

GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA
HENRY F. NACHTRIEB STATE ZOOLOGIST

The Collembola of Minnesota

BY

JOSEPH E. GUTHRIE M. S.

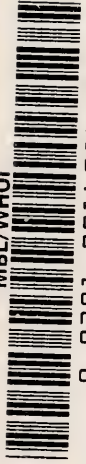
ZOOLOGICAL SERIES IV

EDITED BY

HENRY F. NACHTRIEB

MARCH 1903
MINNEAPOLIS MINNESOTA

MBL/WHOI



0 0301 0016984 3

G 98

GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA
HENRY F. NACHTRIEB STATE ZOOLOGIST

THE
COLLEMBOLA OF MINNESOTA

BY

JOSEPH E. GUTHRIE M. S.

ZOOLOGICAL SERIES IV

EDITED BY

HENRY F. NACHTRIEB

MARCH 1903
MINNEAPOLIS MINNESOTA

LETTER OF TRANSMITTAL.

To the President of the Board of Regents of
The University of Minnesota.

Sir:—I have the honor herewith to submit to the Board of Regents the fourth number of the Zoological Series of the reports of the Geological and Natural History Survey of Minnesota under the title *The Collembola of Minnesota* by Joseph E. Guthrie, M. S., a graduate of the University.

Mr. Guthrie carried on the work on this interesting group of insects under my general direction and the more immediate supervision of my assistant Oscar W. Oestlund.

The material and notes upon which the report is based are now stored with the special collections of the Department of Animal Biology and are at all times accessible to students and investigators.

Very respectfully, your obedient servant,

HENRY F. NACHTRIEB,
Zoologist of the Geological
and Natural History Survey.

The University of Minnesota,
January 12, 1903.

THE BOARD OF REGENTS OF
THE UNIVERSITY OF MINNESOTA.

The Honorable GREENLEAF CLARK, M. A., President, St. Paul
The Honorable STEPHEN MAHONEY, B. A., Sec'y, Minneapolis
The Honorable ELMER E. ADAMS, B. A.....Fergus Falls
The Honorable THOMAS WILSON.....St. Paul
The Honorable WILLIAM M. LIGGETTBenson
The Honorable A. E. RICE.....Willmar
The Honorable THEODORE L. SCHURMEIERSt. Paul
The Honorable O. C. STRICKLER, M. D.....New Ulm
The Honorable JAMES T. WYMANMinneapolis

EX-OFFICIO.

CYRUS NORTHROP, LL. D.....Minneapolis
The President of the University.
The Honorable SAMUEL R. VAN SANTWinona
The Governor of the State.
The Honorable JOHN W. OLSENAlbert Lea
The State Superintendent of Public Instruction.

CONTENTS

Letter of Transmittal.....	iii
The Board of Regents.....	iv
Part I. General.	
Economic Importance of the Collembola.....	3
General Characters of the Collembola.....	5
Relationships of the Collembola.....	9
Collecting and Preserving Collembola.....	13
Literature	15
Part II. Systematic.	
Terms Used.....	23
Keys for the Determination of Orders, Families, Genera, etc.....	25
Order Collembola	25
Family Sminthuridae	25
Genus PAPIRIUS.....	26
“ SMINTHURUS	27
Family Entomobryidae.....	29
Genus ORCHESELLA	30
“ ISOTOMA	31
“ ENTOMOBRYA.....	33
“ TOMOCERUS	35
“ CYPHODEIRUS	35
“ SEIRA	35
“ LEPIDOCYRTUS	36
Family Poduridae	37
Genus ACHORUTES	38
“ PODURA.....	39
“ XENYLLA	40
“ FRIESIA	40

Family Aphoruridae	40
Genus APHORURA	41
" ANUROPHORUS	42
" ANURIDA	42
" NEANURA	42
" APHOROMMA	42
List of new species.....	105
Index.....	107
Plates and Explanations.	

PART I
GENERAL

ECONOMIC IMPORTANCE OF THE COLLEMBOLA

From an economic point of view, the Collembola are regarded as of minor importance when compared with certain other better known insects; yet some of them have been accused of rather serious depredations upon garden crops. Harris, in speaking of some of the Sminthuri, says: "Several years ago I observed that cucumber vines were much infested by some minute jumping insects. They injured the vines very much by eating holes into, or puncturing the leaves, and were expelled by dusting the plants with flour of sulphur."

Mr. Curtis, in his work on farm insects, says: "In Nova Scotia the crops of turnips and cabbages are principally destroyed, whilst in the seed-leaf by some *Smynturus*, the size of a pin's head, and nearly globular. It hops with great facility by means of its forked tail and may be found on every square inch of all old cultivated ground, but it is not plentiful on new land."

Dr. Asa Fitch says: "Our gardeners universally regard these fleas as being injurious, but not so severely injurious as the larger-sized flea-beetles (*Haltica*) with which they are almost always associated. And this appears to be a correct estimate of their character. I have sought to ascertain the exact nature of the injury which they do, and from the best observations which I have yet been able to make, I think these fleas never perforate holes in the leaves or gnaw their texture where it is green and in a healthy growing state. Their small jaws are probably too soft and weak to enable them to break down and masticate the substance of the leaf. But when a flea-beetle perforates a hole in the leaf, these garden fleas afterwards gather around the perforation to feed upon the soft matter which is there formed by the evaporation of the exuding juice. This

matter makes a kind of scab upon the raw surface of the wound, covering it and enabling it to heal. These garden fleas feed upon this scab, thus tearing open the healing wound and causing it to bleed afresh. Hereby the holes in the leaf become much larger than they are first made by the flea-beetle, and nature is interfered with and embarrassed in her efforts to recover from the injuries done by the flea-beetles and other insects which wound the leaves. It is chiefly in this manner, I think, that these little garden fleas are detrimental to the plants on which they occur. Dusting the infested plants with ashes, sulphur, etc., and most of the other remedies which we resort to for expelling the flea-beetles from them, are still more efficacious in driving off these garden fleas also." Fitch says also of another species (*Sminthurus arvalis* Fitch) that: "It is common to see them in the garden, upon the leaves, particularly of the pie rhubarb, *Rheum Rhaponticum*, where these leaves are perforated with holes by the flea-beetles." I have never met any gardeners in this state who were acquainted with the ravages of these insects, and have never observed them feeding upon green leaves, but the fact that they are known to do so in other places and that they are common here, makes it at least advisable that they should be known and guarded against.

Sometimes some species of the *Aphoruras* become very abundant on the surface of water in cisterns and cause considerable inconvenience and annoyance on account of their great abundance. Of course they are not positively harmful in this case. They are easily killed by pouring a few drops of kerosene on the water.

From Prof. H. E. Summers, State Entomologist of Iowa, I learned a new fact in regard to their economic relations. This time it was one of the species that lives in the soil that was the culprit. Probably, from the description, it was one of the *Achorutes*. They were very abundant in the soil in which the gardener planted some seeds, and kept the soil so thoroughly worked up that the little plants found no chance to root and many of them died.

Some species of *Achorutes* might give trouble to the raiser of mushrooms, though I am not certain that they would attack a perfectly fresh mushroom.

GENERAL CHARACTERS OF THE COLLEMBOLA

HEAD.—Among the Collembola we have considerable differences in the form of the head, from the elongate forms, where it is borne almost horizontally, to the shorter-bodied Sminthuridae, in which it approximates the vertical position. The mouth-parts are typically mandibulate, each mandible bearing usually four or five teeth on its inner edge. That the "Entognatha" could constitute a separate group merely by virtue of having the mouth-parts withdrawn (?) into the head, has been proven fallacious by embryology. Dr. J. W. Folsom, in his work on the development of the mouth-parts in *Anurida maritima* Guer., has shown that, developmentally, the mouth-parts are external as in the Orthoptera and other pterygote insects; but that, by a downward folding of the genae, which unite ventrally with the labium, the mouth-parts are pocketed and thus appear withdrawn.

The eyes are of a form, which, I think, has its counterpart in no other order of the Hexapoda. Compound eyes are unknown, and simple ocelli in the positions where they are borne by other insects are likewise unknown. The two dorso-lateral eye patches of pigment material, nearly always dark, are in the normal position for compound eyes; yet they bear simple ocelli, and only a few of these. The normal number throughout most of the genera appears to be sixteen, each eye spot containing eight, which are usually arranged approximately in the form of a letter S, with the lower (posterior) part straighter than the upper part. The eye patch is commonly more or less convex, especially so in the Sminthuridae, where it is quite biscuit-form, with most of the eyes set round the edges. It is evident that the group is degenerating in regard to the eyes at least, and it seems not unreasonable to suppose that one of the stages to be passed

through in the degeneration of compound eyes might appear not unlike the typical collembolan eye. If, as I have supposed, the *Machilis* is very like their ancestor, then we must conclude that the eye patches with their grouped ocelli represent the original compound eyes. The degeneration in the number of ocelli has already been noted.

The antennae vary greatly in their comparative length and segmentation. We may regard four as the normal number of segments; the proximal segment being usually short, and very often the second segment as well. The two distal segments differ among different genera. In *Papirius* and *Tomocerus* the end segment is short and ringed with whorls of short hairs, as is also at least a part of the third segment. In *Sminthurus* only the fourth is ringed, and that not always. The antennae are important tactile organs, as one will soon discover by watching these creatures moving about and keeping the antennae in constant motion. The antennae are always haired, but, besides the ordinary hairs, special long, slender hairs are often borne standing out at nearly right angles to the members which bear them.

In some of the lower genera, as among the *Achorutes* and *Neanura*, where the habit is less active, there appears to be a corresponding degeneration of the antennae; the third and fourth segments being sometimes reduced to one. Whether the ringed condition of the antennae of such forms as *Tomocerus* points to a primitive multiarticulate condition as in *Machilis* is a matter of doubt. While it is possible, yet I incline to think rather that the partial sub-jointing has been developed in the *Tomocerus* and *Sminthuridae* independently in response to a demand for more flexible tactile organs.

The post-antennal organ is characteristic of some of the genera, yet can hardly be regarded as belonging to the group as a whole. It will be noticed under the genera where it occurs.

THORAX.—The thorax is typically that of a hexapod. Three free segments bear each a pair of typical walking legs. In the *Sminthuridae* these segments are fused together. Usually the prothorax is the smallest of the three, and in several of the genera the tergum of the following segment projects over it to a greater or less extent. The fact that the meso- and metathorax tend to be larger than the prothorax has lent

credence to the opinion, sometimes still advanced, that these two segments have attained their super-growth to give more room for the attachment of wing muscles, but inasmuch as the first pair of legs are, as a rule the smallest, I think the other explanation not only far-fetched, but unnecessary.

The legs are five-jointed; consisting, usually, of two short basal segments, coxa and trochanter, a long femur and a still longer tibia, with a very small tarsus, which bears, in all but the lowest genera, two apposable claws, an outer larger, and an inner smaller one. Clubbed hairs, the tenent hairs of many authors, very often project from the end of the tibia over the outer claw. The name "tenent" hair came from the notion that they assisted the claw in grasping, or getting a foothold; yet I think there is little doubt that they are merely tactile in function. The claws often bear notches or teeth (denticles) especially along their inner edges, and the kind and distribution of these present valuable systematic characters. In some of the lower genera, as, for instance, in *Achorutes*, the inner claw is disappearing, while in *Podura* and in most of the *Aphoruridae* it is gone altogether.

ABDOMEN.—This part is usually more or less swollen, and consists of six segments, of which the apical and pre-apical are usually small. The first abdominal segment bears on its ventral surface the so-called ventral tube. This is the typical organ of the Collembola, and one which all possess. True, there is a wide difference in appearance between the ventral tube in *Papirius* on the one hand, with its long stock and two very long, slender, flexible, tuberculated filaments, and that of *Achorutes* or *Neanura* on the other hand, where the tube is hardly more than a tubercle split in the middle so that the two sides shut together like the jaws of a steel trap, and the exsertile part is only so far exsertile as to produce a convex surface when the jaws are open and a concave surface when they are closed. The function of this ventral tube is not well understood. Formerly it was supposed to be an external reproductive organ. Latreille held this opinion, but Nicolet said he could not agree with the former author, although he had been unable to discover any sexual organs. He seems to think it an organ which, by its

mucosity, assists the insect when travelling over a smooth, polished surface, as glass, for instance. To be sure, the feet are not adapted to smooth surfaces. But what smooth surfaces are there where these insects live?

The second abdominal segment bears the tenaculum, catch or halthaken, as it is called by various authors. Although several of the best writers mention it as a character of prime importance in classification, yet I think few have been able to use it to advantage. It probably represents one of the pairs of primitive jointed abdominal appendages, their basal portions fused to each other and their second (terminal) parts turned laterad so as to form a sort of catch to hold the spring in place when not in use. Short notches or teeth serve the better to retain their hold upon the furcula, which is so placed as to extend a ramus (dentes) on either side of and close to the tenaculum, whose two blades extend below them, holding them in position.

The fourth abdominal segment, or sometimes the fifth, bears what is variously called the furcula, saltatory organ, spring, springgabel, tail, caudal appendage, etc. It undoubtedly represents a pair of jointed appendages. Dr. A. S. Packard compares the ovipositor of some Neuroptera (*Panorpa* and *Bittacus*) to "the leaping ovipositor of the *Podura* and its allies." In speaking of Westwood's description of the winter neuropter, *Boreus*, he says: "In this description we are reminded of the Spring-tails (*Podura*) which leap by means of the long ovipositor, and corresponding male organs, bent beneath the body." I feel inclined to question this statement of the furcula being even primitively an ovipositor. Evidence gained by a comparison with the thysanuran genus *Machilis* would certainly seem to deny it. *Machilis* has a sort of primitive furcula, as well as a long, well-developed ovipositor. When at rest, the furcula is carried beneath the body, its muscles continually at tension, and ready for a leap when the tension on the blades of the tenaculum is loosened so as to release the furcula. The powerful muscles of the furcula are balanced by the less powerful muscles of the tenaculum, on account of the shorter leverage of the latter. The final abdominal segment, the sixth, often bears anal horns in the *Poduridæ* and *Aphoruridæ*. The anus is terminal, and the genital papilla opens on the ventral side of the preceding segment.

RELATIONSHIPS OF THE COLLEMBOLA.

The peculiar interest centering in the Collembola is due largely to the fact of their association with the Order Thysanura, which contains the Campodea, an insect supposed by many to represent pretty nearly the ancestry from which the Pterygota have evolved. Whether the Pterygota did actually come from a Campodea-like form, we do not know; one thing is evident, however: if they did, the line of descent was not by way of the Collembola. As to the connection between the two orders of the Apterygogenea, various opinions exist. Some writers see no connection at all, others would place them in the same order. I believe that the differences are marked enough to justify the separation into the two orders, though the evidence seems convincing that the order Thysanura is the older of the two, and is perhaps not far out of the direct line of descent from a common ancestor.

While I confess myself unable to point out the ancestor of the Collembola among the members of the order Thysanura, yet I feel pretty certain that such an ancestor must have closely resembled members of the genus *Machilis* in many important respects. *Machilis* is not the ancestor, but there is no other form known which possesses organs comparable with the characteristic organs of the Collembola: the furcula, the tenaculum and the ventral tube. Scales are also found on the *Machilis* as on several genera of the Collembola. It is interesting to note even in this connection that the *Machilis* shows a very primitive, even pre-hexapod, character in the possession of biramous appendages. That the Collembola are scions of a very old house seems probable, yet their minute size and their comparatively soft bodies make it equally probable that geological rock-writings have but meager records to offer us concerning them. As is so often the case, science must speculate, more

or less futilely, upon the line of descent which brought forth the Collembola. That they are degenerates, retrograded from an early pterygote stock, as some very good scientists have guessed, seems to me a position more and more untenable the better we become acquainted with these insects.

Let us glance, in passing, at some of the evidence. There are no wings, even vestigial, to be found in any members of the group; and even embryological research fails to reveal any wing traces. This fact, while important, should not be overstrained. It is merely a negative character possessed in common with the Pediculidae and others which we have good reason to believe have evolved from various winged orders. The biramous, crustacean-like legs of *Machilis*, together with its possession of a full set of small, jointed abdominal appendages; its campodiform body and simple mouth-parts and internal structure; all claim for it a place among very ancient insects. The apposable claws of *Collembola* are more like the chelae of crustaceans than like the claws of any others of the hexapods.

Compound eyes were probably acquired, or possibly inherited, by the early hexapods; and were possessed even by those which failed to develop in a pterygote direction. The collembolan eye is essentially a compound eye in process of decadence. While most of the Thysanura are very simple and rather sluggish insects, yet the *Machilis* has begun the development of an organ which has become in the *Collembola* a very important organ of locomotion—the furcula. If *Collembola* were descended from pterygote insects, we would expect to find among the latter some organ which we could conceive to have specialized into the furcula. But such is not the case, though *Machilis* does have the last pair of abdominal appendages larger than the rest, and uses them together as a leaping organ. These appendages are three-jointed, and the constant use of the pair together as one organ would naturally tend to make their bases approximate until they would grow together and form one piece, the manubrium of the furcula in the *Collembola*. The two more distal segments are free from each other. Probably none of the appendages of the *Machilis* are used as a tenaculum; but all the appendages are there, and it is not surprising that one pair should have been so modified, for the tenaculum is

evidently only a modified pair of jointed appendages which have taken the function of holding the furcula in position when not in use. As a fore-runner of the ventral tube in Collembola, we have the exsertile vesicles in *Machilis* in which they are found at the bases of the legs. Perhaps the common ancestor had them on all the appendages, or at least on those of the first abdominal segment, and that this pair persisted and moved toward the median line until they grew together and formed one tube.

That the Collembola are extremely old is indicated by the fact that, despite their wingless condition, the same species with almost no variation will occur often throughout three continents. Dr. Folsom considers that this remarkable distribution has been effected by the inland streams and ocean currents, which latter are known to convey inland species to great distances.

Many considerations, on the other hand, point to their being a regressive branch; such, for instance, are furnished by their retiring, dark-loving habit, and minute size. The habit mentioned is, in turn, probably responsible for the tendency noticed in most of the genera toward a loss of the eyes. In isolated species in several genera we find all or nearly all pigment in the body lost, and the ocelli entirely atrophied, owing, probably, to the cave-habit. Worthy of note, along with the assumption of the cave habit and consequent degradation and atrophy of optical sense, has come an hypertrophy of senses along other lines: at least this is the obvious way of accounting for the abundance of multiform tactile hairs in positions where the touch power could be best utilized. Whether we are to recognize merely a protective function in the scales which adorn *Tomocerus* and *Seira*, etc., or whether they also act as sense media, is a matter for further investigation.

No small part of the difficulty arising in the study of this order is due to their diminutive size. Not only does their minuteness, coupled often with extreme agility, render them difficult to observe and still more to capture; but it is often no easy matter to make out such small microscopic characters as the form and disposition of teeth on the claws and furcula. Remembering that several species never attain more than a half millimeter in length,

and that one of five millimeters is a veritable giant among the Collembola, it may readily be imagined how nice are the distinctions which must be looked to for species determination.

It is rather difficult to realize at the outset that a character which will hold true and invariable, and therefore of prime importance in separating the species of one genus, may be so variable in another genus as to be absolutely worthless. Thus, while color is in some genera of little value as a specific distinction, in others it alone would serve to identify species.

In a group which exhibits, throughout, such a tendency to atrophy of ocelli, it is not surprising that genera should have been founded upon the number of ocelli, or, in other words, upon the particular stage to which the ocellar atrophy had progressed. It was almost inevitable that the intervening stages would sometime be found and that the genera founded on nothing more than specific characters would have to be abandoned. This point will receive further consideration under the different families.

Before taking up the more technical portion of this report it may be well to say a few words about the methods found useful in collecting and preserving Collembola for study.



COLLECTING AND PRESERVING COLLEMBOLA

It is often desirable to examine specimens alive, and this, owing to their small size, is impracticable in the field. Small vials containing some moist wood, earth or filter paper, serve well to carry the creatures in, if they can once be induced to enter without being so roughly handled as to injure their health. Moisture in the vial is essential, as their lease of life in a dry atmosphere is extremely brief. It is best to keep the vials containing live specimens in the dark as much as possible, as the insects are liable to injure themselves by the effort to find dark crannies; and the scaled species are almost certain to become denuded of their scales by their activity under cramped conditions. For ordinary work, I find it best to collect and preserve the material in 80% alcohol. It seems to require as high a grade as that to sink them. Apparently they are covered by a sort of wax which requires a solvent before they will sink in liquid. Species vary somewhat in their readiness to sink in alcohol. Mr. MacGillivray recommends the use of a mixture of alcohol and glycerine to collect in, and later transfers the specimens to 80% alcohol. The virtue of the mixture is that it is sticky and the insect will stick readily to a tooth-pick wetted in it, while with clear alcohol one must use a camel-hair brush. Dr. Folsom collects his collembolans in vials and brings them in alive. He kills them by pouring upon them hot 95% alcohol.

Specimens may be examined either alive or in alcohol, but to get at their minute characters it is preferable to clear and mount them. Dissection and mounting in glycerine is very good for a quickly prepared, non-permanent mount; while one may preserve a good glycerine mount, if desired, by ringing it with asphalt cement. I have found it best, however, to mount in xylol damar, which is clear, easily manipulated, and seems to

give good permanent results. Formerly I used xylol as a clearing agent, but found it rather too rapid in evaporation; so that in mounting a dozen or more insects under one cover, it was difficult to keep some of them from getting too dry before applying the damar. Cedar oil is slower in evaporating, and is therefore preferable. The colors in the Collembola are generally almost permanent when in damar mounts, though I think glycerine jelly keeps them brighter, and has, besides, the merit of doing away with the necessity for clearing.

When it is desired to destroy the pigment to better study ocelli, post-antennal organs, etc., a drop of a 5% potash (KOH) solution may be run under the cover glass, and its action arrested by the introduction of alcohol or water when the specimen is clear enough; after which dehydration and mounting may proceed as usual. For a minute examination of the claws, furcula, etc., of some of the thicker bodied species, it will be found necessary to dissect off the parts wished for examination, as the body often makes too thick a mount to allow of focussing with a high power lens.

LITERATURE CONSULTED.

In working upon the order Collembola, one is confronted at the very outset by a paucity of American literature on the subject. Excepting for Sir John Lubbock's Notes and Monograph on the Thysanura, the latest of which has passed its first twenty years and is therefore slightly out of date, there is comparatively little in the English language to guide the systematic student. Dr. Folsom and Miss Claypole have taken up one or two species embryologically; and Say, Packard, Ryder, MacGillivray and Harvey have described not a few new American species. In case of Say and Packard no figures accompany the descriptions, or at best, very useless ones in a few cases. Packard's species seem not unlikely to stand good, though most of them need re-description. Some of this has been already done by MacGillivray.

To Tullberg, and more especially to Schött, must we look for scientific treatises upon the order—works which present the real microscopic characters of furcula and claws, so necessary in determining the species. To the English-taught student the difficulty of pursuing ideas through the French, the German and the Latin, the Italian, the Scandinavian tongues and the Bohemian, often at second-hand by necessity, is not one to be considered lightly. Yet, for all the lingual difficulties, I am very grateful to Professor H. F. Nachtrieb, who has procured for me the greater part of the standard literature upon the subject. Without this aid, much of my work would have been impossible.

There was need of a survey of the order which should do more than merely list species. Working keys of American species, accompanied by figures of the important features, and by descriptions in English, regardless of whether a species is newly described or not; in short, a practical help to American students has been the aim in this work.

Of the American Collembola known hitherto, a few were reported by Fabricius (1780) in his *Fauna Groenlandica*, some by Say (1841) from New York State, also from the same part by Fitch (1846). Packard described mostly from Essex County, Mass., though some of his came from Maine, and others from Tennessee and Texas. A. D. MacGillivray, in the *Canadian Entomologist*, 1891-1896, gives not only several new species, but some very helpful keys. His list of the American species of Collembola, and his key to the American species of *Isotoma* are especially valuable. His specimens were from Massachusetts, New York, Washington, D. C., Washington State, Tennessee, Florida and New Mexico. Harvey and Folsom have published several descriptions, based mostly on Maine specimens, in the *Entomological News* and in *Psyche*. Besides these in the English language, Schäffer has described two collembolans from Southern Georgia, and Schött has a very good paper on California Collembola. These, with a few Chilian species of Nicolet, and a single Venezuelan species by MacGillivray, comprise nearly the whole American list. Thus, the east, the west and the south have been all studied in varying degrees, but from the upper Mississippi basin, few if any species have ever been reported. Probably Dr. Folsom's collection is the only one in the country that contains many specimens from the states of the middle west. Our Collembola fauna would naturally be expected to contain species which have never been described, nor, indeed, found elsewhere; and such proves to be the case. While not nearly all the known American species have been found in Minnesota, so far; yet, on the other hand, many species described from Europe and never hitherto reported from the Western Hemisphere, are found to occur here in Minnesota.

List of Publications Consulted.

ARRANGED ALPHABETICALLY BY AUTHORS.

Articles marked by a star are those that have been found especially important and helpful. To some of these, especially to Schött, Schäffer and MacGillivray, I am largely indebted for many of the keys as well as other things.

Absolon, C. Karl.

1900. Einige Bemerkungen über die mährische Höhlenfauna. *Zool. Anz. Bd. XXIII*, pp. 1-6, 57-60, 189-195.

1900. Vorläufige Mittheilung über einige neue Collembolen aus den Höhlen des mährischen Karstes. *Zool. Anz. Bd. XXIII*, pp. 265-269. 4 figures.

1900. Vorläufige Mittheilung über die Aphoruriden aus den Höhlen des mährischen Karstes. Zool. Anz. Bd. XXIII, pp. 406-414. 12 figures.
1900. Über zwei neue Collembolen aus den Höhlen des österreichischen Occupationsgebietes. Zool. Anz. Bd. XXIII, pp. 427-431. 2 figures.
- Börner, C.**
1901. Vorläufige Mittheilung über einige neue Aphorurinen und zur Systematik der Collembola. Zool. Anz. Bd. XXIV, pp. 1-15.
- Brook, George**
1883. *Notes on some little-known Collembola, and on the British species of the Genus Tomocerus. Journ. Linn. Soc. Zoology. Vol. XVII, pp. 19-25, Pl. I.
1883. *A Revision of the Genus Entomobrya Rend. Journ. Linn. Soc. Zoology. Vol. XVII, pp. 270-288, Plates 10 and 11.
- Claypole, Agnes Mary.**
1898. The Embryology and Oogenesis of Anurida maritima (Guér.). Journ. Morph. Vol. XIV, pp. 119-300, Plates XX-XXV, and 15 text-figures.
- Comstock, John Henry.**
1888. An Introduction to Entomology. P. 63.
1895. A manual for the Study of Insects. Pp. 82-85.
- Curtis, John,**
1883. Farm Insects. Pp. 408-410.
- Cuvier, Georges.**
1846. Le Regne Animal. Les Insectes, I, pp. 63-69, Pl. 13.
- Dalla Torre, K. W.**
1895. *Die Gattungen und Arten der Apterygogenea (Brauer.) Sechsendvierzigtes Programm d. K. K. Staats-Gymnasiums in Innsbruck, 1894-1895. Pp. 1-23.
- Duncan, Martin P.**
Transformations (or Metamorphosis) of Insects. Being an adaptation, for English readers, of M. Emile Blanchard's "Metamorphoses, moeurs et instinctes des insectes;" and a compilation from the works of Newport, Darwin and others.
- Fitch, Asa.**
1862. *Smynthurus hortensis n. sp., S. arvalis n. sp., S. novaeboracensis, S. elegans, S. signifer. Eighth Annual Report of the N. Y. Agr. Society. Pp. 668-675, 2 figures.
- Folsom, J. W.**
1896. *Two new Species of Papirius. Can. Ent. Vol. XXVIII, p. 119-121.
1896. *New Species of Papirius. Psyche, Vol. VII, pp. 344-345.
1896. Notes on the Types of Papirius Texensis Pack, and Description of a New Smynthurius. Psyche, Vol. VII, pp. 384-385.
1896. Neelus murinus, Representing a New Thysanuran Family. Psyche, Vol. VII, pp. 391, 392, Pl. 8.
1896. *New Smythuri, Including Myrmecophyllous and Aquatic Species. Psyche, Vol. VII, pp. 446-450, pl. 10.
1901. *The Distribution of Holarctic Collembola. Psyche, Vol. IX, pp. 159-162.
1901. *Review of the Collembolan Genus Neelus and Description of N. minutus n. sp. Psyche, Vol. IX, pp. 219-222, Pl. 2.

Gervais, M. Paul.

1844. *Histoire Naturelle des Insectes. Apteres par Walkenaer. Vol. III, pp. 377-456. Thysanoures.*

Harvey, F. L.

1892. *An American Species of Templetonia. Ent. News, Vol. III, pp. 57-59, 3 figures.*
 1892. **A New Smynthurus. Ent. News, Vol. III, pp. 169-170, 1 figure.*
 1893. **A new Papirius. Ent. News, Vol. IV, pp. 65-68, Pl. IV.*
 1893. *A New Achorutes. Ent. News, Vol. IV, pp. 182-184, 6 figures.*
 1894. **The American Species of the Thysanouran Genus Seira. Psyche, Vol. VII, pp. 159-162, 2 figures.*
 1894. *A New Species of Lepidocyrtus. Ent. News, Vol. V, pp. 324-326, 4 figures.*
 1895. *Two New Species of Entomobrya. Psyche, Vol. VII, pp. 196-199, 3 figures.*
 1896. *A Thysanouran of the Genus Anoura. Psyche, Vol. VII, pp. 422, 423, 3 figures.*
 1898. *A new Poduran of the Genus Gnathocephalus. Ent. News, Vol. IX, pp. 216-217, 3 figures.*
 1900. *New Maine Collembola. Ent. News, Vol. XI, pp. 549-553, Pl. XV.*

Hyatt, Alpheus, and Arms, J. M.

1890. *Insecta. Guides for Science Teaching. No. VIII.*

Kolenati, Fr.

1858. *Zwei neue oesterreichische Poduriden. Sitzber. d. mathem.-naturw. Classe d. kais. Akademie d. Wissenschaften. Bd. XXIX, Nr. 10, pp. 241-246, 1 pl.*

Krausbauer, Th.

1898. *Neue Collembolen aus der Umgebung von Weilburg a. Lahn. Zool. Anz. Bd. XXI, pp. 495-499, 501-504.*

Lie-Pettersen, O. J.

1897. **Norges Collembola. Bergens Museums Aarvog for 1896. No. VIII. Pp. 1-24, Plates I. II.*

Linnaeus, Carolus.

1758. **Systema Natura. Ed. X. Pp. 608-609.*

Lintner, J. A.

1885. *Second Annual Report of the New York State Entomologist. Pp. 202-210.*

Lubbock, John.

1862. **Notes on the Thysanura. Par I. Smynthuridæ. Trans. Linn. Soc. Vol. XXIII, pp. 423-448, pl. 45, 46. Part II, Smynthuridæ. Id. Pp. 589-601, pl. 59.*
 1867. **Notes on the Thysanura. Part III. Trans. Linn. Soc. Vol. XXVI, pp. 295-304, Plates 21, 22.*
 1869. **Notes on the Thysanura. Part IV. Trans. Linn. Soc. Vol. XXVII, pp. 277-297, Plates 45, 46.*
 1873. **Monograph of the Collembola and Thysanura. The Ray Society for 1871. Pp. I-X, 1-276, Plates 1-78.*
 1874. *On the Origin and Metamorphosis of Insects. Pp. 71 and 91-95.*

MacGillivray, Alex. D.

1891. **A Catalogue of the Thysanoura of North America. Can. Ent. Vol. XXIII, pp. 267-276.*
 1893. **North American Thysanura. Can. Ent. Vol. XXV, pp. 127-128, 173-174, 218-220, 313-318.*

1894. *North American Thysanura. Can. Ent. Vol. XXVI, pp. 105-110.
1896. *The American Species of Isotoma. Can. Ent. Vol. XXVIII, pp. 47-58.

Marlatt, C. L.

1869. The American Springtail. American Naturalist. Vol. XXXI, pp. 163, 164.

Meade, R. H.

1881. The Generic Term "Degeeria." Ent. Monthly Mag. Vol. XVIII, p. 19.

Nicolet, H.

1841. *Recherches pour servir a l'histoire des Podurelles. (Mem. de la Soc. Helvetique. VI.) Pp. 1-88, plates 1-9.

Oudemans, J. Th.

1887. Bijdrage tot de Kennis der Thysanura en Collembola. Pp. 104, Plates I-III.
1896. Systematische Beschrijving der in Nederland voorkomende Thysanura. Tidschr. v. Entom. Nederl. Entom. Vereen. 38 D. 4 Afl. Pp. 164-178, 6 figures.

Packard, A. S.

1873. *Synopsis of the Thysanura of Essex County, Mass., with Descriptions of a few Extralimital Forms. Fifth Annual Report Peabody Acad. Sci. 23-51.
1884. Thysanura. Standard Natural History. Vol. II, pp. 135-138.
1890. Entomology for Beginners. Pp. 54-58.
1898. A Text-book of Entomology. Pp. 72, 164, 486.

Poppe, C. A., & Schäffer, C.

1897. Die Collembola der Umgegend von Bremen. Abh. naturwiss. Ver. Bremen. Bd. XIV. pp. 265-272.

Reuter, O. M.

1890. *Collembola in Caldariis viventia enumeravit novasque species descripsit. Meddel. af Societas pro Fauna et Flora Fennica. XVII, pp. 17-28, Tab. I.
1895. *Finlands Collembola och Thysanura. Acta Societatis pro Fauna et Flora Fennica. XI, No. 4, pp. 1-35, Tab. I, II.
1898. Collembola på snö. Meddel. af Societas pro Fauna et Flora Fennica. XXIII, pp. 44-51, fig. 1.

Ridley, Henry N.

1880. A new species of Lipura. Ent. Monthly Mag. Vol. XVII, p. 1.
1880. A New Species of Machilis. Ent. Monthly Mag. Vol. XVII, pp. 2, 3.
1881. A New Species of Degeeria. Ent. Monthly Mag. Vol. XVII, pp. 270-271.
1881. Notes on Thysanura Collected in the Canaries and Madeira. Ent. Monthly Mag. Vol. XVIII, p. 14-.

Ryder, John A.

1879. *Description of a New Species of Smynthurus. Proc. Acad. Nat. Sci. Philadelphia for 1878. P. 335, 1 figure.

Say, Thomas.

1883. The Complete Writings of Thomas Say on the Entomology of North America. Edited by John L. Le Conte, M.D. Vol. II, pp. 7-9.

Schäffer, Caesar.

1891. Die Collembola von Süd-Georgien nach Ausbeute der deutschen Station von 1882-83. Jahrb. Hamburg. Wiss. Anstalten. IX, pp. 1-9, 8 figures.
1896. *Die Collembola der Umgebung von Hamburg und benach-

barter Gebiete. Jahrb. Hamburg. Wiss. Anstalten. XIII, pp. 149-216. Taf. I-IV. (Aus. "Mittheil. a. d. Naturalist. Museum. XIII.)

Schött, Harald.

1891. Nya Nordiska Collembola. Ent. Tidskr. Arg. 12, pp. 191-192, 2 figures.
 1893. Zwei neue Collembola aus dem indischen Archipel. Ent. Tidskr. Arg. 14, pp. 171-176, Pl. 2.
 1893. Beiträge zur Kenntniss der Insekten-Fauna von Kamerun. I. Collembola. Bihang till K. Svenska Vet. Akad. Handlingar. Bd. 19, Afd. IV, No. 2, pp. 1-28, Taf. I-VII.
 1893. *Beiträge zur Kenntniss kalifornischer Collembola. Bihang till K. Svenska Vet.-Akad. Handl. Bd. 17, Afd. IV, No. 8, pp. 1-25, Taf. I-IV.
 1893. *Zur Systematik und Verbreitung palæarctischer Collembola. Kongl. Svenska Vet.-Akad. Handl. Bd. 25, No. II, pp. 1-100, Taf. I-VII.
 1896. Collembola på snö och is. Ent. Tidskr. Arg. 17, pp. 113-128, Pl. 3.

Sharp, David.

1895. Insects. Part II. The Cambridge Natural History. Vol. V, pp. 182-197.

Sommer, A.

1885. Ueber *Macrotoma plumbea*. Beiträge zur Anatomie der Poduriden. Zeit. Wiss. Zool. Bd. XXI, pp. 683-718, Tafeln 34, 35.

Stscherbakow, A.

1899. Vier neue Collembolen-Formen aus dem südwestlichen Russland. Zool. Anz. Bd. XXII, pp. 79-81, 8 figures.

Tullberg, Tycho.

1871. *Forteckning öfver Svenska Podurider. Öfversigt af Kongl. Vet.-Akad. Förhandl. 1871, No. 1, pp. 143-155.
 1872. *Sveriges Podurider. Kongl. Svenska Vet.-Akad. Handl. Bd. 10, No. 10, pp. 1-70, Taf. I-XII.
 1876. *Collembola Borealia.—Nordiska Collembola. Öfversigt af Kongl. Vet.-Akad. Förhandl. 1876, No. 5, pp. 23-42, Taf. VIII-XI.

Uzel, Jindrich.

1890. *Thysanura Bohemiæ. (Descriptions of new species in Latin, the rest in Bohemian.) Sitzb. Königl. Böhm. Gesellsch. d. Wiss. Jahrg. 1890, Bd. II, pp. 1-82, Tab. I, II.

Wahlgren, E.

1901. Ueber einige neue Collembola-Formen aus dem Südwestlichen Patagonien. Ent. Tidskr. Arg. 21, pp. 265-270, Taf. 2.

PART II
SYSTEMATIC



TERMS USED

- Abd. I, Abd. II, &c.** An abbreviated expression of "first abdominal segment," "second abdominal segment," &c.
- Anal horns.** (Analdornen). Small horns borne dorsally on the most caudal abdominal segment.
- Anal organs.** The two modified hairs arising from a tubercle ventrocephalad of the anus, and usually curving caudo-dorsad.
- Anal papilla or tubercle.** The tubercle bearing the anal organs.
- Ant. I, Ant. II, &c.** An abbreviated expression of "first segment of the antenna," "second segment of the antenna," &c., the numbering of the segments beginning with the proximal (basal) segment.
- Antennal organs.** Sense organs borne usually, when present, on the distal segment of the antennae.
- Clavate (tenent) hairs.** Hairs with swollen or clubbed ends, borne most commonly on the tip of the tibia.
- Claws. Inferior or inner claws**—the smaller claw of the collembolan foot, absent in some of the lower genera.
Superior claw or outer claw—the larger of the two claws borne by the tarsus.
- Dentes.** The second or middle part of the furcula, consisting of two separate parallel pieces which proceed from the distal end of the manubrium, and bear at their own distal ends the two mucrones.
- Furcula** (saltatory appendage, spring). The organ borne by the fourth or fifth abdominal segment and used for leaping. The furcula is considered to be in normal position when lying along the ventral side of the body and pointed cephalad, and its dorsal and ventral sides are considered as taken in this position. As a matter of convenience, the drawings are often made with furcula extended, in which the ventral side turns dorsad and vice versa.
- Genital papilla.** A papilla noticeable in the Sminthuridæ upon which opens the genital aperture.
- Length** is reckoned from the most cephalic part of the head when held in natural position, to the caudal end of the abdomen, not to the tip of the extended furcula.
- Manubrium.** The basal piece of the furcula, joined by its proximal end to the abdomen and at its distal end to the two dentes.
- Mucrones.** The two small end pieces of the furcula proceeding from the two dentes.
- Post-antennal organs.** Oblong or elliptical organs situated just caudad to the bases of the antennae.
- Tenaculum or catch.** A small organ which holds the furcula in position under the abdomen when at rest.
- Th. I, Th. II, &c.** An abbreviated expression of "first thoracic segment," "second thoracic segment," &c.
- Ventral tube.** A tube or tubercle proceeding from the ventral side of the first (anterior) abdominal segment.

KEYS FOR THE DETERMINATION OF ORDERS, FAMILIES,
 GENERA AND SPECIES .

The figures immediately following the names of the orders, families, genera and species refer to the pages on which the descriptions are begun.

SUB-CLASS APTERYGOGENEA.

a—Antennæ multi-articulate. Eyes compound or wanting. No ventral tube or furcula. Abdomen consisting of about ten segments and terminated by long setæ or forcipate appendages. Palpi large, projecting. Order **THYSANURA**.

b—Antennæ 4-6 jointed. Eyes of degenerate compound type, with few (usually 16) ocelli, or sometimes with none. Ventral tube invariably present, furcula typically so. Abdomen consisting of six segments, and never terminated by caudal setæ or forcipate appendages. Palpi not evident.

Order **COLLEMBOLA**.

KEY TO THE ORDER COLLEMBOLA.

a—Body sub-globular, abdomen little longer than broad, the segments fused together. Ventral tube and furcula well-developed. Scales never present. Claws two. Antennæ 4-jointed, no post-antennal organ.

Family **Sminthuridae**, 25.

b—Body sub-cylindrical, segments of abdomen free. Furcula usually on penultimate segment. Scales present or absent. Antennæ 4-6-jointed. Claws two.

Family **Entomobryidae**, 29.

c—Body sub-cylindrical, segments of abdomen free, body without scales (in any of our species). Furcula present, on antepenult. Antennæ 4-jointed. Claws 2 or 1.

Family **Poduridae**, 37.

d—Body sub-cylindrical, segments of abdomen free. Furcula wanting. Body naked or hairy, never with scales. Antennæ 4-jointed, often poorly developed. Claws 2 or 1.

Family **Aphoruridae**, 40.

Family Sminthuridae.

This family seems to have pretty well defined limits, and its species are not likely to be confused with those of other fam-

ilies. The shape of the abdomen, and the fused condition of its segments separate it from the family Entomobryidæ to which it seems most closely related. The shortening up of the body is accompanied by a vertical position of the head, which gives way in a few forms to an approximation to the primitive, horizontal position. The ventral tube is always long and well-developed, and has two long, exsertile filaments, glandular in appearance, which can be thrust out or retracted at will. All are strong jumpers and show a well-developed furcula and tenaculum. The eyes show fewer cases of degeneration than in any other family, the normal number of sixteen being almost always present.

The family is represented in Minnesota by two genera, which differ in the form of the antennæ. Neither of the genera possesses the post-antennal organ.

a—Ant. IV short, with whorls of hairs. The distal part of Ant. III ringed. Genus **Papirius**, 26.

b—Ant. IV long, usually ringed. Ant. III not ringed. Genus **Sminthurus**, 27.

Genus **Papirius** Lubbock 1862.

This genus is represented by at least two species, both of which are large and rather common. They are among the most specialized of Collembola, inhabiting dark, shady places under loose bark, under the caps of mushrooms, etc., where there is a little moisture; but I have never taken them on the surface of water where so many other collembolans are found. In fact, their furcula is not adapted for water leaping. There seems to be little structural difference between our two species, but the difference in color is so marked that one need have little difficulty in separating them.

KEY TO THE GENUS PAPIRIUS.

Color blue or purple marbled with pearly or lilac, sometimes somewhat yellow. Ant. III with about five or six well defined sub-segments, not including those fused into the large, clubbed end. **maculosus**, 58.

Color uniform over the body, usually purplish brown. Ant. III with six or seven well-defined sub-segments besides those fused into the clubbed end. **unicolor**, 59.

Genus *Sminthurus* Latreille 1804.

Of the eleven species of *Sminthurus* taken in the state, three are new to science and others new to the continent.

In the genus are found several interesting modifications. One species is an albino without ocelli and almost without pigment, others are modified for a life on the water, and have their furcula so specialized as to constitute the most efficient instrument for leaping that nature could devise. The normal number of ocelli is present in all our species excepting the above-mentioned albino; though certain ocelli exhibit a tendency to diminish in size in some of the species. For greater convenience in study, most authors have separated the *Sminthuri* into two groups of species: I, *Setosi*, those covered with strong hairs or setæ; and II, *Pilosi*, those covered with fine, short hairs. The latter group contains, as a rule, the smaller species, and the former the larger ones. They are to be found in dark, slightly moist situations, some of them even around and on the water. Many of them occur under loose bark, among leaves and rubbish in the woods, etc. They are remarkably spry, and challenge the liveliest movements on the part of their would-be captors.

KEY TO THE GENUS SMINTHURUS.

1. a.—Ant. IV distinctly ringed. 2.
b.—Ant. IV not distinctly ringed. 7.
2. a.—Eyes present, body dark, or at least well pigmented. 3.
b.—Eyes wanting, body white with small reddish-brown specks. Two outward-pointing spurs at distal end of manubrium. Mucrones $\frac{3}{4}$ as long as dentes.
caecus, 49.
3. a.—Furcula adapted for water leaping. Dentes with two rows of laterally developed bristles. Mucrones spoon-like. 4.
b.—Furcula not adapted for water leaping. Mucrones narrow, grooved. 5.
4. a.—Furcula fan-like, lateral bristles on dentes very long, especially on the inner side, mucrones not ribbed, broadest at distal end. Back set with long bristles among the shorter hairs. Length, 2 mm. *spinatus*, 57.

- b.—Furcula not fanlike, lateral rows of bristles on dentes rather short, mucrones broadly elliptical, ribbed. Back without long bristles. Smaller claw bearing a branched hair at tip. Length 1 mm. **penicillifer, 55.**
5. a.—Large claw enclosed in a tunic, which gives it a plump appearance. Ant. IV about as long as I, II and III together. Mucrones dentate. Length 2 mm. **fuscus, 53.**
- b.—Large claw not enclosed in a tunic. 6.
6. a.—Ant. IV little longer than III. Mucrones dentate. Body beautifully marbled, sparsely covered dorsally with long, much-curved bristles. Length 1.5mm. **minnesotensis, 52.**
- b.—Ant. IV about as long as II and III together. Mucronal edges smooth. Body dark, without dorsal bristles but with short, fine hairs. Length 1 mm. **pruinus, 48.**
7. a.—Back set with strong, truncate bristles. 8.
- b.—Body short-haired, without bristles, often nearly naked. 9.
8. a.—Three or four clavate hairs present on the tibia, also several very long ones on the dentes. Ant. II equalling III in length, each of these segments bearing a few long, straight bristles. Length 1.25mm. **longisetis, 51.**
- b.—No clavate hairs on tibia or dentes. Ant. II shorter than III, long bristles not present. Length 1.25mm. **curvisetis, 50.**
9. a.—Body black, sometimes with bluish or brownish tint, bearing four white spots dorso-laterally, and with two small white spots medially to the eyespots. Length 1 mm. **quadrifasciatus, 45.**
- b.—Body without the four white spots. 10.
10. a.—Body yellow, sometimes darkening to orange or olive, young specimens darker. Eye-spots and a frontal spot between the bases of the antennæ black. Length 1mm. **aureus, 43.**
- b.—Body dark. 11.

11. a.—Body inky black excepting lower part of anal segment. Head black as far front as the eyespots. Fore part of head, antennæ, legs and lower part of anal segment bright yellow, furcula pale. Length 1 mm.

minutus, 44.

- b.—Black, with antennæ nearly so. Legs and furcula brown. A white spot mediad to each eyespot. Length 1 mm.

niger, 47.

Family **Entomobryidae.**

This large family is rich in genera as well as in species. It differs from the preceding in the different form of the body, the general form being elongate and the segment unfused. In most of the genera the antennæ are four-jointed, and the antennal segments are seldom ringed. The ocelli show the tendency to atrophy in most of the genera. The prothorax is short and usually more or less hidden by the projecting dorsal part of the mesothorax. The feet are two-clawed, and very frequently clavate hairs are borne on the tips of the tibiæ. The furcula is found in various stages, but is usually strongly developed and of very material assistance in keeping its owner out of harm's way. The family contains both haired and scaled genera. It is interesting to note that many instances of parallelism occur between species of genera which are only separated by this difference. Probably the family would be a more natural one if we omitted the genus *Tomocerus*, but as a matter of convenience it is regarded as belonging here.

KEY TO THE FAMILY ENTOMOBRYIDÆ.

1. a.—Body naked or covered with hairs. 2.
- b.—Body covered with scales. 4.
2. a.—Antennæ composed of six segments. Ocelli 12.
Genus **Orchesella**, 30.
- b.—Antennæ composed of four segments. Ocelli usually 16. 3.
3. a.—Abd. III and IV about equal in length.
Genus **Isotoma**, 31.
- b.—Abd. IV at least four times as long as III.
Genus **Entomobrya**, 33.

4. a.—Antennæ ringed on III and IV. Genus **Tomocerus**, 35.
 b.—No Antennal segments ringed. 5.
5. a.—Eyes absent. Genus **Cyphodeirus**, 35.
 b.—Eyes present. 6.
6. a.—Pronotum projecting forward so as to partly hide the head. Genus **Lepidocyrtus**, 36.
 b.—Pronotum not produced forwards. Genus **Seira**, 35.

Genus **Orchesella** Templeton 1835.

Orchesella is especially interesting as the only collembolan genus with six-segmented antennæ. In size all our species are rather large for Collembola, and nearly all species of the genus are quite strikingly colored. I have generally taken them singly or in small numbers under stones, etc., but once found them very abundant after a rain on the tops of stumps. They are active in their movements. Each eyepatch has six ocelli, and I believe there are no cases of degeneration from this number throughout the genus. The body is without scales but well covered with hairs, the larger of which are clubbed.

Three species have been taken in Minnesota, of which at least two are new.

KEY TO THE GENUS *ORCHESELLA*.

1. a.—Body yellow mottled with dark blue. 2.
 b.—Body white or almost colorless, with no dark markings. Ant. III with a dark ring at distal end, longer than the width of Ant. II. Head with a black median spot front of the eyes. **albosa**, 61.
2. a.—Antennæ short, not so long as the distance from cephalic end of head to Abd. IV. Ant. III colorless, short, its length being not greater than the width of Ant. II. Ant. II, IV and V with dark distal rings. **zebra**, 61.
- b.—Antennæ reaching as far as middle of Abd. IV. Ant. II, III and IV with black distal rings. Ant. III much longer than II is wide. Sides of head with dark lateral stripes which include the eyespots.. (n. sp.?)

There is but one specimen of the third species in the collection and I do not feel safe in giving it a name. It is certainly distinct from both of the others but may possibly be a variety of some known species.

Genus *Isotoma* Bourlet 1839.

This genus is represented in our fauna by at least 11 species and it is likely that more may be found.

The body is cylindrical, sometimes a little flattened dorso-ventrally.

In color we may expect anything from pure white or black or modest gray, to gorgeous greens and purples. The species are all pretty active, especially those in which the legs and furcula are long. The four-jointed antennæ are rather short and stout, often little longer than the head. In most species there are sixteen ocelli present, but some cases of atrophy are found in which the number on each side is reduced to seven, two, or none. A postantennal organ, consisting of a more or less elongate ring just caudad to the base of each antenna of found in most species, and is often of importance in species determination. The feet bear two claws which are furnished with teeth in many cases, and the tips of the tibiæ are often provided with one or several clavate hairs. The abdominal segments are subequal in length. The furcula is usually fastened to the fifth, though in a few of the lower species it seems to be shifting forward so that it seems to proceed from the fourth segment as in the Poduridæ. It seems to me probable that in all of the *Isotomas* at least, the furcula really belongs to the fifth segment. Perhaps further embryological studies will determine this for certain, both in this genus and also in the Poduridæ. The ventral tube is well developed, and quite prominent.

We are especially fortunate in having the American species of this genus written up by our best authority upon the subject, Mr. Alex. D. MacGillivray. In vol. XXIII of *The Canadian Entomologist* may be found his key to the more than thirty species then known to be found in the United States. He says "No measurements are given, as they have been looked upon as worthless; the formulæ of the claws and mucro are all that are necessary to recognize the species, young or adults."

On neither of these points can I fully agree with him. However he has certainly made available many of Dr. Packard's species by redescribing them from the types, and has added not a few new species.

KEY TO THE GENUS ISOTOMA.

1. a.—Furcula short, not reaching ventral tube. Claws unarmed. Antennæ little longer than head, post-antennal organ long, narrowly elliptical. 2.
- b.—Furcula reaching nearly or quite to the ventral tube. Antennæ considerably longer than the head. 5.
2. a.—Mucrones tridenticulate. Color light gray-blue. Ocelli 16. Length .75 mm. **minima, 63.**
- b.—Mucrones bidenticulate. 3.
3. a.—Entirely white. Ocelli absent. Dentes about twice as long as manubrium. Length 1.25 mm. **fimetaria, 64.**
- b.—White or pigmented. Ocelli 4 or 16. Manubrium longer than dentes. 4.
4. a.—White or light blue. Ocelli 4. Length 1 mm. **quadrioculata, 65.**
- b.—Gray-blue or brown. Ocelli 16. Length 1.5 mm. **bidenticula, 66.**
5. a.—Dentes much longer than manubrium. Male and female alike. 6.
- b.—Dentes little longer than manubrium. Clavate hairs on tibia. Color dense black. Male with prominent horns on Abd. IV, and with a covering of yellow sensory tubercles. **muskegis, 72.**
- 6.a.—Ant. II curved. Tawny yellow or white. Claws unarmed. Manubrium about half as long as dentes. Mucrones tridenticulate. Length 2.33 mm. **leonina, 67.**
- b.—Ant. II straight. 7.
7. a.—Body marked with blue, green or purple. No clavate hairs on tibia. 8.
- b.—Bluish or greenish gray. Tibiæ with clavate hairs. Length 2 mm. **sensibilis, 67.**

8. a.—Mucrones tridenticulate, no small apical tooth present. Neither entirely dark, nor with longitudinal markings. Body covered with short hairs, interspersed with a few longer ones. Post-antennal organ broadly elliptical. Large claw with one outer and one inner tooth. Length 2 to 5.5 mm. **viridis, 68.**
- b.—Mucrones quadridenticulate. 9.
9. a.—Long pre-apical tooth, far over-reaching the apical, which is very minute. Short hairs on body interspersed with long. Large claw with one outer and two inner teeth; small claw with one inner tooth. Length 3.8 mm. **catena, 69.**
- b.—Apical tooth of mucrones projecting at least as far as pre-apical. 10.
10. a.—Dark blue, Abd. V and VI with a few long hairs. Apical mucronal tooth outstanding, projecting far distal to preapical tooth. Two proximal teeth set nearly opposite to each other and at right angles to the mucrones. **caeruleatra, 70.**
- b.—Dorsal median dark stripe, hair entirely short. Apical tooth projecting little beyond pre-apical, proximal teeth set obliquely to mucrones, pointing distally. Length 2.75 mm. **palustris, 70.**

Genus **Entomobrya** Rondani 1861.

This genus, formerly known as *Degeeria*, stands next to *Isotoma*, from which it is separated by the much greater length of Abd. IV. In *Entomobrya* this segment is at least as long as the three preceding taken together. The antennæ are shorter than the body. Each eyespot contains eight ocelli in all our species; and indeed in all the species excepting those which belong to the genus *Sinella*. The latter genus was erected for the reception of those *Entomobryas* having but two ocelli on each side of the head. The weight of authority today seems in favor of relegating these species back to the genus *Entomobrya*, as the number of ocelli alone is not thought sufficient to constitute a generic difference. There is no postantennal organ. The body is well covered with fine short hairs, besides which, on the anterior part of the body there are longer, clubbed ones; and on

the posterior end of the abdomen, geniculate ones. The claws are armed with teeth. Clavate hairs are borne on the tibiæ. The ventral tube is well-developed. The furcula is long, slender and arcuate. The mucrones is small and bears always two strong teeth: a hooked or much curved apical, and a straight, strong tooth about the center of the mucrones, and at right angles to it. Besides these there is usually, if not always, a very slender basal tooth which points distally, its point almost reaching that of the middle tooth. In fact this type of mucrones, with but slight variations, is common to the scaled genera: *Lepidocyrtus*, *Seira* and *Cyphodeirus*, to all of which this genus is closely allied. I have taken five species of *Entomobrya* in the state, of which two are new. Some, as *E. clitellaria*, are perhaps local; but others as *E. multifasciata* are common under bark and rubbish throughout the state. None of the species live upon or about the water. In certain species, color variations and gradations are frequent and puzzling; and on this account many varieties have been described as species. In 1883 George Brook revised the genus, and, by careful synonymizing, reduced the number of species then recognized to less than half. His work is not universally accepted by more recent writers.

KEY TO THE GENUS ENTOMOBRYA.

1. a.—Abd. IV about seven times as long as III. A large species, very long and slender. Length 3 mm. bicolor, 73.
- b.—Abd. IV not more than five times as long as III. 2.
2. a.—Color yellow with the exception of a distinct, saddle-like, dark marking covering Th. III and Abd. I, II and III. Abd IV about five times as long as III. Length 2 mm. clitellaria, 75.
- b.—Color other than yellow. 3.
3. a.—Color nearly uniform purplish throughout. No segmental crossbands. purpurascens, 76.
- b.—With segmental cross-markings. 4.
4. a.—Yellow, with four very strongly defined dark crossbands situated on Th. III, on the dorsal part of Abd. III taking in the caudal edge of II, on Abd. IV, and on V

and VI. Head yellow with small median black spot before the eyes. **spectabilis, 77.**

b.—Cross-bands less clearly marked. Some dark color on Th. II and III. The band on Abd. IV usually broken. Head commonly with anchor-shaped marking between the eyes. **multifasciata, 77.**

Genus *Tomocerus* Nicolet 1841.

The genus *Tomocerus* seems so distinct from the other members of the family Entomobryidæ that some good authorities recognize a family Tomoceridæ. For convenience sake, however, we let it remain where it is usually placed. The mere fact that *Tomocerus* is scaled should not receive too much stress in determining its relationships to other scaled genera, as its scales are quite markedly different from those of *Lepidocyrtus*, *Seira*, etc. The body is long and somewhat cylindrical in form, and is heavily mailed with scales which have a leaden, semi-metallic lustre. The long antennæ have, like those of *Papirius*, a short apical segment. The third and fourth segments are whorled with short hairs and are very flexible. This genus resembles *Orchesella* in having but twelve ocelli. The mucrones is large and long and differs in form from all others excepting a few closely allied genera, which are not represented in our fauna. Another striking peculiarity is the presence of sharp spines on the inner edges of the dentes.

KEY TO THE GENUS TOMOCERUS.

Spines on dentes about 7 or 8. Mucrones with the large, spur-like tooth somewhat removed from the base.

arcticus, 79.

Spines on dentes about 12 or 16. Mucrones with the large, spur-like tooth close to base on inner edge, and a smaller one opposite it on outer edge.

niger, 80.

Genus *Cyphodeirus* Nicolet 1841.

There is but one species of this genus known here, so far; and it is the type species upon which the genus was founded. It is essentially merely a white, eyeless Entomobrya with scales.

albinus, 82.

Genus *Seira* Lubbock 1869.

This is another scaled genus of the Entomobrya group and

probably from *Seira* the preceding genus became specialized by a cave habit which caused it to lose its eyes and color.

Both of our species were originally described from England by Sir John Lubbock, and are likely to be found in greenhouses and dwelling houses. The *Seiras* seem to flourish in dryer places than are chosen by other Collembolans. Our species are readily distinguished by their difference in color.

KEY TO THE GENUS *SEIRA*.

General color dark purple. Head yellow except the eyespots and their connecting dark band. **buskii, 83.**

General color dark yellow, with a few dark blue markings. Very narrow cross-bands on the caudal edges of Abd. III, IV and V, all of Abd. VI, and the cephalic and lateral edges of Th. II, dark. Noticeable dark spots on the sides of Abd. IV near its caudal edge. **nigromaculata, 84.**

Genus *Lepidocyrtus* Bourlet 1839.

This is also an entomobryoid genus bearing scales and having the pronotum more or less produced forwards so as to conceal the head wholly or in part. The scales have a brilliant metallic lustre, being brightly iridescent in some species. We may recognise two types of species in the genus: first, those with a strongly produced pronotum, to which belongs our *L. albicans*; and, second, those smaller forms in which the pronotum is more massive and projects less. To this latter division our other five species may be referred. These latter are heavier bodied throughout, and have less rangy limbs and shorter antennæ in proportion to the length of the body. The fourth abdominal segment is from three to four times as long as the third. Ocelli (in our species) 16, 10 or 6. Antennæ never more than half as long as the body.

KEY TO THE GENUS *LEPIDOCYRTUS*.

1. a.—Pronotum strongly produced forwards so as to conceal much of the head. Color yellowish white, with some blue on antennæ. Length 1.5 mm. **albicans, 85.**

b.—Pronotum massive (see figures). Smaller, heavier bodied species. 2.

2. a.—Color silvery white. 3.

- b.—Color blue of purple. 4.
3. a.—With two rounded eyespots, 10 ocelli, antennæ blue.
decemoculatus, 85.
- b.—With four eyespots, the anterior ones each containing two ocelli; the posterior ones, one each. Antennæ white.
sexoculatus, 86.
4. a.—Color dark purple; with legs, top of head, and bases of antennæ brownish yellow. **purpureus, 87.**
- b.—Color blue and white. Antennæ entirely blue. 5.
5. a.—Rather blackish blue with five white segmental cross-bands. Head entirely blue, antennæ dark blue, concolorous throughout. Tibiæ blue. **aenescens, 89.**
- b.—Rather a clear blue, without noticeable white cross-bands. Head rather light on top. Antennæ light blue at base, gradually becoming darker distally. Tibiæ clear.
pusillus, 88.

Family Poduridae.

The family Poduridæ is a large one and seems to occupy a position somewhat lower than the Entomobryidæ. Its genera show rather less specialization, or perhaps, as seems to me, they show the specialization of reduction. Among them we fail to find any of the long, slender antennæ modified for tactile uses. To be sure, many have curious sense bulbs at the ends of the antennæ, but such modifications as ringed antennæ are altogether unknown. In most cases the typical four-jointed antenna is found in its simplest form. The claws show reduction. In some genera the inferior claw is absent, while in others it is reduced in some species to little more than a bristle. In others, again, the claws are both well developed. The forms are mostly low and more or less flattened, which necessitates a short ventral tube in most cases. The furcula is generally short, sometimes so short as to make it difficult to determine whether a species is a Podurid or an Aphorurid. On the other hand, the gulf between some of the lower Isotomas and the Poduridæ is not so great as some of the older collembolists supposed, basing their conclusions upon the forms then known. "Furcula on the antepenultimate (fourth) abdominal segment," used always to mean a Podurid, but now a few Isotomas are known of which

the same may be said. Most of the Podurids love the dark and are to be found beneath bark, moss, stones, etc., where there is moisture, and some of them live about or upon the water. The social instinct is often very apparent, and sometimes a colony of Podura or Achorutes may be found to fairly blacken the snow or water by thousands. We have four genera in the family, three of which are represented in the state by one species each.

KEY TO THE FAMILY PODURIDÆ.

1. a.—Feet two-clawed. Two anal horns. Post-antennal organ present. Ocelli 16. Genus **Achorutes**, 38.
- b.—Feet with a single claw. No post-antennal organ. 2.
2. a.—Anal horns present. Furcula short, not reaching to ventral tube. 3.
- b.—Anal horns absent. Furcula reaching as far as ventral tube, dentes much bowed. Body shortened. Ocelli 16.
Genus **Podura**, 39.
3. a.—Three anal horns. Furcula extremely short and thick. Body robust. Ocelli 16. Genus **Friesia**, 40.
- b.—Two anal horns. Furcula short but very slender. Body slender, Ocelli 10. Genus **Xenylla**, 40.
Genus **Achorutes** Templeton, Schäffer 1834.

These insects are of a slightly flattened cylindrical form, with strong legs and a heavy body. The four-jointed antennæ are stout, and about as long as the head. Sometimes the third and fourth antennal segments appear fused when seen from certain positions. Each eye-spot contains eight ocelli, and there is present a post-antennal organ composed of about four or five tubercles arranged in a ring. The prothorax can be seen dorsally, although quite short. In our species each tibia bears a single clavate hair at its tip. The body is sparsely haired. Ventral tube very short, the two halves of its end apposing when closed. No extensible filaments. Abd. IV bears the short, stout furcula, which consists of a very heavy manubrium, thick dentes, usually tapering but little. On the ventral side of the dentes are one or several long, straight hairs; which are not, however, clavate, as in some Sminthuridæ. The mucrones is of various forms, more or less toothed at apex, and sometimes

equals half the length of the dentes. At or near the apex of Abd. VI are borne the two anal horns. Sometimes these are long, sharp, curved and quite prominent; sometimes scarcely visible; and in certain species (the *Achorutes* of MacGillivray) entirely lacking. Our five species all have them. These chitinous horns proceed from the papilæ more or less raised above the dorsal surface. The *Achorutes* are among the snow insects, several species having been found on the surface of snow-pools, in early Spring. They are often found in wet places, in decaying wood, under bark and stones, and on fungi, on which some of them feed.

KEY TO GENUS *ACHORUTES*.

1. a.—Superior claw with a tooth. Tenant hair strong. Mucrones less than half as long as dentes (except *A. schötti*). Anal horns short. 2.
 - b.—Superior claw not toothed. Tenant hair feebly developed, not very distinctly clavate. Mucrones about half as long as dentes. Anal horns long, curved and sharp. 4.
2. a. Dentes with several sharp pointed spikes borne ventrally near its distal end. Dark blue, pruinose. Mucrones two-toothed. Anal horns hardly visible. Inferior claw tapering suddenly in its distal third. **socialis, 92.**
 - b. Dentes without spikes. 3.
3. a.—Inferior claw very slender, almost bristle-like. Mucrones more than half as long as the dentes. **schötti, 93.**
 - b.—Inferior claw becoming bristle-like beyond the middle. Mucrones one-third to one-fourth as long as the dentes, which tapers considerably. **schneideri, 91.**
4. a.—Uniform dark blue in color. **longispinus, 90.**
 - b.—Light ground color, whitish beneath, covered dorsally with gray specks. **boletivorous, 89.**

Genus *Podura* Linne 1758.

The genus *Podura* seems to be merely a form adapted for life on the surface of the water. The bow-legged appearance of the furcula reminds one strongly of the water *Sminthuri*: *S. spinatus* and *S. penicillifer*. And here too the mucrones is flattened in such a manner as to be most efficient in leaping by striking the

surface of the water flatwise. The body is considerably shortened for a Podurid. There are no anal horns present, and no post-antennal organs. The legs are strong and longer than in *Achorutes*, and bear no clavate hairs, though there is a long hair in the position of a tenant hair. There is no inferior claw present, but the single claw is long, strong and unarmed.

Our single species is that upon which the genus was founded, and is perhaps the most cosmopolitan of all the *Collembola*
aquatica, 93.

Genus *Xenylla* Tullberg 1869.

I believe this is the first record of this genus in the United States. The genus is not a large one. Its position would seem to be inferior to *Achorutes*, from which it has perhaps degenerated. *Xenylla* is characterized by its slender body, the abdomen being somewhat fusiform, as in *Achorutes*, but less stout; the absence of the inferior claw as well as of the postantennal organ; by its having the ocelli reduced to ten, five in each eyespot; the presence of anal horns and by the small, weak furcula. The single species found in Minnesota appears to be quite new and its slender form suggests the name "gracilis."

gracilis, 95.

Genus *Friesia* Dalla Torre 1895.

This genus is represented in Sweden and England by the type species, *F. mirabilis* Tullberg, which was the only species known hitherto. Whether ours is a true Minnesota species or only a sojourner here, I cannot say, for it has only been found in the greenhouse.

The characters of the genus are the absence of the inferior claw and of a post-antennal organ, and the unique presence of three anal horns. The body is stout and the furcula extremely short and thick.

caldaria, 95.

Family Aphoruridae.

These insects are at the very foot of the ladder of Collembolans. Rather slow-moving, sluggish, dark-loving creatures they are, living in the soil, in moist, decaying wood, etc. A few species live on the surface of the water, both salt and fresh. The Aphoruridæ are in some ways less degenerate than some of the lowest Poduridæ.

The most characteristic point to be noted is the absence of a furcula. The head is held nearly horizontal. Th. I is apparent from the dorsal side. In some of the genera the feet bear one claw, in others, two. The cuticle is usually quite plainly granular. In most cases a post-antennal organ is present, consisting of a ring of raised tubercles situated in a slight hollow. We have five genera in this family.

KEY TO THE FAMILY APHORURIDÆ.

1. a.—Dorsal side of the body with large, warty protuberances. Abdomen ending in four rounded tubercles. Post-antennal organs present or absent. Genus **Neanura**, 42.
- b.—Dorsal part of body without such protuberances. 2.
2. a.—Pseudocelli present. Post-antennal organ nearly present, generally elongate. Anal horns 0 or 2. Feet with two claws. Genus **Aphorura**, 41.
- b.—Pseudocelli absent. Feet with but one claw. 3.
3. a.—Post-antennal organ absent. Anal horns wanting. Genus **Anurophorus**, 42.
- b.—Post-antennal organ present. Anal horns wanting. 4.
4. a.—Ocelli absent. Mouthparts produced cone-like beneath the head, mouth opening in a narrow transverse slit. Genus **Aphoromma**, 42.
- b. Ocelli present. Mouth-parts not produced conelike. Genus **Anurida**, 42.

Genus **Aphorura** MacGillivray 1893.

The Aphoruræ are small, white, slender insects, somewhat flattened, and are often very abundant in rotten wood, in loose soil, or under stones. They are characterized by the absence of eyes, and the presence of the inferior claw which the other Aphoruridæ lack. Our two species, though appearing the same to the naked eye, are easily distinguished.

KEY TO THE GENUS APHORURA.

- a.—Without anal horns. Each post-antennal organ composed of 14 to 16 tubercles. Length 1 mm.
- inermis, 96.

b.—With two long anal horns. Each post-antennal organ composed of 12 to 14 tubercles. Length 2 mm.

ambulans, 97.

Genus **Anurophorus** Nicolet 1841.

Anurophorus has neither post-antennal organ nor anal horns. The body is slender and appears more like one of the Isotomas in that the granular appearance common to most of the Poduridæ and Aphoruridæ is hardly apparent. Probably our species is the type species upon which the genus was founded.

laricis, 98.

Genus **Anurida** Laboulbene 1864.

This genus differs from the preceding in the possession of a post-antennal organ. There are no anal horns. The body is longer and comparatively more bulky than in Anurophorus. Our species is an inhabitant of fresh water surfaces, unlike *A. maritima* which occurs on the surface of some of the ocean tidepools and is said to be found only on and near salt water.

tullbergi, 99.

Genus **Neanura** MacGillivray 1893.

The Neanuras are sluggish, uncouth looking insects, with a velvety appearance due to the granular surface.

They may be readily recognised by their short, tapering antennæ, and broad, flat bodies. They occur in moist, rotten wood, wandering around in old worm holes, or under bark or moss. Some species grow to a large size, four millimetres. Our commonest species is one which is found almost all over the world.

KEY TO THE GENUS NEANURA.

Dark colored, heavy, with very prominent abdominal tubercles. A rather large species. Ocelli 6.

muscorum, 100.

Yellowish white, with body less noticeably tubercled.

A small species. Two black, separated ocelli on each side of the head.

quadrioculata, 101.

Genus **Aphoromma** MacGillivray 1893.

I am in doubt as to whether this should be recognized as a distinct genus, as the principal character which separates it from *Anurida* is the absence of ocelli. This character alone would be hardly of generic importance; yet the peculiar conical

extension of the mouthparts allies it rather to *Neanura* from which it differs in the transverse slit-like opening of the mouth. We have the single species of the genus. **granaria, 102.**

***Sminthurus aureus* Lubb.**

Pl. V, Figs. 5-9.

1862. *Sminthurus aureus*. Lubbock, Notes on the Thysanura. In Trans. Linn. Soc. Part II, p. 589. Pl. 59, f. 1-3.
1872. *Sminthurus aureus*. Tullberg, Sver. Podur. p. 32.
1873. *Sminthurus aureus*. Lubbock, Monogr. Coll. and Thys. p. 112. Pl. VII and LXIII, 9. . .
1890. *Sminthurus aureus*. Uzel, Thys. Bohem. p. 31.
1893. *Sminthurus aureus*. Schött, Palæarct. Collemb. p. 31.
1896. *Sminthurus aureus*. Schäffer, Collemb. v. Hamburg. p. 208.
1896. *Sminthurus aureus*. Lie-Pettersen, Norges Collemb. p. 10.

Lubbock's description is as follows: "Yellow with black eyes. Antennæ four-jointed; basal segment shortest, terminal segment longer than the other three. Under side of body pale, saltatory appendage white. Body with a few scattered hairs, which are longer and more numerous toward the posterior extremity. The four segments of the antennæ increase in length progressively from the base to the apex, each being about twice as long as the preceding. The long apical segment has whorls of short hairs, but no distinct evidence of segmentation. The eyes are situated as usual on a black ground, and near the central line, a little in front of the antennæ, is a black double spot which looks like the seat of two ocelli. The two claws are simple. The feet are also provided with four or five tenant hairs.

"Length, 1/30 of an inch. Common from February to June under dead pieces of wood in Kent."

My specimens were taken in December, March and April, under leaves and boards, in places which were slightly moist and somewhat light. In all important respects they agree with Lubbock's description. In color, however, they exhibit a variation noted neither by Lubbock nor Tullberg. Many of the young specimens up to a half a millimetre in length, show an olive tinting on the back which often extends even to the antennæ, and but few of those measuring three-fourths of a millimeter had entirely lost the olive on the back. My largest specimens measure 1 mm.

The mucrones has its lower edges very finely serrate. In Lubbock's figures there are but six ocelli depicted on each eye spot, and no one seems to have noted the great reduction of the second ocellus from the front on the inner row. It has shifted in position until it has come to lie close to the front margin of the ocellus lying next behind it, and has become triangular in shape. The central ocellus is small as is commonly the case in this genus, and particularly so in the closely allied species: *niger*, *4-maculatus* and *minutus*. The eyespot itself is broader than in any of the three species named. The sub-anal papilla is slender as in *4-maculatus*, but squarer on the end.

I have noticed that when this insect takes a full leap it nearly always lights on its back.

***Sminthurus minutus* MacG.**

Plate V, Figs. 11a-15.

1862. *Sminthurus minutus*. MacGillivray, *Canad. Ent. XXVI*, p. 109.

It is always unfortunate that a species should be described without accompanying figures, as was the case in this following description by MacGillivray, yet with a description so carefully written of a species so characteristic in coloration little confusion is liable to result. "Black and yellow; head yellow, except behind and the eyespots which are black, black extending around on the side of the face below the eyespots, eyespot narrowly encircled with yellow; on each side below the eye spot, three clear spots arranged in a transverse line; a black, ocellus-like spot on the vertex between the antennæ; antennæ reaching beyond the apex of the thorax; basal segment black, globular, one-half the length of the second; second segment sub-equal to the third, petiolate at base, naked; third segment about one-half the length of the fourth, enlarged at middle, yellow, with a few scattered hairs; fourth segment yellow, blunt at tip, moderately hairy, not ringed; thorax black, except a small part of the sternum, which is yellow; legs short, stout, yellow; claws short, outer claw about as long as the tibia is broad, sinuate beneath, with a single tooth above; three tenant hairs present; abdomen black except a yellow spot on the under side of the anal tubercle, naked, except a few bristles on anal tubercle; furcula slender, slightly hairy beneath; manubrium reaching the

middle of the anal tubercle; dentes sub-equal in length to the manubrium; mucrones one-third the length of dentes, simple, pointed, with a slight hook at apex, with a high power appearing very finely serrate. Length, 1 mm. Habitat: Ithaca, N. Y. Under pieces of wood in a plant jar in the University Insectary."

My specimens agree pretty closely with the foregoing in most particulars, though I have failed to find any denticle on the larger claw, and Ant. I is invariably yellow. The mucrones is the same as in *aureus*, but the claws differ slightly from that species. The claws of the second and third pairs are alike, but the inferior claw of the first pair becomes narrower and has no distinct inner denticle. The antennæ are like those of *niger*, fig. 18, having Ant. III plumper than in *aureus*.

Taken only in the University greenhouse, where the species is common in empty, inverted flower pots, under loosely lying boards, etc.

Though so minute, the species is readily identified even with the unaided eye, from the strongly contrasting bright yellow and inky black, which are seen rather less plainly in the young, as their black is less intense. The yellow spot on the anal tubercle is so large as to be seen at the sides of the tubercle from a dorsal view. The positions of the ocelli are shown in fig. 12.

The sub-anal papillæ are rather stout, and bear a flattened bristle of the same form as in *4-maculatus*, figs. 11a and 11b.

***Sminthurus quadrimaculatus* Ryder.**

Pl. V, Figs. 10a, 10b.

1878. *Sminthurus quadrimaculata*. Ryder, Proc. Acad. Nat. Sci. Phila. p. 335 and figure.

1892. *Sminthurus 6-maculata*. Harvey, Ent. News. III. pp. 169-170. fig.

Ryder describes the species as follows: "Dark brown, nearly black on the sides; median dorsal and ventral surfaces lighter; spring and middle of legs still more pale. Its distinguishing character consists in the two pure white spots, low down on each side of the abdomen, the posterior ones larger than the anterior by one-third to one-half, are arranged, when the back of the animal is viewed from above, in an equilateral quadrangle. The surrounding dark color immediately bordering the white spots is intense, but becomes paler more remote from them in

all directions, and especially in the middle of the back. Antennæ four-jointed, sminthuriform, resembling those of *S. Bourletii* Gerv." Harvey, in describing the species which he names "6-maculata," speaks of it as deep blue-black, with four conspicuous enamel-white spots on the body and two smaller ones between the eyes. The posterior pair of spots on the body somewhat reniform in outline, with the sinuses on the dorsal side. Antennæ and legs paler, shaded with purple. Antennæ slender, nearly two-thirds the length of the body and head, the terminal segment composed of about nine subjoints." Harvey also remarks: "The species is apparently related to *S. quadrimaculata* Ryder, but differs in the larger size, broader body, purplish color and white spots between the eyes."

There is little doubt that the two species are identical. As to color, it is rather difficult on some specimens to be certain of the presence of the pearly spots beside the eyes, yet I am convinced that they are always present. Indeed, Ryder's figure shows that he saw white, or at least clear spots in exactly the right position, though he makes no mention of the fact. These particular markings are homologous with those on *S. niger*, and caused Tullberg to name that species *S. bimaculatus*, which has since been reduced to a synonym of *S. niger*. The same spots are likewise present in the allied species: *S. minutus* and *S. aureus*, though on these two species, that part of the head being yellow, their pearly color is not very evident. Some of my specimens have the general body color brownish black, which becomes a light yellowish brown on the legs, while on others the purplish black prevails, in which case the legs are often light purple also. Quite likely Ryder had immature specimens before him, as his description shows them to be both smaller and lighter colored on the back than Harvey's.

As to the antennæ: Ryder's figure shows no indication of subjoints on Ant. IV, yet he speaks of them "resembling those of *S. Bourletii*," having, probably, Lubbock's figure before him, in which the antennæ are shown almost exactly as in Harvey's figure of *S. 6-maculata*. My largest specimens measure almost 1 mm. The furcula and legs are proportionately longer than in *S. aureus* or *S. minutus*. The nucrones also is more coarsely serrate, being like that of *S. niger*, fig. 17. The claws are like

those figured for *S. minutus*, having the same difference between those of the first pair and the others. The sub-anal papillæ are slender when seen from the sides, and the accompanying bristles, the "appendices anales" of Tullberg, have the appearance of simple, curved bristles when seen laterally, that is, looking at their edge. When the end is slightly turned, however, as is usually the case, it appears somewhat ragged or serrate, fig. 10b. When viewed on the flat it is seen to be much flattened, rather palmate in form, with the median edge deeply cleft or slit up, fig. 10a. The papillæ are grooved along their front sides, the bristles proceeding from the groove as shown in fig. 11b, which is a cross-section of the papilla at the base of the bristle in *S. minutus*. The eyes are like those of *S. minutus*, as seen in fig. 12. *S. quadrimaculatus* is a summer species, usually found under loose bark. On account of its size and color it is not an easy species to see; but when once located, the four white spots render it easy to identify, even with the naked eye.

***Sminthurus niger* Lubbock.**

Pl. V, Figs. 16-18.

1867. *Sminthurus niger*. Lubbock, Notes on the Thys. Part III, p. 297. Plate XXI, figs. 11-12.
 1871. *Sminthurus bimaculatus*. Tullberg, Sver. Podur. p. 145.
 1873. *Sminthurus niger*. Lubbock, Monogr. Coll. and Thys. Part III. Pl. VI, and LXIII, fig. 3.
 1890. *Sminthurus niger*. Uzel, Thys. Bohem. p. 35.
 1891. *Sminthurus niger*. Schött, Kaliforn. Collemb. p. 12. Pl. II, 1.
 1893. *Sminthurus niger*. Schött, Palæarct. Collemb. p. 32. Pl. II, 12.
 1895. *Sminthurus niger*. Reuter, Finlands Collemb. och. Thys. p. 13.
 1896. *Sminthurus niger*. Lie-Pettersen, Norges Collemb. p. 12. Pl. II, 1.

Lubbock describes this species as "Bluish black; feet, terminal segment of spring, and a spot on the front inner corner of each eye patch pale. Hairs short, white, more or less in longitudinal rows. Length, $1/23$ of an inch. Under boards in my kitchen-garden. Not common, solitary. August to December. This ugly little species does not resemble any yet described. It differs from *S. ater* DeGeer in the form of the spring etc., and from *S. fuliginosis* Nicolet in the absence of white patches on the body and in having the head and antennæ black. The terminal portion of the antennæ is not distinctly ringed, the posi-

tion of the subsegments being, however, indicated by the whorls of hairs. The large claw is simple, the smaller one is narrower in the anterior legs than in the posterior ones. The terminal lamellæ of the saltatory appendage are narrow and pointed. Both appear to have on the same side a row of fine teeth; in fact there are two rows on the under surface, which, being almost always thrown either to one side or the other, give the appearance of a symmetry."

Evidently the species does not vary much, for the above description exactly fits my specimens. The sub-anal papillæ bearing the anal appendages, are hardly stouter than those of *S. quadrimaculatus*, fig. 10, but are rather squarer on the ends. The appendages are apparently of the same form as in that species. The antennæ, fig. 18, are slightly stouter than in *S. aureus*, especially the third segment. The mucrones is of the same type, but not so minutely serrate as in either *S. minutus* or *S. aureus*. The claws differ little from those of the former species. My specimens reach 1 mm. in length.

Some were taken under bark of a dead log, others from the under side of chips in rather a damp place, where a stagnant pond was drying up. Besides these from the southern part of the state, it was found to be quite common under loose bark in the region around Lake Vermillion, being frequently taken in company with *S. quadrimaculatus*.

Sminthurus pruinosis Tullb.

Pl. III, Figs. 14, 15.

1871. *Sminthurus pruinosis*. Tullberg, Fort. öfver Sv. Podur. p. 145.
 1872. *Sminthurus pruinosis*. Tullberg, Sver. Podur. p. 34. Pl. III, 15-16.
 1890. *Sminthurus frontalis*. Uzel, Thys. Bohem. p. 37. Pl. I, 3; II, 3-5.
 1893. *Sminthurus pruinosis*. Schött, Palæarct. Collemb. p. 28. Pl. II, 13-16.

I have a single specimen which I think belongs to this species. Gathering from the various descriptions given, it seems that it is a dark species; mine is very dark, greenish black above, and lighter, somewhat violet below, as well as on the antennæ, except at their proximal ends, and on the entire furcula. The legs are very light violet. On the back are a few lines and dots of a light yellow color. The top of the head between the eyes

is bright yellow. The antennæ have the first joint short, the others increasing in length distally; Ant. IV is about as long as the sum of II and III; its proximal one-third is not apparently annulated, the other two-thirds quite distinctly so; showing, in my specimen, six pretty well-marked subdivisions, besides some others not so plain. The tibiæ have two or three clavate hairs each. The claws appear to me unarmed, though Schött has figured a small inner tooth on the superior tooth of the third pair. The furcula is rather stout; when extended, the manubrium hardly reaches beyond the caudad end of the final abdominal segment. The dentes is a little longer than the manubrium and nearly three times the length of the mucrones. The dentes bears ventrally a row of short hairs, and two longer ones situated near its two ends. The mucrones is of the narrow type, but not acuminate. Its edges are quite smooth. The species is rather heavy-bodied. It bears no long or strong spines on the back, but is covered quite thickly with fine, short hairs, giving it a pruinose appearance. The specimen was taken under a stone in rather a damp situation in a rocky coulee which runs down the side of the bluff to the Mississippi River below Red Wing, Minn. I believe the species has not hitherto been reported from this continent, though known in Sweden, Germany and Bohemia.

Sminthurus caecus Tullb.

Pl. IV, Fig. 13; V, Figs. 1-4.

- 1871. *Sminthurus caecus*. Tullberg, Fört. öfver Sv. Podur. p. 146.
- 1872. *Sminthurus caecus*. Tullberg, Sver. Podur. p. 33. Pl. III, 24-25.
- 1890. *Sminthurus caecus*. Reuter, Coll. in Caldar. viv. p. 19.
- 1890. *Smynthurus caecus*. Uzel, Thys. Bohem. p. 36.
- 1893. *Sminthurus caecus*. Schött, Palaearct. Collemb. p. 38.
- 1895. *Sminthurus caecus*. Reuter, Finl. Coll. och. Thys. p. 13.
- 1896. *Smynthurus benitus*. Folsom, Psyche. VII, 446.
- 1896. *Sminthurus caecus*. Schäffer, Coll. von Hamburg. p. 208.
- 1896. *Sminthurus caecus*. Schäffer, Coll. von Hamburg. p. 208.

Tullberg's brief description serves well to identify this albino among the *Sminthurids*. His description reads: "White, dotted all over with rufous. Ocelli none. No clavate hairs on the tibia. Mucrones equalling three-fourths the length of the dentes. Length 2/3 mm."

It seems to have been found chiefly under flower pots,

though I have taken it out of doors as well; where it occurs throughout the summer months under damp boards and drift-wood, in low, moist woods. It is an active species when touched, but much more easily caught than eyed species. Ant. IV is slender and well haired, especially toward the end. It is distinctly ringed. The legs are unusually long and slender. The claws are long and slender, especially so on the first pair of feet, fig. 4. A peculiarity of the furcula is to be found in the presence of two stout spines, probably originating from hairs, which are borne by the distal ends of the dentes at their outer sides, fig. 2; smaller ones are found farther up on the dentes, on the inside. The sub-anal papillæ, fig. 1, are not slender, but short and bunch-like; and the bristle is nearly straight, appearing narrower than in most species, and less branched, if at all. The reddish-brown spots which appear under a low magnifying power, are seen upon greater magnification to be clusters of many exceedingly minute pigment dots. Older specimens show more pigmental color than do younger ones. The clearness of the body makes it an especially favorable species for the study of the muscles in situ.

Although occasional individuals have been found, yet the species was taken in abundance on one occasion only. On March 27, 1901, I found them in abundance on a small island in the Mississippi River below Red Wing, Minn.

Sminthurus curvisetis n. sp.

Pl. III, Figs. 1-7.

Dull black above; around the eyes, under side of anal segment and two low lateral spots just in front of the base of the manubrium, yellow. Antennæ, legs and furcula dark blue. The back is sparsely set with strong, truncate, backward-curving spines. Antennæ slender, with segments increasing progressively in length and decreasing in breadth distally; of a purplish blue throughout. Legs rather stout, claws stout, unarmed, the tip of the inner claw bearing a strong, clavate hair which slightly overreaches the end of the larger claw. Tibiæ without clavate hairs. Furcula rather stout; manubrium about as long, measured ventrally when extended, as the dentes and mucrones together; dentes tapering

somewhat. A few long hairs are borne on the ventral side of the dentes, but none clavate, or longer than the breadth of the dentes itself. Mucrones short and stout, with a single notch on the outer edge, and about five on the inner edge; at the base, on the dorsal side, is a notch extending part way around. The sub-anal bristles are very much curved, and from them the species derives its name; they are pinnate in form. Length, 1.25 mm.

Not very common. Found only, so far, in low, dark woods, on the bottom lands of the Mississippi, where it was taken under chips and pieces of drift-wood.

***Sminthurus longisetis* n. sp.**

Pl. III, Figs. 8-13b.

A brownish-black species, indistinctly mottled with yellow. Back and top of head set with strong, truncate bristles, nearly straight, and pointing backward. Antennæ very slender excepting Ant. I; Ant. II as long as Ant. III. The antennal segments measure in the ratio 5:14:14:19. Ant. IV is not distinctly ringed, but whorls of short hairs indicate where rings would come. On Ant. II and III are a few stiff sense hairs, about as long as three times the width of the antennæ, and standing out at right angles to those organs. The head bears at its vertex a prominent tubercle, as in *S. minnesotensis* and *S. curvisetis*. The eye-spots are dark yellow in color, and very convex. Legs short and with very stout claws, the larger one bearing a notch-like inner tooth. At the tip of the inferior claw is borne a slender, simple hair, which projects about half its own length beyond the tip of the larger claw. The tibia bears four clavate hairs. Furcula strong; manubrium as long as dentes and mucrones taken together, and reaching back as far as the tip of the anal segment when extended. Dentes stout and somewhat tapering, each ramus bearing on its ventral side three long sense hairs, set at almost right angles to the dentes. Mucrones short and stout; the outer edge nearly smooth, except for the rounded scollop near the tip, the inner edge somewhat coarsely serrate, a rounded tooth at the back running part way around the base. The anal organs are deeply cleft and much curved. Length, 1.8 mm.

Found in deep, dark woods, under drift-wood. Quite rare.

Sminthurus minnesotensis n. sp.

Pl. II, Figs. 10-16 and Pl. XIV.

Purple and yellow above; antennæ, legs, furcula and under side of body dark blue; under side of small abdominal segment yellow; head marbled with yellow and purple. A narrow, median, dorsal band of purple on the thorax; in front of this, two, and behind it, four or five cross-bands of purple, alternating with broader ones of yellow. Ant. IV showing about seven distinct, bead-like rings, each bead most enlarged at the distal end, fig. 10. Head broad in proportion to the body, bearing on the vertex an elevated mound, on which may be seen a pair of short, horn-like hairs, fig. 16. The central ocellus is small, the rest about of a size, with a slight preference in favor of the front one of the median row, fig. 13. The long, curved bristles on the head point forward. The body is elliptical from a dorsal view; rather low, and sloping from the thorax, as seen from the side. The back is covered with long, pale, backward-curving bristles. Abdomen not broader than the thorax, its apical segment large. Anal appendages, genital papillæ and tenaculum shaped much like those of *S. fuscus*. The furcula also resembles that of *S. fuscus* in general form, but differs in the dark color, and in the mucrones, which has the outer edge entirely smooth, and is more inclined to the acuminate form, and not quite so deeply trenchant. The feet differ slightly, the upper claw of the third pair being rather more slender than on the first and second pairs. In the third pair, too, the inferior claw is of slightly different form, fig. 14, and appears to bear the hair at its very apex, instead of farther up, as in the others. The superior claw bears a small, inner tooth. No clavate hairs are present. The claws are not enclosed in a tunic. The dorsal side of the trochanters is colorless. Length 1.5 mm.

Taken all through the summer, though never very abundant, under bark and pieces of drift-wood, in low, dark woods along the Minnesota and Mississippi Rivers, and in July at Lake Vermillion. They often occur with *Papirius muculosus* Schött, which they closely resemble in general coloration. Sometimes I have taken them with *S. niger* Lubb. Their general appear-

ance suggests that of *S. multifasciatus* Reuter, and I was long in doubt as to whether it might not be merely a variety; but the mucrones is distinctly serrate, while that of Reuter's species, to quote Schött, "hat die Ränder ganz glatt." *S. multifasciatus* also differs in wanting the inner denticle on the claw. Again, in color, neither the figure of Reuter nor that of Schött shows the median dorsal band.

***Sminthurus fuscus* (L.).**

Pl. II, Figs. 1-9.

1743. *Podura fusca*, globoso, antennis longis articulis plurimis. DeGeer, Vet. Akad's Handl. Vol. IV, p. 296.
1746. *Podura globosa fusca*. Linné, Fauna Suecica.
1758. *Podura fusca*. Linné, Syst. Nat. Ed. X. Tome I, 668.
1762. *Podura fusco-nigra*; abdomine globoso signaturis ferrugineis. Geoffroy, Ins. Env. Paris.
1762. La Podure brune enfumée. Geoffroy, Ins. Env. Paris.
1767. *Podura atra*. Linné, Syst. Nat. Ed. XII. Tome I, 2. p. 1019.
1776. *Podura atra*. Müller, Zool. Dan. Prod.
1778. La Podure brune ronde. DeGeer, Gesch. d. Ins.
1781. *Podura atra*. Schrank, Enum. Insect. Austr. p. 495.
1781. *Podura atra*. Fabricius, Spec. Ins. I. p. 381.
1781. *Podura signata*. Fabricius, Spec. Ins.
1804. *Smynthurus fuscus*. Latreille, Hist. Nat. VIII, p. 82.
1804. *Smynthurus signatus*. Latreille, Hist. Nat. VIII, p. 82.
1835. *Smynthurus fuscus*. Lacordaire & Boisd., Faun. Ent. Env. Paris.
1835. *Smynthurus ater*. Lacordaire & Boisd., Faun. Ent. Env. Paris.
1835. *Smynthurus signatus*. Lacordaire & Boisd., Faun. Ent. Env. Paris.
1835. *Smynthurus ater*. Templeton, Trans. Ent. Soc. I.
1838. *Smynthurus fuscus*. Burmeister, Handb. d. Entom. II. 2, p. 451.
1839. *Smynthurus fuscus*. Bourlet, Mem. Soc. Roy. Lille.
1842. *Smynthurus fuscus*. Lucas, Hist. Nat. Anim. Art.
1842. *Smynthurus ater*. Lucas, Hist. Nat. Anim. Art.
1842. *Smynthurus signatus*. Lucas, Hist. Nat. Anim. Art.
1842. *Smynthurus fuscus*. Bourlet, Mem. Soc. Roy. Douai.
1842. *Smynthurus signatus*. Nicolet, Mem. Soc. Helv.
1844. *Smynthurus ater*. Gervais, in Ins. Apt. III, 492.
1844. *Smynthurus signatus*. Gervais, in Ins. Apt. III, 400.
1862. *Smynthurus buskii*. Lubbock, Notes on the Thys. Pt. I, p. 431.
1869. *Smynthurus signatus*. Porath, Of. af. k. Vet-Akad. Forhandl.
1871. *Smynthurus fuscus*. Tullberg, Fort. öfver. Sv. Podur. p. 144.
1872. *Smynthurus fuscus*. Tullberg, Sver. Podur. p. 29. Pl. I, 1-27; II, 1-15.

1873. *Smynthurus fuscus*. Lubbock, Mongr. Coll. and Thys. Pl. II, pp. 101-107.
 1890. *Smynthurus fuscus*. Uzel, Thys. Bohem. p. 34.
 1893. *Sminthurus fuscus*. Schött, Insekten-Fauna v. Kamerun, p. 6.
 1893. *Sminthurus fuscus*. Schött, Palæarct. Collemb. p. 21.
 1895. *Sminthurus fuscus*. Reuter, Finl. Coll. och Thys. p. 9.
 1896. *Sminthurus fuscus*. Schäffer, Coll. v. Hamberg, p. 209, Pl. IV, 124.
 1897. *Sminthurus fuscus*. Poppe & Schäffer, Coll. v. Bremen, p. 271.

Schött describes the species as "Yellowish-brown or reddish-violet, shining. Antennæ little longer than the head. Superior claw vaginate. Dentes set with very long hairs. No clavate hairs on the tibia. Mucrones with both edges dentate. Length, 2 mm."

This description applies to the principal form, of which I have taken but two individuals in the state. These were taken at Lake Vermillion. They are very dark, appearing black when seen dorsally. The antennæ are pale violet. Legs deep blue, and furcula dark blue even on the mucrones. Besides this principal form, we have another form which differs much in color, but seems the same in structure and is probably merely a variety of this species. Our variety is unique in having three longitudinal dark stripes on head and thorax. The middle one is narrow, and extends down the front of the head to a point midway between the bases of the antennæ. The two side stripes run forward over the top of the head, taking the eyespots in their course, and reaching down almost to the mouth in front, their ends approaching but not uniting. From the head they pass backward along the sides of the thorax. These stripes are of the same color as the back of the abdomen; being usually of a dark sepia brown in the older specimens, and lighter in younger ones. The young have the three stripes continued back to the posterior part of the abdomen. Between the stripes, and the lower part of the body are citron yellow in older specimens, and rather brighter in young. The rings on Ant. IV are about 16 in number, and are more distinct in the very young than in adults. Compare figures 8 and 9. The antennæ are deep violet and bear a few very long sense hairs on the second and third segments. The superior claw is enclosed in a tunic which seems to be pierced by the tip of the claw, and by the one strong inner denticle. A distinct, much-curved hair, from the

under side of the tip of the tibia, bends up into, or beside the superior claw. There are no tenent hairs on the tibia. The inner claw is slender, and bears, near its tip, a hair which slightly over-reaches the superior claw.

The ocelli are about equal in size, and are situated on a black patch. The legs and furcula are brown. Several long hairs are borne by the dentes, their ends very slightly clavate, fig. 1. The mucrones is grooved, truncate at the end, serrate on the inner edge, and smooth with the exception of two or three teeth on the outer edge. I believe this is the only species in which the anal appendages have been noted heretofore. Both Tullberg and Lubbock have figured them, and the latter remarks: "At the base of the spring are two scimitar-shaped organs which appear to be hairs specially modified and of unusual size. The apical half of the inner margin and a small part of the outer edge are roughened by irregular teeth; which, however, are so unsymmetrical as to suggest the idea of the borders being fretted by use. The two scimitars often differed considerably in the extent to which they were thus affected. They arise from slight papillæ and bend outward and upward in a wide curve. The tenaculum is directed backward as usual and appears rather pointed from a side view, fig. 3a, truncate when seen from the lower surface, fig. 3b, bearing on each side three lobe-like processes which project backward. On the tip are a few hairs. The genital papilla is prominent, and is situated beneath the base of the small abdominal segment, fig. 2. Its opening is horizontally slit-like. Length, 2 mm. Not very common. Found under boards in a low, damp meadow.

Sminthurus penicillifer Schöff.

Pl. IV, Figs. 9-12.

1896. *Sminthurus penicillifer*. Schöffler, Coll. v. Hamburg. p. 211.

Pl. I, 7; and IV, 117-119.

1897. *Sminthurus penicillifer*. Poppe & Schöffler, Coll. v. Bremen, p. 272.

Schöffler gives the following description of this species: "Color yellowish. Abdomen marked above with two broad, dark-blue, longitudinal spots. Sides of the abdomen each with a dark-blue, longitudinal band. This dark-blue color also broad-

ens out over the entire surface of the small abdominal segment. At the insertion of the legs, the thorax is a faded, grayish-blue, a continuation of the side bands of the abdomen. Legs, manubrium, dentes, and medial part of the mucrones gray-blue. A dark-blue spot between the antennæ. Ocelli on a black patch. Antennæ bright violet, at least Ant. II, III and IV. Antennæ much longer than the head. Ant. IV ringed, composed of about seven rings. Upper claw slender, without a tooth, apparently without a tunic. Under claw ending in a brush-like, much-slit continuation (Untere Klaue in eine pinselförmig, zerschlitzen Fortsatz auslaufend), which reaches considerably beyond the end of the upper claw. Tenent hair wanting on the tibia. Dentes about three times as long as the mucrones. Mucrones broad, lancet-like with hyaline edges; the dorsal edge broad, with about 11 or 12 distinct ribs, the ventral narrow with indistinct ribs. Length, .75 mm.

"In the nature of the mucrones it approaches *S. aquaticus* and *S. malmgrenii*. In breadth of mucrones it comes between these two species. *S. penicillifer* is, however, distinguishable from them in the ringed form of Ant. IV, the shape of the under claw and the color markings." In our collection this species is represented by but one specimen, which would indicate that it is probably rare. Schäffer had but three specimens, which were taken in a small pool near Bremen. Mine was taken in the edge of a slough on Gray Cloud Island, in the Mississippi River, July, 1899. The antennæ are distinctly reddish violet. Ant. IV rather noticeably ringed, fig. 11. The feet of the third pair, fig. 9, are smaller and shorter than those of the first and second pairs. Though the "pinselförmig" prolongation is not so much branched as in that figured by Schäffer, there is little doubt of the species, and possibly if the other claws in the specimen were more favorable for observation they might prove the correctness of his figure. Schäffer has made no mention of several very long, brownish bristles which proceed from the manubrium, and reach beyond the middle of the dentes when the furcula is held erect. My specimen is darker than that described; the dark bluish color entirely covering the back and the terminal segment, but shading down on the sides to a citron yellow ground color. The sides of the abdomen are lighter than

the back, hardly well enough defined to be called banded. The specimen measures 1 mm., which is somewhat larger than those described. Possibly further collecting will prove this a distinct American variety.

Sminthurus spinatus MacG.

Pl. IV, Figs. 1-8.

1893. *Sminthurus spinatus*. MacGillivray, Canad. Ent. XXV, p. 127.

1894. *Sminthurus spinatus*. MacGillivray, Canad. Ent. XXVI, p. 109.

This singular species is thus described by MacGillivray: "Olive, tinted with purple, lighter on the sides, olive around the mouth and eyes; coarsely and sparsely punctate, punctures light olive, each bearing a white hair. Antennæ purplish, basal joint lighter, as long as the body; apical segment with from 17 to 20 subsegments. Abdomen fuscous with lighter spots; the apical part with an olivaceous cloud, the remainder fuscous with whitish or olveaceous blotches; on the middle of the back a number of groups of circular white spots, and on the posterior part of each side a row of white spots, varying from four to ten. Underneath olive. Anal papillæ large, distinct, with numerous bristles; the upper part and the sides purplish or fuscous, the remainder olive with darker spots. Legs long and slender, purplish or fuscous, mottled with variously formed olive or whitish blotches; apex of the tibiæ and base of the larger claw blackish purple. Claws long and slender, inner claw indistinct; apex of the tibiæ with a few clubbed hairs. Spring long, broad and flat, reaching the mouth; second joint broad, each side with a row of long, stiff bristles; bristles twice as long as the spring is broad; third join long, broad, bluntly rounded. Length, 2 mm. Habitat, Ithaca, N. Y.

"A very variable species, in young specimens the back is pea-green, and in some specimens there is a broad olive band down the middle of the back. The color varies from pea-green to purplish and fuscous. Collected on the surface of standing water. The species can be easily recognized by the row of stiff hairs on each side of the spring." To the above description a little might, perhaps, be added.

The species is evidently an American relative of Tullberg's *S. novemlineatus*, which it very much resembles. In coloration

there is quite a difference, but that counts for little in a species in which the color is so variable. Tullberg's species is known to have three distinct varieties. *S. spinatus* is about a third larger than its European relative, however, and differs somewhat both in the claws and in the furcula. I find no mention of the inner tooth on the superior claw in the original description, yet it is plainly apparent, though small, in my specimens. A reference to the figures will show that quite a difference exists between the claws of the first pair and those of the third pair. It seems to me that the male and female are more differentiated in this species than in others of the genus. The male is the more slender-bodied of the two. The mucrones in *S. spinatus* is not so elliptical as in *S. novem-lineatus*, being more abruptly terminated at its distal end.

Like *S. penicillifer*, and like *Podura aquatica*, though in far greater degree than either, this species possesses a highly specialized furcula, well adapting it to its mode of life on the surfaces of ponds. Although quick and powerful jumpers on water, yet when undisturbed they appear to prefer to rest on leaves just above the water. They are rather common along the bottom lands of the Minnesota and Mississippi rivers, also among wet grass and debris upon the shores of Lake Vermillion.

Papirius maculosus Schött.

Pl. I, Figs. 1-7.

1891. *Papirius maculosus*. Schött, Kaliforn. Collemb. p. 14. Pl. III, 1-3.

"White or brownish yellow, with blue spots scattered about on the back and head. Antennæ blue, shorter than body. Superior claw naked, armed with two teeth, inferior claw with one perpendicular tooth. Length, 1.5 to 2 mm."

Besides this description, Schött says of the species that "it approaches *P. ater* (L). The manubrium is short, the dentes about three times as long as the mucrones. The dentes bears two distinct kinds of hairs; some of them simple, some pinnate or notched (*ausgesperren*), which are systematically situated with respect to one another, so that in general two simple hairs have between them two pairs of the spurred hairs. The most distal of the simple hairs reaches almost to the very end of the

mucrones. The animal has a white ground color, sometimes varying to a yellowish or grayish tone. Almost the entire upper part of the body shows dark spots of various forms and dark-blue color, which often varies to a sky-blue. Antennæ dark blue. Legs with distal half of tibia white. Furcula pale violet, and the ventral side of the animal clear white."

Schött described the species from three specimens taken in California. He distinguishes it from *P. marmoratus* Packard by its having but two inner denticles to the superior claw. On examination of a large series, however, I am led to conclude that there may possibly be a mistake here, for while some show the inner edge of the claw smooth, others show quite a decided notch near the base, amounting, indeed, almost to a tooth. Having but three specimens, Schött may have had no opportunity to see this notch. There is, moreover, the possibility that Minnesota specimens would show a gradation between those found in Massachusetts or Maine, and those from the Pacific coast. Packard mentions no tooth on the inferior claw, however, so the species are probably distinct.

I have often taken this species with *S. minnesotensis*, and the two resemble each other very greatly in coloration. Evidently the species is well distributed throughout the state, as it has been taken along the Mississippi from St. Paul to the Iowa border, as well as in the Vermillion Lake region in the extreme northern part of the state.

***Papirius unicolor* Harvey.**

1893. *Papirius unicolor*. Harvey, "A new *Papirius*." Ent. News, IV, p. 65. Pl. IV.

"Light brownish purple throughout; color much like that of a Delaware grape with the bloom removed. Back, ends of the legs and apical half of the antennæ darker. Dorsum often with two interrupted stripes of darker shading. Head, base of antennæ, base of legs, spring and ventral surface lighter; one specimen had the two terminal segments of the antennæ conspicuously clear. Young, half-grown specimens, and full-grown specimens in damp situations paler. Occasionally a very large specimen and those taken in dry places are more brown, but all

show the purple tint; sides of the full-grown specimens often obscurely marked with much paler, oblong spots.

"Body, including head, twice as long as broad, breadth and depth equal; gradually widening from the neck to the greatest breadth, abruptly narrowing with a slight reëntering angle to the conspicuous terminal segments. Head, viewed from front, as long as broad, depth half the length. Eye patches prominent, elevated, black, conspicuous, bearing eight ocelli; four on the inner row, three on the outer, and a single smaller one in the middle; the second ocellus from the front on the inner row is also smaller than the others; front of the head between the eyes, elevated and bearing a tuft of long hairs. Antennæ long, slender, elbowed at the second joint, nearly as long as the body; basal joint short but slightly longer than the terminal; second joint shorter than third, the portion beyond the elbow usually somewhat longer than the two basal joints; third joint usually longest, the terminal half composed of seven or eight short sub-segments; terminal joint short, conical, narrower than the clubbed end of the third joint; composed of about ten subsegments, the three basal of which are about the same width, and obscure; fourth and fifth wider and well-defined; sixth and seventh narrower and somewhat obscure; each segment bears a whorl of hairs; and as there are three whorls on the portion beyond the seventh segment, probably it represents three more; when walking, the basal portion is projected upward and outward from the head, the apical portion below the elbow, outward and downward. Legs long, claws prominent, the larger curved, and bearing two teeth on its inner face below the middle; smaller claw slender, over half the length of the other. Suckers nearly as long as the body, cylindrical, white, covered with papillæ; tenaculum cylindrical, prominent. Spring rather long and slender, about three-fourths the length of the body; terminal segment less than half the length of the second, lanceolate, unarmed, concave below, and bearing on each edge of the concavity a row of about forty teeth; the teeth increase in size outward, and at the end join in a common tubercle.

"Hairs are sparsely found on all parts of the body. Under a high power those on the second joint of the spring, which I especially examined, were barbellate. Length, 2.5 mm.

"Under rubbish and the loose bark of stumps, also on agarics and boleti. Found under boards as late as November, probably hibernating there. Common in Maine."

This is our most common species in Minnesota, often occurring with *P. maculosus*, which it much resembles in anatomical details. Harvey mentions no inner denticle on the inferior claw. He may have overlooked it, as it certainly shows on all my specimens.

***Orchesella albosa* n. sp.**

Plate I, Figs. 14, 15.

Yellow or white in color, antennæ more or less purplish, shading evenly out to tip of Ant. VI, which is darkest of all. Sometimes the antennæ are almost entirely yellow, excepting the dark distal end of Ant. III. The body is comparatively shorter than in *O. zebra*, and the antennæ longer, the ocelli also differ in being relatively smaller and farther apart. Perhaps, as the lighter coloring indicates, this is more of a dark-loving species, and the tendency is toward a reduction in the size of the ocelli on that account. In respect to the character of the claws, furcula, etc., it resembles *O. zebra*, but I believe it is the only species of *Orchesella* recorded, in which neither body nor legs show color markings. Length, 2.5 mm. Found under boards near Minneapolis. Not common.

***Orchesella zebra* n. sp.**

Pl. I, Figs. 8-13; XVI, Fig. 1.

Form elongate. Color, dark purple and yellow. Along the median dorsal line is a dark stripe, sometimes narrowing to a mere line or entirely broken, again broadening out into almost a cross-band on Abd. III and Th. III. Two lines of longitudinal spots situated dorso-laterally on all segments except the pro- and meso-thorax, constitute another series of markings, while the body markings are completed by another such line of spots, only larger and more widely separated, situated laterally. The head has a black band connecting the eyes, but no other color markings. Eyes black. The ocelli are larger in proportion to the eye spot, and therefore closer together than in the case of

O. albosa. Antennæ slender and hairy, about three times as long as the head. Ant. III is yellow with the faintest possible tinge of blue in a spot at the distal end in some of the darker specimens. IV and V have each about the distal halves dark blue, VI shades out distally from yellow to a dead, blackish purple. While I am aware that color characters are often of doubtful value, yet the species at hand varies so little in the scores of specimens examined, that I believe an antenna alone would serve to identify it.

The body is thickly covered with short hairs, some longer ones appearing on Abd. V and on the furcula, also bunches of long, clubbed hairs on dorsal parts of head and thorax. The claws are of the ordinary *Orchesella* type—long and slender, the inner claw narrow lanceolate, with a small outer tooth, the outer claw with an outer and two inner teeth. The tibia bears one clavate hair.

The whole furcula is very hairy, two or three feather-like hairs project from dentes beyond mucrones, the longest projecting over by nearly the length of the mucrones. Manubrium slightly arcuate, dentes slender, slightly longer than manubrium, arcuate, serrulate beneath.

Mucrones small, tridenticulate; the apical tooth curved, acute, the next stouter; proximal tooth very slender and pointing towards the tip of the next tooth, it stands on the outer lateral side of mucrones.

The antennæ seem quite subject to mutilation, and one finds many different forms in consequence. Figures 12a and 12b show two such antennæ. Lubbock's experiments upon the antennæ of *O. cincta*, as recorded in his notes on the *Thysanura*, Part IV, p. 285, show that when an antenna is mutilated by the loss of one or more segments the terminal remaining segment elongates often far beyond its norm, coming to resemble the normal Ant. VI in form; but that no new segments are formed. Thus in figs. a and b, which were found on the same specimen, and were of equal length, a had lost only Ant. VI, or possibly in addition a part of Ant. V, while the long distal segment on b is Ant. III, which is normally very short. Perhaps we might better say that the distal segment is not merely the third, but essentially all the segments from the second one out.

Although it has lost the power of sub-segmenting into the normal number, yet the normal amount of growth-power remains unimpaired by the mutilation.

While the species is rather common, I have taken it but once in great numbers. One morning after a night shower they appeared by hundreds in all stages of growth on the moist surfaces of stumps in the woods, where they seemed to be enjoying the moisture from the wood, and perhaps feeding on the softened particles of decaying wood. They moved about fitfully at times, but often stopped and squatted down to bring the ventral tube into contact with the moisture.

Isotoma minima n. sp.

Pl. IX, Figs 17-19; X, Fig. 1.

Light grayish-blue in color, body subcylindrical, elongate, almost naked except on the fifth and sixth abdominal segments, which bear some long scattered hairs. Fourth, fifth and sixth abdominal segments apparently so fused as to form almost a continuous segment. Antennæ gray, little longer than the head; Ant. IV longest, very much swollen, III much rounded, shorter than II and slightly longer than I. Ocelli 16. Post-antennal organ long, narrowly elliptical, slightly emarginate along anterior edge.

Furcula short, not reaching to ventral tube; insertion at junction of fourth and fifth abdominal segments. Manubrium stout and thick. Dentes straight, not tapering greatly toward distal end, irregularly serrulate along greater part of lower edge, upper edge with a few stout, scattered hairs. Mucrones and dentes together about as long as the manubrium. Mucrones long and narrow, tridenticulate, the distal tooth almost straight, the ante-distal tooth close to, and at right angles to it; proximal tooth smaller and set about the middle of the mucrones, pointing slightly distal-wards. Each tibia bears one long simple hair in the position of a tenent hair. The claws are unarmed.

The species may be that referred to by Schött in his *Systematik und Verbreitung der palaearktischen Collembola* as *I. minuta* Tullb. His figure of the mucrones certainly comes nearer to mine than to that given by Tullberg in his "Sveriges Podurider" as *I. minuta*; moreover, Tullberg also expressly states, as his figure also shows, that the two ante-apical teeth

are set next one another and near the end. Length, three-fourths millimetre.

This species probably occurs more abundantly than its numbers in my collection would show, its minute size and light gray color lending a mimicry which shields it from all but the most careful observation. It seldom jumps, seeming averse to that mode of motion, but moves about uneasily when its hiding places are exposed to the sunlight. I have taken it in the greenhouse of the University, under moist boxes and flower pots, where it usually lived among the faeces of a certain small millipede, though possibly this coöccurrence was purely accidental. Out of doors it is sometimes met with under stones and damp boards, usually where there is a slight layer of thin, slimy mud. Not uncommonly it is taken with *I. bidenticula*, the light-colored young of which it greatly resembles until one observes it with a compound lens.

Isotoma fimetaria (L.), Tullb.

Pl. X, Figs. 5, 6.

1746. *Podura terrestris alba*. Linné, Fn. Sv. Ed. I. p. 343.
 1758. *Podura fimetaria*. Linné, Syst. Nat. Ed. X. Prt. I, p. 609.
 1871. *Isotoma alba*. Tullberg, Fört. öfver Sv. Podur. p. 152.
 1872. *Isotoma fimetaria*. Tullberg, Sver. Podur. Pl. IX, 32-33.
 1876. *Isotoma fimetaria*. Tullberg, Coll. Borealia, p. 37.
 1890. *Isotoma fimetaria*. Uzel, Thys. Bohemiæ. p. 66.
 1893. *Isotoma fimetaria*. Schött, Palæarct. Coll. p. 75.
 1895. *Isotoma fimetaria*. Reuter, Finl. Coll. p. 28.
 1896. *Isotoma fimetaria*. Schäffer, Coll. von Hamburg, p. 183.
 1896. *Isotoma fimetaria*. Lie-Pettersen, Norges Coll. p. 18.
 1897. *Isotoma fimetaria*. Poppe & Schäffer, Coll. v. Bremen. p. 268.
 1900. *Isotoma n. sp.* Harvey, Ent. News. XI, p. 552.

Tullberg thus describes it: "Third abdominal segment shorter than the fourth into which the furcula is inserted. Ocelli none. Dentes nearly twice as long as the manubrium, straight; mucrones bidenticulate. Length, 1 mm."

Some specimens found in the state measure 1.25mm., but otherwise the correspondence is exact, except that the slender dentes is often arcuate. Claws unarmed, no clavate hairs on the tibiæ. Post-antennal organ narrowly elliptical as in *I. quadrioculata*. It is a more slender species than *I. quadrioculata*, and

has the antennæ comparatively longer and slenderer, though the proportions between the segments are about as in *I. minima*, III being little shorter than II, which is nearly twice as long as I; I and III together about equal IV. The claws are straighter and rather more slender than in *I. quadrioculata*.

This species is well distributed, though seldom very numerous; under bark, sticks and stones, under flower pots in the green-house, almost anywhere where there is darkness and moist mud, it may be sought. I have once taken it among the gills of mushrooms. Not infrequently it lives with other white collembolans such as *Aphorura ambulans* and *Cyphodeirus albinus*, and the unaided eye can hardly distinguish the difference between the three species.

Isotoma quadrioculata Tullb.

Pl. X, Figs. 7, 8.

1871. *Isotoma quadrioculata*. Tullberg, Fört. öfver Sv. Podur. p. 152.
 1872. *Isotoma quadrioculata*. Tullberg, Sver. Podur. p. 48. Pl. IX, 25-31.
 1876. *Isotoma quadrioculata*. Tullberg, Coll. Borealia, p. 36.
 1890. *Isotoma quadrioculata*. Uzel, Thys. Bohemiæ, p. 66.
 1893. *Isotoma quadrioculata*. Schött, Palæarct. Coll. p. 74.
 1895. *Isotoma quadrioculata*. Reuter, Finl. Coll. p. 28.
 1896. *Isotoma quadrioculata*. Schäffer, Coll. v. Hamburg. p. 183. Pl III, 71.
 1896. *Isotoma quadrioculata*. Lie-Pettersen, Norges Coll. p. 18.
 1897. *Isotoma quadrioculata*. Poppe & Schäffer, Coll. v. Bremen. p. 268.

Tullberg's description is: "Third abdominal segment shorter than the fourth, into which the furcula is inserted. Ocelli 4, 2 on each side of the head. Dentes not longer than the manubrium, straight; mucrones bidenticulate. Length, $\frac{3}{4}$ mm."

This has the shortest furcula of any species we have seen, the dentes and mucrones together do not equal the manubrium. There is one long hair at the base of the dentes as in *I. bidentata*. No clavate hairs are borne by the tibiæ. The claws are unarmed.

Tullberg gives the color as gray-blue. One of our specimens, measuring 1 mm. in length, answers well to the description in all but size. It is gray-blue, with furcula and ends of legs lighter or colorless. The others are entirely white with the exception of the eye spots, and they measure but .75 mm. The

body is sparsely covered with short hairs interspersed with a few longer ones. As Schött and Lie-Pettersen both mention having found white specimens, it is not improbable that there is a white and a colored variety.

They are found under bark of logs and under flower pots in the greenhouse.

***Isotoma bidenticula* n. sp.**

Pl. X, Figs. 2-4.

Dull blackish gray, varying from light to dark, and bearing usually a brownish, though sometimes a bluish tint. Lighter beneath, also on furcula and at junction of body segments. Antennæ darker, and not longer than head; Ant. I shortest, III slightly longer than II, and less than twice the length of I. Ant. I and III together nearly as long as IV. Body sparsely haired, the hairs being longest and most numerous on the final abdominal segment. Claws without teeth or tenent hairs, outer one curved, inner one very slender. Furcula small, straight, reaching only to anterior edge of third abdominal segment. Manubrium rather longer than dentes and mucrones together. About the middle of the dorsal edge of dentes are a few rounded serrations. The same edge has, besides several short hairs, one long straight hair, borne not far from the manubrium. Mucrones bidentulate, the apical tooth somewhat curved, the other pointing a little towards the front so that they form almost a right angle. The fourth and fifth abdominal segments are so fused as often to appear but one. The furcula seems to be borne by the fourth. Length, 1.5 mm.

This species very closely resembles *I. minima* in general body form, and sometimes, when young, in color as well, though the tendency is more often towards a brown than a blue. The post-antennal organ is of the same shape in both, but is comparatively longer in *I. minima*. As to comparative length of furcula, antennæ, abdominal segments, etc., they differ but little, but a glance at the mucrones will at once separate the two species. Again *I. bidenticula* is much the larger of the two, measuring twice the length of the other species named. Found under stones and bark, and under flower pots in the University greenhouse. Rather common.

***Isotoma leonina* Pack.**

Pl. IX, Figs. 1-4.

1873. *Isotoma leonina*. Packard, Synopsis of the Thys. of Essex Co., Mass. Fifth Report Peabody Acad. Sci.
1896. *Isotoma leonina*. MacGillivray, The Amer. sp. of *Isotoma*. Canad. Ent. XXVIII.

Light tawny yellow, the young nearly white. Ground color whitish, pretty uniformly spotted with rather coarse brown specks. A remarkably long, slender species with body somewhat sparsely covered with short hairs, except on Abd. V, where they are long. The head is rather longer than broad and square in front. Antennæ less than twice the length of the head; Ant. II much curved, slightly longer than I, which is equal to III, IV longest of all. Claws without teeth or tenent hairs. Furcula long and slender, though shorter than usual in the genus, extending beyond body by a distance about equal to greatest breadth of abdomen; when pointed forwards it reaches the ventral tube. Dentes about twice as long as the manubrium, becoming very slender at distal end. Mucrones much curved, tridenticulate; apical tooth distant from the second, and making a prominent curve; second and third vertical, the latter (proximal) slightly the shorter of the two. Eyes on a conspicuous black patch, ocelli 16. Post-antennal organ broadly elliptical. Length, 2.33 mm. Under bark of stranded pine logs along the Mississippi River, not very abundant.

***Isotoma sensibilis* Tullb.**

Pl. IX, Fig. 20.

1876. *Isotoma sensibilis*. Tullberg, Coll. Borealia. p. 36. Pl. IX, 23-26.
1894. *Isotoma sensibilis*. Schött, Palæarct. Collemb. p. 72. Pl. VI, 31-32.
1895. *Isotoma sensibilis*. Reuter, Finlands Collembola.

The original description may be rather freely translated as follows: "Hairy, Abd. III and IV about equal in length. Antennæ slightly longer than the head, Ant. III shorter than II. the Mucrones bears three teeth inserted one after the other. On the anterior pair of tibiæ two clavate hairs, on the posterior tibiæ, three. Length, 2 mm."

The post-antennal organ is broadly elliptical. The species is slender, blue-gray or greenish gray in color. Manubrium very

thick and stout, dentes unusually slender and whip-like, the furcula just about reaching the ventral tube. Tullberg's figure shows a minute inner tooth near the distal end of the large claw. Schött's figure shows no such tooth. I have seen this in some specimens.

Isotoma viridis Bourl.

Pl. IX, Figs. 5-7.

1778. *Podura viridis*. Gmelin, Linnæus Syst. Nat. Ed. XIII, p. 2910.
 1839. *Isotoma viridis*. Bourlet, Mem. cur. les. Podures. p. 401.
 1841. *Desoria cylindrica*. Nicolet, l'Hist. des Podurelles. p. 60.
 1841. *Desoria viatica*. Nicolet, l'Hist. des Podurelles. p. 61.
 1841. *Desoria pallida*. Nicolet, l'Hist. des Podurelles. p. 61.
 1841. *Desoria ebriosa*. Nicolet, l'Hist. des Podurelles. p. 61.
 1841. *Desoria annulata*. Nicolet l'Hist. des Podurelles. p. 61.
 1841. *Desoria fusca*. Nicolet, l'Hist. des Podurelles. p. 62.
 1843. *Podura viridis*. Bourlet, Mem. sur les Podurelles. p. 24.
 1844. *Isotoma viridis*. Gervais, Hist. Nat. des Ins. Apt. III. p. 433.
 1844. *Heterotoma chlorata*. Gervais, Hist. Nat. des Ins. Apt. III. p. 421.
 1862. *Isotoma lineata*. Lubbock, Notes on the Thys. Pt. II, p. 597.
 1871. *Isotoma palustris*. Tullberg, Fört. öfv. Sv. Podur. p. 151.
 1872. *Isotoma palustris*. Tullberg, Sver. Podur. p. 46.
 1873. *Isotoma anglicana*. Lubbock, Monogr. Coll. and Thys. p. 171.
 1873. *Isotoma tricolor*. Packard, Thys. of Essex Co., Mass. p. 34.
 1890. *Isotoma viridis*. Uzel, Thys. Bohemiae.
 1893. *Isotoma viridis*. Schött, Palæaret. Coll. Plates V & VI.
 1895. *Isotoma viridis*. Reuter, Finl. Coll.
 1896. *Isotoma viridis*. Lie-Pettersen, Norges Coll.
 1896. *Isotoma viridis*. Schäffer, Coll. der Umgebung von Hamburg.

Several color varieties of this species have been described, but the specimens taken so far all appear to answer best the description of the principal form, as given by Schött. The color is rather a brownish yellow, darkening to an obscure purple along the back. There are no longitudinal markings. Legs yellow, becoming purple in the darker specimens. Antennæ dark purple, often slightly paler at their base. Furcula pale. A dark spot on the head. Ant. IV usually a little longer than III and more plump than in *I. palustris*. Post-antennal organ broader than in *I. palustris*, broadly oval. Abd. III slightly longer than IV. Claws without tenent hairs. Superior claw with one outer and two inner denticles, as in *I. catena*, fig. 15, but without the minute apical tooth. Length, 2-4 mm.

Although one of the most widely distributed among the *Isotomas*, I have taken the species but a few times. When once found, however, the social habit of this insect insures to the collector a considerable number of specimens. They are active, avoiding the light less than most *Isotomas*. Under stones and boards in low, damp places near the edge of the river, or in springy places (I have only taken them in May) along the Minnesota and Mississippi rivers.

***Isotoma catena* n. sp.**

Pl. IX, Figs, 15-16b.

This species seems to be a link in the chain which connects together the two species *I. palustris* and *I. viridis*. In most of its characters it approaches more nearly to the latter than to the former species. It is a dirty, obscure purple above, shading down laterally to a lighter tint, and showing brownish purple beneath. The antennæ are dark purple throughout, the legs rather a weak purple. The dentes, and sometimes the legs as well, show a tendency to a yellow-green tint. The head is dark throughout. Like *I. palustris*, the mucrones is provided with four teeth; the apical one being quite small, the ante-apical very large and long. (in this character resembling *I. palustris*, var. *fucicola* Reuter, of which Schött says: "Der zweite grosse mucronale Zahn ist langgezogen und ueberragt die anderen bedeutend an Grösse."); the other two are set nearly opposite each other as usual. In antennæ, again, it resembles *I. palustris*; Ant. IV being noticeably more slender than III, and seldom so long. Here the resemblance to *I. palustris* ceases, and that to *I. viridis* begins. The claws are armed with one outer and two inner teeth on the superior claw, and one inner tooth on the inferior claw. The body is covered with short, closely set hairs, among which, especially on the posterior end of the abdomen, are interspersed longer hairs as in *I. viridis*. There are no tenent hairs. Length, 3.8 mm. Taken at Minneapolis by Mr. Oestlund. Also by myself near Le Sueur, Minn., on the high wooded bank of the Minnesota River, under the loose bark of a log in May, 1899. A few specimens were found at Lake Vermillion in 1901. Apparently the species is not abundant.

Isotoma caeruleatra n. sp.

Pl. IX, Figs. 11-14.

Dark clear blue, nearly black. Legs yellow, excepting coxæ and basal part of trochanters, which are dark blue. Antennæ entirely blue, slightly lighter at proximal end of Ant. I. Manubrium blue, the same color extending onto the dentes very slightly. Dentes yellow, growing paler toward distal end. Head broad, blue, marked dorsally with yellow. Body narrow, short-haired except for a few longer hairs on the two last abdominal segments. Abd. II, III and IV about equal in length. Ant. II equal to III, Ant. IV about twice as long as III, I very small. Superior claw with two small teeth set on opposite edges and so placed that one covers the other when the claw is seen in profile. They show well when one views the claw from below. Inferior claw with one small inner tooth situated on the most prominent part of the inner hump. The inferior claw seems to bend away from the superior one, particularly in the third pair (the figure is from the second pair), making the hump appear the more prominent. No tenent hairs present.

Manubrium about half as long as dentes and mucrones together. Dentes short and comparatively thick, arcuate, set dorsally with a row of stiff hairs, rather slender at distal end, crenulate or dentate on lower margin, the proximal one-third irregularly so. Mucrones four-toothed; the ante-apical tooth long and slender, the two proximal teeth set nearly opposite each other. Length, 2 mm. Taken but once, in Apr. 1894, by Mr. O. W. Oestlund near Minneapolis.

The species approaches very closely to *I. grandiceps* Reuter, but lacks the outer denticle on the superior claw, and possesses, besides, the normal number of ocelli. *I. grandiceps* has but seven to each eyespot. From *I. hiemalis*, to which it is even more closely related, it differs in its much darker color, and in the presence of teeth on the claws.

Isotoma palustris Müller. Forma principalis.

Pl. IX, Figs. 8-10.

1740. *Podura aquatica cinerea*. DeGeer, Act. Soc. Roy. Ups.
1776. *Podura palustris*. Müller, Zool. Dan. Prodr. p. 184.

1788. *Podura palustris*. Gmelin, Linnæus Syst. Nat. Ed. XIII. Prt. VI. p. 2911.
1842. *Podura palustris*. Bourlet, Mem. Soc. Roy. Douai.
1842. *Aetheocerus aquaticus*. Bourlet, Mem. Soc. Roy. Douai.
1843. *Podura palustris*. Bourlet, Mem. sur les Podurelles. p. 29.
1857. *Podura psi*. Herklots, Notices Entomologiques.
1872. *Isotoma palustris*. Tullberg, Sver. Podur. p. 45. Pl. IX, 1-8.
1873. *Isotoma palustris*. Lubbock, Monogr. Coll. and Thys. p. 169.
1890. *Isotoma palustris*. Uzel, Thys. Bohemiæ. p. 62.
1893. *Isotoma palustris*. Schött, Palæarct. Coll. p. 63. Pl. V, 8, and VI, 3-5.
1895. *Isotoma palustris*. Reuter, Finl. Coll. p. 26.
1896. *Isotoma palustris*. Lie-Petersen, Norges Coll. p. 16.
1896. *Isotoma palustris*. Schäffer, Coll. der Umgebung von Hamburg. p. 186.

Schött gives about the best diagnosis of this variety: "Yellow with a median black dorsal line. On the sides of the apical segments of the abdomen, scattered fuscous spots which sometimes form dark longitudinal bands. Length, 2.5 to 3 mm."

Ground color a dirty yellow with a dark blue median band. The sides are usually a dirty purple, sometimes forming well-defined lateral bands, sometimes shading off lighter to the dorsal yellow. Two characteristic, dark purple spots appear on the sides of the last abdominal segment. Often the furcula, under side of body and of head, mouth-parts, lower sides of femurs and of tibiae, and basal part of ventral tube are of a bright green. Distal part of ventral tube yellow. Dorsal side of femur purple, cheeks washed with purple, antennæ purple, also purple around their base. Post-antennal organ oval. A dorsal purple spot on the head. Older specimens are darker than young and usually show more green. Ant. IV is more slender than III, and seldom quite as long. The whole antenna is covered with short, stout hairs. Indeed, the entire body is set thickly with short, dark brown hairs of uniform length, in this differing from *I. viridis* which has some longer hairs as well. The mucronis is four-toothed. The claws are much the same as in *I. caerulea*, but lack the inner tooth on the superior claw. Sometimes the claws of the second and third pairs show a small outer tooth on the superior claw as in *I. viridis*, but less noticeable than in that species. No tenent hairs present. Some authors give the length as 4.5 mm., but I have never taken any that measured

more than 2.75 mm. Found on the surface of stagnant water, and on leaves and rubbish along the edge of lakes and streams during the whole summer; and in winter as well, when one can find a place where the snow is sufficiently melted to allow access to their haunts.

***Isotoma muskegis* n. sp.**

Pl. XIII.

Dense blue-black, somewhat lighter on distal portions of legs and furcula, also with a few lighter dorsal markings on the body. Tubercles and abdominal horns (in the male) light yellowish brown, giving to the body a yellow, floured appearance to the naked eye. Head and body sparsely haired. Head squarish, mouth-parts slightly protruding and light yellow. Antennæ blue-black, considerably longer than head, sparsely haired; Ant. I shortest and thickest. II the longest, IV longer than III, I and II together about as long as the rest of the antenna. No post-antennal organ. Ocelli 16, about equal in size, 8 in each eyespot. Eye spots black. Body somewhat flattened, prothorax showing from dorsal side, meta-thorax broader than meso-thorax, and of about the same length. Abdominal segments subequal. Legs strong, third pair longer than the others, especially in the tibiæ. Tibiæ bearing two clavate hairs. Superior claw with a well-marked inner tooth. Inferior claw slender, unarmed. Tenaculum well-developed, its two blades each four-footed. Furcula on Abd. IV. Manubrium much flattened, breadth about twice as great as thickness, slightly shorter than dentes. Dentes pale, rather slender, tapering but little, bearing a few scattered hairs, ventral surface granular or papillated as in *Podura*, to which there is also a slight resemblance in the bowed form of the two rami. Mucrones about one-sixth the length of the dentes, and bearing two strong teeth. Length, 2.5 mm.

I found this species twice during the summer of 1901 in marshes along the shore of Lake Vermillion, on Pine Island in St. Louis Co. On both occasions they were on the upper ends of partially submerged roots, or other decaying pieces of wood. They seem to live socially, hundreds being seen together. They resemble the heavier species of *Achorutes* in habits, being rather slow in their movements. When exposed to the light, they be-

come restless, and move about uneasily seeking for dark corners. Unless considerably disturbed they prefer not to jump, and are not particularly strong leapers when they do.

The most noticeable and interesting thing about the species is the dimorphism, probably due to sex. I have not been able to satisfy myself on this point as yet, but Mr. MacGillivray suggests that it is the males that bear the horns and tubercles. They possess a pair of strong, curved horns on very conspicuous tubercles situated at the outer angles of the fourth abdominal segment. These horns project caudo-laterad and somewhat dorsad. Besides the horns, the males possess variously shaped tubercles upon almost every part of the body surface, most conspicuous and largest on the caudal edge of the segments. Each tubercle is thickly set with short hairs. There seems no doubt that the tubercles are merely modified hairs, for one finds on the same individual nearly all gradations from the thick, stout hair with a very few short hairs at its end to the much swollen tubercles with their haired areas greatly distended. Some of the small tubercles with which the final abdominal segments are thickly set, have the haired surface so much swollen as to form a cap over the rest of the tubercle, giving to the whole a mushroom-like appearance. It appears that the tubercles are haired on one side only, and the swelling of this side causes the opposite (unhaired) side to bend under, as seen in the series of tubercles, figures 8-11. The females possess neither horns nor tubercles, the skin appearing smooth and Abd. IV not widening out laterally. After examining nearly a hundred specimens I have found but one which seems to come between the two. This specimen is without the horns, and has the general build of a female, yet bears some few tubercles, mostly small, on the body. In the male there are tubercles on the antennæ and even on the tibiæ. This anomalous specimen may possibly be an immature male.

***Entomobrya bicolor* n. sp.**

Pl. XVI, Fig. 2.

Dark brown or blue-brown and yellow, appearing yellow and black to the unaided eye in life. More hairy than any other species I have seen. Head and body very dark, with the follow-



ing yellow exceptions: Abd. I, II and VI, dorsal part of III, some elongate dorsal spots on the front part of IV, and the ventral part and two dorso-lateral spots on V. Markings vary somewhat in degree according to age, but not in position. The dark parts are less dark on younger than on older specimens. Legs with trochanter, femur and tibia light yellow, basal segment brown or yellowish. Antennæ at least four-fifths the length of the body; Ant. I light yellow, excepting the dark ring at its base, II and III brownish yellow with narrow, dark rings at their proximal ends, and purplish tinting at distal ends, IV a dirty purplish gray, considerably longer than II, which exceeds III almost as much as the latter exceeds I. The superior claw bears three inner teeth, the inferior claw is unarmed and lanceolate. Mucrones tridenticulate, being provided, as usual in the genus, with a slender basal, and a stout middle and distal tooth. Length, 3 mm.

The species agrees with *E. orcheselloides* Schött, and also with *E. dorsalis* Uzel in many ways, such as the great comparative length of Abd. IV, which is about seven times as long as III; in the greater length of the antennæ, etc.; and even agrees to some extent with the latter in coloration. It must be noted, however, that while the legs of *E. bicolor* are yellow, the femurs and tibiæ of *E. dorsalis* are dark-ringed, although in general Uzel's species is the lighter of the two. Again, the antennæ of *E. dorsalis* are entirely yellow, while those of *E. bicolor* show dark markings. The mucrones, too, seems to differ, for Uzel says of it "*Mucronibus duobus dentibus æqualibus instructis. Nulla spina sub dente inferiore.*"

The species is not very common, yet seems to be pretty well distributed. Taken principally in spring and autumn, under boards lying loosely upon the grass. It usually remains perfectly quiet until disturbed, relying upon its protective coloration, probably, to shield it from observation. I have found them in considerable numbers, both old and young, in April, on a damp paper which was partly submerged in a snow pool, in a vacant lot here in Minneapolis.

Entomobrya clitellaria n. sp.

Pl. XV.

Color brownish yellow with the exception of Th. III, Abd. I, II and the dorsal part of III, the cephalic margin of Th. II, and the dorsal aspect of Th. I, the eye spots, and a connecting patch which also forms a ring at the bases of the antennæ; all of which parts are very dark blue in color, appearing black in life to the unaided eye. The antennæ are tinged with dusky bluish-black at the distal ends of Ant. III and IV, and at the proximal ends of III. The dorsal part of the head between the eye spots, just caudad of the heavy dark connecting spot between the two rings at the bases of the antennæ is light purplish. The color description is given rather fully because I believe this is a species varying but little in coloration. Very young individuals have the dark parts rather lighter than those which are mature, yet are so plainly marked that one readily recognizes even them with the unaided eye. The dark region, taking in the metathorax and the first three abdominal segments (on the dorsal side) looks very like a saddle, hence the specific name. The antennæ have the three ultra-basal segments subequal in length, the basal one shorter and stouter. Legs rather long, each tibia bearing one clavate hair. The superior claw is armed with two well-defined teeth on its inner edge, and one small one on the outer edge. The inferior claw is rather slender, attaining its greatest width near its distal end. The furcula is as usual in the genus, it reaches forward to the ventral tube. The dentes is as usual, serrate beneath, and the mucrones has the typical three-toothed structure. The long hairs on the distal end of dentes reach a very little beyond the tip of the mucrones. Abd. IV five times as long as III. This species was taken in the pine woods in the northern part of the state. Some individuals were taken on the camp tables, where they were running about apparently in search of food; but the favorite haunts were under and among the loose scales of bark of the standing Norway pines (*Pinus resinosa*) where they were fairly abundant.

Entomobrya purpurascens Pack.

1873. *Degeeria purpurascens*. Packard, Thys. from Essex Co., Mass. p. 39.
1883. *Entomobrya purpurascens*. Brook, Revis. of Genus *Entomobrya*. p. 282.

Packard's description is, as usual more generic than specific, yet I think there is little doubt as to the species. He says: "Eyes black with no connecting line. This is rather a large species with unusually long, slender antennæ, with the body, legs, and antennæ of a purplish lead color, the purplish tint especially noticeable on the two basal joints of the antennæ. Not very hairy; the hairs on the prothorax and head of quite uniform length, club-shaped, those on the posterior part of the body very slender, no bowed ones among them(though my specimens are somewhat rubbed). Legs slender, claws long and slender, larger claw with two acute prominent teeth along the inner edge. Elater with long dense hairs along upper side of second joint; serrulate, the teeth suddenly ending, leaving the end narrow, slender, naked, slightly bent, with a long hair projecting beyond the tip of third joint. This joint rather short, much curved on the outer side, ending in a rather slender hook, with an inner one of nearly the same size. 'Catch' large; basal joint longer than broad, with a stout bristle arising from middle of anterior edge and reaching nearly to tip of second joint, both front and hind edges with three or four notches, second joint very slender on the toothed portion, four-toothed; whole joint over half as long as first joint. Length, .08 to .09 inch."

The species has been taken by Packard in the New England states, and in Tennessee by Dr. J. Curtis. The difference in darkness of color between the two first antennal segments and the rest of the body is not very marked in our specimens; nor are the antennæ unusually long if we compare them with those of such forms as *E. bicolor* or *E. dorsalis* Uz.

Packard has regarded the narrow proximal part of the mucrones as a part of the dentes, but in this he is evidently in error. The principal characters, then, which distinguish the species, are the uniform purple color and the absence of segmental cross-bands. The slender basal tooth is present, as

usual in this genus, on the mucrones, but was probably overlooked by the describer. The tenent hair is not greatly swollen. Length, 2.36 mm. Somewhat rare in the southern part of the state, more common in the northern part. Taken under bark and boards in rather damp places.

Entomobrya spectabilis Reut.

Pl. VIII, Figs. 12-16.

1890. *Entomobrya spectabilis*. Reuter, Coll. in Caldar. viv. p. 26. Pl. I, 7.
 1893. *Entomobrya spectabilis*. Schött, Palæarct. Coll. p. 49. Pl. III, 12-14.
 1895. *Entomabrya spectabilis*. Reuter, Finl. Coll. p. 21.
 1896. *Entomobrya spectabilis*. Schäffer, Coll. v. Hamburg. p. 194.

The species is described by Reuter as: "Yellow, hairy, sides of the head and hind part of mesonotum slightly ferruginous, eyespots, margins of meso- and metanotum, also the I, II, IV and V abdominal segments, almost the entire metanotum, posterior part of Abd. II, a regular transverse rectangle on the front part of Abd. IV, with lateral extensions confluent at the sides and behind by curved lines, black; Ant. III and IV cyanescent. Length, 1.5 mm."

The species is very abundant in the greenhouse of the University, but I have never taken it elsewhere, hence there is some doubt as to its being a native of the state. A very constant species as to color. In size, our specimens exceed those of the original description by almost a third, measuring 1.9 mm.

Entomobrya multifasciata Tullberg.

1821. *Podura fasciata*. Say, Jour. Acad. Phil. II. p. 12.
 1838. *Podura variegata*. Guer. & Per. Gen. des Ins.
 1840. *Podura simplex*. Koch, Fauna Ratesbonensis. Herrich-Schäffer's, III. p. 354.
 1840. *Podura Striata*. Koch, ibid. p. 354.
 1841. *Degeeria nivalis*. Nicolet, Soc. Helv. p. 70.
 1841. *Degeeria lanuginosa*. Nicolet, Soc. Helv. p. 74.
 1841. *Degeeria disjuncta*. Nicolet, Soc. Helv. p. 71.
 1841. *Degeeria corticalis*. Nicolet, Soc. Helv. p. 72.
 1862. *Degeeria nivalis*. Lubbock, Notes on the Thys. Pt. II. p. 594.
 1867. *Degeeria Nicoletii*. Lubbock, Linn. Soc. Trans. p. 229.
 1871. *Degeeria muscorum*. Tullberg, Fört öfv. Sv. Podur. p. 148.
 1871. *Degeeria multifasciata*. Tullberg, Fört. öfv. sv. Podur. p. 148.
 1871. *Degeeria arborea*. Tullberg, Fört. öfv. sv. Podur. p. 148.

1871. *Degeeria marginata*. Tullberg, Fört. öfv. sv. Podur. p. 148.
 1873. *Degeeria decemfasciata*. Packard, Thys. Essex Co., Mass. p. 40.
 1881. *Degeeria pulchella*. Ridley, Ent. Mo. Mag. XVII, p. 270.
 1883. *Entomobrya multifasciata*. Brook, Revis. Genus *Entomobrya*.
 1890. *Entomobrya multifasciata*. Uzel, Thys. Bohemiæ, p. 57.
 1893. *Entomobrya multifasciata*. Schött, Palæarct. Coll. p. 49.
 1896. *Entomobrya multifasciata*. Schäffer, Coll. v. Hamburg. p. 197.

"Type.—Antennæ about half the length of the body; the three terminal segments usually sub-equal, but the second may be either a little longer or a little shorter than the other two. Color yellow, shading off to violet in the lighter specimens, to brown in the darker ones; there is sometimes a brown ring at the tip of the first segment. Head yellow, with a broad dark band around the margin as seen from above crossing the eye patches. The anchor-shaped band on the crown of the head is usually well defined.

"Mesothorax slightly longer than metathorax, with a dark band on its anterior margin which runs along the epimera as far as the fourth abdominal segment; there is also a strong central basal band not reaching the margin; there is a similar basal band on the metathorax. The first three abdominal segments increasing in length with similar dark basal bands on each; that on the first shows a little thickening at the extremities; those on the second and third have this thickening increased to a triangular patch. Fourth abdominal segment not so long as the first three and the metathorax taken together, fusiform, with two interrupted bands, one across the center and one across the basal portion of the segment, sometimes the two bands unite by triangular patches on each side of the median line; this segment is narrower at the base than the mesothorax. Fifth and sixth abdominal segments small, with strong basal bands.

"Spring not passing the ventral tube. Claws strong; the upper one with a tooth about the center of the inner margin, but there is often another smaller one, and sometimes a very small one on the outer margin. Lower claw lanceolate. Lateral plates lanceolate and a little curved; sometimes the tip of one of these plates is in such a position as to be easily mistaken for a strong tooth on the upper claw.

"Length, $1/15$ inch; width, $1/50-1/60$ inch."

The description is taken entire from Brook's "Revision of the genus *Entomobrya*." The species is regarded as quite variable, and according to the author quoted, exhibits several varieties which have been described as different species. While many of my specimens answer well to the above description, many others do not, and indeed it is the most perplexing species I know of. Our most common form seems to me rather larger, proportionately narrower, and with less distinct markings than the type. Not unlikely it is more than a variety, yet the color gradations are so perfect in a large series that it seems safer for the present to leave it as it is. A few very pale specimens have been taken which show scarcely any color on the body.

***Tomocerus arcticus* Schött.**

Pl. VI, Figs. 1-9; VII, Figs. 1-4b.

1893. *Tomocerus arcticus*. Schött, Palæarct. Coll. p. 43. Pl. III, 8-9.

1896. *Tomocerus arcticus*. Schäffer, Coll. v. Hamburg. p. 204.

"Antennæ not longer than the body. Dental spines simple, seven or sometimes eight in number, the innermost small. The superior claw armed with four or five teeth, the inferior claw lanceolate. Length about four millimeters. Denuded of its scales the animal is bright yellow in color." Taken in Tschuktsch Lande.

This species appears to be very abundant throughout the state, and is the only species I found out of doors, *T. niger* occurring only in the greenhouse. Dark leaden, with a slight purplish metallic reflection when seen alive with undisturbed scales. While I feel no doubt as to the identification being correct, yet a few points may well be noticed which illustrate the variability of the species. The type seems, by comparison of a very large number of individuals, to have four denticles on the superior claw of each pair of feet, but in not a few instances, the claws of the first pair showed but three denticles. The inferior claw is more slender in the second and third pairs than in the first. In the first pair the inferior claw often shows a very minute inner denticle, which may sometimes be detected even in the other two pairs. The dental spines would be somewhat perplexing if only a few individuals were at hand, but a

careful comparison of many shows that, aside from an occasional spine which has strayed clear out of position, as sometimes occurs, the variation has well-defined limits. One may always expect to find the two most distal spines large; then, there are commonly four or five much smaller ones before the large proximal spine is reached. Occasionally the number of these small spines varies to three, or even six. Often there is a small spine even more proximal than the large one just mentioned, and situated slightly more mesad. In one individual, three small spines instead of one were present. A point of interest may here be mentioned. The specimens from the northern part of the state differed somewhat from those taken in the central and southern parts in that the latter showed a tendency toward a larger number of the small spines on the dentes. Six small spines were not very uncommon, besides those situated proximal of the large proximal spine. These latter small spines, one, two, or even three in number, were also more likely to occur in the southern specimens than in the northern. The minute denticle of the inferior claw, sometimes observed in the northern specimens, was seldom or never present in the others. Notwithstanding these slight differences, I believe they are no more than locality variations, and certainly not to be taken as indicating distinct species.

From *T. niger* this species may be very readily distinguished by the form of the mucrones, which in *T. niger*, bears a large, spur-like tooth close to its base, while in *T. arcticus* the tooth is noticeably separated from the base, and there is a smaller tooth set almost opposite, on the other (outer) edge of the mucrones. The mandibles are respectively four and five-toothed. Rather common throughout the summer under stones, bark, etc.

Tomocerus niger Bourlet.

Pl. VI, Figs. 10-12; VII, Fig. 5.

- 1839. *Macrotoma nigra*. Bourlet, Mem. Soc. Roy. Lille. p. 390.
- 1839. *Macrotoma ferruginosa*. Bourlet, Mem. Soc. Roy. Lille. p. 390.
- 1842. *Tomocerus celer*. Nicolet, Mem. Soc. Helv.
- 1844. *Macrotoma celer*. Gervais, Ins. Apt. Walckenaer. Vol. III. p. 407.
- 1844. *Macrotoma nigra*. Gervais, Ins. Apt. Walckenaer. Vol. III. p. 408.
- 1844. *Macratoma lepida*. Gervais, Ins. Apt. Walckenaer. Vol. III. p. 409.
- 1847. *Tomocerus celer*. Nicolet, Mem. Soc. Ent. France.

1847. *Tomocerus lepida*. Nicolet, Mem. Soc. Ent. France.
 1871. *Tomocerus niger*. Lubbock, Monogr. Coll. and Thys. p. 139.
 1871. *Macrotoma vulgaris*. Tullberg, Fört. öfver Sv. Podur. p. 149
 1876. *Macrotoma vulgaris*. Tullberg, Coll. Borealia. p. 31.
 1882. *Tomocerus vulgaris*. Brook, Some little-known Coll. etc. p. 22 Pl.
 I, 15-19.
 1890. *Macrotoma vulgaris*. Uzel, Thys. Bohemiae. p. 47.
 1893. *Tomocerus vulgaris*. Schött, Palæarct. Coll. p. 41.
 1895. *Tomocerus vulgaris*, Reuter, Finl. Coll. och Thys. p. 15.
 1895. *Tomocerus niger*. Reuter, Finl. Coll. och Thys. p. 15.
 1896. *Tomocerus vulgaris*. Schäffer, Coll. v. Hamburg. p. 204.
 1897. *Tomocerus vulgaris*. Poppe & Schäffer, Coll. v. Bremen. p. 271

Bourlet describes the species as follows: "Same length as the preceding (*T. plumbeus*) as to body and antennæ; body covered with black scales, showing to the unaided eye a slightly silvery reflection. The body denuded of scales waxy yellow (*Jaune de cire*), anterior border of the thorax garnished with a fringe of short, black hairs; antennæ gray or fawn-gray; feet of a greenish-brown, tarsi brown, ventral side yellowish."

Tullberg, whose description of this species as *M. vulgaris*, has been generally accepted in lieu of Bourlet, says: "Antennæ not longer than the body. 12 to 16 simple spines on the dentes. Greater claw armed with 4-6 teeth, lesser claw blunt, lanceolate. Length, 4 millim." I have seen no other record of this species having been taken in America, and am not certain but that it may be an exotic species as it has only been taken in the green-house of the University, where it is rather common. It differs from our common out-door species, *T. arcticus*, in the number and arrangement of the spines on the dentes, which range from 12 to 16, being more numerous than in the above-named species. Another difference is that the distal spine of *T. niger* is always much larger than the two preceding, while in *T. arcticus* it is the second or ante-distal which is large. The mucrones also differs considerably in the first two (proximal) teeth, which are placed almost opposite each other and at some distance from the end of the dentes in *T. arcticus*; while in *T. niger* they are less prominent, and close upon the heel of the mucrones. The antennæ differ somewhat from that figured for *T. arcticus* in that Ant. I is shorter and stouter as compared with Ant. II.

Cyphodeirus albinus Nic.

Pl. VIII, Figs, 9-11.

1783. Crystalpoduren O. Fabricius, Danske Vidensk. Selsk. p. 303.
 1842. *Cyphodeirus albinus*. Nicolet, Hist. des Podurelles. p. 67, Pl. VII, 7
 1844. *Lepidocyrtus albinus*. Gervais, Hist. Nat. Ins. Walckenaer, Vol. III.
 1867. *Lepidocyrtus albinus*. Lubbock, Notes on the Thys. Pt. III. p. 301.
 1871. *Cyphoderus albinus*. Tullberg, Fört. öfv. Sv. Podur. p. 150.
 1872. *Cyphoderus albinus*. Tullberg. Sver. Podur. p. 38. Pl. VI, 12-21.
 1873. *Beckia albinus*. Lubbock, Monogr. Coll. and Thys. p. 49. Pl. XXIV.
 1890. *Cyphoderus albinus*. Uzel, Thys. Bohem. p. 49.
 1893. *Cyphoderus albinus*. Schött, Palæarct. Coll. p. 44.
 1895. *Cyphoderus albinus*. Reuter, Finl. Coll. p. 16.
 1896. *Cyphoderus albinus*. Schäffer, Coll. v. Hamburg. p. 199.
 1896. *Tullbergia immaculata*. Lie-Pettersen, Norg. Coll. p. 16. Pl. II, 1-4.

Described by Nicolet as "Oblong, entirely white, Ant. I and III short and obconiform in shape; Ant. II and IV much larger and oblong. Body slightly hairy and very brilliant. Insect very agile, about 1 mm. long. Inhabits worm-eaten trunks where it lives socially (ou il vit en rassemblement nombreux), and under mosses of forests where it lives solitary. Very common, especially in Autumn and in early winter."

Aside from the very short description given by Tullberg: "Undique albus. Ocelli nulli. Unguiculus superior uno dente magno armatus. Long. 1 mm.," we look in vain for a helpful characterization of this species until 1896, when O. J. Lie-Pettersen, in his "Norges Collembola," attempted to base his new genus, *Tullbergia*, on this species. His figures agree pretty closely with those of Nicolet and Tullberg. The latter has, however, overlooked the smaller tooth on the superior claw, quite likely on account of insufficient material, as he speaks of it as found "sparsamt." His figure of the claw indicates that he did not get a true profile view, as it seems unusually narrow. When the claw is thus tipped to one side, the lesser tooth is only with difficulty visible. Not improbably, too, different localities may produce individuals differing slightly in their minute characters. As to the presence of clavate hairs on the tibia, there seems to be some doubt; Tullberg's figure shows a hair with very slightly swollen tip, while Lie-Pettersen states that they are not present. The figure given by the latter really shows

the same hair in the ordinary position of a tenent hair, but it is drawn as a simple, pointed hair. The tip of this hair appears to me perceptibly swollen. Lie-Pettersen gives the size as 1.5 mm. which corresponds with those I have taken. The species is very common here throughout the summer, among damp, decaying leaves in the woods, at least along the Mississippi valley. Its agility is very astonishing when we consider the absence of eyes.

***Seira buskii* Lubb.**

Pl. VIII, Fig. 8.

1869. *Seira buskii*. Lubbock, Notes on the Thys. Pt. IV. p. 280.
 1871. *Degeeria cyanea*. Tullberg, Fört öfver Sv. Podur. p. 149.
 1872. *Sira buskii*. Tullberg, Sver. Podur. p. 41.
 1873. *Seira buskii*. Lubbock, Monogr. Coll. and Thys. p. 145. Pl. XXII.
 1890. *Sira buskii*. Uzel, Thys. Bohemiæ. p. 54.
 1893. *Sira buskii*. Schött, Palæarct. Coll. p. 52.
 1895. *Sira buskii*. Reuter, Finl. Coll. p. 23.
 1896. *Sira buskii*. Lie-Pettersen, Norges Coll. p. 15.
 1896. *Sira buskii*. Schäffer, Coll. v. Hamburg. p. 203.
 1897. *Sira buskii*. Poppe & Schäffer, Coll. v. Bremen. p. 271.

Lubbock thus describes the species: "Dark violet with metallic reflections. Head, legs and base of antennæ yellowish. Eyes on a black patch, and connected by a black band. Spines yellowish at base, colorless towards the extremity. Length, one-fifteenth of an inch. The basal (antennal) segment is rather shorter than the second or third, which, again, are, though very little, shorter than the apical. The small claw is without teeth. The large one has three teeth on the inner, and one on the outer margin."

Our specimens agree pretty closely with the above description and with the colored figure given by Lubbock in his "Monograph." I have not been able to satisfy myself as to the presence of the above-mentioned outer tooth on the superior claw. If present it must be very small in our specimens. Ant. I is never more than half the length of Ant. II, which is slightly longer than III. Ant. IV usually equals II. The distal parts of tibia and femur show a decidedly blue color. As to the form of the feet and furcula, it is almost exactly the same as *S. nigromaculata* (see figures). The two species are not liable

to be inter-mistaken, however, owing to the decided difference in color. *S. buskii* is also much more hairy and has the ocelli larger in proportion to the size of the eyespot. Collected under boards and paper in dark places, sometimes dry, sometimes wet. Taken once in the basement of Pillsbury Hall at the University. A very active species; living solitary, so far as my observation goes. Not abundant. Hitherto it has been found in England, Finland, Norway, Germany, Austria, Hungaria, Bohemia, the Tirol and Italy. Dr. Folsom also mentions it as one of the species "apparently restricted to the eastern part of the United States," and which may be a recent importation from over the ocean.

Seira nigromaculata Lubb.

Pl. VIII, Figs. 1-7.

1873. *Seira nigromaculata*. Lubbock, Monogr. Coll. and Thys. p. 146.
1872. *Sira elongata*. Tullberg, Sveriges Podurider. p. 41. Pl. VI, 22-35.
1895. *Sira nigromaculata*. Reuter, Finl. Coll. p. 23.
1896. *Sira nigromaculata*. Schäffer, Coll. von Hamburg. p. 202.

"Gray; the scales give it a mottled appearance. The eyes are on dark patches. There is a dark band running along the side of the body, on the front margin of the mesothorax, and on the posterior edge of the third, fourth and fifth abdominal segments. The third abdominal segment has also a transverse dark band in the middle, interrupted at the center. The sixth abdominal segment is black. The legs are annulated; the antennæ iron grey, the segments being paler towards the base. The spring reaches forwards as far as the ventral tube. The clubbed hairs are numerous. The markings on the scales are peculiarly bold. Length one-twelfth of an inch."

Tullberg has tried to identify this species with *Degeeria elongata* Nicolet, but without foundation. He mentions and figures five pairs of specialized touch hairs (kansel har). The superior claw bears three inner teeth, and, according to Tullberg, one outer tooth in addition, though I have failed to find it on my specimens. He gives the length as one and one-half millimetre.

I have taken the species but once. On Sept. 19, 1899, a dozen specimens were found on the outer stone window sill of

a third-story window of Pillsbury Hall at the University, under jars where a little moisture remained untouched by the sun.

Lepidocyrtus albicans Reut.

Pl. VII, Figs 6a-8.

1895. *Lepidocyrtus albicans*. Reuter, Finl. Coll. p. 20.

1896. *Lepidocyrtus albicans*. Schäffer, Coll. von Hamburg. p. 200.

The species is described as: "Silvery, without the scales, entirely white, with only the eye spots and a spot between the bases of the antennæ black, Ant. IV and the distal end of III pale blue, Ant. I, II and III together about as long as the head, IV shorter than II and III taken together; dentes equal to the manubrium in length; or a little longer; mesonotum slightly prominent. Length 1-1.5 mm."

The above description fits well excepting that Ant. III and IV and the tip of II are pale blue, which accords with the description given by Schäffer; and the mesonotum, which seems to me quite prominent. Possibly I am mistaken in my identification of this species. It is rather common, living solitary under sticks and stones.

Lepidocyrtus decemoculatus n. sp.

Pl. VII, Fig. 14.

Entirely white, or with a yellowish or brownish cast, excepting the antennæ which are entirely blue, the black eye spots with a slight blue shading off at their posterior borders, and a dark brown line connecting the anterior ends of the eye spots. Ocelli reduced, 10 in number, six to each eye spot. Antennæ short, stout, the segments proportioned about as in *L. purpureus*, but more hairy. Claws with a single tenent hair and two inner teeth on the superior claw, as usual in the genus. Manubrium equal in length to the combined length of the mucrones and dentes. Mucrones of the usual form.

Probably the smallest species yet described, being but .8 mm. in length. In color it agrees pretty closely with *L. albicans*, but is a much stouter-bodied species, and has the mesothorax more massive, even, than in *L. purpureus*. The scales are silvery white. This little insect is extremely agile and difficult to

capture. Apparently social in their habits. I have taken them but seldom, but where found, under a stone or board in a moist situation, they were in considerable numbers. The number of ocelli in this species would seem to place it near Reuter's genus *Calistella*, but, inasmuch as this is the only essential point of difference from others of the short bodied *Lepidocyrtus*, and as it is probable that the *Calistella* is rather a reduced *Scira*-like form with its more rangy body and long antennæ, I believe this species should be retained in the genus *Lepidocyrtus*. *Isotoma* has a species with but four ocelli, and another in which ocelli are entirely lacking; *Sminthurus* has a species which is eyeless; why not then regard the present genus as embracing species in which the partial reduction of eyes has taken place. I believe that this must ultimately lead to the reabsorption of the eyeless species of *Lepidocyrtus* which are now referred to the separate genus *Cyphodeirus* Nicolet. We certainly have precedent for uniting two or more genera in one when species are found which prove to be their connecting links.

***Lepidocyrtus sexoculatus* n. sp.**

Pl. VII, Fig. 13.

Entirely white, excepting the eye spots, which are four in number, and are black. The two anterior eye spots each contain two ocelli, situated in a line transverse to the head, the posterior eye spots each contain a single ocellus. The body is well covered with scales, which seem to give sometimes a yellowish tint. The mesothorax projects less than in any other species I have seen. Head large, antennæ hairy, not much longer than the head. Ant. IV shorter than II and III together. The legs are long and bear claws of the usual form. The outer claw is slender and has two teeth, the inner one straight and lanceolate. There is a single tenent hair. The manubrium and dentes are about equal in length, and the mucrones is essentially like that figured for *L. albicans*. Length, 1 mm.

It is rare, and is found chiefly under bark and stones, where I have taken it with *L. 10-oculatus*, *Cyphodeirus albinus*, *Isotoma finetaria* and other such white forms. It much resembles *L. 10-oculatus*, but is rather larger and lacks the blue color

of antennæ, and the dark line connecting the eyes, and, most noticeable of all, it has four small black eye spots in place of two larger ones. The species is to the genus *Lepidocyrtus* practically what the genus *Sinella* is to the genus *Entomobrya*, only the ocellar reduction is less advanced. Probably this six-eyed species, in connection with the ten-eyed one, will form a bridge over which we may bring back the eyeless *Cyphodeirus* to the genus from which it was taken.

Lepidocyrtus purpureus Lubb.

Pl. VII, Figs. 9-12.

1873. *Lepidocyrtus purpureus*. Lubbock, Monogr. Coll. and Thys. p. 155. Pl. XXX.
1890. *Lepidocyrtus purpureus*. Uzel, Thys. Bohemiæ. p. 51.
1895. *Lepidocyrtus purpureus*. Reuter, Finl. Coll. p. 18.
1896. *Lepidocyrtus purpureus*. Schäffer, Coll. von Hamburg. p. 201

The original description reads: "Intensely deep blue with beautiful, purple reflections. Legs and basal segment of antennæ yellow. Third segment of the antennæ shorter than the second. Thorax with an upright fringe and a central tuft of short setæ. Length, .045 of an inch; breadth, .013."

Schäffer's description speaks of the thickly set, iridescent scales and says that "Ant. III is at least one-third shorter than II. The first three antennal segments are shorter than the head, Ant. IV as long as II and III together. Dentes little longer than the manubrium. Dark blue. Ant. I and II (excepting the blue end), legs and dentes whitish or yellowish. Length, 1 mm."

The coloration in our specimens exhibits a peculiarity which is noticeably different from those described. The top of the head is quite yellowish, even bright yellow in many specimens. The coxæ of the legs, and the ventral tube are blue, the remainder of the legs usually brownish yellow. The manubrium is usually of a diffuse blue, the dentes clear. The mucrones is as in *L. albicans*, with the "basaldorn" very slender and even sometimes lacking, owing, perhaps, to accidental breakage. The antennæ are short and comparatively stouter than in *L. albicans*. As to the relative lengths of the various antennal segments there is more or less of variation, so that they hardly merit the

importance once attached to them. The mesonotum projects but little, and is more massive than in the preceding species. Some of the specimens attain even 1.5 mm. in length. Abundant under logs and stones.

Lepidocyrtus pusillus (L.).

1767. *Podura pusilla*. Linn. Syst. Nat. Ed. XII. II, 2. p. 1014.
 1788. *Podura lanuginosa*. Gmel. Linnæus Syst. Nat. I, 6. p. 2911
 1871. *Lepidocyrtus æneus*. Tullberg, Fört. öfver. Sv. Podur. p. 150.
 1862. *Lepidocyrtus lanuginosus*. Tullberg, Sver. Podur. p. 38. Pl. VI, 1 7.
 1871. *Lepidocyrtus æneus*. Lubbock, Monogr. Coll. and Thys. p. 154.
 Pl. XXIX.
 1871. *Lepidocyrtus pusillus*. Lubbock, Monogr. Coll. and Thys. p. 156
 1890. *Lepidocyrtus lanuginosus*. Uzel, Thys. Bohemiæ. p. 52.
 1893. *Lepidocyrtus lanuginosus*. Schött, Palæarct. Coll. p. 45.
 1895. *Lepidocyrtus lanuginosus*. Reuter, Finl. Coll. p. 19.
 1896. *Lepidocyrtus lanuginosus*. Schäffer, Coll. von Hamburg. p. 200.
 1897. *Lepidocyrtus lanuginosus*. Lie-Pettersen, Norg. Coll. p. 12.
 1897. *Lepidocyrtus lanuginosus*. Poppe & Schäffer, Coll. v. Bremen. p. 271.

The species is associated with so many insufficient and varying descriptions that it is not easy of determination. However, if I have assigned my specimens rightly to this species, the following description may be ventured,—Color rather a clear blue, of about uniform tint throughout the body. Head somewhat lighted and more purplish in tint, with the posterior part, and a spot mediat to each eye spot nearly colorless. Antennæ short, little longer than the head, entirely blue, growing darker toward the apex. Ventral tube blue. Coxæ and femurs purplish blue, tibiæ and feet colorless. Mantubrium faint blue, dentes colorless.

About like *L. purpureus* in form, but without the brownish-yellow legs and basal parts of the antennæ. The figures given for the claw, mucrones and mesothorax of *L. purpureus* would apply about equally well to this species. The antennæ, however, are shorter in proportion to length of head. When the body is straight, the white, inter-segmental bands are not apparent, except slightly at the anterior ends of Th. III and Abd. IV.

Length, 1 mm. Taken under loose bark, etc.

Lepidocyrtus aenescens n. sp.

A blue species with five white cross-bands. Antennæ entirely white, legs the same, down to the distal end of the tibiæ, beyond that pale. Manubrium tinted but slightly with blue, dentes with a pale yellowish cast. Mesothorax massive, projecting but slightly over base of head. Antennæ short and stout, hardly longer than the head. Ant. IV about equal to the two preceding segments. Ant. III shorter than II. Dorsal parts rather heavily scaled in life, but the scales apparently loosely fastened, as they are very often absent in preserved specimens. The scales are of a light brown color, the blue of the body is rather blackish, and presents more of a granular appearance than in *L. purpureus* or *L. pusillus*, where the pigment is more uniformly spread. In general form, the three species are much alike. The same figures of mucrones and claw would answer for all, yet the species seems distinct from all yet described in the blue tibiæ, the entirely concolorous dark blue antennæ, head entirely blue, blue manubrium, presence of "basaldorn" on mucrones, and the white cross-bands on the body. Not that it is unique in the possession of any one of these characters, but in their combination. Length, 1.25 mm. One of our commonest collembolan forms. Found under sticks and stones throughout the summer.

Achorutes boletivorus Pack.

Plate X, Figs. 13, 14.

1873. *Achorutes boletivorus*. Packard, Thys. Essex Co., Mass.

"A much smaller species than *A. nivicola*, being about half the size, with a rather thicker body, and the head a little smaller in proportion to the body. Antennæ shorter, the joints shorter, sub-spherical, terminal joints ovate, much shorter than in the other species. Eyes conspicuously black. Legs proportioned same as in *A. nivicola*, ending in long, sharp claws; elater as well developed as in *A. nivicola*. Pale gray above with a slight greenish tinge, on the under side of the body lined with white, with scattered gray specks on side of body. Supra-anal spines rather longer than in *A. nivicola*. Length, .05-.07 inch. Sept. 10, very abundant on under side between lamellæ of *Boleti* and

Agaricus, hundreds on one plant, Brunswick, Maine. Salem (Mass.), under a heap of horse manure, Aug. 15."

It is difficult to point out the differences between this species and that which I have identified as *A. longispinus* Tullb. In figuring the antennæ, the claws or the anal spines, one figure would answer for either, though I doubt if *A. boletivorus* has any tenent hair. The tenent hair is so slightly clavate on *A. Longispinus* as to be scarcely noticeable. It appears, however, that *A. boletivorus* is rather the thicker bodied of the two species, and it is slightly smaller and far lighter in color. My specimens reach one and one-third millimeters in length. Have taken them often and in large numbers among the gills of mushrooms of various kinds, and in tunnels which they had evidently bored in the flesh of the caps. Several hundreds have been taken from a single agaric. When the cap is broken up, and their hiding places brought to light, they leap out and usually make a bee-line for some overhanging fragment of mushroom, or other place of shelter. They are very lively, usually running about half an inch, then jumping nearly an inch, then alternating again. The larger specimens can jump two inches when disturbed, but when forced to take their largest leap they overdo themselves and usually turn around, or turn a summersault in the air, so that they alight 'tail end to,' and begin running toward their starting point. Usually under normal conditions they alight on their feet, but when hurried will occasionally come down on their backs. They prefer mushrooms which are beginning to get stale and decay.

***Achorutes longispinus* Tullb.**

Pl. X, Figs. 15-16; XI, Fig. 5.

1876. *Achorutes longispinus*. Tullberg, Coll. Borealia. p. 37. Pl. X, 31-34.
 1896. *Achorutes longispinus*. Schäffer, Coll. v. Hamburg. p. 171. Pl. II, 45.

"Upper claw present. Mucrones of the furcula thick, convergent. Anal spines large, about as long as the upper claw; papillæ separated at their bases. Length, 2 mm." Schäffer adds "Keulenhaare der Tibien undeutlich" and "Der dunkelblaue Pigment gleichmässig verteilt."

I think there is little doubt that the identification is correct, though there seems to be a great disparity in size, mine measuring hardly more than 1 mm.

The fairly uniform dark bluish color, the "undeutlich" tenent hair, and the similarity of the parts of the specimens to the figures given by Tullberg and Schäffer convince one that either our variety is smaller than that from Nova Zembla, or that I have only immature specimens. As I have taken it but once, the latter may be true. They were found by hundreds in a little bunch on the surface of a little pool at the edge of wave-marks at Lake Pepin, in the latter part of August, 1899. This water habit, alone, would seem to separate them from their closest neighbor *A. boletivorus*, which nearly always occurs in mushrooms or occasionally under bark or rubbish. I have never found it near the water. In this form, which is the slenderer of the two, the manubrium narrows greatly before its union with the dentes, while in *A. boletivorus* the manubrium broadens rapidly basal-wards from its very end. For further comparison, see *A. boletivorus*.

***Achorutes schneideri* Schäffer.**

Pl. X, Figs. 9-12; XI, Figs. 1-2.

1896. *Achorutes schneideri*. Schäffer, Coll. v. Hamburg. p. 173. Pl. III, 49.

1897. *Achorutes schneideri*. Poppe & Schäffer, Coll. v. Bremen. p. 266.

"Dark blue, very short haired, Outer claw bearing in the middle a very small, often hardly noticeable tooth. Inner claw suddenly contracted at the middle to a mere bristle. Tibia with one clavate hair, the swelling at its end not very pronounced. Dentes and mucrones together about as long as the manubrium. Mucrones with narrow plate, end of the edge bowed and projecting out. Dentes three to four times as long as the mucrones. Anal spines small, on very small papillæ which are not in contact with each other. Length, 1.7 mm."

The clavate hair on this species is especially large, reaching out nearly as far as the tip of the superior claw, when bent down that way, but habitually carried out at a wide angle from the claw. The hair is nearly straight. The inner edge of the superior claw

has a very minute tooth. The color is exceedingly dark, appearing a dead black to the naked eye. They live socially, as is commonly the case among the *Achorutes*, and often occur in great numbers on the under surface of boards and in other moist situations. Once I found scores of them in the crevices of an axe-wound in a living tree, where the sap was exuding enough to supply the needed moisture. This is probably the most numerous species of the genus in our locality. My specimens seem considerably larger than those of the description, measuring 2.25mm. in length, yet perhaps this is not surprising, as many of our collembolans are somewhat larger than European specimens of the same species.

***Achorutes socialis* Uzel.**

Pl. X, Figs. 20-23; XI, Fig. 3.

1896. *Achorutes socialis*. Uzel, *Thys. Bohemiæ*. p. 69. Pl. II, 16-19.

1893. *Achorutes socialis*. Schött, *Palæarct. Coll.* p. 81. Pl. VII, 6-8.

1896. *Achorutes socialis*. Schäffer, *Coll. v. Hamburg.* p. 172.

"Lower claw present. Upper claw large, slightly curved, an acute tooth not far from the apex. Clavate hair over the claw. Tibia set with long hairs, the clavate hair being longest of all. Mucrones oblong, attenuate toward the end, blunt. Dentes less than three times the length of the manubrium, thick, three times longer than the mucrones. Five acute conical teeth on the lower side of the dentes. Anal spines strong, about equalling the papillæ in length, slightly curved, obtuse. Antennæ as long as the manubrium, the segments successively increasing in length, Ant. II truncate at the apex, III and IV less distinctly separated. Body swollen, narrowed behind, the final segment cylindrical. Dark blue, pruinose, feet, antennæ and furcula purple. Length, 1-1.5 mm."

Uzel mentions their living in very large colonies in low, loamy ground and sometimes being found on snow. So far it has been taken here but once, and that time by Mr. O. W. Oestlund about the middle of April. Though there is no record with the date, yet it is probable that they were in considerable numbers as nearly thirty specimens were secured. The zigzag row of five or six chitinous teeth on the dentes serves well to distinguish it from any of the other species with which I am

acquainted, and the anal horns are much smaller than in any other of our species.

Achorutes schötti Reut.

Pl. X, Figs. 17-19; XI, Fig. 4.

1895. *Achorutes schötti*. Reuter, Finl. Coll. p. 31. Pl. II, 8.

1896. *Achorutes schötti*. Schäffer, Coll. v. Hamburg. p. 171. Pl. III, 57.

"Blue or grayish blue, short haired; tibia with a single clavate hair over the large claw; large claw slightly curved, rather stout, smaller claw very slender, subuliform or almost bristle-like, reaching about to the middle of the large claw. Furcula with the dentes shorter than the manubrium, somewhat thick, slightly narrow at the apex, a long hair behind, near its base, mucrones about $1/3$ to $2/5$ shorter than the dentes, slender, its apex acuminate and slightly curved; anal papillæ minute, spines small, straight, about the length of the papillæ. Length, 1 mm."

It will be noticed that Reuter does not mention the tooth on the inner margin of the large claw, yet he shows in his figure that it is not very large. The antennæ are of the short type, much like that which I have figured for *A. boletivorus*. The body is rather short and heavily built. Some of the specimens show hardly any of the bluish tint, but are a rather light gray. The tenent hair is much shorter and more slender in my specimens than in either *A. schneideri* or *A. socialis*, though it seems long in Reuter's figure. I have only taken the species twice, and then sparingly. Under stones in moist places. Length, 1 mm. Rather a sluggish form.

Podura aquatica Linn.

Pl. XI, Figs. 6-11.

1740. *Podura aquatica nigra*. DeGreer, Acta Soc. Reg. Sc. Upsal.

1746. *Podura aquatica nigra*. Linné, Fauna Suec. Ed. I. p. 343.

1758. *Podura aquatica*. Linnæus, Syst. Nat. Ed. X. p. 609.

1762. La Podure noire aquatique. Geoffroy, Ins. Env. Paris. II. p. 690.

1775. *Podura aquatica*. Fabricius, Syst. Ent.

1776. *Podura aquatica*. Müller, Zool. Prod.

1780. *Podura aquatica*. O. Fabricius, Fauna Groenl. p. 211.

1781. *Podura aquatica*. Schrank, En. Ins. Austriæ.

1804. *Podura aquatica*. Latreille, Hist. Nat. Crust. et Ins.

1835. *Podura aquatica*. Boisduville & Lâcordaire, Faun. Ent. Env. Paris.

1838. *Achorutes aquatica*. Burmeister, Handb. d. Entom.
 1838. *Hypogastrura aquatica*. Bourlet, Mem. sur les Podures. p. 31.
 1839. *Achorutes aquatica*. Gervais, in Walckenaer. Ins. Apt. III. p. 436.
 1841. *Podura aquatica*. Nicolet, l'Histoire d. Podur. p. 55.
 1841. *Podura aquatica*. Lucas, Hist. Nat. des. anim. Art. p. 565.
 1842. *Hypogastrura aquatica*. Bourlet, Mem. Soc. Roy. Douai.
 1847. *Podura aquatica*. Nicolet, Ann. Soc. Ent. France.
 1867. *Podura aquatica*. Lubbock, Trans. Linn. Soc.
 1871. *Podura aquatica*. Tullberg, Fört. öfv. Sv. Podur. p. 153.
 1871. *Podura aquatica*. Lubbock, Monogr. Coll. and Thys. p. 185. Pl. XLII.
 1872. *Podura aquatica*. Tullberg, Sv. Podur. p. 50. Pl. X, 1-6.
 1873. *Podura aquatica*. Packard, Thys. from Essex Co., Mass. p. 35
 1890. *Podura aquatica*. Uzel, Thys. Bohemæ. p. 73.
 1893. *Podura aquatica*. Schött, Palearct. Coll. p. 76.
 1895. *Podura aquatica*. Reuter, Finl. Coll. p. 29.
 1895. *Podura aquatica*. Reuter, Coll. på Snö och is. p. 121.
 1896. *Podura aquatica*. Schäffer, Coll. v. Hamburg. p. 171. Pl. II, 38.
 1896. *Podura aquatica*. Lie-Pettersen, Norg. Coll. p. 19.
 1897. *Podura aquatica*. Poppe & Schäffer, Coll. v. Bremen. p. 266.

Opaque, blackish-blue; antennæ and legs reddish brown. Body broadly fusiform. Furcula reaching beyond second pair of legs; mucrones thick, short and nearly straight. Dentes arcuate, with an incipient joint at the bend; the distal ends covered with transverse rows of small, chitinous tubercles. Mucrones short, somewhat spear-like, with an outer tooth. Claw long and slender, slightly curved, without teeth. Projecting over the claw from the tibia is a long hair, which is not, however, swollen at the end. Antennæ about the length of the head, appearing more slender from a side than from a dorsal view, as they are slightly flattened. The length generally given for this species is 1 mm. though Nicolet says "1 millimetre et demi à 2." Our full grown specimens measure about 1.5 mm.

One of the most widely spread species of the Collembola, being reported from almost every place where this group has been studied. With us it seems very abundant. It is found among rubbish on the edge of lakes where the waves dash up so that part of the time the insects are on the weeds and stones, and again they are jumping about on the surface of the water. Sometimes they may be taken in great numbers from the surface of stagnant pools. It is of interest to compare the furcula with the water-leapers among the Sminthuri, which they somewhat

resemble in form. In both cases the furcula is dorso-ventrally, instead of laterally flattened.

***Xenylla gracilis* n. sp.**

Pl. XI, Figs. 12-15.

Rather dark blue above, paler beneath. Body slender, fusiform, head narrow in front, becoming broader between the eyes and then narrowing again. Thorax narrower than the head. Abdomen gradually broadening posteriorly till the fourth segment, after that narrowing rather abruptly, the fifth and sixth segments being much narrower. The sixth is blunt on the end, and bears two supra-anal spines on separated papillæ, the spines not longer than the papillæ themselves. Claws short, unarmed, tibiæ with two clavate hairs. Ocelli placed as usual in this genus. Antennæ hardly longer than the head. The second, third and fourth segments about equal and somewhat longer than the first. The third and fourth are broad. The mucrones is of a different form from any described or figured so far, the recurved hook at its end being quite characteristic of the species. The dentes and mucrones together are about one-third longer than the claw. Length, .9 mm. Taken rather rarely in damp places under boards along the Mississippi bottom lands, where they live socially.

***Friesia caldaria* n. sp.**

Pl. XI, Figs. 16-18.

Purplish blue above, paler beneath. Eye spots conspicuously black. Body short and thick, with antennæ, legs and furcula to correspond. Head triangular in outline as seen from the side. Claw rather short and stout, tibiæ with two clavate hairs nearly as long as the claw. The fifth and sixth segments of the abdomen bear dorsally several clavate hairs. The furcula is more rudimentary than in any other genus, the manubrium being very short and broad, the mucrones hooked at the end, and two-thirds as long as the dentes. Dentes and mucrones together are but little longer than the larger anal horns. The three anal horns are situated in a triangle, the hindmost one being median, and somewhat smaller than the other two. Each one is set on a short papilla. There is present a well-developed tenaculum, with two-

toothed blades much as an *Achorutes*. The skin is thickly covered with small conical, chitinous tubercles. Length, .75 mm.

Under boxes and plant jars in University greenhouse, where the dirt is quite moist. They are quite rare, and have been taken with *Isotoma minima* and *I. fimetaria*. As I have never taken it out of doors, it is possibly an exotic species. Hitherto, the genus has been, so far as I know, represented by but one type species, *F. mirabilis* (Tullberg). From that species *F. caldaria* differs in the possession of clavate hairs on the tibia, and in the better development of the furcula. Whether *F. mirabilis* has the clavate hairs on the final abdominal segments, it is impossible to determine from any literature at hand, but it is improbable, inasmuch as Brook mentions some strong hairs on the fifth segment, "which, unless accurately focussed, look broad enough at the base to be taken for spines," and yet he says nothing about their ends being clubbed. Probably Tullberg's species is considerably larger, as he gives the length as 1.5 mm.; though my number of specimens of *F. caldaria* is so limited that it is possible none of them are mature. I believe this is the first record of this genus in America.

Aphorura inermis (Tullberg).

1872. *Lipura inermis*. Tullberg, Sver. Podur. p. 55.
 1873. *Lipura inermis*. Lubbock, Monogr. Coll. and Thys. p. 194.
 1873. *Lipura fimetaria*. Packard, Thys. Essex Co., Mass. p. 28.
 1890. *Lipura inermis*. Reuter, Coll. in Cald. viv. p. 20.
 1891. *Lipura inermis*. Schött, Kaliforn. Coll. p. 24.
 1893. *Lipura inermis*. Schött, Palæarct. Coll. p. 88.
 1895. *Lipura inermis*. Reuter, Finl. Coll. p. 33.
 1896. *Lipura inermis*. Lie-Pettersen, Norg. Coll. p. 21.
 1896. *Aphorura inermis*. Schäffer, Coll. v. Hamburg. p. 161. Pl. II, 18 19.

The species is described as: "Post-antennal organ with fourteen elevations. Two ocelliform punctures at the base of each antenna. No anal spines. Length, 1 mm."

The claws are unarmed, the lower one very slender, and, in fact, little different from that figured for *A. ambulans*. The antennæ are comparatively shorter than in *A. ambulans*, and the whole body seems not only shorter, but less slender than in that species. The absence of anal horns in *A. inermis* separates it easily from the species of Linné, which it otherwise so closely re-

sembles, both being entirely white and eyeless. Schött found this species in California and, in referring to Packard's record of *L. fimetaria*, he says: "Ohne Zweifel meint Packard mit *L. fimetaria* obige Art wenn er in seiner Beschreibung sagt: "It may be known from *L. ambulans*, with which at first it may easily be confounded, by wanting the hooks at the end of the abdomen." I have taken but few specimens of this species. They were found in damp places, on the under side of stones, and were not very active.

***Aphorura ambulans* (L., Nicolet).**

Pl. XII, Figs. 3-7.

1758. *Podura ambulans*. Linné, Syst. Nat. Ed. X. p. 609.
 1847. *Anurophorus ambulans*. Nicolet, Essai Classif. l'Ord. Thys. p. 384. Pl. VI, 14.
 1862. *Lipura ambulans*. Lubbock, Notes on the Thys. Pt. II. p. 600.
 1869. *Lipura ambulans*. Tullberg, Skand. Podur. af. Underf. Lipur. p. 17.
 1871. *Lipura ambulans*. Tullberg, Fört. öfv. Sver. Podur. p. 154.
 1872. *Lipura ambulans*. Tullberg, Sver. Podur. p. 55. Pl. XI, 16-29.
 1873. *Lipura ambulans*. Packard, Thys. Essex Co., Mass. p. 29.
 1873. *Lipura ambulans*. Lubbock, Monogr. Coll. and Thys. p. 189 Pl. XLIII.
 1893. *Lipura ambulans*. Schött, Palæarct. Coll. p. 87.
 1895. *Lipura ambulans*. Reuter, Finl. Coll. p. 33.
 1896. *Lipura ambulans*. Lie-Pettersen, Norg. Coll. p. 20.
 1896. *Aphorura ambulans*. Schäffer, Coll. v. Hamburg. p. 161.

"Elevations of each post-antennal organ 12-14. Ocelliform punctures at the base of each antenna 2. Anal spines large, arcuate. Length, 2 mm.," says Tullberg.

Body entirely white, with a few scattered hairs. Prothorax short, but visible from above. The skin is finely granular. The post-antennal organs are not easy to make out; they are elongate, consisting each of a double row of elevations. The antennæ are quite peculiar in form, as may be seen by referring to the figures. The species is quite abundant, under bark and sticks in damp places. They are often found in colonies so that one may take many at once. I have taken them with our other albino collembolans: *Cyphodeirus albinus* and *Isotoma fimetaria*.

Anurophorus laricis Nic.

Pl. XII, Figs. 1-2.

1842. *Anurophorus laricis*. Nicolet, Hist. les. Podur. p. 53. Pl. III, 3.
 1844. *Anurophorus laricis*. Gervais, Ins. Apt. in Walckenaer. Vol. III. p. 442.
 1847. *Anurophorus laricis*. Nicolet, Ann. Soc. Ent. France.
 1862. *Lipura corticina*. Lubbock, Notes on the Thys. Pt. II. p. 600.
 1871. *Anurophorus laricis*. Tullberg, Fört. öfv. Sv. Podur. p. 164.
 1872. *Anurophorus laricis*. Tullberg, Sver. Podur. p. 53. Pl. XII, 1-2.
 1873. *Lipura corticina*. Lubbock, Monogr. Coll. and Thys. p. 191. Pl. XLV.
 1890. *Anurophorus laricis*. Uzel, Thys. Bohemiæ. p. 74.
 1893. *Anurophorus laricis*. Schött, Palearct. Coll. p. 86.
 1895. *Anurophorus laricis*. Reuter, Finl. Coll. p. 33.
 1896. *Anurophorus laricis*. Schäffer, Coll. v. Hamburg. p. 164.
 1896. *Anurophorus laricis*. Lie-Pettersen, Norg. Coll. p. 20.
 1897. *Anurophorus laricis*. Poppe & Schäffer, Coll. v. Bremen. p. 266.

This widely distributed species is described by Nicolet as "Smaller and more compressed than the preceding (*Aphorura fimetaria*). Body irregularly dotted, quite brilliant metallic black, paler beneath, with a few short hairs; Posterior borders of the segments slightly raised; two transverse depressions at the anterior border of each segment near the midline of the back. Antennæ paler than the body; a slight depression on top of the head between the eyes, which are black and only 16 in number, placed in each lunule-like eyespot; the eyespots situated behind the antennæ. Legs pale yellow (fauve). Ventral tube large and deep; no anal horns at the tip of the abdomen. Length, 1.5mm. First found under the bark of *Larix europea* DG."

Later writers speak of it as "without anal spines, post-antennal organ, lower claw and furcula," though these are generic rather than specific characters. The body is broadest at the posterior part of the abdomen, which is broadly rounded off at the end. The color of my specimens is dark blue, which is the color given by most authors. The legs are pale blue, the claw short, stout and unarmed, and at the tip of the tibia are borne two long hairs which seem to me slightly clavate. Tullberg figures but one such hair, and labels it "pilis apice arcuatus." The antennæ are longer than the head; Ant. I being about two-

thirds as long as II, which equals III, IV is about as long as I and II together. The genus has never been reported from North America before, so far as I know; and certainly the species never has. They live socially, but must be rare in the localities where I have collected, as I have taken them but once. They were found under bark or under chips and boards in damp situations near the shore of Lake Pepin.

Anurida tullbergi Schött.

Pl. XII, Figs. 8-9.

1891. *Anurida tullbergi*. Schött, Nya Nordiska Coll. Ent. Tidsk. XII. p. 192.
1893. *Anurida tullbergi*. Schött, Plæarct. Coll. p. 91. Pl. VII, 17-18.
1895. *Anurida tullbergi*. Reuter, Finl. Coll. p. 33.
1896. *Anurida tullbergi*. Coll. v. Hamburg. p. 164. Pl. II, 23.

"Post-antennal organs irregular. Elevations (tumores) in each organ 24-28. Ocelli 10, 5 on each side of the head. Length. 2-2.5 mm."

The claws are without teeth. The dark blue color of the insect is laid on rather irregularly over a darker ground, giving a somewhat netted appearance, the dark color far overweighing the light, which is more in evidence on the ventral side than on the dorsal.

Schött, from whom the substance of the above is taken, also remarks that it lives like *A. maritima* Laboulb. except that he had never taken *A. maritima* in fresh water, while *A. tullbergi* is found on the surface of ponds.

Evidently these species are very closely related, but the shape of the post-antennal organ, as well as the much larger number of elevations composing the ring, will serve to separate it from *A. maritima* which has but seven or eight, and these situated in a circle. I have taken but two specimens of this species. These were taken with a colony of *Achorutes longispinus* Tullb. in a little pool at the edge of the wave-marks at Lake Pepin, Minn.



Neanura muscorum (Templ.).

Pl. XII, Figs. 12-14.

1834. *Achorutes muscorum*. Templeton, Thys. Hib. p. 97.
 1838. *Achorutes muscorum*. Burmeister, Handb. d. Entomol.
 1840. *Achorutes muscorum*. Lucas, Hist. Nat. Crus. Ar. et. Myr.
 1842. *Achorutes tuberculatus*. Nicolet, Mem. Soc. Helv.
 1844. *Anoura tuberculata*. Gervais, Hist. Ins. Apt. Walckenaer. p. 443.
 Vol. III.
 1847. *Anoura muscorum*. Nicolet, Mem. Soc. Ent. France. p. 338.
 1862. *Anoura muscorum*. Lubbock, Notes on the Thys. Pt. II. p. 600.
 1869. *Anura muscorum*. Tullberg, Skand. Podur. af Underf. Lipur.
 p. 21.
 1869. *Achorutes tuberculatus*. Porath, Of. af k. Vetensk.-Akad. Forh.
 1871. *Anura muscorum*. Tullberg, Fört. öfv. Sv. Podur. p. 155.
 1872. *Anura muscorum*. Tullberg, Sver. Podur. p. 58. Pl. XII, 18-24
 1873. *Anoura muscorum*. Lubbock, Monogr. Coll. and Thys. p. 197. Pl.
 LVI, 27-29.
 1873. *Anura gibbosa*. Packard, Thys. of Essex Co., Mass. p. 27.
 1876. *Anura muscorum*. Tullberg, Coll. Borealia. p. 41.
 1890. *Anura muscorum*. Uzel, Thys. Bohemiae. p. 76.
 1890. *Anura muscorum*. Reuter, Coll. in Caldar. viv. p. 20.
 1893. *Anura muscorum*. Schött, Palæarct. Coll. p. 93.
 1893. *Neanura muscorum*. MacGillivray, North. Am. Thys. Pt. IV. Can.
 Ent. XXV. p. 314.
 1895. *Anura muscorum*. Reuter, Finl. Coll. p. 34.
 1896. *Anura muscorum*. Lie-Pettersen, Norg. Coll. p. 21.
 1897. *Neanura muscorum*. Poppe & Schäffer, Coll. v. Bremen. p. 256.
 1900. *Neanura muscorum*. Absolon, Aphoruriden aus d. Höhlen d. Mähr,
 Karstes. Zool. Anzeiger. XXIII. p. 406.

Lubbock's description is: "Body subcylindrical, turned posteriorly, and ending with two mammillæ; dark purplish. Head short, triangular. Eyes not remote from the base of the antennæ, which are very short and have the first joint very large, succeeding necessarily diminishing in size, last acuminate. Legs pale blue. Rings with long, spiny hairs in rows along the back; hairs usually arising in pairs. Length, .07 of an inch."

In the young the color is lighter, as the pigment is not so dense. The eyes are three on each side of the head, and in the young each eye patch is divided into two parts which are separated from each other, the anterior bearing two ocelli, the posterior but one. The sense kernel at the tip of the antennæ is single and nearly globular. From most positions the antennæ appear

but three-jointed, the joint between Ant. III and IV being hardly noticeable. There is little danger of confusing this species with any other species found here. The large tubercles on the back and at the posterior end of the body, which caused Nicolet to name it "tuberculatus"; the presence of but three eyes on each side; the thick body noted by Packard when he named it "gibbosa"; all help to distinguish it.

The mouth cone is sharp in front, and projects front of the head. A very common species in Minnesota, and has been reported as well from many other parts of the United States. It lives in rotten wood and in other moist, protected places. It seems to prefer wood that is in an advanced stage of decay, and pretty juicy, where it is to be found in the cracks and worm holes.

Neanura quadrioculata n. sp.

Pl. XII, Fig. 15.

Entirely white except the two black eye patches on each side of the head, each eye patch containing a single ocellus. Antennæ as long as the head. Tubercles not so prominent as in *N. muscorum*, and bearing long sense hairs. Length, .8 mm., and possibly more.

This might easily be mistaken for the young of the preceding species had it a pigmented skin, but I believe the young of *N. muscorum* always show more or less of the bluish pigment dots which are entirely absent in this species. The color is white, with a yellowish cast. The buccal cone is sharp and projects as far forwards as in *N. muscorum*; while the antennæ are rather larger, comparatively, than in that species, though of the same form. This is what we would expect in an albino species. The presence of but four eyes instead of six is, however, the distinguishing feature, though not very easy of determination. *N. muscorum*, when young has two eye patches on each side of the head, but the front one always bears two ocelli. They are rare and occur under sticks in damp places.

Aphoromma granaria (Nic.).

Pl. XII, Figs. 10-11.

1847. *Anoura granaria*. Nicolet, Ann. Soc. Ent. France.
 1862. *Anoura granaria*. Lubbock, Notes on the Thys. Pt. II. p. 601.
 1871. *Anurida granaria*. Tullberg, Fört. öfv. Sv. Podur. p. 155.
 1872. *Anurida granaria*. Tullberg, Sver. Podur. p. 56. Pl. XII, 13-17.
 1873. *Anoura granaria*. Lubbock, Monogr. Coll. and Thys. p. 198. Pl. XLIX.
 1890. *Anurida granaria*. Uzel, Thys. Bohem. p. 76.
 1891. *Anoura granaria*. MacGillivray, Cat. Thys. of N. Amer. Can. Ent. XXIII. p. 276.
 1893. *Aphoromma granaria*. MacGillivray, Can. Ent. XXV.
 1893. *Anurida granaria*. Schött, Palæarct. Coll. p. 92.
 1895. *Anurida granaria*. Reuter, Finl. Coll. p. 33.
 1896. *Anurida granaria*. Lie-Pettersen, Norg. Coll. p. 21.
 1896. *Anurida granaria*. Schäffer, Coll. v. Hamburg. p. 167.

"Entirely white. Body, antennæ and legs finely granular. Length, 2mm. Entirely of a uniform, opaque, alabaster white, excepting the median part of the back, which is slightly tinted with dark yellow and rather transparent. The body is clothed with short hairs, more numerous on the antennæ; the whole surface above and below, as well as the antennæ and legs, covered with a granulation, very fine and regular; the granules in rounded cones. The buccal cone is large, short, rounded at the tip, its opening indicated by a very distinct little transverse slit; the feet bear a single rather long claw: finally, the anal segment is composed of three hemispherical tubercles (mamelons), a superior and two inferior, at the center of which is the anus." I think no one has mentioned the sense knobs on the antennal tips. They are much as in *Anurida tullbergi*. The post-antennal organs are situated rather high up on the head, instead of more laterally as in the *Aphoruras*, and are rounded in outline, consisting of 12 to 14 "tumores" of triangular shape, their longest points extending inward toward the center of the ring. Nicolet remarks a yellow tint down the middle of the back. Tullberg says most of his specimens were entirely white, but a few found among some rubbish thrown up by the sea were yellowish. The specimens are so colorless that any yellow food matter in the intestinal tract shows through very plainly, and may possibly have

given rise to the above observations. I have but three specimens, which were taken under the bark of a pine log on Gray Cloud Island, in the Mississippi River below St. Paul. The log came down from the northern pineries, and possibly the specimens came down with it. MacGillivray records the species from Ohio.

LIST OF NEW SPECIES

The figure immediately following the name of the species refers to the text page; the others refer to the plate and figures.

- Sminthurus curvisetis*, 50; III, 1-7.
 " *longisetis*, 51; III, 8-13b.
 " *minnesotensis*, 52; II, 10-16 and XIV.
Orchesella albosa, 61; I, 14, 15.
 " *zebra*, 61; I, 8-13 and XVI, 1.
Isotoma minima, 63; IX, 17-19 and X, 1.
 " *bidenticula*, 66; X, 2-4.
 " *catena*, 69; IX, 15-16b.
 " *caeruleatra*, 70; IX, 11-14.
 " *muskegis*, 72; XIII.
Entomobrya bicolor, 73; XVI, 2.
 " *clitellaria*, 75; XV.
Lepidocyrtus decemoculatus, 85; VII, 14.
 " *sexoculatus*, 86; VII, 13.
 " *aenescens*, 89.
Xenylla gracilis, 95; XI, 12-15.
Friesia caldaria, 95; XI, 16-18.
Neanura quadrioculata, 101; XII, 15.

INDEX

Names and figures in boldface indicate respectively full descriptions and the pages on which the descriptions begin. Roman numerals indicate plates.

- Abd. I, Abd. II..... 23.
 Abdomen of the Collembola.... 7.
 Abdominal appendages.....7, 8.
ACHORUTES..38, 6, 7, 40, 72, 96.
 aquatica 94.
 boletivorus..... 89, X, 91, 93.
 longispinus..... 90, X, XI. 99.
 muscorum 100.
 nicicola 89.
 schneideri..... 91, X, XI. 93.
 schötti..... 93, X, XI.
 socialis.....92, X, XI. 93.
 tuberculatus 100.
Aetheocerus aquaticus..... 71.
 Anal horns..... 8, 23.
 Anal organs..... 23.
 Anal papilla..... 23.
 Anal tubercle..... 23.
Anoura
 granaria 102.
 muscorum 100.
 tuberculata 100.
 Ant. I, Ant. II..... 23.
 Antennæ 6.
 Antennal organs..... 6, 23.
Anura
 gibbosa 100.
 granaria 102.
 muscorum 100.
ANURIDA 42.
 granaria 102.
 maritima 5, 99.
 tullbergi 99, 102.
ANUROPHORUS 42.
 ambulans 97.
 laricis 98.
 Anus 8.
APHOROMMA 42.
 granaria 102.
APHORURA 41.
 ambulans 97, XII, 65, 96.
 fimetaria 98.
 inermis 96.
APHORURIDAE 40, 3.
 Apterygogenea 9, 25.
 Appendages, of the abdomen... 7.
 biramus 9, 10.
 of the head..... 5.
 of the thorax..... 6.
Beckia albinus..... 82.
 Bibliography 15.
 Biramus appendages..... 10.
 Bittacus 8.
 Boreus 8.
Calistella 86.
 Campodea 9.
 Catch 8, 23.
 Caudal appendage..... 8.
 Characters of the Collembola.. 5.
 Clavate hairs..... 23.
 Claws..... 7, 10, 23.
 inferior 23.
 inner 23.
 outer 23.
 superior 23.
 Clubbed hairs..... 7, 23.
 Collecting Collembola..... 13.
 Collembola, Key to the order of 25.
 Coxa 7.
 Crystalpoduren 82.
CYPHODEIRUS... 35, 34, 86, 87.
 albinus..... 82, 65, 86, 97.
 Cyphoderus
 albinus 82.
 albinus 82.
Degeeria
 arborea 77.
 corticalis 77.
 cyanea 83.
 decemfasciata 78.
 disjuncta 77.
 lanuginosa..... 77.
 marginata 78.
 multifasciata 77.
 muscorum..... 77.
 nicoletii 77.
 nivalis 77.
 pulchella 78.
 purpurascens 76.

- Dentes 8, 23.
 Denticles of the claws..... 7.
 Desoria
 annulata 68.
 cylindrica 68.
 ebriosa 68.
 fusca 68.
 pallida 68.
 viatica 68.
 Distribution of the Collembola, 11.
- Economic importance of the
 Collembola 3.
 Entognatha 5.
- ENTOMOBRYA**..... 33, 35, 87.
 bicolor..... 73, XVI. 76.
 clitellaria..... 75, XV. 34.
 dorsalis..... 74, 76.
 multifasciata..... 77, 34.
 orcheselloides 74.
 purpurascens 76.
 spectabilis..... 77, VIII.
- ENTOMOBRYIDAE**.... 29, 26, 37.
 Eyepatches 5.
 Eyes..... 5, 10, 11, 12.
- Femur 7.
- FRIESIA** 40.
 caldaria..... 95, XI.
 mirabilis..... 40, 96.
 Furcula..... 8, 10, 23.
 General characters of the Col-
 lembola 5.
- Genital papilla..... 8, 23.
- Habits of the Collembola..... 11.
- Hairs
 clavate 23.
 clubbed 7, 23.
 tactile 6.
 tenent 7, 23.
- Halthaken 8.
 Head of the Collembola..... 5.
 Heterotoma chlorata..... 68.
 Hypogastrura aquatica..... 94.
- Inferior claws..... 23.
 Inner claws..... 23.
- ISOTOMA**..... 31, 33, 86.
 alba 64.
 anglicana 68.
 bidenticula..... 66, X. 64.
 catena..... 69, IX.
 cæruleatra..... 70, IX.
 fimetaria..... 64, X. 86, 96, 97.
 grandiceps 70.
 hiemalis 70.
 leonina..... 67, IX.
- lineata** 68.
minima..... 63, IX, X. 66, 96.
minuta 63.
muskegis..... 72, XIII.
palustris..... 70, IX. 68, 69.
palustris var. **fucicola**..... 69.
quadriculata..... 65, X. 64.
sensibilis..... 67, IX.
tricolor 68.
viridis..... 68, IX. 69.
- Key to the:—
 Family Aphoruridæ..... 41.
 " Entomobryidæ 29.
 " Poduridæ 38.
 " Sminthuridæ 25.
 Genus Achorutes..... 39.
 " Aphorura 41.
 " Entomobrya 34.
 " Isotoma 32.
 " Lepidocyrtus 36.
 " Neanura 42.
 " Orchesella 30.
 " Papiirus 26.
 " Seira 36.
 " Sminthurus 27.
 " Tomocerus 35.
 Order Collembola..... 25.
- La Podure brune enfumée.... 53.
 La Podure brune ronde..... 53.
 La Podure noire aquarique... 93.
 Legs 7.
 Length 23.
- LEPIDOCYRTUS**..... 36, 34, 87.
 ænescens 89.
 æneus 88.
 albicans..... 85, VII. 87.
 albinos 82.
 decemoculatus..... 85, VII. 86.
 lanuginosus 88.
 purpureus.... 87, VII. 85, 88, 89.
 pusillus..... 88, 89.
 sexoculatus..... 86, VII.
- Lipura
 ambulans 97.
 corticina 98.
 fimetaria 96.
 inermis 96.
- Literature consulted..... 15.
 List of new species..... 105.
- Machilis..... 6, 8, 9, 10, 11.
 Macrotoma
 celer 80.
 ferruginosa 80.
 lepida 89.
 nigra 80.
 vulgaris 81.
 Manubrium 10, 23.

- Mesothorax 6.
 Metathorax 6.
 Mouthparts 5.
 Mucrones 23.
NEANURA..... 42, 6, 7.
 muscorum..... 100, XII. 101.
 quadrioculata..... 101, XII.
 Neuroptera 8.
 New species, List of..... 105.
 Ocelli..... 5, 10, 11, 12.
ORCHESELLA 30.
 albosa..... 61, I.
 cineta. Regeneration of an-
 tennæ 62.
 zebra..... 61, I, XVI.
 Orthoptera 5.
 Outer claws 23.
 Ovipositor 8.
 Panorpa 8.
PAPIRIUS..... 26, 6, 7.
 ater 58.
 maculosus..... 58, I, 5, 52.
 marmoratus 53.
 unicolor 59.
 Pediculidæ 10.
 Phylogeny of the Collembola.. 9.
 Pilosi 27.
PODURA..... 39, 38.
 ambulans 97.
 aquatica..... 93, XI. 58.
 " *cinerea* 70.
 " *nigra* 93.
 atra 53.
 fasciata 77.
 fimetaria 64.
 fusca 53.
 fusco-nigra 53.
 globosa fusca..... 53.
 lanuginosa 88.
 palustris..... 70, 71.
 psi 71.
 pusilla 88.
 signata 53.
 simplex 77.
 striata 77.
 terrestris 64.
 variegata 77.
 viridis 68.
PODURIDAE..... 37, 31.
 Postantennal organs..... 6, 23.
 Preserving Collembola..... 13.
 Prothorax 6.
 Pterygota 9.
 Regeneration of antennæ..... 62.
 Relationships of the Collem-
 bola 9.
 Saltatory organ..... 8, 23.
 Scales..... 9, 36, 85.
SEIRA..... 35, 34.
 buskii..... 83, VIII.
 nigromaculata..... 84, VIII. 83.
 Setosi 27.
 Sinella 87.
 Sira
 buskii 83.
 elongata 84.
 nigromaculata 84.
SMINTHURIDAE.... 25, 5, 6, 38.
SMINTHURUS..... 27, 6, 86.
 aquaticus..... 56.
 arvalis 4.
 aureus..... 43, V. 46, 48.
 bimaculatus..... 46, 47.
 cæcus..... 49, IV, V.
 cœcus 49.
 curvisetis..... 50, III. 51.
 fuscus..... 53, II.
 longisetis..... 51, III.
 malmgrenii 56.
 minnesotensis 52, II, XIV. 51, 59.
 minutus..... 44, V. 46, 47, 48.
 multifasciatus 53.
 niger..... 47, V. 46.
 novemlineatus..... 57, 58.
 penicillifer... 55, IV. 39, 56, 58.
 pruinosis..... 48, III.
 quadrimaculatus... 45, V. 47, 42.
 spinatus..... 57, IV. 39.
 Smynthurus
 ater..... 47, 53.
 aureus 43.
 benitus 49.
 bourletii 46.
 buskii 53.
 frontalis 48.
 fuliginosus 47.
 fuscus..... 53, 54.
 minutus 44.
 niger 47.
 quadrimaculata..... 45, 46.
 6—*maculata* 45.
 signatus 53.
 Spring..... 8, 23.
 Springgabel 8.
 Superior claws 23.
 Tactile hairs..... 6.
 Tactile organs..... 6.
 Tail 8.
 Tarsus 7.
 Teeth of claws..... 7.
 Tenaculum..... 8, 10, 23.
 Tenent hairs..... 7, 23.
 Tergum 12.
 Terms, technical..... 23.

- Th. I, Th. II..... 23.
 Thorax of the Collembola..... 6.
THYSANURA..... 25, 9, 10.
 Tibia 7.
TOMOCERUS..... 35, 6, 11, 29.
 arcticus..... 79, VI, VII. 81.
 celer 80.
 lepida 81.
 niger..... 80, VI, VII.
 plumbeus 81.
 vulgaris 81.
 Trochanter 7.
 Tullbergia immaculata..... 82.
 Ventral tube..... 7, 11, 23.
 Vesicles, exsertile..... 11.
 Wings 10.
XENYLLA 40.
 gracilis..... 95, XI.

EXPLANATION OF PLATE I.

Papirius maculosus Schött.

Fig.

1. Antenna
2. Foot of 3d pair
3. Foot of 1st pair
4. Right eye patch
- 5a. Mucrones, dorsal view
- 5b. Mucrones, lateral view
- 5c. Notched hair from 5a
6. Tenaculum
7. Dorsal bristle

Orchesella zebra n. sp.

8. Left eye patch
9. Claw
10. End of Furcula, lateral view
11. Antenna.
- 12a and b. Pair of antennæ, one showing mutilation
13. Pinnate hair from dorsal thoracic fringe

Orchesella albosa n. sp.

14. Right eye patch
15. Antenna.





EXPLANATION OF PLATE II.

Sminthurus fuscus (L.).

Fig.

1. Furcula, lateral view
- 2a. Genital papilla, lateral view
- 2b. Genital papilla, ventral view
- 3a. Tenaculum, lateral view
- 3b. Tenaculum, seen from behind
4. Mucrones
- 5a. Anal organ, seen from above
- 5b. Anal organ seen laterally
6. Left eye patch.
7. Foot, 1st pair
8. Antenna of a young individual
9. Antenna of a mature individual

Sminthurus minnesotensis n. sp.

10. Antenna
11. A dorsal bristle
12. Mucrones
13. Right eye patch
14. Foot, 3d pair
15. Foot, 2nd pair
16. Vertex of head, oblique lateral view



EXPLANATION OF PLATE III.

Sminthurus curvisetis n. sp.

Fig.

1. Antenna
2. Left eye patch
3. Dorsal bristle
4. Anal segment; a, anal organ; b, genital papilla
5. Mucrones
6. Claw
7. Tenaculum, lateral view

Sminthurus longisetis n. sp.

8. Furcula
9. Antenna
10. Mucrones
11. Anal organ, seen flat
12. Claw
- 13a. Dorsal bristle
- 13b. End of 13a enlarged

Sminthurus pruinosus Tullb.

14. End of furcula
15. Foot



EXPLANATION OF PLATE IV.

Sminthurus spinatus MacG.

Fig.

1. Foot, 1st pair
2. Foot, 3d pair
3. Furcula, ventral view
4. Right eye patch
5. Anal segment of female
6. Anal segment of male
7. Antenna of male
8. Antenna of female

Sminthurus penicillifer Schöff.

Fig.

9. Foot, 1st pair
10. Right eye patch
11. Antenna
12. Mucrones

Sminthurus caecus Tullb.

13. Antenna



EXPLANATION OF PLATE V.

Sminthurus caecus Tullb.

Fig.

1. Anal organ and its papilla
2. Furcula, lateral view
- 3a. Mucrones, ventral view
- 3b. mucrones, lateral view
4. Foot, 1st pair

Sminthurus aureus Lubb.

5. foot, 3d pair
6. Furcula, ventral view
- 7a. Mucrones, oblique view
- 7b. Mucrones, lateral view
8. Antenna.
9. Left eye patch

Sminthurus quadrimaculatus Ryd.

- 10a. Anal organ, seen flat
- 10b. Anal organ, seen laterally.

Sminthurus minutus MacG.

- 11a. Anal organ seen laterally
- 11b. Anal organ median section through papilla
12. Left eye patch
13. Foot, 1st pair
14. Foot, 3d pair
15. Mucrones

Sminthurus niger Lubb.

16. Left eye patch
17. Mucrones, lateral view
18. Antenna



EXPLANATION OF PLATE VI.

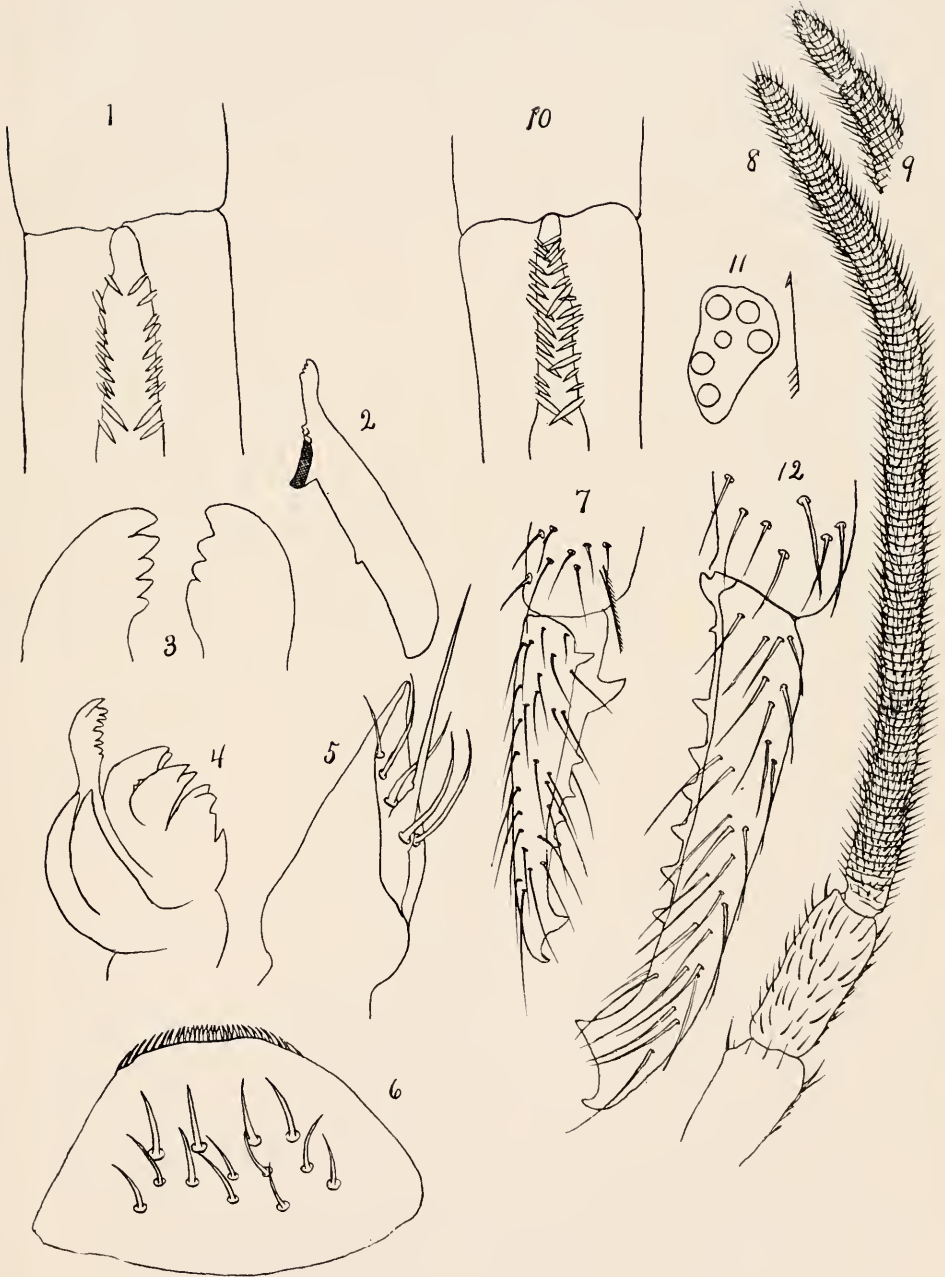
Tomocerus arcticus Schött.

Fig.

1. Dentes, showing spines
2. Mandible
3. Tips of the two mandibles
4. Maxilla
5. Palp
6. Labrum
7. Mucrones
8. Mutilated antenna
9. Tip of normal antenna

Tomocerus niger Bourl.

10. Dentes, showing spines
11. Left eye patch
12. Mucrones



EXPLANATION OF PLATE VII.

Tomocerus arcticus Schött.

Fig.

1. Scale.
2. Scale
- 3a. Claw, seen from above
- 3b. Claw, lateral view
- 4a. Clavate hair of tibia, lateral view
- 4b. Clavate hair of tibia, flat view

Tomocerus niger Bourl.

5. Claw, lateral view

Lepidocyrtus albicans Reut.

- 6a. Mucrones, lateral view
- 6b. Mucrones, ventral view
7. Thorax, lateral view
8. Antenna

Lepidocyrtus purpureus Lubb.

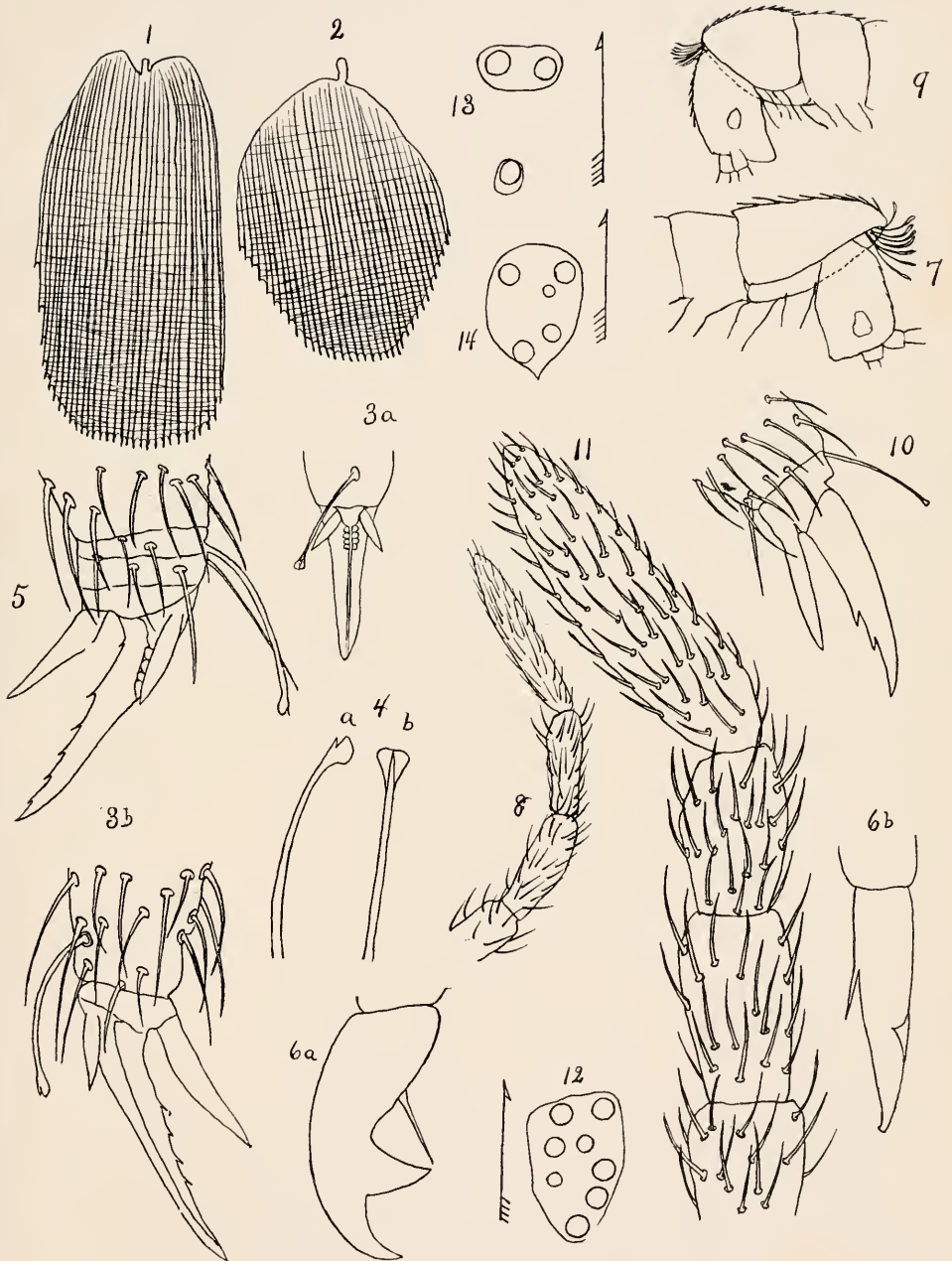
9. Thorax, lateral view
10. Foot
11. Antenna
12. Right eye patch

Lepidocyrtus sexoculatus n. sp.

13. Left eye patch

Lepidocyrtus decemoculatus n. sp.

14. Left eye patch



EXPLANATION OF PLATE VIII.

Seira nigromaculata Lubb.

Fig.

1. Foot
2. Scale
3. Mucrones
4. Right eye patch
5. Furcula, lateral view
6. Dorsal bristle
7. Antenna

Seira buskii Lubb.

8. Right eye patch

Cyphodeirus albinus Nic.

9. Foot
10. Antenna
11. Mucrones

Entomobrya spectabilis Reut.

12. Foot
13. Right eye patch
14. Antenna
15. Furcula, prone
16. Mucrones, lateral view



EXPLANATION OF PLATE IX.

Isotoma leonina Pack.

Fig.

1. Dorsal view of the head
2. Right eye patch and post-antennal organ
3. End of furcula
4. Claw

Isotoma viridis Bourl.

5. Left eye patch
6. Tenaculum
7. Antenna

Isotoma palustris Müller.

8. Antenna
9. Right eye patch
10. End of furcula

Isotoma caeruleatra n. sp.

11. Antenna
12. Foot
13. End of furcula
14. Right eye patch

Isotoma catena n. sp.

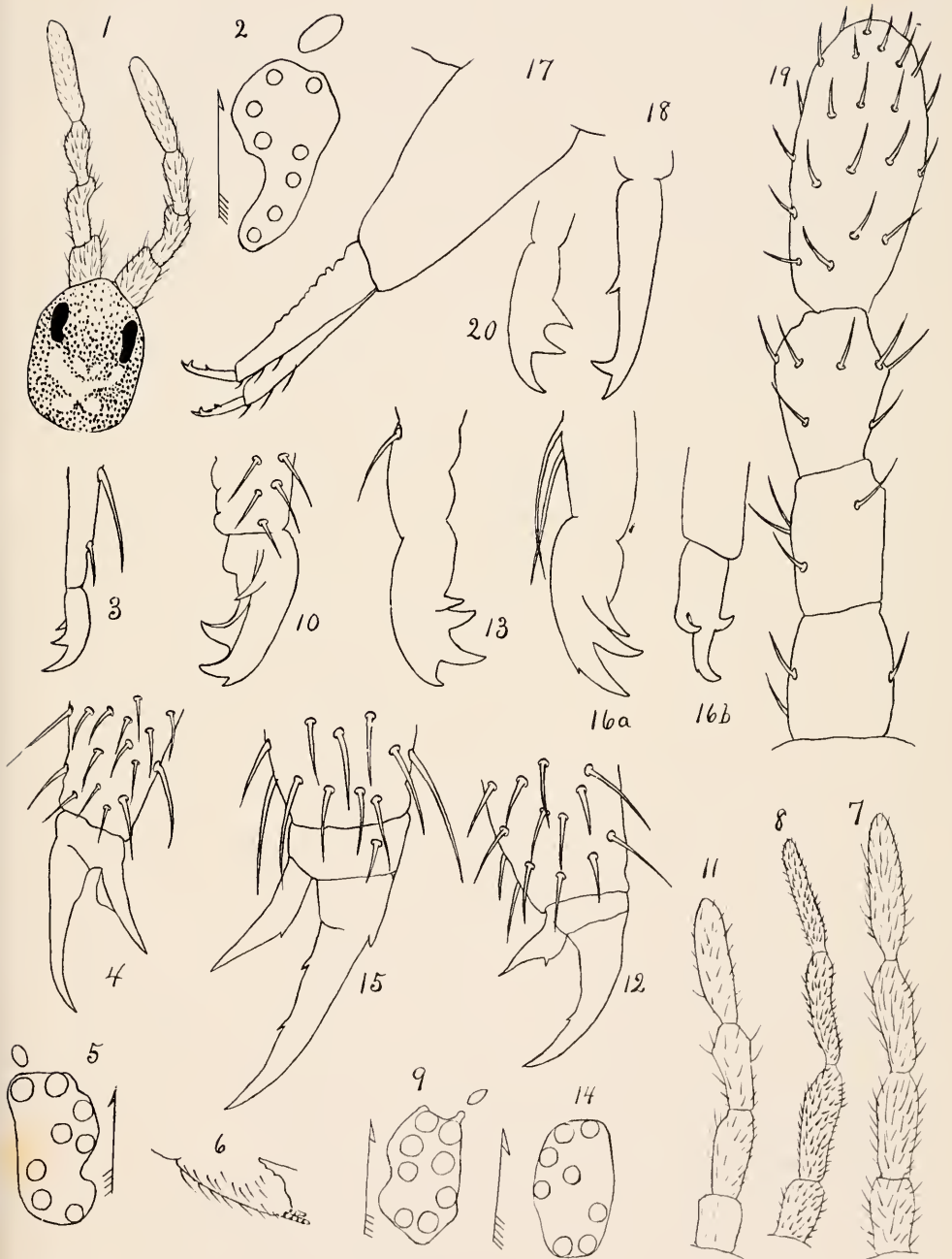
15. Foot.
- 16a. End of furcula, lateral view
- 16b. End of furcula, ventral view

Isotoma minima n. sp.

17. Furcula, lateral view
18. Mucrones, lateral view
19. Antenna

Isotoma sensibilis Tullb.

20. Mucrones



EXPLANATION OF PLATE X.

Isotoma minima n. sp.

Fig.

1. Right eye patch and post-antennal organ

Isotoma bidenticula n. sp.

2. Furcula
3. Mucrones
4. Right eye patch and post-antennal organ

Isotoma fimetaria (L.), Tullb.

5. Foot
6. Furcula

Isotoma quadrioculata Tullb.

7. Right eye patch and post-antennal organ
8. Foot

Achorutes schneideri Schöff.

9. Antenna.
10. Posterior abdominal segments
11. Furcula
12. Dentes and mucrones

Achorutes boletivorus Pack.

13. Antenna
14. Furcula

Achorutes longispinus Tullb.

15. Posterior abdominal segments
16. Anal horn

Achorutes schötti Reut.

17. Posterior abdominal segments
18. Furcula
19. Dentes and mucrones

Achorutes socialis Uzel.

20. Anal horn
21. Posterior abdominal segments
22. Furcula
23. End of furcula



EXPLANATION OF PLATE XI.

Achorutes schneideri Schöff.

Fig.

1. Foot
2. Right eye patch

Achorutes socialis Uzel.

3. Foot

Achorutes schötti Reut.

4. Foot

Achorutes longispinus Tullb.

5. Foot

Podura aquatica Linn.

6. Foot
7. Tenaculum
8. Furcula, extended, seen from above
9. Furcula, lateral view
10. End of furcula, ventral view
11. Antenna

Xenylla gracilis n. sp.

12. Right eye patch
13. Posterior abdominal segments
14. Anal horns, seen from above
15. Furcula

Friesia caldaria n. sp.

16. One of the anal horns
17. Lateral view of posterior part of the abdomen
18. Furcula





EXPLANATION OF PLATE XII.

Anurophorus laricis Nic.

Fig.

1. Antenna
2. Foot

Aphorura ambulans (L., Nic.)^{*}

3. Antenna, lateral view
4. Antenna, ventral view
5. Foot
6. Posterior end of abdomen
7. Posterior end of abdomen, ventral view

Anurida tullbergi Schött.

8. Tip of antenna showing sense organ
9. Right eye spot and post-antennal organ

Aphoromma granaria (Templ.).

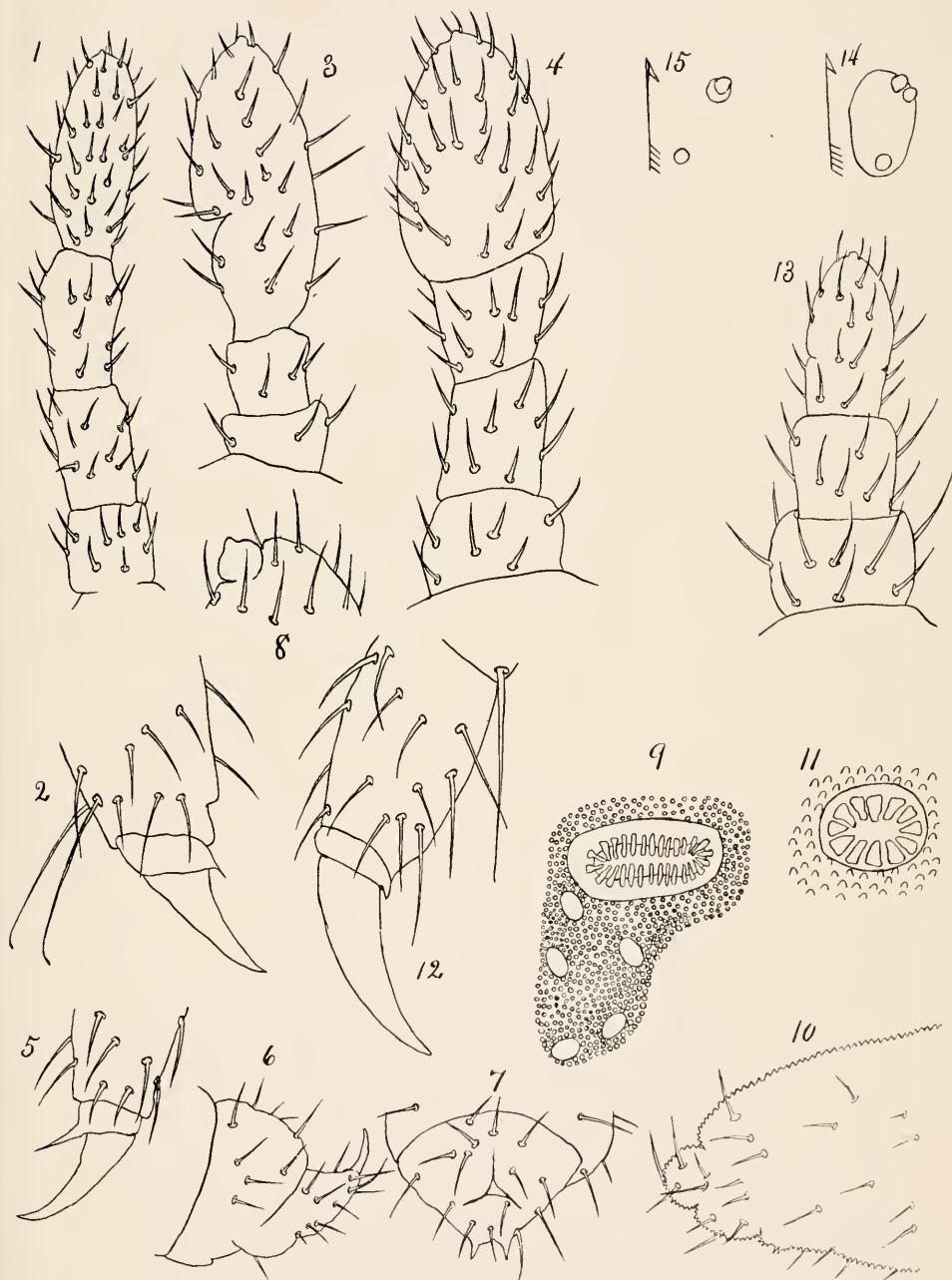
10. Posterior end of abdomen, lateral view
11. Post-antennal organ

Neanura muscorum (Templ.).

12. Foot
13. Antenna
14. Right eye patch

Neanura quadrioculata n. sp.

15. Right eye

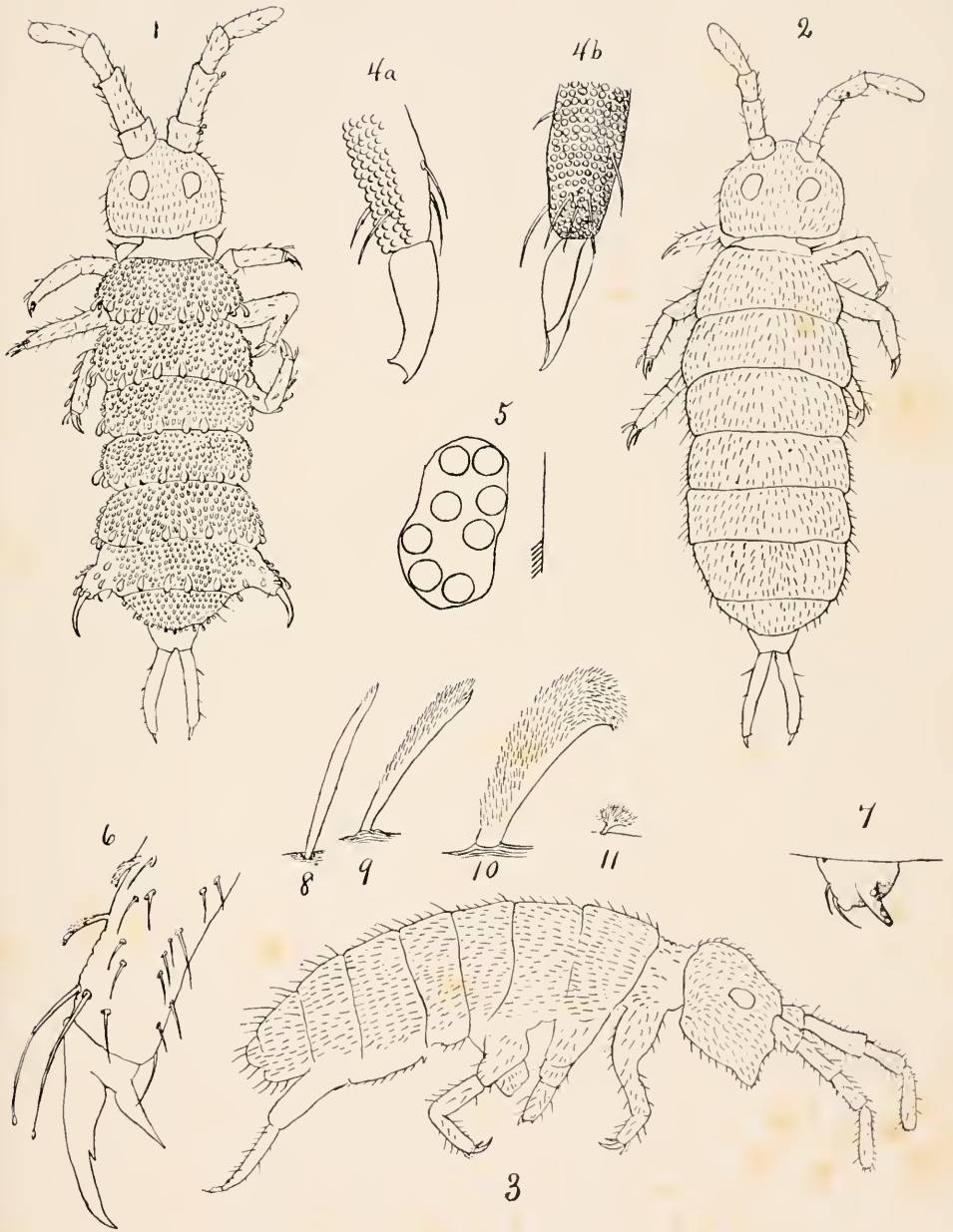


EXPLANATION OF PLATE XIII.

Isotoma muskegis n. sp.

Fig.

1. Dorsal view of male
2. Dorsal view of female
3. Lateral view of female
- 4a. Distal end of furcula, lateral view
- 4b. Distal end of furcula, ventral view
5. Left eye patch
6. Foot of male
7. Tenaculum
- 8—11. Sensory tubercles of male

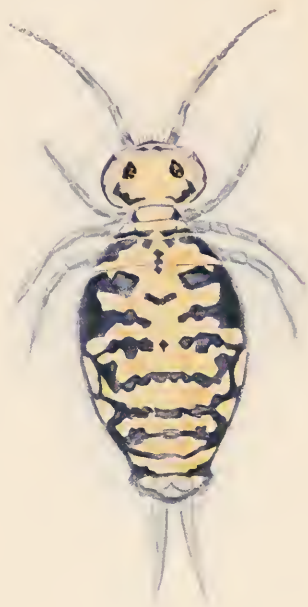


EXPLANATION OF PLATE XIV.

Sminthurus minnesotensis n. sp.

Dorsal and lateral views

Figures made by Charlotte M. King.



Sminthurus minnesotensis

EXPLANATION OF PLATE XV.

Entomobrya clitellaria n. sp.

Dorsal and lateral views



Entomobrya clitellaria

EXPLANATION OF PLATE XVI.

Fig.

1. *Orchesella zebra* n. sp.
2. *Entomobrya bicolor* n. sp.

Figures made by Charlotté M. King.



Orchesella zebra



Entomobrya bicolor

