orange bars on sides.

Face narrow, the clypeus exceeded laterally by second segment of antenna. Anterior emargination of clypeus shallow but broad, labrum thus projecting forward beyond ventral corners of clypeus. Lateral corners of clypeus only slightly distinct, the antennal groove very shallow; parietal sclerite almost flat, tapering gradually cauded. Mandibular cheek not grooved for reception of antenna; stipes rounded or square distally. Eye patches large, extending far mesad, much broader than long; 43–60 eyes per patch. Clypeal setae 6–9; labral setae 12–23. Gnathochilarium with stipital setae fixed at 3 + 3.

Collum with relatively short, rounded paranota; anterior emarginations slight. Second segment not produced at its anterior ventrolateral corner, but bending rather abruptly mesad just below lateral end of collum; cephalic plate without a notch on its mesal margin.

Tergites with very few puncta on hind belts, a few more on mid belts. Strong striae on pleura but only on lower third of portion of hind belts between pleura and repugnatorial pores; striae on sides of mid belts different from those in other genera of the family, being shorter, more arched, and more often running into one another, these striae almost never running parallel as they do in other genera. Tergites each often showing evidence of a secondary segmental "suture" just anterior to the primary one which is sometimes almost obsolete on dorsum; this secondary "suture" actually only an impressed line running across dorsum from one repugnatorial pore to the other.

Tergum of telson much larger than that in any other genus of Spirobolidae, almost completely covering tops of anal valves. Anal valves much compressed; lips very large and prominent, set off by depressions from rest of valve surfaces.

Pregenital legs of male without coxal modifications, no segments swollen or produced, claws usually less than one third as long as last podomere. Fourth and fifth segments of both pregenital and postgenital legs of male with ventral pads, that of fifth segment covering most of ventral area of podomere, that of fourth segment covering only distal half of ventral area. Ventral setae few (e.g. about 1-1-1-0-0-2 in male and 1-1-2-2-1-2 in female). Legs long, much exceeding sides of body when held horizontally; all podomeres slender, the last particularly slender; 3rd segment slightly longer than 2nd in both pregenital and postgenital legs.

Sternum of male anterior gonopods with ventral area broader and more arched than band-like dorsal area; mesal process narrow, often acute distally. Coxal endites much exceeding mesal process ventrally, their mesoventral corners broadly rounded, their ventral margins not sinuate. Anterior telopodites broad at bases, uncinate distally. Posterior gonopod with relatively short coxal apodeme which is spatulate at its inner end; elongate prefemoral endite about one third as long as telopodite excluding distal prong; distal prong with small spines on ridge along its caudal surface; cephalic surface of telopodite with a thinner distal area or *distal plate* which may be toothed or not. Postgenital bar relatively broad and unmodified, the emarginations not unusually deep.

Cyphopods with distal lobe very thin; lateral flange with two or more teeth.

Distribution.—Known only from the states of Nuevo Leon, Tamaulipas, and Zacatecas in Mexico.

Classification.—I recognize two species in the genus *Aztecolus.* Three other species have been described in the genus; I have seen the types of all three. Of these, two, *A. vulcan* Chamberlin and *A. fratrellus* Chamberlin, are here moved to the genus *Hiltonius* in the Tylobolinae. *A. collaris* Chamberlin is not a spirobolid and apparently belongs in *Messicobolus* or a related genus. The species of *Aztecolus* may be separated by the following key.

Key to the Species of Aztecolus

1. Distal plate of male posterior gonopod without teeth; distal prong less acute (figure 107). Distal corner of lateral flange of female cyphopod not produced to form a large tooth, the largest tooth much proximal to the distal corner (figures 119, 120) ..... *nigrior*

   Distal plate of male posterior gonopod toothed; distal prong more acute (figure 113). Distal corner of lateral flange of female cyphopod produced to form a large tooth, which is much larger than the more proximal teeth (figure 117) ..... *pablillo*

Aztecolus nigrior Chamberlin Figures 3, 105–109, 119–121

Spirobolus nigrior Chamberlin, Ent. News, vol. 52, p. 253. 1941.

Aztecolus nigrior Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 3, p. 28, figs. 28, 29. 1943.

? *Aztecolus nigrior* Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 47. 1947.

Diagnosis.—The important differences between this species and *pablillo,* the only other species in the genus, are almost exclusively genitalic ones, despite the mentions of size, color, and other such char-

acters in the literature. The short distal prong and untoothed distal plate of the male posterior gonopod, and the absence of a large tooth at the distal corner of the lateral flange of the female cyphopod are distinctive for this species.

Description.—Inasmuch as the two species of *Aztecolus* differ so slightly, there is no need to give repetitious detailed descriptions for each. I have therefore made the description of the genus as detailed and complete as possible. I will mention here (and under the corresponding heading for *pablillo*) only those characters wherein the two species do, or might, differ.

L of males 46–58 mm. (52.0), of females 55–68 mm. (61.5); W of males 3.7–6.2 mm. (5.30), of females 5.0–6.6 mm. (5.80); L/W of males 9.4–12.4 (10.9), of females 8.3–13.6 (10.9). Segments 53–59 (56.3). Chamberlin's description indicated that the color was dark black; however, all specimens that I have seen have been medium to dark brown. This may be because of fading in alcohol although most specimens of *pablillo* that I have seen have retained their very dark color even after extended time in preservative.

Eyes per patch 48–60 (53.5). Clypeal setae 6–9 (7.5); labral setae 14–18 (16.5).

Male posterior gonopod with distinct distal plate but this with margin smooth, not toothed. Distal prong relatively short and often not spined on distal fourth; a ridge running along caudal side of basal portion of prong, this ridge bearing small spines, the most distal spine often enlarged and a third as long as distal portion of prong itself, the other spines usually much smaller.

Cyphopod with very thin distal lobe; distal corner of lateral flange forming prominent shoulder but not a tooth, one or more very small teeth on margin of distal half of flange, a large acute tooth just proximal of midpoint, a moderately large basal tooth which is often slightly serrate on its distal edge.

Remarks.—Unfortunately I have seen only five specimens of this species. The description given above is based entirely on these specimens so it is expected that the values given for measurements and counts will have to be changed somewhat when more specimens become available for study. I have not used any of the published measurements or counts inasmuch as in many cases I am unable to verify the identifications, particularly those of females. An example of this is the record published by Chamberlin in 1947 and cited with a question mark in the synonymy above. This is a record for a female from Pablillo in Nuevo Leon and is published on the same page with the original description of *Aztecolus pablillo* which was collected at the same locality. At no time has Chamberlin mentioned the female genitalia although

these provide the only fully reliable characters for identification of females. It is, therefore, impossible for me to be sure that Chamberlin's record is actually based on a specimen of *nigrior* and not on an individual of *pablillo* that happened to differ superficially from the other females collected at the same time.

This same difficulty in accepting published identifications of females makes the assignment of the name *nigrior* to the species here described under that name somewhat uncertain. Chamberlin's original description (1941b) of the species was based on a single female which was designated the holotype. Two years later, Chamberlin (1943) described a series of males which he identified as *nigrior*. I have seen two of these males but have not been able to examine the female holotype.

The few specimens available make it impossible to give much information on the variation within the species. The problem is further complicated by the fact that the two specimens (a male and a female) from Zacatecas differ somewhat from the three specimens from Nuevo Leon (one of these three specimens is in very bad condition, the head being missing). The Zacatecas specimens may in time prove to be a distinct subspecies or species. They are retained in *nigrior* until such time as more collecting reveals the true situation. The specimens from the two Mexican states are here compared on the basis of some important characters.

The distal prong of the posterior gonopod of the Zacatecas male lacks the enlarged last spine typical of the males from Nuevo Leon (compare figures 109 and 110). It is possible that this is a subadult male in which the gonopod is not yet fully developed. Segment counts are slightly different (the broken male from Nuevo Leon could not be used for counts and measurements), being 53 and 55 from Nuevo Leon, and 58 and 59 from Zacatecas. Counts for setae and eyes are very close, being as follows: clypeal setae, 8 and 9 from N.L., and 6 and 7 from Zac.; labral setae, 14 and 17 from N.L., and 17 and 18 from Zac.; eyes 51 + 52 and 57 + 60 from N.L., and 48 + 49 and 55 + 56 from Zac. Lengths are in the same range being 55 mm. for the female and 58 mm. for the male from Nuevo Leon, and 68 mm. for the female and 46 mm. for the male from Zacatecas. Widths are

slightly less in the Zacatecas specimens being 5.0 mm. for the female and 3.7 mm. for the male, as opposed to 6.6 mm. for the female and 6.0 mm. and 6.2 mm. for the males from Nuevo Leon. L/W values are much higher in the Zacatecas specimens being 13.6 for the female and 12.4 for the male as opposed to 8.3 and 9.4 for the corresponding sexes from Nuevo Leon.

If the segment counts for all of the above mentioned specimens are considered together, the mean value is 56.3. When this is compared with the mean of 48.5 for the eleven specimens of *A. pablillo* examined, a t-value which is statistically highly significant is obtained. I do not consider that this proves that segment count is a valid character for separation of the two species, however, inasmuch as most of the *pablillo* specimens are from the same locality and thus give no indication of the extent of geographical variation in the species.

Type.—Female (RVC). Locality: Mexico, Nuevo Leon, Villa Santiago (Hacienda Vista Hermosa—Horsetail Falls), "on arid plateau at elevation of 2,500 ft." Twelve other female specimens (paratypes?) reported in the original description; these from Ojo de Agua, Sabinas Hidalgo, elevation 1,500 ft.

Specimens Examined.—5 (3 male, 2 female).

Mexico.—Nuevo Leon: Linares, Cañon de las Anahuas, July 19, 1942 (1 male, 1 female, labelled respectively "paratype" and "allotype" of a name that has never been published), F. Bonet and D. Pelaez (RVC); Linares, June 12, 1942 (1 male) (RVC). Zacatecas: 13 miles west of Milpillas, 8,400 feet, July 10, 1954 (1 male, 1 female), R. H. Brewer (CAS).

Aztecolus pablillo Chamberlin Figures 96, 110–118

Aztecolus pablillo Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 47, figs. 48, 49. 1947.

Diagnosis.—The long distal prong and large teeth on the distal plate of the male posterior gonopod are distinctive for this species, as is production of the distal corner of the lateral flange of the female cyphopod to form a tooth which is much larger than the small, more proximal teeth.

Description.—L of males 34–50 mm. (40.3), of females 31–56 mm. (44.0); W of males 3.3–4.3 mm. (3.70), of females 3.7–5.1 mm. (4.10); L/W of males 8.6–11.5 (10.35), of females 10.7–12.4 (11.28). Segments 47–51 (48.5). A note

in vial with specimens from Gomez Farias states, "Dark blue-black with red or orange bars on each segment." Most preserved specimens are very dark purplish black with no trace of red or orange; a few specimens are dark brown.

Eyes per patch 43–58 (50.7). Clypeal setae 6–9 (7.0); labral setae 12–23 (16.3).

Male posterior gonopod with large distal plate the margin of which is cut into several prominent, acute teeth. Distal prong relatively long and spined along a ridge on its caudal side, the spines larger than in *nigrior*.

Cyphopod with thin distal lobe; distal corner of lateral flange forming large, prominent tooth which is much larger than the several other small teeth located on more proximal portions of flange.

Remarks.—Most of the specimens examined were from the same locality. For this reason it is impossible to give any indication of the geographical variation of the species. I therefore feel it unsafe to use any of the meristic characters to separate this species from *nigrior*.

A note in the vial with the Gomez Farias specimens provides an interesting observation on the habits of this species. The note states, "Found only in bromeliads 5′–12′ above the ground."

Type.—Male (ANSP). Locality: Mexico, Nuevo Leon, Pablillo. I have examined the type.

Specimens Examined.—11 (6 males, 5 females).

MEXICO.—NUEVO LEON: Pablillo, June 27, 1934 (1 male, the holotype), Dr. H. A. Pilsbry (ANSP). TAMAULIPAS: 5 miles west of Gomez Farias in Sierra Madre Oriental, 4000′ (5 males, 5 females), Paul S. Martin (RLH).

Genus **Chicobolus** Chamberlin

Chicobolus Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 46. 1947.
Incobolus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 11, no. 5, p. 7. 1955.
New synonymy.
Chicobolus, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 75. 1955.
Chicobolus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 162. 1958.

TYPE SPECIES: *Chicobolus pilsbryi* Chamberlin, by original designation and monotypy. Type species of *Incobolus: Incobolus thaumastus* Chamberlin, by original designation and monotypy.

Diagnosis.—This genus is very distinctive in being the only genus of the Spirobolinae in which the stipital setae are not fixed at 3 + 3 but are always more and variable in number. It is also distinctive in the large number of ventral setae on the legs, the narrow face (figure

2), the shallow antennal groove (figure 12), the rounded mandibular stipes (figure 12), the unusual development of the male pregenital coxae of which the seventh are enormously swollen and produced (figure 19), and the tooth on the cephalic side of the male posterior gonopod (figure 123).

Inasmuch as the genus contains only one species, this diagnosis will be the only description given for the genus itself. The description of *Chicobolus spinigerus* may be regarded as applying both to that species and to the genus. Likewise, the distribution of the genus is that of *spinigerus*.

Chicobolus spinigerus (Wood) Figures 2, 12, 19, 57–63, 78–81, 94–95, 122–126

Spirobolus spinigerus Wood, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 15. 1864.

Spirobolus spinigerus Wood, Trans. Amer. Philos. Soc., vol. 13, p. 211, figs. 36 [not 38], 39. 1865.

Spirobolus spinigerus, Bollman, Ann. New York Acad. Sci., vol. 4, p. 32. 1887.

Spirobolus uncigerus, McNeill, Proc. U. S. Nat. Mus., vol. 10, p. 325. 1887.

Spirobolus spinigerus, Bollman, Proc. U. S. Nat. Mus., vol. 11, p. 343. 1888.

Julus marginatus Bollman, U. S. Nat. Mus. Bull., no. 46, p. 145. 1893.

Spirobolus spinigerus, Bollman, ibid., p. 146.

Spirobolus bahamensis, Bollman, ibid., pp. 190, 192. **New synonymy.**

Spirobolus paludis Chamberlin, Ann. Ent. Soc. Amer., vol. 11, p. 374. 1918.

Spirobolus bahamensis, Loomis, Smiths. Misc. Coll., vol. 89, no. 14, p. 68. 1934.

[*Arctobolus*] *bahamensis,* Loomis, ibid.

Arctobolus spinigerus, Loomis, Bull. Mus. Comp. Zool., vol. 92, p. 398. 1943.

Spirobolus paludis, Loomis, ibid., p. 398.

Spirobolus spinigerus, Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 46. 1947.

Chicobolus pilsbryi Chamberlin, ibid., p. 46, figs. 46–47. **New synonymy.**

Spirobolus spinigerus, Chamberlin, Great Basin Nat., vol. 11, p. 30. 1951.

Narceus spinigerus, Chamberlin, Amer. Midl. Nat., vol. 50, p. 151. 1953.

Julus marginatus, Chamberlin, ibid., p. 151.

Spirobolus paludis Chamberlin, ibid., p. 151.

Incobolus thaumastus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 11, no. 5, p. 9, figs. 1–4. 1955. **New synonymy.**

Chicobolus pilsbryi, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 76. 1955.

Chicobolus spinigerus, Causey, ibid., p. 76, fig. 1 b.

Spirobolus palustris [sic] Causey, ibid., p. 76.

Chicobolus jucundus Causey, ibid., p. 77. **New synonymy.**

Chicobolus jucundus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 163. 1958.

Chicobolus pilsbryi, Chamberlin and Hoffman, ibid.
Chicobolus spinigerus, Chamberlin and Hoffman, ibid.

Nomenclatorial Considerations.—Chamberlin (1947) originally erected the genus *Chicobolus* to contain only *pilsbryi,* a species which he described as new at the same time. On the same page, he continued to associate *spinigerus* with *Spirobolus* (a practice which he still followed in 1951). Causey (1955a) was the first to suggest that *pilsbryi* and *spinigerus* are congeneric. I have examined the female holotype of *pilsbryi* and find that her conclusion is a sound one, and indeed, that the two are conspecific.

I have examined the holotype of *Spirobolus paludis* Chamberlin and agree with the conclusion of Loomis (1943), followed by Chamberlin (1953) and Causey (1955a) (Causey's spelling of the name as "*palustris*" is obviously a *lapsus calami*), that it is conspecific with *spinigerus.* Examination of the type of *Chicobolus juncundus* Causey has convinced me that this, too, is a synonym of *spinigerus;* my reasons for this conclusion are given in the remarks section below.

The species described by Bollman as *Spirobolus bahamensis* from San Salvador, Bahamas has never been reported since its original description. The type cannot be located in the collections of the U. S. National Museum. Careful comparison of Bollman's description with specimens of *Chicobolus spinigerus* reveals close agreement. I am convinced that *bahamensis* is a synonym of *spinigerus,* and feel that it is highly probable that the location data are erroneous inasmuch as, except for this one reference, no members of the Spirobolidae are known from the Bahamas.

In 1955, Chamberlin erected the new genus *Incobolus* based on a new species *Incobolus thaumastus.* Chamberlin reported the type specimens as being from Peru. The only data on the label with the specimens, however, are the single word "Peru" and "lot No. A3973" of the American Museum of Natural History. The four drawings of *thaumastus* given with the original description indicate that this species and *spinigerus* are conspecific and hence that *Incobolus* is a junior synonym of *Chicobolus.* This immediately casts doubt on the conclusion that the type material of *thaumastus* is from the country of Peru, a region where the Spirobolidae are not known to occur. I have en-

quired at the American Museum about lot No. A3973 and have been informed in a personal communication from Willis J. Gertsch of that institution that the museum has no further data regarding this collection and that the material is old. Consultation of old atlases has revealed that there were (and may still be) two towns named Peru within the possible range of *spinigerus;* one in Hillsborough County, Florida, and the other in Early County, Georgia. It is, therefore, my opinion that the types of *thaumastus* were collected near one of these towns, the Florida location being the more probable.

Description.—The diagnosis is the same as that given for the genus. A more complete description is given here.

L of normal adult males 39–85 mm. (59.4), of females 43–91 mm. (64.5), occasional unusual specimens as low as 34 mm. and 36 mm. for the respective sexes (see discussion of Florida collection No. 92 below); W of normal males 4.4–9.5 mm. (6.74), of females 5.2–10.3 mm. (7.54), specimens of coll. No. 92 as low as 3.8 mm. for males and 4.3 mm. for females; L/W of males 7.3–11.5 (8.9), of females 7.2–11.1 (8.6). Segments 46–51 (49.0). Dorsum dark brown, sides often with posterior bands of light brown, yellow, or orange, these vertical bands often very narrow at their dorsal apex and becoming gradually wider ventrally until they cover all of hind belt and often part of mid belt of tergite and the entire sternum; bands sometimes of approximately same width throughout their length, and sometimes entirely absent. Many specimens fade so much in alcohol that all trace of light bands disappears and specimens appear solid brown or gray; yellow bands often turn greenish in alcohol.

Face narrow, clypeus usually much exceeded laterally by second segment of antenna. Lateral corners of clypeus indistinct, the antennal groove very shallow; parietal sclerite almost flat, tapering gradually caudad. Mandibular cheek not grooved; stipes round or square distally. Eye patches broader than long; 35–57 (45.3) eyes per patch. Clypeal setae 8–13 (10.1); labral setae 15–30 (20.9). Stipital setae of gnathochilarium variable, 4–11 (7.5) per stipes.

Paranota of collum rounded at their ends but more narrowly rounded than *Narceus;* anterior emarginations very slight but margining ridges usually prominent. Second segment exceeding ends of collum laterally but with anterior ventrolateral corner only slightly produced (more so than in *Aztecolus* but less so than in *Narceus*) bending abruptly mesad at its ventrolateral extremity; cephalic plate without deep notch on its mesal margin.

Tergites with few scattered puncta; rugulae not prominent; moderately strong striae on lower portions of hind and mid belts, curving dorsad on the latter, strong striae disappearing dorsally on hind belt below midpoint between pleural suture and repugnatorial pore. No secondary segmental suture.

Tergum of telson only moderately produced caudad, thus much of anal valves

exposed to dorsal view. Valves much compressed, the lips usually very prominent and set off by margining depressions.

Coxae of male 3rd legs less produced than those of 4th to 7th, distally truncate and bearing a variable number of long setae (e.g. 5). Coxae of 4th legs produced into thin, distally acute, compressed processes, these not strongly sclerotized and often partially collapsed, their length extremely variable. Coxae of 5th legs with long flattened, distally rounded processes, these usually with their distal portions bent cauded to cover ends of processes of 6th legs. Processes of coxae of 6th legs shorter than those of 5th or 7th legs, heavy, thick, subrectangular, their rectangular shaped distal ends either flattened or slightly concave. Coxae of male 7th legs with huge, inflated, balloon-like processes, these usually slightly concave on their cephalic surfaces. Second segments of male legs 3 to 7 generally slightly compressed and equal to or slightly shorter than 3rd segments; segments 4 and 5 subequal and shorter than segment 6 which bears claw about half as long as itself. Postgenital legs (and pregenital ones of female) with many large ventral setae somewhat variable in number (e.g. 1-3-4-4-4-4). No ventral pads.

Mesal process of sternum of male anterior gonopods variable in width but generally narrow and longer than wide, usually acute distally. Coxal endites broad, almost meeting mesally, their ventral margins usually somewhat sinuate, the extent of sinuation very variable. Anterior telopodites broad basally, always strongly uncinate distally, exceeded mesally by posterior coxal bars. Telopodite of posterior gonopod with acute tooth at about midpoint of cephalomesal margin; distal end of telopodite truncate, often with small unsclerotized cushion-like structure; prefemoral endite narrow and thin (smaller than that in *Aztecolus* or *Narceus*), less than half as long as telopodite. Seminal receptacle partially covered by flange from posterior wall of telopodite; seminal canal fully exposed. Postgenital bar narrow, the pleurae narrowing abruptly to form the bar (unlike other genera of Spirobolinae); postseral emargination often very deep and almost rectangular; genital emargination deeper at ends than in middle, thus forming pockets in which uncinate processes of anterior gonopods lie when at rest.

Distal lobe of cyphopod thin; distal corner of lateral flange forming prominent shoulder; one or two teeth on margin of flange, these variable in size.

Remarks.—Enough specimens of *Chicobolus spinigerus* were available for study so that it is possible to give a good indication of the variability of the important meristic characters. Table 5 shows the segment counts obtained; Table 6 shows counts of clypeal setae; Table 7 shows labral setae counts; Table 8 shows stipital setae counts. Counts of eyes per patch are show in Table 9. Lengths are shown in Table 10, widths in Table 11, and L/W values in Table 12. An interesting collection (Florida collection No. 92) of specimens taken in migration

TABLE 5

Segment counts for specimens of Chicobolus spinigerus.

Segments	46	47	48	49	50	51	total	mean
Specimens	5	7	18	35	26	9	100	49.0

TABLE 6

Clypeal setae counts for specimens of Chicobolus spinigerus.

Setae	8	9	10	11	12	13	total	mean
Specimens	5	15	47	20	11	1	100	10.1

TABLE 7

Labral setae counts for specimens of Chicobolus spinigerus.

Setae	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Specimens	1	3	6	10	16	14	16	9	8	6	1	3	2	3	1	1

Total specimens 100

Mean 20.9

TABLE 8

Counts of setae per stipes for specimens of Chicobolus spinigerus.

Setae	4	5	6	7	8	9	10	11	Total	mean
Specimens	1	15	33	59	44	25	20	3	200	7.5

is shown separately in the latter three tables. These are much smaller than normal in both length and width but their L/W values fall in the middle of the normal range for adults (immature specimens of spirobolids commonly have much lower L/W values than do adults) and their segment counts, eye counts, and fully-developed genitalia indicate that they are mature. This collection has already been discussed in the section on biology.

TABLE 9

Number of eyes per patch in specimens of Chicobolus spinigerus.

Eyes	Specimens	Eyes	Specimens
35.	1	48.	12
36.	2	49.	14
37.		50.	6
38.	5	51.	3
39.	7	52.	5
40.	7	53.	9
41.	12	54.	3
42.	11	55.	1
43.	24	56.	
44.	27	57.	1
45.	14	--	
46.	19	total	200
47.	17	mean	45.3

None of the variation in meristic characters seems to vary geographically but some of the more qualitative characters do. For example, specimens from the extreme western portion of the Florida panhandle show extremely deep postseral emarginations, and unusually short processes of the coxae of the male seventh legs. It was specimens from this region upon which Causey's *jucundus* was based. If specimens from throughout the panhandle are examined, however, it is found that these characters grade gradually into the more usual condition as one moves eastward. I am unable to understand Causey's statement that specimens of *spinigerus* lack the caudad bend of the processes of the male fourth and fifth coxae. The fifth coxae are bent caudad in the majority of specimens from throughout the range of the species, and only a few specimens show such bending of the fourth coxae no matter whether they are from the panhandle or from other portions of the range.

TABLE 10

Lengths of specimens of Chicobolus spinigerus. The measurements were made to the nearest millimeter but are shown here in groups of five millimeters each. The means are based on the original measurements.

Length	all specimens except coll. #92		coll. #92	
	Male	female	male	female
33-37.			8	1
38-42.	2		10	11
43-47.	3	1	3	4
48-52.	9	5	1	5
53-57.	10	7		1
58-62.	12	9		
63-67.	8	10		
68-72.	7	10		
73-77.	2	6		
78-82.	1	3		
83-87.	1			
88-92.		1		
totals	55	52	22	22
means (by sex)	59.4	64.5	39.2	43.4
means (both sexes)	61.9		41.3	

The length of the processes of the male fourth coxae is extremely variable, ranging all the way from less than a fourth the length of the processes of the fifth coxae to a subequal length; all intermediate stages occur and, indeed, are the most common lengths. Neither this variation, nor variation in the shape of the ventral margins of the coxal endites, nor variation in color appears to be correlated with distribution.

TABLE 11

Widths of specimens of Chicobolus spinigerus. The measurements were made to the nearest tenth of a millimeter but are shown here rounded off to the nearest half a millimeter. The means are based on the original measurements.

	all specimens except coll. #92		coll. #92	
Width	male	female	male	female
4.0			8	
4.5	1		9	5
5.0	3	1	5	7
5.5	7			7
6.0	9	6		3
6.5	12	3		
7.0	8	18		
7.5	11	12		
8.0	7	11		
8.5	2	4		
9.0	1	2		
9.5	1	5		
10.0				
10.5		1		
totals	62	63	22	22
means (by sex)	6.74	7.54	4.40	5.16
means (both sexes)	7.15		4.78	

Distribution.—From eastern South Carolina and Georgia south through Florida to Key West, and west throughout the Florida panhandle. (See above for a discussion of a record for the Bahamas.)

Type.—Believed to be lost. Locality: "Florida. South Carolina" (Wood, 1864), restricted by Causey (1955a) to Everglades National Park, Florida. Type of *bahamensis:* male, apparently lost, sup-

TABLE 12

L/W values for specimens of Chicobolus spinigerus. The values were calculated to the nearest tenth of a unit but are shown here rounded off to the nearest half a unit. The means are based on the original values.

L/W	all specimens except coll. #92		coll. #92	
	male	female	male	female
7.0		1		
7.5	1	6		1
8.0	6	10	1	7
8.5	14	16	9	8
9.0	19	12	6	6
9.5	5	8	4	
10.0	2		2	
10.5				
11.0	1	2		
11.5	1			
totals	49	55	22	22
means (by sex)	8.9	8.6	8.9	8.4
means (both sexes)	8.7		8.6	

posed to be in U.S.N.M. Locality: " San Salvador, Bahamas." Type of *paludis:* male (MCZ). Locality: Mixon's Hammock, Okefenokee Swamp, Georgia. Type of *pilsbryi:* female (ANSP). Locality: Boca Chica Key, Florida. Type of *thaumastus:* male (RVC). Locality: " Peru," see nomenclatorial considerations above. Type of *jucundus:* male (NBC), Causey (1955a) says, " the holotype and a female paratype will be deposited in the American Museum of Natural History." Locality: Pensacola, Escambia County, Florida.

Specimens Examined.—282 (134 males, 148 females).

Florida.—" Florida," July–Aug., 1925, and Nov., 1929 (2 males, 1 female), O. F. Cook (USNM). Alachua County: March 12, 1935 (1 female), H. K.

Morrison (MCZ); winter, 1948 (2 males, 1 female), C. J. Goin (RLH). Charlotte County: Punta Gorda, May, 1948 (1 female), Feb., 1953 (1 female), H. Ramstadt (CNHM). Citrus County: 2 miles south of Holder, under oak leaves and logs, April 19, 1936 (1 female), H. Morrison (USNM). Collier County: Collier-Seminole State Park, July 15–18, 1956 (2 females), D. J. Pirone, E. F. Menhinick (WTK); Everglades, Davie, March 24, 1914 (11 males, 9 females), O. F. Cook (USNM); Naples, Sept. 23, 1925 (14 males, 10 females), Nov. 21, 1929 (3 males, 1 female), Cook (USNM). Dade County: Chapman Field, 1927–1931 (15 males, 23 females), O. F. Cook (USNM); Cutler, March 23, 1914 (1 male), Cook (USNM); 15 miles northeast of Flamingo, Everglades National Park, March 22, 1957 (27 males, 31 females), H. E. Evans, H. Dietrich, E. G. Matthews (WTK—Florida collection No. 92); Miami, 1901 (1 male, 1 female), J. E. Benedict (USNM), Sept., 1925 (1 female), Alfred Keys (USNM); Royal Palm Hammock (1 female) (MCZ), March, 1920 (1 male) (MCZ); Royal Palm State Park, May, 1931 (2 males), O. F. Cook (USNM); South Miami, Sept. 29, 1928 (1 male, 3 females), Cook (USNM). Duval County: Jacksonville, Oct. 14, 1943 (1 male), E. S. Ross (CAS). Escambia County: Pensacola (5 females), C. H. Bollman (USNM), March, 1878 (1 male), Mrs. C. H. Willard (MCZ), Dec. 12, 1954 (1 male, 1 female, the holotype and a paratype of *jucundus*), N. E. Savelle (NBC). Franklin County: St. Vincent Sound, Apalachicola, in "Fish Hawk" on shore, April 2, 1915 (1 male, 1 female), U. S. B. Jr. (USNM). Hardee County: Zolfo Springs, Feb.–March, 1944 (2 males), Jan. 25, 1945 (1 male), Mrs. A. G. Rueckert (CNHM). Hernando County: Brooksville-Dade City, Nov. 8, 1929 (1 male, 1 female), O. F. Cook (USNM). Highlands County: Highlands Hammock State Park, July 15–18, 1956 (1 male), D. J. Pirone, E. F. Menhinick (WTK). Hillsborough County: April 14, 1949 (1 male), H. K. Wallace (RLH). Indian River County: Roseland, April 10, 1919 (1 male, 1 female), George Nelson (MCZ). Lee County: April 14, 1949 (2 males, 1 female), H. K. Wallace (RLH); Fort Myers (1 female) (USNM); Fort Myers Beach, April 8, 1937 (1 female), H. I. Scudder (CU). Leon County: Apalachicola National Forest, near Tallahassee, March 6, 1956 (13 females), J. F. Hanson (JFH). Levy County: between Romeo and Williston, March, 1957 (1 male), J. G. Franclemont, C. B. Knowlton, B. A. Foote (WTK). Manatee County: Oneco, March 22, 1955 (2 males), D. M. Anderson (RLH), March 22–28, 1957 (1 male, 1 female), J. G. Franclemont, C. B. Knowlton, B. A. Foote (WTK). Marion County: Jan. 19, 1948 (1 male), H. K. Wallace, K. Strawn (RLH); between Silver Springs and Ocala, Oct., 1929 (1 male), O. F. Cook (USNM); Wiersdale [sic; = Weirsdale], Aug., 1926 (3 males), M. D. Leonard (RVC). Monroe County: Big Pine Key, March 23, 1957 (2 males, 2 females), H. E. Evans, H. Dietrich, E. G. Matthews (WTK); Boca Chica Key, 1907 (1 female, the holotype of *pilsbryi*), H. A. Pilsbry (ANSP); Cape Sable (1 male, 2 females), Moses (USNM); Flamingo, Everglades National Park, March 22, 1957 (1 female), H. E. Evans,

H. Dietrich, E. G. Matthews (WTK); "Florida Keys," April 20, 1932 (1 male), Key Largo (4 males, 3 females), O. F. Cook (USNM); Key West (1 male, 2 females) (MCZ); Key West (6 males, 6 females), H. K. Morrison (MCZ), (4 males, 1 female), S. Henshaw (MCZ); Upper Metacumbe Key, Jan. 3, 1935 (1 female), O. F. Cook (USNM). Orange County: Orlando, Feb., 1929 (1 male), M. D. L. (CU). Palm Beach County: Canal Point, Dec., 1929 (2 males, 3 females), O. F. Cook (USNM). Pasco County: Elfers, April 5, 1934 (1 male), H. I. Scudder (CU). Polk County: Lakeland, Feb. 1, 1955 (1 female), L. D. Ober (USNM).

GEORGIA.—Mixon's Hammock, Okefenokee Swamp, June, 1912 (1 male, the holotype of *paludis*), Cornell Exped. (MCZ).

SOUTH CAROLINA.—Allandale County: Allandale, March 25, 1951 (1 male, 1 female), Leslie Hubricht (RLH). Barnwell County: A. E. C. Savannah River Plant, May 11, 1956 (1 male, 1 female), E. P. Odum (NBC). Charleston County: James Island, 1928–1929 (5 males, 5 females), O. F. Cook (USNM), Aug., 1928 (2 females), Ballard (USNM). Florence County: near Florence, Aug. 7, 1927 (1 male, 1 female), Cook (USNM). Sumter County: 2 miles southeast of Sumter, March 28, 1951 (1 male), J. C. Martin (RLH).

Genus **Spirobolus** Brandt

Spirobolus Brandt, Bull. Soc. Nat. Moscow, vol. 6, p. 202. 1833.
Iulus, Gervais (in part), Histoire Naturelle des Insectes, Aptères IV, pp. 137–138. 1847.
Spirobolus, Pocock, Journ. Linn. Soc. London, Zool., vol. 24, p. 484. 1893.
Spirobolus, Pocock, *in* Max Weber, Zool. Ergeb. Reise Niederl. Ost.-Ind., vol. 3, p. 388. 1894.
Spirobolus, Brölemann, Ann. Soc. Ent. France, vol. 72, pp. 472–476. 1903.
Prospirobolus Attems, Myriopoden, *in* Voeltzkow, Reise in Ostafrika, Band 3, pp. 90, 91. 1910.
Spirobolus, Brölemann (in part), Ann. Soc. Ent. France, vol. 83, p. 31. 1914.
Sinobolus Chamberlin and Wang, Amer. Mus. Nov., no. 1621, p. 12. 1953.
Spirobolus, Hoffman and Crabill, Florida Ent., vol. 36, p. 80. 1953.
Spirobolus, Hoffman, Proc. Biol. Soc. Washington, vol. 70, pp. 61–64, 67. 1957.
Prospirobolus, Hoffman, ibid., p. 67.
Sinobolus, Hoffman, ibid., p. 67.

TYPE SPECIES: *Spirobolus bungii* Brandt, by subsequent designation of Pocock (1893). Type species of *Prospirobolus: Spirobolus joannisi* Brölemann, by original designation and monotypy. Type species of *Sinobolus: Spirobolus joannsi* (sic) Brölemann (= *Spirobolus joannisi* Brölemann), by original designation and monotypy.

Nomenclatorial Considerations.—Brandt's description of what is

now the type genus of both the family Spirobolidae and the order Spirobolida has been mentioned again and again in the literature, but seldom has it actually been seen by present-day workers. It seems appropriate, therefore, to quote here the original description in its entirety.

GENUS SPIROBOLUS. *Nov. gen.*

Antennarum articulus secundus, tertius, quartus, quintus sicuti reliqui valde abbreviati fere subrotundi, sequales, secundus tamen reliquis paulo longior, quintus sexto fere aequalis. (Fig. 31).

This short paragraph, together with the even shorter description of *bungii,* is barely sufficient to identify the described form as a member of one of several families of the Spirobolida. Inasmuch as the description of *bungii* must necessarily be treated as an important part of the generic diagnosis, it is quoted here rather than under the section dealing with that species.

Spirobolus Bungii. Nov. spec.

Labium superius ante marginem anterioriem octo-punctatum, punctis impressis admodum distinctis.
Habitat in China boreali prope Peking.

Fortunately for the taxonomy of the Diplopoda, Peking is in the temperate northern portion of China where few members of the Spirobolida occur. Thus it appears highly probable that the species described as *bungii* by Hoffman (1957) is actually the species to which Brandt referred. In the absence of type specimens, it seems advisable to accept this as *bungii* and thereby to stabilize *Spirobolus* as the generic name for a species that is a member of the family that has traditionally been known as the Spirobolidae.

It is my opinion that *Spirobolus joannisi* is conspecific with *bungii.* I therefore support Hoffman's (1957) contention that *Prospirobolus* Attems and *Sinobolus* Chamberlin and Wang (both having *joannisi* as type) are synonyms of *Spirobolus.*

In the list of synonymy given above, I have made no attempt to include every one of the many references to the genus that appear in the literature. This will also be true of the synonymy given for *Spirobolus bungii.* These names are so old and have been mentioned so often in

the literature that a complete listing would be needlessly long and would add little of value. Only those publications are given that have made important contributions to the history of the names or to the knowledge of the species they designate.

Diagnosis.—The genitalia provide the most distinctive characters for this genus. The prefemoral endite of the male posterior gonopod is short and never subrectangular as it is in other genera of the *Spirobolinae.* The female cyphopods are much thicker than those of *Aztecolus* or *Chicobolus;* they are also usually thicker than those of *Narceus* and have more teeth on the lateral flange.

Description.—L 74–130 mm.; W 6.0–9.3 mm.; L/W 10.4–15.4. Segments 46–61. Color in life unknown, in alcohol usually dark brown with a reddish or yellowish band around each segment on hind belt.

Face narrow or broad. Anterior emargination of clypeus moderately deep. Lateral corners of clypeus usually distinct, sometimes somewhat indistinct; antennal groove not deep, most apparent at its anterior border because of distinct corners of clypeus, its posterior border not evident, the parietal sclerite being almost flat and tapering gradually caudad. Mandibular cheek not grooved; stipes either square or notched distally, the latter condition being most common. Eye patches broader than long; 30–61 eyes per patch. Clypeal setae 6–12, labral setae 12–26. Stipital setae of gnathochilarium fixed at 3 + 3.

Paranota of collum usually broadly rounded laterally, sometimes almost truncate. Anterior margin of collum often abruptly angled at level of eyes; margining ridge present but not strong. Anterior ventrolateral corners of 2nd segment produced, but not as much so as in *Narceus* (more than in *Aztecolus,* about the same as in *Chicobolus*); cephalic plate of female sometimes with a deep notch on its mesal margin.

Tergites with few scattered puncta and inconspicuous rugulae; striae on pleura and lower portion of sides; no secondary segmental suture.

Tergum of telson only moderately produced, thus much of anal valves exposed to dorsal view. Valves not strongly compressed, distinct lips present or not.

Coxae of male pregenital legs slightly produced, their ends broadly truncate; those of all pregenital legs (except, of course, 1 and 2) approximately alike. Each coxa usually bearing one large seta. Claws less than half as long as last podomere. Postgenital legs unmodified; no ventral pads; few ventral setae (e.g. 1-1-1-1-2-3).

Mesal process of sternum of anterior gonopods variable in length and width. Coxal endites broad, much exceeding mesal process ventrally, their ventral margins not as sinuate as those of *Narceus.* Anterior telopodites very broad basally; their ends always uncinate; telopodites exceeded mesally by posterior coxal bars. Posterior telopodites with very prominent prefemoral portion but prefemoral

endite less than half length of telopodite, of variable shape; telopodite truncate distally and with large distal unsclerotized pad; a low ridge running longitudinally along caudal surface of telopodite, this ridge often seen to be serrate if viewed under high power; cephalic surface of telepodite divided slightly beyond its midpoint by transverse groove; distomesal margin of cephalic surface with narrow, often pectinate flange.

Cyphopods usually broad distally; lateral flange with several prominent teeth; cephalic plate of distal lobe sometimes divided by deep longitudinal groove down its midline.

Distribution.—China north of 28° north latitude; and Formosa (probably in mountains).

Classification.—I am here recognizing five species although there is some doubt regarding the validity of one of them. Sexual characters provide the best key characters. Inasmuch as the females of two species and the male of one are unknown, a separate key is given for each sex.

Key to the Species of the Genus Spirobolus

Males

1. Prefemoral endite slightly elongate and with its mesodistal corner subacute (figures 129, 137) 2
   Prefemoral endite not elongate, usually round or oblong, with no acute corner 3
2. Collum narrowly rounded laterally; anterior margins of collum not, or only slightly, angled at level of eye patches (figure 97); face narrow, the clypeus much exceeded laterally by second segment of antenna; clypeus rather rectangular (figure 4) ..... *bungii*
   Collum broadly rounded or truncate laterally; anterior margin of collum abruptly angled at level of eye patches (figure 98); face rarely narrow, the clypeus usually not much exceeded laterally by second segment of antenna; clypeus usually more rounded anteriorly (figure 5) .. *walkeri*
3. Prefemoral endite rounded and with a notch on its mesal margin (figure 144) ..... *umbobrochus*
   Prefemoral endite more oblong, without a notch on its mesal margin (figure 140) ..... *grahami*

Females [3]

1. Collum narrowly rounded laterally; anterior margin of collum not, or only slightly angled at level of eye patches (figure 97); face narrow, the clypeus much exceeded laterally by second segment of antenna; clypeus rather rectangular (figure 4) ..... *bungii*

   Collum broadly rounded or truncate laterally; anterior margin of collum usually abruptly angled at level of eye patches; face rarely narrow, the clypeus usually not much exceeded laterally by second segment of antenna; clypeus usually more rounded anteriorly 2

2. Distal lobe of cyphopod divided down its cephalic face by a deep longitudinal groove (figure 159) ..... *grahami*

   Distal lobe of cyphopod without a longitudinal groove down its cephalic face (figures 147, 151) 3

3. Cephalic plate of second segment with a deep notch in its mesal margin (figure 163); lateral flange of cyphopod usually with several teeth of which the distal is largest (figure 150) ..... *formosae*

   Cephalic plate of second segment without a deep notch in its mesal margin (figure 161); lateral flange of cyphopod usually with several teeth of which the proximal is largest or the teeth are small and subequal (figures 145, 146) ..... *walkeri*

Spirobolus bungii Brandt Figures 4, 97, 127–131

Spirobolus bungii Brandt, Bull. Soc. Nat. Moscou, vol. 6, p. 203. 1833.

Iulus bungii, Gervais, Histoire Naturelle des Insectes, Aptères IV, p. 167. 1947.

Spirobolus exquisitus Karsch, Zeitschr. Ges. Naturw., vol. 54, p. 57. 1881. **New synonymy.**

Spirobolus bungii, Pocock, Journ. Linn. Soc. London, Zool., vol. 24, p. 484. 1893.

Spirobolus bungii, Pocock, *in* Max Weber, Zool. Ergeb. Reise Niederl. Ost.-Ind., Band 3, p. 388. 1894.

Spirobolus joannisi Brölemann, Mem. Soc. Zool. France, vol. 9, p. 359, figs. 1–8. 1896. **New synonymy.**

Spirobolus bungii, Brölemann, ibid., p. 361.

Spirobolus exquisitus, Brölemann, ibid., p. 361.

Spirobolus marginatus, Brölemann, Ann. Soc. Ent. France, vol. 72, p. 477, figs. 1–2. 1903.

Spirobolus joannisi, Attems, Myriopoden, *in* Voeltzkow, Reise in Ostafrika, Band 3, p. 91. 1910.

Prospirobolus joannisi, Attems, ibid.

Spirobolus bungii, Brölemann, Ann. Soc. Ent. France, vol. 83, p. 2. 1914.

---

[3] Although I have never seen a female of *bungii,* I am including it in the key because the male may be separated by nonsexual characters which would presumably be shared by the female.

Spirobolus joannisi Brölemann, ibid.
Spirobolus bungi [sic], Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 44. 1947.
Sinobolus joannsi [sic], Chamberlin and Wang, Amer. Mus. Nov., no. 1621, p. 12. 1953.
Spirobolus bungii, Hoffman and Crabill, Florida Ent., vol. 36, p. 81. 1953.
Spirobolus bungii, Hoffman, Proc. Biol. Soc. Washington, vol. 70, pp. 62–65, 67, figs. 3, 5. 1957.
Spirobolus joannisi Hoffman, ibid., p. 67.

Nomenclatorial Considerations.—The specimen of *bungii* that I have seen is the only representative of *Spirobolus* which I have examined that has a collum with practically no angle in its margin at the level of the eyes and with relatively narrow lateral ends. Likewise, it is the only specimen with no trace of anal lips. Brölemann's description of *joannisi* includes a drawing of the head and first four segments; these resemble almost exactly those of *bungii.* In addition, Brölemann says of *joannisi,* "des valves anales non rebordées." I therefore consider *joannisi* a synonym of *bungii.*

Karsch's description of *exquisitus* gives no good character to distinguish it from *bungii.* It is from the same type locality and is even based in part on one of Brandt's specimens.

Diagnosis.—This species differs from other members of *Spirobolus* in the characters of the collum and in having a narrower face as indicated in the key. In addition, it is the only species with no trace of distinct anal lips.

Description.—Based on a single male specimen. L 74 mm.; W 6.0 mm.; L/W 12.3. Segments 55.

Face narrow, lateral edge of clypeus much exceeded by second segment of antenna. Clypeus rather rectangular, ventral corners more abrupt than in other species; lateral corners not very distinct, antennal groove thus not well-defined anteriorly, also poorly defined posteriorly where parietal sclerite is almost flat and slopes very gradually caudad. Mandibular cheek not grooved; stipes rather square distally with only slight indication of notch. Eye patches wider than long; 54 + 57 eyes. Clypeal setae 8; labral setae 18.

Paranota of collum not long, their ends narrowly rounded; anterior margin of collum not, or only slightly, angled at level of eye patches. Second segment only slightly produced below ends of collum, the productions broad.

Anal valves moderately inflated; no distinct anal lips.

First and second legs much shorter than other legs. Coxae of legs 3–7 all

produced equally, the produced portions relatively short and truncate distally. Second segments of legs 3–7 shorter than 3rd segments; no segments of telopodites swollen or with pads; claws about half as long as last segments. Postgenital legs unmodified, with few ventral setae (e.g. 1-1-2-2-2-4).

Mesal process of sternum of anterior gonopods very short and narrow, much surpassed ventrally by coxal endites which are broad with relatively long, straight mesal margins. Ventral margins of coxal endites only very slightly sinuate, sloping laterodorsad. Posterior telopodites deeply concave mesally; prefemoral portion large, produced mesoventrad. Prefemoral endite much less than half length of telopodite; endite twisted so that it is cupped with concave surface directed ventrally, caudal side of cup high arched, becoming more attenuate distally.

Distribution.—Known only from the area around Peking, China.

Type.—Presumed lost. Locality: " prope Peking ". Type of *exquisitus:* unknown. Locality: Peking. Type of *joannisi:* unknown. Locality: " Kiang Nan ", China.

Specimen Examined.—1 male.

China.—Tsin Lung Shan, 65 miles north of Peking, A. deC. Sowerby (USNM, placed in type collection; the same specimen as that used by Hoffman, 1957, in his description of the species).

Spirobolus walkeri Pocock Figures 5, 98, 132, 136–138, 145–148, 161

Spirobolus walkeri Pocock, Ann. Nat. Hist., ser. 6, vol. 15, p. 367, figs. 14, 14b. 1895.

Spirobolus walkeri, Brölemann, Mem. Soc. Zool. France, vol. 9, p. 361. 1896.

Spirobolus walkeri, Hoffman, Proc. Biol. Soc. Washington, vol. 70, p. 67, fig. 2. 1957.

Diagnosis.—Distinguished from *bungii* by the usually broader face, less rectangular clypeus, broader lateral ends of collum, abrupt angle of collum margin at level of eye patches, and distinct anal lips. Inasmuch as few specimens of *bungii* have ever been studied and no specimens are known from the region between the type localities of *bungii* and *walkeri,* further collecting may show that these characters intergrade and that the two populations are not worthy of specific recognition. A final decision will probably have to await the apparently distant time when world politics will once again allow scientific interchange between China and other nations.

Spirobolus walkeri differs from both *umbobrochus* and *grahami* in

the shape of the prefemoral process. The female cyphopod lacks the groove which is present on the cephalic side of the distal lobe in *grahami;* I predict that the groove will be found in *umbobrochus* when females are discovered. The females of *walkeri* lack the notch which is present in the mesal margin of the cephalic plate of the second segment of *formosae.*

Description.—So few specimens have been examined that values for meristic characters are given for each specimen.

L of males 94, 100, 108, 109 mm., of females 91, 111, 112, 129 mm.; W of males 7.2, 7.0, 8.0, 8.0 mm., of females 7.6, 8.0, 8.7, 9.2 mm.; L/W of males 12.5, 13.1, 13.6, 15.4, of females 12.0, 12.0, 14.0, 14.8. Segments 54, 54, 55, 56, 58, 59, 61.

Face usually broad, lateral edges of clypeus not, or only slightly, exceeded by second segment of antenna; clypeus not rectangular, the ventral corners gradually rounded; face sometimes narrower and lateral edge of clypeus farther exceeded by second segment of antenna, but clypeus never rectangular. Lateral corners of clypeus relatively distinct, antennal groove thus well-defined anteriorly; groove not well-defined posteriorly, the parietal sclerite almost flat. Mandibular cheek only slightly grooved; stipes squared distally, with the distal margin slightly concove. Eyes per patch 42, 43, 44, 45, 46, 47, 47, 47, 48, 49, 50, 52, 54, 54, 59, 61. Clypeal setae 7, 8, 8, 8, 9, 9, 10, 12; labral setae 16, 17, 19, 22, 24, 24, 26, 27.

Paranota of collum relatively long, their ends broadly rounded or subtruncate; anterior margin of collum abruptly angled laterocauded at level of eye patches; margining ridge faint. Second segment produced below ends of collum, the production appearing as a thick, rounded knob. Cephalic plates of 2nd segment of female without deep notches in their mesal margins.

Anal valves not much compressed; anal lips distinct but not prominent.

First and second legs shorter than other legs. Coxae of male legs 3–7 with short, distally truncate productions; third segments of these legs slightly longer than second segments. Claws less than half length of last segments. Postgenital legs unmodified, with few ventral setae (e.g. 1-1-0-0-1-3).

Gonopods like those of *bungii* but mesal process of sternum longer and distally moderately broad or subacute, and prefemoral endite slightly longer with caudal side of cup slightly higher arched and distally slightly less attenuate.

Cyphopod broad distally; cephalic face of distal lobe not divided by longitudinal groove. Lateral flange narrow, its distal corner often slightly produced and tooth-like, a second tooth at about midpoint of flange, a third tooth at proximal end of flange, this often the largest; one tooth sometimes absent; second tooth sometimes slightly larger than third but then both very small.

Distribution.—China, Chusan Island and neighboring parts of the mainland around Ning Po.

Type.—Unknown (British Museum?). Locality: "Chusan Island" and "Da-laen-Saen, 30 miles S.W. of Ningpo, 500–2500 feet alt." Pocock did not actually designate either of these as the type locality, but the only males that he had were from Chusan Island.

Specimens Examined.—8 (4 males, 4 females).

China.—Ningpo (1 female), McCartee (ANSP); Hangchow, Sept., 1919 (3 males, 3 females), O. F. Cook, H. F. Loomis (USNM); Kuatum, July, 1926 (1 male), Dr. C. R. Kellogg, C. N. Pope (USNM). The last specimen has an unusually narrow face; I have unfortunately been unable to locate Kuatum to determine if it is in the area between the known ranges of *walkeri* and *bungii*.

Spirobolus umbobrochus, new species Figures 100, 134, 142–144, 165

Diagnosis.—Distinguished from all other species of the genus by the rounded (in caudal view) prefemoral endite which has a notch in its mesal margin. Differs from *bungii* and *walkeri* in having a longer, less concave posterior telopodite with a larger unsclerotized distal pad. Distinguished superficially from *formosae* by the details of the lateral corners of the second segment.

Description.—Described from three male specimens, one of which is in very poor condition.

L 80, 92 mm.; W 7.1, 8.1 mm.; L/W 11.3, 11.4.

Face broad in two specimens, the lateral edges of clypeus only slightly exceeded by second segment of antenna; face narrow in one specimen, the lateral edges of clypeus much surpassed by second segment of antenna. Lateral corners of clypeus relatively distinct, antennal groove thus well-defined anteriorly; groove not well defined posteriorly, the parietal sclerite almost flat. Mandibular cheek only very slightly grooved; distal margin of stipes always concave, the concavity somewhat V-shaped but not deep. Eyes per patch 30, 32, 34, 37, 37, 37. Clypeal setae 7, 8, 8; labral setae 12, 13, 13.

Paranota of collum relatively long, their ends broadly rounded (right paranotum of one specimen abortive); anterior margin of collum abruptly angled at level of eye patches; margining ridge faint. Second segment only slightly surpassing ends of collum, its production not knob-like but, rather, forming a thick, rounded carina running along anterior two-thirds of ventrolateral margin.

Anal valves only moderately compressed; anal lips distinct but only moderately prominent.

First and second legs shorter than other legs. Coxae of male legs 3–7 with short rounded or subtruncate processes, each bearing a large seta. Third seg-

ments of legs 3–7 slightly longer than second segments; claws less than one-half (sometimes less than one-fourth) as long as last podomeres. Postgenital legs unmodified, with few ventral setae (e.g. 1 or 0, 1, 0, 0, 0, 1).

Mesal process of sternum of anterior gonopods longer than broad. Mesoventral corners of coxal endites more rounded than in *bungii* or *walkeri*. Posterior telopodite relatively long and not as concave as in *bungii* or *walkeri*, with a large unsclerotized distal pad. Prefemoral portion of telopodite large but without the distinct mesal shoulder seen in *bungii* and *walkeri*. Prefemoral endite appearing subcircular in caudal view, with a shallow notch in its mesal margin.

Remarks.—This and the following species are the first spirobolids known from interior China. Unfortunately, it will probably be many years before more specimens will be forthcoming from that area. This doubtless means that the characters of the females of *umbobrochus* will remain unknown for a long time. Judging by the close similarities between *umbobrochus* and *grahami*, I would expect the female cyphopods of these species to be much alike. Those of the present species will probably be found to have the groove down the cephalic face of the distal lobe. It is, of course, possible that I have confused females of *umbobrochus* with those of *grahami* and that some of the specimens listed under the latter species actually belong to the former. I have, however, been unable to detect any consistent major differences between the various female specimens assigned to *grahami*.

Distribution.—Known from the provinces of Szechuan and Kueichow in China.

Types.—China: Szechuan, Yongshien, 3000 ft., Aug., 1934 (male holotype, male paratype, the latter in very poor condition), D. C. Graham (USNM); Kueichow, Shih Men Kan, July, 1934, (male paratype), D. C. Graham (USNM).

Spirobolus grahami, new species Figures 99, 133, 139–141, 152–160, 162, 164

Diagnosis.—Distinguished from all other species in the genus by the large, suboval prefemoral endites of the male posterior gonopods. The very thick distal lobe with a deep groove down the cephalic face makes the female cyphopod equally distinctive.

Description.—L of males 75–130 mm. (99.3), of females 82–117 mm. (98.3); W of males 7.3–8.9 mm. (8.3), of females 7.8–9.3 mm. (8.5); L/W of males 10.7–14.4 (12.2), of females 10.4–12.6 (11.3). Segments 46–54 (50.4).

Face broad, lateral edges of clypeus not, or only slightly, exceeded by second segment of antenna. Lateral corners of clypeus relatively distinct, antennal groove thus well-defined anteriorly; groove not well-defined posteriorly, parietal sclerite sloping gradually cauded. Mandibular cheek only slightly grooved; distal margin of stipes always concave, the concavity usually V-shaped and of variable depth. Eyes per patch 34–49 (40.1). Clypeal setae 6–10 (7.7); labral setae 14–20 (16.8).

Paranota of collum long, their ends broadly rounded or subtruncate; anterior margin of collum usually abruptly angled at level of eye patches, sometimes only slightly angled; margining ridge very faint. Second segment only slightly surpassing ends of collum, its production not knob-like but, rather, forming a thick rounded carina running along anterior two-thirds of ventrolateral margin. Cephalic plate of second segment of female with a shallow notch in its mesal margin.

Anal valves only slightly compressed; anal lips distinct but variable in prominence, sometimes only barely distinct, sometimes large with moderately deep depressions delimiting them.

First and second legs short. Coxae of male legs 3–7 with short rounded productions each bearing a long seta; claws less than half as long as last podomeres. Postgenital legs with few ventral setae (e.g. 1-1-0-0-0-2).

Mesal process of sternum of anterior gonopods moderately large. Posterior telopodite long, much less concave than in *bungii* or *walkeri,* with a large unsclerotized distal pad. Prefemoral portion of telopodite large but without the distinct shoulder seen in *bungii* and *walkeri.* Prefemoral endite large, subovoid, its long axis, if projected, would meet telopodite at approximately a right angle; no notch in mesal margin of endite.

Cyphopod very thick distally; cephalic face of distal lobe cut by a deep groove running longitudinally down its midline, this groove sometimes extending across distal end and a short way onto caudal face. Lateral flange toothed, number and distribution of teeth variable; distal shoulder of flange often produced to form a first, usually small, tooth; a second tooth always present just proximal of first, this often long but usually not acute distally, often almost truncate or with irregular distal edge; a third tooth on basal portion of flange present or absent, acute when present.

Distribution.—Known from the provinces of Szechuan and Kueichow in China.

Specimens Examined.—12 (4 males, 8 females).

China.—Szechuan: Suifu [= Ipin] (male holotype; 1 male, 3 female, 1 subadult female paratypes), D. C. Graham (USNM); south of Suifu, alt. 1,000–2,000 ft., Sept. 9, 1929 (1 male, 1 female paratypes), Graham No. 107737 (USNM); south of Suifu on the Yunnan border, alt. 2,000–3,000 ft., about May 15, 1929 (1 female), D. C. Graham (USNM); Mupin, alt. 7,000 ft., July 12,

1929 (1 female), Graham (USNM); near Yueh-Shi, alt. 6,000–10,000 ft., July 20–23, 1928 (1 female), Graham (USNM); Mt. Omei, 11,000 ft., Aug. 19, 1934 (1 female), Graham (USNM). KWEICHOW: Shih Men Kan, July, 1934 (1 male paratype), Graham (USNM).

Spirobolus formosae, new species Figures 101, 135, 149–151, 163

? *Sinobolus joannsi* [sic], Chamberlin and Wang (in part), Amer. Mus. Nov., no. 1621, p. 12. 1953.

? *Sinobolus* species Chamberlin and Wang, ibid.

Diagnosis.—Distinguished from *bungii* by its broader face which is not exceeded laterally by the second segment of the antenna, and by its distinct anal lips. Differs from *walkeri* in the details of the collum and second segment, in the deep notch of the mesal margin of the cephalic plate of the second segment, and in the details of the cyphopod. Distinguished from *grahami* and *umbobrochus* by the details of the collum and second segment, and from the former by the details of the cyphopod.

Description.—Described from a single female specimen. L 89 mm.; W 6.7 mm.; L/W 11.6. Segments 55.

Face broad, lateral edges of clypeus not exceeded by second segment of antenna; clypeus not rectangular, ventral corners broadly rounded. Lateral corners of clypeus not very distinct, antennal groove thus only moderately defined anteriorly; groove not defined posteriorly, the parietal sclerite broad and flat, tapering caudad. Mandibular cheek not grooved; stipes squared distally, the distal margin very slightly concave. Eyes 41 + 38. Clypeal setae 9; labral setae 19.

Paranota of collum not long, their ends rounded less broadly than in *walkeri, umbobrochus,* or *grahami* but more so than in *bungii;* anterior margin of collum only slightly angled at level of eye patches. Second segment surpassing ends of collum but not produced, the segment ring bending abruptly mesad to form a definite corner resembling that typical of *Aztecolus.* A deep notch in mesal margin of cephalic plate of second segment.

Anal valves moderately inflated but with distinct anal lips.

Legs with few ventral setae (e.g. 1-1-0-0-1-4).

Cyphopod moderately thick distally; cephalic face of distal lobe not divided by a deep narrow groove, but cephalic plate very narrow and small, a broad, concave unsclerotized area projecting laterodistad from mesal membranous attachment, this area occupying much of what is sclerotized plate in other species (a similar unsclerotized area present in *walkeri* but in that species the reduction of sclerotized distal plate not as pronounced). Lateral flange with large distal tooth the apex of which is tripartite, the midpoint being most prominent; several

very small, inconspicuous teeth on more proximal portion of flange.

Remarks.—The description of a new species based on a single specimen, and a female at that, is a cause of some concern to me. I feel, however, that this specimen is distinctly different from any of the species known from the mainland of China and that to include it in any of those would be to give an untrue picture of the ranges of the species involved. In a comprehensive revision, all information pertaining to the group under consideration should be included. It is for this reason that I feel it necessary to add Formosa to the documented range of *Spirobolus* and to describe the species found there.

The specimens reported by Chamberlin and Wang probably belong to this species but I have not seen the material on which their record is based.

Type.—Formosa, Shirin, Aug. 10, 1922 (female), R. Takahashi (MCZ).

Genus **Narceus** Rafinesque

Narceus Rafinesque, Annals of Nature, vol. 1, p. 8. 1820.
Rhexenor Rafinesque, ibid., p. 8.
Spirobolus, Newport (in part), Ann. Mag. Nat. Hist., ser. 1, vol. 13, p. 269. 1844.
Spirobolus, Wood (in part), Trans. Amer. Philos. Soc., vol. 13, p. 207. 1865.
Spirobolus, Bollman (in part), Ann. New York Acad. Sci., vol. 4, p. 28. 1887.
Spirobolus, Bollman (in part), U. S. Nat. Mus. Bull., no. 46, p. 118. 1893.
Spirobolus, Bollman (in part), ibid., p. 156.
Arctobolus Cook, Harriman Alaska Exped., vol. 8, p. 64. 1904.
Spirobolus, Brölemann, Ann. Soc. Ent. France, vol. 83, p. 2. 1914.
Spirobolus, Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 44. 1947.
Narceus, Hoffman and Crabill, Florida Ent., vol. 36, pp. 80, 82. 1953.
Rhexenor, Hoffman and Crabill, ibid., pp. 81, 82.
Narceus, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 70. 1955.
Rhenexor [sic] Causey, ibid., p. 70.
Narceus, Hoffman, Proc. Biol. Soc. Washington, vol. 70, pp. 61–68. 1957.
Narceus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 165. 1958.

Type Species: *Narceus tinctorius* Rafinesque, by monotypy. Type species of *Rhexenor: Rhexenor annularis* Rafinesque, by monotypy. Type species of *Arctobolus: Arctobolus onondaga* Cook, by original designation.

Nomenclatorial Considerations.—Although the name *Narceus* Rafinesque is the oldest generic name in the entire order Spirobolida, it lay neglected from the time of its proposal in 1820 until it was once again brought to light by Hoffman and Crabill in 1953. During the intervening years, the species now referred to *Narceus* were included by most authors in the genus *Spirobolus*. Apparently Newport was the first to apply the name *Spirobolus* to New World species. He was followed by the influential worker H. C. Wood, and later by C. H. Bollman. By 1914, *Spirobolus* had become so closely identified with North American species that Brölemann proposed that for all practical purposes the American *marginatus* Say be used as the type of the genus. This proposal was readily embraced by most workers, some (e.g. Wang, 1951) even going so far as to formally list *marginatus* as type of the genus (Wang says of "Genus *Spirobolus Wood* 1865" [sic, incorrect author and year], "Generotype: *Spirobolus marginatus* Say"). O. F. Cook raised the lone dissenting voice and described a new genus, *Arctobolus,* for the North American species; but Cook was followed by only one worker, H. F. Loomis. With the rediscovery of the Rafinesque names by Hoffman and Crabill, new interest was stimulated in the true identities of the various genera involved. The result of this new attention was an important paper by Hoffman (1957) which effectively redefined both *Spirobolus* and *Narceus*. For a more complete and detailed account of the history of the names, the reader is referred to Hoffman's excellent paper.

Diagnosis.—*Chicobolus* is the only other spirobolid genus occurring within the range of *Narceus*. From this genus, *Narceus* is distinguished by its broader face, notched mandibular stipes, stipital setae fixed at 3 + 3, fewer ventral setae on the legs, different pregenital coxae of the male, different genitalia, and many other characters. *Narceus* differs from *Aztecolus* in the characters of the face, mandible, second segment, legs, tergal sculptering, and genitalia. *Narceus* most closely resembles *Spirobolus,* but differs from it in the characters of the male posterior gonopods, female cyphopods, male pregenital coxae, and other less important characters.

Description.—L 42–124 mm.; W 4.3–12.8 mm.; L/W 7.2–15.0. Segments 45–59. Color brown, with part of hind belts and legs reddish.

Face broad, lateral edges of clypeus not, or only slightly exceeded by second segment of antenna. Clypeus usually not rectangular, the ventral corners broadly and obtusely rounded; anterior emargination deep; labrum usually not prominent. Lateral corners of clypeus usually very distinct, sharply delimiting anterior border of antennal groove; groove moderately deep to very deep, its posterior border well-defined. Parietal sclerite with surface buckled to form part of posterior border of antennal groove; sclerite narrowing gradually caudad in two species, narrowing much more abruptly just outside groove in one species. Mandibular cheek grooved for reception of antenna, depth of groove variable; stipes with deep V-shaped notch in its distal margin. Eyes most often in 6 rows but varying from 5 to 8; eyes per patch 32–60. Clypeal setae 4 (very rare, only found in atypical specimens in which all or most setae are on one side) –16; labral setae 7–35; number of setae in each series different for different species. Stipital setae of gnathochilarium fixed at 3 + 3.

Paranota of collum usually not as long as in *Spirobolus,* their ends relatively broadly rounded (but not as much so as in *Spirobolus*). Shape and size of collum variable with species. Second segment usually much produced below ends of collum, shape and extent of production variable. Cephalic plate of second segment with no notch in its mesal border.

Tergites usually densely punctate and with numerous low rugulae; prominent striae on sides, not extending as high as pores. No secondary segmental suture.

Tergum of telson moderately produced, its caudal end rounded; not covering all of anal valves which are clearly visible from dorsal view. Anal valves compressed, with distinct anal lips set off by crescentric depressions.

Segments of legs 1 and 2 often swollen and expanded mesally. Coxae of male legs 3–7 usually produced ventrad, the third coxae produced most; extent and shape of productions different for the species. Third segments of male legs 3–7 much longer than 2nd segments, often compressed; 4th and 5th segments subequal, 6th slightly longer; claws less than a third as long as last podomeres. Postgenital legs unmodified, with few ventral setae (e.g. 1-1-0-0-1-3). Legs variable in length with the species.

Mesal process of sternum of anterior gonopods usually broad. Mesoventral corners of coxal endites usually rounded; ventral margins of endites often strongly sinuate. Anterior telopodites broad basally, always uncinate distally; telopodites exceeded mesally by posterior coxal bars. Posterior telopodite curved, hood-like, with deeply concave mesal surface. Prefemoral endite elongate, usually reaching or slightly surpassing end of telopodite. Postgenital bar moderately broad, emarginations not abrupt.

Distal lobe of cyphopod thin to moderately thick but never as thick as in *Spirobolus,* cephalic face not divided longitudinally by a groove. Lateral flange usually prominent but seldom toothed; distal shoulder of flange sometimes produced to form a tooth and an additional, more proximal, tooth sometimes present.

Distribution.—Southern Ontario and Quebec south through Florida; west to eastern Nebraska, Kansas, Oklahoma, and Texas.

Classification.—Nineteen proposed specific names are referable to the genus *Narceus.*[4] Despite this great amount of Latin verbiage, I recognize only three species. Two of these are exceedingly variable, but I can find no biological justification for designating subspecies within them. Most of the variation is both individually and geographically erratic. What little variation does seem to be correlated with distribution is of a clinal type.

The following key is admittedly difficult to use. There are many differences between *annularis* and *americanus* but most of them are difficult to define and there is an overlap in practically every character. The two species are discussed together in the remarks section under *annularis* and other methods for separating them are given there.

Key to the Species of the Genus Narceus

1. Antennal groove very deep, the second segment of antenna being entirely below surface of face when at rest; parietal sclerite distinctly carinate at border of groove, not tapering caudad but narrowing abruptly behind groove (figure 15); collum very broad, curving slightly forward at level of eye patches, projecting far over head to cover on each side half of eye patch and entire base of mandibular cheek (figure 14) .. *gordanus*

   Antennal groove moderately deep but the second segment of antenna never entirely below surface of face when at rest; parietal sclerite not carinate although its surface curved, tapering caudad; collum not so broad, curving slightly caudad at level of eye patches, not projecting far over head, usually covering only the vertex, leaving eye patches and bases of mandibular cheeks exposed (figure 10) 2

2. Usually less than 53 segments, never more than 55; usually more than 14 labral setae; width commonly greater than 7.5 mm.; L/W (rounded off to nearest half unit) usually less than 11.0 for males and 10.5 for females; 3rd coxal lobes of male usually expanded laterally and with a deep groove across cephalic surface (figure 17), 4th and 5th coxal lobes usually long and relatively narrow, often turgid; prefemoral endite often acute distally (figure 31); cyphopods thinner distally (figures 73, 74) and often with toothed lateral flange (figures 70, 71); 3rd coxae of females usually produced ventrad (figures 84, 85) ..... *americanus*

[4] While this study was in press, Causey (Florida Ent., vol. 42, pp. 135–137, figs. 1, 2. 1959) published an additional name, *Narceus woodruffi,* based on a single male specimen from Hawthorn, Putnam County, Florida, and several females from Alachua County. I have not seen Mrs. Causey's specimens, and thus will make no attempt to evaluate *woodruffi.*

Usually more than 53 segments, commonly more than 55; usually 14 or fewer labral setae; width commonly less than 7.5 mm.; L/W (rounded off to nearest half unit) usually 11.0 or greater for males and 10.5 or greater for females; 3rd coxal lobes of male seldom expanded laterally and never with a deep transverse groove across cephalic surface (figure 16), 4th and 5th coxal lobes shorter and not so narrow, seldom turgid; prefemoral endite not acute distally (figure 25); cyphopods thicker distally (figures 67, 68), often with a noticeable depression across caudal face of distal lobe, lateral flange never toothed (figure 65); 3rd coxae of females not produced ventrad (figure 83) ..... *annularis*

Narceus annularis (Rafinesque)

Figures 1, 7, 10, 16, 20, 22–29, 35–43, 64–68, 82–83, 86–88, 192–193

Rhexenor annularis Rafinesque, Annals of Nature, p. 8. 1920.

Julus marginatus Say [not Olivier, 1792], Journ. Acad. Nat. Sci. Philadelphia, vol. 2, p. 105. 1821. **New synonymy.**

Spirobolus marginatus, Newport, Ann. Mag. Nat. Hist., ser. 1, vol. 13, p. 269. 1844.

Sporobolus marginatus, Wood, Trans. Amer. Philos. Soc., vol. 13, p. 207, fig. 38 [not 35]. 1865.

Iulus americanus, Wood, ibid., p. 207.

Iulus incertus, Wood, ibid., p. 207.

Iulus ornatus, Wood, ibid., pp. 207, 208.

Iulus atratus, Wood, ibid., pp. 207, 208.

Spirobolus agilis Cope,. Proc. Amer. Philos. Soc., vol. 11, p. 181. 1869. **New synonymy.**

Spirostreptus ignobilis Humbert and Saussure, Rev. Mag. Zool., ser. 2, vol. 22, p. 177. 1870. **New synonymy.**

Spirobolus ignobilis, Bollman, Ann. New York Acad. Sci., vol. 4, p. 43. 1887.

Spirobolus marginatus, Bollman (in part), Proc. U. S. Nat. Mus., vol. 11, p. 343. 1888.

Arctobolus onondaga Cook, Harriman Alaska Exped., vol. 8, p. 64. 1904.

Spirobolus marginatus, Brölemann, Ann. Soc. Ent. France, vol. 83, p. 2, fig. 2. 1914.

Spirobolus marginatus, Williams and Hefner (in part), Ohio State Univ. Bull., vol. 33, p. 123. 1928.

Spirobolus spinigerus, Williams and Hefner, ibid., p. 123.

Arctobolus marginatus, Loomis, Journ. Washington Acad. Sci., vol. 23, pp. 100–109, fig. 1. 1933.

Arctobolus marginatus, Loomis, Bull. Mus. Comp. Zool., vol. 92, p. 397, fig. 12. 1943.

Spirobolus orophilus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 2, p. 8, figs. 17–21. 1943. **New synonymy.**

Spirobolus scotti Chamberlin, Proc. Biol. Soc. Washington, vol. 56, p. 148, figs. 12–14. 1943. **New synonymy.**
Spirobolus orophilus Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 46. 1947.
Spirobolus marginatus, Chamberlin, ibid., p. 46.
Spirobolus americanus, Hoffman (in part), Florida Ent., vol. 34, pp. 15–16. 1951.
Arctobolus marginatus, Snodgrass, Arthropod Anatomy, pp. 242–246, figs. 63C, 64B–C, 64F, 67E, 68A–C, 68F–K. 1952.
Rhexenor annularis, Hoffman and Crabill, Florida Ent., vol. 36, pp. 81, 82. 1953.
Arctobolus onandaga [sic], Hoffman and Crabill, ibid., pp. 81, 82.
Narceus annularis, Hoffman and Crabill, ibid., pp. 81, 82.
Narceus americanus, Chamberlin (in part), Amer. Midl. Nat., vol. 50, p. 150. 1953.
Narceus annularis, Chamberlin, ibid., p. 151.
Narceus orophilus Chamberlin, ibid., p. 151.
Narceus marginatus, Causey, Journ. Kansas Ent. Soc., vol. 28, pp. 71, 72, figs. 1a, 3. 1955.
Narceus annularis, Causey, ibid., p. 74.
Arctobolus onondaga, Causey, ibid., p. 74.
Narceus scotti, Causey, ibid., p. 75.
Narceus annularis, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 166. 1958.
Narceus orophilus, Chamberlin and Hoffman, ibid., p. 167.
Narceus scotti, Chamberlin and Hoffman, ibid., p. 167.
Spirostreptus ignobilis, Chamberlin and Hoffman, ibid., p. 168.

Nomenclatorial Considerations.—Since its reintroduction into the literature in 1953, the name *annularis* has been applied to specimens from New York, with the single exception of a record published by Chamberlin (1953) for Illinois. It has been supposed that Rafinesque's description referred to the same population described by Cook as *onondaga.* I have examined Cook's type and find it to be a specimen of the species that is common from Canada south to Virginia and western North Carolina, and west through the north central states. I have examined many specimens from New York and can find no other species there. It is thus apparent that *annularis* is the oldest name for the northern species of *Narceus.*

Say's name *Julus marginatus* is a junior primary homonym of *Julus marginatus* Olivier, as pointed out by both Bollman and Hoffman. (Many early writers regarded Olivier's *Iulus marginatus,* 1792, as a reference to the earlier *Oniscus marginatus* of de Villers, 1789.

Careful examination of Olivier's work reveals that this is not the case. In every instance where Olivier mentions a species described by someone else, he gives a synonymy listing all previous nomenclatorial combinatons. No such synonymy is given for *Iulus marginatus* and it must be regarded as a name proposed for a new species by Olivier, not as a reference to de Villers' species. Thus, regardless of whether or not *marginatus* Olivier and *marginatus* de Villers are zoologically synonymous in *Glomeris, Julus marginatus* Say is a primary, not secondary, homonym of *Iulus marginatus* Olivier). It is thus of only academic interest to determine which spirobolid species Say actually described. An examination of the original description of *marginatus* immediately shows why there has been no agreement between later workers as to the species it designates. It is my opinion that Say considered all the spirobolids in eastern North America to belong to one species and intended his description to apply to all of them. For example, the color described in Say's first paragraph is typical of *Narceus* while that in the last paragraph, " It varies in color; the margin of the segments and all beneath are sometimes white ", obviously refers to *Chicobolus*. Inasmuch as the characters of *Chicobolus* are given as exceptions, it seems safe to assume that *Narceus* species were the ones upon which the main part of the description was based. An attempt logically to determine whether Say was most concerned with the northern or the southern species of *Narceus* would be useless, particularly in view of the fact that, in addition to being a homonym, *marginatus* would be a junior synonym in either case. An arbitrary assignment seems fully warranted; I therefore accept Causey's (1955a) designation of Philadelphia as the type locality. Only the northern species of *Narceus* occurs there and, hence, *marginatus* is here listed as a synonym of *annularis*.

No attempt has been made to list all of the hundreds of references to *marginatus* that appear in the literature; in most cases it is impossible to tell which species was actually involved. Only those references are mentioned that made significant contributions to the history of the name or to the knowledge of the animal. *" Spirobolus marginatus "* will doubtless continue to be " the " milliped in textbooks and supply house catalogues. The publishers of such works are welcome

to the name.

Spirobolus agilis Cope is based on an immature specimen; the type is lost. I have collected at the type locality and have seen many specimens from there. Both *annularis* and *americanus* are found in the area but the former is far the more abundant. I, therefore, list *agilis* as a synonym of *annularis.*

The type of *ignobilis* is supposed to be in the Vienna Museum but a personal communication from Dr. Friedrich Kasy of that institution reveals that it cannot be found. I believe, however, that the original description gives enough information for an identification to be made. The statement, " primo segmento utrinque tigonali-rotundato, secundo in processum subacutum marginis antici infere producto," seems sufficient to consider this a spirobolid. The segment count of 55, length of 68 mm., width of 5.5 mm., and easily calculated L/W value of 12.36 all combine to make it almost certain that *ignobilis* is a synonym of *annularis,* as reference to the tables for the various genera will show. Bollman (1887) apparently guessed that this might be the case inasmuch as he gave the range for this species as " Eastern Province, northern part."

I have not seen the type of *orophilus* but I have seen a specimen reported by Chamberlin (1947) as that species. It is typical of *annularis.* The drawings with the original description appear to be of *annularis.* The segment counts (51–57) given by Chamberlin indicate that he had both *annularis* and *americanus* before him (both occur at the type locality). Judging from the drawings (*americanus* specimens from that locality have much longer and narrower lobes of the fourth and fifth coxae) and from the width of 6 mm., I think it probable that the type is a specimen of *annularis.*

I have seen the type and a male paratype of *scotti;* they are normal specimens of *annularis.* Both other new species (*Spirostrephon lactarium* and *Sigmoria houstoni*) described by Chamberlin from Houston in the same paper with the description of *scotti* are, like *scotti,* typical Appalachian forms and are otherwise unknown in Texas or neighboring states. I feel, therefore, that it is highly probable that these three species, all collected by R. Scott, were not taken in Texas, and that they were either accidentally mislabelled or were collected in some other " Houston " such as Houston County, Tennessee.

Diagnosis.—Distinguished from *gordanus* by the shape of the collum, the shallower antennal groove, the absence of a carina across the parietal sclerite, more segments and fewer facial setae, longer legs, more produced male pregenital coxae, and characters of the genitalia of both sexes. Differs from *americanus* in the characters given in the key and discussed in the remarks below.

Description.—L of males 46–101 mm. (71.1), of females 46–109 mm. (72.2); W of males 4.5–8.0 mm. (5.96), of females 4.3–9.2 mm. (6.46); L/W of males 9.2–15.0 (11.9), of females 8.4–14.9 (11.2). Segments 51–59 (55.1). Generally dark brown with reddish hindbelts and legs; the red disappears in alcohol.

Face broad; lateral corners of clypeus distinct. Antennal groove moderately deep, well-delimited both anteriorly and posteriorly. Surface of parietal sclerite sinuate but without a carina; sclerite tapering caudad. Mandibular cheek moderately grooved. Eyes per patch 32–57 (42.5). Clypeal setae 4 (atypical specimens, usually with all or most setae on one side) –12 (8.1); labral setae 7–18 (13.0).

Collum usually covering only vertex of head, leaving eye patches, antennal grooves, and mandibular cheeks exposed; anterior margin of collum usually angling slightly caudad at level of eye patches, and shallowly emarginate below the angles. Second segment much produced below ends of collum, the production often long, narrow, and relatively acute; a strong ridge along anterior margin of production, this much stronger than striae on median surface of production.

Tergites densely punctate and with numerous small regulae.

Coxae of male 3rd legs produced ventrad, lobe thus formed not much expanded laterally (figures 35–38), its lateral margin often running obliquely mesoventrad; no deep groove across cephalic surface although shallow depression sometimes evident. Coxae of male legs 4 and 5 produced, the lobes subtriangular, broad, seldom turgid, usually bent slightly cephalad and crossed by several folds; lobes of these pairs of legs subequal. Lobes of 6th legs similar but shorter. Coxae of 7th legs sometimes produced, sometimes not, the production always short. Third segments of male legs 3–7 much longer than 2nd segments, compressed, usually concave on caudal surface. Coxae of female 3rd legs not produced. Legs relatively long, exceeding sides of body when held horizontally.

Shape and length of mesal process of sternum of anterior gonopods variable, usually relatively broad. Coxal endites narrower than in *Spirobolus,* their mesoventral corners very broadly rounded; ventral margins usually strongly sinuate, degree of such curvature variable. Prefemoral endites of posterior gonopods long, relatively narrow, distally rounded.

Cyphopod thicker distally than in *americanus,* distal lobe usually curved slightly caudad thus causing shallow transverse depression on caudal surface. Lateral flange not toothed, its distal corner sometimes sharp but not greatly produced.

Remarks.—One of the most vexing problems in the taxonomy of the spirobolids has been the confusion regarding the species of *Narceus.* Great variation is, perhaps, the most distinguishing character of the genus. It is no wonder that so many specific names have been proposed. Indeed, with much careful study one might eventually be able to distinguish the specimens of every county in which the species occur. The difficulty, then, is one of establishing what true biological species exist in the genus, and of finding some method whereby such variable entities may be identified by other workers.

I am convinced that only three species of *Narceus* are now known. One of these, *gordanus,* is so different from the other two that it poses no problem. The separation of *annularis* and *americanus,* however, is a very difficult one. Where the two occur together, they are usually very different; but the same species may occur together at two different places and, while always distinguished from each other, appear so different at the two localities as to give the impression that four species are involved. Thus the problem is not one of separating specimens of the two species taken at the same locality, but one of devising a scheme that will make possible the association of members of a single species. This done, the whole aggregate of dissimilar individuals that constitutes one species must be separated in a key from the likewise variable aggregate of the other species. It is at this point that this taxonomist begins to wish that keys had never been invented!

Table 13 gives a brief summary of some of the most outstanding differences between *annularis* and *americanus.* All of the included characters are variable and the description of each must be regarding as applying to a hypothetical, ideal specimen. Probably no single real specimen would fit all the character descriptions of its species inasmuch as the characters vary independently of each other.

Table 14 shows observed segment counts for the species. In general, *annularis* has more segments than *americanus.* I will mention here one outstanding exception to this generalization in order to point out the danger of using a single character for identification. A collection of *annularis* from Cunningham Falls State Park, Frederick County, Maryland is typified by having fewer segments than normal for the species. The collection contains 34 adults and 11 immatures. The following segment counts of adults were obtained: 2 at 51, 7 at 52,

TABLE 13

A Comparison of Narceus annularis and Narceus americanus.

Character	annularis	americanus
segments	more	fewer
clypeal setae	fewer	more
labral setae	fewer	more
width	smaller	larger
length	shorter	longer
L/W	greater	less
production of 2nd segment	longer, narrower, more acute, ridge more distinct	shorter, broader, more rounded, ridge less distinct
male 3rd coxae	shorter, not expanded laterally, without deep groove	longer, much expanded laterally, with deep groove
male 4th and 5th coxae	shorter, broader, less turgid, with folds	longer, narrower, more turgid, without folds
female 3rd coxae	not produced	produced
prefemoral endite	distally rounded	often distally acute
distal lobe of cyphopod	thicker	thinner
lateral flange of cyphopod	not toothed	often toothed

9 at 53, 9 at 54, 5 at 55, 1 at 56, and 1 at 57. The average count for this collection is 53.4 as opposed to the general average for the species of 55.1. All other collections from Maryland were normal. This is the only collection of *annularis* with such a reduced segment count that I have seen. Inasmuch as most collections used in this study contained fewer than 5 specimens, I did not feel it proper to allow this one, accidentally large, sample to skew the mean for the species. I therefore drew at random five specimens to be included in the overall

TABLE 14

Segment counts for specimens of the species of Narceus.

Segments	annularis	americanus	gordanus
45.			1
46.			
47.		3	3
48.		7	5
49.		15	13
50.		16	18
51.	1	28	9
52.	5	19	5
53.	22	18	2
54.	66	8	1
55.	77	2	
56.	60		
57.	37		
58.	5		
59.	4		
totals	277	116	57
means	55.1	51.1	49.9

species average. This collection thus had equal weight with the other collections used.

Tables 15–20 are self-explanatory and need no further comment here.

With so many differences in meristic characters, all of which overlap, it is often difficult to take the value for each character independently

TABLE 15

Clypeal setae counts for specimens of the species of Narceus.

Setae	annularis	americanus	gordanus
4.	4		
5.	1		
6.	21		
7.	56	1	
8.	203	32	3
9.	84	35	15
10.	26	38	35
11.	5	21	14
12.	2	5	8
13.		3	
14.		1	
15.		1	
16.		1	
totals	402	138	75
means	8.1	9.7	10.1

and then to combine the results as an aid in identification. I have found it helpful to use a formula which unites characters in such a way as to pull the means for the two species farther apart. The formula I use is as follows: S – Cs – Ls – W + L/W. In words, this is segment count, minus clypeal setae count, minus labral setae count, minus width to nearest millimeter, plus L/W value rounded off to nearest whole unit. Table 21 shows the effective separation of the species

TABLE 16

Labral setae counts for specimens of the species of Narceus.

Setae	annularis	americanus	gordanus	Setae	annularis	americanus	gordanus
7.	2			22.			6
8.	1			23.			4
9.				24.		1	9
10.	13			25.		1	3
11.	19			26.			10
12.	136	2		27.			10
13.	217	7		28.			5
14.	125	18		29.			1
15.	27	22		30.			2
16.	5	24		31.			1
17.	2	19		32.			4
18.	2	15		33.			
19.		6	2	34.			
20.		9	4	35.			3
21.		1	6				
				totals	551	125	70
				means	13.0	16.3	25.5

TABLE 17

Number of eyes per patch in specimens of the species of Narceus.

Eyes	annularis	americanus	gordanus
32.	1		
33.			
34.	2		
35.	3	1	
36.	5	2	
37.	10	9	3
38.	21	7	1
39.	38	17	3
40.	34	11	3
41.	43	12	3
42.	43	14	1
43.	36	10	3
44.	35	9	4
45.	24	7	4
46.	28	17	4
47.	15	11	1
48.	15	8	4
49.	10	10	5
50.	4	3	2
51.	3	5	1
52.	1		
53.	2	1	1
54.		2	2
55.		2	1
56.			2
57.	1		
58.			1
59.		1	1
60.		1	
totals	374	160	50
means	42.5	43.7	46.0

TABLE 18

Lengths of specimens of the species of Narceus. The measurements were made to the nearest millimeter but are shown here in groups of five millimeters each. The means are based on the original measurements.

Length	annularis		americanus		gordanus	
	male	female	male	female	male	female
41-45.				2		
46-50.	1	1				
51-55.	2	4	2	4		
56-60.	13	16	2	2		1
61-65.	22	19	4	5		1
66-70.	26	21	6	5	2	1
71-75.	22	23	4	5	1	2
76-80.	13	18	6	8	2	2
81-85.	13	13	1	9	1	5
86-90.	4	9	3	9	3	4
91-95.	3	5	2	6	4	3
96-100.	1	2	4	6	2	1
101-105.	1	1	1	2	5	4
106-110.		1			2	3
111-115.			1		3	6
116-120.						1
121-125.			1			
totals	121	133	37	63	25	34
means (by sex)	71.1	72.2	78.5	78.5	94.2	93.3
means (both sexes)	71.7		78.5		93.7	

TABLE 19

Widths of specimens of the species of Narceus. The measurements were made to the nearest tenth of a millimeter but are shown here rounded off to the nearest half a millimeter. The means are based on the original measurements.

Width	annularis		americanus		gordanus	
	male	female	male	female	male	female
4.5	2	2				
5.0	15	7	2	1		
5.5	42	19		1		
6.0	40	37	5	3		
6.5	26	29	5	4		
7.0	9	24	3	9	1	2
7.5	3	18	8	8	1	
8.0	1	6	6	9	1	
8.5		2	1	9		1
9.0		2	4	10	2	4
9.5			1	6	2	5
10.0			7	6	2	6
10.5				2	2	1
11.0			1		6	3
11.5					5	3
12.0			1		4	6
12.5						3
13.0						1
totals	140	146	44	68	26	35
means (by sex)	5.96	6.46	7.92	8.15	10.41	10.45
means (both sexes)	6.21		8.06		10.43	

TABLE 20

L/W values for specimens of the species of Narceus. The values were calculated to the nearest tenth of a unit but are shown here rounded off to the nearest half a unit. The means are based on the original values.

L/W	annularis		americanus		gordanus	
	male	female	male	female	male	female
7.0						1
7.5						
8.0				1	4	2
8.5		2	1	5	6	11
9.0	1	1	5	13	7	11
9.5	2	1	9	12	8	6
10.0	3	15	10	16	1	2
10.5	8	26	10	9		
11.0	20	29	5	8		
11.5	21	33	2	2		
12.0	24	11	1			
12.5	30	5				
13.0	9	4				
13.5	7	2				
14.0	1	1				
14.5		1				
15.0	3	2				
totals	129	133	43	66	26	33
means (by sex)	11.9	11.2	10.1	9.8	9.0	8.9
means (both sexes)	11.6		9.9		8.9	

TABLE 21

Combination values for specimens of the genus Narceus. Values were obtained using the formula given in the text.

Value	annularis	americanus	gordanus
4.			2
5.			
6.			
7.			1
8.			2
9.			3
10.			2
11.			5
12.			2
13.			7
14.			7
15.			3
16.		1	1
17.			8
18.			4
19.			3
20.		1	
21.		3	
22.		9	
23.		6	
24.		6	
25.		8	
26.		7	
27.		11	
28.		8	
29.		6	
30.		9	
31.	1	9	
32.	1	4	
33.	5	3	
34.	5	3	
35.	13	2	
36.	16		
37.	22		
38.	33		
39.	42		
40.	43		
41.	26		
42.	13		
43.	12		
44.	9		
45.	3		
46.	3		
47.	2		
48.	1		
49.			
50.			
51.	1		
totals	251	96	50
means	39.2	27.1	13.4

of *Narceus* that is obtained by this formula. All 34 specimens from the unusual Maryland collection are included in the table. If it be said that this is an unusual way to identify species, I will agree. Yet any tool seems justified if it accomplishes its purpose. If this combination value is used with the qualitative characters given in Table 13, practically every specimen, regardless of sex, can be easily identified.

Most of the qualitative characters need no explanation except the warning that they, too, are variable. For example, the female cyphopod is much more commonly toothed in *americanus* specimens from the west than in specimens from the east.

One other complicating matter must be mentioned. This is the occurrence of a few specimens which I consider to be the result of occasional hybridization between *annularis* and *americanus*. Such specimens are rare, and occur only in the areas where the two species are found together. They usually show strange combinations of characters of the two species. An example is a male with 56 segments, 20 labral setae, and third coxal lobes that are long and much expanded laterally in the usual *americanus* manner, but that entirely lack the transverse groove. A number of the hybrids examined were malformed in one or more ways, e.g. dwarfed, or exoskeleton leathery; it is interesting to speculate that such deleterious effects may be the direct result of hybridization. Hybrid specimens are listed separately below under the species they most closely resemble.

Type.—Presumed lost. Locality: " in the woods of the highland hills of New York "; restricted by Chamberlin and Hoffman (1958) to " vicinity of Catskill, Greene County, New York." Type of *marginatus:* presumed lost. Locality: none given by Say; designated by Causey (1955a) as Philadelphia, Pennsylvania. Type of *agilis:* presumed lost. Locality: Giles County, Virginia. Type of *ignobilis:* male (NHMV, apparently lost, see above). Locality: " America borealis "; here restricted to Green County, New York. Type of *onondaga:* male (USNM). Locality: Kirkville, Onondaga County, New York. Type of *orophilus:* male (RVC, Chamberlin says in publication, " Field Museum "). Locality: Tennessee, Great Smoky Mountains National Park, Gatlinburg. Type of *scotti:* male (RVC). Locality: Texas, Harris County, Houston (see discussion under nomenclatorial considerations above).

Distribution.—Ontario, Quebec, and New England south in the coastal and piedmont zones to Virginia, and in the mountains to western North Carolina and eastern Tennessee; west to Kansas (see map 1). The southern border of the range of this species corresponds

Map. 1.—Spot map of distribution records for *Narceus annularis* reported in this paper.

closely with the boundary between the Upper and Lower Austral regions. A vial of specimens (1 male, 1 female) labelled "Florida" (in the Vienna Museum) must be incorrectly labelled.

Specimens Examined.—541 (232 males, 241 females, 68 early instar larvae).

"AMER. BOR."—(1 male, labelled "*Spirobolus Woodi* male var.?"), Senger (NHMV).

ILLINOIS.—Champaign County: Urbana (4 males) (MCZ). Cook County: Willow Springs, Aug. 2–Sept. 27, 1942 (2 males, 3 females), H. Dybas (CNHM). Knox County: Galesburg (2 males), C. W. Strunky (MCZ). La Salle County: Ottawa, Aug., 1901 (2 males) (MCZ).

INDIANA.—Benton County: (1 female) D. M. Mottier (USNM). Fulton County: (1 male) S. A. Forbes (USNM). Howard County: Kokomo (2 males, 6 females), A. W. Moon (USNM). Marshall County: Lake Maxinkuckee, July 18, 1900 (1 male), B. W. Evermann (USNM).

IOWA.—Scott County: Davenport (1 male), D. S. Sheldon, S. Kenshaw (MCZ).

KANSAS.—Osage County: Osage River (2 males, 2 females) (MCZ).

KENTUCKY.—Breathitt County: (1 male) (MCZ). Edmonson County: Bee Spring, Jan. 8, 1874 (1 female), F. S. S. (MCZ); Mammoth Cave (1 male) (MCZ). Harlan County: Pine Mountain, July, 1946 (2 males, 1 female), W. L. and C. K. Necker (CNHM), April 30, 1921 (1 male) (ANSP).

MARYLAND.—Baltimore, 1923 (1 female), N. Riggs (MCZ). Charles County: (1 male, 4 females) Bryand (MCZ). Frederick County: Cunningham Falls State Park, April 27, 1957 (20 males, 25 females), E. MacLeod, R. Highton (RLH). Prince Georges County: Branchville, May 6, 1915 (1 female) (MCZ). Washington, D. C., April 1893 (1 female), Sinell (USNM).

MASSACHUSETTS.—"Massachusetts" (1 female) (MCZ). "Tuckernuch Island", June 23–25, 1893 (1 female), G. S. Miller, Jr. (MCZ). Berkshire County: (3 males) (MCZ). Essex County: Salem Neck, Aug., 1879 (1 male), J. H. Bears (MCZ). Franklin County: Warwick (1 female) (MCZ). Middlesex County: Concord, May 26, 1868 (1 male), Maj. P. Mann (MCZ); Winchester (4 males, 3 females) (MCZ). Norfolk County: Blue Hills, May 4, 1912 (1 male, 1 female) (MCZ). Worcester County: Southboro (1 female), C. A. Frost (MCZ).

MICHIGAN.—"Michigan" (1 female), Capt. Meade (MCZ). Berrien County: Lakeside, Warren Woods (2 females), H. Dybas (CNHM).

MISSOURI.—"wagon Road to Bridger's Pass, R. Mts. St. Louis Mo.", May 6, 1857 (1 male), Lt. F. T. Bryan U.S.A., W. S. Wood (ANSP).

NEW HAMPSHIRE.—"Lake Winipiseogee" [old spelling for Winnepesaukee], Three Mile Island, Aug., 1900 (1 male), Miss J. Butchelder (MCZ). Merrimack County: Sutton, Sept., 1911 (1 female), W. R. Zappey (MCZ).

NEW JERSEY.—Warren County: near Blairstown, May, 1958 (2 males, 5 females), F. A. McKittrick, B. S. Orcutt, W. T. Keeton (TE).

NEW YORK.—Allegany County: Fillmore, Oct., 1957 (1 male) (WTK). Cortland County: Cortland, July, 1917 (1 male), R. V. Chamberlin (MCZ). Essex County: Au Sable (1 male, 1 female), L. W. Putnam (MCZ); Crown Point, Sept. 11, 1904 (1 male) (MCZ); Port Douglas, Aug. 19, 1902 (3 males, 4 females) (MCZ). Onondaga County: (4 males, 7 females) O. F. Cook (USNM); East Onondaga, Sept. 15, 1904 (1 male) (MCZ); Kirkville, June, 1895 (1 male holotype, 1 female paratype of *onondaga*) (USNM); Marcellus, Sept., 1889 (1 male) (USNM); Syracuse, 1886 (1 male) (USNM). Saint Lawrence County: Somerville (2 males, 4 females) (MCZ). Tompkins County: Freeville, June, 1917 (1 male), R. V. Chamberlin (MCZ); Ithaca (2 females)

(CU); Taughannock, Aug., 1917 (2 males, 5 females) (MCZ), Sept. 20, 1957 (1 male), R. L. Hoffman (RLH). Wayne County: (1 female) J. A. Allen (MCZ). Westchester County: White Plains, Saxon Woods, Aug. 24, 1957 (1 male, 5 females), D. J. Pirone (WTK); Bedford Village, Ward-Poundridge Reservation, Aug. 31, 1955 (4 males, 4 females), D. J. Pirone (WTK). Wyoming County: Attica, "from maple trees", May 15, 1957 (1 male, 2 females), R. Reiner (WTK).

North Carolina.—Ashe County: Mount Jefferson, Aug., 1948 (1 female), M. Wright (RLH). Avery County: Grandfather Mountain, Jan. 28, 1916 (1 male) (USNM); Wilson's Creek, Aug. 13, 1948 (1 male, 1 female), M. Wright (RLH).

Ohio.—Hocking County: Goodhope Twp., "Neotoma", April 25, 1946 (8 males, 2 females), J. R. Bailey (RLH). Lake County: Painesville, Sept., 1918 (2 females) (MCZ). Noble County: Olive (1 female), H. L. Higginson (MCZ).

Pennsylvania.—"Pennsylvania" (1 male), Shaler (MCZ). "Pennsylv. Amer. bor.", 1870 (1 male), d. Sauss. (NHMV). "West Penna." (3 females), R. J. Wood (USNM). Centre County: (1 male) Shaler (MCZ). Fayette County: Ohiopyle, June 13, 1931 (1 male, 2 females), G. M. Kutchka (CMP). Green County: along South Branch of Ten Mile Creek, Waynesburg, April 11, 1932 (1 female), Dr. and Mrs. S. T. Brooks (CMP). Lawrence County: Heinz House Camp, Slippery Rock Creek, Ellwood City, July 20, 1931 (4 males, 2 females), Dr. S. T. Brooks (CMP); Moravia, Aug. 22, 1930 (2 males, a note in the vial with one specimen says, "Specimen kept alive in vivaria until Sept. 23, 1930. Specimen was injured. Noted color changes from bright red to an ashy gray. H. Hilsman"; when examined in Nov., 1958, the alcohol preserved specimen appeared dark purple), G. Netting (CMP). Lebanon County: Indiantown Gap (2 males, 6 females), L. Hubricht (RLH). Northumberland County: near Sunbury, July, 1871 (1 male), Galer (MCZ). Westmoreland County: woods near Baggaley, July 6, 1931 (2 males, 2 females), G. K. MacMillan (CMP); Twin Echo Camp, near Florence, July, 1930 (2 males, 1 female), Dr. and Mrs. S. T. Brooks (CMP).

Rhode Island.—Washington County: Exeter (1 male) (ANSP).

Tennessee.—Carter County: Burbank (1 male, 1 female), R. Thaxter (MCZ). Greene County: Camp Creek, Oct. 11, 1947 (1 female), M. Wright (RLH). Knox County: (1 female) G. G. Ainslee (MCZ). Sevier County: Porter Creek, Greenbriar Cove, June 12, 1939 (1 male), D. C. Lowrie (CNHM).

Texas(?).—Harris County: Houston, Sept.–Dec., 1941 (2 males, holotype and paratype of *scotti*), R. Scott (RVC).

Vermont.—"Vermont", 1869 (10 males, 3 females), Rev. Perry (MCZ). Chittenden County: Burlington (2 males, 1 female), J. B. Derry (MCZ).

Virginia.—"Plumbers Island, Va. shore", May 5, 1916 (2 males, 4 females), H. F. Loomis (USNM). Augusta County: Sherando Lake, Aug., 1947

(2 males, 2 females), L. G. Carr (RLH). Bath County: Aug. 14–18, 1871 (2 males, 1 female), Shaler (MCZ). Bedford County: Peaks of Otter, Sept., 1938 (1 female), A. B. Gurney, H. E. Ewing (USNM). Bland County: Mechanicsburg, May, 1956 (29 males, 37 females), Hoffman, Keeton, E. Willis (WTK), June, 1957 (2 males, 3 females), Keeton, E. M. Raffensperger, W. C. Lund (WTK). Fairfax County: Great Falls, June 20, 1915 (2 females) (USNM). Fauquier County: (1 male, 2 females) E. P. Drowne (USNM); north end of Pond Mtn. at Thorofare Gap, elv. 650 ft., 1938 (10 males, 8 females), J. P. E. Morrison (USNM). Floyd County: Rocky Knob Park, July 3, 1947 (2 males), R. L. Hoffman and H. I. Kleinpeter (RLH). Giles County: Castle Rock Mtn., July, 1947 (1 female), H. H. Hobbs (RLH); Eggleston, July 23, 1957 (1 male, 2 females, 68 early instar larvae), Keeton, B. S. Orcutt (WTK); Mountain Lake, July, 1957 (1 male, 1 female), Hoffman (RLH), 1948 (1 female), H. K. Wallace (RLH). Montgomery County: Dry Run, 5 miles e. of Blacksburg, April 27, 1957 (1 male), Hoffman (RLH). Nelson County: Crabtree Falls, June 11, 1948 (1 female), Hoffman (RLH); Crabtree Falls, near Nash, Aug. 18, 1931 (2 males, 1 female), M. G. Netting (CMP). Norfolk County: Truck Farm Station, Oct. 30, 1913 (1 male) (USNM). Page County: Hawksbill Mtn., Aug. 9, 1947 (1 female), R. L. Hoffman, H. I. Kleinpeter (RLH); Skyland, June 9, 1940 (1 male, 4 females), J. P. E. Morrison (USNM). Rockbridge County: Blue Ridge Parkway MP-30, May, 1954 (2 males, 1 female), Hoffman (RLH); Goshen, 1947 (1 male), Hoffman (RLH); Goshen Pass, 1947 (1 male, 1 female), Hoffman (RLH); Natural Bridge, May, 1884 (1 female), F. W. Putnam (MCZ), Oct. 12, 1928 (1 female) (USNM); Vesuvius, Aug., 1954 (6 males, 1 female), Keeton, M. Caskie (WTK), 1956 (1 male, 4 females), Keeton (WTK). Russell County: across Clinch Mtn. from Mendota, July 30, 1941 (1 male, 1 female), Dr. and Mrs. S. T. Brooks (CMP); Clinch Mtn., Aug. 1, 1941 (1 male), Brooks (CMP). Tazewell County: Bandy, Aug. 23, 1941 (1 male) (CMP); Mill Gap, Burkes Garden, July 1, 1947 (1 male), Hoffman and Kleinpeter (RLH). Washington County: Duncansville, Clinch Mtn., July 29, 1941 (1 male) (CMP); Konnarock, Aug. 2, 1941 (1 male), Dr. and Mrs. Brooks (CMP); Taylors Valley (1 male), S. T. Brooks (RLH).

West Virginia.—Barbour County: Sugar Creek Valley, 5 miles se. of Philippi (1 female), G. K. MacMillan, N. D. Richmond (CMP). Boone County: Lens Creek Mtn., 3 miles n. of Racine (1 male), G. K. MacMillan, N. D. Richmond (CMP). Grant County: (2 males, 2 females) (MCZ); Sept. 2, 1940 (9 males, 11 females), J. P. E. Morrison (USNM). Lincoln County: Mud River Valley, 2 miles n. of Myra, Aug. 15, 1938 (2 males, 2 females), G. K. MacMillan, N. D. Richmond (CMP). Ritchie County: Petroleum (1 female), E. Ingersoll (MCZ).

Wisconsin.—Clark County: Worden Twp., June 21, 1946 (1 male), B. Patterson (CNHM). Sauk County: Devil's Lake, May, 1946 (1 female), H. Levi (HWL); Wisconsin Dells, Oct. 9, 1948 (1 male), H. Levi (HWL).

Ontario.—Durham, July, 1913 (1 male) (MCZ). Ford Island, Bobs Lake, s. of Maberly, Aug., 1958 (2 males, 1 female), L. D. Uhler (TE). Gull Lake, Sept. 4, 1948 (5 males, 3 females), R. E. Crabill, Jr. (RLH). Renfrew, Aug. 15, 1917 (1 male) (MCZ). White Lake, Aug. 9–10, 1957 (1 male, 1 female), D. Beneway (WTK).

Quebec.—Saint Nicholas (1 female), J. A. Salter (MCZ).

The following specimens are considered hybrids with *americanus*.

Arkansas.—near Crystal Springs Rec. Area, 3.5 miles northeast of Norman, Aug. 14, 1955 (3 females), Leslie Hubricht (RLH).

Indiana.—Benton County (1 male), Mottier (USNM).

Iowa.—Boone County, Boonesboro, July, 1867 (1 female), J. A. Allen (MCZ).

Narceus americanus (Palisot de Beauvois)

Figures 17, 30–31, 44–51, 69–74, 84–85, 89–91

Julus americae borealis Palisot de Beauvois, Insectes recueillis en Afrique et en Amérique, livr. 9, p. 155. 1817.

Julus americanus Palisot de Beauvois, ibid., Aptères, pl. IV, fig. 3.

Narceus tinctorius Rafinesque, Annals of Nature, p. 8. 1920. **New synonymy.**

Iulus americanus, Gervais, Hist. Nat. Insectes, vol. 4, Aptères, p. 181. 1947.

Julus atratus Girard, *in* Marcy, Exploration of Red River of Louisiana, p. 244. 1853. **New synonymy.**

Julus crassus Motschulsky [not Linnaeus, 1758], Etudes Entomologiques, Cinquième année 1856, p. 4, 1857. **New synonymy.**

Spirostreptus woodi Humbert and Saussure, Rev. Mag. Zool., ser. 2, vol. 22, p. 177. 1870. **New synonymy.**

Spirobolus marginatus, Bollman, Ann. New York Acad. Sci., vol. 4, p. 28. 1887.

Spirobolus pensacolae Bollman, ibid., p. 29. **New synonymy.**

Spirobolus atratus, Bollman, ibid., p. 43.

Spirobolus woodi, Bollman, ibid., p. 44.

Spirobolus pensacolae Bollman, Entomologica Americana, vol. 2, p. 227. 1887.

Spirobolus marginatus, Bollman (in part), Proc. U. S. Nat. Mus., vol. 11, p. 343. 1888.

Julus americae-borealis, Bollman, U. S. Nat. Mus. Bull., no. 46, p. 146. 1893.

Arctobolus marginatus, Cook, Harriman Alaska Exped., vol. 8, p. 65. 1904.

Spirobolus marginatus, Williams and Hefner (in part), Ohio State Univ. Bull., vol. 33, p. 123. 1928.

Spirobolus oklahomae Chamberlin, Ent. News, vol. 42, p. 98. fig. 1. 1931. **New synonymy.**

Arctobolus dolleyi Loomis, Bull. Mus. Comp. Zool., vol. 92, p. 398, fig. 13. 1943. **New synonymy.**

Spirobolus ramstadti Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 2, p. 7, figs. 12–16. 1943. **New synonymy.**

Spirobolus melanior Chamberlin, ibid., p. 9. **New synonymy.**
Spirobolus dolleyi, Hoffman, Journ. Elisha Mitchell Sci. Soc., vol. 66, p. 31. 1950.
Julus americae borealis, Hoffman, Florida Ent., vol. 34, p. 15. 1951.
Julus americanus, Hoffman, ibid., pp. 15–16.
Spirobolus marginatus, Hoffman, ibid., p. 16.
Spirobolus americanus, Hoffman (in part), ibid., p. 16.
Narceus tinctorius, Hoffman and Crabill, Florida Ent., vol. 36, pp. 80, 82. 1953.
Narceus americanus, Chamberlin (in part), Amer. Midl. Nat., vol. 50, p. 150. 1953.
Narceus melanior Chamberlin, ibid., p. 150.
Narceus tinctorius, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 71, fig. 2. 1955.
Julus atratus, Causey, ibid., p. 71.
Spirobolus agilis, Causey, ibid., p. 71.
Spirobolus woodi, Causey, ibid., p. 71.
Arctobolus dolleyi, Causey, ibid., p. 71.
Narceus americanus, Causey, ibid., p. 72.
Julus americae borealis, Causey, ibid., p. 72.
Julus americanus, Causey, ibid., p. 72.
Julus americanus borealis [sic], Causey, ibid., p. 72.
Narceus oklahomae, Causey, ibid., pp. 71, 74.
Narceus orophilus, Causey, ibid., pp. 71, 75.
Narceus pensacolae, Causey, ibid., p. 75.
Narceus melanior, Causey, ibid., p. 75.
Narceus ramstadti, Causey, ibid., p. 75.
Narceus tinctorius, Hoffman, Proc. Biol. Soc. Washington, vol. 70, p. 65, figs. 1, 4. 1957.
Narceus ramstadi, Causey, Proc. Biol. Soc. Washington, vol. 70, p. 205. 1957.
Narceus americanus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 165. 1958.
Narceus atratus, Chamberlin and Hoffman, ibid., p. 166.
Narceus dolleyi, Chamberlin and Hoffman, ibid., p. 166.
Narceus melanior, Chamberlin and Hoffman, ibid., p. 166.
Narceus oklahomae, Chamberlin and Hoffman, ibid., p. 167.
Narceus pensacolae, Chamberlin and Hoffman, ibid., p. 167.
Narceus ramstadi, Chamberlin and Hoffman, ibid., p. 167.
Narceus tinctorius, Chamberlin and Hoffman, ibid., p. 167.
Narceus woodi, Chamberlin and Hoffman, ibid., p. 168.

Nomenclatorial Considerations.—The oldest specific names in the Spirobolidae are *americae borealis* and *americanus,* both published in 1817 (according to Griffin, 1937) by Palisot de Beauvois, and both applied to the same species. Exercising the " right of the first reviser ", Hoffman (1951) selected *americanus* as the name to be used. There

has been no agreement, however, as to which species Palisot described.

The original description of *americanus* gave little information on which to base an identification. It is my opinion, however, that it gave enough. Three characters must be considered: Palisot's statement that his specimen had 49 segments, and the color and size as indicated by the figure (which is supposed to be natural size). Four species occur in the area in which Palisot traveled. *Chicobolus spinigerus* can be eliminated by its color. *Narceus gordanus* can be eliminated by its body proportions. The common northern species, *Narceus annularis,* never has as few as 49 segments (see Table 14). This leaves only the common southern species of *Narceus,* and it is herein designated *americanus.*

I have examined the types of *woodi, pensacolae, oklahomae, dolleyi,* and *melanior,* and consider them conspecific. The male pregenital coxae of *oklahomae* are somewhat unusual but appear to be the result of incomplete development; the female allotype is not unusual in any way. Both *atratus* and *crassus* were described from a locality where only one species of spirobolid occurs. I have examined topotypes of *ramstadti* that agree in every way with Chamberlin's description; the mesal processes of the sterna of the anterior gonopods are narrower than usual but study of other Florida specimens indicates this is a variable character and not worthy of nomenclatorial recognition. Two species of *Narceus* occur in Kentucky, but I have accepted the definitions of *tinctorius* given by Causey (1955a) and by Hoffman (1957); these descriptions apply to the more common species in that area.

Diagnosis.—Distinguished from *gordanus* by shape of the collum, shallower antennal groove, lack of a carina on the parietal sclerite, longer legs, larger lobes on the male pregenital coxae, and characters of the genitalia of both sexes. Differs from *annularis* in the characters given in the key and in Table 13. These characters are discussed in the remarks section under *annularis.*

Description.—L of males 51–125 mm. (78.5), of females 42–103 mm. (78.5); W of males 5.0–11.9 mm. (7.92), of females 4.9–10.4 mm. (8.15); L/W of males 8.4–11.8 (10.1), of females 8.1–11.7 (9.8). Segments 47–55 (51.1). Generally medium to dark brown (averaging somewhat lighter than *annularis*) with reddish hindbelts and legs; specimens of this species seem to fade worse in alcohol than do those of *annularis.*

Antennal groove moderately deep, well-delimited both anteriorly and posteriorly. Surface of parietal sclerite undulate but without a carina; sclerite tapering caudad. Mandibular cheek moderately grooved. Eyes per patch 35–60 (43.7). Clypeal setae 7–16 (9.7); labral setae 12–25 (16.3).

Collum usually covering only vertex of head, leaving eye patches, antennal grooves, and mandibular cheeks exposed; anterior margin of collum usually angling slightly caudad at level of eye patches, emarginate below angles. Second segment produced below ends of collum, the production moderately long, usually broad and rounded or truncate (sometimes subacute); ridge along anterior margin of production, this usually curving around ventral end of production, the ridge usually not as large as that of *annularis,* not much stronger than striae on median surface of production.

Coxae of male 3rd legs with large ventral lobes, these usually long and expanded laterally (figure 44); a deep transverse groove usually present on cephalic surface. Coxal lobes of 4th and 5th legs usually long, relatively narrow, and usually turgid. Lobes of 6th legs similar but usually shorter and broader. Coxae of 7th legs sometimes slightly produced, often not. Third segments of male legs 3–7 longer than 2nd segments, compressed, usually concave on caudal surface. Coxae of female 3rd legs usually produced ventrad, the lobe sometimes bent caudad. Legs relatively long, exceeding sides of body when held horizontally.

Gonopods like those of *annularis* except coxal endites usually slightly broader and prefemoral endites often acute distally.

Cyphopod thinner distally than in *annularis,* distal lobe usually not curved caudad. Distal corner of lateral flange often produced to form a tooth, a second tooth sometimes present on more proximal portion of flange.

Type.—Presumed lost; a personal communication from J. M. Demange of the Paris Museum indicates that Palisot's specimen is not in the collection of that institution. According to Merrill (1936), most of Palisot's American specimens were destroyed. Locality: " États-Unis d'Amérique ". Apparently Palisot's chief southern collecting spots were Savannah, Georgia and Charleston, South Carolina. Extant letters indicate that he found no new species of animals at Savannah. The type locality is, therefore, here restricted to Charleston County, South Carolina.

Type of *tinctorius:* presumed lost. Locality: Kentucky; restricted by Causey (1955a) to Natural Bridge, Powell County, Kentucky (this antedates Hoffman's, 1957, restriction of the locality to " knobby hills of Estill county, in Kentucky "). Type of *atratus:* unknown. Locality: prairie Mer Rouge, Louisiana. Type of *crassus:* unknown. Lo-

cality: " Les rives du lac Pontchartrain ", Louisiana. Type of *woodi:* male (NHMV; Chamberlin and Hoffman, 1958, incorrectly say, " Geneva Museum "). Locality: St. Louis, Missouri. Type of *pensacolae:* female (USNM). Locality: Pensacola, Florida. Type of *oklahomae:* male (RVC). Locality: Murray County, Oklahoma. Type of *dolleyi:* male (MCZ). Locality: Feemster's Lake area near Tupelo, Lee County, Mississippi. Type of *ramstadti:* male (RVC, Chamberlin says in publications, " Field Museum "). Locality: Punta Gorda, Florida. Type of *melanior:* female (RVC, " Field Museum "). Locality: Stephen E. [sic] [F.] Austin State Park, 5 miles east of Scaley [sic] [Sealey], Austin County, Texas.

Distribution.—Southeastern United States; from peninsular (the single record from Key West may be a result of mixing specimens) Florida and the Gulf States north to Illinois, Indiana, and Ohio west of the Appalachian Mountains, and to southern Virginia in the mountains and east of them (see map 2).

Specimens Examined.—178 (77 males, 101 females).

Alabama.—Baldwin County: Mobile Bay, Oak Bayou, April 4, 1958 (2 males, 1 female), S. Lazell (NBC). Cullman County: Ardell, May 4, 1915 (1 male), A. O. Howell (USNM). Mobile County: 10 mi. s. of Mobile, west shore Mobile Bay, Aug. 17–20, 1949 (1 male) (CNHM).

Arkansas.—Faulkner County: mountainside,4 miles nw. Conway, Aug. 7, 1955 (1 female), L. Hubricht (RLH). Hempstead County: Hope, June 11, 1954 (1 female), J. W. Green (CAS). Lawrence County: Imboden, 1923 (1 female), B. C. Marshall (MCZ). Logan County: Magazine Mtn., 1903 (1 female) H. A. Pilsbry (ANSP), 2800 ft., Aug. 12, 1939 (1 female), Rehn, Rehn (ANSP). Montgomery County: Caddo Mtn., 1.3 mi. se. Caddo Gap, Aug. 13, 1955 (1 male, 2 females), L. Hubricht (RLH). Pulaski County: Camp Robinson, April 21, 1943 (1 female), D. D. Davis (CNHM); Little Rock (1 male), Bollman (USNM), July-Aug., 1942 (1 female), W. Beecher (CNHM), 1943 (2 males), E. M. Nelson (CNHM). Saline County: 5 mi. e. Crows, Aug. 13, 1955 (1 female), L. Hubricht (RLH). Yell County: south side Magazine Mtn., 3 mi. n. Havana, Aug. 6, 1955 (1 female), L. Hubricht (RLH).

Florida.—" Magnolia " (2 females) (MCZ). Alachua County: (2 females) J. A. Oliver (RLH). Charlotte County: Punta Gorda, 1928 (2 males, 1 female), H. Ramstadt (CNHM). Duval County: Jacksonville, June 9, 1928 (2 females), O. F. Cook (USNM); in swamp, 5 mi. w. of Jacksonville, June 23, 1928 (5 males, 2 females), Cook (USNM). Escambia County: Pensacola (female, type of *pensacolae*) (USNM), Oct. 7, 1928 (1 male), Cook (USNM). Hernando County: Brooksville, March 22, 1928 (2 females), Cook (USNM).

Map 2.—Spot map of distribution records for *Narceus americanus* reported in this paper.

Highlands County: Highlands Hammock State Park, July 15–18, 1956 (1 female), D. J. Pirone, E. F. Menhinick (WTK), March 29, 1957 (1 female), Cornell Exped. (WTK). Hillsborough County: Tampa Springs (1 male), W. M. Beakley (ANSP). Indian River County: Sebastian (2 females), Nelson (MCZ). Lake County: between Astor and Altoona, Sept. 20, 1928 (1 male, 2 females) (USNM). Monroe County: Key West (1 female) (MCZ). Volusia County: St. John's River, Volusia (2 females) (MCZ).

GEORGIA.—"Georgia" (1 female) (USNM). Bibb County: Macon (1 female), L. M. Underwood (USNM). Camden County: St. Marys, 1896 (1 female), Outram Bangs (MCZ). Floyd County: Spring Creek, Aug. 27, 1913 (1 female) (MCZ). Rabun County: Tallulah (1 male, 2 females), L. M. Underwood (USNM).

ILLINOIS.—"Illinois" (1 female), Richards (MCZ). Champaign County: Urbana (2 females), Blake (MCZ). McLean County: Normal (1 male, 1 female) (MCZ). Richland County: 2 mi. n. of Olney, Bird Haven, May 14, 1943 (1 male), D. Lowrie (CNHM).

INDIANA.—Carroll County: Delphi (1 male) (MCZ). Howard County: Kokomo (1 male), Moon (USNM). Monroe County: Bloomington (1 male, 1 female), Bollman (USNM). Porter County: Tremont, Aug. 21, 1943 (1 male, 1 female), H. Dybas (CNHM).

KENTUCKY.—Edmonson County: Bee Spring, Jan. 8, 1874 (1 male, 3 females), F. S. S. (MCZ); near Mammoth Cave (1 female) (MCZ). Estill County: 5 mi. e. of Irvine, Rt. 80, May 9, 1954 (2 males), Hoffman (RLH). Harlan County: Pine Mountain, July, 1946 (2 males, 2 females), W. L. and C. K. Necker (CNHM).

LOUISIANA.—Jefferson Parish: Harahan, Sept. 20, 1944 (1 female), H. S. Dybas (CNHM). Natchitoches Parish: Creston, 1915 (1 male, 3 females), K. P. Schmidt (MCZ); Chastine, 2 mi. n. of Creston, April 29, 1947 (1 male), J. M. Schmidt (CNHM). Orleans Parish: New Orleans, June 22, 1883 (3 females), R. W. Shufeldt (USNM), Jan., 1917 (1 male, 1 female) (MCZ), Oct. 20, 1943 (1 male, 1 female), E. S. Ross (CAS). Rapides Parish: Forest Hill, Sept.–Oct., 1945 (3 males), R. L. Wenzel (CNHM). Red River Parish: East Carroll, Sept. 12, 1926 (1 female) (USNM). St. Charles Parish: Norco, Aug. 27, 1944 (4 males), H. S. Dybas (CNHM).

MISSISSIPPI.—Lee County: Feemster's Lake area near Tupelo, May, 1937 (1 male, type of *dolleyi*), J. S. Dolley (MCZ). Oktibbeha County: Agricultural College, April 1, 1917 (1 male, 2 females), Few, Franklin, Bailey (MCZ). Tishomingo County: Iuka, Sept. 7, 1932 (1 female), T. H. Hubbell (MCZ).

MISSOURI.—St. Louis County: St. Louis (4 females), M. Kaltenthaler (RLH); wagon road to Bridger's Pass, R. Mts., May 6, 1857 (1 female), Lt. F. T. Bryan (ANSP); St. Louis (1 male) (NHMV). Wayne County: S. A. Baker State Park, Aug. 28, 1946 (1 male), J. A. Peters (RLH).

NORTH CAROLINA.—Buncombe County: Ashville, July 1896 (1 female) (USNM). Carteret County: Beaufort (1 female), J. G. Shute (MCZ). Clay County: White Oak Bottom, June 4, 1952 (1 male), C. E. Wood, C. L. Rodgers (RLH); Tuni Gap, July 20, 1952 (1 male), Thelma Howell (RLH). Macon County: Highlands, Aug. 1, 1949 (1 male), R. L. Hoffman (RLH). Richmond County: n. of Rockingham, Sept. 14, 1928 (1 male) (USNM). Wake County: Raleigh, April 15, 1927 (1 female), D. L. Wray (RLH).

OHIO.—Vinton County: Tar Hollow State Forest, April 27, 1946 (2 males, 4 females), J. R. Bailey and E. S. Thomas (RLH).

OKLAHOMA.—"Camp Boulder", June 12, 1926 (1 male), T. H. Hubbell (RLH). Murray County: (male holotype, female allotype of *oklahomae*) (RVC).

South Carolina.—"South Carolina" (2 females) (MCZ). "Yellow Head" (1 female) (MCZ). Berkeley County: Bonneau, Aug. 23, 1929 (1 male), Cook (USNM). Oconee County: Cherry Hill Recreation Area, Route 107, Sept. 6, 1958 (1 male), J. G. Franclemont, R. W. Hodges (WTK); Whitewater River, Lower Falls, Aug. 22, 1949 (1 female), T. Howell (RLH).

Tennessee.—Cocke County: Newport, March 29, 1948 (1 male), M. Wright (RLH); Wolf Creek (1 female), C. B. Branner (USNM). Davidson County: Nashville, Glendale Hills, April 21, 1917 (1 male), H. Cummins (MCZ). Morgan County: Burrville, June 27, 1951 (1 female), B. Benesh (CNHM). Sevier County: Elkmont, el. 3,500 ft. (2 males), G. G. Ainslee (MCZ); Great Smoky Mountains National Park, Sept. 23, 1951 (1 male), Hoffman (RLH), Chimneys, May 19, 1956 (1 male, 2 females), Hoffman, Keeton, Lund (WTK).

Texas.—"Birkville", March 29, 1943 (1 male), B. A. Maina (CNHM). "Between Lufkin and Houston", Jan., 1931 (1 female), O. F. Cook (USNM). Austin County: Stephen F. Austin State Park (female, type of *melanior*), K. P. Schmidt (RVC). Brazos County: College Station, Dec., 1905 (1 male) (MCZ). Galveston County: Galveston, 1871 (3 females) (MCZ). Leon County: 5 mi. w. of Marquez, April 18, 1945 (2 females), K. P. Schmidt (CNHM). Williamson County: Georgetown (1 male) (MCZ).

Virginia.—Montgomery County: Dry Run, 5 miles e. of Blacksburg, Sept., 1957 (1 male), R. L. Hoffman (WTK), April, 1957 (1 male, 1 female), R. L. Hoffman (RLH). Norfolk County: Dismal Swamp, June, 1897 (1 female), D. W. Prentiss (USNM). Pittsylvania County: Smith Mtn. Gorge, June 19, 1955 (1 female), R. L. Hoffman (RLH). Russell County: summit of Clinch Mt., July 29, 1941 (1 female), Dr. and Mrs. S. T. Brooks (CMP). Surry County: Swann's Point, April 20, 1947 (1 male), Hoffman (RLH).

West Virginia.—Mingo County: along Pigeon Creek, 5 miles e. of Taylorsville (1 male), G. K. MacMillan, N. D. Richmond (CMP). Monongalia County: Cooper Rock, May 18, 1932 (1 female), M. G. Netting (CMP).

The following specimens are considered hybrids with *annularis*.

Illinois.—Champaign County: Champaign, Sept. 18, 1921 (1 male), A. O. Weese (MCZ); Urbana (1 male) (MCZ). Cook County: Willow Springs, Sept. 27, 1942 (1 female), H. S. Dybas (CNHM). McLean County: Normal (3 males) (MCZ).

Kentucky.—Edmonson County: Bee Spring, Jan. 8, 1874 (1 male), F. S. S. (MCZ).

Missouri.—St. Louis (1 male), M. Kaltenthaler (RLH).

Nebraska.—Richardson County: 4 mi. e. of Barada, May 29, 1948 (2 males, 1 female), M. H. Muma and O. S. Bare (RLH).

Ohio.—Greene County: Yellow Springs, 1868 (1 female) (MCZ).

Tennessee.—Carter County: Burbank (1 male), R. Thaxter (MCZ).

Narceus gordanus (Chamberlin) Figures 14–15, 32–34, 52–56, 75–77, 92–93

Spirobolus gordanus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 2, p. 5, figs. 6–11. 1943.
Arctobolus keysi Loomis, Psyche, vol. 51, p. 169, fig. 2. 1944. **New synonymy.**
Narceus gordanus Chamberlin, Amer. Midl. Nat., vol. 50, p. 150. 1953.
Narceus gordanus, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 75. 1955.
Narceus keysi, Causey, ibid., p. 75.
Narceus keysi, Causey, Proc. Biol. Soc. Washington, vol. 70, p. 205. 1957.
Narceus gordanus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 166. 1958.
Narceus keysi, Chamberlin and Hoffman, ibid., p. 166.
Narceus gordanus, Keeton, Bull. Brooklyn Ent. Soc., vol. 54, p. 7. 1959.

Nomenclatorial Considerations.—I have examined the type of *keysi* and am thus sure that that name is based on the species here described. I have been unable to study the type of *gordanus,* but Chamberlin's mention of the large size of the male prefemoral endite and of the only slight production of the male pregenital coxae seems to fit this species despite his description of the color, a variable character.

Diagnosis.—Differs from the other species of *Narceus* in having much shorter legs, a larger, differently shaped collum which covers much of the head, much deeper antennal grooves, carinate parietal sclerites which do not taper caudad, more labral setae, very thin distal lobes of cyphopods, broader prefemoral endites of posterior gonopods, and less production of male pregenital coxae. Other differences in meristic characters are shown in Tables 14–21.

Description.—L of males 66–114 mm. (94.2), of females 59–119 mm. (93.3); W of males 7.0–12.2 mm. (10.41), of females 6.9–12.8 mm. (10.45); L/W of males 8.1–9.8 (9.0), of females 7.2–9.8 (8.9). Segments 45–54 (49.9).

Segment rings light greenish tan on dorsum and sides, often becoming steel grey below; posterior half of each hind belt slightly darker tan. Cephalic margin of collum, extreme caudal margin of telson, caudal margin of anal scale, and anal lips reddish brown. Face and antennae moderately dark brown; eyes black. Legs dark brown. Specimens often become darker at death but generally fade to very light tan after a year or more in alcohol. Color varies considerably between localities, e.g. live specimens examined from Ocala, Florida were darker than live specimens from Highlands Biological Station (of possible interest is the fact that the latter occurred in a substrate of very light-colored sand).

Antennal groove very deep, strongly delimited both anteriorly and posteriorly. Parietal sclerite carinate at border of antennal groove; sclerite narrowing

abruptly behind carina. Mandibular cheek deeply grooved for reception of antenna. Eyes per patch 37–59 (46.0). Clypeal setae 8–12 (10.1); labral setae 19–35 (25.5).

Collum broad, covering much of head; half of eye patch, most of antennal groove, and base of mandibular cheek hidden; anterior margin of collum angling slightly forward at level of eye patches. Second segment produced below ends of collum but the productions not long, usually rounded.

Tergites not as densely punctate as those of other species of *Narceus;* few rugulae.

Anal lips often indistinct or absent.

Pregenital coxae of male not much produced; those of 3rd–5th legs usually with short, broad lobes. All legs very short, not reaching sides of body when held horizontally. Few ventral setae (e.g. 1-0-0-1-2-4).

Gonopods of usual *Narceus* type except coxal endites often very broad, and prefemoral endites usually broad, twisted at base, truncate distally.

Cyphopod very thin distally. Distal corner of lateral flange often produced to form prominent tooth.

Type.—Male (RVC, Chamberlin says in publication, "Field Museum"; cannot be located at present). Locality: Punta Gorda, Florida. Type of *keysi:* male (MCZ). Locality: Lantana, Florida.

Distribution.—Peninsular Florida north to South Carolina and (?) Tennessee. The specimens from Tennessee here reported were in a large jar containing other *Narceus* species; they may have been mixed erroneously at some time.

Specimens Examined.—164 (78 males, 86 females).

Florida.—"Florida, July–Aug., 1925" (1 male) (USNM). Alachua County: 1948 (1 male, 1 female), C. J. Goin (RLH); Gainesville, Oct. 11, 1929 (2 males, 2 females), O. F. Cook (USNM), March, 1931 (2 females), Cook (USNM); Gainesville, Paynes Prairie, Oct., 1929 (1 male), Cook (USNM). Broward County: Deerfield, Aug. 19, 1929 (2 females), Cook (USNM). Collier County: Cape Romano (2 females) (USNM); Naples, Sept. 23, 1928 (3 males, 10 females), O. F. Cook (USNM). Hernando County: betw. Brooksville and Dade City, Nov. 8, 1929 (1 male), Cook (USNM). Highlands County: Highlands Biological Station, Aug., 1958 (43 males, 41 females), T. Eisner, J. Nowosielski, R. S. Payne (TE). Hillsborough County: Tampa Springs (1 male), W. M. Beakley (ANSP). Lake County: betw. Astor and Altoona, Sept. 20, 1928 (1 male, 3 females), Cook (USNM). Marion County: Ocala, Aug., 1958 (17 males, 13 females) (TE); Ocala National Forest, Oct., 1929 (1 female), Cook (USNM). Palm Beach County: Lantana, Dec., 1944 (2 males), A. Keys (USNM), May 12, 1944 (male, type of *keysi*), A. Keys

(MCZ); near Palm Beach, Aug., 19, 1929 (1 female), Cook (USNM). Polk County: betw. Fort Meade and Wauchula, Sept. 21, 1928 (3 males, 4 females), Cook (USNM). Saint Johns County: St. Augustine (1 male) (MCZ).

South Carolina.—Charleston County: James Island, Sept. 15, 1928 (1 female), Cook (USNM).

Tennessee.—Carter County: Burbank (3 females), R. Thaxter (MCZ).

Subfamily TYLOBOLINAE, new

This subfamily is readily distinguished from the Spirobolinae by the characters listed in Table 1 and in the key. A more complete description is given here.

L 35–92 mm.; W 4.2–10.1 mm.; L/W 6.3–12.6. Segments 40–54.

Face moderately broad, clypeus usually only slightly exceeded laterally by second segment of antenna; ventral corners of clypeus broadly rounded; lateral corners of clypeus usually not fully distinct, sloping into antennal groove and forming part of floor of groove. Antennal groove never very deep, the depth a generic characteristic. Mandibular cheek at most only slightly grooved; stipes rounded or squared distally, sometimes with a small knob on ventrodistal corner. Eye patches as long as broad, separated by a distance greater than twice the width of a patch. Usually fewer eyes per patch than in the Spirobolinae, 21–50. Clypeal setae 6–12; labral setae 10–24. Number of stipital setae of gnathochilarium never fixed, 5–15 per stipes.

Collum usually covering only vertex of head; lateral ends of collum narrowly rounded or subacute; anterior borders of paranota usually emarginate below level of eye patches, second segment produced below ends of collum, the production variable in shape but never long and acute. Cephalic plate of second segment without deep notch in its mesal margin.

Tergites usually only sparsely punctate and with few rugulae; striae on lower portion of hindbelt usually ending about midway between pleural suture and repugnatorial pore. No secondary segmental suture.

Tergum of telson produced but never covering all of anal valves which are clearly visible from above. Valves not as compressed as in the Spirobolinae; anal lips distinct or not.

Second segment of male 2nd legs often greatly enlarged, its surface sometimes papillate. Male 3rd coxae always with uncinate ventral lobes, each lobe appearing oval from below, its caudal end more narrowly rounded than its cephalic end (figure 18). Second segments of male legs 3–7 usually as long or longer than 3rd segments. Third coxae of females often with more than one ventral seta.

Sternum of anterior gonopods broad, subtriangular, without a mesal process. Coxal endites varying in shape and size, usually papillate on mesoventral portion

of cephalic surface. Anterior telopodites relatively narrow basally, uncinate or not distally. Posterior telopodite without the deeply concave mesal surface typical of Spirobolinae; seminal receptacle large, usually with a restricted opening; seminal canal usually entirely closed. Mesal apodeme of posterior telopodite long, sclerotized. Part of surface of telopodite often spinose. No prefemoral endites.

Cyphopod with relatively long, distinct distal lobe; no lateral flange.

Distribution.—From Oregon south through Mexican highlands to Guatemala. Only one rare species is known west of the Rocky Mountains in the United States.

Classificaton.—Four nominal genera are referable to the Tylobolinae. I recognize only two of these as valid. They may be separated by the following key.

Key to the Genera of the Tylobolinae

1. Ventrodistal corner of mandibular stipes rounded (figures 11, 218–220); anal lips not distinct; no props on caudal surfaces of coxal endites of male anterior gonopods; posterior telopodite without long spine-like distal process; distal lobe of female cyphopod thin, not papillate (figures 196–201) ..... *Hiltonius*

   Ventrodistal corner of mandibular stipes sharp (figures 13, 221, 222); anal lips usually distinct; a shelf-like prop on caudal surface of each coxal endite of male anterior gonopods; posterior telopodite with long spine-like distal process (figure 226); distal lobe of female cyphopod thick, papillate (figures 194, 195) ..... *Tylobolus*

Genus **Hiltonius** Chamberlin

Hiltonius Chamberlin, Proc. Biol. Soc. Washington, vol. 31, p. 166. 1918.
Hiltonius Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 166. 1949.
Hiltonius, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 163. 1958.

Type Species: *Hiltonius pulchrus* Chamberlin, by original designation and monotypy.

Description.—The distinguishing characters of the genus are given in the key and listed in Table 3.

L 35–70 mm.; W 4.3–10.1 mm.; L/W 6.3–10.5. Segments 40–49.

Lateral corners of clypeus relatively indistinct, blending into antennal groove and forming part of floor of groove. Antennal groove very shallow, hardly defined at all posteriorly. Parietal sclerite subtriangular, tapering caudad. Mandibular cheek not grooved for reception of antenna; stipes rounded distally. Eye patches small, 21–37 eyes per patch. Clypeal setae 6–12; labral setae 12–24.

Stipital setae of gnathochilarium 5–15 per stipes.

Collum narrowly rounded or subacute laterally; anterior margin emarginate below level of eye patches, extent of emargination varies with species. Second segment exceeding ends of collum laterally but the production often not limited to anterior corner; production usually very broadly rounded.

Striae ending on hindbelts well below pores in all species except *fossulifer* and *carpinus*.

Anal lips never distinct, although anal valves sometimes slightly compressed.

Lobes of male 3rd coxae smaller than those of *Tylobolus,* their ventral surface more convex. Coxae of male legs 4–7 with short, compressed, distally rounded lobes; other segments not specially modified; claws relatively long, often more than half as long as last podomeres. Postgenital legs not modified. Legs usually short, often not reaching sides of body when held horizontally.

Coxal endites of anterior gonopods always broad, much exceeding mesal apex of sternum ventrally; mesoventral corners of endites often slightly produced ventrad forming knob-like processes. Anterior telopodites sometimes uncinate distally, sometimes with the uncinate portion obsolete. Posterior telopodite without long spine-like distal process but sometimes with short, subspatulate, very strongly sclerotized distal portion. Opening of seminal receptacle sometimes very restricted, sometimes relatively large. Coxae of posterior gonopods usually somewhat reduced. Postgenital bar relatively narrow but never raised or ridge-like; postseral emargination more distinct than genital emargination but neither very deep.

Cyphopod with large, thin distal lobe; surface of distal lobe smooth, never papillate. Lateral suture very distinct, providing species characters.

Distribution.—From extreme southern California south through Mexican highlands to southwestern corner of Guatemala.

Classification.—I am here recognizing seven species of *Hiltonius.* Two of the species are doubtful ones and further study may reveal that they are not valid. Two species, the types of which I have been unable to examine, are listed as *nomina inquirenda.* The sexes are keyed separately below.

Key to the Species of Hiltonius

Males

1. Telopodites of anterior gonopods distinctly uncinate distally (figure 166) .. 2
   Telopodites of anterior gonopods not, or only slightly, uncinate distally (figure 178) 4
2. Distal portion of posterior telopodite spinose and distinctly bilobate (figure 173) ..... *carpinus*
   Distal portion of posterior telopodite either not spinose or not bilobate .. 3
3. Distal portion of posterior telopodite not spinose and not bilobate, usually strongly compressed (figure 168); tergal striae usually ending well below repugnatorial pores ..... *mexicanus*
   Distal portion of posterior telopodite spinose but not bilobate; tergal striae reaching level of repugnatorial pores on at least the posterior segments, striae very strong ..... *fossulifer*
4. Distal portion of posterior telopodite narrowly spatulate, hook-like; serrate flange of cephalic surface produced to form a very large tooth (figures 187, 188) ..... *mimus*
   Distal portion of posterior telopodite broadly spatulate; serrate flange of cephalic surface not forming such a large tooth 5
5. Distal spatulate portion of posterior telopodite with serrate edges, the cephalic edge usually continuous with a mesally directed serrate flange of the cephalic surface of the telopodite; no serrate flange of caudal surface (figures 179–182) ..... *pulchrus*
   Distal spatulate portion of posterior telopodite not serrate, not continuous with serrate cephalic flange, the latter continuous distally (proximomesal of spatulate portion) with a large serrate flange of the caudal surface of the telopodite (figures 190, 191) ..... *hebes*

Females

1. Distal lobe of cyphopod usually shorter and thicker; distal half of lateral suture running diagonally in an impressed groove (figures 196, 197) *mimus* and *pulchrus*
   Distal lobe usually longer, thinner; distal half of lateral suture not running diagonally in such an impressed groove (figures 198–201) 2
2. Lateral surface of cyphopod usually without a discal concavity (figure 198) *hebes*
   Lateral surface with a discal concavity 3
3. Lateral suture only slightly bent in discal concavity (figure 199) .. *mexicanus*
   Lateral suture strongly and abruptly bent in discal concavity (figures 200, 201) 4
4. Discal concavity very deep (figure 200) ..... *carpinus*
   Discal concavity moderately deep (figure 201) ..... *thebanus*

Hiltonius mexicanus (Saussure) Figures 166–170, 199, 202–203, 209–210

Julus mexicanus Saussure, Linnaea Ent., vol. 13, p. 332. 1859.
Julus mexicanus Saussure, Mem. Soc. Phys. Hist. Nat. Geneve, vol. 15, pt. 2, p. 366 [erroneously numbered "566"], fig. 34. 1860.
Spirobolus mexicanus, Saussure and Humbert, Mission scientifique au Mexique, Myriapodes, p. 177. 1872.
Spirobolus mexicanus, Pocock, Biol. Centr.-Amer., Diplopoda, p. 81. 1908.
Spirobolus mexicanus, Carl, Rev. Suisse Zool., vol. 27, p. 402, figs. 40–42. 1919.
Eurelus tancitarus Chamberlin, Ent. News, vol. 52, p. 255, figs. 5–7. 1941. **New synonymy.**
Hiltonius federalis Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 3, p. 22, fig. 38. 1943. **New synonymy.**
Hiltonius michoacanus Chamberlin, ibid., p. 23, figs. 39–41. **New synonymy.**
Hiltonius tancitarus Chamberlin, ibid., p. 23.
Hiltonius veracruzanus Chamberlin, ibid., p. 24, figs. 42–43. **New synonymy.**

Nomenclatorial Considerations.—I have seen the types of *mexicanus, tancitarus, federalis,* and *michoacanus* and specimens of *veracruzanus* listed by Chamberlin at the time of the original description of that species. I consider them all conspecific.

Diagnosis.—Distinguished from other species of the genus by characters of the male and female genitalia as given in the key. Differs from *carpinus,* with which it is sympatric, also in the sharper lateral ends of the collum, the deeper emarginations of the anterior margins of the paranota of the collum, and the usually more rounded ventrolateral corners of the second segment, the productions of which are generally not limited to the anterior corner.[5]

Description.—L of males 35–58 mm. (49.0), of females 46–67 mm. (55.5); W of males 4.3–6.4 mm. (5.66), of females 5.7–7.8 mm. (6.86); L/W of males 8.1–9.3 (8.6), of females 7.3–8.8 (8.1). Segments 40–49 (42.6).

Eyes per patch 21–36 (27.9). Clypeal setae 6–9 (8.0); labral setae 13–20 (15.4). Stipital setae of gnathochilarium 5–9 (7.0) per stipes.

Lateral ends of collum subacute; anterior margins of paranota of collum emarginate below level of eye patches, the emarginations often very deep. Sec-

[5] With the aid of a grant from the American Philosophical Society I was able to spend the summer of 1959 in Mexico. Series of both *Hiltonius mexicanus* and *Hiltonius carpinus* were collected and are now being studied. Further information concerning these species will be published in the future, but one unexpected fact should be mentioned in this monograph. The two species differ markedly in color, *mexicanus* being banded with vivid red and black while *carpinus* is banded with duller red and yellow.

ond segment much exceeding ends of collum but its productions usually not limited to anterior corner, often consisting of large rounded knobs extending over entire ventrolateral portions of segment.

Tergal striae usually not very strong, ending about midway between pleural sutures and repugnatorial pores.

Legs short, usually not reaching sides of body when held horizontally.

Anterior telopodites of gonopods distinctly uncinate distally. Posterior coxae sometimes greatly reduced, the reduction generally greatest in region of cephalic surface. Posterior telopodite decidedly compressed, without numerous small spines on its distal surface; prefemoral portion distinct but only partially set off from tibiotarsal portion on cephalic surface. Elongate opening of seminal receptacle located on mesal margin just proximal to distal end of telopodite; opening bordered by thin sclerotized lips. Telopodite usually bearing small hook-like distal process, this often with a small serrate flange.

Cyphopod with shallow depression in disc of lateral surface; lateral suture relatively straight or gently sinuate, never with loop in discal depression.

Remarks.—Unfortunately, few specimens of the various species of *Hiltonius* have been available for study. Potential meristic characters must, therefore, remain unutilized as key characters until such time as adequate series can be studied and more reliable means and extremes determined. Tables 22–29 give what information I have obtained regarding the meristic characters.

Distribution.—At present known only from Michoacan, Morelos, Distrito Federal, and extreme west-central Veracruz in Mexico.

Type.—Male (MHNG). Locality: "Le Mexique"; here restricted to Michoacan, Tancitaro. Type of *tancitarus:* male (RVC). Locality: Mexico, Michoacan, Tancitaro. Type of *federalis:* subadult male (RVC). Locality: D. F., Salazar, el. 3000 meters. Type of *michoacanus:* male (RVC). Locality: Mexico, Veracruz, 18 miles west of Perote.

Specimens Examined.—19 (11 males, 8 females).

MEXICO.—"Mexique" (male, holotype of *mexicanus*) (MHNG). DISTRITO FEDERAL: 25 kl. n. of Cuernavaca, 42 kl. from Mexico City, July 23, 1950 (3 females), Martin (RLH); Salazar, 3000 meters, June 29, 1941 (2 males, labelled holotype and allotype of *federalis*), J. Alvarez (RVC); Tres Cumbres, summer, 1949 (4 males, 3 females) (RLH). MICHOACAN: Tancitaro, moist woods, July 20, 1940 (male holotype, female paratype of *tancitarus*), Hoogstral (RVC); 10 miles n. of Zamora, July 10, 1942 (male holotype, female allotype of *michoacanus*), B. C. Brown (RVC). MORELOS: Zempoala, el. 2800 meters, May 13, 1940 (2 males), C. Bolivar (RVC).

TABLE 22

Segment counts for specimens of species of Hiltonius.

Segments	40	41	42	43	44	45	46	47	48	49	total	mean
c. carpinus			1		1	1					3	43.7
c. vulcan	1	1									2	40.5
mexicanus	2	1	10	2					1	1	17	42.6
hebes				1		2	4				7	45.3
pulchrus							1	1	1	4	7	48.1
mimus							1		1		2	47.0

TABLE 23

Clypeal setae counts for specimens of species of Hiltonius.

Setae	6	7	8	9	10	11	12	total	mean
c. carpinus			4	2				6	8.3
c. vulcan	4							4	6.0
mexicanus	1	3	8	5				17	8.0
hebes				1	3	2	1	7	10.4
pulchrus		1	5	4				10	8.3
mimus		2	2	1	1			6	8.2

Hiltonius fossulifer (Pocock), new combination

Spirobolus fossulifer Pocock, Biol. Centr.-Amer., Diplopoda, p. 78, Tab. 7, fig. 2. 1908.

Remarks.—Pocock's species has not been reported since its description and I have seen no specimens that fully fit the original description. The drawings of the gonopods definitely indicate that the species should

TABLE 24

Labral setae counts for specimens of species of Hiltonius.

Setae	12	13	14	15	16	17	18	19	20	21	22	23	24	total	mean
c. carpinus	2		1		1						1			5	15.2
c. vulcan		1			3	1								5	15.6
mexicanus		2	5	3	3	3	1		1					18	15.4
hebes								2	1		1	1	1	6	21.2
pulchrus	1		1	1	5	1		1						11	15.7
mimus			4	1	1									6	14.5

TABLE 25

Counts of setae per stipes for specimens of species of Hiltonius.

Setae	5	6	7	8	9	10	11	12	13	14	15	total	mean
c. carpinus		1	2	1		1	2	2	1	1	1	12	10.5
c. vulcan		3										3	6.0
mexicanus	1	6	16	5	1							29	7.0
hebes		1	3	1	1	2	3	1				12	9.1
pulchrus		6	6		1	1						14	6.9
mimus	1	6	4	1								12	6.4

be placed in *Hiltonius*. The posterior gonopod resembles that of *mexicanus* but its distal portion is covered with prominent spicules. A drawing of the eighth segment shows strong striae on the hindbelt up to the level of the repugnatorial pore; this condition is more typical of *carpinus* than of *mexicanus*. It seems possible that Pocock had before him a subadult specimen of *carpinus* in which the bilobate condition of the posterior gonopods was not yet fully evident. Figures 176 and 177 show a subadult male of *carpinus* in which the bilobate condition can be seen but in which it is not yet very evident in caudal view.

TABLE 26

Number of eyes per patch in specimens of species of Hiltonius.

Eyes	c. carpinus	c. vulcan	mexicanus	hebes	pulchrus	mimus
21.			2			
22.		1				
23.		1	2			
24.	3	1	2			
25.	1	1	2			
26.	2		1	1		
27.	1		2	1	1	
28.	3		6	5	1	
29.			3	2	2	2
30.	1		2		2	1
31.			2	1		
32.	3			2	3	1
33.			1		2	
34.			1		2	
35.			1		1	1
36.			1			
37.					2	1
total	14	4	28	12	16	6
mean	27.6	23.5	27.9	28.8	32.0	32.0

I feel that it would be premature to consider *fossulifer* and *carpinus* conspecific on the basis of such guesswork. It is to be hoped that future collecting will facilitate a more complete understanding of the species of *Hiltonius* and will result in a definite decision regarding Pocock's species. If the evidence indicates that *fossulifer* and *carpinus* are synonyms, the former will, of course, be the older name.

TABLE 27

List of lengths of specimens of two species of Hiltonius.

mexicanus								
male	35,	46,	47,	50,	51,	56,	58	
female	46,	52,	52,	52,	57,	57,	61,	67
pulchrus								
male	45,	48,	55,	59				
female	49,	70						

TABLE 28

List of widths of specimens of two species of Hiltonius.

mexicanus								
male	4.3,	5.4,	5.7,	5.8,	6.0,	6.0,	6.4	
female	5.7,	6.0,	6.2,	6.6,	7.3,	7.6,	7.7,	7.8
pulchrus								
male	5.5,	5.8,	5.9,	6.6				
female	5.6,	6.9						

TABLE 29

List of L/W values of specimens of two species of Hiltonius.

mexicanus								
male	8.1,	8.1,	8.5,	8.5,	8.8,	9.1,	9.3	
female	7.3,	7.8,	7.9,	7.9,	8.1,	8.3,	8.7,	8.8
pulchrus								
male	7.6,	8.3,	8.7,	10.2				
female	7.9,	8.8						

Type.—Male, presumed lost. A personal communication from G. Owen Evans of the British Museum states that Pocock removed the specimen from the museum and that it was never returned. Locality: Mexico, Guerrero, Omilteme, 8,000 ft.

Hiltonius carpinus Chamberlin Figures 171–177, 200, 204, 211–213

I recognize two subspecies of *carpinus* which may be identified by use of the following key.

1. Clypeal setae more than 3 + 3 ..... *c. carpinus*
   Clypeal setae 3 + 3 ..... *c. vulcan*

Hiltonius carpinus carpinus Chamberlin, new status

Hiltonius carpinus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 3, p. 21, figs. 34–36. 1943.
Hiltonius crassus Chamberlin, ibid., p. 21, fig. 37. **New synonymy.**
Hiltonius tepoztlanus Chamberlin, ibid., p. 21. **New synonymy.**

Nomenclatorial Considerations.—The name *tepoztlanus* is apparently one which Chamberlin once intended to use for specimens which he included in *carpinus* in the published description. The name was, unfortunately, validated by the comparison of *crassus* with it, this comparison constituting an " indication ". I exercise the " right of the first reviser " in selecting *carpinus* as the valid name for this species.

Diagnosis.—Readily distinguished from other species of the genus by the characters of the male and female genitalia as indicated in the key. Differs from *mexicanus,* with which it is sympatric, also in the slightly more rounded lateral ends of the collum, the usually less pronounced anterior emarginations of the collum, and the more often subacute anterior ventrolateral corners of the second segment.[6] The clypeal setae are not fixed at 3 + 3 but are usually more and variable in number; this character easily distinguishes this form from *c. vulcan.*

Description.—L of males 46, 59 mm., of female 57 mm.; W of males 5.7, 7.1, 7.4, 8.4 mm., of females 6.9, 8.1 mm.; L/W of males 8.0, 8.1, of female 7.0. Segments 42, 44, 45.

Eyes per patch 24–32 (27.6). Clypeal setae 8–9 (8.3); labral setae 12–22 (15.2). Stipital setae of gnathochilarium 6–15 (10.5) per stipes.

Lateral ends of collum narrowly rounded; anterior emarginations of collum usually not deep. Second segment much exceeding ends of collum; anterior ventrolateral corner usually more produced than posterior corner.

Tergites of posterior portion of body often with very strong striae which sometimes extend up on sides to level of repugnatorial pores; striae often produced caudad to form small hooks along caudal borders of tergites.

Legs short, usually not reaching sides of body when held horizontally.

---

[6] For color differences, see footnote 5 on page 100.

Anterior telopodites of gonopods distinctly uncinate distally. Coxal endites usually produced ventrad at their mesoventral corners, extent of this production variable but usually greater than that in *mexicanus*. Posterior coxae often somewhat obsolete distally. Posterior telopodite large, strongly sclerotized, without the wide membranous groove on cephalic face that is typical of some species of the genus; telopodite distally bilobate, the more mesal portion smaller, this often with a very small digitiform process at its mesodistal corner; both distal lobes curving slightly caudad and both with numerous small spicules on their cephalic surfaces. Opening of seminal receptacle and canal on mesal margin just proximal of distal end of telopodite; opening bordered by projecting thin, sclerotized lips.

Cyphopod with very deep depression in disc of lateral surface; lateral suture abruptly and strongly bent within discal depression.

Remarks.—Unfortunately, only three of the adult specimens examined were in good enough condition for segment counts and lengths to be determined. The values obtained are listed in the description but no means are given. It is to be hoped that future collecting will make possible an analysis of these and other meristic characters. Only then will the apparent differences between this subspecies and *c. vulcan* be capable of evaluation.

Distribution.—At present known only from the states of Mexico, Morelos (Chamberlin, 1943), and Tamaulipas in Mexico.

Type.—Male (RVC). Locality: Mexico, Tamaulipas, 2 miles south of Limon. Type of *crassus:* male (RVC). Locality: Mexico, Ixtapan del Oro.

Specimens Examined.—6 (4 male, 2 female).

MEXICO.—"MEXICO" (2 males, 1 female) (USNM). MEXICO: Ixtapan del Oro, June 8, 141 (1 male, holotype of *crassus*), F. Bonet (RVC). TAMAULIPAS: 2 mi. s. Limon, June 24, 1942 (male holotype, female allotype of *carpinus*), R. C. Brown (RVC).

Hiltonius carpinus vulcan (Chamberlin), new combination

Aztecolus vulcan Chamberlin, Amer. Midl. Nat., vol. 50, p. 148, figs. 25–26. 1953.

Rhinocricus vulcan Chamberlin, ibid., p. 144.

Aztecolus fratrellus Chamberlin, ibid., p. 148, figs. 23–24. **New synonymy.**

Nomenclatorial Considerations.—I have seen the types of both *vulcan* and *fratrellus*. It is evident that they belong in *Hiltonius*, not in *Aztecolus*. The holotype of *fratrellus* is an immature male but it is

clearly conspecific with *vulcan*. Both names were proposed at the same time. I invoke the " right of the first reviser " in selecting *vulcan* as the more suitable name.

Diagnosis.—Similar in all qualitative characters, including genitalia, to *c. carpinus;* differing from that subspecies in meristic characters, the most important of which is the apparently fixed count of 3 + 3 clypeal setae.

Description.—Like *c. carpinus* except in the characters here mentioned.

L of male 44 mm., of female 44 mm.; W of male 4.2 mm., of female 4.8 mm.; L/W of male 10.5, of female 9.2. Segments 40, 41.

Eyes per patch 23 + 22, 24 + 25. Clypeal setae 3 + 3 in all 4 specimens; labral setae 13–17 (15.6). Stipital setae of gnathochilarium 6 per stipes.

Remarks.—Ordinarily the clypeal setae count alone would not be considered a reliable or important character for nomenclatorial distinction. However, of 652 specimens of spirobolids (exluding *vulcan*) examined for this character, only 11 had clypeal setae counts of 6. Most of those 11 had uneven distribution of the setae (e.g. a specimen of *Hiltonius mexicanus* with a count of 4 + 2). It is thus very unlikely that by pure chance a collection of four specimens from a given locality would show only counts of 3 + 3.

This collection is of special interest inasmuch as it is the only record of spirobolids in Guatemala. The specimens were taken by K. P. Schmidt on the very high volcanic peak Volcan Tajumulco in extreme southwestern Guatemala. Schmidt (1936) has published an excellent account of the unusual conditions existing on this mountain.

It seems probably that *vulcan* constitutes an isolated population existing in the temperate forests of the mountain slopes. The surrounding tropical areas may act as a barrier to genetic interchange with the larger population of *c. carpinus* in the Mexican highlands. In a small inbreeding population such as that on Tajumulco, it would not be difficult for a clypeal setae count of 3 + 3 to become fixed as typical of the population.

Type.—Male (RVC; Chamberlin says in publication, " Chicago Natural History Museum "). Locality: Guatemala, Volcan Tajamulco. Type of *fratrellus:* imm. male (RVC, " Chicago Natural History Museum "). Locality: Guatemala, Volcan Tajumulco. The subspecies is known only from the type locality.

Specimens Examined.—4 (2 males, 2 females).

I have seen the male holotype and 2 female paratypes of *vulcan,* and the male holotype of *fratrellus.* All were taken by K. P. Schmidt on Feb. 18, 1934 (the Mandel Expedition).

Hiltonius pulchrus Chamberlin Figures 11, 178–183, 197, 206, 216

Hiltonius pulchrus Chamberlin, Proc. Biol. Soc. Washington, vol. 31, p. 166. 1918.

Hiltonius conservatus Chamberlin, Proc. Acad. Nat. Sci. Philadelphia, vol. 99, p. 53, figs. 61–63. 1947. **New synonymy.**

Hiltonius palmaris Loomis, Journ. Washington Acad. Sci., vol. 43, p. 418, figs. 6–9. 1953. **New synonymy.**

Hiltonius conservatus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 164. 1958.

Hiltonius palmaris, Chamberlin and Hoffman, ibid.

Hiltonius pulchrus, Chamberlin and Hoffman, ibid.

Diagnosis.—Males are distinguished from all other species of the genus by the characters of the gonopods as given in the key. Females differ in the characters of the cyphopods from all other species of the genus except *mimus.* I am unable to give any reliable character to separate females of these two species. Specimens of *pulchrus* usually differ from those of *hebes* (with which they are sympatric) in having shorter, less acute paranota of the collum, in the shape of the lateral portion of the second segment, and in body preportions. In all of these characters, *pulchrus* and *mimus* closely resemble each other.

Description.—L of males 45–59 mm. (51.8), of females 49–70 mm. (59.5); W of males 5.5–6.6 mm. (6.0), of females 5.6–6.9 mm. (6.3); L/W of males 7.6–10.2 (8.7), of females 7.9–8.8 (8.4). Segments 46–49 (48.1).

Eyes per patch 27–37 (32.0). Clypeal setae 7–9 (8.3); labral setae 12–19 (15.7). Stipital setae of gnathochilarium 6–10 (6.9) per stipes.

Paranota of collum relatively short, their lateral ends very narrowly rounded, subacute but not as sharply so as in *hebes;* anterior emarginations of collum moderate. Second segment usually more produced at anterior ventrolateral corner than at posterior corner, thus differing from most common condition in *hebes.*

Legs not as short as in most other species of *Hiltonius,* usually almost reaching sides of body when held horizontally.

Anterior telopodites of gonopods not uncinate distally but rounded and sometimes with small knob corresponding to distal process in *carpinus* and *mexicanus.* Coxal endites slightly produced ventrad at mesoventral corners. Posterior telopo-

dite subspatulate distally, the spatulate portion with serrate edges; serrate cephalic edge of spatulate portion continuous with serrate margin of large mesally directed flange of cephalic surface of telopodite; the flange variable in size and shape, its mesodistal corner sometimes sharp and tooth-like but never as long and narrow as that of *mimus*. A wide membranous groove curving across cephalic face of posterior telopodite and thus separating prominent prefemoral region from more distal tibiotarsal region, this groove typical of all California species of *Hiltonius*. Opening of seminal receptacle on mesal face of tibiotarsal portion of telopodite just distal to shoulder of prefemoral portion, this more proximal location typical of California species of *Hiltonius* as opposed to distal location of opening in *carpinus* and *mexicanus*. Cephalic face of coxae of posterior gonopods usually obsolete.

Cyphopod with relatively short distal lobe, this usually curved caudad distally. Lateral suture with a long distal section running diagonally across lateral face of cyphopod in an impressed groove.

Distribution.—Known only from the southern portion of California.

Type.—Male (MCZ). Locality: Claremont, California. Type of *conservatus:* male (ANSP). Locality: Ft. Tejon, California. Type of *palmaris:* male (USNM). Locality: Palm Canyon, Palm Springs, California.

Specimens Examined.—10 (6 males, 4 females).

California.—Kern County: Ft. Tejon (male, holotype of *conservatus*) (ANSP). Los Angeles County: Claremont (2 males, one the holotype of *pulchrus*), W. A. Hilton (MCZ); Los Angeles (1 male, 1 female) (USNM); San Francisquito Canyon, 1953 (1 female) (LACM). Riverside County: Palm Canyon, Palm Springs, Dec. 4, 1919 (2 males, 1 female, holotype and paratypes of *palmaris*), H. F. Loomis (USNM). San Diego County: San Diego, Nov. 22, 1932 (1 male), McKeever (USNM).

Hiltonius mimus Chamberlin Figures 184–188, 196, 205, 217

Hiltonius mimus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 6, no. 4, p. 9, figs. 8–9. 1941.

Hiltonius pius Chamberlin, ibid., p. 7, fig. 6. **New synonymy.**

Hiltonius congregans Chamberlin, ibid., p. 9, fig. 10. **New synonymy.**

Hiltonius congregans, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 163. 1958.

Hiltonius mimus, Chamberlin and Hoffman, ibid., p. 164.

Hiltonius pius, Chamberlin and Hoffman, ibid., p. 164.

Nomenclatorial Considerations.—I have seen type material of all three of the above names and consider them conspecific. The type of

pius is a female, while that of *congregans* is an immature male. I therefore exercise the " right of the first reviser " in selecting *mimus* as the name to be used, inasmuch as it is based on an adult male.

Diagnosis.—Distinguished by the characters of the gonopods of the male as indicated in the key. Differs from *hebes* in the details of the collum and second segment. The species closely resembles *pulchrus,* and I am unable to give an adequate method for separating females of the two.

Description.—L of male unknown, of females 55, 79 mm.; W of male 5.4 mm., of females 6.1, 7.9 mm.; L/W of females 8.9, 9.0. Segments 46, 48.

Eyes per patch 29–37 (32.0). Clypeal setae 7–10 (8.2); labral setae 14–16 (14.5). Stipital setae of gnathochilarium 5–8 (6.4) per stipes.

Paranota of collum usually not as long as those of *hebes,* very narrowly rounded at their ends; anterior emarginations shallow. Second segment usually slightly more produced at anterior ventrolateral corner than at posterior corner.

Legs almost reaching sides of body when held horizontally.

Anterior telopodites of gonopods very slightly uncinate, the hook not long and rounded like those of *carpinus* and *mexicanus.* Coxal endites slightly produced ventrad at ventrolateral corners. Posterior telopodite narrowly subspatulate distally, the spatulate portion rather hook-like and with serrate edges, its caudal edge expanded basally into prominent serrate flange; cephalic flange with mesodistal corner strongly produced to form long curved tooth. A wide membranous groove curving across cephalic face of posterior telopodite and separating prefemoral region from tibiotarsal region. A large tubercle on cephalic face of mesal apodeme of telopodite. Opening of seminal receptacle just distal to shoulder of prefemoral portion.

Cyphopod with relatively short distal lobe, this usually somewhat curved caudad. Lateral suture with a long distal section running diagonally across lateral face of cyphopod in an impressed groove.

Type.—Male and female cotypes (RVC); the male is here designated as lectotype. Locality: Mountain Springs, San Diego County, California; this is also the type locality for the two synonyms. Type of *pius:* female (RVC). Type of *congregans:* imm. male (RVC).

Specimens Examined.—6 (4 males, 2 females).

I have seen the male and female cotypes of *mimus,* the female type of *pius,* and 3 imm. male paratypes of *congregans;* all were collected Jan 8, 1941 by S. and D. Mulaik.

Hiltonius hebes (Bollman) Figures 189–191, 198, 207, 214

Spirobolus hebes Bollman, Ann. New York Acad. Sci., vol. 4, p. 31. 1887.
Spirobolus hebes Bollman, Entomologica Americana, vol. 2, p. 228. 1887.
Tylobolus hebes, Cook, Harriman Alaska Exped., vol. 8, p. 66. 1904.
Hiltonius balboanus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 6, no. 4, p. 10, fig. 11. 1941.
Hiltonius balboanus, Loomis and Hoffman, Proc. Biol. Soc. Washington, vol. 61, p. 51. 1948.
Hiltonius hebes, Loomis and Hoffman, ibid., p. 51.
Hiltonius hebes, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 164, 1958.

Diagnosis.—Males are readily distinguished by the gonopods as indicated in the key. Females are more difficult but may usually be identified by the combination of the characters of the cyphopods, collum, second segment, labral setae, and body proportions.

Description.—L of males 63, 65 mm., of females 64, 70 mm.; W of males 7.8, 8.1, 9.1, 9.2 mm., of females 9.8, 10.1 mm.; L/W of males 6.9, 7.1, of females 6.3, 7.1. Segments 43–46 (45.3).

Eyes per patch 26–32 (28.8). Clypeal setae 9–12 (10.4); labral setae 19–24 (21.2). Stipital setae of gnathochilarium 6–12 (9.1) per stipes.

Paranota of collum usually rather long, acute at their ends; anterior emarginations often relatively deep. Second segment usually about equally produced along entire ventrolateral portion.

Legs short, not reaching sides of body when held horizontally.

Anterior telopodites of gonopods not uncinate distally, but each with a small rounded knob. Posterior telopodite broadly spatulate distally; margins of spatulate portion not serrate; large serrate cephalic flange continuous distally, just proximal to distal spatulate area, with large serrate flange of caudal surface, the two flanges together forming large, oval, concavity. Seminal opening just proximal to area enclosed by serrate flanges. Wide membranous groove curving across cephalic face of posterior telopodite and separating very prominent and produced prefemoral region from distal tibiotarsal region.

Cyphopod usually without large concave area on lateral surface and with relatively straight lateral suture; sometimes suture runs diagonally in impressed groove but then distal lobe usually longer, thinner, and less bent caudad than in *pulchrus* or *mimus.*

Distribution.—Known only from San Diego County, California and nearby Baja California.

Type.—Male and female cotypes supposed to be in USNM but search fails to locate them. Locality: San Diego, California. Types

of *balboanus:* male and female cotypes (RVC). Locality: Balboa Park, San Diego, California.

Specimens Examined.—8 (5 males, 3 females).

CALIFORNIA.—"California", 1925 (1 male), O. F. Cook (USNM). San Diego County: Balboa Park, San Diego, March 5, 1922 (parts of 2 males, 1 female, cotypes of *balboanus*), G. Grant (RVC); Chula Vista, Dec., 1924 (1 female), O. F. Cook (USNM); San Diego, March, 1951 (1 male), G. P. Kanrkoff (LACM); Torrey Pines, Jan. 9, 1933 (1 male), Cook (USNM).

MEXICO.—Baja California: Coregus Canyon, Ensinada, Jan. 5, 1925 (1 female), O. F. Cook (USNM).

Hiltonius thebanus Chamberlin Figures 201, 208, 215

Hiltonius thebanus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 6, no. 4, p. 8, fig. 7. 1941.

Hiltonius thebanus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 165. 1958.

Diagnosis.—This species is so far known only from females and discovery of males may eventually necessitate its being lumped with one of the other species.[7] The cyphopods provide the best characters for identification; the lateral suture is abruptly looped in a shallow depression of the lateral surface of the cyphopod.

Description.—Described from one female specimen. L 65 mm.; W 8.0 mm.; L/W 8.1. Segments 43.

Eyes 29 + 29. Clypeal setae 8; labral setae 14. Stipital setae of gnathochilarium 9 + 9.

Collum resembling that of *hebes,* rather long, acute laterally, and with relatively pronounced anterior emarginations. Second segment in my specimen broadly produced over entire ventrolateral area, only slightly more produced at anterior corner than at posterior corner; Chamberlin's specimen apparently showed more production at the anterior corner.

Legs short, not reaching sides of body when held horizontally.

Cyphopod with shallow depression in disc of lateral surface; lateral suture making abrupt loop within concavity.

Type.—Female (RVC). Locality: Theba, Arizona.

Specimen Examined.—ARIZONA.—Santa Cruz County: Madera Cañon, Santa Rita Mountains, June 11, 1898 (1 female) (USNM).

[7] I received two collections of this species while this study was in press; both sexes are included. They will be described in a later publication.

Nomina inquirenda

Spirobolus callipus Bollman, U. S. Nat. Mus. Bull., no. 46, p. 191. 1893.

Bollman's description of this form is sufficient to assign it to *Hiltonius;* the species should now be known as *Hiltonius callipus* (new combination). It is impossible, however, to be sure of its specific identity until such time as the type specimen may be found. Bollman's statement, " anterior surface tuberculate," regarding the posterior gonopod makes it probable that *callipus* is conspecific with either *carpinus* or *fossulifer* (or both!). In either case, *callipus* would be the older name.

Type.—Supposed to be in USNM but search has failed to locate it. Locality: Guanajuato, Mexico.

Hiltonius erythrotypus Chamberlin, Bull. Univ. Utah, biol. ser., vol. 8, no. 3, p. 22. 1943.

The original description of this form mentions no character of specific importance except the red and black color, and no figure is given. The species is based on a female. Inasmuch as I have been unable to see the type specimen, I can do nothing but list the name. It is my guess that, when the type is found, *erythrotypus* will prove to be a synonym of *mexicanus.* (Concerning color, see footnote 5 on page 100.)

Type.—Female (RVC; cannot be located at present). Locality: Mexico, Distrito Federal, Santa Rosa.

Genus **Tylobolus** Cook

Tylobolus Cook, Harriman Alaska Exped., vol. 8, p. 65. 1904.
Tylobolus, Brölemann, Ann. Soc. Ent. France, vol. 83, pp. 9, 22. 1914.
Californibolus Verhoeff, Bull. Southern California Acad. Sci., vol. 43, p. 55. 1944. **New synonymy.**
Auxobolus Chamberlin, Journ., Washington Acad. Sci., vol. 39, p. 163. 1949. **New synonymy.**
Californibolus, Chamberlin, ibid., p. 165.
Tylobolus, Chamberlin, ibid., p. 166.
Californibolus, Causey, Journ. Kansas Ent. Soc., vol. 28, pp. 70, 78. 1955.
Auxobolus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 160. 1958.

Californibolus, Chamberlin and Hoffman, ibid., p. 161.
Tylobolus, Chamberlin and Hoffman, ibid., p. 168.

TYPE SPECIES: *Tylobolus deses* Cook, by original designation. Type species of *Californibolus: Californibolus michelbacheri* Verhoeff, by monotypy. Type species of *Auxobolus: Auxobolus ergus* Chamberlin, by original designation.

Description.—The distinguishing characters of the genus are given in the key and listed in Table 3. L 36–92 mm.; W 4.9–9.9 mm.; L/W 7.0–12.6. Segments 42–54.

Lateral corners of clypeus only moderately distinct, blending into antennal groove. Antennal groove moderately deep (deeper than that of *Hiltonius* but not as deep as that of *Narceus*). Parietal sclerite subtriangular, tapering caudad. Mandibular cheek shallowly grooved for reception of antenna; stipes squared distally, with sharp ventrodistal corner. Eye patches small, 27–50 eyes per patch. Clypeal setae 6–12; labral setae 10–22; stipital setae of gnathochilarium 5–10 per stipes.

Paranota of collum narrowly rounded laterally, sometimes subacute; anterior margin emarginate below level of eye patches, extent of emargination variable. Second segment exceeding ends of collum laterally, the produced portion variable in shape but always relatively rounded. Both shape of collum and shape of produced portion of second segment intraspecifically variable and of no taxonomic value.

Striae of hindbelts ending low on sides except in *uncigerus* where they reach repugnatorial pores in many specimens.

Anal lips often distinct, when not the valves more compressed and more indication of depression before lip regions than in *Hiltonius.*

Second segments of male 2nd legs enormously enlarged and usually papillate; claws of 1st and 2nd legs usually long, often longer than last podomeres. Coxae of male 3rd legs always with uncinate ventral lobes, these directed cephalad and often resting on swollen area of anterior portion of coxae proper. Coxae of male legs 4–7 usually with relatively short, compressed, distally rounded lobes, these modified in only one species (*castaneus*). Podomeres of telopodites of male legs 3–7 sometimes slightly swollen on their mesal surfaces but greatly so only in *castaneus;* postgenital legs often with ventral pads on second segments, these sometimes present on third segments also.

Sternum of anterior gonopods broad and triangular, its exact shape intraspecifically variable and of no taxonomic value, its ventral apex variable in degree of sclerotization, this in turn determining angle of apex. Coxal endites very variable in shape and size, of some specific constancy; always papillate on mesal portion of cephalic surfaces; endites always bearing on their caudal surfaces large props on which posterior telopodites rest. Anterior telopodites some-

TABLE 30

Segment counts for specimens of some species of Tylobolus.

Segments	claremontus	castaneus	monachus	uncigerus	female sp.?
42.	1				1
43.					
44.	2				1
45.	1				
46.			2		3
47.			1		1
48.	3	1	1	3	1
49.	1	5		1	1
50.	1	3		2	
51.		2		7	
52.		3		2	
53.		1		1	
54.		1		1	
total	9	16	4	17	8
mean	46.4	50.5	46.8	50.6	45.3

times uncinate distally; when not uncinate, distal portion noticeably enlarged. Posterior telopodites similar in all species but with small, specifically constant differences in detail; always arched with distal portion forming long subcylindrical distal process with acute apex; telopodite always distinctly divided by depression on lateral surface into proximal prefemoral portion and distal tibiotarsal portion; tibiotarsal region containing in its proximal half a large seminal receptacle cavity, this with small mesally directed opening; caudal wall of receptacle thin and semitransparent, often milk-white, shape of this wall of specific importance; proximal portion of distal half of tibiotarsal region with thinner inner plate, its shape sometimes of taxonomic importance; small spicules present on restricted areas of tibiotarsal region. Mesal apodeme of telopodite long, well-sclerotized. Posterior coxae not degenerate. Postgenital bar variable specifically.

Distal lobe of cyphopod swollen and papillate, set off from proximal lobe by wide crescentric groove on caudal surface. Cyphopods alike in most species.

TABLE 31

Clypeal setae counts for specimens of species of Tylobolus.

Setae	6	7	8	9	10	11	12	total	mean
claremontus			3	3	4	3		13	9.5
castaneus			8	11	9	2	1	31	9.3
monachus			3	1	1			5	8.6
uncigerus	1	2	10	3	2	1		19	8.3
female sp.?			3		5			8	9.3

TABLE 32

Labral setae counts for specimens of species of Tylobolus.

Setae	10	11	12	13	14	15	16	17	18	19	20	21	22	total	mean
claremontus					1	3	2	2	3		1		1	13	17.0
castaneus			1	5	11	6	3	2			1			29	14.6
monachus					3	1	1							5	14.6
uncigerus	1	1	8	3	1	1		2						17	12.9
female sp.?			1	1	4	1		1						8	14.1

TABLE 33

Counts of setae per stipes for specimens of species of Tylobolus.

Setae	5	6	7	8	9	10	total	mean
claremontus		5	11	4	1	1	22	7.2
castaneus	1	10	12	15	12	4	54	7.7
monachus		2	6	1		1	10	7.2
uncigerus	5	7	13	8	1		34	6.8
female sp.?	1	2	9	3	1		16	7.1

TABLE 34

Number of eyes per patch in specimens of species of Tylobolus.

Eyes	claremontus	castaneus	monachus	uncigerus	female sp.?
27.			1		
28.			1		
29.					
30.	2	1			
31.	1	1		2	2
32.	1	1		3	1
33.		1	2	1	
34.	2			4	1
35.	1	4		5	1
36.	2			3	2
37.	2	6		2	2
38.		3	1	2	1
39.		3	1	4	
40.	1	7			2
41.		4	1	1	
42.				3	1
43.	2	5		1	1
44.					1
45.	2	1			1
46.		3	1		
47.		1		1	
48.		2			
49.				1	
50.				1	
total	16	43	8	34	16
mean	36.8	39.6	35.6	37.4	37.6

TABLE 35

List of widths of specimens of species of Tylobolus.

claremontus	
male	5.9, 6.0, 7.0, 7.9
female	5.2, 7.8, 7.8, 8.3, 9.5
castaneus	
male	5.3, 5.9, 6.3, 6.6, 6.6, 6.6, 7.3, 7.8, 7.8, 7.9, 8.0, 9.6
female	5.0, 6.1, 6.2, 6.6, 7.0, 8.9, 9.9
monachus	
male	5.8, 6.2, 6.3, 7.0
uncigerus	
male	4.9, 4.9, 5.6, 5.8, 5.9, 6.0, 6.0, 6.8
female	5.1, 6.1, 6.3, 6.8, 6.9, 7.0, 7.8, 8.0, 8.1
species ?	
female	7.3, 8.3, 8.4, 8.9, 8.9, 8.9

TABLE 36

List of lengths of specimens of species of Tylobolus.

claremontus	
male	47, 49, 55, 64
female	36, 55, 65, 76, 82
castaneus	
male	54, 59, 64, 68, 71, 72, 76,77, 77
female	46, 54, 57, 63, 83, 92
monachus	
male	48, 57, 66, 69
uncigerus	
male	52, 54, 54, 56, 61, 65, 66
female	54, 57, 63, 68, 69, 70, 70, 75, 78, 86
species ?	
female	58, 65, 66, 67, 68, 70, 71

Distribution.—Most common in Oregon and California. Known also from Utah and from Kansas.

Classification.—The differences in the male gonopods are often striking and have led to the erection of several different genera. If this policy of establishing genera on the basis of sexual characteristics of the males were followed consistently, practically every species in this group would require its own genus. The species show almost no major differences in other characters, however, and females are very difficult,

TABLE 37

List of L/W values for specimens of species of Tylobolus.

claremontus	
male	7.0, 8.0, 8.1, 9.2
female	7.1, 8.3, 8.6, 8.9, 9.2
castaneus	
male	8.2, 8.9, 9.0, 9.6, 9.9, 10.2, 10.4, 10.5, 10.8, 10.8
female	8.6, 8.7, 9.2, 9.3, 10.3
monachus	
male	8.3, 9.2, 9.4, 11.0
uncigerus	
male	9.2, 9.8, 10.0, 10.0, 10.6, 10.8, 11.0
female	8.6, 8.7, 9.0, 9.8, 10.0, 10.0, 10.6, 11.0, 11.2, 11.5
species ?	
female	7.0, 7.5, 7.6, 7.9, 7.9, 9.1

if not impossible, to identify with certainty. I therefore recognize only one genus for this group of species.

Separate keys are given here for males and for females. The one for males includes all species here recognized except *fredricksoni* which is known from an immature specimen. The key to females is incomplete and exceedingly difficult to use; females of *deses, ergus, monachus, utahensis,* and *fredricksoni* are unknown to me. One unnamed species is included in the key to females. I must regretfully admit that only about 90% of the females will be correctly identified by use of the key.

Key to the Species of Tylobolus

Males

1. Anterior telopodites of gonopods distinctly uncinate distally (figure 224) .. 3
   Anterior telopodites not uncinate (figure 253) 2
2. Inner plate of tibiotarsal portion of posterior telopodite extending far along distal process and distally forming an approximately right angle with the process (figures 262, 263); striae of hindbelts not extending as far up on sides as level of pores ..... *utahensis*
   Inner plate of tibiotarsal portion not extending so far along distal process and distally forming a very obtuse angle with the process (figures 255, 256); striae of hindbelts often extending as high on sides as level of pores ..... *uncigerus*
3. Coxae of 4th legs flattened distally (figures 18, 248); podomeres of both pregenital and postgenital legs greatly swollen mesally (figures 247–252) ..... *castaneus*

Coxae of 4th legs narrow and rounded distally; podomeres of legs not so greatly swollen (figures 232, 233) 4

4. Distal process of posterior gonopod very large and long, spinose for almost its entire length (figures 239–241) ..... *deses*

Distal process not so large or so long, at most only spinose at its base (figures 226, 230, 237) 5

5. Mesal corner of cephalic face of coxa of posterior gonopod not projecting ventrad (figure 226); posterior telopodite shorter, with many spicules on base of distal process; ventral margins of coxal endites of anterior gonopods more evenly rounded (figure 224) ..... *claremontus*

Mesal corner of cephalic face of posterior coxa projecting ventrad (figure 230); posterior telopodite longer, with no (or few) spicules on base of distal process; ventral margins of coxal endites either more sinuate or with a large ventrally directed hump (figures 228, 234) 6

6. A large swollen area on caudal surface of posterior telopodite just distal to wall of seminal receptacle, this area constricting wall of receptacle (figure 236) ..... *monachus*

No such swollen area, the wall of seminal receptacle not restricted mesally (figure 229) ..... *ergus*

Females

1. Distal papillate lobe of cyphopod very broad and without a narrow portion projecting dorsad into groove of caudal surface (figure 223) *T.* species?

Distal lobe not so broad and usually with a narrow portion projecting dorsad into groove of caudal surface (figure 194) 2

2. Striae of hindbelts present on sides almost as high as level of repugnatorial pores; anal lips usually very conspicuous ..... *uncigerus*

Striae of hindbelts ending about midway between pleural sutures and repugnatorial pores; anal lips not so prominent 3

3. Usually 2 or fewer setae on each third coxa; anal lips usually distinct; usually 49 or more segments ..... *castaneus*

Usually 3 or more setae on each third coxa; anal lips usually indistinct; usually fewer than 49 segments ..... *claremontus*

Tylobolus claremontus Chamberlin Figures 6, 21, 224–227

? *Spirobolus californicus,* Bollman, Ann. New York Acad. Sci., vol. 4, p. 31. 1887.

Tylobolus claremontus Chamberlin, Proc. Biol. Soc. Washington, vol. 31, p. 165. 1918.

Tylobolus stebbinsi Chamberlin, Proc. Biol. Soc. Washington, vol. 57, p. 113, figs. 4–5. 1944. **New synonymy.**

Auxobolus claremontus Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 163, figs. 1–2. 1949.
Auxobolus simulatus Chamberlin, ibid., p. 165, figs. 12–13. **New synonymy.**
Auxobolus stebbinsi Chamberlin, ibid., p. 165.
Auxobolus claremontus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 160. 1958.
Auxobolus simulatus, Chamberlin and Hoffman, ibid., p. 161.
Auxobolus stebbinsi, Chamberlin and Hoffman, ibid., p. 161.

Diagnosis.—Most readily distinguished by the characters of the male gonopods. In addition to the details mentioned in the key, the band of relatively large spicules along the outer border of the seminal receptacle wall is distinctive; these spicules are often visible even from cephalic view (see fig. 226).

Description.—L of males 47–64 mm. (53.8), of females 36–82 mm. (62.8); W of males 5.9–7.9 mm. (6.70), of females 5.2–9.5 mm. (7.72); L/W of males 7.0–9.2 (8.1), of females 7.1–9.2 (8.4). Segments 45–50 (46.4).

Eyes per patch 30–45 (36.8). Clypeal setae 8–11 (9.5); labral setae 14–22 (17.0). Stipital setae of gnathochilarium 6–10 (7.2) per stipes.

Anal lips usually very indistinct.

Coxae of male legs 4–7 with broad, compressed, distally rounded lobes, those of 4th and 5th pairs much longer than those of 6th and 7th; other segments of legs not specially produced mesally. Claws usually about as long as last podomeres anteriorly, slightly shorter posteriorly. Third coxae of female usually with 3 or more ventral setae each.

Coxal endites of anterior gonopods only very slightly exceeding apex of sternum mesally; ventral margins of endites relatively evenly rounded laterodorsad from mesal corners. Anterior telopodites distally uncinate. Posterior telopodite relatively short, forming smooth arc; distal process rather long, the angle between its base and inner plate of tibiotarsus very obtuse and rounded. Wall of seminal receptacle evenly curved. Large spicules present in two patches, one along outer border of wall of receptacle and another on cephalic surface of basal portion of distal process. Coxa of posterior gonopod with mesodistal corner of cephalic face not produced ventrad as in other species of the genus. Postgenital bar moderately broad, flat.

Distal lobe of cyphopod swollen and papillate, not as broad as basal portion, separated from basal portion by wide groove across caudal surface.

Distribution.—Known definitely only from the southern portion of California. The provisional listing of Bollman's reference to "*Spirobolus californicus*" under this species (see nomenclatorial considerations under *Tylobolus uncigerus*) extends the possible range of this species into northern Baja California.

Type.—Male (MCZ). Locality: California, Claremont. Type of *stebbinsi:* male (RVC). Locality: California, Meadow Canyon, Santa Monica Mountains. Type of *simulatus:* male (RVC). Locality: California, Riverside.

Specimens Examined.—13 (8 male, 5 female).

CALIFORNIA.—Los Angeles County: Claremont (5 males, 1 female, including the holotype), W. A. Hilton (MCZ); Meadow Canyon, Santa Monica Mtn., March 4, 1944 (1 male, holotype of *stebbinsi*), R. C. Stebbins (RVC). Riverside County: Riverside, Nov. 26, 1925 (1 male, holotype of *simulatus*), J. C. Chamberlin (RVC); San Jacinto Mts., Dec. 1, 1932 (3 females), O. F. Cook (USNM). San Diego County: Hodges Lake, Dec. 16, 1925 (1 male), O. F. Cook (USNM); San Ysidro, Dec. 26, 1910 (1 female), W. M. Wheeler (MCZ).

Tylobolus ergus (Chamberlin), new combination Figures 228–233

Auxobolus ergus Chamberlin, Journ. Washington Acad. Sci., Vol. 39, p. 163, figs. 5–7. 1949.

Auxobolus ergus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 160. 1958.

Nomenclatorial Considerations.—I have been unable to examine the holotype of this species. My assignment of the name is of doubtful accuracy inasmuch as it is based solely on a male specimen from Glennville (in a different county from that of the type locality) which was reported by Chamberlin at the time of the original description. This specimen resembles *castaneus* very closely, differing from typical representatives of that species only in the much less modified legs. I have seen no other specimens which combine *castaneus*-type gonopods with relatively unmodified leg podomeres and it seems highly probable that the Glennville specimen is a male of *castaneus* in which the secondary sexual characteristics failed to develop normally.[8] I hesitate to assert this definitely, however, so long as the characters of the holotype are unknown. Chamberlin's description does not mention the characters of the leg podomeres. The matter is further complicated by the fact that examination of two male paratypes of *ergus* collected in a county (San Joaquin) different from both that of the type (Fresno) and that of the Glennville specimen (Kern) reveals that they belong to two different

[8] Further evidence for this conclusion of abnormal development comes from a recently examined specimen of *castaneus* which has the leg modifications typical of that species on all legs of one side of the body, but has unmodified legs on the other side.

species; one is a typical specimen of *castaneus* and the other is a specimen of *uncigerus*.

I am here describing the Glennville specimen as a separate species from *castaneus* and assigning the name *ergus* to it. It is my opinion, however, that when the holotype of *ergus* is found it will prove to be a typical specimen of *castaneus*, and that the Glennville specimen will be considered as a poorly developed male of the same species. In that event, *ergus* will have to be regarded as a junior synonym of *castaneus*.

Description.—Described on the basis of one male specimen which is distinguished by the characters mentioned in the key.

L 73 mm.; W 7.1 mm.; L/W 10.3. Segments 49.

Eyes 32 + 33. Clypeal setae 9; labral setae 15. Stipital setae of gnathochilarium 10 + 13.

Anal lips moderately distinct.

Coxae of male legs 4 and 5 with broad, compressed, distally rounded lobes, these with no indication of the round flat distal surface that distinguishes *castaneus;* coxae of 6th and 7th legs similar to those of 5th but shorter; other podomeres of legs slightly swollen but lacking the very large mesal projections typical of *castaneus*. Claws of 1st and 2nd legs almost as long as last podomeres, those of other pregenital legs less than half as long as last podomeres, those of postgenital legs long but not quite as long as last podomeres.

Coxal endites of anterior gonopods slightly exceeding apex of sternum ventrally, their ventral margins decidedly sinuate. Anterior telopodites distally uncinate. Posterior telopodites moderately long; distal process moderately long, forming smooth obtuse arc at its basal meeting with inner plate of tibiotarsus. Wall of seminal receptacle evenly curved, not constricted mesally. Spicules in two patches, one along outer border of wall of receptacle, another on distal half of cephalic surface of tibiotarsal region, this patch not extending onto base of distal process. Coxa of posterior gonopod with mesodistal corner of cephalic face produced ventrad. Postgenital bar moderately broad, flat, with small caudally directed spur at midpoint of caudal margin.

Type.—Male (RVC; cannot be located at present). Locality: California, Tollhouse.

Specimen Examined.—CALIFORNIA.—Kern County: 7 miles n. of Glennville, March 19, 1941 (1 male), S. and D. Mulaik (RVC).

Tylobolus monachus (Chamberlin), new combination Figures 234–237

Auxobolus monachus Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 165, figs. 10–11. 1949.

Auxobolus monachus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 161. 1958.

Diagnosis.—Only the males of this species are known. They are distinguished by the prominent swollen area on the caudal surface of the tibiotarsal portion of the posterior telopodite. This area is sclerotized and causes the wall of the seminal receptacle to be constricted mesally. The huge arch of the coxal endites and the very marked separation of the regions of the posterior telopodite are also diagnostic.

Description.—Applies only to males. L 48–69 mm. (60.0); W 5.8–7.0 mm. (6.33); L/W 8.3–11.0 (9.5). Segments 46–48 (46.8).

Eyes per patch 27–46 (35.6). Clypeal setae 8–10 (8.6); labral setae 14–16 (14.6). Stipital setae of gnathochilarium 6–10 (7.2) per stipes.

Anal lips moderately distinct.

Segments and claws of both pregenital and postgenital legs similar to those described for *ergus*.

Coxal endites of anterior gonopods sometimes not exceeding apex of sternum mesally, sometimes with mesal corners produced ventrad and surpassing apex of sternum; ventral margins of endites always with large ventrally directed archs lateral to lower mesal regions. Anterior telopodite distally uncinate. Posterior telopodite moderately long, with relatively long distal process, the latter not projecting diagonal or perpendicular to base of telopodite but almost parallel with it, thus giving telopodite hook-like appearance; distal process almost perpendicular to distal margin of inner plate of tibiotarsus but angle between the two rounded, not abrupt. Division between prefemoral and tibiotarsal portions of telopodite marked on outer surface by relatively deep groove; outer surface of tibiotarsus often high-arched or humped, sometimes with a groove separating it from base of distal process. Wall of seminal receptacle constricted by large swollen area of caudal surface of tibiotarsus, this swelling just distal to receptacle area. A few small, obscure spicules on swollen area and on cephalic surface just proximal to base of distal process. Coxa of posterior gonopod with mesodistal corner of cephalic face slightly produced ventrad. Postgenital bar similar to that described for *ergus* but spur missing.

Distribution.—Known only from Monterey and Fresno Counties, California.

Type.—Male (RVC). Locality: California, Monterey County, Hastings Reservation.

Specimens Examined.—5 (4 males, 1 imm. female).

California.—Fresno County: El Rancho Cantua, near Mendota, "from hole in living *Astragalus* root", March 3, 1952 (1 male), L. Christie (CAS). Monterey County: Hastings Reservation, March 17, 1940 (1 male, the holotype), J. M. Linsdale (RVC); Jelon, Jan. 1, 1944 (2 males, 1 imm. female), E. Ray (CNHM).

Tylobolus deses Cook Figures 238–241

Tylobolus deses Cook, Harriman Alaska Exped., vol. 8, p. 65, pl. 3, figs. 3 a–h. 1904.

Tylobolus deses, Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 168. 1949.

Tylobolus deses, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 168. 1958.

Description.—I have seen only one male specimen; it is distinguished by the characters of the gonopods mentioned in the key.

L 41 mm.; W 5.0 mm.; L/W 8.2. Segments 45 (Cook says 44–46).

Eyes 30 + 32. Clypeal setae 8; labral setae 14. Stipital setae of gnathochilarium 10 + 7.

Anal lips weakly distinct.

Legs similar to those of *claremontus.*

Coxal endites of anterior gonopods slightly exceeding apex of sternum mesally, their ventral margins more evenly rounded than those of *ergus* or *castaneus* but with more arch than those of *claremontus.* Anterior telopodites broken in specimen examined but apparently distally uncinate. Posterior telopodite relatively long, its distal process very thick and very long, much longer than processes of other species of the genus; prominent spicules covering surface of process almost to its apex. Receptacle area and general form of telopodite similar to that of *castaneus* but distal process more curved and inner plate of tibiotarsus not distinct. Mesodistal corner of cephalic face of coxa of posterior gonopod produced ventrad. Postgenital bar narrow and somewhat ventrally produced to form small ridge.

Type.—Cook stated that he had 15 specimens before him at the time of the description of *deses.* Most of these types were supposedly in the USNM but much searching has failed to locate them. I have seen one (male) of the cotypes which is in the private collection of Dr. R. V. Chamberlin. Locality: "California". No further specimens have been taken since the collection of the types.

Tylobolus castaneus Chamberlin Figures 13, 18, 242–252

Tylobolus castaneus Chamberlin, Proc. Biol. Soc. Washington, vol. 31, p. 166. 1918.

Auxobolus castaneus Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 163. 1949.

Auxobolus discipulus Chamberlin, ibid., p. 165, figs. 3–4. **New synonymy.**

Auxobolus friantus Chamberlin, ibid., p. 165, figs. 8–9. **New synonymy.**

? *Axobolus* [sic] *ergus,* Causey, Pan-Pacific Ent., vol. 30, p. 226. 1954.

? *Auxobolus ergus,* Causey, Proc. Biol. Soc. Washington, vol. 68, p. 88. 1955.

Auxobolus castaneus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 160. 1958.
Auxobolus discipulus, Chamberlin and Hoffman, ibid.
Auxobolus friantus, Chamberlin and Hoffman, ibid.

Nomenclatorial Considerations.—I have seen type material of all three of the names listed above. The holotype of *castaneus* is an immature male and thus does not show full development of the leg modifications typical of adults of the species treated here. I have compared it with immature males of most of the species of the genus and it agrees in every way with those of the form here designated *castaneus.*

Diagnosis.—The unusual modifications of both the pregenital and postgenital legs of the males are found only in this species. These characters make this the easiest species of the genus to recognize because study of the gonopods is not necessary for identification.

Description.—L of males 54–77 mm. (68.7), of females 46–92 mm. (65.8); W of males 5.3–9.6 mm. (7.14), of females 5.0–9.9 mm. (7.10); L/W of males 8.2–10.8 (9.8), of females 8.6–10.3 (9.2). Segments 48–54 (50.5).

Eyes per patch 30–48 (39.6). Clypeal setae 8–12 (9.3); labral setae 12–20 (14.6). Stipital setae of gnathochilarium 5–10 (7.7) per stipes.

Anal lips usually moderately distinct.

Coxae of 3rd male legs produced, forming subcylindrical, distally flattened lobes, these diagnostic of the species. Coxae of male legs 4–7 similar to those of other species but not as compressed, their ends broader. Podomeres of pregenital legs of male highly modified; 2nd and 3rd segments of legs 3–7 with prominent large swollen areas, those of 2nd segments limited to distal portion of ventral surfaces, those of 3rd segments larger and covering most of ventral surfaces; 4th and 5th podomeres not greatly modified. Second and 3rd segments of postgenital legs with ventral pads, those of 3rd segments on prominent projecting lobes. Claws of 1st and 2nd legs longer than last podomeres, those of legs 3–7 shorter, those of postgenital legs often about as long as last podomeres. Coxae of 3rd legs of females each usually with 2 or fewer ventral setae.

Gonopods like those described under the name *ergus* above.

Distal lobe of cyphopod swollen and papillate, not as broad as basal portion, separated from basal portion by wide groove across caudal face, a portion of distal lobe projecting into groove near its midpoint.

Distribution.—Known from several counties in central California.

Type.—Imm. male (RVC). Locality: California, Brookdale. Type of *discipulus*: male (RVC). Locality: California, Ione. Type of *friantus:* male (RVC). Locality: California, Fresno County, Friant.

Specimens Examined.—33 (21 males, 12 females).

California.—"California" (1 male) (MCZ); (3 males, 5 females) (ANSP); (1 male, 1 female) E. D. Cope (ANSP). Alameda County: Berkeley, Strawberry Canyon, April 9, 1938 (1 male), T. P. Maslin (CAS); Niles Canyon, March 11, 1928 (2 males, 1 female), E. C. Vandyke (CAS). Amador County: Ione, March 27, 1941 (1 male, holotype of *discipulus*), J. C. Chamberlin (RVC). Contra Costa County: Antioch, March 5, 1954 (1 female), H. B. Leech (CAS); Mt. Diablo, Corall Hollow, March 6, 1931 (4 males, 1 female), M. Olney (CAS). Fresno County: Friant, March, 1913 (1 male, paratype of *friantus*), R. V. Chamberlin (RVC). San Joaquin County: Clements, March 27, 1941 (1 male, labelled paratype of *ergus*), S. and D. Mulaik (RVC). Santa Clara County: Stanford (4 males, 1 female) (MCZ); Orinda, April 3, 1938 (1 female), Maslin (CAS); San Jose, Feb. 6, 1930 (1 female), L. E. Slevin (CAS). Santa Cruz County: Brookdale, March 13, 1913 (1 male, type of *castaneus*), R. V. Chamberlin (RVC). Tulare County: Sequoia Park, April 10, 1949 (1 male), O. Bryant (CAS).

Tylobolus uncigerus (Wood) Figures 194–195, 253–261

Spirobolus uncigerus Wood, Proc. Acad. Nat. Sci. Philadelphia, vol. 16, p. 15. 1864.

Spirobolus uncigerus Wood, Trans. Amer. Philos. Soc., vol. 13, p. 209, fig. 36. 1865.

Spirostreptus californicus Humbert and Saussure, Rev. Mag. Zool., ser. 2, vol. 22, p. 177. 1870. **New synonymy.**

Spirobolus uncigerus, Bollman, Ann. New York Acad. Sci., vol. 4, p. 30. 1887.

Spirobolus californicus, Bollman, ibid., p. 43.

Tylobolus uncigerus, Cook, Harriman Alaska Exped., vol. 8, p. 67. 1904.

Tylobolus uncigerus, Brölemann, Ann. Soc. Ent. France, vol. 83, pp. 9, 22, fig. 6. 1914.

Californibolus michelbacheri Verhoeff, Bull. Southern California Acad. Sci., vol. 43, p. 56, figs. 1–3. 1944. **New synonymy.**

Californibolus michelbacheri, Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 165. 1949.

Californibolus oregonus Chamberlin, ibid., p. 166, figs. 14–15. **New synonymy.**

Californibolus pontis Chamberlin, ibid., p. 166, figs. 18–19. **New synonymy.**

Californibolus rectus Chamberlin, ibid., p. 166, figs. 16–17. **New synonymy.**

Californibolus uncigerus, Chamberlin, ibid., p. 166.

Californibolis [sic] *pontis,* Causey, Pan-Pacific Ent., vol. 30, p. 224. 1954.

Californibolis [sic] *uncigerus,* Causey, ibid.

Californibolus uncigerus, Causey, Journ. Kansas Ent. Soc., vol. 28, p. 80. 1955.

Californibolus uncigerus, Causey, Proc. Biol. Soc. Washington, vol. 68, p. 87. 1955.

Californibolus pontis, Causey, ibid., p. 88.

Californibolus michelbacheri, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 161. 1958.
Californibolus oregonus, Chamberlin and Hoffman, ibid., p. 162.
Californibolus pontis, Chamberlin and Hoffman, ibid., p. 162.
Californibolus rectus, Chamberlin and Hoffman, ibid., p. 162.
Californibolus uncigerus, Chamberlin and Hoffman, ibid., p. 162.
Spirostreptus californicus, Chamberlin and Hoffman, ibid., p. 168.

Nomenclatorial Considerations.—I have examined the holotypes of *oregonus, pontis,* and *rectus.* The types of both *oregonus* and *pontis* are immature; this explains the lack of development of the distal portions of the anterior telopodites inasmuch as these structures do not attain their characteristic shape until maturity. The type of *pontis* has very small undeveloped gonopods; it is thus not unexpected that the distal process is short. The process is not present at all in individuals in earlier instars and is progressively lengthened at each molt.

Study of specimens from both Oregon and California has convinced me that Wood's *uncigerus* is the only valid species with non-uncinate anterior telopodites that occurs in the region.

According to Dr. Friedrich Kasy of the Vienna Museum, the type of *californicus,* which is supposed to be in that institution, cannot be found. The type locality, " California," together with the mention of the production of the second segment, seems to place this species in the Tylobolinae. The segment count of 50 and the easily calculated L/W value of 11.67 indicate that this form belongs in *Tylobolus* rather than in *Hiltonius.* These same characters resemble most closely the corresponding ones for *castaneus* and *uncigerus,* particularly the latter. Accordingly, *californicus* is here considered a synonym of *uncigerus;* this solution of the problem removes the need for any name change. The type locality restriction herein given serves to strengthen the argument for this assignment of the name. Bollman's (1887) reference to *californicus* probably pertains to *Tylobolus claremontus;* the eye count of 45 definitely places his specimen in *Tylobolus,* while the locality and the L/W value of 7.5 indicate the species is *claremontus.*

Diagnosis.—The non-uncinate anterior gonopods of the male distinguishes this from all the species of the genus except *utahensis* and *fredricksoni.* From those species, it differs in the details of the posterior gonopods. This is the only species commonly having striae on

the hindbelts almost up to the level of the repugnatorial pores. Likewise, most specimens have much more pronounced anal lips than occur in other species.

Description.—L of males 52–66 mm. (58.3), of females 54–86 mm. (69.0); W of males 4.9–6.8 mm. (5.74), of females 5.1–8.1 (6.90); L/W of males 9.2–11.0 (10.2), of females 8.6–11.5 (10.0). Segments 48–54 (50.6).

Eyes per patch 31–50 (37.4). Clypeal setae 6–11 (8.3); labral setae 10–17 (12.9). Stipital setae of gnathochilarium 5–9 (6.8) per stipes. Antennal groove often deeper and lateral corners of clypeus slightly more distinct than in other species of the genus.

Many striae on midbelts and hindbelts, these often present almost up to level of repugnatorial pores.

Anal lips distinct, often very prominent, usually most prominent in specimens from northern part of range of species.

Coxae and other podomeres of male legs similar to those of *claremontus*. Claws of 1st and 2nd legs not quite as long as last podomeres, those of male legs 3–7 much reduced, often only small stubs. Claws of postgenital legs about three-fourths as long as last podomeres. Third coxae of females usually with 3 or more ventral setae each.

Coxal endites of anterior gonopods much exceeding apex of sternum, their mesoventral corners usually produced ventrad. Anterior telopodites not uncinate but with broad distal portion, this often bent more ventrad. Division between prefemoral and tibiotarsal portions of posterior telopodite prominently indicated by deep depression on outer surface. Distal process not unusually long, joining inner plate of tibiotarsus in smooth curve, the angle usually obtuse; inner plate not elongate nor extending far along process, its free corner usually rounded, sometimes angled but never as distinctly so as in *utahensis*. Wall of seminal receptacle broadly rounded, covering much of caudal surface of tibiotarsal region. Small spicules on most of cephalic surface of inner plate of tibiotarsal region, these not usually extending onto distal process; no large band of spicules along outer border of receptacle wall. Postgenital bar very narrow and raised to form ridge.

Cyphopod much like that of *claremontus*.

Distribution.—Oregon and the northern half of California.

Type.—Presumed lost. Locality: "California"; here restricted to Solano County, California. Type of *californicus:* male (NHMV, apparently lost, see above). Locality: "California"; here restricted to Solano County, California. Type of *michelbacheri:* presumed to be in Verhoeff Collection, Zoologisches Staatsammlung, München. Locality: vicinity of Ford Seward, California. Type of *oregonus:* imm. male (RVC). Locality: Oregon, Springfield. Type of *pontis:* imm. male

(RVC). Locality: California, Bridgeville. Type of *rectus:* male (RVC). Locality: California, Solano County.

Specimens Examined.—25 (11 males, 14 females).

CALIFORNIA.—"California" (1 male, 5 females) (MCZ). Contra Costa County: Orinda, April 3, 1958 (1 female), Maslin (CAS). Humboldt County: Bridgeville, March, 1928 (1 male, holotype of *pontis*), J. C. Chamberlin (RVC). Mariposa County: Yosemite National Park, Aug., 1951 (1 female), M. Hood (LACM). Sacramento County: Sacramento, Feb., 1913 (2 males, 2 females), E. O. Essig (MCZ). San Joaquin County: Clements, March 27, 1941 (1 male, labelled paratype of *ergus*), S. D. Mulaik (RVC). Solano County: (1 male, holotype of *rectus*) (RVC).

OREGON.—Benton County: Corvallis, May 9, 1949 (1 male), V. Roth (RLH); Philomath, May 21, 1949 (1 female), V. Roth (RLH). Lane County: Springfield, Oct. 29, 1927 (1 male, holotype of *oregonus*), D. T. Jones (RVC). Linn County: Albany (1 female), Holleman (MCZ). Multnomah County: Portland (1 male, 1 female) (USNM), March 10, 1923 (1 male, 1 female), H. Sargent (MCZ); South Portland, May, 1905 (1 male), J. E. Benedict (USNM); Tanner Creek, Portland, May, 1905 (1 female), J. E. Benedict (USNM).

Tylobolus utahensis Chamberlin Figures 262–264

Tylobolus utahensis Chamberlin, Pan-Pacific Ent., vol. 2, p. 60. 1925.
Californibolus utahensis Chamberlin, Journ. Washington Acad. Sci., vol. 39, p. 166. 1949.
Californibolus utahensis, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 162. 1958.

Diagnosis.—Distinguished from all other species of the genus except *uncigerus* and *fredricksoni* by the broad distal ends of the anterior telopodites of the male gonopods. Differs from the two species mentioned in details of the posterior gonopods, and from the former also in having few striae on sides and weak anal lips.

Description.—Measurements and segment count based on one male, all other characters based on two males.

L 68 mm.; W 5.4 mm.; L/W 12.6. Segments 53.

Eyes 35 + 36, 33 + 34. Clypeal setae 8, 9; labral setae 14, 14. Stipital setae of gnathochilarium 8 + 7, 8 + 9. Antennal groove not as deep as in *uncigerus.*

Striae of hindbelts ending about midway between pleural sutures and repugnatorial pores.

Anal lips indistinct.

Coxae and other podomeres of male legs similar to those of *claremontus.* Claws of 1st and 2nd legs not quite as long as last podomeres, those of legs 3–7

about a third as long as last podomeres; claws of postgenital legs slightly shorter than last podomeres.

Coxal endites of anterior gonopods much exceeding apex of sternum, their mesoventral corners produced ventrad. Anterior telopodites broad distally, not uncinate. Posterior telopodite not curved like that of other species, tibiotarsal portion relatively straight and approximately perpendicular to prefemoral portion, distal process thus directed away from base of telopodite. Inner plate of tibiotarsal region subrectangular, running far along process, distally forming approximately right angle with process; free corner of inner plate sharply angled. Spicules on cephalic face of tibiotarsus and also along outer border of receptacle wall. Postgenital bar relatively broad and flat, not raised as in *uncigerus*.

Type.—Male (MCZ). Locality: Utah, Zion National Park. I have seen the holotype and a male paratype. The species has not been taken since its original collection.

Tylobolus fredricksoni (Causey), new combination Figures 265–268

? *Spirobolus uncigerus,* Cragin, Washburn Lab. Nat. Hist. Bull., vol. 1, no. 4, p. 145. 1885.

? *Spirobolus uncigerus,* Kenyon, Proc. Nebraska Acad. Sci., vol. 3, p. 16. 1893.

? *Tylobolus uncigerus,* Gunthorp, Kansas Univ. Sci. Bull., vol. 7, p. 164. 1913.

? *Tylobolus uncigerus,* Gunthorp, Canadian Ent., vol. 53, p. 88. 1921.

Californibolus fredricksoni Causey, Journ. Kansas Ent. Soc., vol. 28, p. 78, figs. 1c, 4, 5. 1955.

Californibolus fredricksoni, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 161. 1958.

Diagnosis.—It is my opinion that the holotype of this species is a subadult. I cannot check segments, however, because the vial labelled " holotype " contains fragments of the anterior end of a small specimen and of the posterior end of a larger one. The gonopods resemble those of immature specimens of related species and it is impossible for me to give any indication of their characteristics in the adult. The species certainly differs from *uncigerus* in having few striae on the sides. The weaker development of the inner plate of the tibiotarsal region of the posterior gonopods may prove to hold in the adult as a character for separating this from *utahensis*. The true status of the species must await discovery of an adult.

Description.—Based on the type specimen (specimens?). W of smaller anterior portion 4.7 mm., of larger posterior portion 6.1 mm. The anterior por-

tion consists of fragments including the head, first 10 segments, and 11 other segments. The posterior portion consists of 27 segments including the telson and anal valves. The total number of segments is thus 48 (Causey's count of 58 must have been a typographical error; no specimens of the subfamily that I have examined have had that many segments).

Eyes 33+33. Clypeal setae 6, labral setae 14. Most stipital setae are missing but apparently there were about 6 per stipes.

Striae of hindbelts ending about midway between pleural sutures and repugnatorial pores.

Anal lips indistinct.

Coxae and other podomeres in general resembling the usual form for the genus; some pregenital coxae still retaining the ventral setae always present in immatures. Claws of 1st legs as long as last podomeres; other claws missing.

Coxal endites of anterior gonopods much exceeding apex of sternum, their mesoventral corners only slightly produced ventrad. Anterior telopodites apparently not uncinate distally although this character not certain for adults. Posterior telopodites short, simple, no prominent division between prefemoral and tibiotarsal portions; distal process very short (may be longer in adult); margins of opening of seminal receptacle slightly serrate, this perhaps a diagnostic character.

Type.—Male (SMUK). Locality: Douglas, Kansas. The type material was collected Sept. 1, 1949 by R. W. Fredrickson. No further specimens have been taken.

Tylobolus species? Figure 223

Remarks.—I have seen eight female specimens from central California which show important differences from the females of the species for which that sex is known. The cyphopods of these specimens are the most distinctive in the genus.

The females of *deses, ergus,* and *monachus* are unknown to me. It seems probable that the females here described belong to one of these species, but I have been unable to associate them with any males and cannot safely say to which they should be referred. I prefer not to designate them by a specific name until such time as their true affinities are determined.

Description.—L 58–71 mm. (66.4); W 7.3–8.9 mm. (8.45); L/W 7.0–9.1 (7.8). Segments 42–49 (45.3).

Eyes per patch 31–45 (37.6). Clypeal setae 8–10 (9.3); labral setae 12–17 (14.1). Stipital setae of gnathochilarium 5–9 (7.1) per stipes.

Striae of hindbelts ending about midway between pleural sutures and repugnatorial pores.

Anal lips distinct, relatively prominent.

Third coxae large, usually with 4 or more ventral setae on each.

Distal lobe of cyphopod very broad, about as broad as basal portion. Groove of caudal face very wide and often with numerous small ridges running from one side of groove to other; the portion of distal lobe that projects into mid-part of groove not as large or as prominent as in most other species. The very large broad distal lobe distinguishes the species.

Specimens Examined.—8 females.

CALIFORNIA.—" California " (1 female) (MCZ). " California " (1 female), L. F. Ricksecker, S. Henshaw (MCZ). Alameda County: Berkeley, May, 1891 (1 female), June, 1896 (1 female), W. S. Blasdale (MCZ). Contra Costa County: 1 mile n. of Saint Marys College, San Leandro Creek, 500 ft., Dec. 30, 1938 (1 female), T. Rodgers (CAS). Marin County: Tocaloma, May 17, 1952 (1 female), H. S. Dybas (CNHM). Napa County: Calistoga, June 12, 1934 (1 female), O. Bryant (CAS). San Francisco County: San Francisco, March 12, 1955 (1 female), P. Rubtzoff (CAS).

Nomen inquirendum

Tylobolus viduus Chamberlin, Journ. Ent. Zool., vol. 32, p. 82. 1940

Tylobolus viduus, Chamberlin and Hoffman, U. S. Nat. Mus. Bull., no. 212, p. 168. 1958.

This form is based on a female specimen which I have not seen. The original description mentions no character of specific importance. The type specimen was collected at the same locality by the same person as was the type of *Tylobolus monachus* (Chamberlin), and the two may prove to be conspecific. In that event, *viduus* would be the older name for the species.

Type.—Female (RVC; cannot be located at present). Locality: California, Carmel Valley, Hastings Reservation.

Literature Cited

Attems, C. 1909. Myriopoda, *in* Sjöstedt, Wissenshaftliche Ergebnisse der Schwedischen zoologischen Expedition nach dem Kilimandjaro, dem Meru und den umgebenden Massaisteppen Deutsch-Ostafrikas 1905–1906, pp. 1–64, 163 figs.

———. 1910. Myriopoden von Madagaskar, den Comoren und den Inseln Ostafrikas, *in* Voeltzkow, Reise in Ostafrika in den Jahren 1903–1905, Band 3, pp. 73–115, 40 textfigs., 43 figs.

Bollman, C. H. 1887. Notes on North American Julidae. Ann. New York Acad. Sci., vol. 4, pp. 25–44.

———. 1893. Classification of the Myriapoda. U. S. Nat. Mus. Bull., no. 46, pp. 153–162.

Brandt, J. F. 1833. Tentaminum/quorundam monographicorum/Insecta Myriapoda Chilognatha Latreillii spectantium/Prodromus. Bull. Soc. Imp. Nat. Moscou, vol. 6, pp. 194–209, 1 table.

Brölemann, H. W. 1914. Étude sur les Spirobolides. Ann. Soc. Ent. France, vol. 83, pp. 1–38, 9 figs.

Causey, Nell B. 1955a. Spirobolidae (Spirobolida: Diplopoda) east of the Rocky Mountains. Journ. Kansas Ent. Soc., vol. 28, pp. 69–80, 5 figs.

———. 1955b. The life history of a common eastern spirobolid milliped. Turtox News, vol. 33, no. 10, 4 pp., 1 fig.

———. 1957. *Floridobolus,* a new milliped genus (Spirobolidae). Proc. Biol. Soc. Washington, vol. 70 pp. 205–207, 3 figs.

Chamberlin, R. V. 1918. New spirobolid diplopods. Proc. Biol. Soc. Washington, vol. 31, pp. 165–170.

———. 1941a. New American millipeds. Bull. Univ. Utah, biol. ser., vol. 6, no. 4, pp. 1–39, 49 figs.

———. 1941b. Seven new millipeds from Mexico (Chilopoda) [sic]. Ent. News, vol. 52, pp. 250–255, 13 figs.

———. 1943. On Mexican millipeds. Bull. Univ. Utah, biol. ser., vol. 8, no. 3, pp. 1–103, 172 figs.

———. 1947. Some records and descriptions of diplopods chiefly in the collections of the Academy. Proc. Acad. Nat. Sci. Philadelphia, vol. 99, pp. 21–58, 78 figs.

———. 1949. On some western millipeds of the order Spirobolida. Journ. Washington Acad. Sci., vol. 39, pp. 163–169, 19 figs.

———. 1951. Records of American millipeds and centipeds collected by Dr. D. Elden Beck in 1950. Great Basin Nat., vol. 11, pp. 27–35, 3 figs.

———. 1955. New millipeds from Peru and adjacent parts. Bull. Univ. Utah, biol. ser., vol. 11, no. 5, pp. 1–47, 87 figs.

Chamberlin, R. V., and R. L. Hoffman. 1958. Checklist of the millipeds of North America. U. S. Nat. Mus. Bull., no. 212, pp. 1–236.

Cook, O. F. 1895. Introductory note on the families of Diplopoda, *in* Cook and Collins, The Craspedosomatidae of North America. Ann. New York Acad. Sci., vol. 9, pp. 1–8.

————. 1897. New relatives of *Spirobolus giganteus*. Brandtia, no. 18, pp. 73–75.

Griffin, F. J. 1937. A further note on "Palisot de Beauvois, Insectes Rec. Afr. Amér." 1805–1921. Journ. Soc. Bibl. Nat. Hist., vol. 1, pt. 4, pp. 121–122.

Hoffman, R. L. 1951. The name of the common eastern spirobolid milliped. Florida Ent., vol. 34, pp. 15–16.

————. 1957. Studies on spirobolid millipeds. IV. The characters and relationships of the genera *Narceus* Rafinesque 1820 and *Spirobolus* Brandt 1833. Proc. Biol. Soc. Washington, vol. 70, pp. 61–68, 5 figs.

Hoffman, R. L. and R. E. Crabill. 1953. C. S. Rafinesque as the real father of American myriapodology: an analysis of his hitherto unrecognized species. Florida Ent., vol. 36, pp. 73–82.

Karsch, F. 1881. Neue Juliden des Berliner Museums, als Prodromus einer Juliden-Monographie. Zeit. Ges. Naturw., vol. 54 (Folge 3, Band 6), pp. 1–79.

Keeton, W. T. 1959. A new family for the diplopod genus *Floridobolus* (Spirobolida: Spirobolidea). Bull. Brooklyn Ent. Soc., vol. 54, pp. 1–7, 16 figs.

Loomis, H. F. 1933. Egg-laying habits and larval stages of a milliped, *Arctobolus marginatus* (Say) Cook, native at Washington. Journ. Washington Acad. Sci., vol. 23, pp. 100–109, 1 fig.

————. 1943. New cave and epigean millipeds of the United States, with notes on some established species. Bull. Mus. Comp. Zool., vol. 92, pp. 373–410, 18 figs., 1 pl.

Merrill, E. D. 1936. Palisot de Beauvois as an overlooked American botanist. Proc. Amer. Philos. Soc., vol. 76, pp. 899–920, 1 pl.

Olivier, M. 1792. Histoire Naturelle Insectes. Encyclopedie Methodique, vol. 7, pp. 1–827.

Palisot de Beauvois, A. M. F. J. 1817. Insectes recueillis en Afrique et en Amérique, livr. 9, pp. 136–156, 6 pls.

Pocock, R. I. 1893. Contributions to our knowledge of the arthropod fauna of the West Indies. Part III. Diplopoda and Malacopoda, with a supplement on the Arachnida of the class Pedipalpi. Journ. Linn. Soc. London, Zool., vol. 24, pp. 473–544, 4 pls.

————. 1894. Chilopoda, Symphyla, and Diplopoda of the Malay Archipelago, *in* Max Weber, Zoologische Ergebnisse einer Reise in Niederländisch Ost-Indien, vol. 4, pp. 307–404, 4 pls.

Rafinesque, C. S. 1820. Annals of Nature; or annual synopsis of new genera and species of animals, plants, etc., discovered in North America; first annual number. 16 pp. Lexington, Ky.

SAY, THOMAS. 1821. Descriptions of the Myriapodae of the United States. Journ. Acad. Nat. Sci. Philadelphia, vol. 2, pp. 102–114.

SCHMIDT, K. P. 1936. Guatemalan salamanders of the genus *Oedipus*. Zool. ser., Field Mus. Nat. Hist., vol. 20, pp. 135–166, 7 figs.

SILVESTRI, P. 1903. Classis Diplopoda, vol. 1, Anatome. Acari Myriopoda et Scorpiones hucusque in Italia reperta. 272 pp., 346 figs., 4 tables.

SNODGRASS, R. E. 1952. A textbook of arthropod anatomy. 363 pp., 88 figs. Ithaca, N. Y.

VERHOEFF, K. W. 1893. Vorläufige Mittheilung über neue Schaltstadium-Beobachtungen bei Juliden, eine neue Gruppierung der alten Gattung *Julus* und einige neue und seltene Diplopoden aus Tirol. Zool. Anz., vol. 16, pp. 479–482.

VILLERS, C. DE. 1789. Aptera. Caroli Linnaei Entomologia, vol. 4, pp. 1–198.

VIOSCA, P. 1925. Perambulating millipeds. Science, vol. 61, pp. 19–20.

WANG, Y. M. 1951. The Myriopoda of the Philippine Islands. Sericea, vol. 1, pp. vi + 80, 12 pls.

WOOD, H. C. 1864. Descriptions of new species of North American Julidae. Proc. Acad. Nat. Sci. Philadelphia, vol. 16, pp. 10–16.

List of Abbreviations Used in the Figures.

ag	antennal groove	m	mid belt
al	anal lip	MA	mesal apodeme of posterior telepodite
AV	anal valve		
bp	basal portion of cyphopod	MC	mandibular cheek
BV	basal valve of cyphopod	memb	membrane
C	clypeus	MP	mesal process of sternum of anterior gonopods
Cd	cardo of gnathochilarium		
Cl	collum	P	prebasilare
Co	coxa of anterior gonopod	Pb	postgenital bar
Coe	coxal endite	pcb	posterior coxal bar
Cox	coxa of posterior gonopod	PE	prefemoral endite
Coxp	coxal apodeme	Pl	pleurum
CP	cephalic plate of second segment	pm	postseral emargination
Cp	caudal plate of cyphopod	PS	parietal sclerite
Cph	cephalic plate of cyphopod	Pu	penultimate segment
Crd	cardo of mandible	rp	repugnatorial pore
dl	distal lobe of cyphopod	S	stipes of gnathochilarium
EP	eye patch	Sc	anal scale
F	frons	sc	seminal canal
f	fore belt	sr	seminal receptacle
fs	facial suture	St	sternum
gm	genital emargination	Sta	sternal apodeme
H	hypostoma	Stip	stipes of mandible
h	hind belt	T	tergum
L	labrum	TT	tergum of telson
LL	lingual lamina	Tel	telopodite of anterior gonopod
lc	lateral corner of clypeus	Telp	telopodite of posterior gonopod
lf	lateral flange of cyphopod	V	vertex
M	mentum	vc	ventral corner of clypeus

Explanation of Figures

Plate I

Figs. 1–6.—Faces, anterior views.

Fig. 1.—*Narceus annularis.*

Fig. 2.—*Chicobolus spinigerus.*

Fig. 3.—*Aztecolus nigrior.*

Fig. 4.—*Spirobolus bungii.*

Fig. 5.—*Spirobolus walkeri.*

Fig. 6.—*Tylobolus claremontus.*

Fig. 7.—*Narceus annularis,* gnathochilarium, ventral view.

Fig. 8.—Diagram of two body segments of a spirobolid milliped, lateral view of left side.

Fig. 9.—Diagram of a segment ring of a spirobolid milliped, cephalic view.

Plate II

(Drawings by Frances A. McKittrick)

Figs. 10–14.—Heads and first two segments, lateral views.
Fig. 10.—*Narceus annularis.*
Fig. 11.—*Hiltonius pulchrus* (antenna removed).
Fig. 12.—*Chicobolus spinigerus.*
Fig. 13.—*Tylobolus castaneus.*
Fig. 14.—*Narceus gordanus.*
Fig. 15.—*Narceus gordanus,* detail of area around antennal groove (collum removed).

Plate III

(Drawings by Frances A. McKittrick)

Figs. 16–19.—Bases of male legs 3–7 in normal positions, ventral views.
Fig. 16.—*Narceus annularis.*
Fig. 17.—*Narceus americanus.*
Fig. 18.—*Tylobolus castaneus.*
Fig. 19.—*Chicobolus spinigerus.*
Fig. 20.—*Narceus annularis,* detail of texture of tergum. The reticulate appearance given by stiple board closely resembles the actual texture of the terga (seen only under high magnification).
Fig. 21.—*Tylobolus claremontus,* telson, ventral view.
Fig. 22.—*Narceus annularis,* telson, ventral view.

Plate IV

Figs. 23–29.—*Narceus annularis.*
Fig. 23.—Anterior gonopods, cephalic view.
Fig. 24.—Anterior and posterior gonopods in normal position, caudal view.
Fig. 25.—Diagrams of distal ends of prefemoral endites of two specimens.
Fig. 26.—Left posterior gonopod, cephalic view.
Fig. 27.—Left posterior gonopod, caudal view.
Fig. 28.—Inner surface of distal portion of posterior telopodite.
Fig. 29.—Postgenital bar, ventral view.
Figs. 30–31.—*Narceus americanus.*
Fig. 30.—Left posterior gonopod, distal portion, cephalic view.
Fig. 31.—Diagrams of distal ends of prefemoral endites of four specimens.
Figs. 32–34.—*Narceus gordanus.*
Fig. 32.—Anterior gonopods, cephalic view.
Fig. 33.—Left posterior gonopod, distal portion, cephalic view.
Fig. 34.—Left posterior gonopod, distal portion, caudal view.

Plate V

Figs. 35–43.—*Narceus annularis,* right male legs, cephalic views.
Fig. 35.—Third leg.
Figs. 36–38.—Coxae and second segments of third legs of three other specimens.
Figs. 39–42.—Coxae and second segments of fourth through seventh legs.
Fig. 43.—Postgenital leg.
Figs. 44–51.—*Narceus americanus,* right male legs, cephalic views.
Fig. 44.—Third leg.
Fig. 45.—Coxa and second segment of third leg of another specimen.
Fig. 46.—Coxa and second segment of third leg of specimen in which the coxal lobes are poorly developed (abnormal).
Fig. 47.—Coxa and second segment of third leg of specimen considered to be an intergrade with *annularis.* The coxal lobe is expanded laterally but the transverse groove is absent.
Figs. 48–51.—Coxae and second segments of fourth through seventh legs.
Figs. 52–56.—*Narceus gordanus,* right male legs, cephalic views.
Fig. 52.—Third leg.
Figs. 53–56.—Coxae and second segments of fourth through seventh legs.
Figs. 57–63.—*Chicobolus spinigerus,* right male legs, cephalic views (except figure 60).
Fig. 57.—Third leg.
Figs. 58–59.—Coxae and second segments of fourth and fifth legs.
Fig. 60.—Coxa of fifth leg, distal portion, mesal view.
Figs. 61–62.—Coxae and second segments of sixth and seventh legs.
Fig. 63.—Postgenital leg.

Plate VI

Fig. 64.—*Narceus annularis,* telson and penultimate segment, dorsal view.
Figs. 65–68.—*Narceus annularis,* left cyphopod.
Fig. 65.—Caudal view.
Fig. 66.—Cephalic view.
Fig. 67.—Lateral view.
Fig. 68.—Distal view.
Figs. 69–74.—*Narceus americanus,* left cyphopods.
Figs. 69–72.—Caudal views of four different specimens. The specimen of fig. 72 is one of the very few individuals of *Narceus* seen in which the lateral flange is almost absent.
Fig. 73.—Lateral view.
Fig. 74.—Distal view.
Figs. 75–77.—*Narceus gordanus,* left cyphopod.
Fig. 75.—Caudal view.

Fig. 76.—Cephalic view.
Fig. 77.—Lateral view.
Figs. 78–81.—*Chicobolus spinigerus,* left cyphopods.
Figs. 78–79.—Caudal views of two specimens.
Fig. 80.—Cephalic view.
Fig. 81.—Lateral view.
Fig. 82.—*Narceus annularis,* second segment ring of female, cephalic view.
Fig. 83.—*Narceus annularis,* coxa and second segment of right third leg of female, cephalic view.
Figs. 84–85.—*Narceus americanus,* coxae and second segments of right third legs of two females, cephalic views.

Plate VII

Figs. 86–101.—Colla and second segments, lateral views of left sides.
Figs. 86–88.—*Narceus annularis,* three specimens.
Figs. 89–91.—*Narceus americanus,* three specimens.
Figs. 92–93.—*Narceus gordanus,* two specimens.
Figs. 94–95.—*Chicobolus spinigerus,* two specimens.
Fig. 96.—*Aztecolus pablillo.*
Fig. 97.—*Spirobolus bungii.*
Fig. 98.—*Spirobolus walkeri.*
Fig. 99.—*Spirobolus grahami.*
Fig. 100.—*Spirobolus umbobrochus.*
Fig. 101.—*Spirobolus formosae.*
Figs. 102–104.—Left mandibular stipites of typical specimens of three different genera, lateral views.
Fig. 102.—*Narceus.*
Fig. 103.—*Chicobolus.*
Fig. 104.—*Aztecolus.*

Plate VIII

Figs. 105–109.—*Aztecolus nigrior.*
Fig. 105.—Anterior gonopods, cephalic view.
Fig. 106.—Left posterior gonopod, distal portion, caudal view.
Fig. 107.—Left posterior gonopod, distal portion, cephalic view.
Fig. 108.—Detail of distal portion of posterior telopodite of specimen from Nuevo Leon, distal view.
Fig. 109.—Detail of distal portion of posterior telopodite of specimen (subadult?) from Zacatecas, distal view.
Figs. 110–118.—*Aztecolus pablillo.*
Fig. 110.—Detail of distal portion of posterior telopodite of *holotype,* distal view.

Fig. 111.—Anterior gonopods, cephalic view.
Fig. 112.—Left posterior gonopod, distal portion, caudal view.
Fig. 113.—Left posterior gonopod, cephalic view.
Fig. 114.—Right postgenital leg of male, cephalic view.
Fig. 115.—Right third leg of male, cephalic view.
Fig. 116.—Telson and penultimate segment, dorsal view.
Fig. 117.—Left cyphopod, caudal view.
Fig. 118.—Left cyphopod, lateral view.
Figs. 119–121.—*Aztecolus nigrior,* left cyphopods.
Fig. 119.—Caudal view of specimen from Zacatecas.
Fig. 120.—Caudal view of specimen from Nuevo Leon.
Fig. 121.—Lateral view of distal portion.

Plate IX

Figs. 122–126.—*Chicobolus spinigerus.*
Fig. 122.—Anterior gonopods, cephalic view.
Fig. 123.—Left posterior gonopod, distal portion, cephalic view.
Fig. 124.—Left posterior gonopod, distal portion, caudal view.
Figs. 125–126.—Left anterior gonopods of two other specimens, distal portions, cephalic views. The ventral margins of the coxal endites show different amounts of curvature.
Figs. 127–130.—*Spirobolus bungii.*
Fig. 127.—Anterior gonopods, cephalic view.
Fig. 128.—Left posterior gonopod, cephalic view.
Fig. 129.—Left posterior gonopod, caudal view.
Fig. 130.—Coxa and second and third segments of left third leg of male, cephalic view.
Figs. 131–135.—Left mandibular stipes of the species of *Spirobolus,* lateral views.
Fig. 131.—*Spirobolus bungii.*
Fig. 132.—*Spirobolus walkeri.*
Fig. 133.—*Spirobolus grahami.*
Fig. 134.—*Spirobolus umbobrochus.*
Fig. 135.—*Spirobolus formosae.*

Plate X

Figs. 136–138.—*Spirobolus walkeri.*
Fig. 136.—Anterior gonopods, cephalic view.
Fig. 137.—Right posterior gonopod, distal portion, caudal view.
Fig. 138.—Right posterior gonopod, distal portion, cephalic view.
Figs. 139–141.—*Spirobolus grahami.*
Fig. 139.—Left posterior gonopod, distal portion, cephalic view.
Fig. 140.—Left posterior gonopod, distal portion, caudal view.
Fig. 141.—Anterior gonopods, cephalic view.
Figs. 142–144.—*Spirobolus umbobrochus.*
Fig. 142.—Anterior gonopods, cephalic view.
Fig. 143.—Left posterior gonopod, distal portion, cephalic view.
Fig. 144.—Left posterior gonopod, distal portion, caudal view.

Plate XI

Figs. 145–148.—*Spirobolus walkeri,* left cyphopods.
Figs. 145–146.—Caudal views of two specimens.
Fig. 147.—Cephalic view.
Fig. 148.—Lateral view.
Figs. 149–151.—*Spirobolus formosae,* left cyphopod.
Fig. 149.—Lateral view.
Fig. 150.—Caudal view.
Fig. 151.—Cephalic view.
Figs. 152–160.—*Spirobolus grahami,* left cyphopods.
Figs. 152–158. Caudal views of seven specimens.
Fig. 159.—Cephalic view.
Fig. 160.—Lateral view.
Figs. 161–163.—Left cephalic plates of second segments of females, cephalic views.
Fig. 161.—*Spirobolus walkeri.*
Fig. 162.—*Spirobolus grahami.*
Fig. 163.—*Spirobolus formosae.*
Fig. 164.—*Spirobolus grahami,* coxa and second and third segments of right third leg of male, cephalic view.
Fig. 165.—*Spirobolus umbobrochus,* right third leg of male, cephalic view.

Plate XII

Figs. 166–170.—*Hiltonius mexicanus.*
Fig. 166.—Anterior gonopods, cephalic view.
Fig. 167.—Left posterior gonopod, distal portion, caudal view.
Fig. 168.—Left posterior gonopod, cephalic view.
Fig. 169.—Left posterior gonopod of another specimen, distal portion, caudal view.
Fig. 170.—Distal portion of left posterior telopodite, mesocephalic view.
Figs. 171–177.—*Hiltonius carpinus.*
Fig. 171.—Anterior gonopods, cephalic view.
Fig. 172.—Right posterior gonopod, distal portion, caudal view.
Fig. 173.—Right posterior gonopod, distal portion, cephalic view.
Fig. 174.—Anterior gonopods of another specimen, cephalic view.
Fig. 175.—Distal portion of right posterior telopodite, mesocephalic view.
Fig. 176.—Distal portion of right posterior telopodite of subadult specimen (*holotype* of *fratrellus*), mesocephalic view.
Fig. 177.—Right posterior gonopod of subadult specimen (holotype of *fratrellus*), distal portion, caudal view.

Plate XIII

Figs. 178–183.—*Hiltonius pulchrus.*
Fig. 178.—Anterior gonopods, cephalic view.
Fig. 179.—Left posterior gonopod of *holotype,* caudal view.
Fig. 180.—Left posterior gonopod of *holotype,* distal portion, cephalic view.
Fig. 181.—Left posterior gonopod of another specimen (*paratype* of *palmaris*), distal portion, cephalic view.
Fig. 182.—Left posterior gonopod of *paratype* of *palmaris,* distal portion, caudal view.
Fig. 183.—Distal end of posterior telopodite, distal view.
Figs. 184–188.—*Hiltonius mimus,* male *cotype.*
Fig. 184.—Anterior gonopods, cephalic view.
Fig. 185.—Left anterior telopodite, caudal view.
Fig. 186.—Left posterior gonopod, distal portion, caudal view.
Fig. 187.—Left posterior gonopod, distal portion, cephalic view.
Fig. 188.—Distal end of posterior telopodite, distal view.
Figs. 189–191.—*Hiltonius hebes.*
Fig. 189.—Anterior gonopods, cephalic view.
Fig. 190.—Left posterior gonopod, distal portion, caudal view.
Fif. 191.—Left posterior gonopod, distal portion, cephalic view.

Plate XIV

(Drawings by Frances A. McKittrick)

Figs. 192–193.—*Narceus annularis,* left cyphopod.
Fig. 192.—Caudal view.
Fig. 193.—Lateral view.
Figs. 194–195.—*Tylobolus uncigerus,* left cyphopod.
Fig. 194.—Caudal view.
Fig. 195.—Lateral view.
Figs. 196–201.—Species of *Hiltonius,* cyphopods, lateral views.
Fig. 196.—*Hiltonius mimus,* left cyphopod.
Fig. 197.—*Hiltonius pulchrus,* right cyphopod.
Fig. 198.—*Hiltonius hebes,* left cyphopod.
Fig. 199.—*Hiltonius mexicanus,* left cyphopod.
Fig. 200.—*Hiltonius carpinus,* left cyphopod.
Fig. 201.—*Hiltonius thebanus,* right cyphopod.

Plate XV

Figs. 202–208.—Colla and second segments of species of *Hiltonius,* lateral views of left sides.
Figs. 202–203.—*Hiltonius mexicanus,* two specimens.

Fig. 204.—*Hiltonius carpinus.*
Fig. 205.—*Hiltonius mimus.*
Fig. 206.—*Hiltonius pulchrus.*
Fig. 207.—*Hiltonius hebes.*
Fig. 208.—*Hiltonius thebanus.*
Figs. 209–217.—Species of *Hiltonius,* left cyphopods.
Fig. 209.—*Hiltonius mexicanus,* caudal view.
Fig. 210.—*Hiltonius mexicanus,* distal portion of cyphopod, mesal view.
Fig. 211.—*Hiltonius carpinus,* distal portion of cyphopod, mesal view.
Fig. 212.—*Hiltonius carpinus,* caudal view.
Fig. 213.—*Hiltonius carpinus,* cephalic view.
Fig. 214.—*Hiltonius hebes,* caudal view.
Fig. 215.—*Hiltonius thebanus,* caudal view.
Fig. 216.—*Hiltonius pulchrus,* caudal view.
Fig. 217.—*Hiltonius mimus,* caudal view.
Figs. 218–222.—Left mandibular stipites of typical specimens of two different genera, lateral views.
Figs. 218–220.—*Hiltonius,* three specimens.
Figs. 221–222.—*Tylobolus,* two specimens.
Fig. 223.—*Tylobolus* species?, left cyphopod, caudal view.

Plate XVI

Figs. 224–227.—*Tylobolus claremontus.*
Fig. 224.—Anterior gonopods, cephalic view.
Fig. 225.—Left posterior gonopod, distal portion, caudal view.
Fig. 226.—Left posterior gonopod, distal portion, cephalic view.
Fig. 227.—Right third leg of male, cephalic view.
Figs. 228–233.—*Tylobolus ergus,* specimen from Glennville, California.
Fig. 228.—Anterior gonopods, cephalic view.
Fig. 229.—Left posterior gonopod, distal portion, caudal view.
Fig. 230.—Left posterior gonopod, distal portion, cephalic view.
Fig. 231.—Distal segments of left fifth leg of male, caudal view.
Fig. 232.—Right seventh leg of male, cephalic view.
Fig. 233.—Right postgenital leg of male, cephalic view.
Figs. 234–237.—*Tylobolus monachus.*
Figs. 234–235.—Anterior gonopods of two specimens collected at the same locality at the same time, cephalic views.
Fig. 236.—Left posterior gonopod, distal portion, caudal view.
Fig. 237.—Left posterior gonopod, distal portion, cephalic view.

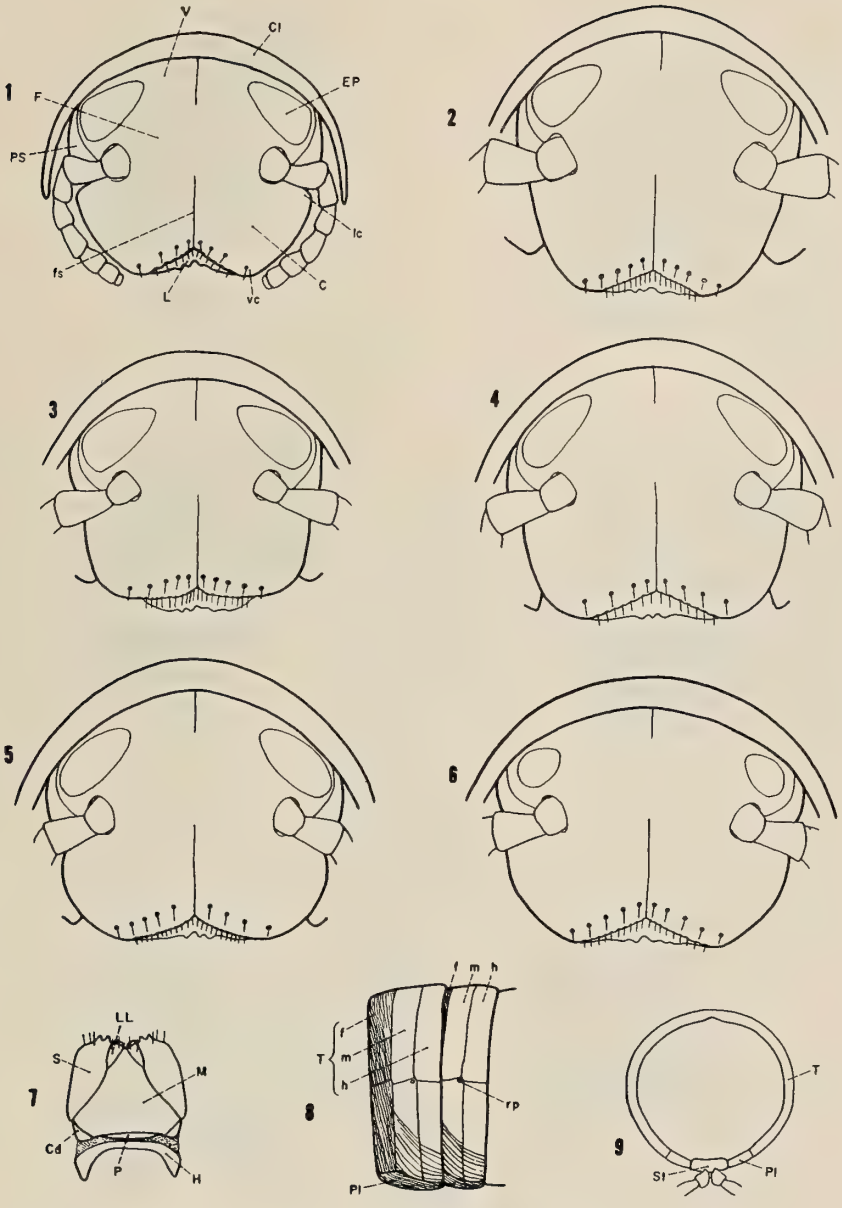
Plate XVII

Figs. 238–241.—*Tylobolus deses, cotype.*
Fig. 238.—Portion of anterior gonopods, cephalic view.

Fig. 239.—Left posterior gonopod, cephalic view.
Fig. 240.—Left posterior gonopod, distal portion, caudal view.
Fig. 241.—Left posterior gonopod, distal portion, mesal view.
Figs. 242–246.—*Tylobolus castaneus,* gonopods.
Fig. 242.—Anterior gonopods, cephalic view.
Fig. 243.—Left anterior gonopod of another specimen, cephalic view.
Fig. 244.—Left posterior gonopod, distal portion, caudal view.
Fig. 245.—Left posterior gonopod, distal portion, cephalic view.
Fig. 246.—Left posterior gonopod of immature specimen, distal portion, cephalic view.
Figs. 247–252.—*Tylobolus castaneus,* right male legs, cephalic views.
Fig. 247.—Third leg.
Fig. 248.—Fourth leg.
Fig. 249.—Fifth leg.
Fig. 250.—Sixth leg.
Fig. 251.—Seventh leg.
Fig. 252.—Postgenital leg.

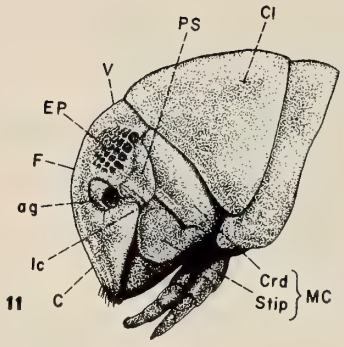
Plate XVIII

Figs. 253–261.—*Tylobolus uncigerus.*
Fig. 253.—Anterior gonopods, cephalic view.
Fig. 254.—Left anterior gonopod of another specimen, cephalic view.
Fig. 255.—Left posterior gonopod, distal portion, cephalic view.
Fig. 256.—Left posterior gonopod, distal portion, caudal view.
Fig. 257.—Right third leg of male, cephalic view.
Fig. 258.—Coxa of left third leg of male, mesal view.
Fig. 259.—Coxa and second segment of right fourth leg of male, cephalic view.
Fig. 260.—Coxa and second and third segments of right fifth leg of male, cephalic view.
Fig. 261.—Coxa of right sixth leg of male, cephalic view.
Figs. 262–264.—*Tylobolus utahensis.*
Fig. 262.—Left posterior gonopod, distal portion, cephalic view.
Fig. 263.—Left posterior gonopod, distal portion, caudal view.
Fig. 264.—Anterior gonopods, cephalic view.
Figs. 265–268.—*Tylobolus fredricksoni,* subadult *holotype.*
Fig. 265.—Anterior gonopods, cephalic view.
Fig. 266.—Left anterior telopodite, distal portion, caudal view.
Fig. 267.—Left posterior gonopod, distal portion, cephalic view.
Fig. 268.—Left posterior gonopod, distal portion, caudal view.



KEETON—FAMILY SPIROBOLIDAE

10

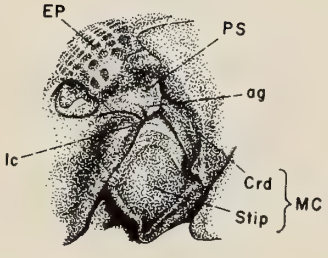


11

12

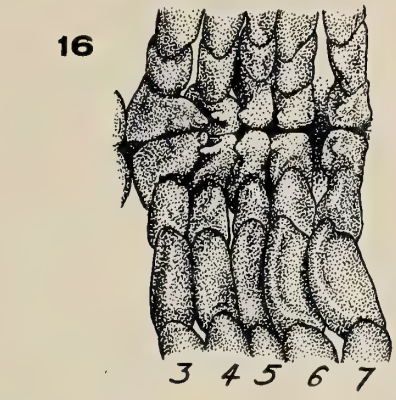
13

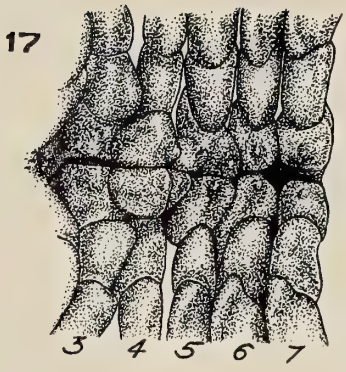
14

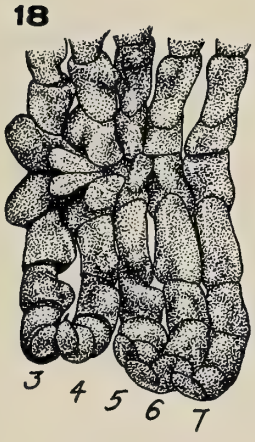


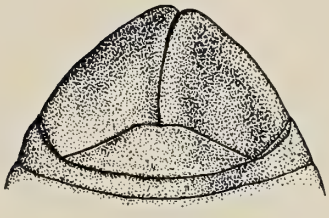
15

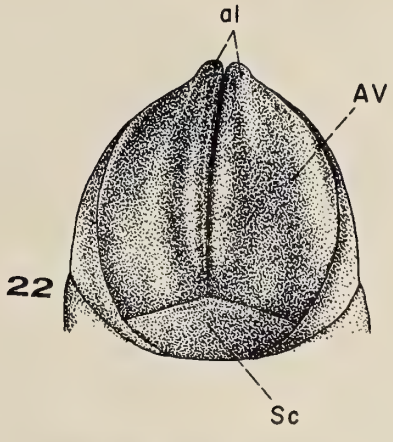
KEETON—FAMILY SPIROBOLIDAE



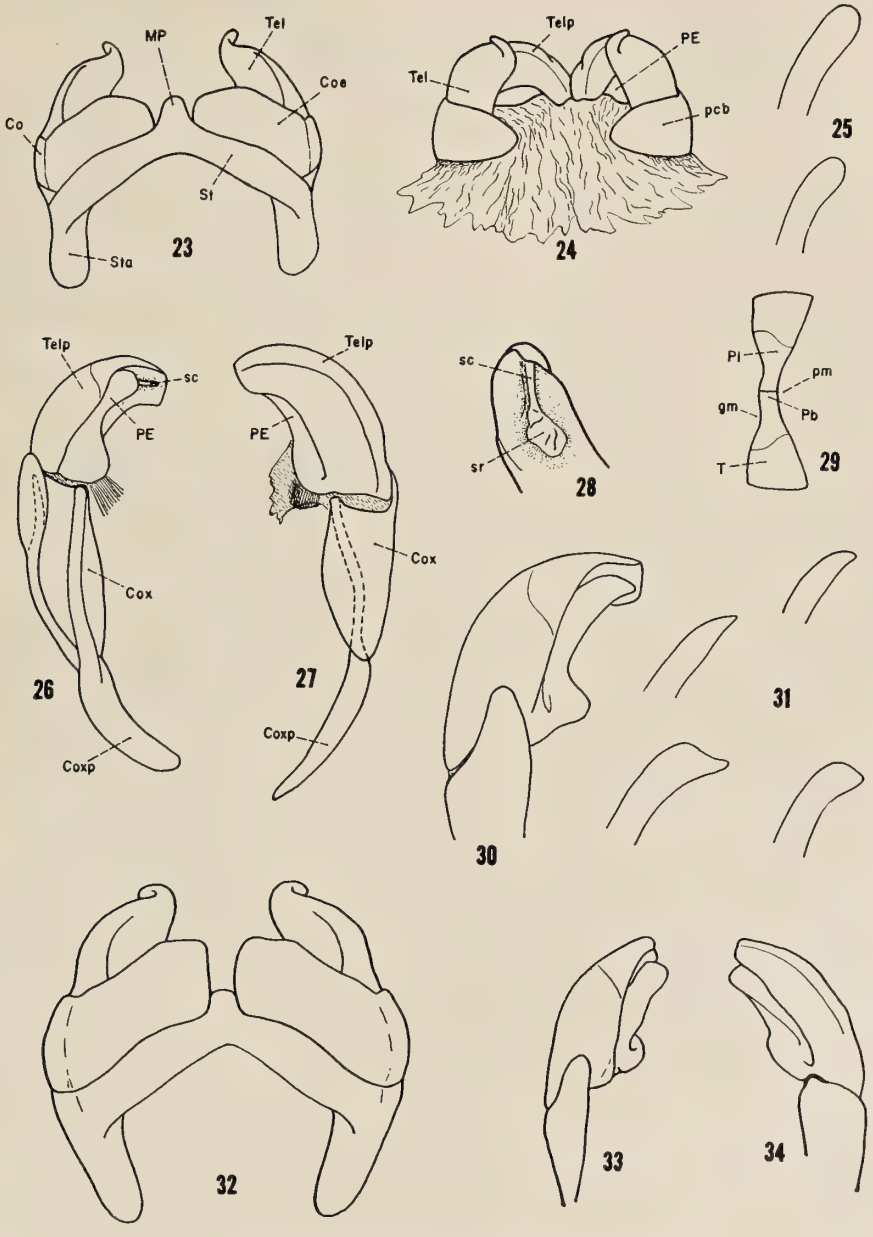




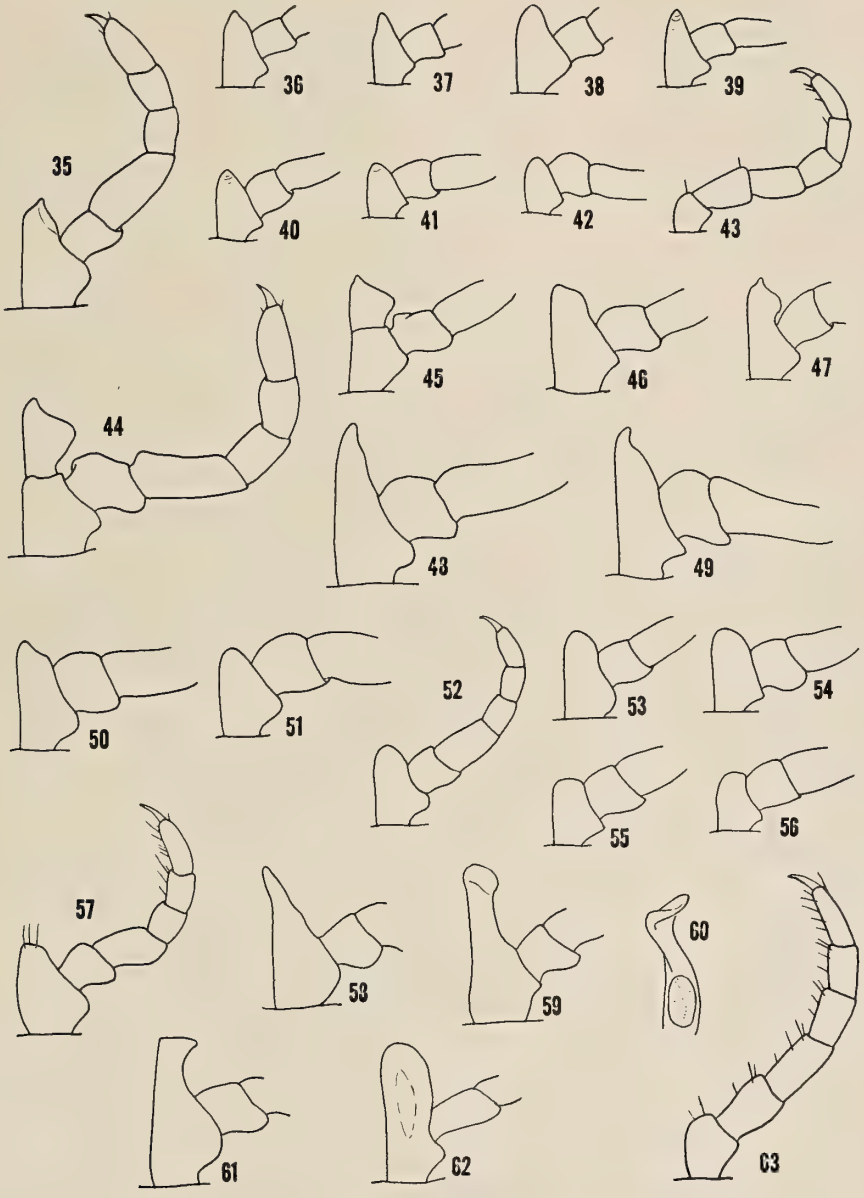




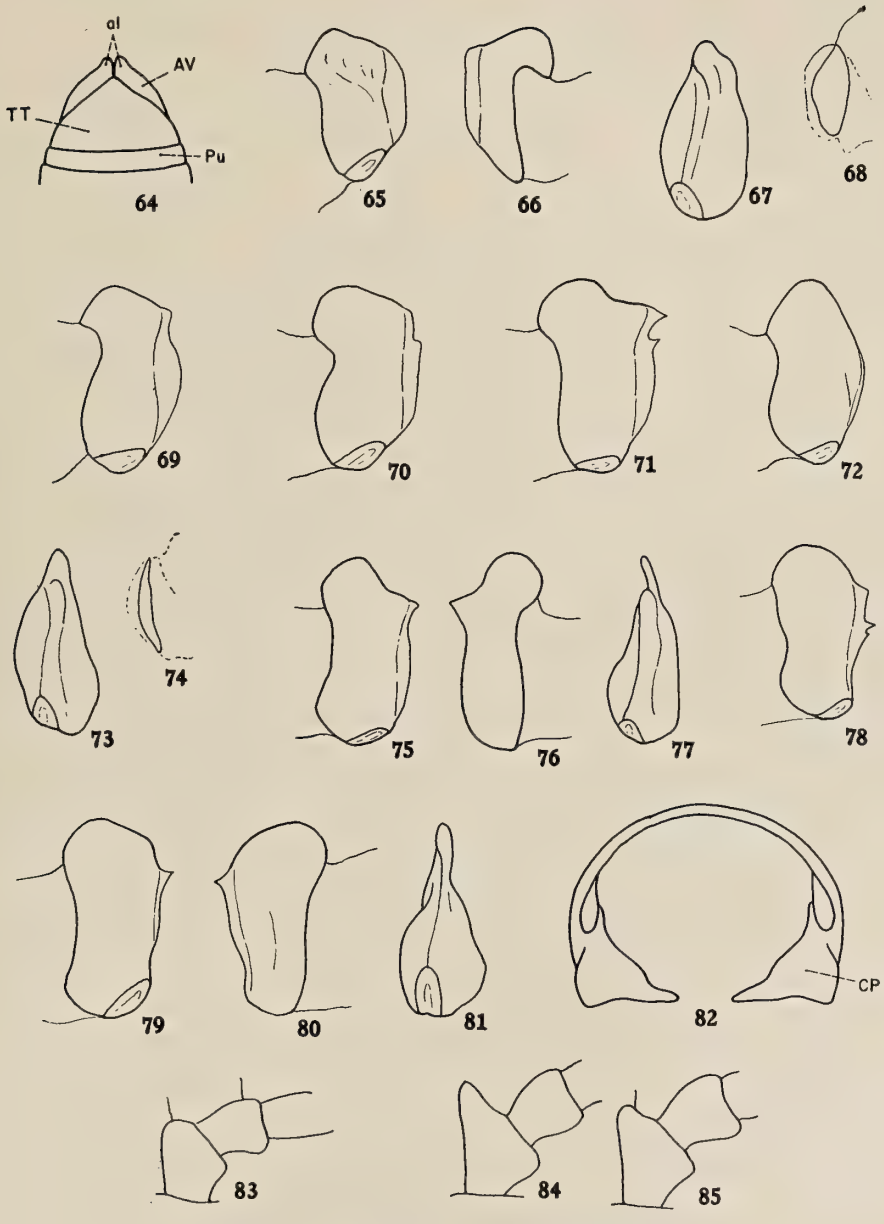
KEETON—FAMILY SPIROBOLIDAE



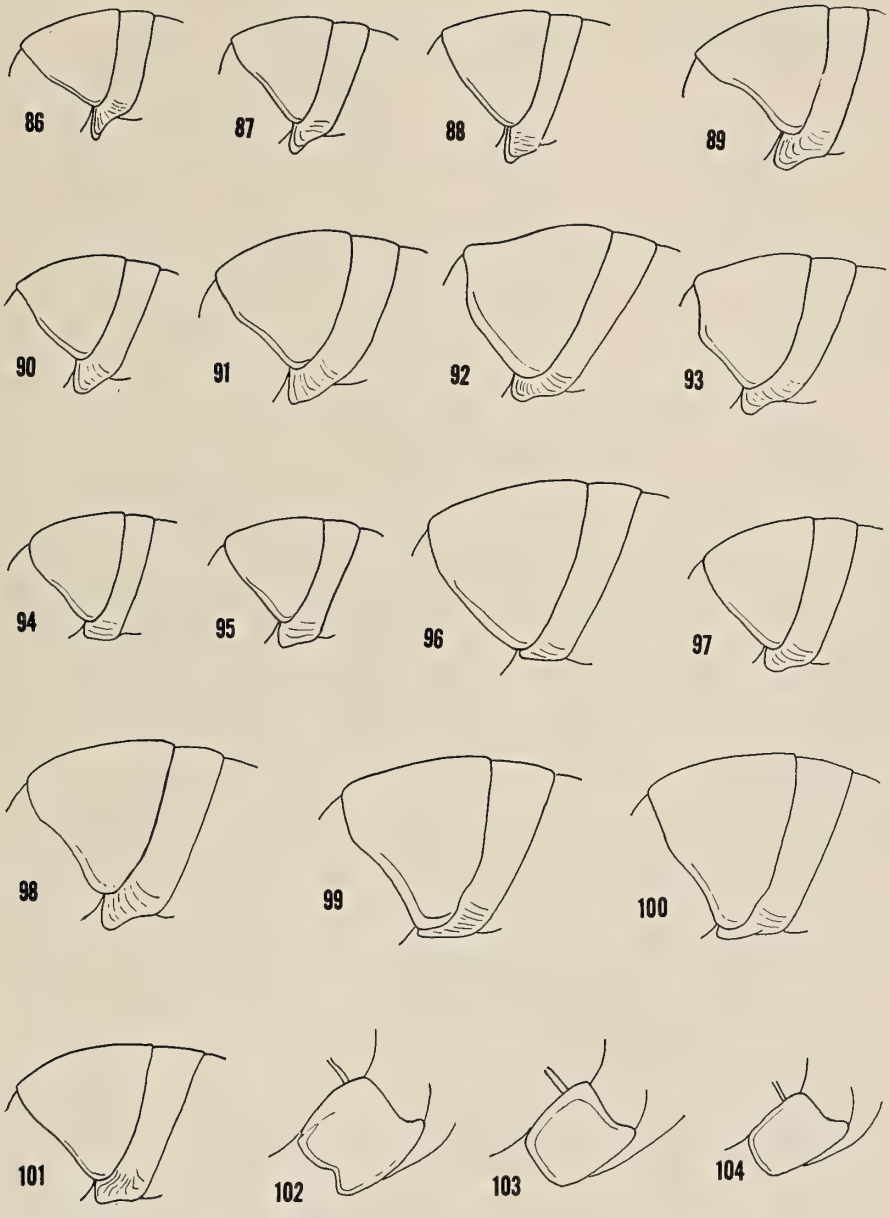
KEETON—FAMILY SPIROBOLIDAE



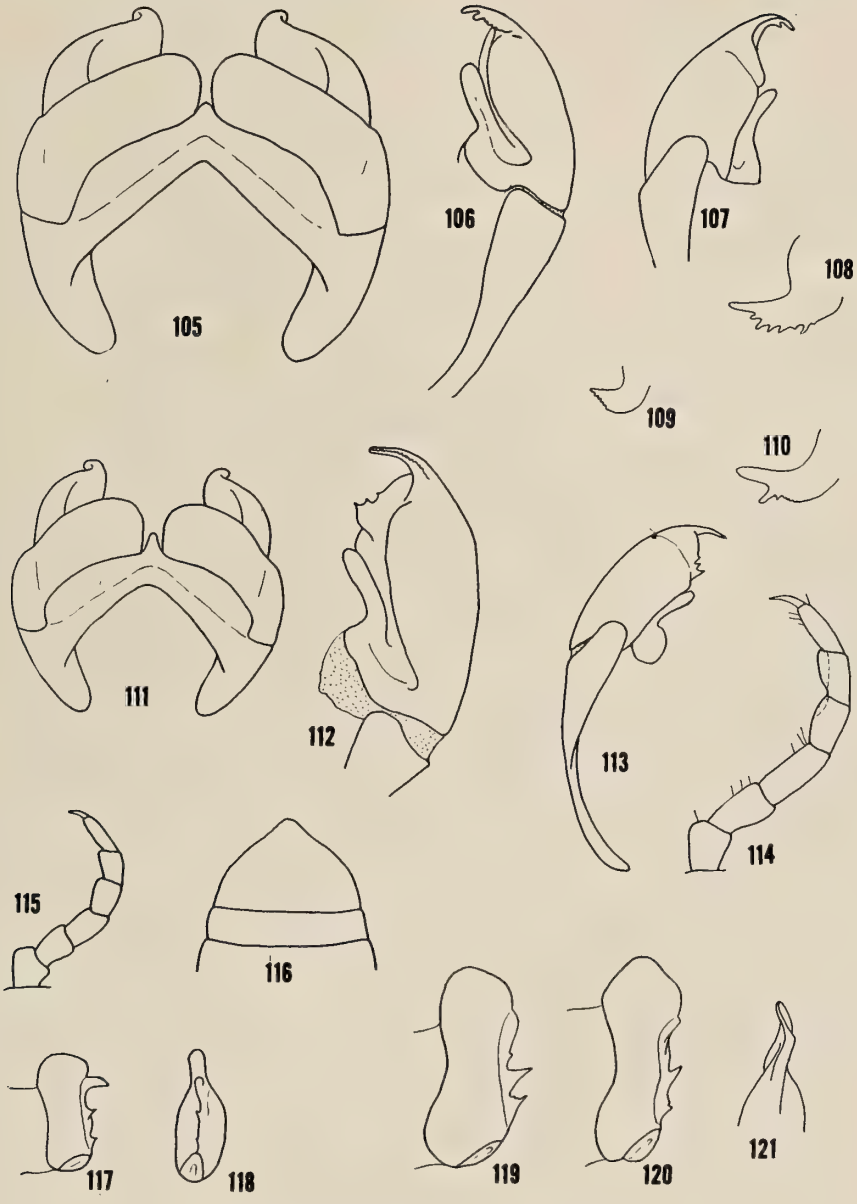
KEETON—FAMILY SPIROBOLIDAE



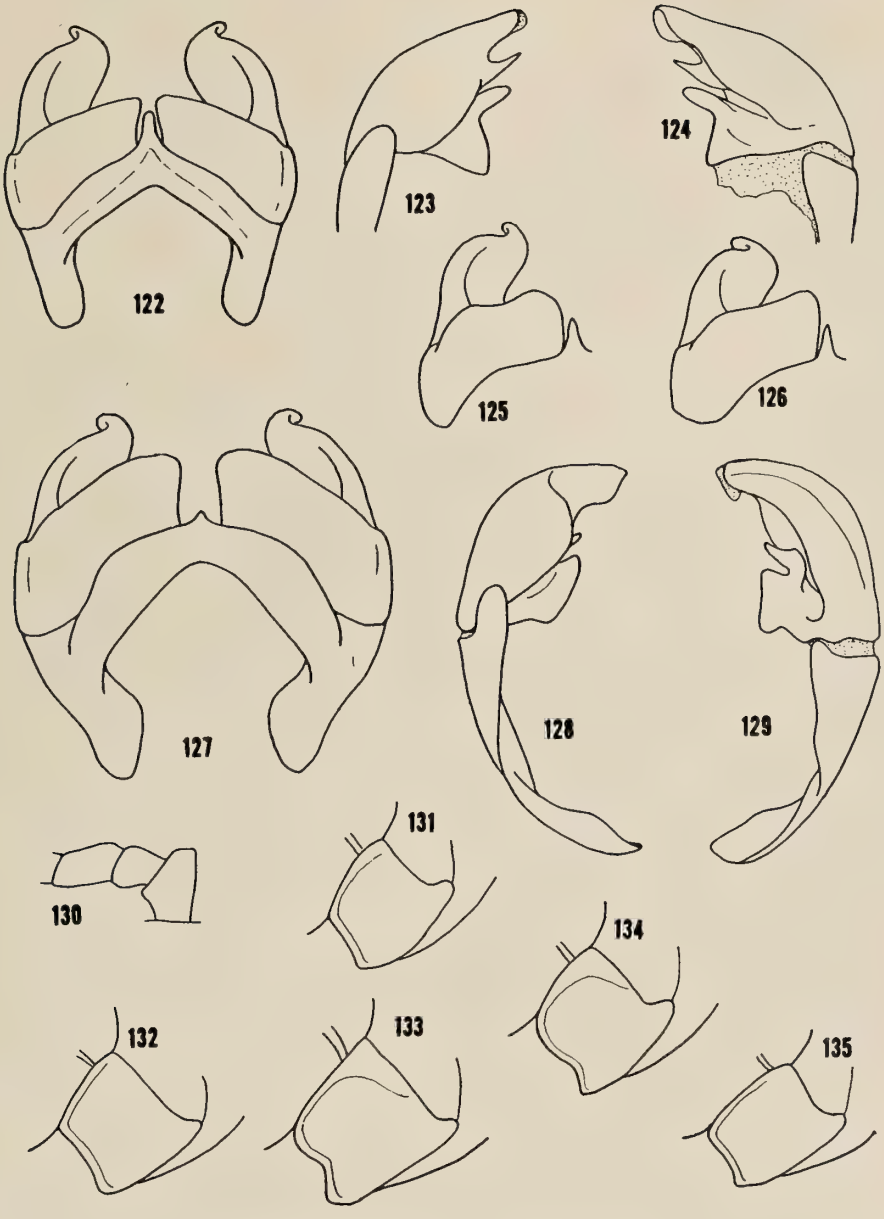
KEETON—FAMILY SPIROBOLIDAE



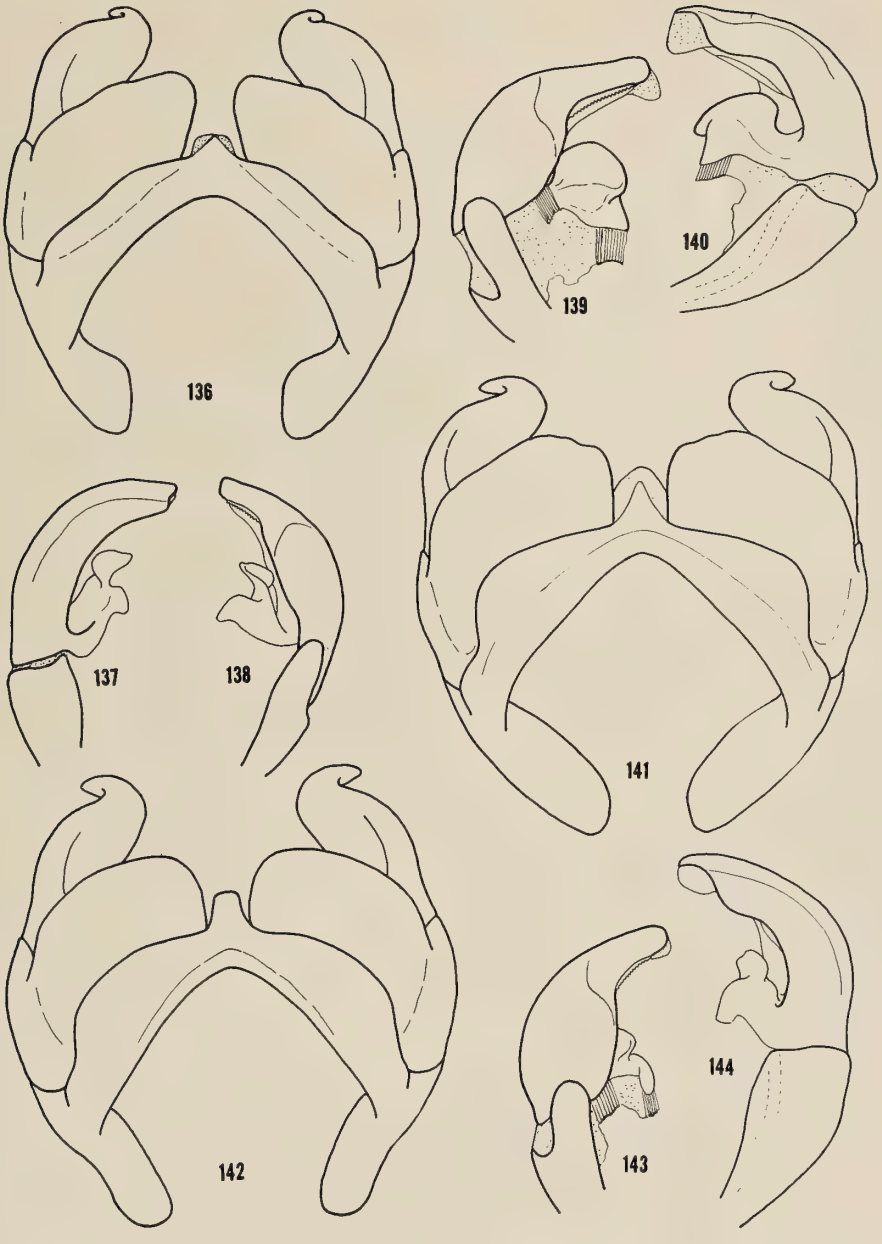
KEETON—FAMILY SPIROBOLIDAE



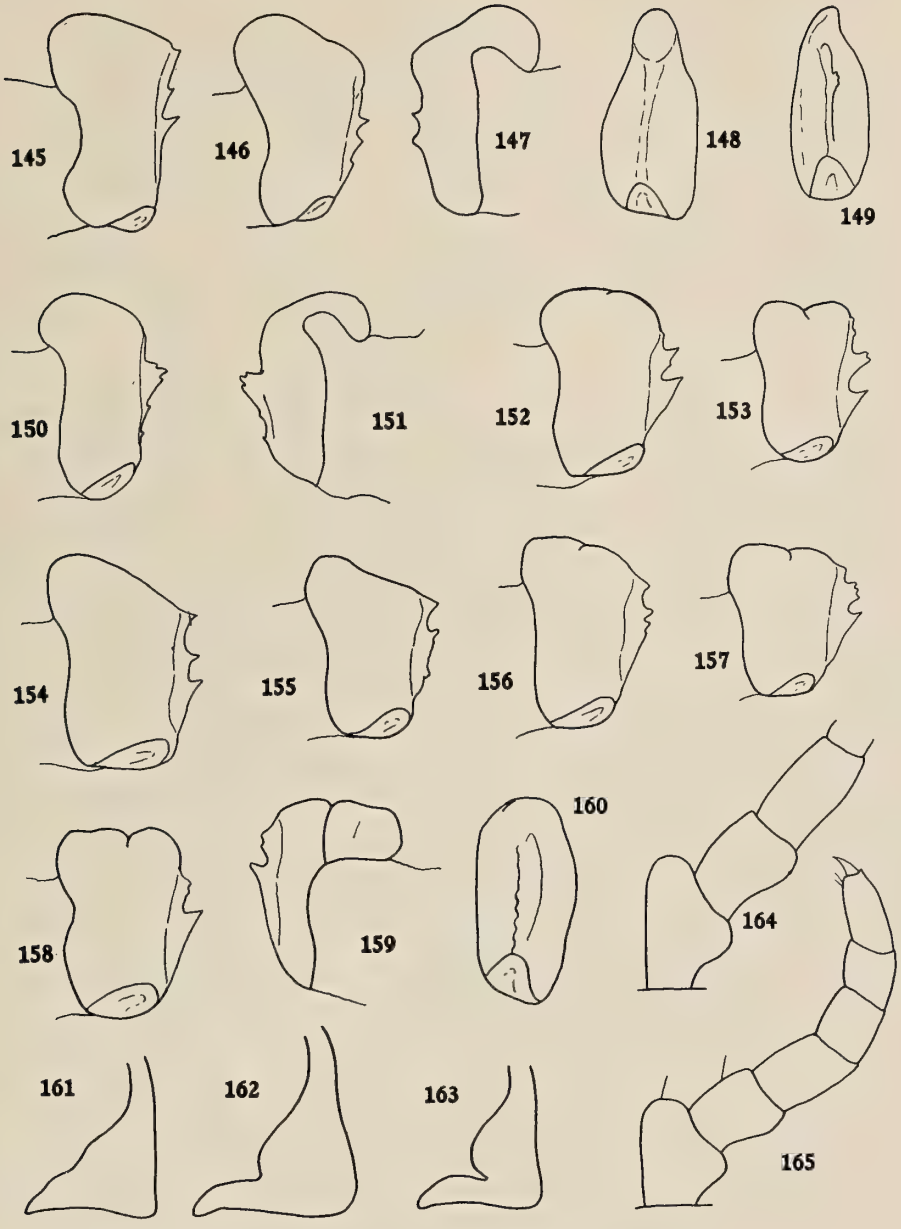
KEETON—FAMILY SPIROBOLIDAE



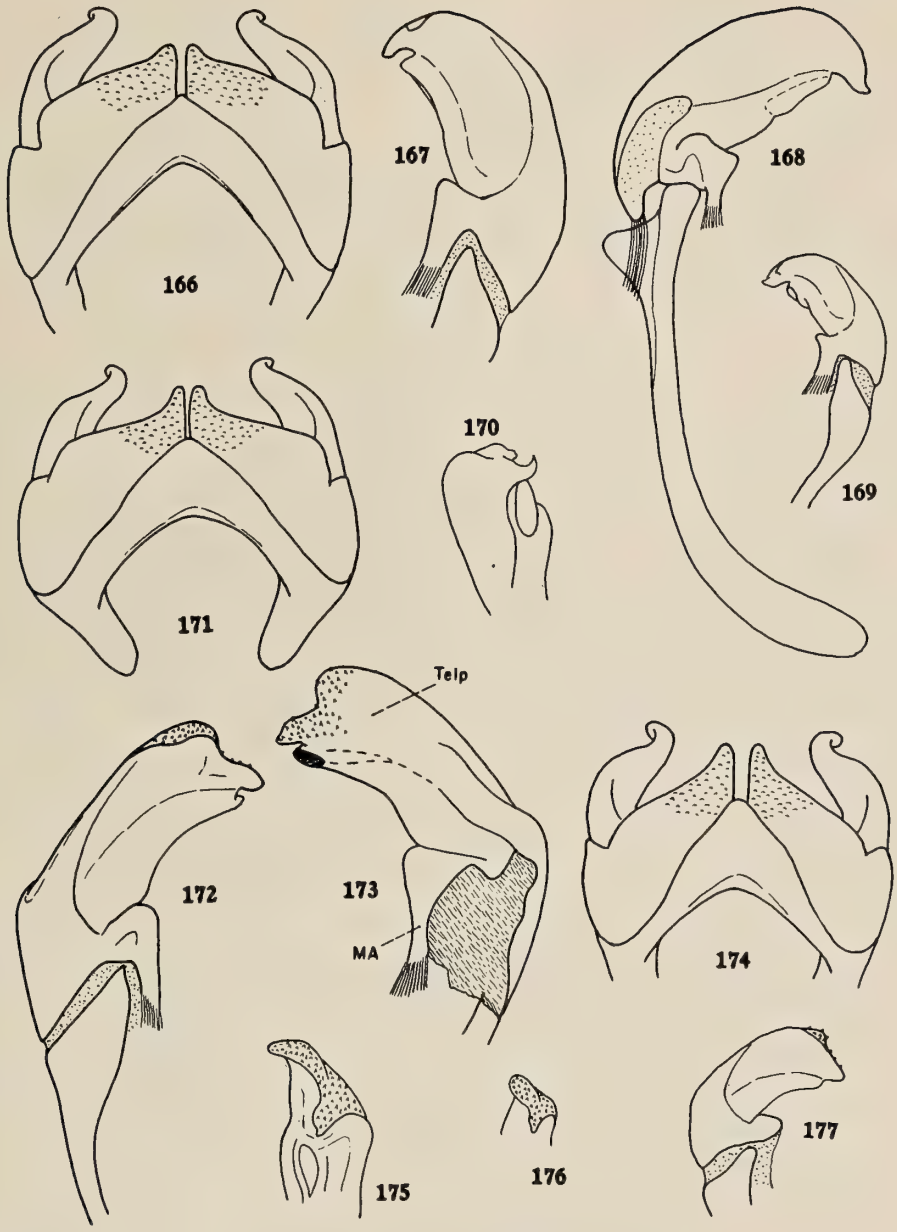
KEETON—FAMILY SPIROBOLIDAE



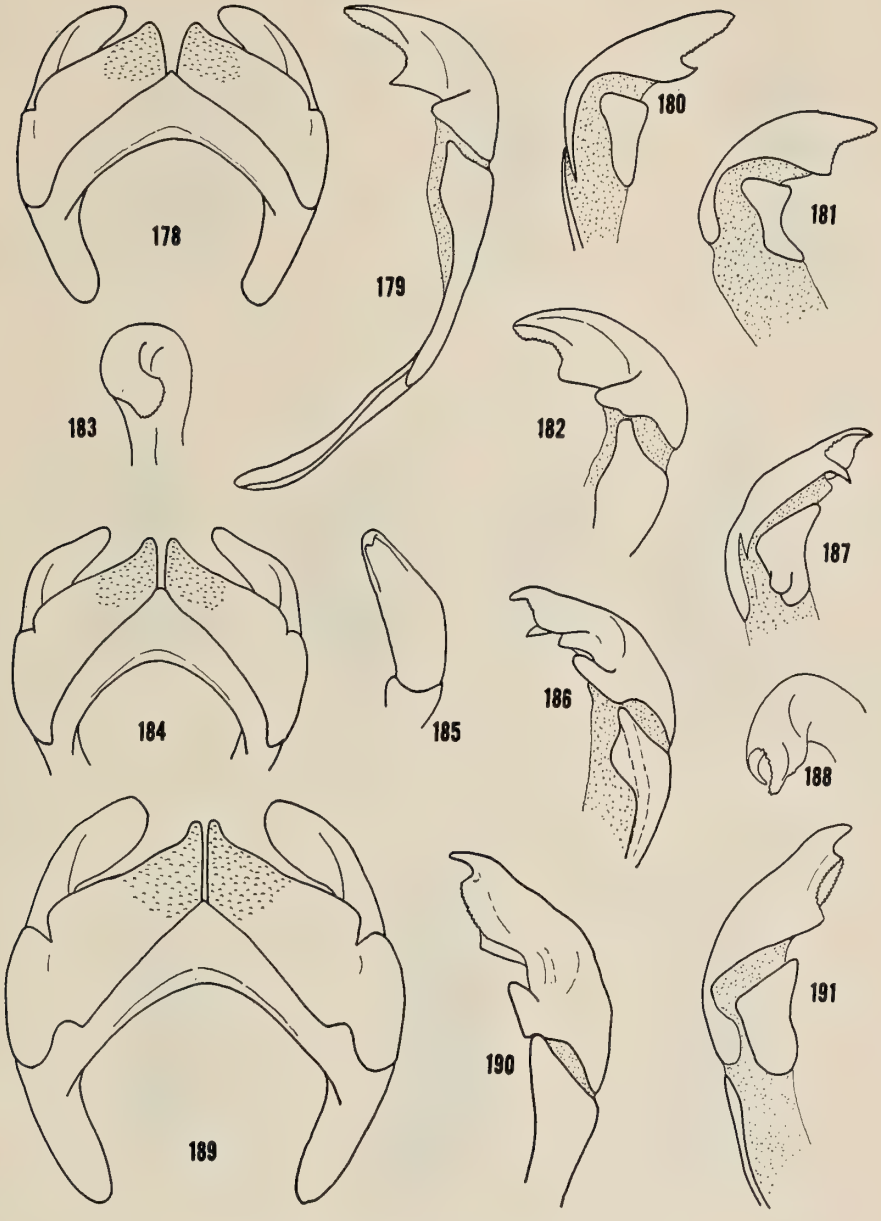
KEETON—FAMILY SPIROBOLIDAE



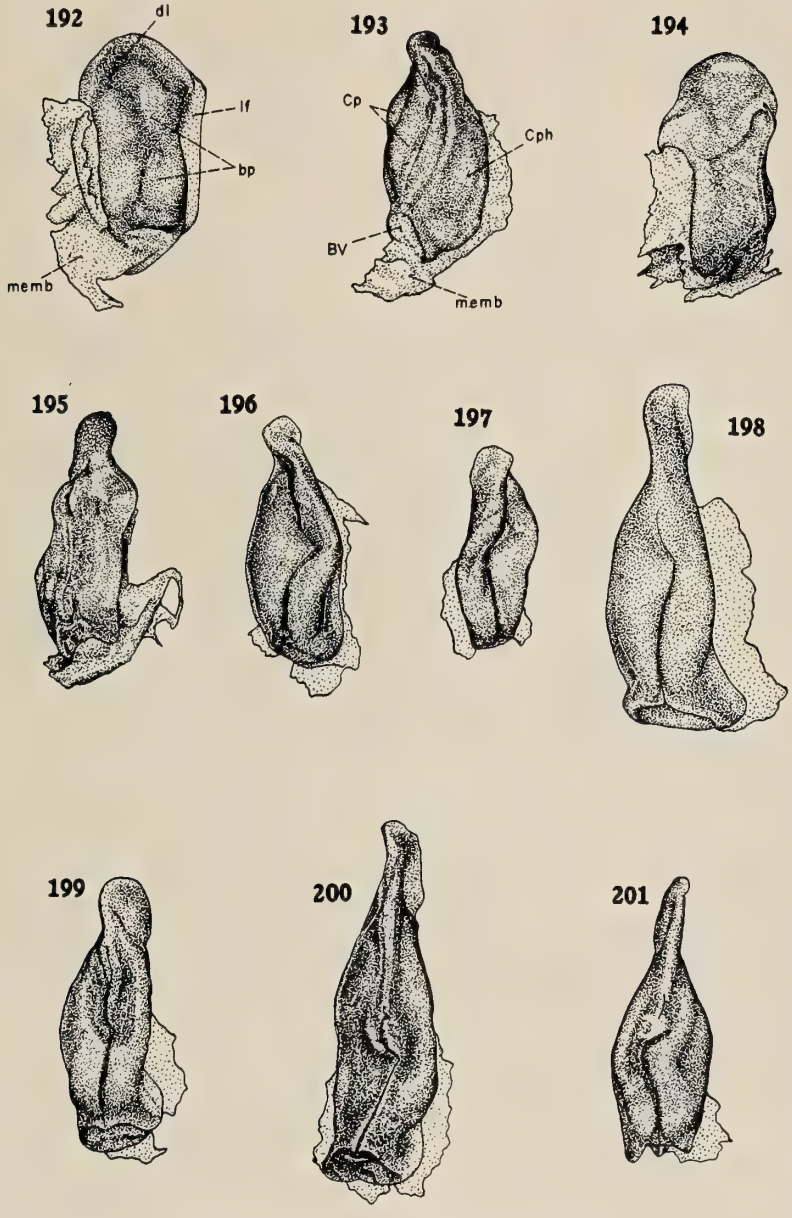
KEETON—FAMILY SPIROBOLIDAE



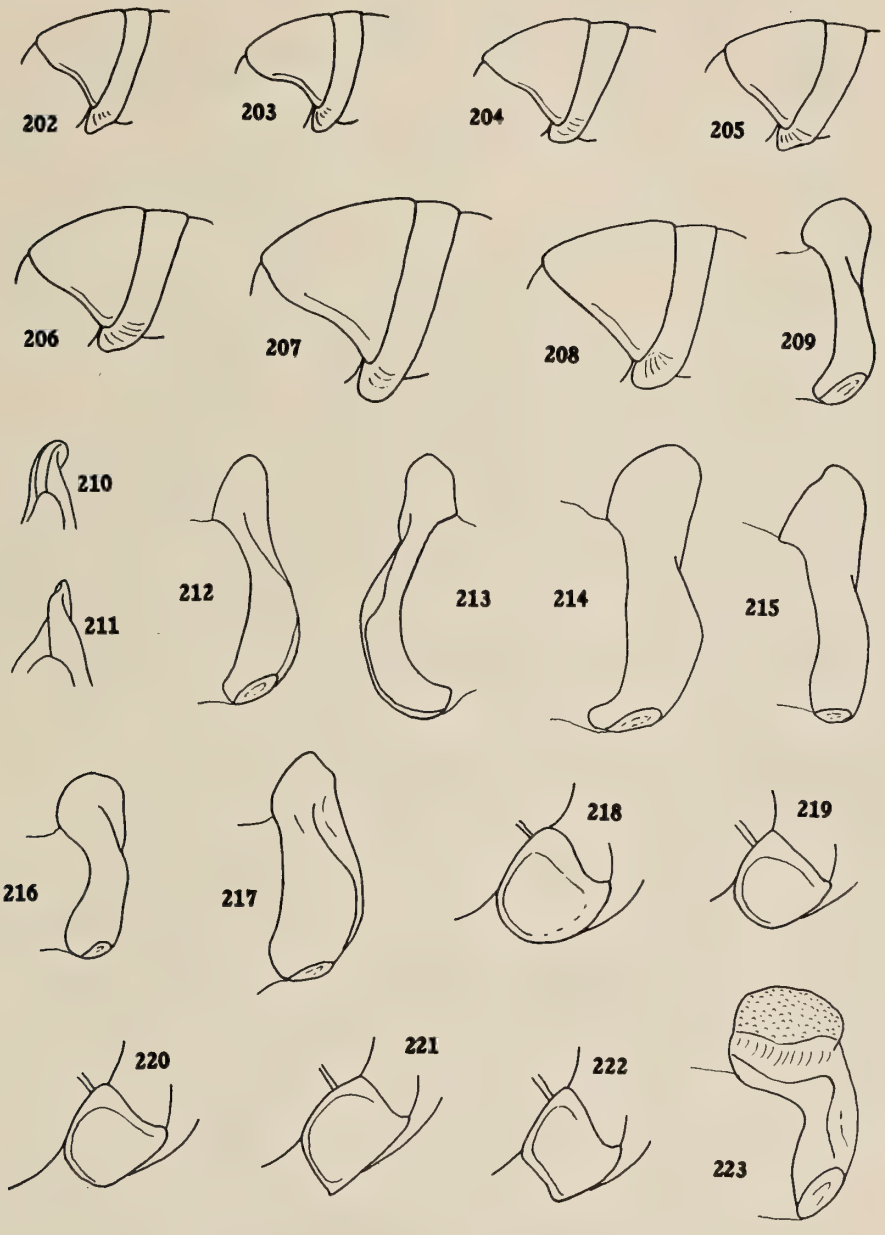
KEETON—FAMILY SPIROBOLIDAE



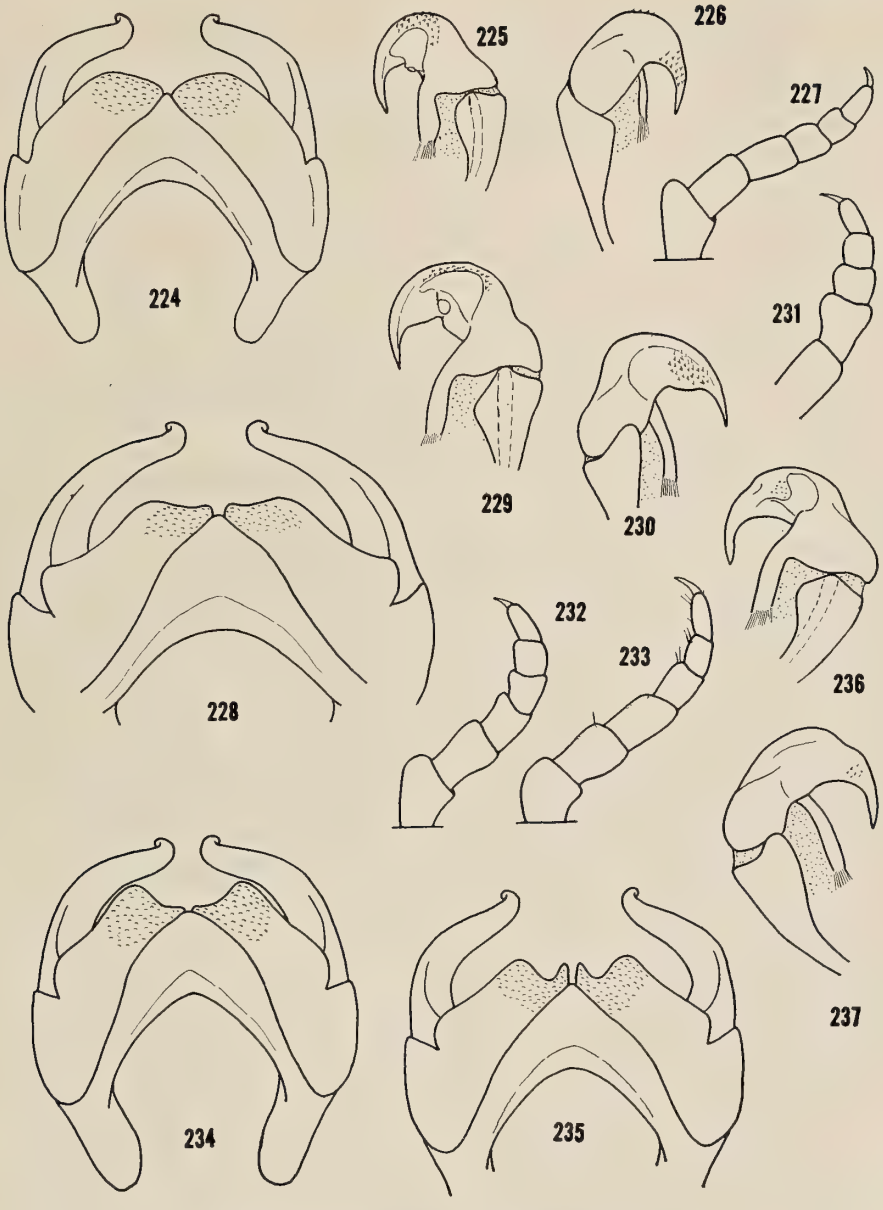
KEETON—FAMILY SPIROBOLIDAE



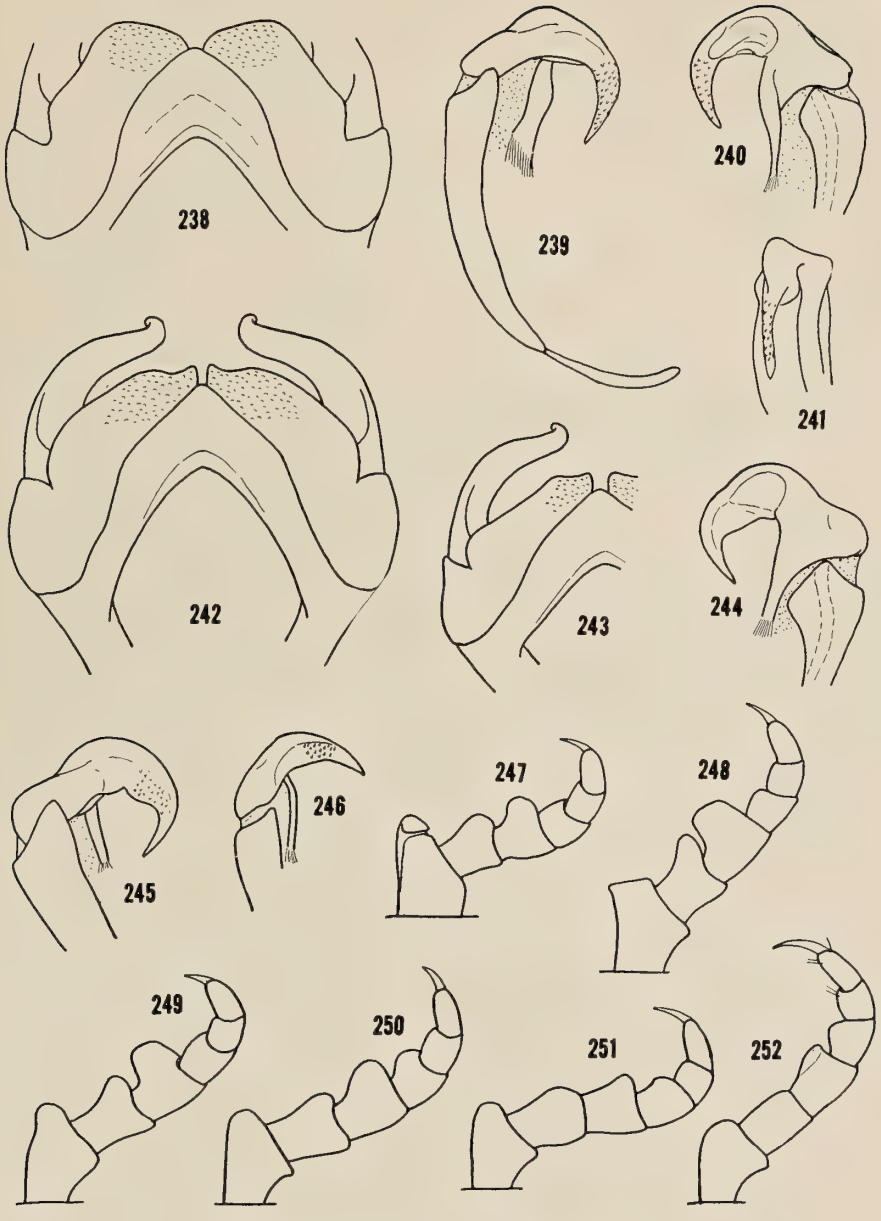
KEETON—FAMILY SPIROBOLIDAE



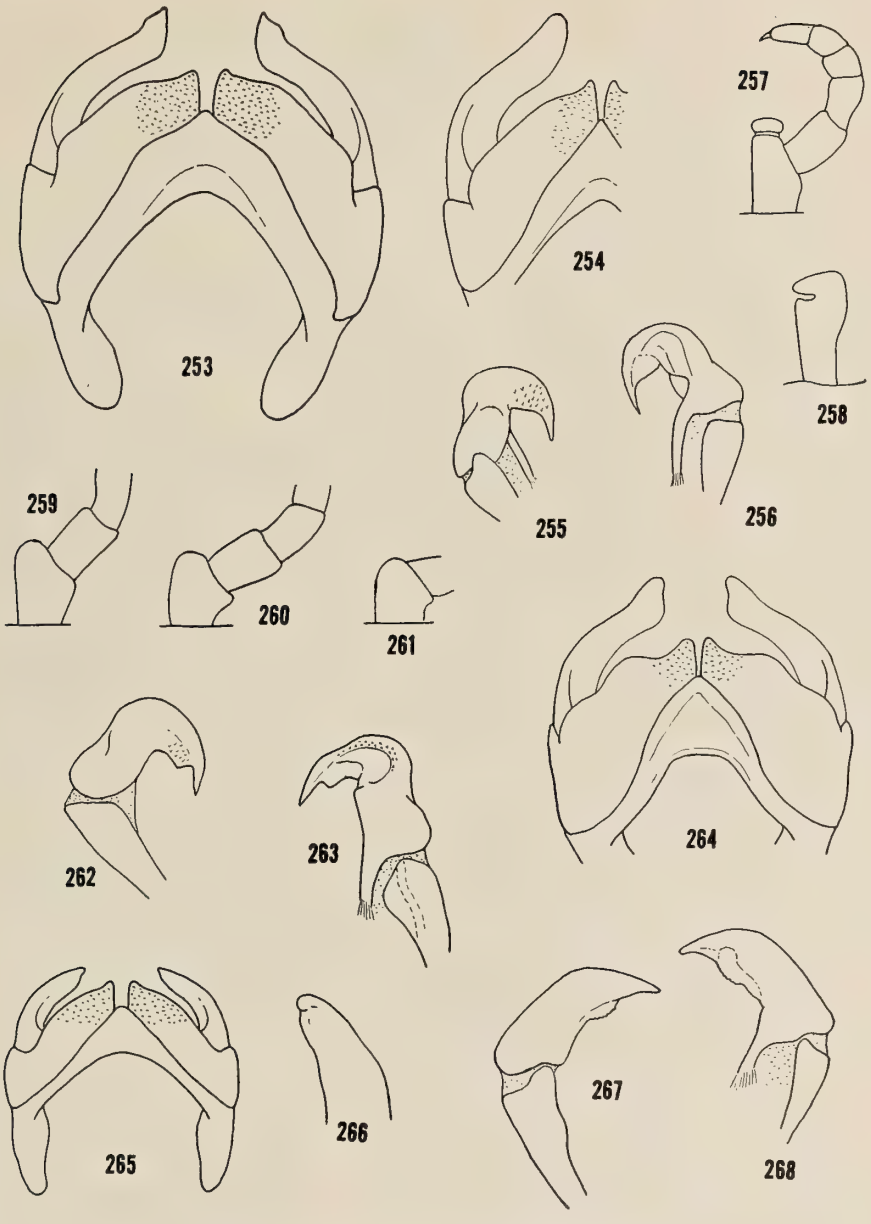
KEETON—FAMILY SPIROBOLIDAE



KEETON—FAMILY SPIROBOLIDAE



KEETON—FAMILY SPIROBOLIDAE



KEETON—FAMILY SPIROBOLIDAE

INDEX

All names printed in **bold face** are synonyms.
When more than one reference is given, the page on which the description or diagnosis appears is indicated by **bold face** type.

abbreviations (used in the figures), 138
agilis Cope, 66
americanus (Palisot de Beauvois), 86, **88**
annularis (Rafinesque), 66, **70**
Arctobolus Cook, 62
atratus Girard, 86
Auxobolus Chamberlin, 114
Aztecolus Chamberlin, **33, 34**
  key to species, 35
bahamensis Bollman, 40
balboanus Chamberlin, 112
bungii Brandt, 54, **55**
Californibolus Verhoeff, 114
californicus Humbert and Saussure, 128
callipus Bollman, 114
carpinus carpinus Chamberlin, **106**
carpinus Chamberlin, 106
carpinus vulcan (Chamberlin), 107, **108**
castaneus Chamberlin, 126, **127**
Chicobolus Chamberlin, **39, 40**
claremontus Chamberlin, 121, **122**
congregans Chamberlin, 110
conservatus Chamberlin, 109
crassus Chamberlin, 106
crassus Motschulsky, 86
deses Cook, **126**
discipulus Chamberlin, 126
dolleyi Loomis, 86
ergus Chamberlin, 123, **125**
erythrotypus Chamberlin, 114
Euspirobolidae Attems, 29
exquisitus Karsch, 54
federalis Chamberlin, 100
formosae new species, **61**
fossulifera (Pocock), 102
fratrellus Chamberlin, 107
fredricksoni (Causey), **132**
friantus Chamberlin, 126
gordanus (Chamberlin), **94**
grahami new species, **59**
hebes (Bollman), **112**
Hiltonius Chamberlin, **97**
  key to species, 99
ignobilis Humbert and Saussure, 66
Incobolus Chamberlin, 39
joannisi Brölemann, 54
jucundus Causey, 40
keysi Loomis, 94
marginatus Say, 66
melanior Chamberlin, 87
mexicanus (Saussure), **100**
michelbacheri Verhoeff, 128
michoacanus Chamberlin, 100
mimus Chamberlin, 110, **111**
monachus (Chamberlin), 124, **125**
Narceus Rafinesque, 62, **63**
  key to species, 65
nigrior Chamberlin, **35, 36**
oklahomae Chamberlin, 86
onondaga Cook, 66
oregonus Chamberlin, 128
orophilus Chamberlin, 66
pablillo Chamberlin, **38, 39**
palmaris Loomis, 109
paludis Chamberlin, 40
pensacolae Bollman, 86
pilsbryi Chamberlin, 40
pius Chamberlin, 110
pontis Chamberlin, 128
Prospirobolus Attems, 50
pulchrus Chamberlin, 109
ramstadti Chamberlin, 86
rectus Chamberlin, 128
Rhexenor Rafinesque, 62
scotti Chamberlin, 67
simulatus Chamberlin, 122

Sinobolus Chamberlin and Wang, 50
spinigerus (Wood), **40, 41, 42, 43**
Spirobolida, key to families, 31
Spirobolidae Bollman, 28, **29**
key to subfamilies, 31
Spirobolinae, new usage, 31, **32**
key to genera, 33
Spirobolus Brandt, 50, **52**
key to species, 53, 54
stebbinsi Chamberlin, 121
tancitarus Chamberlin, 100
tepoztlanus Chamberlin, 106
thaumastus Chamberlin, 40
thebanus Chamberlin, **113**
tinctorius Rafinesque, 86
Tylobolinae, new subfamily, **96**
key to genera, 97
Tylobolus Cook, 114, **115**
key to species, 120, 121
species?, 133
umbobrochus new species, **58**
uncigerus (Wood), 128, **129, 130**
utahensis Chamberlin, **131**
veracruzanus Chamberlin, 100
viduus Chamberlin, 134
walkeri Pocock, **56, 57**
woodi Humbert and Saussure, 86

Memoirs of The American Entomological Society

An irregular serial, containing monographic papers by students of authority in their respective subjects.

No. 1. The Cresson Types of Hymenoptera. By Ezra T. Cresson. 1916. 141 pp. Price $3.00. No. 2. The Blattidae of North America, North of the Mexican Boundary. By Morgan Hebard. 1917. 284 pp., 10 pls. Price $5.50. No. 3. A Venational Study of the Suborder Zygoptera (Odonata), with Keys for the Identification of Genera. By Philip A. Munz. 1919. 78 pp., 20 pls. Price $2.00. No. 4. The Blattidae of Panama. By Morgan Hebard. 1920. 148 pp., 6 pls. Price $3.00. No. 5. The Types of Hymenoptera in the Academy of Natural Sciences of Philadelphia other than those of Ezra T. Cresson. By Ezra T. Cresson. 1928. 90 pp. Price $2.00. No. 6. Revision of the Rhipiphoridae of North and Central America (Coleoptera). By Ezekiel Rivnay. 1929. 68 pp., 4 pls. Price $2.00. No. 7. A Revision of the Dipterous Family Rhagionidae (Leptidae) in the United States and Canada. By Mortimer D. Leonard. 1930. 182 pp., 3 pls. Price $4.50. No. 8. The Eumastacinae of Southern Mexico and Central America. By James A. G. Rehn and John W. H. Rehn. 1934. 84 pp., 6 pls. Price $2.50. No. 9. The Generic Names of the Sphecoid Wasps and their type species. By V. S. L. Pate. 1937. 103 pp. Price $2.50. No. 10. A Revision of the North American species belonging to the genus Pegomyia. By H. C. Huckett. 1941. 131 pp., 9 pls. Price $3.00. No. 11. Catalogue and reclassification of The Nearctic Ichneumonidae. By Henry K. Townes Jr. 1944. 925 pp. Price $15.00. No. 12. The Biology and Identification of Trypetid Larvae. By Venia Tarris Phillips. 1946. 161 pp., 16 pls. Price $5.00. No. 13. Elachistidae of North America (Microlepidoptera). By Annette F. Braun. 1948. 110 pp., 26 pls. Price $4.50. No. 14. Classification of the Blattaria as Indicated by their Wings (Orthoptera). By John W. H. Rehn. 1951. 134 pp., 13 pls. Price $5.00. No. 15. The Neotropical Species of the "Subgenus Aeschna" sensu Selysii 1883 (Odonata). By Philip P. Calvert. 1956. 251 pp., 47 pls., 19 tables, 6 maps. Price $10.00. No. 16. A Taxonomic Study of the North American Licinini with Notes on the Old World Species of the Genus Diplocheila Brullé (Coleoptera). By George E. Ball. 1959. 258 pp., 15 pls., 75 tables. Price $10.00. No. 17. A Taxonomic Study of the Milliped Family Spirobolidae (Diplopoda: Spirobolida). By William T. Keeton. 1960. 146 pp., 18 pls., 37 tables, 2 maps. Price $5.50.

In making inquiries relative to publications, address:

THE AMERICAN ENTOMOLOGICAL SOCIETY,
1900 Race St., Philadelphia 3, Pa.

SMITHSONIAN INSTITUTION LIBRARIES
3 9088 01186 5193