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TABLE OF CONTENTS.

JACKSON, MRS.—A Study of Ohio Forms of the Genus <i>Lepidocyrtus</i>	525
HYDE—The Reduction Division in the Anthers of <i>Hyacinthus Orientalis</i>	539
MCCRAY—Meeting of the Biological Club.....	544

A STUDY OF OHIO FORMS OF THE GENUS *LEPIDOCYRTUS*.*

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The following paper gives the results of a study of the Ohio forms of the genus *Lepidocyrtus*, including notes on the classification, a discussion of the geographical distribution, and observations on the life history.

My studies were carried on at the Ohio State University under the direction of Professor Herbert Osborn, whose kind assistance has been greatly appreciated. Thanks should also be given to Professor J. W. Folsom who has read and criticised the paper.

A review of the literature on the family Entomobryidae has shown but little work done on the genus *Lepidocyrtus* except in the description of species. For this reason a special study of the Ohio species has been attempted with the hope of being able to add some notes of interest on the life history.

The habits of *Lepidocyrtus* are much the same as for other Collembola generally frequenting damp situations. A favorite locality seems to be underneath the bark of old trees, or among dead leaves and under stones. An exception to this is found in the case of *L. cephalopurpureus* Harvey, which was found in stored celery. *Lepidocyrtus* may be taken throughout the year, in winter being found deep beneath the fallen leaves. As a rule they are very active, and are found living either solitary or in colonies. Our North American species range in size from 0.6 to 1.5 mm. in length.

* Contributions from the Department of Zoology and Entomology of the Ohio State University, No. 31.

Color has been used extensively in classifying these insects, but this affords a rather unreliable basis for identification. It is true the color patterns are so permanent in some groups of insects as to become almost a structural character, but it is impossible to give the color such weight in this particular case although many writers have given little else in their identification of certain species of *Lepidocyrtus*. Color is evidently an especially unstable character in this genus on account of the iridescent scales. The opalescent effect never appears the same under two varying lights, and even though the general tone of the insect may be dark or light, it is often very difficult to say just what the most uniform color of the specimen may be. If, however, the structural characters of the antennae, eyes, claws and spring, and the length of the adult insect are given, there should be little trouble in the identification. Not that the color should be disregarded but rather that the greater importance of the structural features should be emphasized. It is the lack of these important characters that makes it impossible to formulate a key to the genus.

The genus *Lepidocyrtus* was proposed by M. L'Abbé Bourlet in his "Mémoire sur les Podures" published in 1839, for that group of the Linnaean genus *Podura* having, "Antennes courtes, de quatre articles, huit ocelles," and "couvertes d'écaillés." Not all of the genera proposed by M. Bourlet at that time were accepted, but *Lepidocyrtus* was, and has been retained until the present time.

CLASSIFICATION:—The distinguishing characters of the genus *Lepidocyrtus* as it is recognized to-day are the projecting mesonotum, the short, four-jointed antennae, and the presence of scales. The number of ocelli has been given as characteristic, but this cannot be depended upon.

In the dorsal view of *L. luteus* n. sp. the head is almost entirely concealed, while in *L. purpureus* Lubbock the pronotum projects but little. The character of the scales and of the antennae may be considered as constant, but it is sometimes a difficult matter to distinguish between the projecting mesonotum of a *Lepidocyrtus*, and that of *Seira* which differs from the former genus only in not possessing the projecting mesonotum. The gradation between the two is so gradual that this character often proves quite unsatisfactory, for which reason it is necessary to take other characters into consideration in the determination of certain species.

The antennae are comparatively short throughout the genus, never being so long as the body. An examination of numerous forms has shown that the number of the ocelli in the eye spot may range from a single ocellus to as many as eight. The

abdomen is long and cylindrical, the fourth segment being about three or four times as long as the third. The dentes are usually serrated, while the mucrones end in the characteristic incurved hook, with a middle tooth nearly as large as the terminal one. There may be also one or two spurs attached above these teeth. A tenaculum is present and lies in a groove underneath the spring.

Most of the species of this genus bear two teeth on the larger claw of the foot and none on the smaller. However in some cases, we find but a single tooth on the larger one. The iridescent scales form a secondary character in classification, as does also the color of the insect, which is so dependent upon the reflection of light on the scales.

Club-shaped hairs may be borne on various parts of the body. On the anterior edge of the mesonotum of some species is a characteristic collar of these club-shaped hairs, sometimes extending over the head for a considerable distance. Tenent hairs are usually present on the tibia, and very long unknobbed hairs are scattered over other parts of the body. Both the long and short hairs are often distinctly fringed.

GEOGRAPHICAL DISTRIBUTION:—As a group, Collembola may be said to have a general distribution, some species covering a wide range. According to Folsom, *Achorutes armatus* has been recorded throughout Europe, in the United States, Uruguay, Valparaiso, Siberia, Sumatra and Greenland. We have no such record as this for *Lepidocyrtus* however. It has been noted that only the more generalized types of Collembola are found in very cold climates, which probably explains why *Lepidocyrtus* is restricted to the warmer regions, at least within the southern Arctic and Temperate zones, it being among the more specialized types of Collembola. They do not seem to be able to withstand the extreme conditions of the arctic regions but have become specialized to such an extent that certain special conditions of moisture, food and temperature are necessary for their existence. Again, it is probable that the somewhat restricted range of *Lepidocyrtus* is due to the fact that they have small chances for dispersal. Water forms one of the most important means of distribution that Collembola have especially for those forms that are structurally adapted for a semi-aquatic life, but I know of no *Lepidocyrtus* that is thus adapted. In fact, my experience has been to find them in the dryer situations, and unable to withstand an excess of moisture. For this reason they are not likely to be carried far by water.

It is not probable that the wind can be a very important factor in carrying *Lepidocyrtus*. Their habit of secreting themselves in the fallen wood, etc., reduces the liability of such trans-

portation to a minimum. They have no wings, and so would not be apt to be caught by the wind and carried for long distances as many other insects are.

Two factors may possibly enter into the distribution of members of the genus. A number of species of Entomobryidae have been found in bird's nests, and it is quite possible for *Lepidocyrtus* to be transported from one locality to another on the material used for building the nests. Another means of dispersal is upon articles of commerce of various kinds, especially on any sort of goods that would afford them some moisture and a vegetable food supply. Probably the most important factor in this connection would be the shipment of logs and lumber products from one section of the country to another.

In the genus *Lepidocyrtus* we have many examples of protective coloration. The iridescent scales reflect the general color of the natural surroundings to such an extent that the insect may be easily overlooked. If a specimen of *L. pusillus* just after molting chances to be on the surface of a dark piece of bark, or on a bit of earth, a very careful search is necessary to reveal it. If in older specimens, in which the bronze tint is more in evidence, the insect happens to be among dead leaves, it is equally well protected.

It is certainly not a very difficult matter for Collembola to adapt themselves to their surroundings and food, requiring, as they do, such simple conditions for their existence that they can live almost anywhere provided they have the required amount of moisture. Still, as regards food habits, there is some degree of preference shown. Some of the Smythuridae frequent moss, cucumber vines and toad stools; many other Collembola as *Isotoma*, *Poduridae*, and *Aphoruridae*, may be adapted to live on the surface of the water, while other species may be found in almost any locality furnishing decaying vegetable matter and moisture. *Lepidocyrtus* show no great specialization in food habits, although I have found *L. pusillus* and *L. purpureus* most abundant under loose bark, or bunches of dead leaves in dryer localities. On the other hand, some of the lighter colored species are found almost exclusively in loose, damp earth.

At present, the center of dispersal of North American *Lepidocyrtus* cannot be located, owing to the vast range of territory not yet studied.

The chances for the distribution of the old world species in America are certainly small in comparison with those of other insects. It is more likely their habits than the absence of wings that so limits their possibilities of distributions. For this reason it is not surprising that the number of new species is constantly being added to as new territory is worked.

DESCRIPTION OF OHIO SPECIES:—No attempt has been made to give a complete bibliography of the species, only the original and the principal American works being cited.

LEPIDOCYRTUS PUSILLUS (Linn.) Pl. XXVIII.

1767. *Podura pusilla* Linn. Syst. Nat. Vol. XII. II, pg. 1014.

1873. *Lepidocyrtus pusillus*. Packard. Syn. Thys. Essex Co., Mass. pg. 37.

1891. *Lepidocyrtus pusillus*. MacGillivray. Canad. Ent., Vol. XXIII, pg. 272.

1903. *Lepidocyrtus pusillus*. Guthrie. Coll. of Minn., pg. 88.

(Description taken from living specimens.)

Color: bluish-bronze or copper, varying from a yellowish tinge in some specimens to bright iridescent blue in freshly molted ones. The prevailing color is bronze, but the scales are so brightly iridescent that the same specimen may at one time appear bronze, at another blue. Antennae: blue, basal segment more yellowish in tint; the blue color of the antennae always retained in mounted specimens; basal segment short, II and III of the same length, IV not quite so long as II and III taken together. Eyes: black; six, possibly eight, ocelli; eye spots plainly visible from dorsal surface at bases of antennae. Various long hairs are found scattered over the body. A long bent hair is situated on either side of abdominal segments IV and V. Mesonotum in dorsal view a little over three times as long as metanotum. Abdominal segment IV, four and one-half times as long as III. Legs: tarsi with two claws, both curving in the same direction; two teeth on larger claw, the distal one just opposite the apex of the smaller claw, the other midway between the distal tooth and the base of larger claw; long hairs present on both femur and tibia. Spring: tinged with blue, mucrones nearly white; manubrium quite a little shorter than dentes, very hairy, dentes long, slender, curved at apex, with sub-annulations on ventral surface; mucrones with two hooks, the apical one long and slender, a spur extending from base of mucrone to opposite point of ante-apical hook; two long, barbed hairs extending from dentes to below end of mucrones; other long, curved hairs found scattered over dentes. Length 1-1.5 mm.

Habits: rather a solitary species, quite common among dead leaves, and under bark, but not in as wet situations as many *Collembola*. When a jar containing dead leaves and rotten wood is brought into the laboratory these insects almost invariably collect in the dryer material on top. If kept in a cell with an excess of moisture they soon die. One specimen measuring 1.5 mm. was kept in a little earthen cell covered with a watch crystal for two months, from the first of March until the first of May. Before molting it appeared decidedly bronze to the naked eye, but afterwards the blues and purples were quite noticeable. Molting took place about every seven or eight days. So many varying descriptions of this species occur with contradictory characters that it is quite impossible to be positive as to the proper identification of specimens. The mesonotum does not project as it does in the extreme forms of *Lepidocyrtus*, although the head is always partially concealed. We believe

that but one other species is liable to be confused with *L. pusillus*, this is *L. purpureus* Lubbock. This species is intensely deep blue, while the third joint of the antennae is shorter than the second, which is not true for *L. pusillus*.

The Ohio specimens agree very closely with Nicolet's description of *L. pusillus*, with the exception of the "granular, deep gray antennae," which probably represent only a variation, or a difference in the interpretation of the iridescent reflections. My specimens do not agree with Guthrie's description in the "clear, nearly uniform tint of the body," but are rather as Nicolet described the species, "d'un bronze foncé et chatoyant." The antennae are longer in proportion to the body than Guthrie gives them, and the colorless spot mediad to each eye was not noticeable. There seems to be many local varieties of this species, which may account for the confusion in the literature. The bent hairs on abdominal segments IV and V may be broken off in mounted specimens, but are always characteristic of living ones. In fact, the Ohio specimens, if we have correctly identified this species, are at once distinguished by the presence of these bent hairs and the bluish-bronze tint of the body.

LEPIDOCYRTUS PURPUREUS LUBBOCK. Pl. XXIX.

1873. *Lepidocyrtus purpureus* Lubbock. Monog. Coll. and Thys., pg. 155; pl. XXX.

1903. *Lepidocyrtus purpureus*. Guthrie. Coll. of Minn. pg. 87.

(Description taken from living specimens.)

Color: to the naked eye a deep, grayish blue, with purple reflections, varying to lighter shades. Under the microscope the color appears a more intense purplish blue. Antennae grayish blue, lighter than body; II nearly twice as long as I; III shorter than II, and nearly one and a half times longer than I; IV over three times as long as I, or nearly equalling II plus III. Eyes: black, eight ocelli. A thick border of clubbed hairs on mesonotum. Fringed hairs are found on the abdomen, legs, manubrium and dentes. Mesonotum in dorsal view almost three times as long as metanotum. Abdominal segment IV three times as long as III. Legs: tibia and tarsi nearly white; coxa, trochanter and femur mottled with blue; the claws are quite characteristic in having a small notch at base of the larger claw, and a slight indentation at the base of the smaller. The ante-apical tooth on the larger claw is opposite the apex of the smaller claw, and the apical tooth a short distance below the ante-apical. Both claws curve in the same direction. True tenent hairs are absent from the tibia. Spring: white; manubrium but little shorter than dentes; the sub-annulations on the dentes not so deep as in some species; apical hook of mucrones more slender than ante-apical; a spur extending from base of mucro to opposite ante-apical hook; long, barbed hairs extending from dentes to apex or slightly beyond apex of mucrones. Total length, 1 mm.

L. purpureus is at once distinguished from *L. pusillus* the most closely allied form, by the much deeper blue color, the absence of curved hairs on the abdomen, and the relative proportion of the segments of the antennae, III being shorter than

II, which is not true for *L. pusillus*. The pigment in *L. purpureus* also presents a decidedly mottled appearance, especially in mounted specimens.

L. purpureus may be synonymous with *L. metallicus*, *L. cyaneus* and *L. iricolor*, but according to Packard's description *L. metallicus* differs in the following respects. The spring is short and thick, the manubrium unusually broad, and the mucrones extra large. It also seems to differ in its blackish-bronze color. As before stated, *L. iricolor* is not sufficiently characterized to identify with any of these species.

L. purpureus is very abundant about Columbus, and may be found in abundance under loose bark of fallen trees, as well as in the other usual localities for *Lepidocyrtus*. It seems to live in the confinement of artificial cells about as well as in its natural surroundings. In coloration it is one of our most beautiful species.

LIFE HISTORY OF *LEPIDOCYRTUS PURPUREUS*. Pl. XXIX. The young of the above species, closely resemble the adults. In color they are a lighter blue, quite silvery to the naked eye, not showing the purple reflections so marked in the adults. The head seems quite out of proportion to the rather slender body. The larvae of *L. purpureus* are remarkably agile, thus very hard to study alive for structural details. Mounted specimens show every detail of character in the claws, spring and antennae found in the adult, even to a constancy in the arrangement of the hairs over the body. The black eye spots are very noticeable at the bases of the antennae, and plainly visible from above, in contrast to *L. sanguineus*. From the colonies observed it seems that eighteen to twenty eggs may be produced at one time by this species. Larval forms measure from 0.20 mm. to 0.25 mm. in length.

LEPIDOCYRTUS SANGUINEUS. n. sp. Pl. XXX.

(Description taken from living and mounted specimens.)

Color: white, with iridescent scales, sometimes with a bluish cast. Antennae: segment III shorter than II; IV nearly or quite twice as long as III, or equalling II plus III; length of segments slightly variable; densely covered with short hairs. Eyes: red, unusually small with single ocellus, appearing at side of head near bases of antennae as mere specks. Plainly visible on ventral surface. Fringe of clubbed hairs on mesonotum clubbed; various long, barbed hairs scattered over the body, legs and head; four long, barbed hairs are found regularly on both abdominal segments II and IV. Scales rectangular, largest on the manubrium. Mesonotum in dorsal view fully four times as long as metanotum. Abdominal segment IV four times as long as III. Legs: tarsi bear two claws, the larger with two teeth; the smaller claw nearly straight with a slight curve at its tip. A long hair is present on the tibia of each foot, but is not a true tenent hair in function. Spring: manubrium densely covered with hairs and large, broad scales; dentes somewhat longer than manubrium,

bearing serrations which in ventral view appear as sub-annulations; mucrones with two hooks, a spur at base extending out almost opposite ante-apical hook, two long, barbed hairs arising from end of dentes, one extending to end of apical hook of mucrones, the other some distance beyond. Length .7-.9 mm.

This small white form is very active, and found commonly about Columbus in the cavities of old rotten wood, and among the leaves and dirt. When feeding the head is barely visible under the projecting mesonotum. It is easily distinguished as a small white form, with the bead-like red eyes at the sides of the head, and the short third joint of the antennae. The eyes, however, soon lose their pigment in alcoholic specimens.

This species is especially interesting as a *Lepidocyrtus* from the fact that it possibly represents the connecting link between *Lepidocyrtus* and the eyeless genus *Cyphodeirus*. Guthrie records one species with five ocelli instead of the typical eight to either eye patch (*L. decemoculatus*) and another (*L. sexoculatus*) with but three ocelli to either eye patch. *L. sanguineus*, as the two above named species, has every character of a *Lepidocyrtus* with the exception of the rudimentary condition of the eyes. When we consider the evidence of such reduction in the other genera, we cannot but feel there is just argument in including such forms with rudimentary eyes in this genus. Again when we consider the gradation in the degree to which the mesonotum projects over the head, and the difficulty in classifying the specimens on this character in some instances, it seems but a step to the genus *Cyphodeirus* in which the thorax projects but little, and possibly even should be united in one genus.

NOTES ON LIFE HISTORY OF *LEPIDOCYRTUS SANGUINEUS*. n. sp.
Pl. XXX.—On May the twenty-fifth the larval forms of *L. sanguineus* were first observed. They were found in colonies of eight or ten individuals in the channels of decayed wood made by wood boring larvae. Each colony probably represented the offspring of one parent. The resemblance to the adult forms was very striking, the apparent absence of eyes, and the larger size of the head in proportion to the body being the only appreciable differences. In color the larvae are silvery-white to the naked eye, the same as the adult, with iridescent scales, and very active. The relative proportions of these larvae when first observed may be seen from the following measurements:

	LARVA.	ADULT.
Total length of insect.....	0.32 mm.	.9 mm.
Width of body.....	0.09 mm.	.30 mm.
Length of antennal segments I.....	0.02 mm.	.045 mm.
II.....	0.03 mm.	.065 mm.
III.....	0.275 mm.	.055 mm.
IV.....	0.065 mm.	.115 mm.
Total length of spring.....	0.17 mm.	.5 mm.
Width of head.....	0.10 mm.	.2 mm.
Length of head.....	0.08 mm.	.16 mm.

Still smaller individuals than the above have been found and it is believed that 0.20 mm. would be a good average for the length of freshly hatched larvae.

One week after the larval forms were first noticed the insects averaged 0.40 mm. in length, an increase of not quite 0.10 mm. The eyes were still not visible.

Three weeks later the average length was 0.55 mm. When the forms showed little change other than an increase in size. One specimen, however, was covered with drops of moisture as if just ready to molt. In a short time the skin split along the mid-dorsal line of the thorax, and the old skin was cast off. For the first time in the life of the now probably five week's old larva the very minute, red, bead-like eyes were visible at the sides of the head at the bases of the antennae. In other words, twenty-eight days had elapsed after the larval forms of 0.32 mm. were first observed before there was any sign of eyes. The forms were now positively identified as *L. sanguineus*.

From the appearance of the eyes of *L. sanguineus* until the adult stage is reached the growth is very slow. Nearly four weeks after the appearance of the eyes the average length of the specimens was 0.7 mm., which may be considered that of the adult form.

The following table will show in brief the relative growth of the insects from the larval to the adult stages:

	AVERAGE LENGTH OF INSECT.	EYES.
March 25.....	0.32 mm.	Absent.
April 1.....	0.40 mm.	Absent.
April 22.....	0.55 mm.	Present.
May 4.....	0.575 mm.	Present.
May 19.....	0.70 mm.	Present.

Specimens of the above species have been kept alive in artificial cells for over ten weeks, but we can not say at present just how long the life of the average individual may be.

LEPIDOCYRTUS LUTEUS n. sp. Pl. XXXI.

(Description taken from living and mounted specimens.)

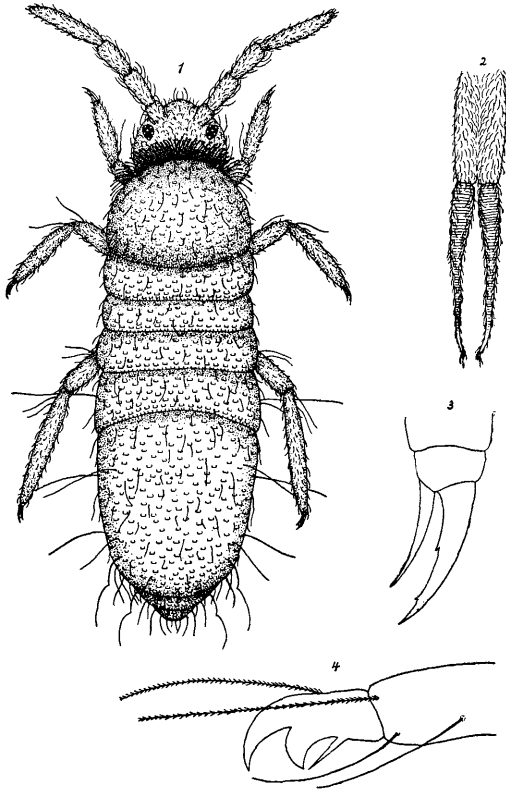
Color: a light bronze or clay color, with iridescent scales reflecting shades of blue and pink. Antennae: I short; II twice as long as I; III shorter than II; IV not quite so long as II plus III. Eyes: black, eye spot much elongated, very characteristic in the arrangement of the eight ocelli. A prominent fringe of clubbed hairs on the mesonotum. An extreme type of *Lepidocyrtus* in the strongly projecting mesonotum, which comes to a decided point over the head, nearly concealing the head beneath it. Barbed hairs are found on various parts of the body, scattered over the spring, abdomen and legs. Legs: with two claws, both curved in the same direction; the larger unusually broad and bearing two teeth, the smaller very slender. Abdomen long and slender; IV about seven times as long as III. Spring: manubrium shorter than dentes; dentes sub-annulated; mucrones as usual, with two hooks, and a long spur extending from base to opposite ante-apical hook; long barbed hairs extending to tip and beyond mucrones. Length, 1-1.5 mm.

Found in the same localities and associated with *L. pusillus* and *L. purpureus*. This species may be readily distinguished by the bronze color of the body, the extreme type of the pointed, projecting mesonotum, and the peculiar arrangement of the ocelli in the elongate eye spot.

NOTE 1. One other form quite numerous about Columbus has been described as a *Lepidocyrtus* by Marlatt in 1896, in *The Canadian Entomologist*, vol. XXVIII, pg. 219, also in U. S. Dept. Agr. Bull., No. 4, pg. 81-83. This species he names *L. americanus*, however it proves to be synonomous with *Seira nigromaculata* Lubbock, which has been reported from Minnesota by Guthrie. Superficially the species possibly resembles a *Lepidocyrtus*, but does not have the projecting mesonotum, while the antennal joints are much longer in proportion than is found among the species of *Lepidocyrtus*.

OHIO NATURALIST.

Plate XXVIII.

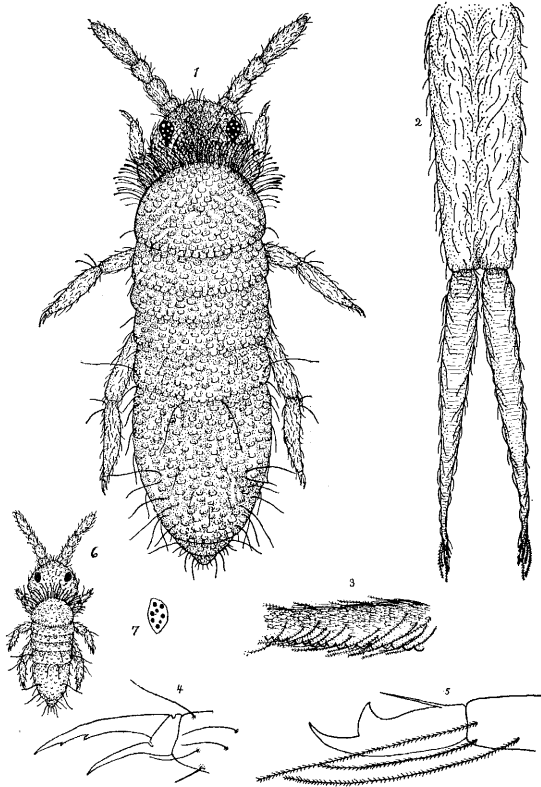


Lepidocyrtus pusillus (Linn.).

1. Dorsal view of insect. 2. Spring. 3. Foot.
4. Mucro, showing spur at base and barbed hairs.

OHIO NATURALIST.

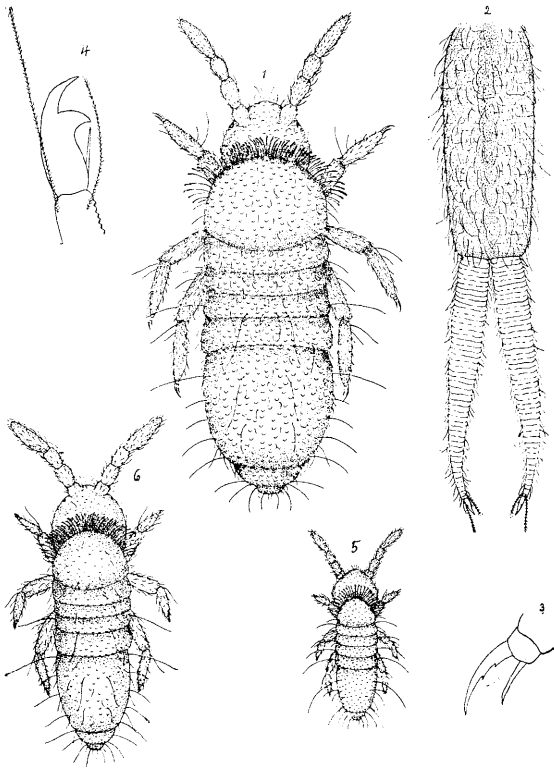
Plate XXIX.

*Lepidocyrtus purpureus* (Lubbock).

1. Dorsal view of insect. 2. Spring. 3. Side view of dens showing serrations and barbed hairs. 4. Foot. 5. Side view of mucro. 6. Larval form. 7. Eyespot of larval form.

OHIO NATURALIST.

Plate XXX.

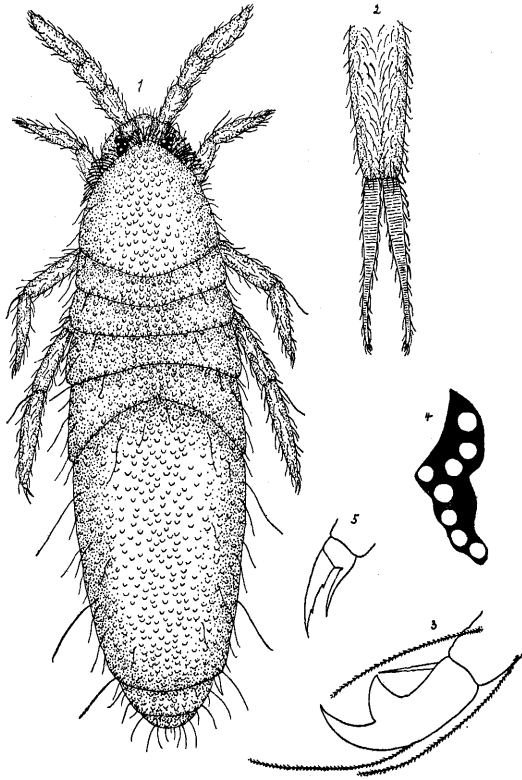


Lepidocyrtus sanguineus (Jackson).

- 1. Dorsal view of insect. 2. Spring. 3. Foot.
- 4. Side view of mucro. 5. Larval form measuring .032 mm. 6. Same as former, one month later, on first appearance of eyes.

OHIO NATURALIST.

XXXI.



Lepidocyrtus luteus (Jackson).

1. Dorsal view of insect. 2. Spring. 3. Side view of mucro. 4. Eye spot. 5. Foot.