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An Anatomical Study of the Neural Tube and Cranial Ganglia of the Developmental Stages of *Amblystoma maculatum* [1]

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ABSTRACT: The olfactory placode is an irregularly shaped mass of cells throughout the four stages of development studied. The lateral surface, which is smooth and relatively flat in the nonmotile stage is somewhat spherical and contains a pit by the early swimming stage. It is essentially the same size throughout the series, except for some increase in thickness. The olfactory placode makes contact with two other structures, the telencephalon ventrally and medially and the eye primordium posteriorly.

The eye undergoes much differentiation. From a relatively flat, irregularly shaped group of cells with a shallow depression on its lateral surface it develops into a thick oval structure having a definite outline. It is in contact with the olfactory placode anteriorly and ventrally, with the diencephalon by way of the optic stalk, and with either one or both of the ganglia of the fifth cranial nerve.

The ganglia of the various nerve complexes differentiate from elongated, irregular masses of cells having very indefinite outlines to more regularly shaped structures which have discernible outlines. In general in the nonmotile stage the ganglia lie at some distance from the neural tube, being connected to the tube by slender root fibers which are surrounded by cells of the root mass at the neural tube. The ganglia gradually recede along the root fibers and come to lie next to the neural tube in the later stages. They are attached to the neural tube along its ventrolateral wall at the rhombic prominences. In the nonmotile stage the ventrolateral wall has two such prominences, one at the site of the fifth nerve root and one at the joint site of the VII, VIII, IX and X nerve roots. The lateral line ganglia lie dorsal to the visceral sensory ganglia and their root fibers enter the neural tube dorsal to those of the visceral sensory root fibers.

The neural tube is flexed in the region of the midbrain with the result that the long axis of the hindbrain is at a right angle to that of the forebrain. With continued flexion the ventral surfaces of the hindbrain and the diencephalon

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very nearly approximate one another. In the early swimming stage there is an indication of the passing of this flexure as the relationship of the forebrain with the hindbrain appears to be changing from angular to linear.

In the mid-line the roof and floor of the neural tube are relatively thick in the nonmotile stage and gradually become thinner in the older stages, with the exception of the floor of the diencephalon which becomes thicker as fibrillar substances begin to appear and as the optic chiasma and hypophyseal gland differentiate. In the telencephalic region the lateral ventricle can be observed in its beginning. In the roof of the diencephalon the epiphyseal gland is seen first as a slight notch in the nonmotile stage and finally in the early swimming stage as a small pocket closed off from the third ventricle.

As the wall expands laterally the ventricles are transformed from shallow cavities and depressions into large recesses and compartments. The continuity from the third to the fourth ventricle becomes considerably restricted and more nearly resembles the narrow canal found in the adult.

CONTENTS

INTRODUCTION

The reconstructions described in this paper are part of a correlated anatomical and histochemical study of the development of the cranial portion of the central nervous system of *Amblystoma* (Amphibia). This is a study in which chemical patterns as they develop will be associated with the morphological (neuronal and gross structures) and behavorial patterns.

Four models of *Amblystoma maculatum* representing the four physiologic stages of development: nonmotile, early flexure, coiled-reaction and early swimming are reconstructed from blotting paper, enlarged 165 times. Coghill ('16) described the afferent system of the head of *Amblystoma* and indicated on drawings the fiber tracts and regions of greatest concentration of nerve cells within the neural tube. In this paper the cranial nerve ganglia and the anterior neural tube are described in detail, with attention given to size, shape and relationship of the ganglia to one another and to the neural tube; the position and depth of the sulci, the thickness of the walls of the ventricles, angles of flexure and the internal and external prominences and depressions are likewise described.

A limited amount of research has previously been done on the development of the nervous system of *Amblystoma* and other lower forms. The early work of Coghill ('02) described the cranial nerves of *Amblystoma tigrium.* Johnston ('09) presented a comprehensive survey of the morphology of the vesicles of the forebrain in the vertebrates. Landacre ('10) described the origin of the cranial ganglia in *Ameiurus.* Landacre and McLellan's paper ('12) on the cerebral ganglia of the embryo of *Rana pipiens* offers helpful suggestions concerning cranial morphogenesis. Herrick ('10) described the morphology of the forebrain in Amphibia and Reptilia. Coghill ('16) published the results of his correlated anatomical and physiological studies of the afferent system of the head of *Amblystoma.* A more recent investigation was made by Baker and Graves ('32) on the development of the brain of *Amblystoma* (3 to 17 mm. body length) which was concerned with the external and internal configuration and the disposition of nuclear and fibrillar material. Two later papers of Herrick ('37, '38) have proved useful in comparing critical stages of development of *Amblystoma.*

Acknowledgment is expressed for the use of Dr. G. E. Coghill's original collection of *Amblystoma maculatum* slides now housed in the archives of the Department of Anatomy, University of Kansas. Our thanks are given to Miss Nancy L. Roofe for her redrawing of the illustrations accompanying this manuscript. Acknowledgment is also extended to the National Institute of Health for their part in making this research possible.

MATERIAL AND METHODS

The slide material used in this study consists of the slides prepared under the direction of Dr. Coghill for his investigation of the nervous system of *Amblystoma* ('14, '16). For his studies of the afferent system of the head, Coghill selected four specimens each of which represented a different stage of early physiological development. The four stages were referred to as: nonmotile, early flexure, coiled-reaction and early swimming. Their numbers were: 467, 473, 449, and 444 respectively. The reconstructions described herein are of specimens 467, 473, and 444. Number 449 was not present in the collection of slides so number 450 was substituted in its place.

Standard weight blotting paper was used for the reconstruction. The methods were developed step by step as the work progressed. Briefly the procedure was as follows: the slides were placed in a projector and an enlarged image of each section was cast upon the blotting paper, a tracing was made of each image, and the tracings were then cut out and assembled with glue in consecutive order. A carbon arc projector with a 45-degree angle projection prism was used.

Prior to drawing the projected images a desirable degree of enlargement of the sections was determined. The slide sections were 10 microns in thickness and the average thickness of the blotting paper was .55 mm. or 550 microns, presenting a specimen to paper ratio of 1:55. Enlargement of the cross section of the specimen by 55 times appeared, when projected, to be too small for reconstruction. Arbitrarily it was decided to triple the initial enlargement of 55 resulting in a total magnification of 165 times. Having increased the cross-sectional dimension of the projected images by an additional 3 diameters it was necessary to make a comparable increase in the thickness of the paper sections. This was accomplished by using three pieces of blotting paper instead of one to represent each section on the slide.

Each section was projected and drawn just once, beginning with the most anterior section of the neural tube and ending some twenty-five sections caudad to the ganglion complex of the tenth nerve. Approximately 150 sections were drawn for each model. These were cut out and two tracings were made from each drawing. By this method three identical copies were obtained for each section on the slide. A casein-base glue was used as the parts were assembled. To reduce distortion in the scale a hard rubber roller was used to approximate the sections.

In assembling the parts into models, lateral-view drawings by Coghill ('16, pp. 309-310) were used as guides. These drawings were enlarged to correspond with the size of the paper sections. The dorsal and ventral margins of the neural tube in the enlarged drawings were used as base lines upon which were placed the corresponding margins of the paper sections as they were assembled.

When the reconstructions were completed, it was necessary to smooth their rough surfaces and to reinforce them with wire. An electrically powered dental burr was used to obtain a relatively smooth surface. The contours of the ganglia or of the brain vesicles were not altered in this process. To eliminate flexibility and to prevent disassembling, long wire brads were embedded throughout the ganglia and the neural tube.

The hard, smooth surface was obtained on the models by applying two very thin coats of Durham water putty. Fine grained sandpaper was used to make the surfaces even smoother. The finish consists of two coats of flat enamel paint followed by a coat of clear varnish. The various ganglia and the neural tube are distinctly outlined and clearly labeled.

DESCRIPTION OF THE NEURAL TUBE

The nonmotile stage

External morphology. In the nonmotile stage the configuration of the brain no longer conforms to the general contour of the egg (figs. 1, 2). In the region of the mesencephalon the forebrain is flexed at nearly a right angle to the hindbrain. The middorsal surface displays regular contours except for the indentation separating the telencephalon from the diencephalon. This indentation is represented on the inside of the neural tube by the velum transversum (vel. tr.). The three primary brain vesicles are easily differentiated by their irregular surfaces, prominent grooves and attached sensory primordia.

The forebrain is conspicuous primarily due to the elaborate optic and olfactory primordia. It constitutes approximately the anterior fourth of the neural tube and consists of two parts, the telencephalon and the diencephalon.

The telencephalon lies anterior to the curved groove which begins in the notch (vel. tr.) on the middorsal line and which courses ventrad between the olfactory and optic primordia to terminate just anterior to the optic stalk. It constitutes roughly a third of the forebrain. Its lateral surface is relatively flat and does not project as far laterally as the diencephalon (fig. 3). There is a slight suggestion of the lateral ventricle in this stage (fig. 2). The olfactory primordium is attached at the anteroventral margin of the telencephalon.

The diencephalon (figs. 1, 2) is roughly crescent-shaped with the concavity facing anteriorly. The anterior boundary is a curved groove already described; however, the posterior border is poorly defined. It is a broad, shallow depression coursing dorsoventrally and slightly caudad from a point on the middorsal line, approximately two centimeters caudad to the previously mentioned notch, to the hypothalamic brain notch (hyth. br. n., fig. 2). Between its two boundaries the diencephalon forms a marked lateral prominence (figs. 3, 4). The middorsal length of the diencephalon is only a fraction of its mid-ventral length. The eye primordium is attached to the most anteroventral margin of the crest by the optic stalk (fig. 1).

The mesencephalon is wedge-shaped (fig. 1) with the apex directed ventrally and the base directed dorsally. Because of the configuration its middorsal line is about six times the length of the mid-ventral line. The mesencephalon is about half the size of the forebrain and has a smooth surface with a slight lateral prominence (fig. 4). Its anterior boundary has been described as the posterior border of the diencephalon. Its posterior boundary is the rhombic fissure (r.f., figs. 1, 2, 3) which appears in this stage as a broad shallow groove coursing across the lateral surface from the middorsal line to the hypothalamic brain notch and which completely encircles the neural tube.

The rhombencephalon (figs. 1, 2, 3, 4) is a thin walled tubular structure having a greater dorsoventral than transverse diameter. It extends directly caudad and is without flexures. The dorsal and ventral surfaces are slightly irregular and the lateral surface has two slight elevations which correspond with the entrance of the roots of nerve V and of nerves VII, VIII, IX, and X. These are referred to as rhombic prominences I and II (r.p.). Alternating with the prominences are rhombic depressions (r.d.). The anterior boundary of the hindbrain is the rhombic fissure immediately behind which, on the dorsal surface, is located a prominent elevation whose long axis is directed transversely. This is the primordium of the cerebellum (cb.p., figs. 1, 4). The hindbrain is approximately equal in length to the combined length of the first two brain divisions.

Internal morphology. Internally the landmarks between the different segments of the neural tube are more poorly defined than on the external surface. The cavities (fig. 2) of the three brain vesicles are conspicuous due to the appearance of the sulci and prominences. In the mid-line the walls of the midbrain, with the exception of the ventral part, are not as thick as those of the forebrain.

A clear line of demarcation exists between the telencephalon and the diencephalon. Dorsoventrally the line extends from the velum transversum through the sulcus ventralis (s.v.) and through the optic recess (op.r.) to end in the mid-ventral line at the terminal ridge (t.r., fig. 2). Anteriorly the telencephalon is bounded by the lamina terminalis (l.t.) and mid-ventrally by the terminal ridge. The telencephalon is represented almost entirely by a large prominence, the telencephalon medium (t.med.), which bulges into the forebrain cavity.

The posterior boundary of the diencephalon is very indefinite. To locate it on the figure one must imagine a line drawn from the tuberculum posterius (tub.p.) directly dorsad to a point on the middorsal line about two centimeters caudal to the velum transversum. The anterior boundary of the diencephalon has been described. In that part of the diencephalon anterior to the tuberculum posterius and posterior to the telencephalon may be seen the hypothalamus (hyth.). This structure presents an elongated prominence projecting slightly into the brain cavity. The ventral portion of the diencephalon is separated from the dorsal portion by a broad, shallow groove, the sulcus dorsoventralis (s.d.v., fig. 2), which passes from the velum transversum to the tuberculum posterius. On the middorsal line is a slight evagination which is suggestive of the developing epiphysis (not labeled).

The anterior boundary of the mesencephalon has been described. The posterior boundary is indicated by the gradual lateral expansion of the brain vesicle at the beginning of the fourth ventricle just caudal to the rhombic fissure. The lateral wall of the mesencephalon projects slightly into the brain cavity and is creased by a shallow longitudinal groove (l.g.).

The tubelike rhombencephalon has a very thin roof, a thicker floor plate and a markedly thickened ventrolateral wall. On cross section the brain vesicle is V-shaped with the apex lying at the floor. Anteriorly the neural canal at the junction of the cerebral aquaduct and the fourth ventricle is narrowed markedly by the elevation of the walls of the mesencephalon. Within the interventricular canal are seen two rhombic depressions (r.d.) and three elevations (r.e.). The depressions correspond to the rhombic prominences on the external surface.

The early flexure stage

External morphology. Several gross changes in the morphology are apparent. The angle between the fore- and hindbrain on the middorsal line is unchanged (fig. 5). On the midventral line, however, at the hypothalamic brain notch the angle is markedly reduced due to the development of the hypothalmic region of the diencephalon (fig. 6). The notch between the telencephalon and the diencephalon on the middorsal line has become deeper and the groove on the lateral surface coursing ventrad from this notch is more prominent. The size of the telencephalon is relatively unchanged. The alteration of its outline is consistent with the differentiation undergone, *i. e.*, thickening, rounding and increased prominence of its lateral wall.

The boundaries of the diencephalon are identified as before. Its outline has changed along the mid-ventral line and now is shorter and presents less bluntness (figs. 5, 6). Due to the marked increase in thickness and ventral growth of the hypothalamus the diencephalon now approximates the floor of the hindbrain. Elsewhere in the diencephalon the wall shows a slight increase in thickness and retains its lateral prominence.

The mesencephalon is essentially the same size. It is well marked posteriorly by the rhombic fissure but poorly marked anteriorly by the posterior boundary of the diencephalon (figs. 5, 6). There is increased thickness in its wall and its lateral projection is more prominent (fig. 8).

In this stage the rhombencephalon is noticeably longer and its middorsal surface is more regular than in the previous stage. The roof is thin and somewhat flat; it slopes laterad and slightly ventrad from the middorsal line and presents a broad transverse diameter (fig. 8). The hindbrain extends caudally to the level of the second rhombomere which is marked by the second ventrolateral prominence.

Internal morphology. Internally a number of changes have occurred as a result of further differentiation of the neural tube. The sulci have become deeper (fig. 6), the prominences have become more pronounced and the middorsal and mid-ventral walls have become thinner.

The telencephalon is bounded posteriorly by the velum transversum, the sulcus ventralis and the optic recess (op.r.) and ventrally by the terminal ridge (t.r.). The lamina terminalis (l.t.), which is noticeably thinner than in the previous stage, bounds the telencephalon anteriorly. Anterior and ventral to the velum transversum can be seen the anlage of the lateral ventricle (an.l.ven.).

The boundaries of the diencephalon can be identified from the previous description. In the middorsal line may be seen a small evagination which is the developing epiphyseal gland (ep.gl.). The hypothalamus lies between the telencephalon medium, the tuberculum posterius and the sulcus dorsoventralis. The latter sulcus (s.d.v., fig. 6) is deeper than in the previous stage and consequently accentuates the projection of the hypothalamic prominence into the brain cavity. In the midplane the developing hypophyseal gland (hyp.g.) can be seen lying ventral and medial to the hypothalamus.

The cavity of the mesencephalon is more apparent and the longitudinal groove (l.g.), which lies in the lateral wall, has become both broader and deeper (fig. 6). This groove terminates near the posterior boundary of the mesencephalon where the cavity narrows down prior to becoming the fourth ventricle.

The rhombencephalon consists of two poorly defined rhombic depressions and three elevations. The V-shaped interventricular canal of the fourth ventricle has become wider at the base since the last stage of development.

The coiled-reaction stage

External morphology. Several changes have occurred in the general morphology since the previous two stages. The neural tube shows continued folding at the midbrain flexure resulting in less than a ninety degree angle between the fore- and hindbrain (figs. 9, 10). As the neural tube acquires more differentation the midplane distance between the rhombic fissure and the anterior border of the telencephalon becomes less and the ventral border of the diencephalon more nearly approximates the floor of the hindbrain. This stage is slightly larger than the previous stage, except for the first two brain divisions which show marked increase in thickness and greater prominence of their lateral walls.

The curved groove (fig. 9) marking the caudal border of the telencephalon, is deeper and more pronounced. The surface of the telencephalon has acquired a spherical configuration and projects farther laterally than the diencephalon (fig. 11). Dorsally a small prominence suggests the beginning of the lateral ventricle. Baker and Graves ('32) described the primordium of the paraphysis, a small evagination on the dorsal surface of the telencephalon, as making its appearance in this stage of development. We are unable to demonstrate this structure on either the reconstruction of the coiled-reaction stage or the early swimming stage.

The outline of the diencephalon in the midplane is nearly the same as in the previous stage. The two most noticeable changes are: the lateral growth of the walls, especially the hypothalamic lobe (l.h.p., fig. 11) and the prominence of the hypophyseal gland (hyp.g., fig. 9) in the mid-ventral plane. The depression on the middorsal line marking the posterior boundary of the diencephalon is prominent due probably to the evagination just anterior to this of the anlage of the epiphyseal gland.

The mesencephalon is relatively unchanged (fig. 9). There has been some lateral growth of the wall. The rhombic fissure is very broad and relatively shallow.

The roof of the rhombencephalon slopes gently ventrad from the cerebellar prominence caudally to its mid-point from whence it slopes upward to the level of the last rhombomere (figs. 9, 10). The roof is flat, with a ventrolateral slope and broad transverse axis as described before (fig. 12). In the mid-ventral line the floor slopes ventrad to about its mid-point. On the dorsal surface immediately caudal to the rhombic fissure is the very apparent transverse prominence of the cerebellular primordium (cb.p., figs. 9, 10, 12). On the ventrolateral surface of this portion of the neural tube are observed three rhombic prominences (r.p., figs. 9, 11, 12). These prominences correspond internally with the rhombic depressions (r.d.). Each prominence is associated with a nerve root or a nerve root complex.

Internal morphology. The changes noted reflect further differentiation of the neural tube (fig. 10). The velum transversum is very prominent. The walls of the brain vesicles are thinner in the midline except in the areas of the epiphyseal gland, optic chiasma and hypophyseal gland where there is thickening of the roof and floor plates respectively. The increased depth of the brain cavities is apparent.

The telencephalon is unchanged in size but presents the following alterations consistent with differentiation: the lateral ventricle is much deeper and the lamina terminalis (l.t.) is approximately one half the thickness of the previous stage. The telencephalon medium (t.med.) is nearly the same size and shape as before.

The anterior boundary of the diencephalon is well defined. The posterior boundary is still represented by an imaginary line extending from the tuberculum posterius (tub.p.) to a point on the middorsal line just posterior to the epiphyseal evagination (ep.gl., fig. 10). Ventrally near the terminal ridge the diencephalon presents a slight thickening at the future site of the optic chiasma (unlabeled). The enlarged hypophyseal gland is seen lying posterior to the optic chiasma and ventromedial to the lateral hypothalamic lobe (hyth.). The walls of the diencephalon no longer project into the brain cavity as elevated prominences, consequently the ventricle of the diencephalon is deeper than previously. The sulcus dorsoventralis (s.d.v., fig. 10) appears to merge dorsally into a broad shallow depression in the thalamic region.

The anterior boundary of the mesencephalon has been described. The posterior boundary corresponds to the indentation of the rhombic fissure (r.f.) on the middorsal line. In the lateral wall of the mesencephalon the longitudinal groove (l.g.) is broad and deep and is continuous anteriorly with the cavity of the diencephalon. Posteriorly the groove terminates at the narrow constriction leading into the fourth ventricle. The roof of the mesencephalon is reduced to about half the thickness of that of the two anterior brain divisions.

The length of the rhombencephalon is unaltered. The striking change in the hindbrain is the pronounced development of the lateral recesses, referred to on the drawings as the rhombic depressions (r.d., fig. 10). The interventricular canal is wider than previously, especially where it extends into the lateral recesses dorsally. Four rhombic elevations alternating with the recesses are seen on the lateral wall (r.e., fig. 10).

The early swimming stage

External morphology. Baker and Graves ('32) classified *Amblystoma* into different stages according to the length of the body measured in millimeters. They identified their first four stages with the four physiological stages described by Coghill. It should be noted that two discrepancies exist between these two systems of classification. Stages one and four of Baker and Graves do not correspond morphologically with Coghill's nonmotile and early swimming stages. In stage one the neural tube has a linear design whereas in Coghill's nonmotile stage the cephalic flexure is present. Also in stage four the linear configuration is present while the early swimming stage still presents the flexure. In the latter stage, however, the angle between the fore- and hindbrain is greater than ninety degrees which may be an indication of the passing of the cephalic flexure and the assumption of the linear form. Perhaps the reason for these differences lies in the fact that Baker and Graves were studying *Amblystoma jeffersonianum.*

The telencephalon has become quite hemispherical (figs. 13, 14, 15) and externally the lateral ventricle is seen to be quite prominent.

The most apparent alteration in the diencephalon (fig. 15) is the change in the hypothalamus from a long structure with a flat lateral surface into a round, shorter hemispherical shape having a prominent lateral lobe. Associated with this change is a shortening of the ventral border of the diencephalon.

The posterior boundary of the mesencephalon is no longer obvious since the rhombic fissure has become obliterated, apparently due to the regression of the cephalic flexure and to the growth in thickness of the walls. The external surface of the mesencephalon has a smooth, regular curvature.

The rhombencephalon has relatively the same length as in the previous stage. Its dorsoventral diameter has gradually decreased in size since the nonmotile stage. The roof has the same curvature, the proximal half courses slightly ventrad and the distal half is directed dorsad. The floor has a gradual ventral slope in its proximal half but the distal half is relatively straight.

Internal morphology. Internally the vesicles are deeper and more compartmented than before (fig. 14). The roof and floor in the midplane are thinner than in the three previous stages.

In the dorsal extremity of the telencephalon the lateral ventricle is a well developed recess (l.vent.). The telencephalon medium (t.med.) is slightly thicker than in the nonmotile stage, but is more conspicuous externally as the telencephalic hemisphere than as an internal prominence (figs. 13, 14). The posterior boundary of the telencephalon is represented by a ridge extending from the velum transversum to the terminal ridge and the anterior boundary is the lamina terminalis.

The diencephalon is clearly marked along its anterior border by the velum transversum, the terminal ridge and the ridge connecting these two structures. The dorsal wall contains the epiphyseal gland (ep. gl.) which now is closed off from the third ventricle. Immediately in front of the posterior wall in the ventral part of the diencephalon is the large mammillary recess (m.r.) In the anteroventral wall of the diencephalon adjacent to the postoptic recess (p.o.r.) can be seen the hypophyseal gland (hyp.g.). In the anterior inferior border of the diencephalon the terminal ridge (t.r.) can be identified and in the midplane the optic chiasma (com. op.) is apparent. The sulcus dorsoventralis (s.d.v.) is seen extending into the deeper mammillary recess (m.r.).

The mesencephalon has a thinner roof and deeper vesicle than before. The longitudinal groove on the lateral wall terminates in a deep recess, the posterior mesencephalic recess (r.p.m., fig. 14). This narrow, steep walled recess is directed dorsoventrally and extends from near the tuberculum posterius half way to the mesencephalic roof. The most posterior portion of this recess is markedly constricted and represents the narrow lumen of the interventricular canal. The canal is a narrow, deep groove with steep walls whereas previously the canal was a broad shallow recess.

An inspection of the rhombencephalon shows that the roof is thinner, the ventrolateral wall is thicker and the lateral recesses are slightly deeper than in the previous stage. Anteriorly where the canal is continuous with the aquaduct it is markedly reduced in size by a prominent elevation of the lateral wall.

DESCRIPTION OF THE AFFERENT SYSTEM OF THE HEAD

The eye and optic nerve

The nonmotile stage. The eye primordium, at this stage, is primarily a compact collection of cells having an irregular nondescript configuration and containing grooves and indentations not seen on the surfaces of succeeding stages (figs. 1, 3, 4). In the later reconstructions the eye is not as flat nor does it appear as large from the lateral view as in the nonmotile stage. Most of the lateral surface of the eye is in contact with the body ectoderm. The optic pit appears as a shallow depression with gently sloping walls and with incomplete development of its anterior lip at the site of the chorioid fissure (c.f.). Lying within but not filling the pit is a discoid thickening of epithelium which represents the lens primordium (L.). At its anteroventral margin the eye indicates its previous extensive connection with the diencephalon by retaining, in this stage, a large connection through the optic stalk (op.st.).

The lens has an irregular outline, is relatively flat, lies directly dorsad to the chorioid fissure, and does not conform closely to the developing retina within the pit. The eye presents two concave surfaces, one of which lies anterior and is the site of contact with the olfactory primordium (Olf.p.); the other is posterior and is overlaid by the Gasserian ganglion of the V nerve (G.G.). Posteriorly the eye contacts only the ophthalmic ganglion of the fifth nerve (G.oph.).

The early flexure stage. In the early flexure stage the eye is thicker and has acquired a slightly oval outline (fig. 5). The optic depression has taken on the configuration of the optic cup seen in the last three stages of development (fig. 7). It is deeper, its walls are nearly vertical and the lips of the cup are sharply delineated. The chorioid fissure (c.f., figs. 5, 7) is shallow but its presence is suggested by the slight depression in the anteroventral lip of the optic cup.

The lens presents the following changes in size and shape; increase in thickness, rounding of the lateral surface and decreased surface in contact with the head ectoderm.

The optic stalk is slightly attenuated with the result that the anterior margin of the eye no longer appears to merge with the diencephalon (figs. 5, 7). Anteriorly the eye presents a concavity where it contacts the olfactory organ. Dorsally the eye contacts the Gasserian portion of the trigeminal nerve complex. With the continued flexion of the forebrain upon the hindbrain the eye is seen to overlie a portion of the rhombencephalon. Due to thickening of both the eye and the hypothalmic lobes closer contact exists between the pigmented layer of the retina, *i. e.*, the external layer of the optic cup and the diencephalon (fig. 7).

The coiled-reaction stage. The configuration of the eye has undergone a marked alteration since the preceding stage of development. The striking change is the increased thickness and oval outline which results in the spherical appearance of the eye for the first time (figs. 9, 11).

The optic cup also presents changes in its appearance. Most apparent is the reduced size of its opening as the sharply delineated lips of the cup converge to nearly touch the margins of the lens (figs. 9, 11). The chorioid fissure is nearly obliterated as only a slight indentation is seen on the anteroventral lip of the cup.

The lens, except for one small area, is free from contact with the somatic ectoderm. It is thick, roughly oval in its lateral outline and presents a spherical configuration. At this stage the lens completely fills the cup, its margins being separated from the lips of the cup by a small cleft.

The eye contacts the neural tube at two sites. One is through the attenuated optic stalk, which represents the neuronal connection between the eye and the diencephalon. The second site, which does not involve neuronal connections, consists of an extensive area of contact between the hypothalamic portion of the diencephalon (fig. 11) and the external layer of the retina. Anteriorly the eye contacts the olfactory primordium and posteriorly it contacts both ganglia of the fifth nerve complex.

The early swimming stage. The eye in the early swimming stage is essentially unchanged (figs. 13, 14, 15). From the lateral aspect it appears to have an ovoid outline, and from the ventral view it is seen to have a roughly spherical configuration.

The optic cup has nearly the same appearance as in the preceding stage. The lips are sharp and well defined and converge upon the margins of the lens. The lips are slightly undercut since the walls within the cup are somewhat concave. Anteroventrally a small depression represents all that remains of the chorioid fissure (fig. 15).

The lens retains its spherical configuration noted in the previous stage. It fills the optic cup and projects laterally through the opening of the cup (fig. 15).

The optic stalk is long and narrow (fig. 15) and allows for the passage of neurons from the retinal layer of the eye to the diencephalon. The point of contact, not involving neuronal connections, exists between the eye and the prominent lateral hypothalamic lobe. The eye also contacts the olfactory organ anteriorly and the fifth nerve ganglia posteriorly.

The Olfactory Organ and Nerve

The nonmotile stage. The olfactory organ in the nonmotile stage consists of an irregularly shaped, thickened patch of ectoderm lying directly lateral to the telencephalon medium (figs. 1, 3). Its lateral aspect is flat and it is in contact with the head ectoderm over a large area. Its thickness is about one half its anterposterior diameter. At its anterior margin it is seen to be continuous with the anteroventral border of the telencephalon (fig. 3).[1] Later in development when neuronal elements are present this will be the site where the olfactory nerve passes from the organ to the telencephalon.

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1. Coghill ('16) in describing these embryos states that this point of contact is not established until the coiled-reaction and early swimming stages of development.

The early flexure stage. The ectodermal placode of the olfactory primordium is essentially unaltered (figs. 5, 7). It is slightly thicker; laterally it presents a larger area in contact with head ectoderm. Also on its lateral surface may be seen a small depression, the olfactory pit (olf.pit, fig. 5). Its relationship to the telencephalon and the eye are unchanged.

The coiled-reaction stage. In this stage of development the olfactory organ continues to be irregular in outline and retains essentially the flat, discoidal configuration (fig. 9, 11). The lateral aspect shows a slight diminution in its size while the olfactory pit shows moderate increase in depth. Its relationship to other structures is the same.

The early swimming stage. In the early swimming stage the ectodermal placode is slightly smaller from the lateral view, and its olfactory pit is slightly deeper than in the preceding stage (fig. 13). Its mediolateral thickness, however, has increased as the olfactory organ tends to become spherical (fig. 15).

The relationships between the olfactory organ, the eye and the neural tube, which were established as early as the nonmotile stage, are essentially unchanged.

The Trigeminal Nerve

The nonmotile stage. The trigeminal nerve complex consists of two ganglia, the ophthalmic and the Gasserian (fig. 1). Peripherially they course in different directions, the ophthalmic ganglion extends forward over the eye and the Gasserian ganglion extends ventrad behind the eye. Medially they converge and are surrounded by a common root mass (r.m.V) before sending their root fibers into the neural tube. The length of the two ganglia is essentially equal.

The ophthalmic ganglion has a long anteroposterior axis with a slight ventral and lateral deviation (figs. 1, 4). It has a cylindrical configuration with a tendency to have a smaller diameter at its periphery. Near its rostral end the ophthalmic ganglion is continuous with the skin at two points which are referred to as ectodermal adhesions (not indicated on the drawings). At this stage there are no peripheral nerve fibers from the ganglion to the skin.

The Gasserian ganglion has a long ventrolateral axis with a slight posterior inclination (figs. 1, 2, 3, 4). It has a long, attenuated configuration with a moderately concave ventral surface and it has a smaller diameter than the ophthalmic ganglion. Distally it appears broad and flat where it overlies but does not touch a portion of the eye. At its periphery there are no cutaneous nerves at this stage but one ectodermal adhesion is present.

The root mass is a collection of cells present about the root of all the cranial nerves, attaining its greatest development about the root of the trigeminal nerve. Coghill states that this mass, ". . . is made up largely of indifferent cells, but cells resembling neuroblasts occasionally occur in it."

The early flexure stage. In this stage the ophthalmic ganglion (figs. 5, 8) has a fusiform configuration. Its mid-portion has the greatest diameter and represents the ganglion itself. The short, thin stalk of cells anterior to the thick area represents the outgrowth of the ophthalmic trunk and posteriorly the attenuated portion of the ganglion represents the nerve roots as they pass medially to the neural tube. The ophthalmic ganglion retains its long anteroposterior axis in this and in the two succeeding stages. It does not, however, present the ventrolateral deviation noted in the previous stage and as a result it now lies closer to and parallel with the neural tube.

The ophthalmic trunk, which is known as the nervus ophthalmicus profundus, divides into two branches upon leaving the ganglion. The larger division courses along the anterior border of the eye and terminates in the vicinity of the olfactory primordium.* Fibers, if they reach the ectoderm, cannot be demonstrated. The smaller of the two divisions passes more directly forward and becomes lost among mesenchymal cells of the head.

The Gasserian ganglion is roughly fusiform in shape (figs. 5, 6, 7, 8). Its long axis is ventrolateral from the neural tube, a characteristic of its position throughout the four stages. From all views it is seen to overlie a small portion of optic primordium. Distally the ganglion, having lost its adhesion to the ectoderm, continues ventrally as the infraorbital nerve trunk. This trunk later differentiates into the mandibular division of the ophthalmic nerve. No nerve fibers can be seen between the nerve trunk and the skin at this time.

The roots of both ganglia converge at right angles at the lateral surface of the mentencephalon where they disappear within a prominent root mass (r.m.V).

The coiled-reaction stage. In this stage the ophthalmic ganglion (g.oph., figs. 9, 12) has receded proximally along its root fibers

* The peripheral nerves were not included on the models and consequently not on the drawings for the reason that they were extremely small and their reconstruction would require more time than their presence warrants.

until it is no longer separated from the neural tube by a cylindrical stalk of cells. Its long axis courses rostrad lying parallel with and close to the wall of the hindbrain. As a result of the continued flexion of the anterior neural tube at the cephalic flexure, the ophthalmic ganglion throughout its length is in contact with the dorsal border of the eye. At the anterior border of the optic primordium the ganglion continues as the nervus ophthalmicus profundus (not shown). This nerve has been described as having two divisions, a smaller anterodorsal branch and a larger branch anterior to the eye. These two nerves show marked development of their peripheral cutaneous fibers; in addition fibers are present which course from the ganglion directly to the overlying skin.

The Gasserian ganglion has its long axis in the ventrolateral direction from the neural tube and in addition has a slight posterior deviation (figs. 9, 10, 11, 12). Proximally the Gasserian ganglion is combined with the ophthalmic ganglion and root mass V to form one large structure. Distally the ganglion presents slight dorsoventral flattening where it overlies and curves around the posterior margin of the optic primordium prior to becoming the infraorbital nerve trunk (not shown). This nerve trunk now divides into two branches; previously there was only one. The ramus maxillaris passes a short distance forward beneath the eye, and the ramus mandibularis extends ventrally and sends fibers to the skin in the postoptic region.

The early swimming stage. The ophthalmic ganglion (g.oph., figs. 13, 16) has receded further along the root fibers and now lies against the neural tube in close association with the Gasserian ganglion. It overlies a small portion of the dorsal border of the eye. It extends forward to less than half the length of the eye where it becomes continuous with the nervus ophthalmicus profundus.

Four pairs of cutaneous nerves, none of which are shown on the drawings, arising from the ophthalmic ganglion have become more apparent. From the anterior end of the ganglion arises the dorsal cutaneous branch of the ramus ophthalmicus profundus. This nerve courses directly anterior from the ganglion. The ramus ophthalmicus profundus in its course around the anterior border of the eye divides into two terminal branches. The lateral terminal branch passes around the anterior surface of the eye to the skin lateral and caudal to the olfactory pit. The mesial terminal branch passes along the mesial aspect of the olfactory epithelium to the skin of that region. The fourth nerve arises from the caudal portion of the ganglion and courses dorsad to the skin.

The Gasserian ganglion likewise has receded along its root fibers to assume a position closer to the neural tube than at any previous time (figs. 13, 15, 16). It lies at a right angle to both the ophthalmic ganglion and the hindbrain. Distally it continues as the infraorbital trunk. This nerve trunk has three terminal branches; first, is the ramus maxillaris, which passes forward under the eye; second, is a small nerve which passes to the balancer organ; and third, the ramus mandibularis which itself has two terminal branches both of which course cephalad and ventrad to the region of the oral plate.

The facial and auditory nerves, and auditory vesicle

The nonmotile stage. The facial lateral line ganglion is a collection of loosely arranged cells having an irregular configuration and outline (G.L.L.VII,a,b, figs. 1, 2, 3, 4). It lies at a right angle to the neural tube and courses in a ventrolateral direction, parallel to the Gasserian ganglion. The ganglion itself is located a short distance lateral to the tube and is broad and somewhat thickened dorsoventrally. Proximally it is connected to the neural tube by a long attenuated stalk which passes through a poorly developed root mass.

From the lateral view (fig. 1) the ganglion is seen to lie anterior to the auditory vesicle (Aud. ves.) and the eighth nerve ganglion (G.VIII). Also it is seen to overlie and obscure all but the most ventral part of the visceral sensory ganglion, *i. e.*, the geniculate ganglion (G.gen.). From the ventral aspect (fig. 3) the lateral line ganglion can be seen on either side of the geniculate ganglion. It can also be seen to extend caudad a short distance to underlie a portion of the auditory ganglion and vesicle. It is apparent that the root of the lateral line ganglion enters the neural tube directly dorsal to the root entrance of the geniculate ganglion (fig. 3).

The portion of the ganglion labeled a, which later gives rise to the ramus ophthalmicus superficialis VII and ramus buccalis VII, is somewhat better differentiated than part b, the hyomandibular division. It extends cephalad to the lateral line primordium, with which it is in direct contact. The hyomandibular division extends rostrad but does not contact the lateral line primordium.

The visceral sensory or geniculate ganglion of the facial nerve is a poorly differentiated group of cells which lies ventral to the lateral line ganglion (figs. 1, 2, 3). It is long, its axis is ventrolaterad and its outline is regular and somewhat rectangular. From the lateral aspect only its distal extremity is visible. Ventrally (fig. 3) it appears to be separated from the auditory ganglion and vesicle by the hyomandibular division (G.L.L.b) of the seventh nerve. Distally the ganglion is continuous with the ectodermal thickening which is associated with the spiracular pouch. No peripheral nerves are present at this stage.

The auditory vesicle (figs. 1, 2, 3, 4), its endolymphatic appendage (End.), and its accompanying auditory nerve (G.VIII) are prominent landmarks along the metencephalic portion of the hindbrain. The vesicle itself is somewhat spheroid in shape. It lies at a right angle to the brain and courses ventrolaterad. It does not extend as far ventrad or laterad as the auditory ganglion or the lateral line and visceral sensory components of the seventh nerve (figs. 3, 4). Jutting out from its most dorsomedial aspect is the poorly differentiated endolymphatic appendage through which the auditory apparatus makes contact with the neural tube.

The auditory ganglion is discoid in shape and appears to be wedged in between the anteroventral border of the auditory vesicle and the posterior edge of the facial lateral line ganglion (G.VIII, figs. 1, 3). Proximally a few fibers reach the neural tube at a point caudad and ventrad to the root connection of the lateral line system.

The early flexure stage. The three ganglia of the facial nerve present changes characteristic of differentiation (figs. 5, 6, 7, 8). They present regular contours, greater compactness of cells and have receded along their respective root fibers so as to lie nearer the neural tube. In addition the cells distal to the ganglia have become attenuated into nerve trunks.

The two parts of the lateral line system, a and b, have been separated distally by the geniculate ganglion into two distinct ganglia (figs. 5, 6). Ganglion a is the more dorsal of the two and the more differentiated. It courses anteriorly and lies parallel to the neural tube. Proximally its nerve root merges with that of the hyomandibular portion of the lateral line system as they enter the brain together. The root of portion a is seen to overlie the root of b (fig. 5). Distally the ganglion is divided into two separate nerve roots, the ramus ophthalmicus superficialis VII and the ramus buccalis VII. The latter is directed more ventrad. Nerve fibers are present between these ganglia and the lateral line primordium.

The hyomandibular ganglion is poorly developed. It courses ventrolateral from the neural tube and lies between the geniculate ganglion and the auditory ganglion. From the lateral view it is seen to enter the neural tube directly ventral to the root entrance of ganglion a. Distally it courses ventrad and a few fibers continue into the primordium of the hyoid arch.

The visceral sensory ganglion (g.gen., figs. 5, 6, 7, 8) lies ventral to ganglion a and anterior to ganglion b. Laterally it can be seen lying between these two ganglia. Proximally its root entrance lies ventral to that of the lateral line root. Distally it extends ventrad and rostrad to the epibranchial placode associated with the formation of the spiracular pouch. No peripheral fibers are seen coming from the geniculate ganglion.

The auditory vesicle is smaller in size and courses ventrolaterally and slightly rostrad (figs. 5, 7). Proximally it contacts the neural tube only at the endolymphatic appendage and anteriorly it contacts nearly the entire posterior surface of the auditory ganglion.

The well-differentiated endolymphatic appendage (End., fig. 5) juts above the surface of the vesicle where it joins the latter to the neural tube.

The auditory ganglion is essentially unchanged. Comparison of figure 7 with figure 3 will illustrate its large ventrocaudal extent in this stage (G.VIII). The ventral view drawing does not show clearly the root entrance of the auditory nerve lying ventral to that of the geniculate ganglion (fig. 7).

The coiled-reaction stage. Essentially the changes seen in the previous stage are seen in this stage after more development. The ganglia have decreased in size, have acquired characteristic outlines, have receded toward the brain and show attenuation of their peripheral nerve trunks (figs. 9, 10, 11, 12).

The lateral line ganglia, a and b, are unchanged except that b now lies entirely dorsal and lateral to the visceral sensory ganglion (G.gen., fig. 9). Proximally ganglia a and b come together at the neural tube where root a is seen to lie dorsal to root b. Distally, ganglion b, hyomandibular branch, courses ventrad and sends fibers to lateral line primordium occurring in the region of the balancer.

The visceral sensory ganglion (G.gen., fig. 11) has acquired a more ventral position as it again underlies ganglion b of the lateral line system. Posteriorly it touches upon the auditory ganglion (G.VIII.). Proximally it is seen to retain its position in the complex ventral to the lateral line ganglia (fig. 11). Its distal end has become broad and flat just prior to giving off nerve fibers which course in the vicinity of the spiracular pouch.

The auditory vesicle (Aud.ves., fig. 9) is unchanged except for showing some increase in size. Around its anteroventral aspect are grouped the components of the facial nerve complex (G.L.L. VII) and auditory ganglion (G.VIII). Its posterior surface is in contact with the visceral sensory component of the ninth nerve (G.vis.IX).

The auditory ganglion is not prominent in the lateral view (G.VIII., fig. 9). From its ventral aspect (fig. 11), however, it can be seen to extend caudad along the ventromesial surface of the vesicle for about two thirds the length of that organ. The root fibers of the auditory ganglion enter the brain ventral to the root fibers of the geniculate ganglion.

The early swimming stage. The ganglia of this complex show further differentiation along the lines set forth in the early flexure stage (figs. 13, 14, 15, 16). The most apparent changes are the smaller ganglia lying closer to the neural tube, giving rise to longer and more attenuated nerve trunks.

Ganglion a of the lateral line system (G.L.L.VIIa) is unchanged except that distally it is seen to give rise to two distinct nerve trunks, the ramus ophthalmicus superficialis VII and the ramus buccalis VII. As in the coiled-reaction stage these nerves follow closely the course of the preauditory lateral-line primordium, extending practically the full length of the primordia.

Ganglion b (G.L.L.VIIb) is changed only in that it has resumed a position posterior as well as dorsal to the visceral sensory ganglion thereby separating the latter from the auditory ganglion (figs. 13, 14, 15). Mesially the root fibers of b join those of a at the neural tube, retaining their usual ventrodorsal relationship as they enter the brain (fig. 15).

The visceral sensory ganglion is essentially unaltered when viewed from the lateral aspect (G.gen., figs. 9, 13). From the ventral and medial view (figs. 14, 15) it is seen to be separated from the auditory ganglion posteriorly by ganglion b of the lateral line system. It was similarly separated in the early flexure stage (figs. 5, 6, 7) but not in the coiled-reaction stage (figs. 10, 11). Its root fibers enter the brain ventral to the lateral line root (fig. 15). Two nerves leave the ganglion distally; one contributes fibers to the ramus hyomandibularis; the other, the ramus palatinus is directed rostrad over the pharyngeal cavity to near the anterior end of the foregut.

The auditory vesicle appears smaller from the lateral view (Aud.ves., fig. 13). This change is only apparent, not actual, and is due to the encroachment upon its anterior margin of the compact ganglionic complex of the seventh and eighth nerves. Posteriorly it is closely bordered by the lateral line and visceral sensory ganglia of the ninth nerve (G.L.L.IX,X; G.vis.IX,X; fig. 13).

The endolymphatic appendage is sharply differentiated from the auditory vesicle. It is seen to approach the neural tube at a point dorsal to the root entrance of the lateral line system (fig. 13).

The auditory ganglion is now very prominent in all but the medial view (G.VIII, figs. 13, 15, 16). Its discoid configuration and its dorsolateroventral projection are apparent in the drawings. On the ventromesial surface of the vesicle the auditory ganglion extends caudad to nearly the posterior border of that organ (fig. 15). It is the marked development of this ganglion which is the principal cause for the shortened appearance of the auditory vesicle.

The glossopharyngeus and vagus nerves

The ganglia of the combined ninth and tenth nerve complex in the nonmotile stage are relatively smaller, excepting the lateral line ganglion of the glossopharyngeus, than in the succeeding three stages (G.LL.IX,X; G.vis.IX,X; G.Jug., figs. 1, 2, 3, 4). Essentially they are of comparable size with the preauditory ganglionic complex seven and eight. In the nonmotile and the early flexure stages there appears to be a disproportion between the ganglia of the fifth nerve and the ganglion of the seventh through the tenth nerves, the former being slightly larger. In the coiled-reaction stage they all appear proportionate and in the early swimming stage the proportions appear to have been slightly reversed. From the standpoint of development the postauditory ganglia seem to lag slightly behind the preauditory ganglia.

The nonmotile stage. As stated previously the ganglia in this stage are relatively smaller than in the succeeding three stages, excepting the lateral line ganglion of the ninth nerve (G.L.L.IX, fig. 1). In spite of their smaller size they appear to be bulkier. They are loosely arranged collections of cells having irregular outlines and nondescript configurations. The lateral line ganglia (G.L.L.IX,X, figs. 1, 3) lie dorsal to the general cutaneous ganglion G.Jug.) and to the visceral ganglion (G.vis.IX,X). In addition their roots are seen to enter the brain dorsal to those of the visceral ganglion (fig. 3).

The lateral line ganglion of the glossopharyngeus is long and narrow and does not present a thickened portion characteristic of the ganglion itself (G.L.L.IX, figs. 1, 2, 3). It courses ventrolateral from the brain and has a slight posterior deviation. Laterally it is seen to overlie all but the distal extremity of the visceral sensory ganglion (G.vis.IX). Anteriorly a small part of it is overlaid by the auditory vesicle (Aud.ves.) and posteriorly it is continuous with the root of the lateral line ganglion of the vagus (fig. 4). Medially its root enters the brain dorsal to the root of the visceral ganglion (fig. 3). Distally the ganglion is continuous with the most anterior of two postauditory lateral line primordia which overlies the first branchial pouch.

The lateral line ganglion of the vagus (G.L.L.X, figs. 1, 3, 4) is a strand of loosely collected cells which courses anteroposteriorly and which lies parallel to the brain. It overlies the general cutaneous ganglion (G.Jug.) and the visceral ganglion of the tenth (G.vis.X). Anteriorly it is continuous with the root of the ninth. Dorsally it has a broad attachment with the lateral line primordium in the region of the first and second myotomes.

Lying along the ventrolateral margin of the lateral line ganglion of the vagus is a collection of cells which represents the jugular or general cutaneous component of that nerve (G.Jug., figs. 1, 2, 3, 4). Proximally it does not reach the neural tube. Caudally this ganglion has a close relationship with an ectodermal thickening which in turn is closely associated with the lateral line ganglion of the vagus.

The visceral ganglion of the glossopharyngeus (G.vis.IX, figs. 1, 2, 3) is long, straight and very narrow. It courses ventrolaterad and lies ventral to the lateral line ganglion of the ninth nerve (G.L.L.IX). Medially (fig. 3) its root is seen to enter the brain posterior to the auditory vesicle and ventral to the lateral line root. Its distal end is greatly thickened and is fused with the ectodermal thickening over the first branchial pouch.

The visceral ganglion of the vagus (G.vis.X, figs. 1, 2, 3, 4) consists of one large group of cells, of nondescript outline, located on the ventrolateral aspect of the jugular (G.Jug.) and lateral line ganglion (G.L.L.X). At its most anterior aspect it fuses with the ectodermal thickening over the second branchial pouch.

The early flexure stage. The postauditory ganglia have changed very little since the previous stage.

The lateral line ganglion of the ninth nerve (G.L.L.IX, figs. 5, 8) is shorter, and extends from the brain in a ventrolateral and slightly anterior direction. It is seen to overlie all but the distal end of the visceral ganglion of the ninth (G.vis.IX, fig. 5). Anteriorly it does not contact the auditory vesicle. Medially it joins the root of the lateral line ganglion of the vagus just before entering the neural tube (fig. 5). Laterally it extends to the lateral line primordium overlying the first branchial pouch.

The lateral line ganglion of the vagus (G.L.L.X, figs. 5, 6, 7) has acquired a somewhat spindle shape. It lies parallel with but several millimeters lateral to the neural tube. In addition, it lies dorsomesial to the general cutaneous (G.Jug.) and visceral sensory ganglia of the vagus (G.vis.X.). Anterolaterally the ganglion retains contact, by a narrow strand of cells, with the primordium over the second branchial pouch. Posteriorily it extends to the primordium over the second to the fifth myotomes of the trunk.

The general sensory component, the jugular ganglion (G.Jug., figs. 5, 7, 8), is more elongated but does not as yet reach the brain medially. A poorly differentiated group of cells can be demonstrated extending from this ganglion to the skin at a point near the second postauditory lateral line primordium.

The visceral sensory component of the glossopharyngeal nerve (G.vis.IX, figs. 5, 8) has essentially the same size and position as before. It extends to the brain along the ventromesial surface of the lateral line ganglion (G.L.L.IX) and enters the brain slightly ventral and caudal to the lateral line root (fig. 7). Its distal extremity has come to lie ventral and lateral to the auditory vesicle in which position it has a broad connection with the large epibranchial placode over the first branchial pouch.

The visceral ganglion of the vagus (G.vis.X, figs. 5, 6, 7) appears to consist of two distinct parts. The smaller anterior portion retains its connection with a poorly developed ectodermal placode over the second branchial pouch. The larger portion extends caudad and ends rather indefinitely in the vicinity of other branchial pouches. From the ventromesial border of the ganglion (fig. 7) a slender stalk of cells is seen to reach the neural tube (R.vis.X). No root fibers can be demonstrated in this strand of indifferent cells at this time.

The coiled-reaction stage. The postauditory ganglia have undergone marked development since the early flexure stage (figs. 9, 11, 12). They present a slight over-all enlargement, but most noticeable is their compactness and striking contours, especially in figure eleven. In addition there is a tendency for some of the ganglia to become attenuated at their distal extremity.

The lateral line ganglion of the ninth nerve (G.L.L.IX, figs. 9, 11, 12) enters the brain medially in connection with the root of the lateral line component of the vagus. It now overlies only the posterior margin of the visceral ganglion (G.vis.IX, figs. 9, 11). Laterally, where it reaches to the skin it appears to be relatively close to the anterior portion of the visceral ganglion of the vagus nerve.

The lateral line ganglion of the vagus (G.L.L.X, figs. 9, 11, 12) shows considerable increase in size. It has progressed cephalad along the root fibers where, together with the lateral line ganglion of the ninth nerve it is in contact with the neural tube. It presents an enlarged portion ventrolaterally which connects with the trunk primordium opposite the third and fourth myotomes. Posterior to this, where it becomes attenuated, it is in contact with the lateral line primordium opposite the seventh to the tenth myotomes.

The jugular ganglion (G.Jug., figs. 9, 11, 12) retains its position on the lateral aspect of the lateral line ganglion of the vagus. It is cuneiform and projects straight laterad where it touches the skin at a point between the primordia innervated by the lateral line ganglia of the ninth and tenth nerves respectively. It pierces the lateral line ganglion to send a rootlike projection to the neural tube (G.Jug., fig. 12). No fibers can be traced into the brain at this time.

The visceral ganglion of the ninth nerve (G.vis.IX, figs. 9, 10, 11, 12) is essentially unchanged in size and outline. Its root entrance, which is ventral to that of the lateral line, may now be seen from the lateral as well as from the ventral aspect. Anteriorly the ganglion overlies a small portion of the auditory vesicle. The enlarged distal end still extends to the entoderm of the first branchial pouch. No nerve trunks arise from the ganglion at this time.

The visceral ganglion of the tenth nerve (G.vis.X, figs. 9, 10, 11, 12) is considerably larger. It is divided into two distinct portions which laterally appear to be separated but ventrally are seen to be continuous (figs. 9, 11). It is roughly Y-shaped, the arms of the Y being the two portions described above and the nerve root representing the stalk. It is noted that the root entrance of the visceral ganglion (R.vis.X) is caudad to that of the lateral line ganglion of the vagus (R.L.L.X, figs. 9, 11). In the absence of peripheral fibers the ventrolateral aspect of the ganglion still reaches out to the branchial pouches.

The early swimming stage. The changes in the postauditory ganglia are characterized by the greater compactness of the parts of the ninth and tenth complexes with attenuation of some of the ganglia to form nerve trunks (figs. 13, 14, 15, 16). Accompanying the changes in the brain and cranial ganglia are changes in the lateral line primordium which unfortunately are not shown here.

The lateral line ganglion of the glossopharyngeus (G.L.L.IX, figs. 13, 16) has retracted considerably and lies close to the neural tube. Its short rootlike process disappears, along with that of the vagus, in a root mass at the side of the brain (R.L.L.IX, X, fig. 13). At their entrance the lateral line fibers of the vagus are seen to lie directly dorsal to those of the glossopharyngeus (fig. 13). Peripherally the ganglion gives rise to the ramus supratemporalis which innervates the most anterior portion of the two postauditory lateral line primordia.

The lateral line ganglion of the vagus (G.L.L.X, figs. 13, 15, 16) is relatively unchanged. At its anteroventral aspect it gives off the ramus auricularis vagi which innervates the other postauditory lateral-line primordia. Caudally the ganglion can be traced to the seventeenth myotome, innervating the lateral-line primordia along its dorsolateral border.

The jugular ganglion, instead of piercing the lateral line ganglion of the vagus nerve, now passes ventral to this ganglion and dorsal to the visceral ganglion (fig. 13). Its root emerges medially from between these two ganglia and projects across the dorsal surface of the visceral root to the side of the neural tube (figs. 13, 16). In this latter position it is bordered posteriorly by the spinal accessory root (R.XI) which extends caudad to the level of the third myotome. Peripherally the jugular ganglion sends fibers to the second of the two postauditory lateral line primordium. Also it sends fibers with those from the visceral ganglion which project to the second and third branchial pouches.

The visceral ganglion of the ninth nerve (G.vis.IX, figs. 13, 14, 15) is relatively the same as in the coiled-reaction stage. It now lies directly ventral to the auditory vesicle and projects cephalad to nearly the level of its anterior margin (figs. 13, 15). Its root is seen to enter the neural tube ventral to that of the lateral line (fig. 15). The large distal extremity of this ganglion retains its contact with the entoderm of the first branchial pouch. In addition it gives off a postbranchial nerve, the ramus lingualis, which courses ventrad to the first branchial bar and then continues rostrad within this bar.

The visceral ganglion of the vagus (G.vis.X, figs. 13, 14, 15) has continued to differentiate. Anteriorly it consists of two distinct portions which are connected to the entoderm of the second and third branchial pouches respectively. The anterior part of the two connections is the more highly developed, and is referred to as the nervus branchialis vagus, and passes some distance into the primordium of the second gill arch. Posteriorly the ganglion spreads out loosely over the branchial region. Medially the root fibers of the ganglion approach the neural tube ventral to those of the jugular ganglion. Several millimeters from the brain the root suddenly turns dorsad to enter the brain at a point slightly anterior and dorsal to the root of the jugular ganglion (R.vis.X; R.G.Jug., fig. 13).

SUMMARY

The olfactory placode is an irregularly shaped mass of cells throughout the four stages of development studied. The lateral surface, which is smooth and relatively flat in the nonmotile stage is somewhat spherical and contains a pit by the time the early swimming stage is reached. It is essentially the same size throughout the series, except for some increase in thickness. The olfactory placode makes contact with two other structures, the telencephalon ventrally and medially and the eye primordium posteriorly.

The eye undergoes much differentiation. From a relatively flat, irregularly shaped group of cells with a shallow depression on its lateral surface it develops into a thick oval structure having a definite outline. It is in contact with the olfactory placode anteriorly and ventrally, with the diencephalon by way of the optic stalk and with either one or both of the ganglia of the fifth cranial nerve.

The ganglia of the various nerve complexes differentiate from elongated, irregular masses of cells having very indefinite outlines to more regularly shaped structures which have discernible outlines. In general in the nonmotile stage the ganglia lie at some distance from the neural tube, being connected to the tube by slender root fibers which are surrounded by cells of the root mass at the neural tube. The ganglia gradually recede along the root fibers and come to lie next to the neural tube in the later stages. They are attached to the neural tube along its ventrolateral wall at the rhombic prominences. In the nonmotile stage the ventrolateral wall has two such prominences, one at the site of the fifth nerve root and one at the joint site of the VII, VIII, IX and X nerve roots. The lateral line ganglia lie dorsal to the visceral sensory ganglia and their root fibers enter the neural tube dorsal to those of the visceral sensory root fibers.

The neural tube is flexed in the region of the midbrain with the result that the long axis of the hindbrain is at a right angle to that of the forebrain. With continued flexion the ventral surfaces of the hindbrain and the diencephalon very nearly approximate one another. In the early swimming stage there is an indication of the passing of this flexure as the relationship of the forebrain with the hindbrain appears to be changing from angular to linear.

In the mid-line the roof and floor of the neural tube are relatively thick in the nonmotile stage and gradually become thinner in the older stages, with the exception of the floor of the diencephalon which becomes thicker as fibrillar substances begin to appear and as the optic chiasma and hypophyseal gland differentiate. In the telencephalic region the lateral ventricle can be observed in its beginning. In the roof of the diencephalon the epiphyseal gland is seen first as a slight notch in the nonmotile stage and finally in the early swimming stage as a small pocket closed off from the third ventricle.

As the wall expands laterally the ventricles are transformed from shallow cavities and depressions into large recesses and compartments. The continuity from the third to the fourth ventricle becomes considerably restricted and more nearly resembles the narrow canal found in the adult.

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ABBREVIATIONS

an.l.vent., the anlage of the lateral ventricle
Aud. ves., the auditory vesicle or otocyst
cb p., the cerebellar prominence
c.f., the chorioid fissure
com.op., the optic chiasma
Dien., the diencephalon
End., the endolymphatic primordium
ep.gl., the epiphyseal gland primordium
F.B.ves., the forebrain vesicle
G.VIII, the ganglion of the auditory nerve
G.G., the Gasserian ganglion
G.gen., the geniculate ganglion
G.Jug., the jugular ganglion of the vagus
G.L.L.VIIa, division a of the lateral line ganglion of the facial nerve
G.L.L.VIIb, the hyomandibular division of the lateral line ganglion of the facial nerve
G.L.L.IX, the lateral line ganglion of the glossopharyngeal nerve
G.L.L.X, the lateral line ganglion of the vagus
G.oph., the ganglion of the ophthalmicus profundus
G.vis.IX, the visceral ganglion of the glossopharyngeus
G.vis.X, the visceral ganglion of the vagus
H.B.ves., the hindbrain vesicle
hyp.g., the hypophyseal gland
hyth., the hypothalamus
h.br.n., the hypothalamic brain notch
L., the lens anlage
l.d, lateral depressions of the rhombencephalon
l.t., the lamina terminalis
l.g., the longitudinal groove of the mesencephalon
l.h.p., the lateral hypothalmic prominence
l.ven., the lateral ventricle
Mes., the mesencephalon
M.B.ves., the midbrain vesicle
m.r., the mammillary recess
Olf.p., the olfactory primordium
olf.pit, the olfactory pit
optic p., the optic primordium
op.r., the optic recess

op.st., the optic stalk
p.o.r., the postoptic recess
r.d., rhombic depression
r.e., rhombic elevation
r.f., rhombic fissure
R.G.Jug., the root of the jurgular ganglion
Rhomb., the rhombencephalon
R.L.L.VII, lateral line root of the facial nerve
R.L.L.IX,X, the lateral line root of the glossopharyngeus and vagus
r.m.V, the root mass of five; a group of indifferent cells surrounding the entrance of the nerve root
r.p., rhombic prominence
r.p.m., the posterior mesencephalic recess
R.V., the root of the trigeminus
R.vis.IX., the visceral sensory root of the vagus
R.vis.X, the visceral sensory root of the vagus
R.XI., the spinal accessory root
s.d.v., the sulcus dorsoventralis
s.v., the sulcus ventralis
Tel., the telencephalon
t.med., the telencephalon medium
t.r., the terminal ridge
tub.p., the tuberculum posterius
Vel.tr., the velum transversum

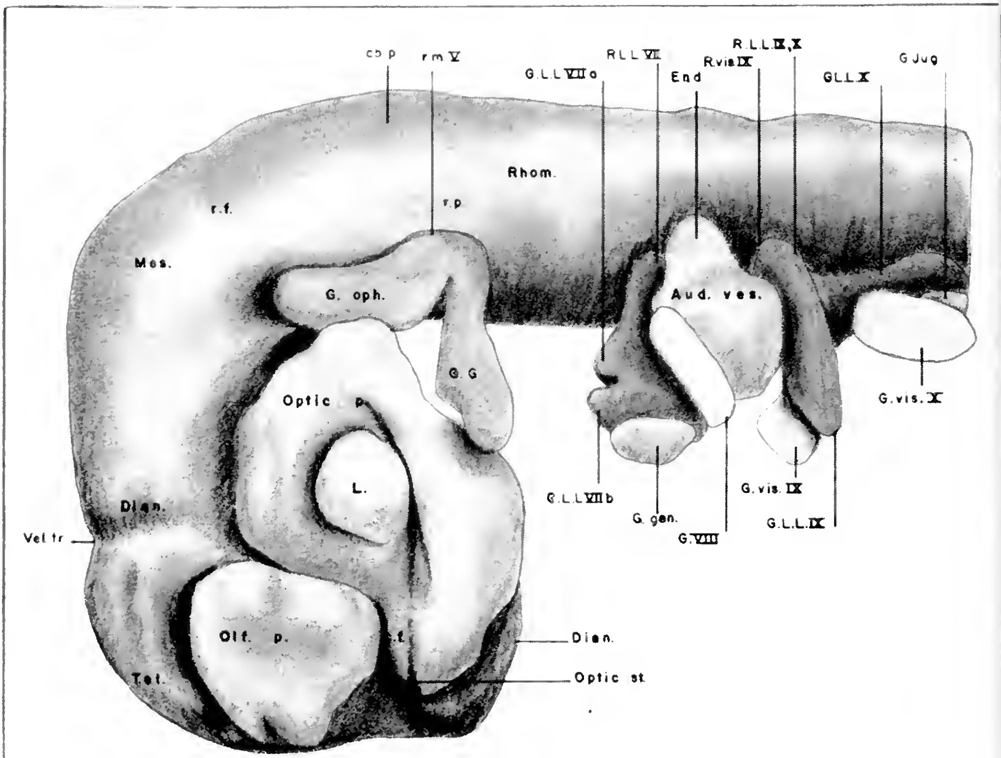

Fig 1
Non-motile Lateral view X153

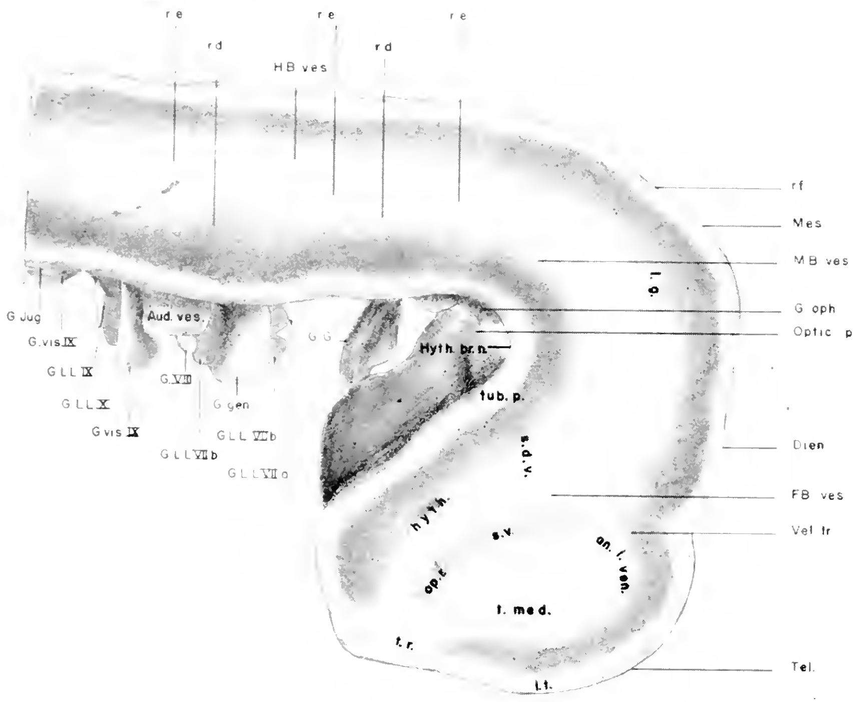

Fig 2
Non-motile Medial view X144

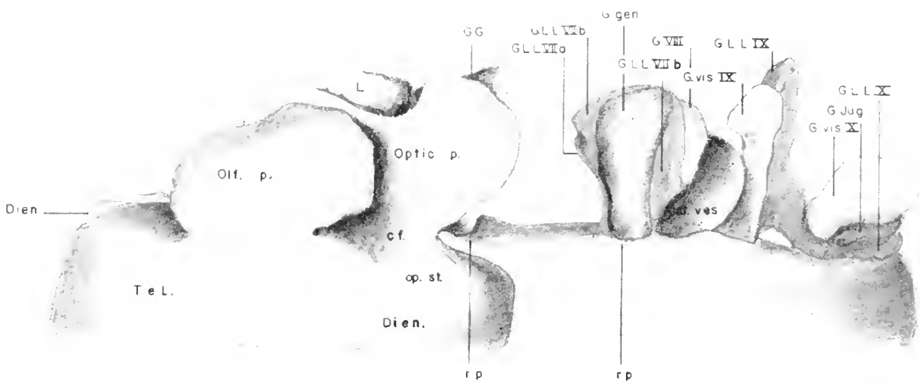

Fig. 3
Non-motile Ventral view X159

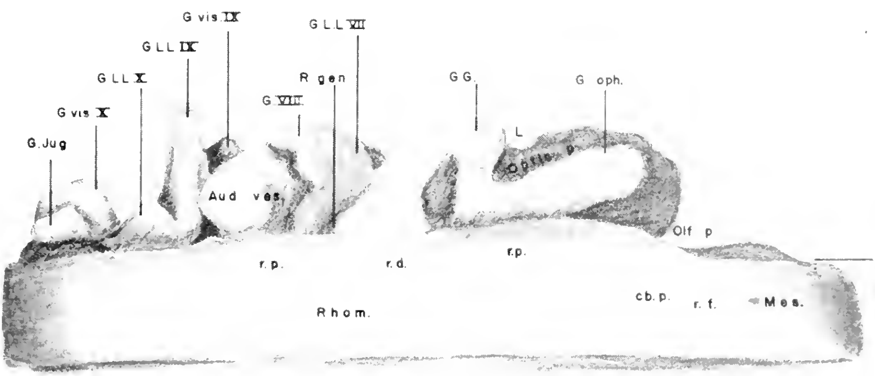

Fig 4
Non-motile Dorsal view X153

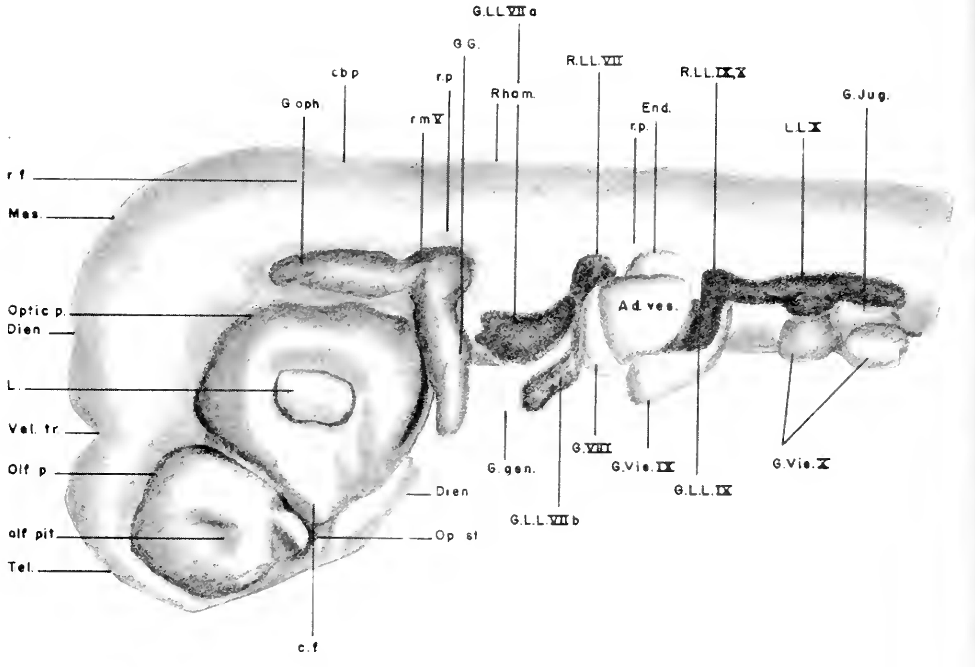

Fig. 5
Early flexure Lateral view X124

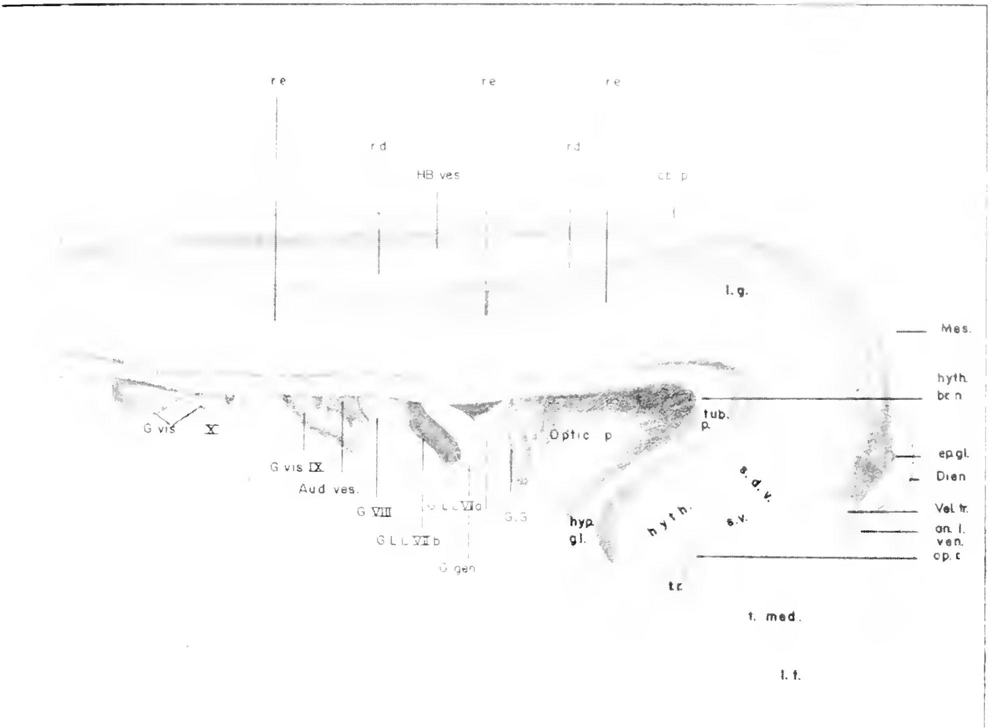

Fig 6
Early flexure Medial view X125

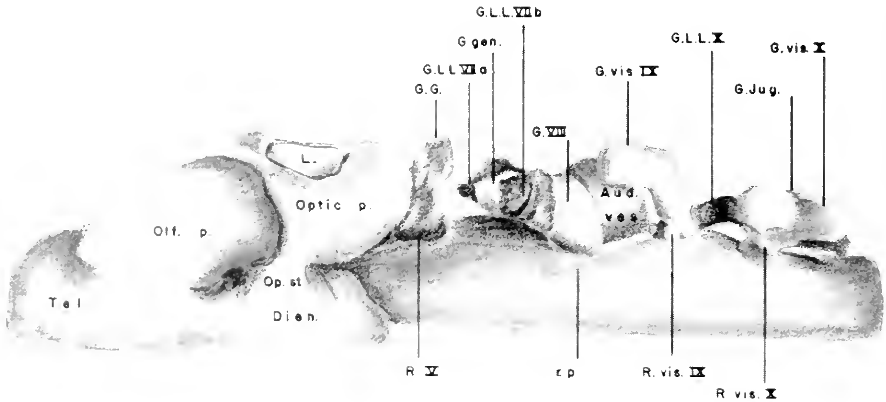

Fig. 7
Early flexure Ventral view X132

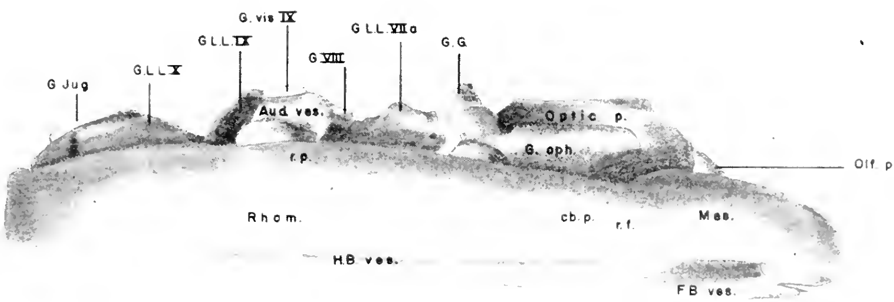

Fig 8
Early flexure Dorsal view X121

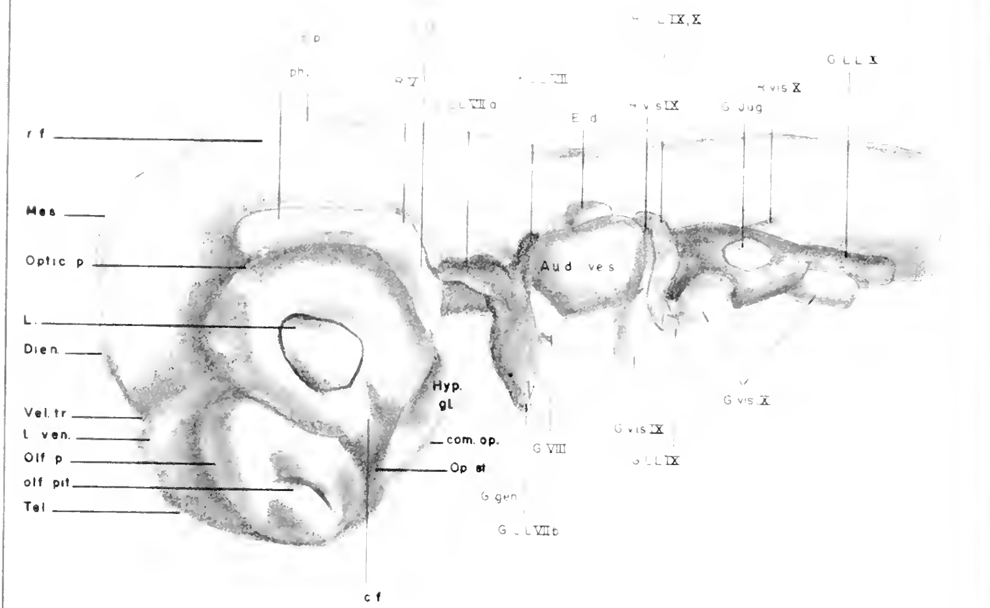

Fig 9
Coiled-reaction Lateral view X127

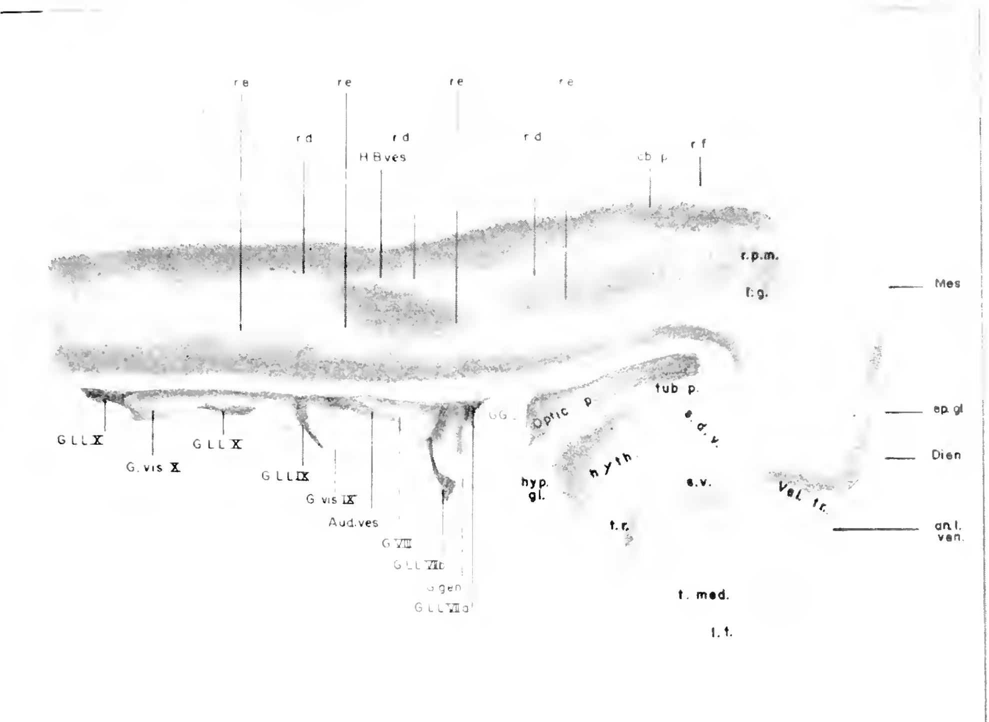

Fig 10
Coiled-reaction Medial view X129

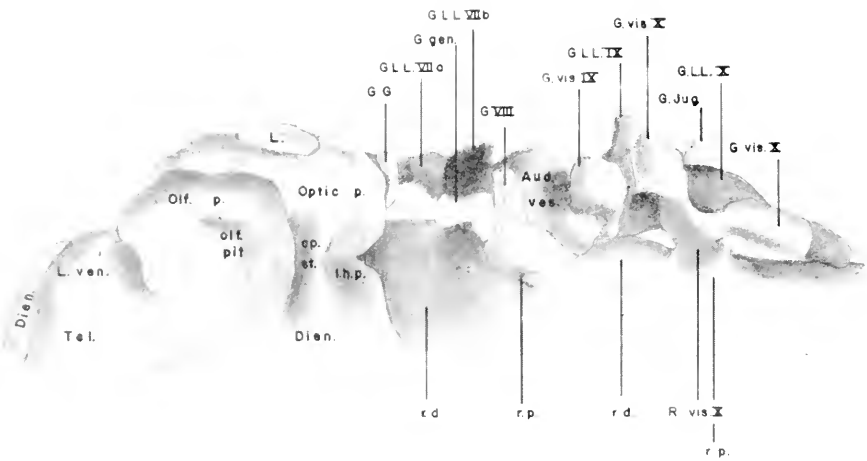

Fig II
Coiled-reaction Ventral view X132

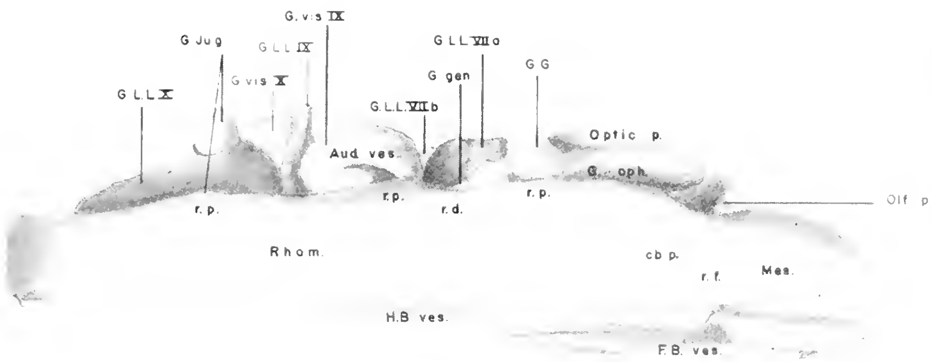

Fig. 12
Coiled-reaction Dorsal view X134

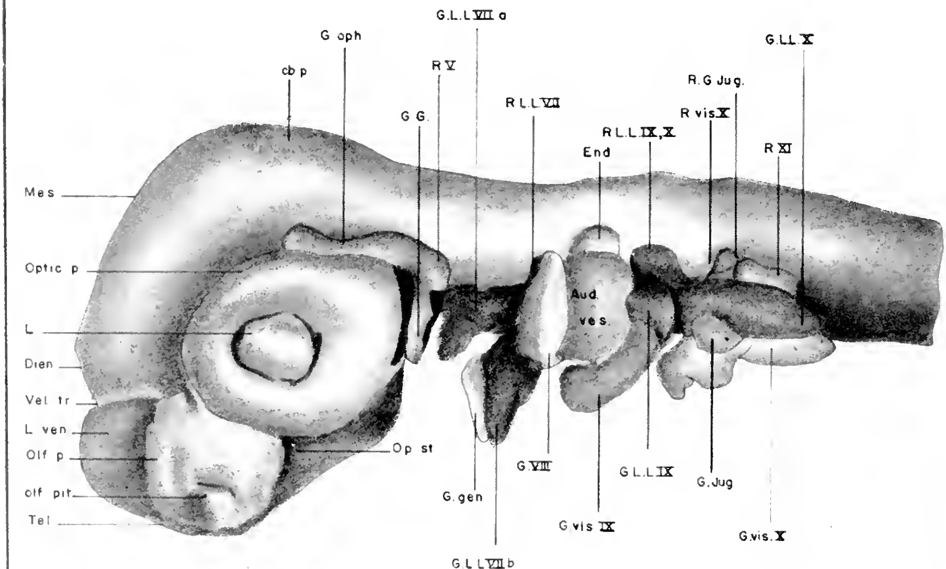

Fig. 13
Early swimming Lateral view X125

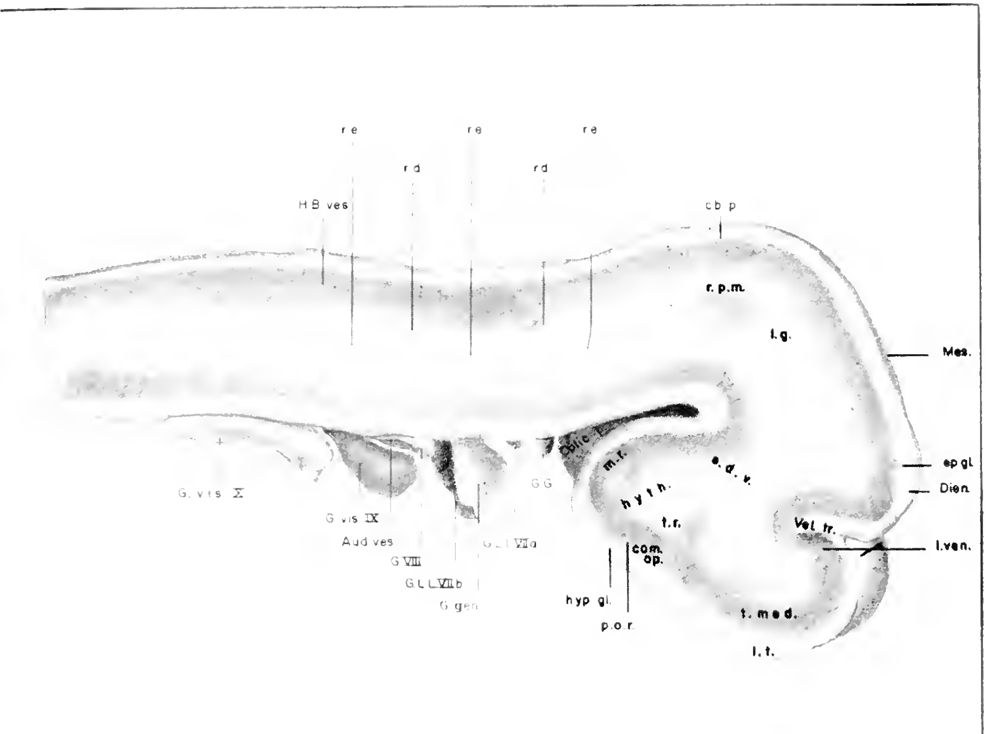

Fig 14
Early swimming Medial view X127

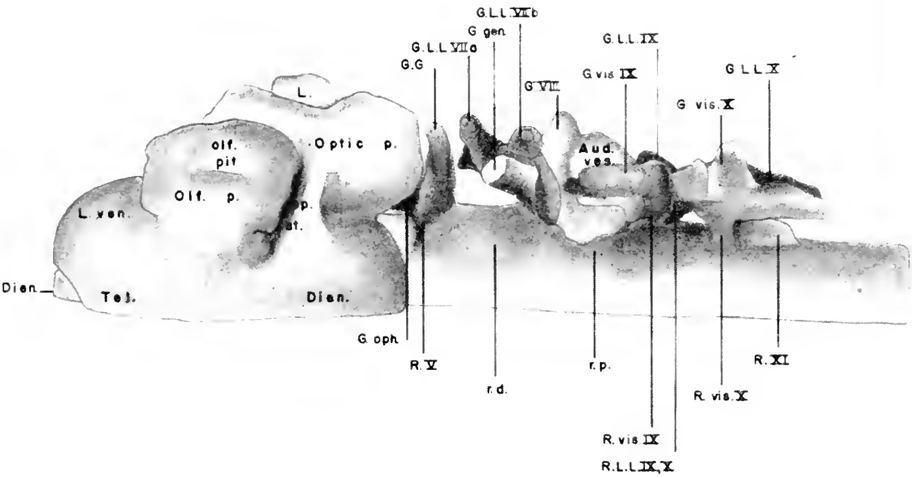

Fig. 15
Early swimming Ventral view X125

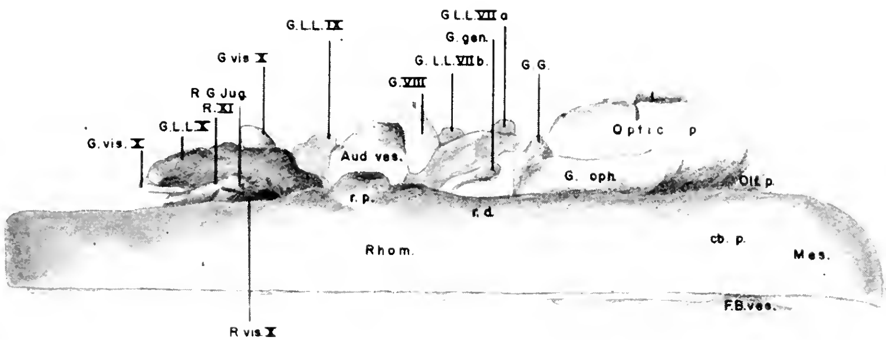

Fig 16
Early swimming Dorsal view X127

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The Taxonomic Value of the Pretarsal Structures in the Classification of Certain Fulgoroidea[1]

By Kathleen C. Doering

Abstract.—This investigation includes a study of eight North American genera of the subfamily Orgerinae and four North American genera of the subfamily Dictyopharinae of the family Dictyopharidae, Fulgoroidea. To detect variability among species a study was made of seven species of the genus *Orgerius* (Orgerinae) and eight species of the genus *Scolops* (Dictyopharinae).

From the generic studies a characteristic pretarsal pattern seems to be evident for each subfamily. In the Dictyopharinae there are four setae on each unguis and two pairs of setae on the arolium. In the Orgerinae there are two setae on each unguis and one pair of setae on the arolium. The genus *Orgerius* in this group showed a variation from the typical pattern in that three species out of the seven studied showed three setae instead of the typical two on each claw.

Specific characters were the shape of the dorsal plates of the arolium, amount of imbrication on the base of the unguis and the shape of the unguitractor plate. Differences in these characters were slight and for the most part the conclusion is that they are of such small magnitude that they could only be useful as additional or corroborative evidence in distinguishing certain species.

INTRODUCTION

Recently two excellent papers have been published which have shown the value of certain structural features of the pretarsus as taxonomic tools in the classification of the order Hemiptera. One of these by Fennah (1945) covers the families of the Auchenorhyncha (Homoptera) and the other by Dashman (1953) includes twenty families of the Heteroptera (Hemiptera). Fennah's emphasis was on the significance of differences between the four superfamilies and also between families of the superfamily Fulgoroidea. He pointed out that for certain families the pretarsus gave additional

1. Contribution No. 897 of the Department of Entomology, University of Kansas.

corrobative evidence in the placement of certain puzzling genera in their proper family. Dashman describes the unguitractor plate as the main taxonomic character of the pretarsus in the Heteroptera and considers it to be a valuable aid in the classifying of this suborder into families.

In the present paper the immediate objectives were to test the characters of the pretarsus described by Fennah for the Fulgoroidea as to uniformity within a single family and likewise their significance, if any, as taxonomic tools at the generic and specific levels. Furthermore, as a long range objective it was hoped that some new characters might be found which would throw light on the more fundamental problems as to whether there is justification in the current practice of dividing the superfamily Fulgoroidea into some eighteen or nineteen families.

TECHNIQUE AND MATERIALS

Twelve genera of the family Dictyopharidae were studied, which includes all the North American genera except two. To determine whether any pretarsal characters showed species variation nine species of the genus *Scolops* were studied and seven species of the genus *Orgerius*. To check the stability of the character for a species, specimens of *Scolops pungens* were studied from eleven geographical locations. For this same group both males and females were compared to determine any sexual variation. Likewise several dissections were made of the pretarsi from all six legs of the same individual in order to test variation as regards the three pairs of legs.

The pretarsi of many species used in this study were minute structures which made them exceedingly difficult to dissect, mount and study in any standard aspect for the purpose of comparison. In order not to lose the minute structures in passing them through the various solutions in the mounting process it was necessary to remove a major part of the legs. Then the separation of the pretarsus was made on the slide just before applying the coverslip. The procedure for mounting was to first boil the leg in caustic potash for a minute or two, followed by thorough washing in water. Next it was boiled in hydrogen peroxide for 3 to 6 minutes. This decolorization was necessary in order to make the setae plainly visible. After washing out the peroxide the specimen could be stained in an aqueous solution of acid fuchsin if desired. It could be first studied in glycerine and later mounted in diaphane. In glycerin a ventrolateral view of the unguis could be obtained which frequently gave a more accurate picture of the setae. The mounting proved to be a delicate task. In order to make accurate comparative drawings it was necessary to mount the pretarsus in a flat position so that both ventral and dorsal surfaces were completely exposed. But due to the minute size and the natural curvature of the claws the specimens had a tendency to roll to one side or the other as the coverslip was applied.

Specimens were first studied and drawn by using an ordinary microscope. A micrometer disc marked into millimeter squares was used in the eye piece. Corresponding one-half inch squares were marked on drawing paper. All drawings were made to this scale. A final check on setal count was made by using a phase contrast microscope which gave an additional check for doubtful cases.

The writer is indebted to Mr. Ranendra Nath Sinha for making a large proportion of the mounts for this study.

Family Characters in the Pretarsus

In the Dictyopharidae the pretarsus shows the typical auchenorhynchus pattern for the pretarsus, namely a pair of stout ungues, a large median padlike arolium and a strongly sclerotized unguitractor plate. Fennah (1945) set up further standard characteristics for the superfamily Fulgoroidea which he believes to be fundamental characteristics in the identification of this superfamily. He states that "a pair of setae on the plantar surface of the arolium, dorsolateral sclerites devoid of setae, and a triangular and transversely ridged unguitractor plate constitute the most fundamental of all Fulgoroid characters, transcending in their universality both the presence of tegulae and the nonsegmented condition of the antennal flagellum."

Details of the pretarsus for the Dictyopharidae are as follows: the apices of the ungues usually extend somewhat beyond the apical margin of the arolium; usually their basal lateral surfaces are ornamented with small pointed scales; laterally or ventrolaterally each unguis bears either two, three (exceptional) or four, stout, spinelike setae.

The well-developed arolium which according to Fennah is "essentially an extension of the membrane at the apex of the tarsus between the tarsal claws" is a conspicuous membranous pad bearing on its dorsal surface a pair of heavily sclerotized crescent-shaped plates called the "dorso-lateral sclerites" (Fennah 1945). At base these plates articulate with a condyle on the base of each unguis and distally they are tapered. Ventrally the arolium bears one or two pairs of minute setae. The presence of this second pair of setae found in several groups is at variance with Fennah's idea of the generality of one pair for the superfamily Fulgoroidea as quoted above.

The unguitractor plate is subtriangular in outline, the distal end is expanded and the margin truncate or shallowly concave where it joins the arolium; basally the plate is bluntly pointed; the convex ventral surface of the plate has a somewhat imbricated appearance due to shallowly scalloped, transverse ridges. Sometimes the scallops are deep enough to appear as overlapping scales.

Generic Variation of the Pretarsus

Following Metcalf's classification (1946) the family Dictyopharidae is divided into two subfamilies, the Orgerinae and the Dictyopharinae. For the subfamily Orgerinae the following North American genera were studied.

Acinaca Ball and Hartzell (*lurida* B. & H).
Deserta Ball and Hartzell (*raptoria* Ball)
Orgamara Ball (*argentia* Ball)
Orgerius Stål (*bicornis* Doering and Darby), *concordus* Ball and Hartzell, *foliatus* Doering and Darby, *junceus* Doering and Darby, *pajaronius* Ball and Hartzell, *rhyparus* Stål and *ventosus* Ball and Hartzell)
Ticida Uhler (*cingulata* Uhler)
Timodema Ball (*miracula* Ball)
Timonidia Ball and Hartzell (*solitaria* Ball)
Yucanda Ball and Hartzell (*albida* Ball)

Specimens of two genera, *Aridia* Ball and Hartzell and *Loxophora* Van Duzee were not available for study.

The North American genera of Dictyopharinae studied were:

Nersia Fennah (*florens* Stål)
Phylloscelis Germar (atra var. *albonervosa* Melichar)
Rhynchomitra Fennah (*recurva* Metcalf)
Scolops Schaum (*angustatus* Uhler, *grossus* Uhler, *maculosus* Ball, *pallidus* Uhler, *perdix* Uhler, *pungens* Germar, *snowi* Breakey, *sulcipes* Say and *uhleri* Ball)

This group includes a proportionally small number of genera of the subfamily and is therefore less representative of this category. However a general pattern apparently holds for these four genera. This fact is particularly interesting since it has been suggested that possibly *Phylloscelis* and *Scolops* have more affinity with the Orgerinae than the Dictyopharinae. On the basis of this study it would seem that they belong where they are now placed even though in superficial appearance they resemble the Orgerinae more than they do other genera of the Dictyopharinae.

Pretarsal variations other than the number of setae, are minor characters which can best be understood by a study of Table I below and by looking at the drawings on the accompanying plates. For example there are definite differences in the size and shape of the ungues which are difficult to describe in words but which can readily be noted by a study of the drawings. Also the extent of the imbrication on the base of the ungues is distinctive for some. The size and shape of the dorsolateral sclerites of the arolium vary from broad to linear and in some cases are more crescent-shaped than in others. The Orgerinae showed more variability of this character than did the Dictyopharinae.

The most significant character exhibited by the pretarsus was the number, size and arrangement of the large spinelike setae on the ungues. Fennah (1945) states that in the Dictyopharidae three or four setae are present on each unguis. In this study it was found that the Orgerinae are typically bisetose and the Dictyopharinae quadrisetose. One exception to the rule occurred in the genus *Orgerius* where three setae were found in three species studied and only two in the remaining four species. The position of the setae varied from the condition of all setae being mostly lateral and hence visible from either ventral or dorsal surface or all ventral. In the latter case if the mesal setae are smaller than the lateral ones and lying prone on the claw they can readily be overlooked by the observer. It was for this reason that decolorizing the specimen in hydrogen peroxide proved helpful since by this process the alveolus or socket was generally visible even though the seta might be broken.

Differences in the unguitractor plate and the arolium did not seem to be distinctive enough to attach any significance to them. In the drawings there may appear differences that are more apparent than real. Some of this may be due to slight differences in mountings and also to inaccuracies in drawing. It was difficult to get the plate oriented properly with the rest of the pretarsus; frequently the specimen had to be shifted a little and therefore inaccuracies in width versus length of the plate or the size relationship of the plate to claws and arolium might readily have occurred.

Finally a few isolated differences showed up. One unique character appeared in the distitarsus or last tarsomere of *Acinaca lurida* Ball and Hartzell. In this species the ventral surface of the distitarsus is concave and membranous. This condition did not appear in any other genera. In the genus *Scolops* all species show more sclerotization of the arolium. In tracing the evolutionary trend in the Fulgoroidea Fennah postulates that the primitive or ancestral type of pretarsus has the ungues simple or unisetose without any mesal condylar development, and the dorsolateral sclerites absent or indicated merely as slight thickenings without definite boundaries. Therefore he concludes that the tri- and quadrisetose condition of the ungues, condylar development on mesal surface and the presence of dorsolateral plates are specializations. Furthermore he states that in nymphal Fulgoroidea as well as the adults of the more generalized families such as the Tettigometridae, Cixiidae and Del-

TABLE I.—*Synopsis of Structural Differences of the Pretarsus in Various Genera*

	Orgerinae								Dictyopharinae			
	Acinaca	Deserta	Timodema	Orgamara	Orgerius	Ticida	Timonidia	Yucanda	Nersia	Phylloscelis	Rhynchomitra	Scolops
Ungues bisetose.........	+	+	+	+	+	+	+	+				
trisetose........					+							
quadrisetose.....									+	+	+	+
setae ventral and lateral....	+	+	+	+	+	+	+	+	+		+	+
setae all ventral					+					+		+
Arolium approximately as long as ungues....	+	—	+	+	—	+	+	+	—	+	—	—
bisetose on plantar surface	+	+	+	+	+	+	+	+				
quadrisetose on plantar surface									+	+	+	+
dorsolateral plates broad...	+				+		+	+	+		+	+
dorsolateral plates linear...		+	+?	+	+	+				+		+
somewhat sclerotized in addition to plates..	—	?	—	—	—	—	—	—	—	—	—	+
distitarsus with ventral surface membranous..	+	—	—	—	—	—	—	—	—	—	—	—

phacidae, the arolium is well developed and the ungues are bisetose.

Applying these interpretations to this study it would seem that the Orgerinae represent the primitive group and the Dictyopharinae the more specialized. The latter claim is further substantiated by another specialization occurring in the Dictyopharinae, namely an additional pair of setae on the plantar surface of the arolium.

Species Variation in the Pretarsus

An attempt was made to see if structural differences were exhibited by the pretarsus among species of the same genus. In view of the fact that only minor differences appeared between genera it was not expected that any very useful differences would be discovered among species. This proved to be true. The amount of variation that occurs is of still smaller magnitude than that between genera, the variable characters being such things as width

TABLE II.—*Synopsis of Pretarsal Characteristics in the Genus Scolops Schaum*

	angustatus Uhler	grossus Uhler	maculosus Ball	pallidus Uhler	perdix Uhler	pungens Germar	snowi Breakey	sulcipes Say	uhleri Ball
dorsal plate of arolium broad and subtriangular......	+			+			+		
narrow and crescent-shaped...		+						+	+?
linear (rodlike).............			+		+	+			
arolium narrow and somewhat reduced..................	—	+	+	—	—	—	—	—	—
arolium more heavily sclerotized between dorsal plates........	—	+	+	—	+	—	+	+	+
unguitractor plate broad.........	+	—	—	—	—	+	+	—	—
setae of unguis, 3 ventral and 1 lateral.......				+					
2 ventral and 2 lateral.......			+		+		+	+	
1 ventral and 3 lateral.......	+	+				+			+
imbrications on unguis heavy.....	—	—	—	—	—	+	—	—	+

or degree of curvature of the dorsal sclerites, amount of sclerotization of the arolium other than the plates, relative position of the setae on the ungues and the width of the arolium and the extent of development as compared to the ungues.

Nine species of the large genus *Scolops* were studied. These species are listed and summarized in Table II. The differences can best be followed by studying this table and the accompanying drawings. By far the most useful character seems to be the relative width to length of the dorsal sclerite on the arolium, which in some species appeared as a slender brown rod (linear in table) but in others was broader and subtriangular.

In the genus *Orgerius* seven species were studied. Here a striking variation occurred in the number of setae on each unguis. Three species distinctly bore three setae on each claw while four species show only two. In the former group the mesal seta was always ventral and quite small and might easily be overlooked. Thinking of this as a possibility for the species where only two setae appeared additional examinations were made but failed to reveal this third seta. Again in this genus as well as in *Scolops*

TABLE III.—*Synopsis of Pretarsal Characteristics of the Genus Orgerius Stal*

	bicornis Doer. & Darby	concordus Ball & Hart.	foliatus Doer. & Darby	junceus Doer. & Darby	pajaronius Ball & Hart.	rhyparus Stal	ventosus Ball & Hart.
dorsal plate of arolium							
broad and subtriangular	+						+
narrow and crescent-shaped		+	+				
linear (rodlike)				+	+	+	
unguitractor plate broad	+	+	+	+			+
elongate					+	+	
unguis bisetose	+		+		+		+
trisetose		+		+		+	
imbrications heavy	—	+	—	—	—	+	—

the size and shape of the dorsal plate was a variable character. Note particularly the differences in the plates of *Orgerius rhyparus* Stål and *Orgerius bicornis* Doering and Darby. The summary of variations for this genus is given in Table III.

In order to test the constancy of the characters within a given species numerous examples of *Scolops pungens* Germar were studied from the following localities: Brazoria, Hidalgo, Cameron and Harris counties in Texas; from Ames, Iowa; from Polk county, Arkansas and from Chautauqua and Douglas counties in Kansas. No apparent differences were noted.

Likewise pretarsi from pro-, meso-, and metathoracic legs of the same specimen were compared. Again no noticeable differences were noted among the different pairs of legs.

Finally no differences could be discovered between the sexes.

To summarize the value of the pretarsal characteristics in species identification it would seem that the characteristics of most value are the number of setae on the unguis in the case of one genus and the shape of the dorsal plates of the arolium. For the most part species differences are slight. Therefore they can be relied upon mainly as secondary and additional data to corroborate other findings.

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1954. Characters of taxonomic importance in the pretarsus of Auchenorhyncha (Homoptera). Proc. Ent. Soc. Washington, vol. 47, pp. 120-128.

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1946. General catalogue of the Hemiptera, Fasc. 14, Fulgoroidea, Part 8, Dictyopharidae.

PLATE I

FIGURE

1. Dorsal view of pretarsus of *Phylloscelis atra* var. albonervosa Mel.
2. Ventral view of pretarsus of *Phylloscelis atra* var. albonervosa Mel.
3. Dorsal view of pretarsus of *Timonidia solitaria* Ball & Hartzell.
4. Ventral view of pretarsus of *Timonidia solitaria* Ball & Hartzell.
5. Dorsal view of pretarsus of *Orgamara argentia* Ball.
6. Ventral view of pretarsus of *Orgamara argentia* Ball.
7. Dorsal view of pretarsus of *Acinaca lurida* Ball and Hartzell.
8. Ventral view of pretarsus and last tarsomere of *Acinaca lurida* Ball and Hartzell.
9. Dorsal view of pretarsus of *Ticida cingulata* Uhler.
10. Ventral view of pretarsus of *Ticida cingulata* Uhler.
11. Dorsal view of pretarsus of *Yucanda albida* (Ball).
12. Ventral view of pretarsus of *Yucanda albida* (Ball).
13. Ventral view of pretarsus of *Timodema miracula* Ball.
14. Dorsal view of pretarsus of *Timodema miracula* Ball.
15. Dorsal view of pretarsus of *Deserta raptoria* Ball.
16. Ventral view of pretarsus of *Deserta raptoria* Ball.

PLATE I

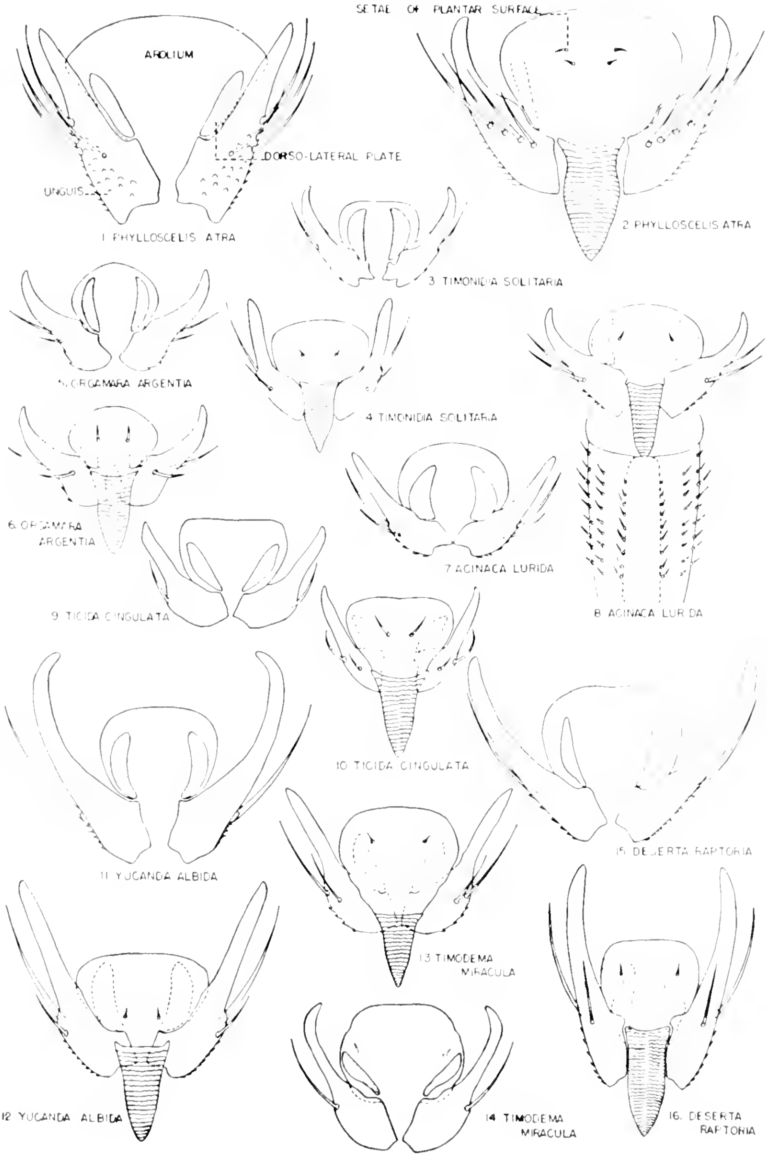

SETAE OF PLANTAR SURFACE
AROLIUM
DORSO-LATERAL PLATE
UNGUIS
1 PHYLLOSCELIS ATRA
2 PHYLLOSCELIS ATRA
3 TIMONIDIA SOLITARIA
4 TIMONIDIA SOLITARIA
5 ORGAMARA ARGENTIA
6 ORGAMARA ARGENTIA
7 ACINACA LURIDA
8 ACINACA LURIDA
9 TICIDA CINGULATA
10 TICIDA CINGULATA
11 YUCANDA ALBIDA
12 YUCANDA ALBIDA
13 TIMODEMA MIRACULA
14 TIMODEMA MIRACULA
15 DESERTA RAPTORIA
16. DESERTA RAPTORIA

PLATE II

FIGURE

1. Dorsal view of pretarsus of *Scolops perdix* Uhler.
2. Dorsal view of pretarsus of *Scolops uhleri* Ball.
3. Dorsal view of pretarsus of *Scolops snowi* Breakey.
4. Dorsal view of pretarsus of *Scolops pungens* Germar.
5. Dorsal view of pretarsus of *Scolops maculosus* Ball.
6. Dorsal view of pretarsus of *Scolops angustatus* Uhler.
7. Dorsal view of pretarsus of *Scolops pallidus* Uhler.
8. Dorsal view of pretarsus of *Scolops sulcipes* Say.
9. Dorsal view of pretarsus of *Scolops grossus* Uhler.
10. Ventral view of pretarsus of *Rhynchomitra recurva* (Metcalf).
11. Dorsal view of pretarsus of *Rhynchomitra recurva* (Metcalf).

PLATE II

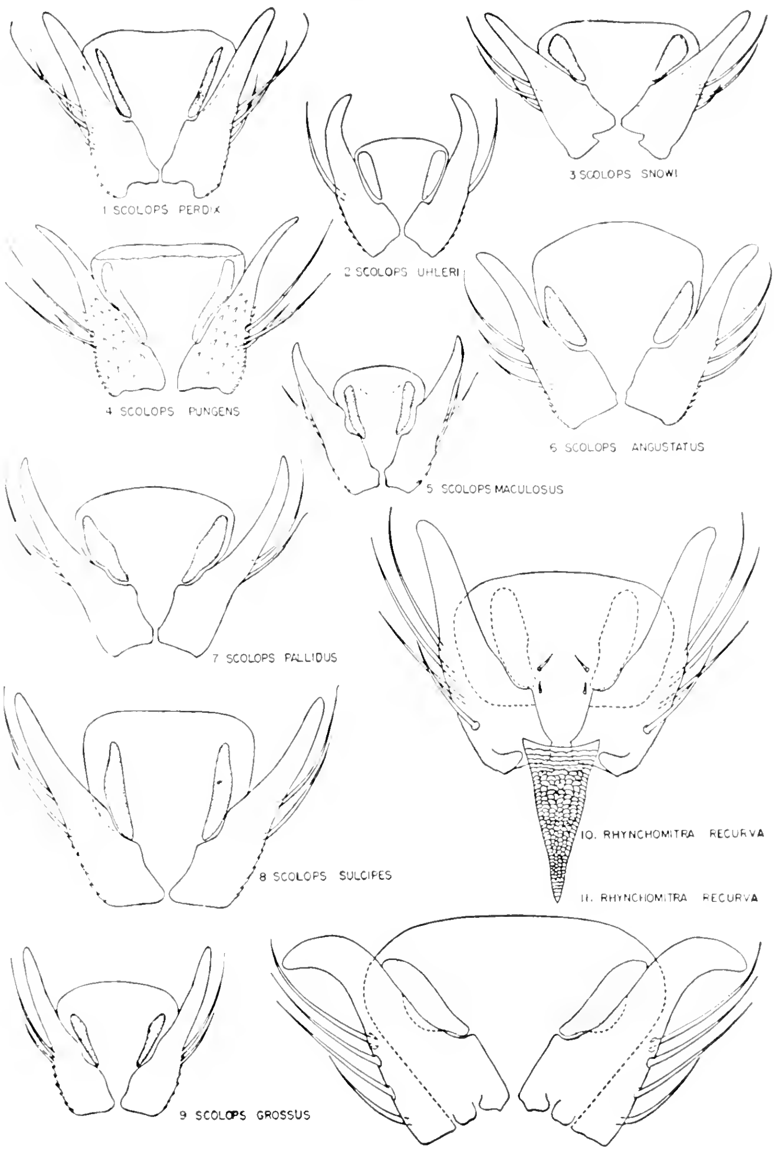

1 SCOLOPS PERDIX
2 SCOLOPS UHLERI
3 SCOLOPS SNOWI
4 SCOLOPS PUNGENS
5 SCOLOPS MACULOSUS
6 SCOLOPS ANGUSTATUS
7 SCOLOPS PALLIDUS
8 SCOLOPS SULCIPES
9 SCOLOPS GROSSUS
10. RHYNCHOMITRA RECURVA
11. RHYNCHOMITRA RECURVA

PLATE III

FIGURE

1. Ventral view of pretarsus of *Scolops sulcipes* Say.
2. Ventral view of pretarsus of *Scolops pallidus* Uhler.
3. Ventral view of pretarsus of *Scolops grossus* Uhler.
4. Ventral view of pretarsus of *Scolops snowi* Breakey.
5. Ventral view of pretarsus of *Scolops uhleri* Ball.
6. Ventral view of pretarsus of *Scolops angustatus* Uhler.
7. Ventral view of pretarsus of *Scolops pungens* Germar.
8. Ventral view of pretarsus of *Scolops perdix* Uhler.
9. Ventral view of pretarsus of *Scolops maculosus* Ball.
10. Dorsal view of pretarsus of *Nersia florens* Stål.
11. Ventral view of pretarsus of *Nersia florens* Stål.

PLATE III

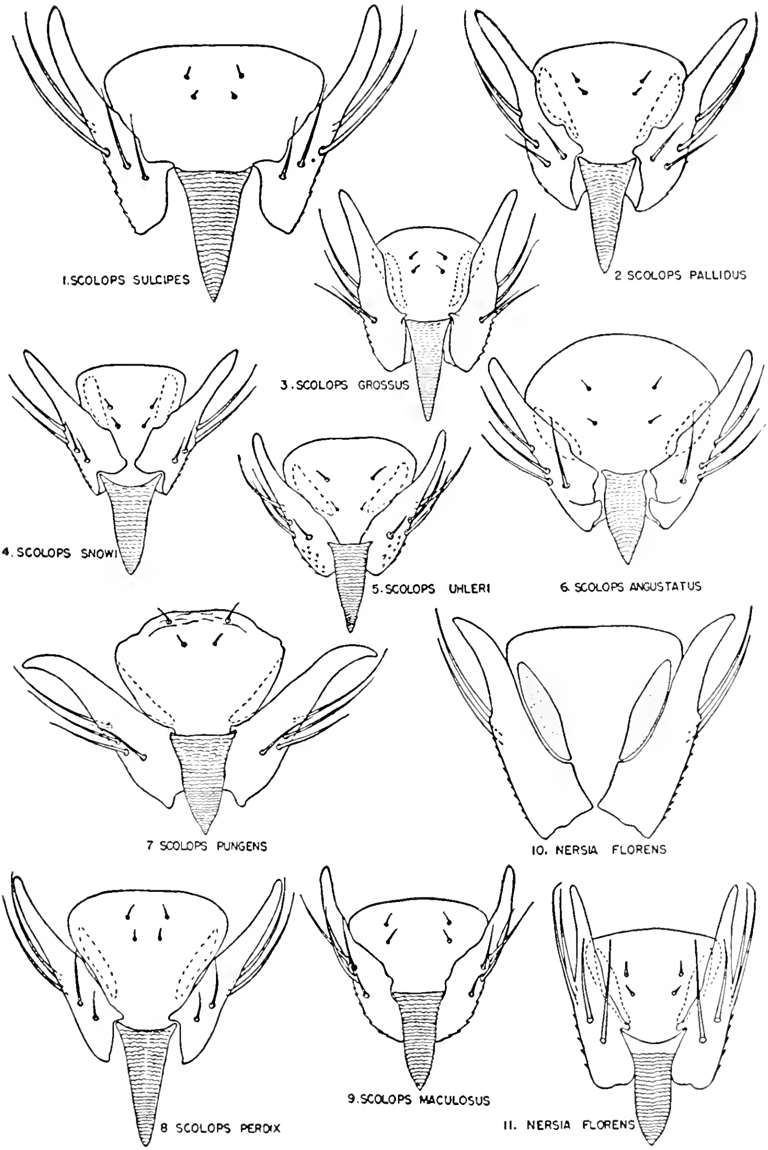
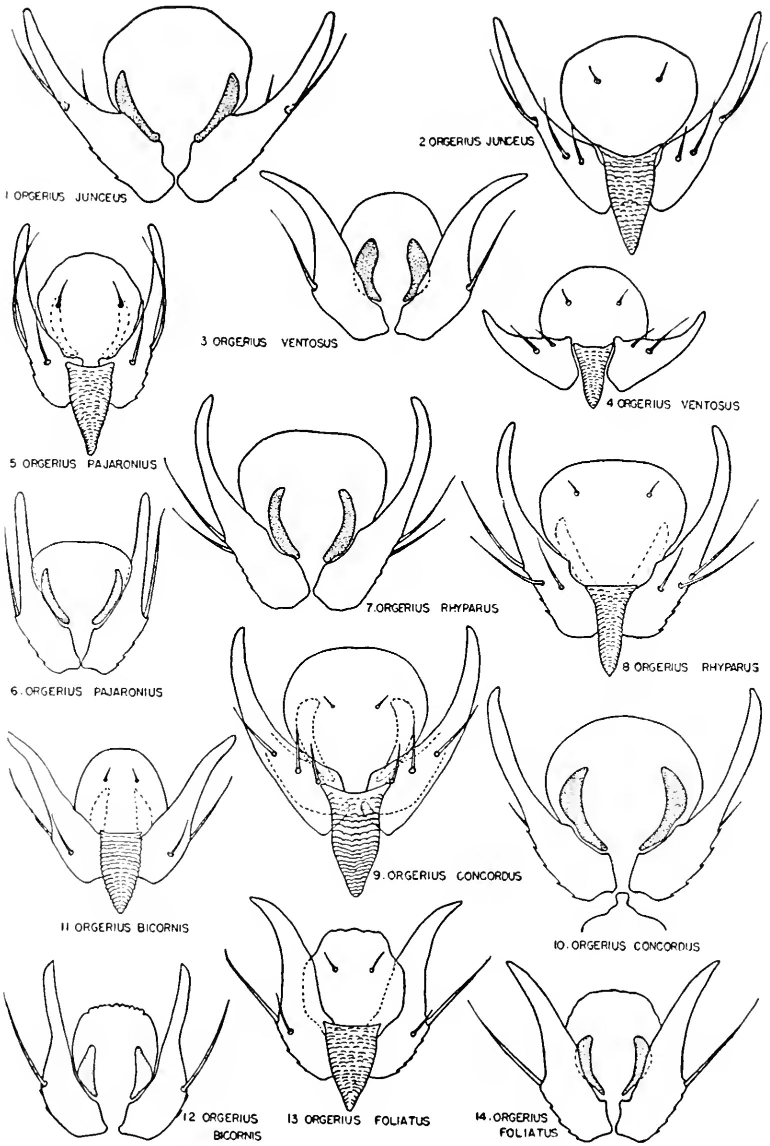

1. SCOLOPS SULCIPES
2 SCOLOPS PALLIDUS
3. SCOLOPS GROSSUS
4. SCOLOPS SNOWI
5. SCOLOPS UHLERI
6. SCOLOPS ANGUSTATUS
7 SCOLOPS PUNGENS
10. NERSIA FLORENS
8 SCOLOPS PERDIX
9. SCOLOPS MACULOSUS
11. NERSIA FLORENS

PLATE IV

FIGURE

1. Dorsal view of pretarsus of *Orgerius junceus* Doering and Darby.
2. Ventral view of pretarsus of *Orgerius junceus* Doering and Darby.
3. Dorsal view of pretarsus of *Orgerius ventosus* Ball and Hartzell.
4. Ventral view of pretarsus of *Orgerius ventosus* Ball and Hartzell.
5. Ventral view of pretarsus of *Orgerius pajaronius* Ball and Hartzell.
6. Dorsal view of pretarsus of *Orgerius pajaronius* Ball and Hartzell.
7. Dorsal view of pretarsus of *Orgerius rhyparus* Stål.
8. Ventral view of pretarsus of *Orgerius rhyparus* Stål.
9. Ventral view of pretarsus of *Orgerius concordus* Ball and Hartzell.
10. Dorsal view of pretarsus of *Orgerius concordus* Ball and Hartzell.
11. Ventral view of pretarsus of *Orgerius bicornis* Doering and Darby.
12. Dorsal view of pretarsus of *Orgerius bicornis* Doering and Darby.
13. Ventral view of pretarsus of *Orgerius foliatus* Doering and Darby.
14. Dorsal view of pretarsus of *Orgerius foliatus* Doering and Darby.

PLATE IV


1 ORGERIUS JUNCEUS
2 ORGERIUS JUNCEUS
3 ORGERIUS VENTOSUS
4 ORGERIUS VENTOSUS
5 ORGERIUS PAJARONIUS
6. ORGERIUS PAJARONIUS
7. ORGERIUS RHYPARUS
8 ORGERIUS RHYPARUS
9. ORGERIUS CONCORDUS
10. ORGERIUS CONCORDUS
11 ORGERIUS BICORNIS
12 ORGERIUS BICORNIS
13 ORGERIUS FOLIATUS
14. ORGERIUS FOLIATUS

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The Ethology of *Andrena erythronii* with Comparative Data on Other Species (Hymenoptera, Andrenidae)[1]

BY

CHARLES D. MICHENER and CARL W. RETTENMEYER

ABSTRACT.—*Andrena erythronii* is an early spring burrowing bee here recorded for the first time from Kansas. It collects pollen primarily from *Erythronium* but after that plant ceases blooming it visits other plants for pollen. Females appear at the surface of the soil in nesting areas almost as early as males but burrow into the soil and hence are not or rarely seen in flight until several days after the males are seen. Each female constructs two, occasionally three, nests, one after the other, provisioning about four cells in the first and two in the second, so that her total offspring probably number only about six individuals. Occasionally two females occupy a single nest, either simultaneously or one after another. This may be an important clue to the way in which social behavior was established among bees which do not practice progressive feeding.

After a period of flight in March and April the adults die, males before females. Larvae develop in their cells in the soil and pass the summer, pupating in the fall. Adults emerge from the pupae in late fall but stay in their cells through the winter, burrowing to the surface of the ground in March.

CONTENTS

1. Contribution number 895 from the Department of Entomology, University of Kansas, Lawrence, Kan.

INTRODUCTION

The purpose of this paper is to present information on the bionomics of *Andrena erythronii* with the broader objective of contributing data that may be used in a study of comparative behavior. With the latter idea in mind, comparative material from our investigations of *A. bipunctata* and from ethological studies of *Andrena* made by other authors have been incorporated into this account. This paper becomes, therefore, something of a summary of available information on the nesting behavior of *Andrena*, an enormous, principally holarctic genus with over 500 species currently recognized in North America. The only similar previous summary is that of Malyshev (1926), published in the Russian language.

Field data on *Andrena erythronii* were obtained during the five years, 1951 to 1955, with the most detailed study being in 1954. Our studies were made by observing bees nesting on the campus of the University of Kansas at Lawrence, Kansas. The only previous record of nesting of *A. erythronii* is in a path near Chicago, Illinois (Lanham, 1949) and the species was known previously only from that State. The Kansas nesting site is in a slightly sloping path, the soil of which is firm and well packed. In it, nests of other species of bees have been observed as follows: *Calliopsis andreniformis* Smith (15 + per season), *Lasioglossum stultum* (Cresson) (12 + per season), *Halictus ligatus* Say (3), *Andrena bipunctata* (8 + per season), *Andrena* sp? (1), *Augochloropsis* sp? (1).

There are two principal nesting areas for *A. erythronii* in the path. Area I is about six meters long and three broad, an area where the soil is hard and contains much clay. It is exposed to sun all day throughout the year. Area II is about ten meters long and three broad; its soil is loam containing little clay. This area is shaded except at midday by trees which are, however, leafless during much of the season of flight of *A. erythronii*. In addition there are a very few isolated nests elsewhere along the path.

The reason for the aggregations is not known although they occur in many species of *Andrena*. Some similar species of *Andrena* scatter their nests instead of aggregating them. In writing of another species (*A. vaga*) which nests in dense aggregations of up to several hundred individuals, Malyshev (1926) stated that there is a tendency for nests to be constructed at the place where the bees emerge. He mentions little groups of four to six holes, presumably around a single nest of a year or two before, as well as the larger aggregations of various sizes. Perkins (1919) makes a similar statement and records the growth of an aggregation of *A. cineraria* from a few nests to a permanently large group.

The bee populations in our two areas have not changed greatly during the years of observation. The nests in the more densely populated part of Area II were marked, mapped and watched in 1954. In a zone nine meters long and three meters wide 247 nests were marked. As will be shown later, each female may dig two or three nests. On the other hand, two females may use the same nest, either concurrently or one after the other. For these reasons the relation between the number of nests and the number of female bees is not obvious. In the same zone 130 female bees were marked for individual recognition. Some of these may have been nesting in adjacent parts of Area II, outside the zone of special study, while some nesting inside the zone are known to have escaped marking. However, a reasonable estimate of the number of female bees in the whole of Area II would be 200, while perhaps 65 nested in Area I.

In Area II 154 males were marked in 1954. Since some were missed, the estimate of 200 females for this area seems reasonable if the number of males equals the number of females. Friese (1882) has recorded a sex ratio of approximately one to one in dug cells of *Andrena vaga* in spite of the superabundance of one sex or the other often observed in collections.

SEASONAL HISTORY

The following brief account is provided here as orientation for subsequent parts of this paper. *Andrena erythronii* is the first native bee to become active in the spring in the vicinity of Lawrence, Kansas. Table I shows a number of significant dates concerning the season of flight. This species feeds primarily on the dog-tooth violet, *Erythronium mesochoreum*, which is the first wild flower blooming in this region. There is but one generation per year. The evidence elaborated below indicates that the females come to the surface at very nearly the same time as the males, mate, and promptly dig into the soil again, constructing their first nests. Usually or always they make new burrows rather than use old emergence burrows. It is interesting that females at first have the thoracic hair quite ochraceous but that it fades to cinereous like that of the males in a few days. The males continue to fly about the nesting area on each warm day while the females are burrowing and hence out of sight in the soil. This may have led certain students to the impression that males of various *Andrena* species are much more numerous than females. The males survive less than a month. At night and during cold weather the males can be found in the soil of the nesting area. Sometimes they merely dig into patches of soft dirt; often they enter old emergence holes; and they also enter new burrows dug by females. Early in the season two to four males often will be found buried together, sometimes with a female. The males also visit flowers of *Erythronium*. Males die long before the end of the season of female activity.

Probably because of frequent storms and cold weather, construction of the first burrow and cell by the females is a slow process, and is usually not complete until after the *Erythronium* is in rather full bloom. Pollen collecting begins, apparently, as soon as the first cell is completed. Each cell is provisioned with a firm mass of pollen and nectar on which an egg is laid. After a few cells are constructed and provisioned in the first nest, the bee abandons it and constructs a second nest, which is sometimes followed by a third before she dies. By the time the *Erythronium* flowers die numerous other plants are in bloom, and some of them are used as pollen sources for the later cells. The last females die in late April or early

TABLE I.—Data on the Season of Flight of *Andrena erythronii* (Dates in italics are doubtfully accurate because of lack of appropriate earlier or later observations).

	First ♂♂	First ♀♀	First ♀ in flight	Erythronium in good bloom	First pollen collecting trip	Last ♂	Erythronium out of bloom	Last ♀
1951	Mar. 23			*Apr. 13*	*Apr. 14*	Apr. 14	Apr. 25	*May 5*
1952	Mar. 19	Mar. 19	Mar. 27	Mar. 27	Mar. 31	Apr. 2		Apr. 30
1953	Mar. 12	Mar. 14	Mar. 16	Mar. 18	Mar. 21	*Mar. 23*	Apr. 6	*Apr. 27*
1954	Mar. 9	Mar. 10	Mar. 16	Mar. 21	Mar. 26	Apr. 2	Apr. 6	Apr. 26
1955	Mar. 11	Mar. 14	*Mar. 30*	*Mar. 22*	*Apr. 1*		*Apr. 15*	*Apr. 25*

May, and adults are not seen above the surface of the soil until the following March.

The egg stage lasts several days. The larvae grow rapidly; some individuals had consumed all stored provisions by May 11, 1951. The summer is passed as a mature larva or "prepupa." One male pupa, already dark in color, was dug from its cell on September 23, 1954. A number of adults of both sexes have been found in their cells in October. Thus this species evidently passes the winter as

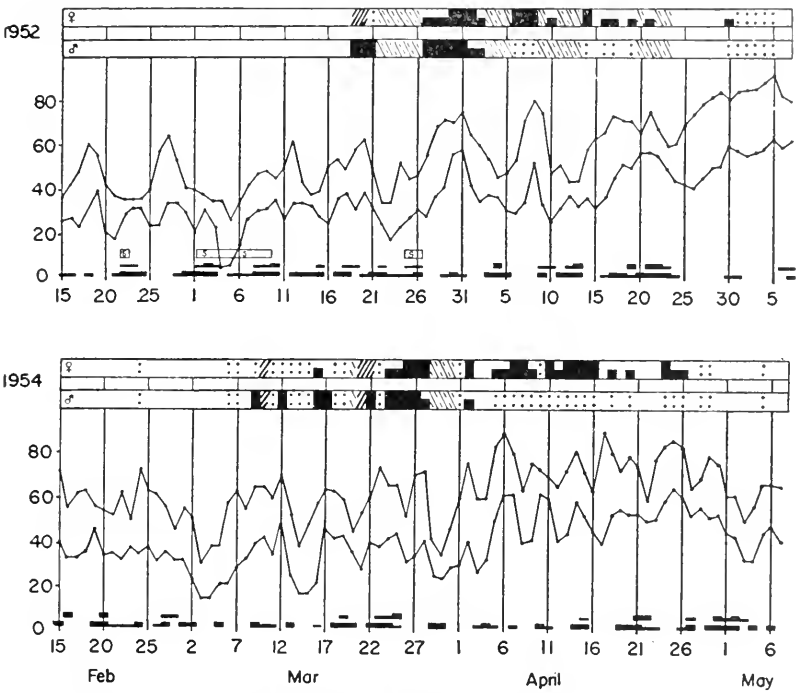


FIG. 1.—Activity of *Andrena erythronii* in 1952 and 1954 in relation to certain weather conditions. The days of the spring months are indicated across the bottom, temperature in degrees F. at the left. Maximum and minimum temperatures for each day are shown. Horizontal bars across the bottom have the following meanings: Lower row, wide bar, cloudy; narrow bar, partly cloudy. Upper row, wide bar, over .25 inches of rain during the day; narrow bar, under .25 inches of rain during the day. Open bar marked "S" indicates snow on ground.

Bars above weather data for each year indicate the activities of the bees, females above males. Black indicates many flying, black only in the lower half of the bar indicates few flying, heavy shading indicates bees at surface but not flying, light shading indicates days within season of activity when no observations were made but weather was obviously such that bees would not have been active, dots indicate that nesting areas were checked at a favorable time of day and no bees were seen. No observations were made on days in which no markings appear in the bars.

an adult in its cell in the soil, as do other species of *Andrena*. As Box (1919) and Malyshev (1926) indicate, statements that andrenas overwinter as mature larvae are erroneous.

PHYSICAL FACTORS OF THE ENVIRONMENT

No serious effort was made to solve the complex interrelation between air temperature, soil temperature, wind, light intensity and perhaps other factors that determine when this bee is active and when it is inactive. However, some data of interest was obtained. Figure 1 shows official United States Weather Bureau maximum and minimum daily temperatures taken about a mile from the nesting area during the spring months of 1952 and 1954, together with information from the same source on cloudiness and precipitation. It is obvious that considerable cold and often rainy weather occurs during the season of flight. In 1951 and again in 1952 enough snow fell after the first appearance of these bees to cover the ground for two days. Many spring days are so cool, even if sunny, that the bees are active for only an hour or two. On days which are sufficiently warm, however, flight may start before 8:00 a. m. and continue as late as 5:30 p. m., so that on the average the daily period of flight increases as the season becomes progressively warmer. This observation was also made for *A. vaga*, another spring *Andrena*, by Vleugel (1947).

It is evident, both from figure 1 and from comparable data for other years, that the maximum temperature (air temperature taken at the Weather Bureau station) must be at least in the upper 50's (F) if flight is to occur. As shown in the first column of figure 2, occasional flights occur when air temperatures taken at the nesting places (in open shade ten centimeters above the ground) are 50° F. The data show (figure 2) that even between 10:00 a. m. and 2:00 p. m., on clear or partly cloudy days, complete inactivity occasionally occurs at air temperatures as high as 60°; occasional, usually short, flights occur from 50° to 64°, while regular and extensive flights occur from 55° to 80°.

The variation in the type of activity which occurs at an air temperature of, for example, 55° is presumably due to factors such as surface temperature, soil temperature, wind, and light. Data on surface and soil temperatures are also shown in figure 2. As would be expected, the range of surface temperatures is higher than that of air temperatures, while the range of soil temperatures is lower, when activity occurs.

The fact that in figure 2 the temperature range of female flight extends higher than that of males is due to the survival of females later in the spring and therefore into warmer weather than males. At times when both sexes are active, the temperature factors influencing flight probably affect both sexes similarly although on some occasions the impression was gained that males fly at lower temperatures than females. This impression is not supported by the summary of data shown in figure 2.

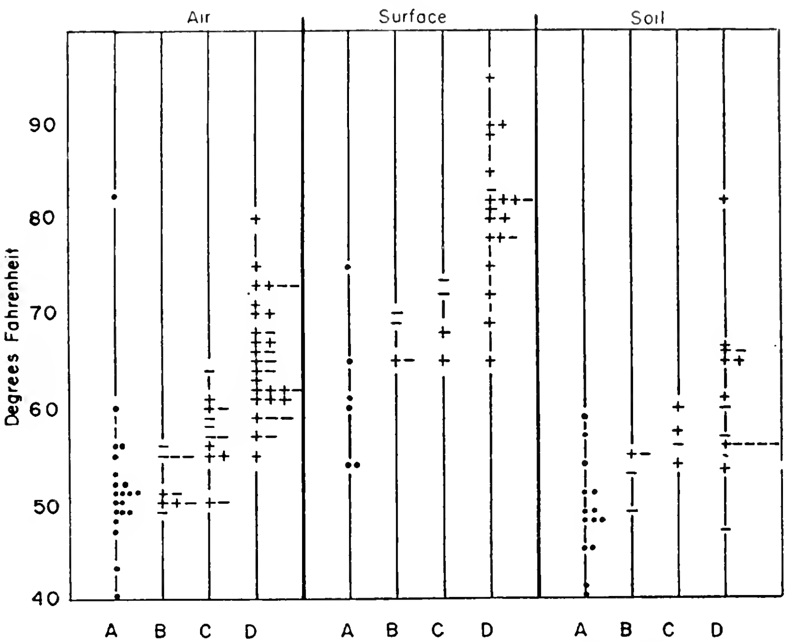


FIG. 2.—Relations of air, surface, and soil temperatures (taken between 10:00 a. m. and 2:00 p. m.) to activities of *Andrena erythronii.* Column A shows temperatures at which no activity was observed on various occasions. Column B shows temperatures at which bees were seen on the surface in the nesting areas but not in flight. Column C shows temperatures when only one or two bees were seen in flight in a 15 minute period. Column D shows temperatures when numerous bees were in flight. In columns B to D, + means females, — means males. Horizontal rows of symbols indicate several observations at one temperature. Air temperatures were taken in open shade 10 cm. above the soil, surface temperatures were taken by laying the thermometer on the soil, soil temperatures were taken 2.5 to 3 cm. deep.

Figure 3 shows all of our simultaneous records of air and soil temperatures. The occurrence of all the points about the line a-a (fitted by eye) reflects the expected correlation between air and soil temperatures. The points indicating slight activity (crosses and solid circles) are concentrated in the region b-b, where the points are particularly widely scattered about the axis a-a. Perhaps this is because slight activity often occurs at times of temperature change when the air temperature is rising above that of the soil or dropping beneath that of the soil.

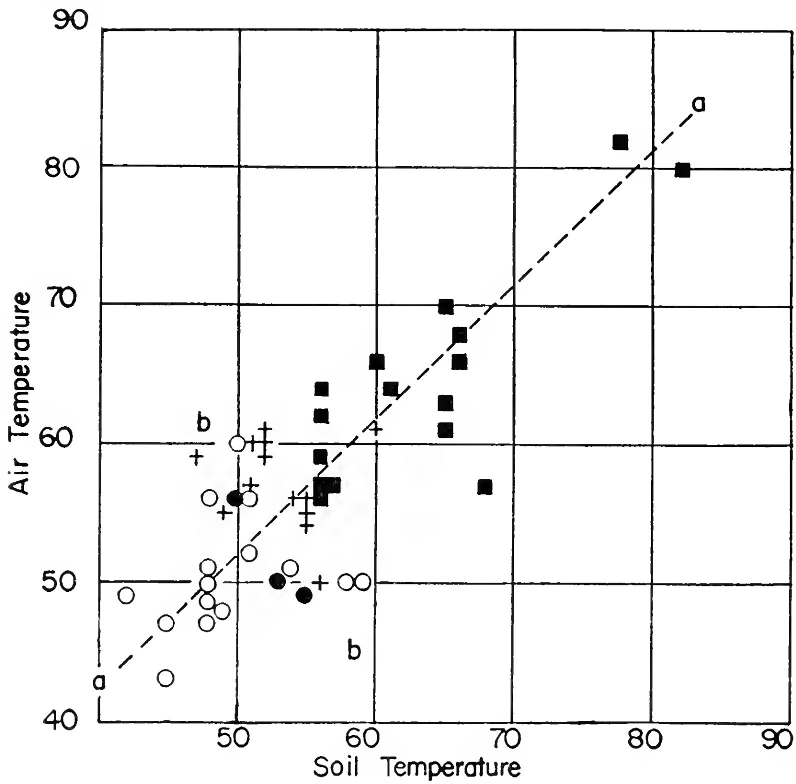


FIG. 3. Records of simultaneous air and soil temperatures (F) and activity of *Andrena erythronii.* Open circles indicate no activity. Squares indicate many bees flying. Beginning of activity is shown by closed circles (bees at surface but not flying) and crosses (only one or two flying in a 15 minute period). See text.

Our two nesting areas are similarly situated and (until Area II becomes shaded part of the day by growing leaves of trees) are similarly exposed to the sun. Activities of the bees in these areas have been rather well synchronized. It is likely that the longer seasons of activity recorded from flower-caught specimens rather than from studies of a particular nesting area are due partly to differences in exposure of nesting places. For example Vleugel (1947), in a study of *Andrena vaga* in Holland, states that aggregations on southeast slopes of dykes became active earlier in the spring, and the males disappeared earlier, than those on west slopes. Those on southeast slopes became active earlier in the morning and ceased activity earlier in the afternoon than those on west slopes. Unfortunately, he gave no actual temperature data.

No significant correlations between temperature or time of day and the duration of pollen collecting trips could be discovered from our data.

The bees are active even on windy days if the temperature is high. Warm spring winds are often strong in Kansas. We have seen the bees collecting pollen and flying about the nesting areas when the wind was so strong that each gust forced the bees to the ground or carried them far to leeward, while many of the bees that dropped to the ground would be rolled over the soil for many feet before stopping.

EMERGENCE OF ADULTS

The adults emerge from the soil, digging essentially vertical burrows which do not usually coincide with the burrows made the preceding spring by the mothers of the emerging bees. At least in the few cases where our nest markers have survived from one spring to the next, emergence holes have been a few centimeters from the previous year's hole. Emergence is rather well synchronized. In 1954 exit holes were first seen on March 9 at which time rather numerous males were flying about the nesting area. One male was seen reaching the surface, the opening being too small for the bee to escape. No bees or exit holes were in evidence on March 7. Exit burrows are largely full of loose dirt and ordinarily no loose dirt is piled up at the surface of the soil; rather they appear as open holes. Probably because emergence started early in the season in 1954 and was interrupted by cold weather (March 14, 15, 20; see figure 1), it continued for some days, so that some exit burrows were noted for the first time on March 17 and 18 and a few as late as March 21. An abundance of unmarked males on March 24 (last previous date on which males were marked was March 21) suggests that there may have been some emergence after March 21. In other years emergence seems to have occurred more rapidly than in 1954, all early spring activities occupying less time than in 1954.

A. erythronii has been regarded previously as protandrous (see Robertson, 1918, 1930). Insofar as any extensive flight is concerned, it is evident that males do precede females in activity. However, in actual emergence from the soil males are little in advance of females. In 1952 females were seen on the same day that males were first seen, in 1953 and 1955 females were seen two days after appearance of males, and in 1954 females were seen one day after appearance of males. Because the females disappear into the soil soon after emergence, they are inconspicuous early in the season and it is quite possible that they regularly appear almost simultaneously with males. There is no evidence as to whether one sex or the other predominates among bees which emerge late (*e. g.* March 21, 1954).

The fact that *A. erythronii* is not very protandrous at time of emergence, although it would be inevitably regarded as such by anyone studying ordinary collecting records, throws some doubt on the type of protandry existing in many species of bees usually called protandrous. Some species of *Andrena* are evidently truly protandrous in emergence time, for Malyshev (1926) describes emergence of males of *A. vaga* two or three days in advance of females and Vleugel (1947) also says that the first males of that species emerge several days before the females.

BEHAVIOR OF MALES

Males emerge before the first *Erythronium* flowers open. At first their flights seem mainly restricted to the vicinity of the nesting area. They fly about zigzag fashion over the area, often very close to the soil, less commonly thirty centimeters above the ground. Vleugel (1947) describes, for *A. vaga,* the gradual extension of flights of males as they grow older, until eventually they reach the *Salix* flowers on which they feed. They may fly around *Salix* bushes even if they are not yet in flower (Malyshev, 1926). Probably similar gradual learning of the features of the environment occurs with *A. erythronii* although the learning must be rapid for on March 16, 1953 a male with pollen grains on its body was taken at a nesting area. This was only four days after bees were first observed. After the flowers are in bloom (see figure 1) males visit them, probably sucking nectar occasionally. More often they merely fly from flower to flower, hesitating for only a moment beside each before flying on. In any case the males are able to fly to the flowers and to find their way back to their own nesting area. In 1954 22 males were marked in Area I and 168 in Area II, different colors being used in the two nesting areas. At no time was a male found in either area which had been marked in the other area. Bees from both areas must visit *Erythronium* in the same general locality. This indicates that they return to their areas of origin. It should be emphasized that on any warm day in their season, males may be seen flying over the nesting area; there is no time when they all disappear to the flowers.

Early in the season, on first emergence and also at later times when they come out of the ground, males often rest with their heads just below the surface and the antennae projecting up above the surface. A male may remain in this position, only the face and the antennae visible, for a short time or, especially early in the morning or on cool days, for as much as half an hour before crawling out. On coming out of the soil, the male may turn and re-enter the hole, or it may crawl about over the surface of the nesting area. These activities are particularly likely early in the morning, late in the evening, or on days scarcely warm enough to cause the bees to appear. During warmer hours, the males fly much of the time, as has already been indicated. Even on warm days, at the height of male flight activity, some males are to be found on and in the soil. They have repeatedly been seen to burrow in, especially at the approach of evening, and must normally spend nights and periods of bad weather in the nesting areas. They enter patches of loose dirt, old emergence holes, or even the burrows of females. Occasionally they emerge promptly and dig in elsewhere; twice this was observed when the male had entered a burrow known to be occupied by a female. One male, observed for fifteen minutes, near midday (air temperature 65°) entered five different burrows. Males which re-enter the soil for protection may be found close to the surface or down to a depth of ten centimeters. They lie in the loose dirt filling the burrows. Whether the burrow is dug at the time by the male (as is often the case), or is an old emergence burrow, or the burrow of a female, it is largely full of loose soil. Males burrowing in push dirt up over themselves much as do females (see below) forming tumuli or hills at the surface, considerably smaller than those made by females when digging nests. Such a hill over an emergence hole almost invariably indicates that a male has entered it. However, because of the various sorts of places where they enter the soil, their tumuli vary from completely absent to ones about sixteen millimeters in diameter. Possibly because of the tendency of the males to walk over the soil, biting here and there with their jaws, finally burrowing in at a soft spot, several males often enter a single burrow, and may be found clustered together. Early in the season a female may be found in the same burrow as males.

Data on longevity of males are meager. Doubtless survival depends to an important degree on weather. Our data were obtained by marking bees with quick drying paints as indicated by Michener *et al.* (1955). In 1954, males marked between March 9 and 16 were still seen as late as March 25 (Table II) but not thereafter, although males marked later continued in evidence until April 2.

From Table II one can see that, although by March 16 about 80 percent of the males in flight about the nesting area had been marked as A. This dropped to five or ten percent for the period March 21 to 25, and to nothing after the latter date. This decrease is probably due to a combination of (1) death of the older bees (A), (2) the dispersal of these bees to flowers so that younger bees still spending most of their time around the nesting area make up the greater part of the population there, and (3) the emergence of these younger bees.

PREMATING BEHAVIOR OF FEMALES

Females of *A. erythronii* are rarely seen before mating. The first evidence that they have emerged is usually the appearance in the nesting areas of tumuli larger than those produced by males. On March 19, 1952, two females were seen flying about with numerous males; possibly the bees had been out before that date. In 1953, although males were in flight on March 12 and 13, females were not seen until March 14 when several female tumuli were recognized and one female was seen as she was digging into the soil in late afternoon, her abdomen still partially exposed. This female and two others dug from the soil on March 14 and ten dug from their burrows on March 16 all had mated, having sperm cells in their spermathecae. This seems to indicate that the females emerge from the soil, mate almost immediately, and burrow in again to construct the first nest.

In 1954, as noted previously, the early spring activities seem to have progressed more slowly than in earlier years. Males were first seen on March 9. On March 10 tumuli of a few female burrows were recognized. Two were dug, one was seven centimeters deep, another thirteen centimeters deep (in soft soil of Area II). Other females were in loose soil of partially filled emergence burrows, sometimes with males in the same burrows. On March 11 it was too cool for bees to fly but there were many more emergence holes and tumuli than on the previous day. One hole, full of loose soil, contained two males and two females at various levels. Some may have been working up; others may have crawled in for protection from cold. On March 12 there was some flight of males but no females were seen at the surface. On March 13 to 15 it was much too cold for bee activity. All females dug from the soil until this time were unmated, having no sperm cells in the spermathecae, and on March 16 an unmated female was seen to emerge from a large tumulus and fly about the nesting area, and a very few other females were seen in flight. At least some of these females mated on that day and by March 18 all females obtained (10) whether in their burrows or in flight, had mated.

TABLE II.—Information on Male *Andrena erythronii* Marked in Area II, 1954

On the days in March indicated, males were marked in three different ways indicated as A, B, and C. Censuses after marking show on five days the approximate percentage of the males seen having each type of marking and the approximate percentage of unmarked individuals (U). The approximate number of bees counted in each census is shown in the bottom row of figures.

Date (March)	9 10 11 12 13 14 15	16	17 18 19 20	21	22	23	24	25	26	27
No. marked	87 A		31 B					45 C		
Censuses (%)		80A 20U		10A 10B 80U	5A 10B 85U			10A 40B 50U		0A 0B 50C 50U
Approx. No. counted		40		20	20			20		20

Subsequent observations of fifteen marked burrows dug by females before March 16 show that, with one exception, these burrows were not used as nests. The abandonment of these burrows suggests that after mating the females dig new nesting burrows. The premating burrows of the females are presumably comparable to the burrows sometimes dug by males, that is they serve only for protection during nights and inclement weather. The one exception mentioned above may have been due to closely adjacent burrows which were not distinguished or, more likely, to the use of the premating burrow by its maker or by another bee for a nest.

To summarize these meager data we may conclude that females usually if not always emerge from the soil unmated. They may then mate almost immediately (apparently the usual thing in 1953) and burrow in again, perhaps with no flight whatever, to construct their first nest. If mating does not occur on first emergence, they burrow in anyway for protection and mate on a subsequent emergence (as was observed in 1954), then promptly construct new burrows for nests. The period of several days (reported by Vleugel (1947) for *A. vaga*) after mating and before nest construction, during which the females orient themselves and find flowers, does not seem to occur in *A. erythronii.*

MATING

In at least some species of *Andrena* which do not nest in aggregations, individuals of both sexes often gather about particular bushes or trees, flying about or resting on the foliage or bark, and mating commonly occurs there (Alfken, 1890; Friese, 1885; Höppner, 1899; Jones, 1930; Perkins, 1919). Among species which nest in aggregations, mating often occurs on the soil in the nesting area. Schroeder (1921) reports that males of *A. fulva* fly over the soil and pounce on the waiting females. Vleugel (1947) reports the males of *A. vaga* digging with "passion" into the soil to find females and says that the males "help" the females out of the ground and mate with them immediately. *A. vaga* has been observed mating both on the soil of the nesting area (Friese, 1882; Vleugel, 1947) and on incompletely open *Salix* flowers visited by this bee (Malyshev, 1926). Observations of others (Vleugel, 1947) agree with our data showing that a female, once mated, will repulse other males that try to mate with her, so that as Vleugel (1947) has stated, the stay of the males around the nesting area soon seems to be useless.

A male of *A. erythronii* was seen to pounce on a female visiting *Erythronium* flowers, although copulation did not result. From this it seems probable that mating sometimes occurs on or near flowers. Although males have often been seen to enter female burrows, and have been found in the soil with virgin females, there is no clear evidence of mating in the ground. On one occasion a male walking over the soil did dig out and attempt to mate with an injured female buried just beneath the surface. It may be that the failure of male *A. erythronii* to dig actively for the females is due to the fact that the two sexes appear more nearly at the same time than in *A. vaga,* but even in that species mating occurs on the surface and not, so far as known, beneath it (Vleugel, 1947). The only evidence for underground mating is merely the rarity of observation of surface mating. In view of the data presented in the preceding section, this evidence seems weak.

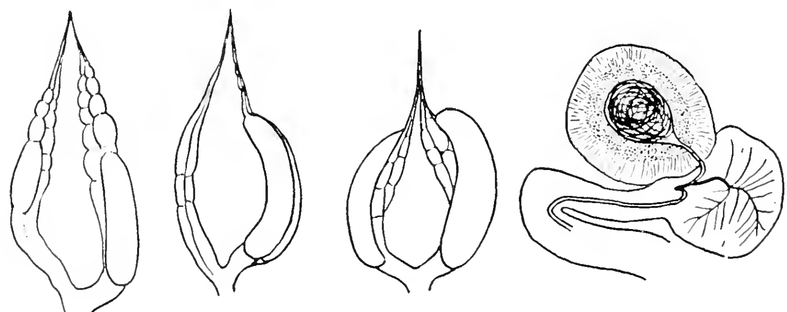
Except as noted above, all observed mating or courtship behavior of *A. erythronii* has been on the soil surface in the nesting areas. Males have been observed to pounce on stones, sticks, tacks, and other males, as well as on females. They often pounce upon females, whether mated or not, even sometimes on a female bringing pollen to her nest. Usually in such cases males are repulsed promptly but occasionally one grasps a mated female with his legs, and sometimes bites at her metasoma, delaying her for perhaps as much as twenty seconds, enough time that one to three additional males may also pounce on the original pair before the female escapes. The accounts of Donisthorpe (1930) and Jones (1930) suggest similar behavior for *A. argentata*. Usually the males pounce on females on the ground but occasionally they strike females flying as much as two or three centimeters above the soil and the two fall to the ground.

We have conducted no experiments to determine how the male recognizes the female. It is partially visual, to judge by the various objects on which males pounce. The same thing has been recorded by Vleugel (1947) for *A. vaga*. He also noted males of *A. fulva* pouncing several times on *Bombus lapidarius* and *B. agrorum* which have areas of the same fulvous color as females of *A. fulva*. For this reason he felt that color plays a part in recognition of females by males. However, the digging by males of *A. vaga* suggests that scent also plays a role.

Actual mating of *A. erythronii* has been observed only once on March 16, 1954, at 2:15 p.m. A female marked fifteen minutes earlier landed on the soil and instantly a male pounced on her, apparently grasping her metasoma with his legs. Both were headed in the same direction, the male on top of the female. There was no noticeable struggle. With his head at the level of the female's propodeum, the male curved his abdomen around and copulation took place within about 15 seconds of the time he pounced on her. At the same time he slid back on the female so that his head was near the posterior third of the female's metasoma. At no time did he bite her wings, as has been recorded for *A. vaga* (Vleugel, 1947), The female was extremely quiet, but immediately after copulation began the male began short stroking movements with his fore and middle legs. Usually the back and forth strokes, which continued constantly during copulation, were not against the female but were on his own body or in open air. Also, during the period of copulation, the straight antennae of the male were kept vibrating in a small arc. Some pumping movements of the male abdomen were visible at the beginning of copulation. About a minute after copulation began a second male pounced on the pair. Before he was removed by the observer he had knocked the first male over so that he lay with his back on the ground, the pair end to end, but the mating male righted himself, apparently merely by flexion of the body, so that his head was above the apical third of the female's metasoma. Perhaps the observer's head and body shielded the pair from other males flying about. The pair were in copulation about four minutes. A slight simultaneous stirring of both ended copulation and both walked away, and were promptly captured. The female remained vigorous but the male died within a few hours.

RESULTS OF DISSECTIONS

The only practical way to determine whether a female bee is mated or not is to dissect her and examine the spermatheca for sperm cells. For this reason a number of dissections were made and some supplementary information obtained. The following notes indicate the results:



4 5 6 7

FIGS. 4-7.—*Andrena erythronii.* 4, Ovaries of unmated female that was digging a burrow. 5, Ovaries of female in midst of nest provisioning. 6, Ovaries of old female with much worn mandibles and wings. 7, Spermatheca, its gland, and duct.

Female bees regularly eat pollen; often the crop is crowded with pollen grains and it may contain pollen from the time before the female has started to construct her first cell, until late in her life, when she is working on her last nest.

No detailed study of ovary development was made but figure 4 shows the ovaries of an unmated female which was digging a burrow; figure 5 shows the ovaries of a female in the midst of her active life; while figure 6 shows ovaries of an old, probably senile female with very much worn mandibles and wings. She was caught while flying apparently aimlessly about the nesting area on one of the last days of activity of *A. erythronii.* There are three ovarioles per ovary, and most often one large egg in each ovary, although sometimes (figure 5) there are two large eggs in one ovary. The largest ovarian eggs measured were 2.27 mm. long.

The spermatheca (figure 7) is more or less round and differs strikingly from that of halictine bees (*Lasioglossum, Halictus, Augochlorella*) in its thick wall which is full of granular material. When it is crushed in saline solution on a slide, the granules take on vibratory activity suggestive of Brownian movement, but since this ceases after a time it is possible that the granules, which are of various sizes and shapes, are living material of some sort. The granules are concentrated in the zone around the cavity of the spermatheca but may occur throughout the spermathecal wall and also in the wall of the spermathecal duct. They do not occur in the cavity or duct lumen; the former is filled with very long filiform sperm cells in mated individuals. The spermathecal gland and duct are, in major features, similar to those of halictine bees.

NEST CONSTRUCTION

Females apparently spend very little time selecting sites for their first nests in early spring, for we rarely observed "searching" activity. Perhaps this is because at this season the soil is uniformly moist. Later in the season, especially when the soil is dry and has a hard surface, females establishing second or third nests are often seen walking about on the soil, or flying from place to place, picking at cracks and soft places with their jaws. Sometimes they will enter abandoned or even occupied burrows made by other bees of this species, and may nest in such appropriated burrows. We have watched a marked female engaged in "searching" for over an hour before she finally started to dig, and from other data we do not feel this period at all unusual. The bees at such times may start to dig at one point and then after going down a few millimeters, abandon the site and go elsewhere.

In digging, the bee loosens particles of soil largely with the mandibles and scrapes them back with the first two pairs of legs, using the hind legs to brace herself. After she is into the soil her full length or more, she uses the abdomen and the hind legs to push loose soil up to the surface. This process has been observed in greater detail for *A. macra* by Sivik (1954). It is this soil that forms the tumulus over the nest entrance. The tumulus is symmetrical around and over the opening of the approximately vertical burrow because, as she excavates, the digger's body rotates on its vertical (longitudinal) axis, not regularly but erratically, so that the soil, from time to time, is pushed up on every side of the opening of the burrow. The tumulus is always closed over the entrance to the nest and the bee comes and goes by digging through it. During the time that the main tunnel is being dug, it is open (*i. e.* free of loose dirt) except for the top one to three centimeters, which are full of loose soil continuous with that of the tumulus. As the bee digs deeper, she pushes loose dirt up into this region and fresh moist dirt can be seen pushing into the center of the tumulus. Sometimes such movements in the tumulus can be seen as often as once every three or four minutes; at other times there may be half an hour, or in cold weather, days, between such additions to the tumulus. Some other species (*e. g.*, *A. macra*, see Sivik, 1954) apparently retain an opening to the surface during the digging process.

Most digging seems to occur in the late afternoon and even after dark at night. The rate of digging varies enormously. On warm days, bees are out of sight within seven to twenty minutes of the time they start digging. The average of four such observations was 11 minutes. We do not know how soon the tunnel is complete, but in warm weather we have repeatedly seen pollen being carried into a nest the day after the tumulus first appeared. This indicates that the bees can construct the entire burrow, one side branch, and a cell in a day. In cold weather, of course, progress is very slow and in early spring we have dug mated females that had been in the ground for at least two days from burrows only seven centimeters deep.

BEHAVIOR IN BURROWS

It is apparently common for species of *Andrena* and indeed other andrenids such as *Spinoliella* and *Calliopsis* to keep the nest closed with the loose dirt which forms the tumulus and extends down the burrow for a short distance. Thus nests of *Andrena vaga* have the upper two to seven centimeters slanting and full of loose soil (Malyshev 1926). *A. erythronii* has no such differentiated slanting region in its nest, perhaps because it does not nest in loose sand as does *vaga* and perhaps because it keeps the main burrow, down to the side branches which contain the cells, full of loose dirt. As explained above, the burrow is empty except near the surface during construction. It seems likely that when the main burrow is complete and a side burrow is being dug, soil is no longer pushed to the surface but remains as the loose material in the main burrow. Probably soil from the second side burrow is used to fill in the first, etc., but for some reason it often happens that soil is pushed up as a new tumulus after one or more cells in a nest are completed.

Action of wind and rain in removing tumuli, and perhaps rain water washing the loose soil in the burrows, often seem to result in a reduction in the amount of loose dirt available to the bee. (In *A. vaga* the bee itself removes the tumulus after the burrow is dug (Malyshev, 1926) but this is not true of *A. erythronii.*) The disappearance of the tumulus alone apparently causes no action to replace it, for most nests lose their tumuli yet activity continues normally. However, if the level of the column of loose dirt in the burrow falls much below the surface of the soil, the bee loosens soil with its jaws from the walls of the upper part of the burrow. The diagrams (figure 8) show the results of this activity. This activity has provided

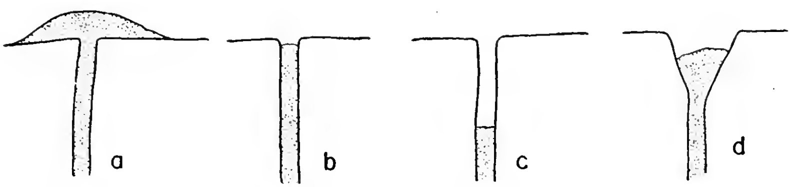


FIG. 8. Nest entrance of *Andrena erythronii.* a, with tumulus; b, with tumulus washed or blown away; c, with loose soil of burrow partly lost; d, with level of loose soil raised by particles removed from walls of upper part of burrow.

our principal opportunity to learn some details of this bee's working methods in the burrow. The following notes were made on April 25, 1951, when new dirt was being loosened in several nests.

The bees work in their holes head up. As a bee bites at the upper part of her burrow, the loosened dirt falls back into the hole. The front legs are kept more or less constantly in motion while biting is going on, brushing dirt down, apparently with the outer surfaces of the front basitarsi serving as brushes. At intervals each bee stops all activities and backs down the hole to where it is of normal diameter and rests there, head up, apparently supported largely by spreading the rear legs and bringing the outer surfaces of the rear femora, and perhaps especially the basitibial plates, to bear on the walls of the burrow. She may rest thus for only a few seconds or for four or five minutes. Then she resumes loosening of dirt. Where the burrow is too large for the outer surfaces of the tibiae to support the bee, the apices of the outer sides of the middle and hind basitarsi serve this purpose. The small segments of the legs bend aside, and the claws are little used, but the rigid basitarsi are very important. The front legs are not used in this way, but only brush the dirt down the hole. One bee loosened dirt for fifty minutes before turning and digging down through the loose dirt into her nest. In most instances, however, loosening of soil occurred prior to departure from the nest.

BEHAVIOR OF FEMALES AROUND NESTS

Premating behavior and certain activities connected with establishing and maintaining nests have already been described. The present section consists primarily of data on the coming and going of females, largely in pollen collecting. It may be mentioned here, however, that *A. erythronii* seems not in the least aggressive and that Friese's (1882) description of striking the soil of the nesting area of *A. vaga* with a stick and observing the females come out, buzz around, and then alight is quite foreign to anything which we have observed. It should be mentioned that *A. erythronii* does not have a functional sting.

In leaving her nest, a bee may, especially on a warm day, come out rather quickly from the loose dirt of the burrow (or tumulus if present) and fly off. Much more commonly, however, and always if the temperature is low, emergence from the nest is a slow process. The bee may wait for minutes with only its head, or head and thorax, exposed. Then it comes out, crawls about the vicinity of the nest and often over the tumulus before flying. The departing bees do not mark the nest entrance or tumulus in any way making it possible for us to tell from the entrance whether the bee is in or out. According to Malyshev (1926) when females of *A. vaga* leave the nest they make a depression in the loose sand of their tumulus before they fly away. He also reports that after a rain, which makes the soil firm so that they cannot dig the depression, the bees go back into their nests rather than fly away.

Once in flight the departing females do not long remain in the vicinity of their nests, but fly two to fifteen centimeters above the soil, making in a very few seconds a zigzag flight above the nest, then after a few broader flights over the nesting area, flying off toward the flowers. Figure 9 shows some attempts to indicate the flight patterns of departing bees. Rarely a bee alights on the soil immediately after leaving its nest, then flies off toward the flowers.

On returning to the vicinity of the nests, females of *A. erythronii* exhibit no ability to find their nests rapidly, as do many bees. It can often be observed that they come to the nesting area from the general direction of the flowers; evidently their orientation with regard to major features is reasonably accurate.

It is the unusual situation, however, when a female once in the nesting area goes directly to her nest. Much more often, a bee alights somewhere, walks about, biting at the soil, flies on to another point, repeats the process and eventually, after a very few minutes

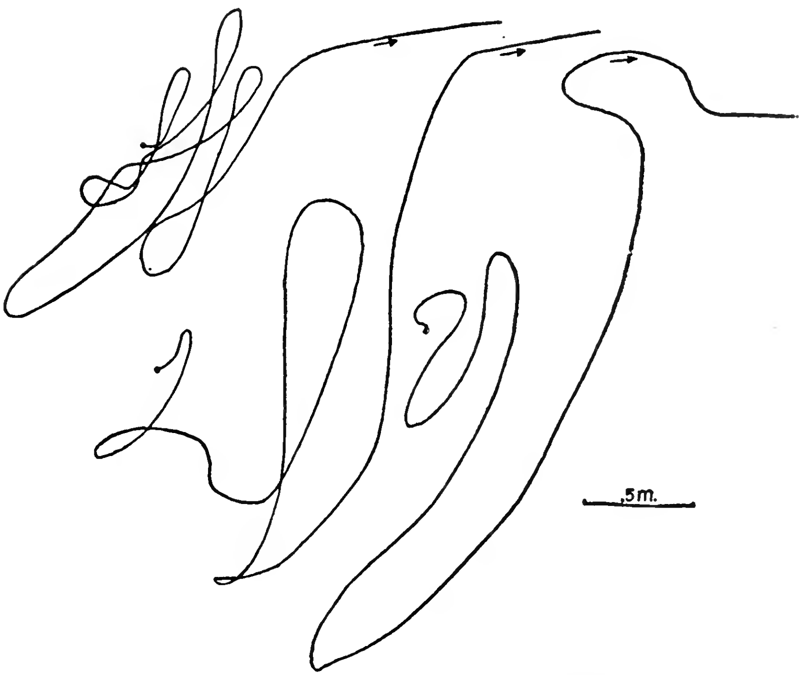


FIG. 9. Diagrams of flight patterns of females of *Andrena erythronii* as they leave nests. At upper left is shown an unusually compact "orientation flight."

to half an hour, finds her nest and enters it. Often a marked bee from a known nest was observed to go within a few centimeters of her nest only to wander away, sometimes as far as three or four meters before eventually returning. Presence of a conspicuous tumulus or other striking landmark near the nest did not seem to facilitate re-entry. The seeming disorientation occurs even when the observer is far away and certainly not a disturbing factor.

On cool days (surface temperature 65° or 68°) the returning bees often bask repeatedly for a few seconds to two minutes on the soil in the nesting area during the process of finding nests. Considerable individual variability was noted in the ability of bees to find their nests. Thus the same bee was sometimes noted day after day spending a very long time locating its nest.

On finding her nest a female not carrying pollen digs into the loose soil of the tumulus, or burrow, using all her legs. A female carrying pollen, however, holds the pollen-laden hind legs against the sides of her body and does not move them, but does all the digging with fore and middle legs. This same behavior, which prevents the pollen from being lost in the loose soil, was reported for *A. vaga* by Malyshev (1926).

Considerable data were gathered on the duration of trips away from the nest, and on the periods spent in the nest between such trips, as shown in figures 10 and 11. This information was obtained for individually marked bees with the aid of small screen cones placed over the nests (see Michener, *et al.*, 1955). Bees leaving the nests flew up into the cones, where they were noted and released with little delay. The cones were then usually removed, so that they would not interfere with the returning bees. Because a returning bee is usually so slow to enter its nest, it was ordinarily seen and noted on its return, and a cone put over the nest again. This method leaves a possible source of error since if a returning bee were not seen it might enter its nest, leave again, and be recorded only later on its second return. The records of lengths of trips from the nest do show great variation (27 to 235 minutes) and it may be that some of the longer periods recorded do result from such errors. However, if the source of error described were of great importance, and if one assumes that the true records produce the peaks shown between 25 and 95 minutes duration (figure 10), then a second peak should be found in the vicinity of 160 to 180 minutes

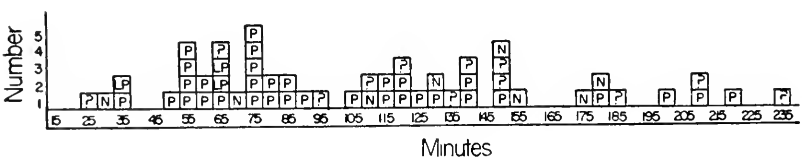


FIG. 10.—Block histogram showing the durations of flights from nests by females of *Andrena erythronii*. The ordinate shows number of bees. Letters in the blocks are explained as follows: P, pollen load brought to nest at end of flight; LP, small pollen load; N, no pollen load; ?, pollen not observed but may have been present.

(twice the average trip plus the average period in the nest). No such second peak occurs. For this reason we believe that at least many of the records of longer trips are valid. Vleugel (1947) records much variation in length of pollen collecting of *A. vaga* (25 to 105 minutes in three trips timed).

There is no evidence that the duration of the trips is correlated with pollen collecting or lack of it, temperature, time of day, or season.

As shown in figure 11, the periods in the nests between trips are less variable in length than the trips, ranging from 17 to 88 minutes.

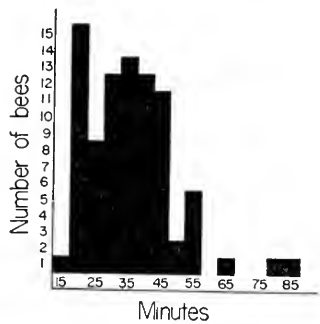


FIG. 11.—Histogram showing lengths of time that females of *Andrena erythronii* remained in nests between flights.

Assuming for convenience that each trip involves an hour and a half of time (60 minutes actually on the trip, 30 minutes in the nest before the next trip), it would theoretically be possible for a bee to make six or seven trips on a warm day when work can start at 8:00 a. m. or earlier and continue to 5:00 p. m. or later. Actually we know of no bee having worked so continuously. Probably four trips is a normal daily maximum, and often only one or two are made. Sometimes even in warm weather when some bees start flying early, others do not appear at the surface until midday. Vleugel (1947) believed that *A. vaga* also made very few (he suggests one or two) pollen collecting trips daily.

NUMBER OF NESTS PER FEMALE

Malyshev (1926) showed that in *Andrena vaga*, and probably also in *A. bimaculata*, after a female constructs a nest with about four (*vaga*) or ten (*bimaculata*) cells, she builds an independent secondary nest usually containing two cells. That more than one nest is often constructed by *A. erythronii* became apparent early in our studies when marked females were seen constructing nests several centimeters to a meter or more from their previous nests.

In 1954 a special effort was made to shed light on this matter. In the mapped zone of Area II, there were 173 nests whose date of origin could be rather accurately fixed. Figure 12 shows the dates on which these nests were started. There are two major peaks of

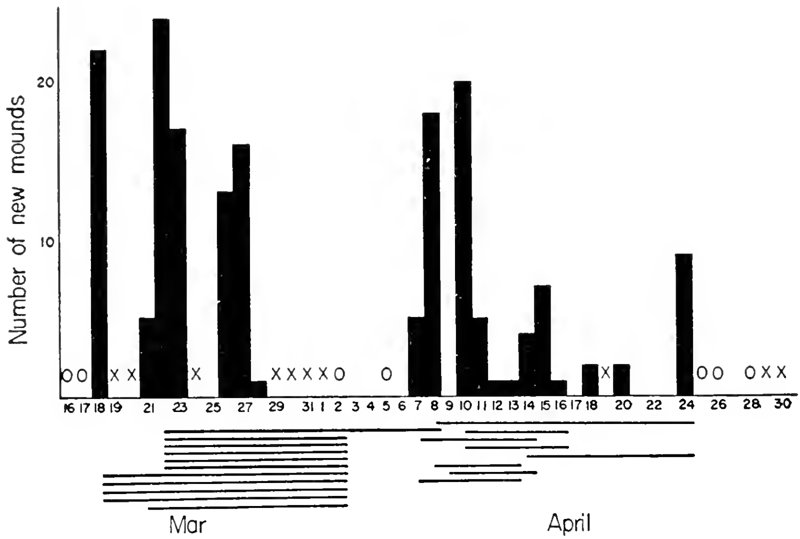


FIG. 12.—Histogram showing appearance of new tumuli (mounds) of *Andrena erythronii* in a regularly surveyed part of Area II during March and April, 1954. X indicates cold or rainy days when presumably no new tumuli would be formed, O indicates more favorable days when observations were made and no new tumuli found. Days for which no new mounds were recorded and which are not marked by either symbol were days of reasonably good weather when no survey of new mounds was made. Most of the new mounds that may have appeared on such days were doubtless recorded as new on the day of the next survey.

Horizontal lines below the histogram indicate known duration of activity of individually marked bees at their nests. In most instances activity may have begun earlier or continued later than these lines indicate.

starting nests, probably with a small additional peak at the end of the season. It is certain that emergence was complete well before March 28, so that all nests started after that date must have been second or third nests, made by bees that had already completed and abandoned their first nests.

The lengths of time that marked bees occupied their nests correspond satisfactorily with the other data, as shown by the horizontal lines in the bottom part of figure 12. These lines are based on nests whose dates of origin are known, and which were probably abandoned at or after the dates indicated by the right hand ends of the lines. The date of abandonment is always uncertain, since especially in periods of little rain an abandoned nest is indistinguishable from an active nest whose tumulus has been brushed away.

Marked bees were repeatedly recorded going into a nest, and later going into another nest. This information in itself is not always significant, since in the process of finding its nest a returning bee may enter nests of other bees; however she comes out soon if she is in the wrong nest. Although we had some difficulty with the marking system, so that every record is not trustworthy, we have presumably accurate records of some twenty marked bees which were repeatedly seen provisioning a certain nest, and later were seen bringing pollen to a second nest. There is a single, probably accurate, record of a bee seen provisioning three nests, one on March 28 to April 2, another on April 11, and a third on April 24.

Although there is no record of a bee marked in one nesting area ever visiting the other, second or third nests were not necessarily close to first nests within Area II. Second nests were recorded as much as six meters from the corresponding first nests.

Of the 173 nests whose dates of origin are indicated in figure 12, 98 are first nests, 66 are probably second nests, and 9 are third nests. It seems quite likely that some of the later ones classified as second nests may in reality be third nests. Irrespective of this, it is obvious that there is a reduction in the number of bees, the number of second nests being smaller, and the number of third nests much smaller, than the number of first nests. Apparently most of the bees survive to make second nests, only a few to make third nests. The latter could not have been late emergents whose first nests coincided with the second nests of other bees, for dissection showed that they were fertilized, yet no males were seen after April 2, a date well before second nests began to appear.

A significant behavioral observation is that before the provisioning of the second nests, rather numerous females may often be seen returning without carrying pollen from the direction of flowers and entering their nests. This shows that before or during construction of these nests, female bees visit flowers, presumably to obtain food. The same thing has been observed during construction of first nests.

NUMBER OF BEES PER NEST

In the preceding account it has been indicated that a single female constructs, provisions, lays eggs in, and abandons her nests without association with other females except for those that briefly enter the wrong nest while searching for their own. This is not always the case, however. Twice we have observed a female, biting at the soil and digging here and there before constructing her second nest, happen on an abandoned first nest, enter it, and continue to work there for several days provisioning her own cells. Such sequential occupancy of the same nest probably occurs largely because old burrows are easy to re-excavate, and when second and third nests are being dug there is often a hard dry crust on the soil. Sequential occupancy by *A. erythronii* was recorded with certainty in eight of the marked nests, and doubtless occurred in a few others in which tumuli were seen after the nest ought to have been abandoned but in which one or both bees were not seen or were not marked for individual recognition. In two additional nests which were occupied in sequence the second occupant was *A. bipunctata.*

In one sequentially occupied nest which was later excavated, the second main burrow diverged from the first three centimeters below the surface; in another the same main burrow apparently was used but new lateral burrows were constructed by the second occupant.

Nests of *Andrena erythronii* are also occasionally used simultaneously by two bees. Probably simultaneous occupancy arises in much the same way as sequential occupancy, that is, a bee about to establish a nest goes into an existing hole because the loose dirt in it is softer than the surrounding hard soil. Among our records are four cases of holes known to be occupied by two different bees on one or more days. For example, bee 1 would emerge from a hole. Soon after, bee 2 would emerge. Later bee 1 would return with pollen, still later bee 2 would also return. There are a few other instances of probable simultaneous occupancy of a nest when both bees were not recorded on the same day but when circumstances indicated that they must have overlapped in their occupancy of a nest. In two additional nests there was simultaneous occupancy by *A. erythronii* and *A. bipunctata.* A meeting of the two occupants of a nest was never observed.

Several simultaneously occupied nests were later dug and only a single main burrow was found, although each bee doubtless dug its own lateral burrows.

These records of two bees and even two species in a single nest suggest that Tunkl's (1932) record of a *Halictus* and *Andrena albicans* using the same nest is not as absurd as Hohndorf (1932) thought, although it does seem unlikely.

The occurrence of more than one *Andrena* in a nest has been recorded previously, for Perkins (1919) reported that all the aggregations of *Andrena bucephala* that he had seen had only a single entrance. "Into this one may see dozens of heavily laden females enter when they are storing their pollen and it is to be presumed that separate tubes will be found to be excavated from the common hole."

NEST STRUCTURE

Malyshev (1926) has given exceedingly detailed accounts of the nests of certain species of *Andrena*. In general his account of *A. vaga* agrees with our observations on *A. erythronii* except that the former is a considerably larger species with larger and deeper burrows, larger cells with thicker linings, etc. In the accounts of nest and cell structure and provisions given below agreement with *A. vaga* except in size may be assumed except where disagreement is specifically indicated.

A. erythronii nests are very difficult to study because the main burrow is regularly entirely full of loose soil so that it cannot be poured with plaster of Paris, and the side branches are also filled with soil except for the one leading to a cell being constructed or provisioned. So far as could be determined neither the main burrow nor the side branches were lined in any way. After a rain the soil in a burrow no longer in use becomes firm and almost indistinguishable from the surrounding soil. Therefore it has rarely been possible to draw accurately a completed nest, including all of its side branches; reconstructed portions are shown by dotted lines on the accompanying diagrams (figures 13 to 17).

In Area I where the ground is very firm, nests average shallower than in Area II. The depths of 26 cells in Area I ranged from 7.5 to 16.5 cm., the average depth being 11.3 cm. The depths of 25 cells in Area II ranged from 8 to 23 cm., the average depth being 15 cm. Among other species of *Andrena* the depth of cells varies from a few centimeters to 80 cm. in *A. morio* (Ferton, 1901) and about 94 cm. in *A. bicolor* (Smith, 1901).

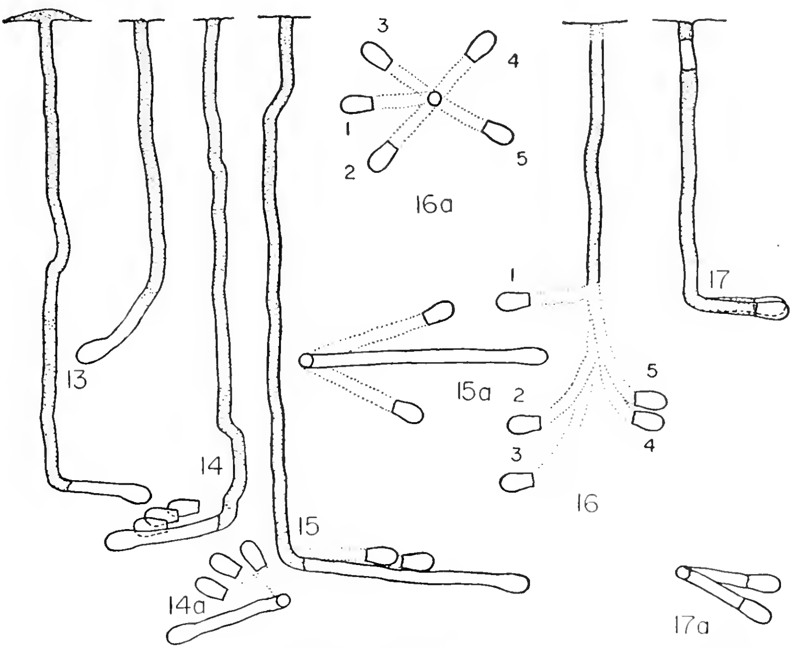
The nest consists of an irregularly vertical main burrow, the inner walls of which are smooth but not lined. Perhaps because it nests in loose sandy soil, *A. vaga* cements the particles of the burrow wall together to form a firm lining which extends into the tumulus and appears as a turret when the latter is brushed away (Malyshev, 1926). Similarly firm burrow linings occur in many other *Andrena* species (see Peus, 1926; Pickles, 1940). In *A. erythronii* there is no slanting segment of the main burrow near the surface, as described by Malyshev (1926) for *A. vaga* and other species. Horizontal initial parts of burrows, followed by a vertical region, occur in various species nesting in hills and banks (see Peus, 1926; Friese, 1921). The diameter of the main burrow is 4.5 to 5 mm.

As explained previously, the main burrow in nests of *A. erythronii* is usually entirely full of loose soil, continuous with that of the tumulus. In *A. vaga, A. florea,* and others, only a slanting upper part of the main burrow is filled with loose soil, and this appears to be the usual situation in bees of this genus. A modification occurs in *A. argentata* and perhaps other species which nest in soil beneath loose sand. Instead of constructing a firm wall for a burrow through sand, as does *A. vaga,* females of *A. argentata* dig down through 15 to 20 cm. of seemingly uniform sand to their burrows in the soil beneath (see Nielson, 1934). In *A. rhodotricha,* by contrast, the burrows are empty (MacSwain, 1945; Lanham, 1949) and open to the surface, and in certain other species loose dirt is not mentioned as closing the burrows (see Fahringer and Tölg, 1912).

The tumulus in *A. erythronii* is from 2 to 3 or sometimes 3.5 cm. in diameter, and as much as 1.5 cm. high. It is probably the nature of the soil that makes it so different in shape from the broad low sand tumuli of *A. vaga,* which are 5 to 9 cm. in diameter and only 1 cm. high (Malyshev, 1926). A symmetrical tumulus is characteristic of the nests of most andrenas but in *A. morio* the material from the burrow accumulates to form a straight or curved turret (Ferton, 1901).

From the bottom of the main burrow of *A. erythronii* a lateral burrow or side branch is constructed which may be horizontal or may slope down at a 45° angle. The lateral, which ends in a cell (figure 13), has the same diameter as the main burrow or slightly less close to the cell, and has the same type of wall as the main burrow, but is free of loose dirt or nearly so. It varies from one to 3.5 cm. in length. Great variability in length of laterals seems to characterize nests of many species of the genus. In *A. cineraria* the laterals may be longer than the main burrow (Malyshev, 1926). After the first cell is constructed and provisioned, a second lateral burrow is dug from the bottom of the main shaft, dirt from it probably being used to fill the first. The second and subsequent laterals or at least their cells tend to be deeper than the first, although this tendency is not as consistent as in *A. vaga*, in which, however, it is by no means a universal rule. In *A. vaga* and possibly in *erythronii* the tendency for progressively deeper cells is due to more steeply sloping laterals (Malyshev, 1926). Data based on a single or a very few nests of each species indicate that *A. florea* and *cineraria* (Malyshev, 1926) also in general make later cells deeper than earlier ones.

It is evident from the studies by Malyshev (1926) and others that this general type of nest architecture with rather long laterals ex-



FIGS. 13-17. Nests of *Andrena erythronii*. Stippled portions were filled with loose soil. Burrows indicated by dotted lines were so filled with soil as to be unrecognizable and their positions may not be accurate. Figures marked "a" are drawn from above to show the orientation of the cells about the central axis or burrow.

13, Two first nests excavated when first cell was being provisioned. 14, 15, First nests, each with one cell still open and being provisioned, the others closed and with provisions and eggs. 16, A sequentially occupied nest, first nest of one bee and second of another bee, abandoned when dug. Cell 1 contained a three-fourths grown larva; cells 2-4 contained half grown larvae, cell 5 contained a small larva. There was no certainty that the second bee provisioned any cells but probably cell 5 was made by it. 17, Second nest, dug after it was abandoned. Both cells contained eggs.

tending from near the lower end of the main burrow is common to most species of *Andrena* including *A. vaga*. Friese's descriptions and figures of nests of that species (1882, 1891, 1923) with cells close along the main burrow like a cluster of grapes are presumably erroneous, perhaps because the close proximity of nests led to confusion as to which cells belonged to which nests. Rudow (1913) illustrates a group of ten closely approximate cells of *Andrena* (? *hattorfiana*) but his work is without documentation and is to be used with extreme caution. An entirely different type of nest, however, is reported by Fahringer and Tölg (1912) for *A. flavipes*. In that species, the burrow ends in a large chamber, in the floor of which several cells are excavated.

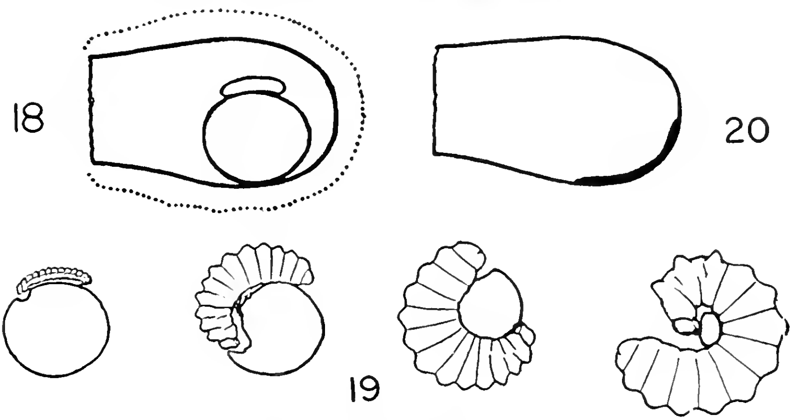
We were not able to establish whether or not the laterals and cells are constructed in a regular clockwise or counterclockwise order as reported by Malyshev (1926) for *A. vaga*. The horizontal angles between laterals are highly erratic (see figures 14 to 16); in *A. vaga* these angles are reported to vary from 5° to 200° (Malyshev, 1926).

So far as known, two or more cells are not constructed on the same lateral in *A. erythronii*, although a second cell on an occasional lateral is reported by Malyshev (1926) in nests of *A. vaga*. In *A. bimaculata*, however, three cells may be constructed on each lateral, the two that are not terminal being partly within the earth-filled lateral and partly projecting from it so that the series of three cells is almost exactly intermediate between the nest type having a cell in each lateral burrow and that occurring among many other bee genera, consisting of a series of cells placed end to end.

Abandoned first nests of *A. erythronii* have been found with from two to five cells (figures 14 to 16); perhaps if the bee survives it normally constructs about four cells in its first nest, as does *A. vaga* as studied by Malyshev (1926). The two abandoned second nests dug contained only two cells (figure 17), as do second nests of *A. vaga*. One of the abandoned third nests dug contained an empty cell, the other contained two cells. Probably six or seven offspring are all that a female *A. erythronii* can usually produce, although if one counts the maximum number of cells observed for first, second and third nests ($5 + 2 + 2$), it is conceivable that nine progeny would result. Six seems to be the normal number of young produced by a female of *A. vaga* while *A. bimaculata* probably produces twice that number, ten in the first nest and two in the second (Malyshev, 1926). Data on other species are inconclusive either because nests were incomplete when dug or because the possibility of second nests was not considered, but it may be of some value to note some figures on numbers of cells per nest for some other species, as follows: *A. florea*, 4; *A. cineraria*, 4 (Malyshev, 1926); *A. labialis* (?), 12+ (Friese, 1921) (Friese, 1923, in reporting on the same nest, attributes it without question to *labialis* and says there were 14 cells); *A. labiata*, 3-4 (Friese, 1921, 1923); *A. erythrogaster subaustralis*, 9 (Bohart, 1952).

CELL STRUCTURE

The cells of nests of *A. erythronii* are horizontal or slant slightly downward, as in *A. vaga, florea, bimaculata* (Malyshev, 1926), and



FIGS. 18-20. Cells of *Andrena erythronii* and contents. 18. Sectional side view of cell showing thick wall, the pollen mass, and the egg. 19. Sketches of stages in the eating of the pollen mass by the larva. These sketches are based on observations of larvae reared in opened cells and may not reflect normal larval orientation. 20. Sectional side view of a cell of *Andrena erythronii* showing deposit of fecal matter.

erythrogaster subaustralis (Bohart, 1952). Cells are vertical in nests of *A. cineraria* according to Malyshev (1926), and Bischoff (1927) states incorrectly that they are vertical or only a little slanting in *Andrena* in general. Their inside dimensions in *A. erythronii* vary from 10 x 6 mm. to 13 x 8 mm. (figure 18). As in the species described by Malyshev (1926), the cell wall of *A. erythronii* consists of two layers. The outer one, about 1.5 mm. in thickness, consists of compacted earth whose particles are cemented together probably by penetration of a liquid secreted by the bee. That a secretion and not merely moisture is used in this compacting process and in that which forms the similar burrow linings of many *Andrena* species is suggested by the work of Pickles (1940) who found that the soil of the mound and particularly of the cemented core of the mound of *A. fulva* has, until weathered, a higher pH than the surrounding soil. This outer cell wall is very smooth on the inside, which is covered with the inner layer of the cell wall. The inner layer is a very thin, translucent film that looks like wax, small bits of which can, with difficulty, be peeled off the thick outer layer. It is the inner layer which gives the fine polish to the inside of the cell. According to Malyshev (1926) this inner lining is impervious to cold water and is not soluble in chloroform or ether, although it breaks up in boiling water.

The plug which closes a finished cell is made of compacted earth. The spiral pattern often visible in such plugs in other bees [including *Andrena vaga*, according to Malyshev (1926)] is not evident in *A. erythronii*.

PROVISIONS

As in *A. bimaculata*, the pollen ball is a vertically flattened sphere placed in the distal end of the cell (figure 18). Dimensions range from 4.2 to 5 mm. in horizontal diameter and 4 to 4.75 mm. in vertical diameter. The mass is firm and remains so until it is eaten. The mass is much broader (7 x 4 mm.) and softens with age in *A. vaga* (Malyshev, 1926). In *A. erythronii* there is no free nectar or honey either in the bottom of the cell surrounding the solid material as in *Andrena vaga* or in droplets on the wall of the cell as in *Andrena florea* and *cineraria* (Malyshev, 1916, 1926).

Cells dug in the process of being provisioned contained pollen balls of small size (e. g. 2.5 mm. in diameter). From this it is evident that pollen is worked into the ball as it is brought into the nest. These small pollen balls are dryer and less smooth than completed ones, indicating that moisture, probably nectar, is added late in the formation of the ball.

IMMATURE STAGES

The egg is white, slightly curved, 2.5 mm. long, 0.65 mm. thick, and is found flat on top of the pollen mass (figure 18). In *A. erythronii* and *A. bimaculata* (Malyshev, 1926) there is no evidence that the egg is laid in a semierect position as in *A. vaga* and *A. cineraria* (Malyshev, 1926), although in at least the former it slumps down to the position in which we have seen it in *A. erythronii* after the food mass softens. The duration of the egg stage is several days; we do not know just how long, but two eggs known to have been laid between April 27 and 30 hatched on

May 5. Malyshev (1926) marshalled evidence indicating that the egg stage of *A. vaga* was 18 to 21 days, of *A. cineraria*, 6 to 7 days, and of *A. bimaculata* 10 to 11 days.

The growth and feeding of the larva is indicated by figure 19. The observations on which these illustrations were based were made in the laboratory, cells being opened on top and kept in stender dishes to reduce water loss.

Larvae that have not eaten are white, straight, with a large ridge on each side of the body below the spiracles. As they feed the body becomes more curved, less clear white, the lateral ridges disappear, while the dorso-lateral tubercles become conspicuous. Certain details of structure of mature larvae are described and illustrated by Michener (1953).

Inconclusive data based on several fractional rearing records indicate that it takes about eleven days for the larva to consume all its provisions. This period compares with two weeks for *A. vaga* (Malyshev, 1926). About four days (in one larva) after finishing its food, the larva defecates for the first time, depositing soft blackish feces on the lower side of the cell, near the end away from the plug. The feces run together to form a layer which remains there indefinitely (figure 20). At the time it defecates the larva becomes somewhat straighter and whiter than previously, and may be called a prepupa.

What little we know of subsequent development has been indicated under "Seasonal History."

FLOWER RELATIONSHIPS

Andrena erythronii has long been regarded as oligolectic on dog-tooth violet or *Erythronium* (see Robertson, 1918, 1930), and our collecting records in Kansas for a long time seemed to support this view. This bee is in flight before *Salix, Prunus,* and other plants attractive to *Andrena* species are in bloom, and in the vicinity of the nesting areas *Erythronium mesochoreum* was the only very early spring flower that could possibly be used by this bee.[1] It seems likely that *Erythronium* is actually necessary for the survival of this bee. It is not extensively visited by any other species of *Andrena,* or so far as we know by any other bee except *Apis.* After the *Erythronium* ceases to bloom (dates shown in Table I), the bees continue to provision cells. In 1951, 1952, and 1953, this was done, so far as we know, only with oak (*Quercus*) pollen, although

1. In wooded areas near Lawrence, Kan., it has also been taken on *Erythronium albidum.*

by that season many generally more attractive flowers such as *Prunus, Malus, Crataegus,* and *Salix* were in bloom in the vicinity of the nests.

We interpret these data as follows: *A. erythronii* must be an insect highly sensitive to competition. Perhaps selection to reduce competition or to escape natural enemies moved its season of flight so early into the spring that snow often falls after the species is first in flight. At that season the only useful pollen source is *Erythronium.* On this flower it escapes competition of other *Andrena,* even after the latter are in flight. When the *Erythronium* is no longer in bloom, *A. erythronii* turns to another flower, namely oak catkins, which is not attractive to most bees and on which competition is minimal, avoiding the more showy and more fragrant flowers of *Prunus, Malus, Crataegus* and *Salix* on which abound several other species of *Andrena.*

The data for 1954 may not invalidate this theory but do show that *A. erythronii* is quite plastic in its pollen collecting behavior. In that year two hot days caused the *Erythronium* flowers to wilt well before oak catkins produced any pollen. Without any noticeable break in their activity, the bees began to bring pollen of *Taraxacum, Prunus* and *Malus* to their nests.

We feel that a re-evaluation of reports of oligolecty for species of *Andrena* and other bees is required by these data.

ANDRENA ERYTHRONII AND THE ESTABLISHMENT OF SOCIAL BEHAVIOR

We feel that there may be some advantage in pointing out here that at least among the halictid bees, social behavior with caste differentiation and division of labor cannot have arisen from a subsocial stage in which the mother lives with and cares for her offspring for a time but dies before they are mature. Various authors (Wheeler, Michener) have believed that all social insects arose from such subsocial ones. That this cannot have been true with these bees is shown by the fact that all of them practice mass provisioning, sealing the cell after it is provisioned and the egg laid. None of them see their progeny as larvae; only among those that are actually social and have long lived females or queens do the mothers live with their progeny at all and then it is only the mature offspring that associate with their mother.

For this reason it seems likely that the incipient stages of establishment of social behavior in these bees did not consist of families of a mother and her immature progeny, as was the case with vespid wasps and almost certainly also among the ancestors of ants and termites. Instead it is more likely that the relationship arose among the adult insects.

A. erythronii may give us some clue to the origin of such behavior, for here we find that, probably due to difficulties in digging, two bees may sometimes occupy the same nest, although each makes its own lateral burrows and cells. The other steps in the establishment of social behavior, as well as situations rather similar to that of *A. erythronii*, can all be found among halictid bees and will be discussed elsewhere.

ANDRENA BIPUNCTATA Cresson

This is a later spring bee than *A. erythronii*. So far as known it does not nest in groups, but constructs isolated nests, a few of which often are in the path where *A. erythronii* nests and have therefore been studied in some detail along with those of that species. No animosity between the two species, such as that described by Nielsen (1934) between *A. argentata* and *A. sericea*, has been observed. In a surprising number of details of behavior *A. bipunctata* resembles *A. erythronii*. The following account is organized to indicate the known similarities and differences.

Males have never been seen around the nesting areas. This indicates that they leave on emergence and probably mating occurs, as with other species that do not nest in groups, on the flowers or in other places where both sexes congregate.

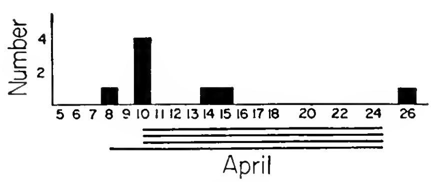


FIG. 21. Histogram showing appearance of new tumuli of *Andrena bipunctata* in regularly surveyed part of Area II during April, 1954. See figure 12 for further explanation.

The tumuli look like slightly undersize tumuli of *A. erythronii*. From meager observations, the nests are dug in the same way as those of *A. erythronii*, and like that species, most commonly in the afternoon or evening. As indicated in the discussion of that species, *A. bipunctata* sometimes makes use of either abandoned or occupied nests of *A. erythronii*, using the same main burrow but making its own lateral burrows and cells. No nests of *A. bipunctata* have been dug while in use but those dug later have the main burrow completely full of soil, just as does A. *erythronii.* That their nests are similarly full of loose soil when in use is also indicated by the successful simultaneous use of a single main burrow by a bee of each species.

The season of first nest building of A. *bipunctata* coincides with that of second nest building of A. *erythronii,* as shown in figure 21 where the dates of origin of eight nests for which this datum was known in 1954 are plotted. Lines below the graph indicate the period of activity in four of these nests. The nest started on April 26 is a second nest of a marked bee seen at her first nest as late as April 24.

Females of A. *bipunctata* have the same apparent difficulty in locating their nests as do those of A. *erythronii.* When carrying pollen, the females dig into the tumuli or into the loose dirt in the burrow if the tumulus is gone, just as do A. *erythronii,* holding the hind legs quietly back against the abdomen and thus protecting the pollen load.

The periods of time spent on trips away from the nest, and spent between trips in the nest, seem to average less than in A. *erythronii,* although we have only six records of each on which to base conclusions. Periods away from the nest range from 17 to 199 minutes, with an average of 87. (Pollen was brought in at the end of the 17 minute trip, as well as after some much longer trips.) Periods in the nest between flights range from 18 to 45 minutes with an average of 36.

The only first nest of this species that we dug (started April 10, occupied at least until April 24) contained nine cells at levels from 13 to 24 cm. from the surface. Since the main burrow and laterals were all full of dirt and difficult to recognize, the structure of the nest could not be determined.

The only second nest of this species which we dug contained only a single empty cell, although the nest had been abandoned.

The cells are constructed and provisioned as in A. *erythronii.* Measurements of one were 11.5 mm. by 5.5 mm. The similarity in cell number as well as other features of behavior to A. *bimaculata* is striking (see Malyshev, 1926).

Our observations around the nests add nothing to the knowledge of flower preferences of this species but specimens from eastern Kansas have been taken on the following flowers: *Cercis canadensis, Malus ioensis, Malus pumila* (cultivated apple), *Prunus americana,* *Prunus domestica* (cultivated plum), *Prunus serotina*, *Pyrus communis* (cultivated pear), *Spiraea spp.* (cultivated), *Spiraea thunbergi* (cultivated), *Viburnum molle*. Dates of collection range from April 10 to May 25.

We have never seen any evidence of parasites on *Andrena erythronii*, but *A. bipunctata* is probably the host of a *Nomada* which we occasionally see in the nesting area. We have seen an anthomyiid fly, *Leucophora obtusa* (Zetterstedt), follow a pollen carrying female of *A. bipunctata* to its nest. After the bee had disappeared down its hole, the fly moved onto the tumulus and inserted several elongate white eggs into the loose soil. Huie (1916) has reported on the habits of a related fly. We are indebted to Dr. H. C. Huckett for identification of the fly and reference to the paper by Huie.

LIST OF *ANDRENA* SPECIES CITED

To avoid repetition and to indicate such synonymies as are pertinent to an understanding of the literature cited in this paper the species of *Andrena* mentioned are listed below with their authors and dates.

albicans (Müller), 1776
argentata Smith, 1844
bicolor Fabricus, 1775
bimaculata (Kirby), 1802
bipunctata Cresson, 1872
bucephala Stephens, 1846
cineraria (Linnaeus), 1758
erythrogaster subaustralis Cockerell, 1898
erythronii Robertson, 1891
flavipes Panzer, 1799
florea Fabricius, 1793
fulva (Schrank), 1781
hattorfiana Fabricius, 1775
labialis (Kirby), 1802
labiata Schenck, 1851
morio Brullé, 1832
macra Mitchell, 1951
rhodotricha Linsley, 1939
sericea Christ, 1791
vaga Panzer, 1799 (=*ovina* Klug, 1810; =*pratensis* Nylander, 1848)

ACKNOWLEDGMENTS

We wish to acknowledge the aid of various individuals who have made supplementary observations, especially Wilbur R. Enns, now of the University of Missouri, Jerome G. Rozen, now at the University of California, and Wallace E. LaBerge and Earle A. Cross of the University of Kansas. Mrs. H. V. Daly assisted in the preparation of the illustrations.

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A Revision of the Genera Nemognatha, Zonitis, and Pseudozonitis (Coleoptera, Meloidae) in America North of Mexico, with a Proposed New Genus

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ABSTRACT: The present paper results from a taxonomic study of the genera *Nemognatha, Zonitis,* and *Pseudozonitis* of the beetle family Meloidae. Only the species occurring north of Mexico are included. A new genus, *Rhyphonemognatha,* is proposed for a group of four species occurring principally in Mexico but one of which extends from Mexico as far north as Nebraska and Iowa. A discussion of distribution and phylogeny in three genera is given. Thirty-four forms of *Nemognatha* are recognized of which twenty-seven appear to be discrete species. These are segregated into eight species groups which are divided into four proposed subgenera. Nineteen forms of fourteen species in the genus *Zonitis* are included in four species groups forming two subgenera also newly proposed. The genus *Pseudozonitis* includes thirteen species divisible into five species groups but no subgenera are indicated since the genus itself may possibly be a subgenus of *Zonitis.* A brief résumé of the bionomics of these insects is included. A full synonymy is attempted for each species with the appropriate literature cited in a bibliography. Keys to all the forms are given. A total of sixty-six forms is recognized most of which are redescribed completely and twenty-two of which are new. Distribution maps are given for most of the forms as well as one hundred eighty-nine figures of taxonomic characters.

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INTRODUCTION

For the last 75 years no revisionary or even synoptic study has been made of the genus *Nemognatha* in America north of Mexico. The genus *Zonitis,* prior to 1951, had not been restudied for 76 years. In 1951 MacSwain redefined the tribes of North American Nemognathinae and indicated certain changes to be made in *Zonitis* including the suggestion that the Longicornis group might merit subgeneric designation. That group was designated as a distinct genus, *Pseudozonitis,* by Dillon (1952) but his material was insufficient to permit a restudy of the entire complex. The desirability of revisionary studies in at least these three genera is therefore obvious. The present paper presents the results of three years of study in this subfamily of Meloidae although the writer had worked in this group for several previous years.

Some work has been done within comparatively recent years on some of the genera closely related to those mentioned above. In 1942 Linsley published a comprehensive paper on the systematics of the genus *Hornia.* In 1952 MacSwain published a synopsis of the genus *Gnathium.* The remaining nemognathine genera in North America, *Nemognatha, Zonitis,* and *Tricrania,* are consequently the more urgently in need of attention. Due to the paucity of new material and information in *Tricrania* it has been omitted from the present study. However, two excellent papers exist on the biology of members of that genus, one by Parker and Böving (1924) and the other by Linsley and MacSwain (1951). The genera *Cissites* and *Tetraonyx* do not appear to belong to the present subfamily, or if so, then certainly in distinct tribes.

The species in this section of the Meloidae have always been difficult to identify. The difficulty has been due largely to the fact that too much importance has been attached to morphological characters which are highly variable, principally the color pattern and the variously modified maxillae. Indeed, the genus *Nemognatha* was originally based solely on the length of the galeae! Studies on the comparative morphology of the male terminalia and on the larval forms have resulted in what appears to be a more natural association of species into genera and tribes. It is hoped that these studies in conjunction with a re-evaluation of characters previously utilized plus the rather meagre biological information at hand will help to dispel much of the confusion which has been so discouraging to students of this group.

Contributing to the unsatisfactory situation regarding the systematics of these beetles has been, and still is to some extent the scarcity of many of the species in most collections. To state the situation mildly, individuals of practically all of the species are unusually variable in their external morphology and it has been difficult to obtain series of adequate size to demonstrate the range of variation. To mitigate this difficulty, an intensive effort has been made to assemble for this study as many collections as could be located in the United States and Canada. A glance at the acknowledgments section of this paper will suffice to indicate the extent of these efforts. Even so, some of the species are represented by regrettably short series.

The rather obscure life histories of the species constitute another barrier to the clear understanding of their systematics. In the immature stages they live in the nests of bees of various genera but unfortunately bees' nests are not readily available for study. Some of the more gregarious bees, such as certain species of *Anthophora* and a few other genera, are fairly easily accessible for study and from such studies a certain amount of information has been extracted. At present the host relationships of the greater percentage of the nemognathine species remain unknown. Linsley and MacSwain (1952) have summarized our knowledge of the host relationships of the North American species of *Nemognatha.* Selander and Bohart (1954) have published the results of the only study made on the host relationships of a North American species of *Zonitis.*

The Mexican species are omitted, for the most part, from the present study principally because of the scarcity of available specimens. It is the writer's intention to follow the present study with one covering the Latin American forms. Also, additional material is accumulating so that revisionary work in the other North American nemognathine genera can soon be under way.

The four genera which are the subject of the present study are here considered as members of the subfamily Nemognathinae

(Zonitinae *auctt.*) and they are equally divided among the two tribes currently recognized in this subfamily in North America. The tribe Nemognathini includes *Nemognatha, Hornia, Tricrania,* and *Rhyphonemognatha*; the tribe Zonitini includes *Zonitis, Pseudozonitis,* and *Gnathium.* The tribes have been defined by MacSwain (1951) on the structure of the male terminalia. The tribe Nemognathini shows a high degree of specialization in having the aedeagus (median lobe) modified into an entirely semimembranous structure (Figs. 149-184), whereas the Zonitini exhibit a more primitive, sclerotized, bilobed condition of the aedeagus (Figs. 185-218). According to MacSwain, the larval morphology supports this classification. The genera will be defined in the section on systematics to follow.

The subfamily name Nemognathinae is used here because a subfamily of Mollusca, based on the genus *Zonites,* has priority for the name Zonitinae. According to the International Rules of Zoological Nomenclature, Copenhagen Decisions, 1953, pp. 32-37, the correct spelling of the subfamily name is derived by removing the genitive ending from the type genus name and adding -inae to the stem. This would, in the present case, result in exactly the same spelling of the subfamily name Zonitinae whether based on *Zonites* or *Zonitis.* It seems best to me to avoid eventual confusion by adopting the name Nemognathinae which Cockerell proposed in 1910 based on the subtribal name Nemognathini of LeConte (1862).

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BIONOMICS

It has been mentioned in a preceding section that the larvae of nemognathine beetles live in the nests of various wild bees. Since there is comparatively little information available concerning the bionomics of bees, it follows that even less is known of the beetles which live at their expense. However, several species of *Nemognatha* have been reared from cells of various bees and the life histories of most species of *Hornia* and at least one species of *Tricrania* are fairly completely worked out, but the species of *Gnathium*, *Zonitis*, and *Pseudozonitis* remain practically unknown as to their host relationships.

With one known exception the North American species of *Nemognatha* deposit their eggs on the phyllaries of buds and flowers of numerous plants principally of the family Compositae. *Nemognatha scutellaris* is exceptional in that the eggs are inserted between the florets on the disk (Linsley & MacSwain, 1952). The species of *Zonitis* appear to be more variable in their choice of sites for oviposition. According to my own observations, *Z. vittigera* and its allies oviposit like most species of *Nemognatha, i. e.,* on phyllaries of flowers. *Z. bilineata,* however, deposits its eggs at the junctures of veins on the lower surfaces of sunflower leaves, while *Z. atripennis flavida* deposits its eggs on the florets of *Cleome serrulata* (Selander & Bohart, 1954). In all probability, additional preferred sites for oviposition will be discovered in the future because the eggs of many of the species have not yet been found.

As far as our present knowledge goes, most members of the Meloidae produce large numbers of eggs. The females of many of the species produce several clusters of eggs during their lifetime. Parker and Böving (1924) record a maximum total of 1,925 eggs from a single female of *Tricrania sanguinipennis* under laboratory conditions. Linsley & MacSwain (1942) record a maximum of 1,308 from a single female of *Hornia minutipennis occidentalis.* The same authors (1952) record a maximum of 740 for *Nemognatha soror*; 375 for *N. lurida*; 510 for *N. dubia*; and 285 for *N. apicalis.* The writer made counts on ten clusters of eggs of *Zonitis bilineata* and the average was found to be 265 per cluster. Four clusters of eggs of *Nemognatha nemorensis* averaged only about 25 eggs per cluster. In both instances, the eggs had been laid in the field. Selander & Bohart (1954) record 314 and 514 eggs in two separate clusters of *Zonitis atripennis flavida.*

It has been my experience with two species of *Nemognatha* and four of *Zonitis* that the newly hatched larvae remain in a rather compact cluster on the remains of the eggs for a day or two before they begin to disperse. At this time they climb up on the disks of the flowers and attempt to attach themselves to any moving object touching the flower. They will attach as readily to a camel's hair brush as an insect and apparently attach to any kind of an insect that is hairy enough to furnish a hold. They attach by their mandibles which are furnished with various numbers of dentes on the mesal surfaces. The writer has taken them from several insects including Bombyliid flies, various beetles including their parents, and bees.

Some writers have advanced the theory that if the larvae become attached to male bees they could effect a transfer to the female during copulation and thus be transported to the nest which otherwise they would not attain because many male bees do not return to the nest. It seems more plausible to me to believe that they simply remain attached to a male bee for a period of time and if it does not go to the nest they detach and try again, or perhaps they perish.

Be that as it may, the larva presumably gains access to the cell by riding the bee into the nest. The larva then remains inactive probably until the cell is sealed whereupon it devours the egg and completes the remainder of its growth by feeding on the stored pollen and honey. Linsley and MacSwain (1952) have recorded what appears to be the typical life cycle for the majority of nemognathine species.

Parker and Böving (1924, p. 10) report an interesting incident in rearing larvae of *Tricrania sanguinipennis.* In a cell of *Colletes* which they dug from the ground they found three first instar larvae of this beetle but the manner of finding them was unusual. The cell had been disarranged but not ruptured and at first they noted only one larva which had apparently eaten the egg of the host. This larva molted and the next morning was found dead but replaced by a second larva. The dead one was removed and the second left to develop. The day after the second larva molted, a third larva was discovered which had killed the second and was feeding on it. Thus there seems to be good evidence for the statement that only one larva develops in a cell just as only one epicautine larva survives in a grasshopper egg pod.

Hypermetamorphosis, including six or seven larval instars, enables the larva to withstand adverse environmental conditions and the time required for completion of the life cycle may vary from one to several years. In this connection, Linsley and MacSwain (1945) have recorded an exceedingly interesting observation on the longevity of fifth instar larvae of *Hornia boharti*. Collected in 1941, the larvae had not fed at least since 1940 and possibly not since 1939 because they feed only in the first four larval stages. Adults emerged in each succeeding year from 1942 to 1945. Mating occurred and the females produced viable eggs, those emerging in 1945 apparently no different from the others except considerably smaller in size. The last adults to emerge, therefore, came from larvae which had not fed for at least five years.

In the section on systematics to follow, records of bee hosts from which adults have been reared are listed in the discussion following each species. It will be noted that hosts are known for comparatively few species of the genera studied. Flower hosts of the adults are also listed but here again it should be pointed out that the flower hosts of some of the species have not been recorded. It is frequently helpful in identifying the species, and almost indispensible in studying the larval habits, to know the host plant, and collectors are urged to attach host labels to all specimens collected.

Concerning host specificity, the available evidence is incomplete but the comparatively few species I have been able to study in the field have rather definite preferences for certain species or genera of flowers. Host data on the specimens studied and various published reports support this observation. Thus *Nemognatha lurida* and *Zonitis bilineata* are usually associated with *Helianthus annuus* while *Z. vittigera* and *Z. cribricollis* are associated with *Rudbeckia*, *Z. atripennis* almost exclusively with *Cleome*, and *N. bifoveata* with *Monarda*. However, in seasons unfavorable for preferred species or during periods when they are not in bloom adults may be found on flowers of closely related plants and infrequently also on unrelated forms. As shown in the discussions following each species, certain species of *Nemognatha*, particularly in the western United States, are taken on a variety of different plants. In the complete absence of host records for some of the species it seems premature to make broadly inclusive statements. Undoubtedly some species are rather highly host specific while others are not. This again appears to parallel the situation as it occurs in the bees. It seems logical to assume that the bee hosts of the larvae are about as varied as the kinds of bees that visit the preferred flowers. It should be kept in mind, however, that eggs of many of the species have not yet been found and the possibility that the beetles prefer to feed on one species or group of flowers but deposit their eggs on another should not be ruled out.

As pointed out by Graenicher (1910), there is also some correlation between the length of the galeae and the kind of flower preferred by various species of nemognathines. The galeae are well adapted for obtaining nectar from flowers and in general it may be said that the greater the length of the galeae the deeper may be the corollas of the flowers from which they obtain nectar. Thus, *Nemognatha lurida* with moderately long galeae prefers *Helianthus* while *N. piazata bicolor* with galeae as long as the body prefers *Cirsium*. It will be interesting to learn what flower is preferred by *N. chrysomeloides*, a Mexican species in which the galeae are longer than the body. In this connection, a series of *Nemognatha lutea dichroa* from Idaho presents an interesting feature. The form is usually taken on *Cirsium* but this series was taken on *Helianthus* and each specimen has only moderately long galeae (as in *dubia*) instead of the extremely long ones characteristic of the subspecies. In all other respects they are typical. Perhaps this is a local population adapted to feeding on *Helianthus*.

Some species of *Zonitis* and all of *Pseudozonitis* have lobiform or scooplike galeae provided with a brush of hairs with which pollen is brushed into the mouth. These beetles usually feed on flowers in which the anthers are readily accessible.

Larvae of certain nemognathines are consistently recovered from cells of certain genera of bees only (*e. g.*, species of *Hornia* from cells of *Anthophora* spp., and *Tricrania sanguinipennis* from cells of *Colletes*). Others such as *Nemognatha scutellaris* have been reared from cells of a number of bee genera (Linsley & MacSwain, 1952). As pointed out elsewhere, the rather large disparity in size of individuals in the same species of beetles probably indicates broad adaptation to food stored by different species and genera of bees.

Certain bees apparently never serve as hosts for nemognathines because their flight season is over before the beetles are active. Also, according to Selander and Bohart (1954), the distance from the nests of the bees to the nearest concentration of host flowers of the beetles may be quite significant. The bees they studied (*Nomia melanderi*) nest gregariously and have a normal flight range of about five miles. They become infested with *Zonitis atripennis flavida* which occurs almost exclusively on flowers of *Cleome serrulata*. Concentrations of *Cleome* occur sporadically over most of the range and any group of bee nests more than five miles distant from such a concentration of *Cleome* presumably would not become infested. These authors suggest that elimination of concentrations of *Cleome* near the nesting site of *Nomia* would be an effective method of controlling the beetles and increasing the population of bees.

Adult nemognathines apparently chew their way out of the bee cell and those which have emerged from the extremely hard clay cells of such bees as *Anthophora abrupta* frequently have the mandibles so worn that they scarcely meet at the apices. The adults seem to feed mostly on nectar and pollen, the galeae of *Nemognatha* and some of *Zonitis* being modified to form a sucking tube. That they do suck nectar can be demonstrated readily with a short-tongued species such as *Z. cribricollis.* A wad of cotton soaked with sugar water forms a convenient synthetic flower. A hungry beetle is placed on the wad and may be observed under the microscope. By turning it so that the gular area is visible, a pulsating action will be noted in the membranous area between head and thorax. That at least some pollen is ingested by species of *Nemognatha* is evident from the fecal matter but the writer has not observed ingestion of pollen either in the field or laboratory.

Adults of this group are of little economic importance but may be considered as possibly beneficial in their capacity as pollenizers though the host plants are usually of no great commercial value. The larvae are harmful in that they destroy bees, some of which are highly valuable as pollenizers of commercial crops. To what extent they reduce a colony of bees is debatable and varies from one group to the next. The species of *Hornia* apparently are never responsible, *per se*, for the demise of a colony of *Anthophora* (*vide* Linsley & MacSwain, 1942). Mickel (1928) records that *Leonidia anthophorae* (= *Hornia neomexicana*) ranks second to a chalcoid wasp (*Monodontomerus montivagus*) in the number of host individuals of *Anthophora occidentalis* destroyed in a large number of cells from Manitou, Colorado. Selander and Bohart (1954) record about one per cent of the cells of *Nomia melanderi* infested by *Zonitis atripennis flavida* in Utah. Judging by the large numbers of certain species of *Nemognatha* present in favorable seasons, they probably constitute an important factor in the reduction of the number of bees. Here then is a complete reversal of the situation compared to some epicautine beetles where the adults are often serious pests as destroyers of foliage while the larvae are beneficial in destroying the eggs of grasshoppers.

DISTRIBUTION AND PHYLOGENY

The subfamily Nemognathinae is cosmopolitan in distribution, representatives occurring on nearly every major land mass in the world including Australia. It is therefore held to be the oldest of the subfamilies. In 1917 some 320 species in 32 genera were catalogued for the world.

There seem to be two centers of distribution in the genus *Nemognatha,* one in Africa, the other in the United States. The number of described species for various parts of the world as listed in Borchmann's catalogue (1917) may be tabulated thus:

Africa	19
Eurasia	10
New World	43
Oceania	1
Total	73

However, to judge by recent systematic changes made in the North American species alone, about twenty per cent of the species properly belong in other genera. But in the present paper ten new species are decribed bringing the total back very nearly to that listed in the catalogue. It seems possible that about the same percentages would hold for other parts of the world so that of the species described in this genus probably enough new forms will be found to balance those incorrectly assigned to the genus.[1] Therefore, the numbers listed above may serve as a rough estimate of the present distribution.

A somewhat different situation seems to exist in the genus *Zonitis.* The tabulation of the species catalogued for the world in 1917 shows the following distribution:

Africa	14
Eurasia	35
New World	26
Oceania	61
Total	137 (1 unknown)

This would indicate that more than twice as many species of *Zonitis* occur in the South Pacific region, principally Australia, as in either Eurasia or the New World. It seems most unusual to find more species in Australia (48 of the 61 species described from Oceania are listed only from Australia) than in any other area of the world. In an attempt to arrive at a plausible explanation for such a distribution, it should be pointed out that very likely a higher

1. Since the publication of Borchmann's catalogue in 1917, a number of new species have been described in *Nemognatha* and *Zonitis* from various parts of the world but the number of such new forms is insufficient to change materially the proportional distribution here given.

percentage than indicated above of the species described in *Zonitis* from Australia may be incorrectly placed and properly belong elsewhere. However, Borchmann lists five other related genera, all small, from Australia and two additional ones from the East Indies, indicating a remarkably extensive fauna in this area compared to the six or seven genera in North America and seven or eight in Africa. It is regrettable that lack of specimens from the South Pacific makes it impossible to delve more deeply into the matter in the present study.

However, the fact remains that numerous species of this group occur in Australia although no species of *Nemognatha* have been reported from there. It does not seem likely that this group arose in the Australian region. A more probable theory would be that it arose in the Eurasian region and spread in three directions, one branch invading Africa, another migrating across the Bering Straits, and the third going through the East Indies to Australia. The limited competition from other genera, and complete absence of *Nemognatha,* could have made possible the proliferation of species in Australia.

The information presented above is inconclusive but indicates a rich and interesting field for further investigation.

The genera *Tricrania, Hornia,* and *Gnathium* appear to be restricted to North America. *Pseudozonitis* also appears to be restricted to America but further study may reveal that it is congeneric with certain previously described genera such as *Zonitoschema* or *Zonitopsis* described from Africa and the East Indies respectively. The situation remains confused at present because there has been little agreement on generic limits in the Meloidae. Insufficient comparative material from the various parts of the world precludes drawing conclusions in the present paper. What material is available indicates that only *Zonitis* and *Nemognatha* of the genera known to occur in America occur also in other parts of the world. Further study of the Latin American fauna may reveal more genera common to the Eastern and Western Hemispheres.

The writer believes that one of the most significant recent developments has been the clarification of the tribal limits based on studies of male terminalia. Credit for this work goes to J. W. MacSwain of the University of California. Correlated with this development is the work on larval morphology by Linsley and MacSwain in North America and by Cros in Africa. But the larval morphology and biological habits are occasionally misleading or appear so since larvae of unrelated genera may closely resemble, or behave like, nemognathine larvae (*e. g., Tetraonyx*) or may live in bee nests (*e. g., Meloe*). In general, however, larval morphology and ethology of immature as well as adult stages support the revised relationships of the species.

Since there is an extremely close relationship between these beetles and their bee hosts it would be reasonable to assume that their dissemination and present distribution is very similar to that of some of the bees. From what is known of the distribution of bees, a number of them probably entered America via the Bering Straits at a time when that area was warm (Michener, 1941). It seems likely that the nemognathines entered at that time, too. If evidence may be admitted from the distribution of some of the species here described, these beetles have been in America long enough to leave relict species in the southeastern United States from bygone glacial periods. The fossil record is sketchy but species assigned to the genera *Gnathium* and *Nemognatha* have been described from the Oligocene shales of Florrisant, Colorado.

As will be seen from the systematic section to follow, the greatest number of species in North America occurs in the arid southwestern states. Here are found several species apparently adapted to desert conditions, this adaptation having involved at least some morphological change. The more constantly recurring morphological changes include extremely fine dense punctation and pubescence, the latter exaggerated into long dense pile in one species; galeae more slender than in other species; and generally pale golden color. Ethologically, some species appear to be nocturnal as indicated in the discussion under *Nemognatha cantharidis.* Such adaptations have occurred independently in all of the genera included in this paper except *Rhyphonemognatha.* A few other species, however, are distributed from coast to coast and some from southern Canada into Mexico. It appears that the species become less and less numerous northward, southward and eastward from the southwestern United States. This is not an unfamiliar pattern of distribution to students of bees, supporting the correlation of nemognathine distributions with bee distributions.

At least some species of one or more of these genera occur in almost all parts of North America from southern Canada southward through Mexico. The distribution of the various species included in the present study is indicated on the maps, at least for those represented by sufficient specimens to give some indication of their distribution. The ranges as outlined should not be considered as definitely limited to the shaded areas because these are based entirely on specimens examined and do not include records from literature. This procedure was necessary because of the large number of misidentifications that have been published. Furthermore, collections of many of the species are very scanty and certainly do not indicate the entire range of the species. It is hoped the maps will be useful in visualizing distributional patterns and perhaps in stimulating more extensive and intensive collecting in these groups.

For most of the species studied, localities by states and provinces are given in the discussion of the species when reasonable numbers of localities are involved. Where large numbers of localities are concerned, only states and provinces are listed with notation made of the marginal localities. For species known from very few localities, all the collection data on each specimen is given.

In a study of this kind it is useful to show where the greatest number of species occur. Chart I shows the distribution of the forms in the four genera based on specimens examined. It should not be assumed that the number of forms listed is final foı any given area. There are obviously great gaps in collecting in certain regions and extension of ranges and new records will certainly make it necessary to revise the number of forms for many of the states.

Phylogenetically, the subfamily Nemognathinae has obviously been separated from the rest of the meloids for a long time. Numerous morphological features support this opinion, among the more significant being the male genitalia, the variously modified maxillae, the tarsal claws, and the form of the larvae.

The origin of the larval habits in this group forms an interesting subject for speculation. Many of the Meloinae lay their eggs in cavities excavated in the soil by the female. Upon emerging fıom the eggs, the free-roving larvae search for egg packets of various Orthoptera, principally grasshoppers, and spend the remainder of their larval lives in the egg packet. This is probably the primitive type of life history for the entire family. Presumably some larvae eventually became introduced into the nests of bees built in the ground and became adapted to bee food. The various adaptations followed, including phoresy, for taking advantage of bees. These adaptations have become very highly developed in the nemognathine beetles but also occur to a lesser extent in at least one meloine genus, *Meloe*, offering some support for the statement above. Studies on comparative morphology and phylogeny of the larvae of meloids are being published by others elsewhere and will not be discussed here.

CHART I.—Distribution of Forms in Four Nemognathine Genera by States and Provinces

Rank	State or province	Nemognatha	Zonitis	Pseudozonitis	Rhyphonemognatha	Total No. of forms	% of total* possible
1	Ariz.	15	10	6	1	32	48.5
2	Cal.	15	7	6	0	28	42.4
3	Texas	10	9	6	1	26	39.4
4	N. Mex.	10	8	5	1	24	36.4
5	Utah	10	9	1	0	20	30.3
6	Colo.	9	9	0	0	18	27.3
7	Kan.	7	8	1	1	17	25.8
8	Neb.	6	7	0	1	14	21.2
9	Nev.	7	3	1	0	11	16.7
10	Mo.	4	5	0	1	10	15.2
	Okla.	4	6	0	0	10	15.2
	Wyo.	7	3	0	0	10	15.2
11	Fla.	3	2	3	0	8	12.1
	Idaho	4	4	0	0	8	12.1
	Minn.	4	4	0	0	8	12.1
	Ore.	7	1	0	0	8	12.1
	S. Dak.	5	3	0	0	8	12.1
12	Ind.	3	4	0	0	7	10.6
	Iowa	2	4	0	1	7	10.6
13	Ark.	1	4	1	0	6	9.1
	Ill.	1	4	0	1	6	9.1
	Mont.	3	3	0	0	6	9.1
14	Ala.	3	2	0	0	5	7.6
	Ga.	3	1	1	0	5	7.6
	La.	2	2	1	0	5	7.6
	Mich.	2	3	0	0	5	7.6
	Miss.	4	1	0	0	5	7.6
	N. Dak.	3	2	0	0	5	7.6
	Wash.	4	1	0	0	5	7.6
15	N. Car.	3	1	0	0	4	6.1
	Ohio	2	2	0	0	4	6.1
	Pa.	2	2	0	0	4	6.1
	Va.	3	1	0	0	4	6.1
	Alta.	3	1	0	0	4	6.1
16	Md.	2	1	0	0	3	4.5
	S. Car.	2	1	0	0	3	4.5
17	Ky.	1	1	0	0	2	3.0
	N. J.	1	1	0	0	2	3.0
	N. Y.	1	1	0	0	2	3.0
	B. C.	2	0	0	0	2	3.0
18	Conn.	0	1	0	0	1	1.5
	D. C.	1	0	0	0	1	1.5
	W. Va.	1	0	0	0	1	1.5
	Wis.	0	1	0	0	1	1.5
	Man.	0	1	0	0	1	1.5
	Ont.	0	1	0	0	1	1.5
	Sask.	0	1	0	0	1	1.5
19	Del., Me., Mass., N. H., R. I., Tenn., Vt.				0	0	0.0

* Total number of forms recognized in this paper is 66.

To discuss the phylogeny of the nemognathine beetles from a world standpoint is beyond the scope of the present paper but a few generalities may be justified and remarks on phyletic lines in North America as they appear to the writer will be presented.

In the genus *Nemognatha*, there appears to be some evidence to indicate that the species in the Western Hemisphere are distinct branches from the phyletic line which gave rise to those in the Eastern Hemisphere. This is based on the form of the male genitalia, modification of abdominal sterna, metatibial spurs, and form of the galeae. Furthermore, the North American species fall into several distinct categories which the writer believes to be natural groups. Table I summarizes the writer's findings on the species groups in America north of Mexico. The groups are listed vertically from what appears to be the most generalized at the top to the most highly specialized at the bottom with the exception that the true position of *punctulata* is not clear but it certainly belongs near the Nigripennis group. The characters are listed horizontally from the most constant at the left to the more variable at the right. It should be emphasized that some variation occurs in any given character listed for any group shown. For instance, in *scutellaris* some specimens have the second abdominal sternum of the male tufted but the majority have only the third and fourth sterna thus ornamented. Again, two members of the Lurida-Lutea group (and one of the Bridwelli group) have the punctulate areas tufted instead of merely densely punctulate and pubescent, in this respect being somewhat transitional with the following groups. Sufficient information on larvae is not available to the writer to ascertain whether this grouping is supported by larval morphology. It may well be that the order of precedence would have to be modified on the basis of the larvae but almost certainly the Sparsa group would be least specialized and one of the groups toward the bottom of the list would be most specialized.

It is possible that the Lurida-Lutea complex should be divided into two discrete groups since the number of forms involved seems to be disproportionately large but to do so would indicate a more distant relationship than appears actually to exist. It could be done if columns 3, 5, 7, and 10 were modified or omitted. On this basis, the Lurida group would include *lurida, pallens, werneri,* and *brevirostris* while the Lutea group would include *lutea, soror, curta, explanata, nitidula, meropa,* and *angusta.*

TABLE I.—Species Groups in North American Nemognatha

1	2	3	4	5	6	7	8	9	10
Group	No. of forms	Abdominal sterna of males	Metatibial spurs	Cephalic outlines	Tegmen of male terminalia	Protarsi of females	Galeae	6th abdominal sternum of females	Basic colors
Sparsa	4	feebly or not modified	similar spatulate apices rounded	elongate triangular	slender straight apex subacute	very short erect hairs	very short	feebly emarginate medially at apex	black to fulvous
Lurida-Lutea	14	4 and 5 triangularly or trape-zoidally punctulate medially	dissimilar concave at least outer spurs rounded at apices	triangular	stout apex blunt	long erect hairs	moderately long to very long	feebly emarginate medially at apex	fulvous to black
Bridwelli	4	4 and 5 triangularly or trape-zoidally punctulate medially	dissimilar concave at least outer spurs rounded at apices	triangular to sub-triangular	slender straight to curved apex blunt	long erect hairs	moderately long to very long	feebly emarginate medially at apex	fulvous to flavous
Cribraria	4	3 to 5 tufted	similar triangular flattened acute	triangular	somewhat sinuate apex blunt	short to moderately long hairs	moderately long to short	feebly emarginate medially at apex	testaceous to black

Punctulata	1	2 to 5 tufted	similar slender spiniform to feebly flattened acute	sub-triangular frons depressed	slender curved apex subacute	short hairs	moderately long	broadly moderately deeply emarginate	testaceous
Nigripennis	2	3 to 5 tufted	similar slender spiniform acute	rounded	slender straight apex subacute	long hairs	moderately long	feebly emarginate medially at apex	black to rufous
Scutellaris	1	3 and 4 tufted 6th curved downward	similar slender spiniform acute	triangular	extremely slender attenuate apex blunt	short hairs	moderately long	feebly emarginate medially at apex	black and testaceous or rufous
Piazata	4	4 and 5 deeply excavated medially	similar concave to flat subacute	triangular to sub-triangular	stout apex acutely recurved	long erect hairs	moderately long to very long	narrowly emarginate medially at apex	fulvous to black
Total	34								

An enumeration of the species in the various groups together with the distribution of each group follows:

Sparsa group	*sparsa* *cantharidis* *selanderi* *zonitoides*	Southwestern U. S. into Mexico.
Bridwelli group	*bridwelli* *hurdi* *macswaini* *miranda*	Principally southern California, one species extending to Texas.
Lurida-Lutea group	*lurida* *pallens* *nitidula* *werneri* *meropa* *brevirostris* *lutea* *soror* *curta* *explanata* *angusta*	North America, Canada to Mexico except eastern U. S.
Cribraria group	*cribraria* *nebrascensis* *capillaris*	U. S.
Punctulata group	*punctulata*	Southeastern U. S.
Nigripennis group	*nigripennis* *nemorensis*	U. S.
Scutellaris group	*scutellaris*	Western U. S.
Piazata group	*piazata* *bifoveata*	North America, Canada to Mexico, except west coast.

The Sparsa group most nearly resembles members of the Zonitini in its morphological characteristics and indeed shares a number of them with that tribe including the short galeae, unmodified abdominal sterna, and spatulate metatibial spurs.

One of the features of the Bridwelli group not listed in the table is the densely puctulate elytra of all the species (except *miranda*) with a peculiar modification occurring in *macswaini*. In that species the elytra of the males are densely punctulate whereas the females have much less densely and more coarsely punctate elytra. Also, in the nominate species of this group a unique feature is found in the long, dense pile covering the entire body surface so deeply as to obscure the punctation. All the species of this group apparently are adapted to desert conditions.

The remainder of the species groups are characterized principally as listed in the table. With columns 3, 4, 6, and 8 as a basis, four subgenera may be erected, the first including the Sparsa group with a total of four species; the second including the Bridwelli and Lurida-Lutea groups with a total of 15 species or 18 forms; the third including the Cribraria, Scutellaris, Nigripennis, and Punctulata groups with a total of seven species or eight forms; and the fourth including only the Piazata group with two species or four forms.

As in *Nemognatha,* the North American species of *Zonitis* appear to represent phyletic lines distinct from those of the Old World. In this connection, Selander and Bohart (1954) show that the only North American species of *Zonitis* so far studied in detail differs in its behaviour from those studied in the Old World. Where a larva of *Z. atripennis flavida* develops in a single bee cell, larvae of the Old World species develop only partially in one cell then attack another and complete their development by feeding on the bee larva in the second cell.

Morphologically, insufficient comparative material makes the drawing of conclusions from the world standpoint unprofitable but the North American forms appear to segregate into rather distinct lines and certain evolutionary trends may be worth noting.

Table II is constructed in a manner similar to that of Table I with the species groups listed vertically from what appears to be the most generalized at the top to the most specialized at the bottom. The morphological characters are arranged so that the more constant ones are at the left and progress to the more variable at the right.

The Bilineata group includes three species, *Z. bilineata, Z. sulcicollis,* and *Z. atripennis.* The distribution is general over the United States and into southern Canada. The Vermiculata group includes four species, *Z. vermiculata, Z. hesperis, Z. aurea,* and *Z. interpretis.* It is distributed primarily in western United States. The Vittigera group includes three species, *Z. vittigera, Z. perforata,* and *Z. cribricollis.* It is distributed in eastern and midwestern United States. The Sayi group includes four species, *Z. sayi, Z. dunniana, Z. punctipennis,* and *Z. tarasca.* It is rather generally distributed in the western portions of North America. With columns 3, 4, 5, 6, and 8 as a basis, two subgenera may be erected, the first including the Bilineata and Vermiculata groups with a total of seven species or nine forms; the second including the Vittigera and Sayi groups with a total of seven species or ten forms.

TABLE II.—Species Groups in North American Zonitis

1	2	3	4	5	6	7	8	9	10	11
Group	No. of forms	Galeae	Cephalic outline	Eyes	Pronotum	Antennae	Sculpture of elytra	Abdominal punctation	Tegmen of males	Basic color
Bilineata	5	scarcely modified to lobiform	rounded	small	trans-versely oval to elongate	submonili-form	feebly to distinctly punctate	denser in males	medially inflated rather straight	white to testaceous and black
Vermiculata	4	scarcely modified to lobiform	subquadrate	feebly to markedly produced	angulate to trans-versely oval	filiform	smooth to vermiculate to feebly punctate	no denser in males	short slender	blue to fuscous or golden
Vittigera	4	modified into a sucking organ	triangular to elongate triangular	small	quadrate to trans-versely oval	submonili-form	densely finely to moderately coarsely punctate	no denser in males	stout arcuate downward	fulvous to reddish and black
Sayi	6	modified into a sucking organ	triangular	small	quadrate to feebly elongate	submonili-form	coarsely punctate	denser in males	stout some-what sinuate	green to testaceous to fulvous and black
Total	19									

TABLE III.—Species Groups in North American Pseudozonitis

1	2	3	4	5	6	7	8	9	10
Group	No. of forms	Cephalic outline	Abdominal sterna of females	Pronotum	Tegmen	Elytral sculpture	Basic color	Metatibial spurs	Approximation of eyes below head
Schaefferi	1	subtriangular to subquadrate	5th not modified; 6th deeply U-emarginate	disk convex	sides and apex recurved; angulate distally	moderately densely rugose punctate	flavous or testaceous to black	equal	feeble
Martini	3	elongate oval	5th not modified; 6th deeply U-emarginate	disk moderately flattened	evenly arcuate; apex feebly recurved	densely finely punctate	flavous to fuscous and black	subequal	moderate
Vittipennis	2	ovate to ellipsoid	5th not modified; 6th deeply U-emarginate	disk convex	short stout; apex recurved	shallowly rugose punctate	pale fuscous to flavous and brown	dissimilar to equal	moderate (variable)
Longicornis	3	subtriangular to subquadrate	5th not modified; 6th deeply U-emarginate	disk depressed	coarsely sinuate; apex feebly recurved	moderately coarsely to rugosely punctate	fulvous to black	equal to subequal	moderately to extremely close
Arizonica	4	elongate oval to subrectangular	5th broadly emarginate; 6th deeply triangularly emarginate	disk depressed to feebly convex	short straight; apex somewhat recurved	densely punctate	pale flavous to testaceous to black	equal to subequal	extremely close
Total	13								

So far as the material at hand goes, indications are that the genus *Pseudozonitis* is restricted to North America. Many of the species superficially rather closely resemble certain other species, which the writer believes are not congeneric with them, occurring in the East Indies, Australia, and Asia. This opinion is based on preliminary studies of the male genitalia which will be published later when more extensive material is available. It may be that a re-evaluation of the genitalic characters will result in changes on the subfamily level which will affect the limits of the recognizable genera. Provisionally it seems best to consider *Pseudozonitis* as a distinct genus.

Table III is an attempt at a grouping of the species into phyletic categories but the scarcity of many of the species and the rather variable characters utilized for the purpose do not warrant the conclusion that these are distinct natural groups. They do serve to indicate relationships, however, which may be desirable. With two possible exceptions, the groups seem to be much too closely related to justify any attempt at subgeneric designations.

P. schaefferi is morphologically considerably more like most species of *Zonitis* than like its congeners. Indeed at least one species of *Zonitis* is superficially more like the other species of *Pseudozonitis* than is *schaefferi* except for the genitalic characters of the males, the color pattern, and form of the pronotum. Judging by its generalized characteristics and restricted distribution, the writer believes that *schaefferi* may be one of the relict forms occurring in extreme southeastern United States.

On the other hand, one of the species of *Pseudozonitis* (*P. brevis*) exhibits at least in its cephalic outline and pronotal form an approach to the structure of *Zonitoschema*, a genus described from South Africa. Unfortunately, insufficient material precludes any further discussion of that exotic genus.

While in the two preceding genera stability of color patterns is the exception rather than the rule, in *Pseudozonitis* the color patterns are relatively more constant at least in the material available for study. A certain amount of variation occurs but mostly of a minor degree so that many of the species are readily recognizable by the color pattern alone, particularly of the pronotum and femora.

Concerning Table III then, the Schaefferi group, containing only the nominate species, is held to be the least specialized and somewhat annectant with *Zonitis*. It appears to be restricted to Florida. The Martini group consists of three species, *martini*, *vigilans*, and *maculicollis* (the last being somewhat distinct but probably belonging here) distributed along the western and southern margins of the United States. One of the species, *P. vigilans,* appears to be restricted to the deserts of southern California. The Vittipennis group includes two species, *vittipennis* and *brevis* (both rather distinct but probably belonging together) occurring principally in southern Arizona. The Longicornis group includes three species, *longicornis, roseomaculatis,* and *labialis,* and is distributed from Kansas to Texas, east to Florida. The Arizonica group includes four species, *arizonica, pallida, vaurieae,* and *stroudi.* The nominate form, seemingly adapted to xeric conditions, occurs in Arizona; *pallida* occurs in Texas; *vaurieae* is widely distributed from extreme southern Arizona, California, and New Mexico to Guerrero, Mexico; and *stroudi* occurs in New Mexico, Arizona, and Texas.

INDIVIDUAL VARIATION

Much confusion has prevailed concerning the taxonomy of the genera which are the subject of the present study. As pointed out in a preceding section, at least part of the confusion has been due to the use of color and the length of the galeae to distinguish the species and genera. With the possible exception of *Pseudozonitis* in which at least some of the color characteristics are fairly constant, the general statement may be made that color is extremely variable in all of the species studied. To be sure, an occasional species (*e. g., Nemognatha bifoveata*) has remarkably constant color patterns but these are exceptional. However, as indicated in Tables I to III, basic colors can be indicated in the various species groups although even here variability is obvious.

The color of the pubescence is more stable than the color of the cuticle. Again exceptions must be indicated especially in the genus *Nemognatha.* In some of the species (*e. g., N. lurida* and *N. cantharidis*) the pubescence may be either pale or dark while in others, such as *N. nitidula,* the color seems to be subject to little or no variation. Often it coincides with the color of the underlying integument so that it is pale where the integument is pale and dark where elytral vittae or other dark areas prevail.

An attempt has been made to point out such color variations in the descriptions and discussions of each species which follow. Some writers have pointed out that varying percentages of specimens in some species show more or less discontinuous color patterns. On the basis of numerous specimens available for this study the writer is forced to conclude that these discontinuities disappear when a sufficiently large series is available.

In 1853 LeConte described a species which he named *Nemognatha bicolor* and ever since that time the name *bicolor* has caused confusion. It can now be demonstrated that *N. bicolor* is a subspecies of *N. piazata* on the basis of more substantial evidence than color. LeConte (1880) had suspected that this was the case. The term refers to those forms which are entirely piceous except for the head and prothorax which are red. The confusion results from the fact that this color pattern is repeated again and again in various forms, occurring not only in *N. piazata* but also in *N. lurida lurida, N. lurida apicalis, N. lutea dichroa, N. lutea dubia,* and *N. soror.*

In species like *N. nigripennis,* the color of the elytra varies from entirely piceous to fuscous to rufous. In *N. scutellaris* the elytra vary from reddish-testaceous to almost flavous. In this species the marginal and sutural black margins are also quite variable in extent, being fairly broad in most specimens but narrower in others and absent in some. The same may be said for the elytral vittae in those species which are vittate. The vittae may be lacking in some individuals, broad in others, and occupying the entire elytra in still others. In species like *N. cribraria* the vittae apparently start as apical crescents, while in species like *N. piazata* they start as faint median stripes on the disk of each elytron.

Linsley and MacSwain (1942, 1952) have already pointed out that considerable variation in size is found in individuals of the species of *Nemognatha.* This is believed to be due to the limitation of the food available to a given larva. The larvae appear to complete their growth in a single bee cell and since the bees they infest are of various sizes, the adult meloids are likewise variable in size. Species which appear to infest only a single species of bees (*e. g., Tricrania sanguinipennis* on *Colletes* sp.) frequently show less variation in size. In the species descriptions which follow it will be noted that a considerable range in length is given for each species. These ranges should not be regarded as particularly diagnostic. The measurements are for the length from the vertex to the apices of the elytra.

The form of the pronotum is also quite variable, being unusually so in *N. cribraria.* The disk of the pronotum is also variable, some individuals having the disk evenly convex, others having it feebly uneven, and still others showing distinct elevations or, as in some species of *Zonitis,* shallow to deep foveae. The median sulcus is usually subject to but little variation and in most species is present only on the basal third of the pronotum.

The length of the galeae is useful in species determination but subject to some variation. The principal abuse of this character in taxonomy has been over-emphasis of its importance at the generic level. When properly used in conjunction with other characters it is as stable as any character in this variable group. The remarkable development of the galeae into a sucking tube in at least three genera (*Nemognatha*, *Zonitis*, and *Gnathium*) constitutes an interesting case of parallel development. It is also interesting to note that in the African genus *Leptopalpus* the maxillary palpi appear to have undergone similar specialization so that the palpi are opposable apparently to form a sucking tube.

The metatibial spurs are fairly constant in size and form but some variation occurs. In *Nemognatha lutea dichroa*, for instance, the inner spur is typically slender and spiniform with the apex acute, while the outer is somewhat flattened and concave with the apex rounded or at least subacute. However, these vary to the point where they both may be like the inner spur just described but more commonly are both like the outer one described above. An occasional aberrant specimen is found in which the spurs have fused into an irregularly shaped mass. The spurs may be atypical, too, by being broken or worn, presumably in leaving the bee cell.

In this subfamily the tarsal claws are cleft and the upper portion of each claw is furnished with two rows of dentes on the lower surface. Some variation occurs in the number of teeth forming the inner row on the tarsal claws. In series of several species examined by the writer, no constant difference could be found between the sexes nor between most species. In one or two instances where a large gap occurs this is valuable in species determination (*e. g.*, *Zonitis vermiculata* and *Zonitis hesperis*) but in most species of *Nemognatha* it does not appear to be trustworthy.

Density of punctation is another variable in these genera. In many species the punctation of the elytra or pronotum is striking and characteristic but a small percentage of such species shows variation in density, or depth, or sculpture of the intervals between the punctures. For example, the punctation of the elytra in *Zonitis atripennis* and *Z. cribricollis* is quite distinct and easily recognizable but in both species individuals occur which are quite at variance with the more characteristic form.

Sexual dimorphism, particularly of the abdominal sterna, is well marked in most of the species. In *Nemognatha* the variously ornamented abdominal sterna of the males form a good basis for grouping the species. The function of the densely punctulate and finely pubescent areas is unknown. They may be glandular and if so possibly constitute scent brushes. Conversely, the erect hairs on the anterior tarsi of the females are probably sensory in nature. The length and density of these hairs in the females does not seem to be correlated with a given type of abdominal punctulate area in the males, and indeed in at least one species (*N. explanata*) the males appear to have erect tarsal hairs as long as those of the females.

In some of the species groups of *Zonitis* a peculiar dimorphism is found in that the males have considerably more densely punctate abdominal sterna than the females. In other groups this feature is not evident. In some species of *Pseudozonitis* the sixth abdominal sternum of the females greatly resembles the corresponding structure in the male. An examination of Van Dyke's "paratype" of *P. arizonica* reveals that it is a female rather than a male as Van Dyke's designation would indicate, and at first glance it is easily mistaken for a male. However, the fifth sternum is not triangularly impressed and the sixth lacks the deep oval impression characteristic of the males.

The unique sexual dimorphism of the elytral punctation in *Nemognatha macswaini* has been noted in a previous section.

The form of the male genitalia constitutes a good character for specific determination and in conjunction with the degree of sclerotization appears to be reliable for distinguishing higher categories also. Although a certain amount of variation due to size is found among individual males of a given species, the form of the aedeagus in conjunction with the form of the tegmen is very useful in separating species. In many species the characters of the tegmen are more diagnostic (and constant) than those of the aedeagus.

Variation in the characters of the female genitalia should be investigated and will perhaps form the subject of a later study. This would be highly desirable because many females, especially of *Nemognatha,* are extremely difficult to determine to species and reliance for valid determination must largely be placed on association with males.

The cephalic outline of the head and the modification of the head and pronotum as seen in the lateral aspect appear to be characteristics useful in the systematics of this group. The modification of the eyes in *Zonitis* and *Pseudozonitis* is similar to that found in *Zonitoschema* and *Zonitopsis,* both exotic genera. The antennal characteristics are mostly useful in segregating groups and genera rather than species but a few instances occur where species may be identified by antennal structure. An occasional monstrosity occurs in which the antennal segments show spurlike prolongations or fusion of segments.

SYSTEMATICS

GENUS NEMOGNATHA Illiger

Nemognatha Illiger, 1807, Magazin für Insektenkunde, vol. 6, p. 333. Type species *Zonitis vittata* Fabricius, 1801 (= *Z. piazata* Fabricius, 1798) (monobasic).

Nemognatha, Say, 1817, Jour. Acad. Nat. Sci., Philadelphia, ser. 1, vol. 1, p. 22; LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 345; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 212; LeConte and Horn, 1883, Smithsonian Misc. Coll. 507, p. 416; Beauregard, 1890, Les Insectes Vésicants, p. 395; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 372; Péringuey, 1909, Trans. Royal Soc. S. Africa, vol. 1, p. 288; Wellman, 1910, Canadian Ent., vol. 42, p. 396; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 166; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Parker and Böving, 1924, Proc. U. S. Nat. Mus., Art. 64, p. 32; Van Dyke, 1928, Univ. California Publ. Ent., vol. 4, p. 402; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 205; Dillon, 1952, Amer. Mid. Nat., vol. 48, p. 344.

Nematognatha, Gemminger and Harold, 1870, Catalogus Coleopterorum, vol. 7, p. 2163 (emendation).

Zonitis, Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 170; Wickham, 1905, Canadian Ent., vol. 37, p. 171; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; Blackwelder, 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, p. 6.

The members of this genus may be distinguished from other meloids by the following combination of characters: wings functional; elytra entirely covering abdomen, not attenuate; head triangular, rounded, or somewhat elongate; tempora often inflated; antennae filiform, distal segments not inflated; eyes moderately large, somewhat oblique, not produced beneath head; galeae produced into a sucking tube, in some species longer than the body, in others quite short; tarsal claws cleft, upper portion with two rows of fine dentes, lower portion reduced to a slender lobe; spurs of posterior tibiae usually modified; abdomen with six visible segments, males with various modifications of the sterna, females usually little modified; aedeagus and tegmen almost entirely semimembranous, aedeagus not bilobed, often spinulate at apex. (*Cf.* Figs. 35, 41, 56, 89, 118, 178).

The original description is not readily available at most institutions. It is therefore given here verbatim:

"*Nemognatha* Nobis. *Zonitis vittata* Fab. verdient wegen der langen fadenförmigen Kinnladen eine besondre Gattung zu bilden."

KEY TO THE SUBGENERA OF NORTH AMERICAN NEMOGNATHA

1. Males with abdominal sterna 2 to 5 not modified; metatibial spurs broadly spatulate, similar and equal Subgenus *Pronemognatha*
   Males with at least fourth abdominal sternum modified; metatibial spurs dissimilar or, if similar and equal, then not broadly spatulate 2
2. Males with fourth and fifth abdominal sterna medially excavated; metatibial spurs elongate, parallel-sided, concave, usually similar and equal Subgenus *Nemognatha*
   Males with fourth and fifth abdominal sterna not so excavated; metatibial spurs dissimilar, or triangular, or spiniform 3
3. Males with transversely oval, tufted, punctulate areas at least on fourth and fifth (third and fourth in *scutellaris*) abdominal sterna; metatibial spurs usually similar, slender, spiniform; or triangular, concave, apices acute Subgenus *Pauronemognatha*
   Males with trapezoidal punctulate areas on fourth and fifth abdominal sterna; metatibial spurs usually dissimilar, apices rounded, Subgenus *Meganemognatha*

Subgenus PRONEMOGNATHA, subg. nov.

North American Nemognathini with abdominal sterna of males (except sixth sternum) not modified, tegmen slender, almost straight; metatibial spurs broadly spatulate, similar and equal; galeae very short.

Type: *Nemognatha sparsa* Le Conte, 1868.

KEY TO SPECIES OF PRONEMOGNATHA

1. Head yellow; galeae distinctly longer than pronotum *sparsa*
   Head black; galeae scarcely as long as pronotum 2
2. Elytra at least in part testaceous; pubescence golden; length usually more than 9 mm. *cantharidis*
   Elytra usually entirely piceous; pubescence black; length less than 8 mm. 3
3. Elytra rather coarsely punctate; pronotum coarsely punctate, usually with a median macula, in some specimens divided into two, one on either side of disk; Mexican and Central American species occasionally with elytra fulvous *zonitoides*
   Elytra finely punctate or rugose; pronotum finely to moderately coarsely punctate, immaculate; northern Mexico and southwestern U. S., *selanderi*

Nemognatha (Pronemognatha) sparsa LeConte

(Figs. 1, 34, 45, 62, 67, 90, 149)

Nemognatha sparsa LeConte, 1868, Trans. Amer. Ent. Soc. vol. 2, p. 53; 1880, Trans. Amer. Ent. Soc. vol. 8, p. 215; Snow, 1883, Trans. Kansas Acad. Sci., vol. 8, p. 43; Horn, 1885, Trans. Amer. Ent. Soc., vol. 12, p. 113; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 380; Pierce, 1904, (Nebraska) Univ. Studies, vol. 4, p. 176; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchman, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 100.

Nemognatha brunneopennis (in part) Dillon, 1952, Amer. Midl. Nat., vol. 48, p. 341 (misidentification).
Zonitis sparsa, Wickham, 1905, Canadian Ent., vol. 37, p. 171; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

This species is allied to *N. zonitoides*, *N. selanderi,* and *N. cantharidis* but is easily distinguished by its yellowish head, sparsely punctured pronotum, and stout, pale galeae. Its spatulate metatibial spurs in addition to the characters above will readily distinguish it from all others.

Body surface moderately shining. Head, prothorax, scutellum, coxae, and femora flavo-testaceous or flavous. Eyes, antennae, labrum, palpi, and tips of mandibles fuscous or testaceous. Elytra, mesothorax, metathorax, basal abdominal segments of males, tibiae, and tarsi fuscous or black. Galeae attaining metacoxae. Spurs of posterior tibiae similar, spatulate, concave. Length 6-7.5 mm.

Male: Head transversely suboval above mandibles, short, distance from vertex to labroclypeal suture subequal to distance across tempora, vertex evenly rounded, tempora rounded, not inflated; surface coarsely, moderately densely punctured, punctures denser and finer around eyes and bases of antennae, often absent medially on frons, a short, black semirecumbent seta arising from each puncture, setae on labrum and sides of mandibles longer and paler. Eyes reniform, half as wide as long, feebly emarginate at anterior third, moderately coarsely faceted, slightly protruding, obliquely subtruncate at upper ends. Clypeus impressed, subtriangular, coarsely punctate but with narrow anterior margin glabrous. Labrum narrow at base, widest across middle, sides strongly rounded, medially impressed at base, anterior margin evenly rounded, surface moderately densely punctate, hairy. Mandibles long, each with distal half abruptly curved inward. Maxillary palpi long, slender, hairy. Labial palpi long, extending well beyond closed mandibles. Galeae usually pale, slender, pubescent, in repose attaining or scarcely exceeding metacoxae. Antennae moderately long, almost two and one-half times as long as pronotum, each with first segment inflated and curved, not reaching half way across eye behind emargination, shining, sparsely punctured and pubescent; second scarcely shorter than first, widened to apex, shining, punctured and pubescent like first; third almost twice as long as second, less shining, densely punctate and pubescent; fourth shorter than third, otherwise similar; fifth shorter than fourth; sixth to eleventh subequal, longer than fifth; eleventh with apex subacutely rounded.

Pronotum scarcely wider than long, widest just before middle, gradually narrowed posteriorly, more abruptly narrowed anteriorly, disk shining, sparsely, irregularly, coarsely punctate, punctures bearing dark setae, a shallow median sulcus present in some specimens. Scutellum moderately large, rounded at apex, with a moderately deep median impression, in some specimens reduced to a foveiform basal impression, surface coarsely punctate, punctures bearing setae as on pronotum. Elytra moderately densely punctate basally becoming scabrous-punctate apically, clothed with moderately sparse, short black pubescence which is slightly longer and denser at apices. Thorax and abdomen shining ventrally, sparsely, finely, shallowly punctate, sparsely pubescent. Coxae smooth, shining, feebly excavated externally, sparsely, finely pubescent. Trochanters and femora shining, moderately densely pubescent except middle and posterior femora which are glabrous on inner sides. Tibiae slender, pubescent; spurs of anterior and middle tibiae slender, acute, equal; metatibial spurs concave, contiguous along inner margins, outer margins arcuate, apices obtuse. Fifth abdominal sternum impressed apically, sixth cleft medially with a central, circular impression.

Female: Similar to male except abdomen usually entirely flavous, fifth abdominal sternum scarcely or not impressed, sixth feebly emarginate.

Types: Lectotype male, no. 4968, lectoallotype, and one female lectoparatype (new designations) from "South of Raton Mountain", New Mexico, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined).

Specimens examined: NEW MEXICO: Albuquerque; Bellview; Jemez Mountains; Las Vegas; Luna, Santa Fe Canyon; Sapello; Socorro. COLORADO: Boulder; Colorado Springs; Crook; Denver; Golden; Julesburg; La Junta; Wray. ARIZONA: Joseph City. UTAH: Carbon County; Corinne; Salt Lake City; Uintah County. WYOMING: Beulah. KANSAS: Gove County; Greeley County; Lawrence; Logan County; Manhattan; Meade County; Onaga; Wallace County. SOUTH DAKOTA: Hot Springs.

Collection dates: July 20 to September 20.

Flower hosts of adults: Grindelia squarrosa; Grindelia sp.; Compositae sp.

Bee hosts of larvae: unknown. Oviposition has been observed on the buds of *Grindelia* sp. (Linsley and MacSwain, 1952.)

A specimen in the U. S. National Museum labeled "paratype" "*N. brunneopennis* Dillon" is a female of *N. sparsa*.

This seems to be an Upper Sonoran life-zone species, its western limits probably being the valley of the Green River in Utah, its eastern limits the eastern edge of the Great Plains area. Small andrenid bees (*Perdita, Calliopsis*), may be its hosts.

Nemognatha (Pronemognatha) cantharidis MacSwain

(Figs. 1, 94, 150)

Nemognatha cantharidis MacSwain, 1951, Pan.-Pac. Ent., vol. 27, p. 76; Linsley & MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 94.

This species is closely related to *N. selanderi* and *N. zonitoides* but is easily distinguished by its larger size, short, pale pubescence, longer galeae, and varicolored elytra. Also, this is a west coast species extending from southeastern California into Baja California and eastward into extreme southwestern Arizona whereas *N. selanderi* occurs in Texas, New Mexico, and Arizona and *N. zonitoides* occurs in Mexico and Central America. The elongate, piceous head, reddish prothorax, and pale pubescence are distinctive features of *cantharidis.* The galeae are as long as the head. The metatibial spurs are similar; fifth abdominal sternum feebly or not modified.

"Body surface shining, elytra dull. Color; head piceous; antennae, palpi, maxillae, metasternum, and legs dark brown, nearly piceous; pro-, mesothorax and abdomen orange; elytra flavo-testaceous with dark piceous suffusion near humeri and apices, coloration variable, rarely with all of elytra, except extreme outer margin, piceous. Pubescence golden. Length 9-11 mm." (from original description).

"Types: Holotype male no. 6219 (Calif. Acad. Sci., Ent.): Bennett Wash near Parker Dam, San Bernardino Co., CALIFORNIA, on flowers of *Encelia* sp., February 24, 1951 (C. D. McNeill and P. A. Adams); allotype (Calif. Acad. Sci., Ent.) same data as holotype; and 15 paratypes as follows: 1, same data as holotype, 5, 3 mi. S Palo Verde, Imperial Co., California, on flowers of *Geraea canescens,* April 8, 1949 (P. D. Hurd), 1, Ocotillo, San Diego Co., California, on flowers of *Pluchea sericea,* April 23, 1950 (J. W. MacSwain), and 1, Palm Springs, Riverside Co., California, April 16, 1916 (J. O. Martin)."

Nine paratypes representing the paratype localities listed above have been examined.

Specimens examined: CALIFORNIA: Bennett Wash near Parker Dam, San Bernardino Co.; Borrego; Palo Verde; Ocotillo; Indio;

1000 Palms; Truckhaven; Eden; Cathedral City; Palm Springs. ARIZONA: Wellton; Dublin. BAJA CALIFORNIA.

Collection dates: February 18 to April 23.

Flower hosts of adults: Encelia sp.; *Encelia farinosa; Geraea canescens; Pluchea sericea.*

Bee hosts of larvae: unknown.

Referring to this species, Linsley & MacSwain (1952, p. 94) offer the following observation:

"An interesting feature of its biology was observed by G. A. Marsh who reported to us that he found the species abundant on blossoms of *Geraea* at night although they were not evident on the same plants in the daytime (locality: 5 mi. SE of Ocotillo, San Diego County, California, March 27, 1949). This nocturnal habit, if it proves characteristic, may well be shared by other desert species of *Nemognatha* and thus explain their relative "rarity" in relation to most other species in the genus. Our largest collection of *N. cantharidis* was made on a partially overcast day near Indio, Riverside County, California."

I have myself observed *Zonitis atripennis atripennis* on *Cleome serrulata* flowers at night. They appeared to be much more active than during the day. In the daytime they were partially concealed, head down, in the flowers while at night they were actively crawling about on the flowers. *Zonitis vittigera, Z. cribricollis* and *Z. perforata* are frequently not in evidence during the hot part of the day on the same flowers on which they occur abundantly early and late in the day. On cloudy days and even on days with a few drops of rain falling occasionally they may be found feeding and laying eggs on flowers of *Rudbeckia,* but if the sun comes out at midday they disappear until evening. *Nemognatha lurida,* however, seems to be present on the flowers during all the daylight hours. Specimens in the laboratory usually remain more or less quiescent on the flowers or under them on the phyllaries when the lights are turned off at night.

Nemognatha (Pronemognatha) selanderi, sp. nov.

(Figs. 3, 71, 92, 151)

Nemognatha zonitoides Dugès (in part), 1876, La Naturaleza, Primera Serie, vol. 3, p. 47, pl. 2; Leng (in part), 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 77; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 100; MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pl. 2; Dillon, 1952, Amer. Mid. Nat., vol. 48, p. 340; Selander (as different species), 1954, Jour. Kansas Ent. Soc., vol. 27, p. 91, fig. 3a-c.

Zonitis zonitoides, Wickham, 1905, Canadian Ent., vol. 37, p. 171; Denier (in part), 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder (in part), 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; Vaurie (in part), 1950, Amer. Mus. Novitates, no. 1477, p. 6.

This species is closely allied to *N. sparsa* and *N. cantharidis* but most closely related to the Mexican *N. zonitoides*. From the former two species it is recognizable by the combination of yellow, campanulate pronotum, piceous, coarsely punctured head, and short galeae. From *zonitoides* it differs in the larger size, shorter galeae, immaculate pronotum, finely punctate or rugose elytra, and form of the male genitalia. In addition the pronotum is more slender and elongate.

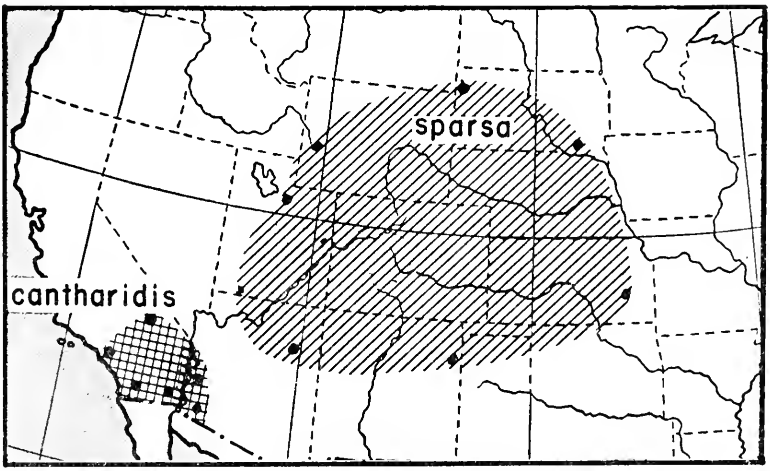

FIG. 1. Map showing the distribution of *Nemognatha (Pronemognatha) cantharidis* and *N. (Pronemognatha) sparsa*.

Selander (1954) has already pointed out that this form is specifically distinct from *zonitoides*. It is therefore named in honor of Dr. Richard B. Selander for having discovered it and for his valuable assistance in the present study.

Body surface moderately shining. Prothorax yellow. Head piceous except anterior margin of clypeus, outer margin of labrum, maxillae (except palpi), and labium yellow. Scutellum and abdomen varying in color from flavous to testaceous, occasionally piceous. Remainder of body fuscous to black. Galeae not attaining metacoxae. Elytra distinctly rugose or densely punctate. Spurs of posterior tibiae spatulate, similar and equal. Length 5.5-7.5 mm.

Male: Head moderately elongate, distance from vertex to labroclypeal suture one and one-half times as long as distance across tempora; vertex evenly rounded, rarely slightly tumid medially; tempora rounded, not inflated; surface coarsely, moderately densely punctured, a narrow median longitudinal area impunctate, polished, a short black seta arising from each puncture, setae on labrum, sides of mandibles, and under side of head longer and paler. Eyes reniform feebly emarginate at anterior third, twice as long as wide, fringed with long hairs posteriorly below. Labrum scarcely longer than wide, hairy, impressed medially, evenly rounded apically. Mandibles elongate, curved at apical third. Maxillary and labial palpi long, slender, hairy, articulations usually pale. Galeae short, produced beyond mandibles a distance slightly exceeding length of mandibles or scarcely longer than maxillary palpi, sparsely clothed basally with long coarse hairs. Antennae moderately long, almost three times as long as pronotum, segments one and two shining, hairy, three to eleven feebly shining, densely pubescent, first segment twice as long as second, second half as long as third, fourth to eleventh subequal, slightly shorter than third, apex of eleventh tapered, bluntly pointed.

Pronotum shining, as long as wide, campanulate, sparsely but irregularly, moderately coarsely punctured, a short semierect seta arising from each puncture. Scutellum moderately large, apex broadly rounded, a moderately broad, shallow impression near apex, surface finely, densely punctate, clothed with long setae which are denser and shorter at anterior angles. Elytra moderately shining, distinctly rugose or finely punctate, punctures becoming progressively less distinct from base to apex, moderately densely clothed with short, semirecumbent dark pubescence, humeri feebly inflated, side margins somewhat raised from base almost to apex.

Thorax and abdomen shining ventrally, densely, finely punctate and pubescent. Apical two abdominal segments usually flavous, basal segments fuscous. Coxal excavations smooth, polished; remainder of leg segments densely, finely punctured and pubescent except middle and posterior femora glabrous on inner sides. Spurs of fore and middle tibiae slender, slightly flattened, blunt at apices; metatibial spurs flared, similar, contiguous along inner margins. Fifth abdominal sternum with a minute impression medially at apex, sixth cleft, broadly and deeply impressed centrally. Genitalia as in Fig. 151.

Female: Similar to male except fifth abdominal sternum not modified, sixth extremely feebly emarginate medially at apex. All abdominal segments usually flavous or reddish-testaceous, rarely fuscous.

Types: Holotype male, Presidio, Texas, August 16, 1948, J. H. Russell collector, type no. 62732, on flowers of *Baileya multiradiata*; allotype, same locality as holotype, August 22, same collector, on *Atriplex canescens*, both in the U. S. National Museum. Paratypes: two males and two females, Green Valley, Brewster Co., Texas, J. W. Green collector, July 14, in the collection of Mr. J. W. Green, California Academy of Sciences.

Additional specimens examined: TEXAS: Alpine; Chisos Mts., Big Bend Park; Davis Mountains, Jefferson Davis County; Marfa. NEW MEXICO: Alma; Isleta; Jemez Mountains; Las Vegas; Sabinosa; San Jon; San Jose; Silver City. ARIZONA: Cochise County; Douglas; Huachuca Mts.; Joseph City; Nogales; Winslow. Specimens have been examined from northern Mexico also.

Collection dates: July 6 to Sept. 10.

Recorded elevations: 3750 to 4860 ft.

Flower hosts of adults: Grindelia sp.; *Melilotus* sp.; *Petalostemum* sp.; *Croton texensis; Croton* sp.; *Baileya multiradiata; Atriplex canescens; Baccharis glutinosa;* and *Fallugia paradoxa.*

Bee hosts of larvae: unknown.

In the holotype and allotype the abdominal sterna appear to be entirely fuscous but the other specimens all show sexual color variations in this respect.

Subgenus MEGANEMOGNATHA, subg. nov.

North American Nemognathini with at least fourth and fifth abdominal sterna of males medially trapezoidally or subtriangularly punctulate and pubescent (except tufted in *explanata, angusta,* and *miranda*), tegmen stout, apex bluntly rounded in lateral aspect; metatibial spurs usually dissimilar, often extremely so; galeae moderately to extremely long.

Type: Nemognatha lurida LeConte, 1853.

KEY TO SPECIES OF MEGANEMOGNATHA

1.	Outer metatibial spurs greatly enlarged, more than twice, usually three times as wide as inner spurs; apices flared	2
	Outer metatibial spurs at most twice as wide as inner, often only scarcely wider, apices moderately or not flared	5
2(1).	Galeae no longer than head from vertex to apices of mandibles,	*brevirostris*
	Galeae distinctly longer than head	3
3(2).	Galeae extending almost to apex of abdomen	*werneri*
	Galeae extending at most to fourth abdominal sternum	4

4(3). Pronotum usually transverse, about one fifth wider than long, angles moderately abrupt, surface irregularly, sparsely punctured; elytral pubescence and entire body flavous, rarely pale testaceous; galeae extremely slender, scarcely exceeding metacoxae . . . *pallens*

Pronotum scarcely wider than long, sides divergent from anterior to posterior angles or feebly sinuate, elytral pubescence usually dark, occasionally pale; galeae moderately stout extending well beyond metacoxae . . . *lurida*

5(1). Elytra shallowly rugose-punctate or finely and at least moderately densely punctate but not punctulate nor pilose; or (females only) with elytra shining, shallowly but only moderately densely punctate . . . 6

Elytra finely, extremely densely punctulate or with punctation concealed by dense, long pubescence . . . 14

6(5). Females only with elytra shining, shallowly, moderately densely punctate . . . (females) *macswaini*

Both sexes with elytra shallowly rugose-punctate or finely and densely punctate . . . 7

7(6). Elytra shallowly rugose-punctate . . . 8

Elytra distinctly punctate, usually finely and densely so . . . 10

8(7). Galeae scarcely longer than pronotum . . . *soror*

Galeae considerably longer than pronotum usually extended beyond metacoxae . . . 9

9(8). Pronotum rather coarsely punctate; elytra finely and densely rugose-punctate; length usually over 8 mm. . . . *lutea*

Pronotum finely punctate; elytra coarsely, shallowly rugose-punctate, length rarely exceeding 7 mm. . . . *curta*

10(7). Males with finely pubescent trapezoidal or subtriangular punctulate areas medially on fourth and fifth abdominal sterna; outer metatibial spurs not flared, usually narrowed at apices; dorsal pubescence pale golden or light reddish . . . 11

Males with tufts of hairs on transverse punctulate areas of fourth and fifth abdominal sterna; outer metatibial spurs usually somewhat flared at apices; dorsal pubescence reddish or black 12

11(10). Reddish-testaceous, usually with piceous elytral vittae; pubescence golden; pronotum moderately densely rather coarsely punctate; length usually over 10 mm. . . . *nitidula*

Flavous or pale testaceous, elytra vittate or not; pubescence pale; pronotum extremely finely sparsely punctate, length usually less than 10 mm. . . . *meropa*

12(10). Reddish-testaceous; posterior angles of pronotum distinctly expanded; galeae usually attaining apex of abdomen *explanata*

Flavous or pale testaceous or fulvous; posterior angles of pronotum feebly or not expanded; galeae not attaining apex of abdomen . . . 13

13(12). Pronotum distinctly narrowed from anterior angles to base; galeae extending well beyond metacoxae . . . *angusta*

Pronotum not narrowed from anterior angles to base; posterior angles usually feebly produced; galeae scarcely exceeding metacoxae . . . *miranda*

14(5). Pronotum extremely densely, finely punctulate; entire body surface densely clothed with long, pale silky pilosity obscuring punctation *bridwelli*

Body surface pubescent or not, never pilose 15

15(14). Pronotum transversely suboval except posterior angles feebly produced, nearly one fourth wider than long, feebly to sharply emarginate medially at base (males) *macswaini*

Pronotum subquadrate, scarcely one sixth wider than long, not oval, base evenly arcuate *hurdi*

Nemognatha (*Meganemognatha*) *lurida* LeConte

(Figs. 2, 50, 58, 87, 88, 100, 156, 157)

Resembles *N. lutea* but readily distinguishable from that species by its shorter galeae, more densely punctured pronotal disk, and extremely dissimilar metatibial spurs.

This is the nominate form of a complex which includes what have heretofore been regarded as two distinct species. They are here reduced to infraspecific status because of their obviously close morphological structure, preference for the helianthoid assemblage of flowers, and geographical distribution. They appear to be allopatric and in zones of overlap the entire spectrum of gradation occurs. The distinction between the two forms is not very great. Specimens from opposite extremes of the range, however, may be separated as follows:

Pronotum usually densely punctate, punctures laterally on disk often contiguous; anterior angles moderately abrupt; pubescence pale or dark; pronotal outline as illustrated in Fig. 87 *lurida lurida*

Pronotum moderately densely punctate, punctures usually separated by at least their diameters; anterior angles broadly rounded; pubescence dark; pronotal outline as in Fig. 88 *lurida apicalis*

N. (*Meganemognatha*) *lurida lurida* (LeConte)

(Figs. 2, 50, 58, 87, 100, 156)

Nemognatha lurida LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 345; 1859, Coleoptera of Kansas and Eastern New Mexico, p. 46; Snow, 1878, Trans. Kansas Acad. Sci., vol. 6, pp. 69, 77; Popenoe, 1878, Trans. Kansas Acad. Sci., vol. 6, p. 85; Le Conte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 212; Snow, 1881, Trans. Kansas Acad. Sci., vol. 7, p. 70; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 373; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Mickel, 1928, Ent. News, vol. 39, p. 69; Carruth, 1931, Ent. News, vol. 42, p. 54; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 96.

Zonitis lurida, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, pp. 6, 9, 12.

Nemognatha rufa Dugès, 1889, Ann. Mus. Michoacana, vol. 2, p. 111; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 374; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169.

Zonitis rufa, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, p. 9.

Body surface moderately shining. Color variable but typically with pubescence and integument flavous, testaceous, or fulvous above and below except antennae, eyes, tips of mandibles, palpi, galeae, tibiae, and tarsi fuscous or black. Most common color variation with entire underside, scutellum, and pubescence fuscous or piceous. Extreme dark forms with head and pronotum reddish-testaceous, remainder black. All intermediate forms occur. Galeae distinctly exceeding metacoxae. Metatibial spurs extremely dissimilar. Length 6.5-15 mm.

Male: Head large, elongate-triangular, distance from vertex to labroclypeal suture one sixth shorter than distance across tempora; tempora distinctly inflated; vertex slightly tumid; surface irregularly coarsely punctate becoming densely so or rugose-punctate on clypeal area, labrum, sides of mandibles, and near eyes; a short, fine, pale seta arising from each puncture, setae longer on labrum and sides of mandibles; an irregular impunctate area usually present on frons. Eyes moderately large, about one third as wide as long, oblong-oval, distinctly protruding, feebly emarginate at anterior third. Clypeal area moderately impressed, punctate basally, glabrous apically. Labrum large, one fourth wider than long, anterior margin evenly rounded. Mandibles stout, sides straight basally, apical third of each gradually rounded to apex. Maxillary palpi long, apical two segments exceeding mandibles, segments finely punctate and pubescent. Labial palpi short, barely attaining tips of mandibles, punctulate and pubescent, slender. Galeae stout, moderately long, in repose usually attaining third abdominal sternum, clothed with semierect hairs. Antennae moderately long, about two and one half times as long as pronotum, each with first segment large, inflated, arcuate, reaching beyond middle of eye behind emargination, shining, punctured and pubescent; second two thirds as long as first, widened apically, otherwise like first; third long, filiform, twice as long as second, darker, more densely punctate and pubescent, less shining than first and second, distinctly flattened; fourth three fourths as long as third otherwise similar; fifth and sixth subequal in length, shorter than fourth, submoniliform; seventh to tenth similar to each other, shorter than sixth, submoniliform; eleventh one third longer than tenth, feebly widened at distal third, thence tapered to subacute apex.

Pronotum about one seventh wider than long, margins straight, almost imperceptibly but regularly widened from anterior angles to base, anterior angles abruptly rounded; apex broadly and shallowly emarginate medially; base very feebly emarginate medially; disk moderately densely, regularly punctate, but often more densely so along sides, punctures fine, shallow, setigerous; a short, shallow, median sulcus on basal third, in some specimens feebly produced to apex; surface usually evenly convex, but feebly, irregularly raised in some specimens. Scutellum large, triangular, sides carinate basally, surface densely, finely punctate and pubescent, broadly impressed medially, the impression usually glabrous, apex subacute. Elytra densely, finely punctate with fine, erect pubescence. Legs more densely punctate and pubescent except coxal excavations which are glabrous. Spurs of anterior and middle tibiae long, slender, acute; outer metatibial spurs greatly enlarged, at least twice as wide as inner, apices flared, concave, obliquely truncate; inner spurs shorter than outer, flattened and concave, sides parallel, apices oblique, bluntly rounded. Fourth abdominal sternum with a broad, triangular punctulate area medially; fifth with a broad, median, punctulate area and a small, round, glabrous impression medially at apex; sixth deeply cleft with a broad circular, median impression.

Female: Similar to male but with abdominal sterna not punctulate, sixth sternum with apex evenly rounded or feebly emarginate. Anterior tarsi with moderately long, erect hairs.

Type: Lectotype female, no. 4952, and lectoallotype male (new designations), each bearing a green label, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). The type of *rufa* Dugès is lost.

Type locality: "Missouri Territory, on Platte River" (= Nebraska).

Specimens examined: Numerous specimens from Nebraska, Kansas, Missouri, Iowa, Oklahoma, Texas, New Mexico, Arizona, Colorado, South Dakota, North Dakota, and one from Wyoming. The species occurs also in Mexico. Westernmost localities represented in the material examined include Phoenix, Arizona; Durango and Grand Junction, Colorado; Worland, Wyoming; Sturgis, South Dakota; and Sentinel Butte, North Dakota. No specimens have been seen from the area east of the Mississippi River nor from Arkansas or Louisiana.

Collection dates: May 1 to October 6. One male labeled "Feb." and one female labeled "April," both from Texas, also have been examined.

Flower hosts of adults: Helianthus annuus; H. petiolaris, H. lenticularis; H. ciliaris; Silphium integrifolium; S. speciosum; Rudbeckia sp.; *Solidago* sp., *Chrysothamnus* sp.; *Verbesina encelioides.* Numerous adults taken from the Japanese Beetle traps in St. Louis, Missouri, and a few from light traps in Texas.

Bee hosts of larvae: Recorded by Mickel (1928) from the cells of *Anthophora occidentalis* in Colorado. One specimen reared from these cells is in the University of Minnesota collections.

N. (Meganemognatha) lurida apicalis LeConte

(Figs. 2, 88, 157)

Nemognatha apicalis LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 345; Snow, 1878, Trans. Kansas Acad. Sci., vol. 6, p. 69; LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 212; Schwarz, 1890, Insect Life, vol. 2, p. 288; Snow, 1907, Trans. Kansas Acad. Sci. vol. 20, p. 174; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 166; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 78; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 93.

Zonitis apicalis, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha bicolor Walker, 1866, *in* Lord, The Naturalist in Vancouver Island and British Columbia, vol. 2, p. 331; Schwarz, 1890, Insect Life, vol. 2, p. 288; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis bicolor, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha walkeri Beauregard, 1889, Bull. Soc. Ent. France, p. 212; Schwarz, 1890, Insect Life, vol. 2, p. 288; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis walkeri, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Similar to the nominate subspecies, differing principally in the form and punctation of the pronotum, dark pubescence, characteristic color pattern, and distribution. The characters given in the key are sufficient to distinguish this subspecies. The color pattern is variable from entirely pale except appendages to black with only head and pronotum testaceous.

Body surface moderately shining. Color variable, usually fulvous or testaceous above, elytra with black apical crescents; ventral surfaces varying from testaceous or fulvous to piceous, apical abdominal segments usually testaceous; appendages black; pubescence black, rarely pale. Some specimens with elytra and ventral surfaces entirely black. Galeae and metatibial spurs as in *lurida*. Sexual differences as in *lurida*. Length 7-15 mm.

Types: Lectotype female (new designation), no. 4954, from Benicia, California, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Lectoallotype (new designation), same data as lectotype and in same collection. The specimen from Texas mentioned by LeConte in the original description belongs to the nominate subspecies. The type of *bicolor* Walker, hence also of *walkeri* Beauregard, is presumably in the British Museum (Natural History).

Specimens examined from numerous localities in CALIFORNIA, OREGON, WASHINGTON, IDAHO, MONTANA, WYOMING, UTAH, NEVADA, ARIZONA, NEW MEXICO and COLORADO with the following localities marginal: Boulder and Golden, Colo.; Columbia Falls, Mont.; Worland, Wyo.; Newcomb, N. Mex.; Pullman, Wash. The areas of central Colorado, western New Mexico and eastern Arizona are zones of intergradation between this and the nominate subspecies.

Collection dates: March 28 to October 13.

Flower hosts of adults: Helianthus annuus; Helianthus sp.; *Grindelia* sp.; rarely on *Cirsium; Solidago; Melilotus;* or at light.

Bee hosts of larvae: Possibly *Melissodes* sp. (Linsley & MacSwain, 1952).

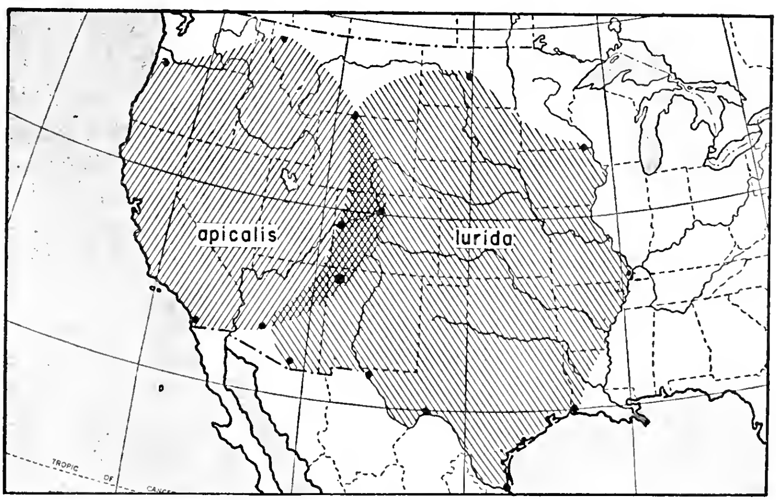

FIG. 2. Map showing the distribution of *Nemognatha (Meganemognatha) lurida*. The zone of intergradation between the subspecies is indicated by the overlapping of types of shading.

Nemognatha (Meganemognatha) werneri, sp. nov.

(Figs. 104, 159)

Extremely similar to *N. lurida* but differing in having longer galeae; sparser elytral punctation but longer, more recumbent pubescence dorsally, pubescence on pronotum distinctly anteriorly inclined; labrum distinctly transverse; punctation ventrally sparser; and minor differences in the male genitalia.

Body surface shining. Color variable, usually fulvous above, flavous below except apices of femora, tibiae, tarsi, antennae, palpi, galeae, and apices of mandibles piceous. Some specimens with scutellum piceous; ventral surfaces varying from flavous to piceous, the dark extremes with abdominal segments pale at least laterally, usually with first sternum entirely dark, second broadly infuscate medially, third with only small area at base dark, fourth and fifth pale, some males entirely black below except sixth abdominal sternum pale medially at apex. Galeae nearly attaining apex of abdomen. Pronotum as in *lurida* but more sparsely, coarsely punctate. Pubescence dark, fine, longer than in lurida, recumbent, anteriorly inclined on pronotum. Labrum almost twice as wide as long. Metatibial spurs as in *lurida*. Males with pubescent, punctulate areas medially on fourth and fifth abdominal sterna, the latter with a small, round impression medially at apex; sixth medially cleft, deeply impressed at center. Female similar to male but abdominal sterna not so modified, sixth with a moderately deep, narrow, triangular emargination medially at apex; anterior tarsi with erect hairs. Length 11-15 mm.

Types: Holotype male no. 62733, and allotype, on Canadian Thistle flowers, near Portales, New Mexico, July 10 (45-16467). Paratypes as follows: four males, same data as holotype; two females, same data except labeled "VII-10-15, 45-16470"; one male, same data labeled "VII-10-15, 45-16471," all in the U. S. National Museum.

This species is named in honor of Dr. Floyd G. Werner of the University of Arizona, whose aid and encouragement in this study have been invaluable.

Nemognatha (Meganemognatha) brevirostris, sp. nov.

(Figs. 105, 160)

This species closely resembles *N. lurida* but is readily distinguishable by the very short galeae, rounded head, and form of the male genitalia.

Body suface moderately shining. Color fulvous or rufo-testaceous except eyes, antennae, tips of mandibles, palpi, galeae, apices of femora, entire tibiae and tarsi fuscous or black. Some specimens have the entire sternum and legs piceous except the apical three or four abdominal segments. Galeae stout, about as long as the head. Metatibial spurs greatly dissimilar as in *N. lurida*. Length 10-12 mm.

Male: Head in cephalic aspect subtriangular, distance from vertex to labroclypeal suture about one fifth less than distance across tempora, vertex evenly rounded or feebly tumid, tempora scarcely or not inflated; surface moderately densely, coarsely punctate with suberect black setae, a distinct median carina present on upper third of frons. Eyes large, protuberant, more than half as wide as long, emarginate at anterior third. Clypeus trapezoidal, deeply impressed, basal half coarsely punctate and pubescent, apical half glabrous. Labrum scarcely wider than long, sides almost parallel, surface densely punctured and hairy, anterior margin evenly rounded. Mandibles large, stout, distal half of each arcuate inward, sides densely punctured and clothed with long, golden pubescence. Maxillary palpi longer than mandibles, segments punctured and pubescent. Labial palpi similar to maxillary but shorter than mandibles. Galeae about as long as head from vertex to anterior margin of labrum, stout with short, erect, pale pubescence, apices acute. Antennae less than two and one-half times as long as pronotum, segments 2 to 11 somewhat flattened; each antenna with first segment stout, curved and inflated, scarcely reaching half way across eye behind emargination, shining, moderately densely punctured and pubescent; second scarcely shorter than first, moderately enlarged to apex, punctured and pubescent like first, third one fourth longer than second, almost parallel-sided, more densely punctured and pubescent than second; fourth to tenth similar to third but progressively shorter, appearing somewhat more submoniliform; eleventh one third longer than tenth, distal third unevenly narrowed to apex.

Pronotum one sixth wider than long, base evenly arcuate from side to side, posterior angles not produced, sides subparallel to apical third, thence broadly rounded to apex; disk evenly convex, surface irregularly, shallowly moderately coarsely punctate, a rather long, coarse, black seta arising from each puncture, a feeble median sulcus present on basal third. Scutellum moderately large, pale or dark, sides feebly raised, surface densely punctate and pubescent, broadly impressed at center, apex broadly rounded. Elytra densely, shallowly punctate clothed with suberect, dark setae; sutures and margins feebly raised. Thorax and abdomen shining ventrally, moderately densely punctate and pubescent; fifth abdominal sternum with a triangular, median punctulate area and a small glabrous impression medially at apex; sixth deeply cleft medially and with a deep, central, funnel-shaped impression. Legs more coarsely and densely punctate than thorax, pubescent; spurs of anterior tibiae slender, spiniform, acute; of middle tibiae somewhat flattened, outer spurs scarcely broader than inner; metatibial spurs greatly dissimilar, outer spurs widely flared and concave apically, apices rounded; inner spurs scarcely more than half as long as outer, concave, parallel-sided, somewhat arcuate, apices rounded.

Female: Similar to male but abdominal sterna not so modified, sixth usually concealed but when visible feebly emarginate medially at apex. Anterior tarsi with moderately long, erect hairs.

Types: Holotype male, Brownwood, Texas, May 10, 1919, Acc. 23972, in the American Museum of Natural History. Allotype, Santa Anna, Texas, May 27, 1942, taken on *Lepadys*, C. P. Alexander collector, in the University of Massachusetts collection.

Larval hosts: unknown.

Nemognatha (Meganemognatha) pallens LeConte

(Figs. 3, 96, 158)

Nemognatha pallens LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 346.

Nemognatha lutea pallens, LeConte, 1880, Trans. Amer. Ent. Soc. vol. 8, p. 213; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 98.

Nemognatha lutea, Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 375; Borchman, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Nemognatha pallens lutea, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 336.

Zonitis lutea, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, pp. 6, 9, 11.

Resembles *N. lurida apicalis* but distinguishable by its pale color, short slender antennae, more sparsely punctate pronotum, shorter, more attenuate galcae, and form of the male genitalia.

Body surface shining. Color pale flavous or testaceous except eyes, antennae (except first segments), apices of mandibles, palpi, galeae (entire head in some specimens), scutellum, thoracic sternum, and legs fuscous or black, some specimens entirely flavous except antennae and tarsi fuscous. Vertex evenly rounded, shining, sparsely and shallowly punctate. Pubescence usually pale, rarely dark. Pronotum variable in outline, usually evenly convex, sides straight or sinuate, disk shining, moderately sparsely but coarsely punctate. Galeae slender, attenuate, scarcely exceeding metacoxae. Metatibial spurs as in *lurida*. Length 8-10 mm.

Male: Head short, triangular, distance from vertex to anterior margin of labrum equal to distance across tempora, tempora feebly swollen, vertex evenly rounded and sparsely punctate, remainder of head coarsely, moderately densely punctate, a short semierect seta arising from each puncture. Eyes moderately large, scarcely more than one and one-half times as long as wide, emarginate anteriorly, upper halves moderately protruding, lower halves more so, upper margins evenly rounded. Clypeus sharply, deeply impressed, anterior angles in most dry specimens curved inward giving clypeus a sharply triangular appearance, surface densely, coarsely punctured except apical third glabrous. Labrum nearly one fourth wider than long, moderately densely punctate with long, pale setae, anterior margin evenly rounded or feebly and broadly emarginate medially. Mandibles moderately long, stout, distal halves broadly arcuate inward, sides densely punctate and pubescent. Palpi as in *apicalis*. Galeae very slender, pale or dark, short, scarcely exceeding metacoxae, clothed with short, pale pubescence. Antennae short, about twice as long as pronotum, each with first segment moderately large, reaching half way across eye behind emargination, inflated distally, shining, moderately densely punctured and pubescent, in some specimens testaceous in color; second little more than half as long as first, widened to apex, fuscous, shining, punctured and pubescent like first; third scarcely twice as long as second, filiform, densely punctate and pubescent, black; fourth subequal in length to third, similarly sculptured; fifth almost one fourth shorter than fourth, submoniliform, otherwise like fourth; sixth to tenth subequal to fifth; eleventh scarcely one fourth longer than tenth, widest just beyond middle, tapered to apex; all segments feebly or not at all flattened.

Pronotum variable, usually transverse, about one sixth wider than long, sides straight or sinuate, posterior angles scarcely produced, anterior angles abruptly rounded at anterior fifth, basal margin feebly arcuate; disk unevenly convex, shining, moderately densely, coarsely punctate. Scutellum large, carinate at sides, impressed near apex, densely, coarsely punctate, pubescent, apex rounded. Elytra densely, moderately finely punctate, clothed with semierect, short pubescence, sutures and margins narrowly, feebly raised.

Thorax and abdomen ventrally shining, moderately densely and finely punctate, pale pubescent, color variable, thorax fuscous or flavous, abdomen usually entirely pale in females, males usually with part of first abdominal sternum fuscous, both sexes frequently entirely pale beneath. Legs densely punctate and pubescent, anterior and middle tibiae with both spurs slender, spiniform, acute; metatibial spurs dissimilar, the outer greatly enlarged and flared, concave; the inner slender, flattened, parallel-sided, apex subacute. Fourth and fifth abdominal sterna with broad median punctulate areas; fifth broadly, shallowly emarginate with a small, glabrous impression medially at apex; sixth deeply cleft medially with a deep, central impression.

Female: Similar to male but abdominal sterna not so modified, sixth rounded at apex or feebly emarginate. Anterior tarsi with short erect hairs.

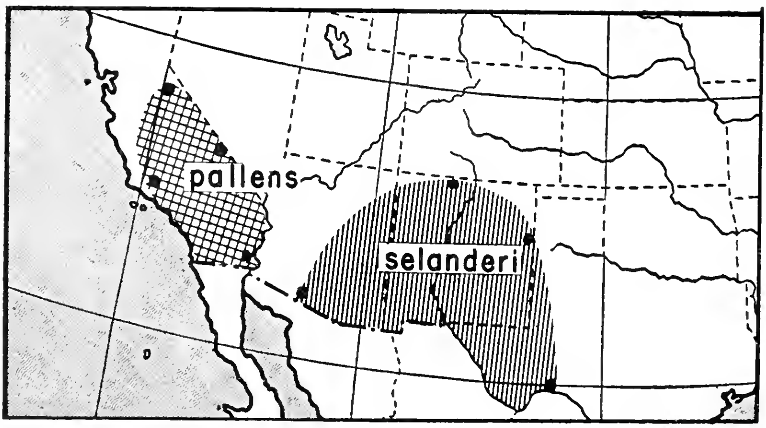

Fig. 3. Map showing the distribution of *Nemognatha* (*Meganemognatha*) *pallens* and *N.* (*Pronemognatha*) *selanderi.*

Types: Lectotype male (new designation), no. 4956, from Vallecitas, California, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Neallotype (new designation), Brawley, California, October 3, 1923, in the Snow Entomological Museum, University of Kansas.

Specimens examined: California: one female, Calipatria, October 3, 1923, A. Davis, in Snow Entomological Museum, University of Kansas; one male, two females, Colton, Pilate collector, 1888;

two males, same locality, September 19, 1888, same collector, all in Museum of Comparative Zoology, Harvard University; one male, one female, Oro Grande, September 14, 1935, on *Isocoma acradenia*, P. H. Timberlake; 17 males and 8 females, Kane Springs, Imperial County, October 14, 1949, L. D. Anderson and H. T. Reynolds, collected on *Isocoma veneta*, the preceding in the California Insect Survey collections.

Dates of collection: Sept. 14 to Oct. 14.

Hosts of adults: Isocoma acradenia; Isocoma veneta.

Bee hosts of larvae: Anthocopa sp. (Linsley and MacSwain, 1952).

This form as here defined is a distinct species. Its affinities clearly seem to be with the *lurida* complex and not the *lutea* complex. The slender galeae, finer antennae, and male genitalia warrant specific status.

Nemognatha (*Meganemognatha*) *lutea* LeConte

(Figs. 4, 43, 59, 69, 98, 161)

This species is represented by three subspecies occurring principally in western North America. Specimens from any given locality are extremely variable, particularly in color, but in general those taken in that part of their range farthest from the adjoining subspecies are fairly easily distinguishable.

The nominate subspecies is usually distinguished from the form *dichroa* by its broader inner metatibial spurs; moderately flared apices of the outer metatibial spurs; entirely pale head; and more eastern distribution. From the form *dubia* it is readily separable by its long galeae, wider outer metatibial spurs, pale color, less densely punctate pronotum, and distribution.

In tabular form the subspecies may be distinguished thus:

1. Galeae extremely long, usually attaining apex of abdomen 2
   Galeae moderately long, rarely exceeding fourth abdominal sternum, *lutea dubia*
2. Outer metatibial spurs distinctly flared at apices; inner metatibial spurs flattened; apices subacute; mouthparts and clypeus usually testaceous; pronotum evenly convex usually lacking median sulcus *lutea lutea*
   Outer metatibial spurs parallel-sided, apices rounded, not flared; inner metatibial spurs slender, often spiniform, apices acute; mouthparts and clypeus black; pronotum unevenly convex, usually sulcate medially at base . . . . . *lutea dichroa*

N. (*Meganemognatha*) *lutea lutea* LeConte

(Figs. 4, 43, 59, 69, 98, 161)

Nemognatha lutea LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 346, 1859, The Coleoptera of Kansas and Eastern New Mexico, p. 46, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p, 374; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Carruth, 1931, Ent. News, vol. 42, p. 55.

Zonitis lutea, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, pp. 6, 9, 11.

Nemognatha pallens, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 336 (misidentification).

Body surface moderately shining. Color variable, usually with head, prothorax, elytra, and at least fifth and sixth abdominal sterna flavous or testaceous. Antennae, eyes, labrum, palpi, galeae, apical two thirds of mandibles, and scutellum usually fuscous or piceous. Galeae attaining apex of abdomen. Spurs of posterior tibiae markedly dissimilar. Length 8-14 mm.

Male: Head subtriangular, short, distance from vertex to base of labrum two thirds distance across tempora; tempora moderately inflated, vertex evenly rounded; surface moderately densely punctate, each puncture giving rise to a short, pale seta, setae longer and denser on sides of mandibles, frons medially usually impunctate. Eyes moderately large, elongate-oval, feebly emarginate. Clypeus impressed, punctate. Labrum moderately large, one third wider than long, anterior margin evenly rounded. Mandibles stout, evenly rounded from bases to apices. Maxillary palpi long, exceeding mandibles. Labial palpi short, slender, scarcely exceeding mandibles. Galeae moderately stout, long, in repose attaining or exceeding apex of abdomen. Antennae moderately long, about two and one-half times as long as pronotum, each with first segment rather short, inflated, shiny, moderately punctured and pubescent; second slightly shorter than first, moderately enlarged apically, shiny, punctured and pubescent like first; third twice as long as second, slightly flattened, more densely punctulate and with finer, denser pubescence than second; fourth to tenth successively shorter than each preceding, otherwise like third; eleventh very little longer than tenth, widest at apical third, apex subacutely rounded.

Pronotum transverse, one sixth wider than long, anterior angles rather abruptly rounded, widest at anterior fourth, side margins rounded, slightly convergent to base; disk regularly convex, moderately sparsely, somewhat unevenly punctate, punctures setigerous, some specimens with a prebasal, slightly elevated, impunctate area on each side, a very feeble remnant of a sulcus on basal third medially. Scutellum large, triangular, shining, sparsely punctate medially, more densely so laterally, pubescent like thorax, apex broadly rounded. Elytra moderately densely rugose-punctate basally becoming scabrous-punctate apically, each puncture giving rise to a short, pale semirecumbent seta, apices of elytra sometimes with an irregular black spot or blotch. Thorax and abdomen shining ventrally, moderately sparsely, finely punctate and with fine pale setae which are longer than those on upper surfaces. Legs more densely and coarsely punctate than thorax, clothed basally with pale recumbent setae becoming darker distally; spurs of anterior and middle tibiae slender, acute, equal; outer spurs of posterior tibiae moderately large, concave, slightly widened to apices; inner spurs scarcely shorter than outer, flattened, concave, parallel-sided, subacutely rounded at apices. Third abdominal sternum with a very small, triangular, punctulate area medially at apex; fourth with a large triangular median punctulate impression; sixth deeply cleft medially, shallowly impressed; all impressed areas usually testaceous, pale pubescent.

Female: Similar to male but with abdominal sterna not so modified except fifth which is feebly triangularly emarginate medially at apex; sixth usually not visible; anterior tarsi with long, erect hair.

Types: Holotype female, no. 4955, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Type locality "Missouri Territory" (= Nebraska).

Specimens examined from numerous localities including the following states and provinces: ALBERTA, NORTH DAKOTA, SOUTH DAKOTA, NEBRASKA, KANSAS, OKLAHOMA, TEXAS, NEW MEXICO, COLORADO, WYOMING, UTAH, NEVADA, and ARIZONA. This form also occurs in Mexico. The following localities are marginal: Medicine Hat, Alberta; Las Vegas, Nevada; Santa Catalina Mts., Arizona; Eagle Pass, Texas; Valentine, Nebraska; Sentinel Butte, North Dakota.

Collection dates: March 28 to October (?).

Recorded elevations: 3200 to 8000 feet altitude.

Flower hosts of adults: Cirsium sp.; *Carduus* sp.; *Cnicus* (=*Cirsium*) *undulatus; Astragalus* sp.; *Helianthus* sp. Adults apparently prefer flowers of thistle (*Cirsium* sp.).

Bee hosts of larvae: unknown.

This form intergrades with *dichroa* over a fairly wide area all along the western margin of its range.

N. (*Meganemognatha*) *lutea dichroa* LeConte

(Figs. 4, 53, 162)

Nemognatha dichroa LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 346; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars. 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 78; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 94.

Zonitis dichroa, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Extremely similar to the nominate form and resembling pale specimens of the form *dubia*. From *dubia* it is distinguished by its longer galeae, more sparsely punctate, usually partially sulcate pronotum, and dissimilar metatibial spurs. From *lutea lutea* it differs chiefly in color pattern, form of metatibial spurs, and range.

Body surface shining. Color variable (but much less so than in *dubia*) characteristically flavous or pale testaceous except appendages, distal half of head, scutellum, apical elytral crescents, portions of thoracic sterna, and abdomen piceous with side margins and portions or all of apical abdominal segments reddish or testaceous. Extremely pale forms are testaceous above and below except appendages piceous; dark extremes are entirely piceous except prothorax and upper third of head reddish. Galeae usually extremely long, in repose attaining apex of abdomen. Spurs of posterior tibiae dissimilar; inner spurs extremely slender, spiniform; outer spurs flattened, concave, apices rounded, rarely somewhat flared. Length 7.5-15 mm.

Male: Head elongate triangular, distance from vertex to base of labrum subequal to distance across tempora; tempora slightly inflated; vertex slightly tumid; surface rather sparsely, finely punctate, a moderately long, fine, dark seta arising from each puncture. Eyes large, elongate oval, moderately protruding, emarginate anteriorly. Clypeal area distinctly impressed. Labrum moderately large, one third wider than long, anterior margin evenly rounded. Mandibles stout, sides straight basally, distal halves moderately abruptly rounded to apex. Maxillary palpi long, apical two segments exceeding mandibles, finely pubescent. Labial palpi short, slender, not exceeding mandibles, sparsely and finely pubescent. Galeae moderately stout, extremely long, in repose attaining or exceeding apex of abdomen, clothed basally with sparse, erect dark setae. Antennae about two and one-half times as long as pronotum, each with segments 2 to 11 distinctly flattened, first segment short, half as wide as long, inflated, densely punctate and pubescent; second subequal to first, slightly widened to apex, punctate and pubescent like first; third twice as long as second, filiform, little if any more pubescent than first and second; fourth to tenth progressively shorter than each preceding, otherwise like third; eleventh one third longer than tenth, usually widest at middle, tapered to bluntly rounded apex.

Pronotum transverse, one fourth wider than long, margins almost straight, anterior and posterior angles abruptly rounded, in some specimens posterior angles slightly produced, disk somewhat irregular, sparsely and finely punctate, pubescent like head, usually distinctly sulcate medially at least basally. Scutellum large, triangular, shining, almost impunctate, impressed, apex broadly rounded. Elytra shallowly, moderately coarsely punctate becoming rugose-punctate apically, each puncture with a short, dark semirecumbent seta; apices usually with outer angles black. Thorax and abdomen shining ventrally, moderately densely, very finely punctate and pubescent. Legs more coarsely punctate than thorax and with longer pubescence; spurs of anterior and middle tibiae long, slender, acute; outer metatibial spurs usually wider than inner, flat, concave, sides parallel, apices not or very little flared, obliquely truncate; inner spurs slender, spiniform, acute or varying to flat, concave at apex, subacutely pointed. Fourth and fifth abdominal sterna broadly, triangularly impressed medially, impressions punctulate; sixth deeply, narrowly, triangularly emarginate medially with a central circular, punctulate impression.

Female: Similar to male but with apical abdominal sterna not modified except fifth which is narrowly and shallowly triangularly emarginate medially, sixth not visible. Anterior tarsi with moderately long, erect hair.

Type: Holotype male, no. 4959 in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined).

Type locality: Oregon.

Specimens examined from numerous localities including the following states and provinces: BRITISH COLUMBIA, WASHINGTON, OREGON, CALIFORNIA, UTAH, NEVADA, IDAHO, ALBERTA, MONTANA, WYOMING, and COLORADO. Marginal localities include Pueblo, Colo.; Choteau, Mont.; Medicine Hat and Scandia, Alta.; Fairmont, Vernon, and Kamloops, B. C.; Lake, Trinity, Alpine, Mono, and Inyo Counties, Calif.; Bruneau and Bear Lake, Idaho; Wells, Nev.; Salt Lake City and Logan, Utah; Atlantic City and Laramie, Wyo. It will be noted that a broad area of overlap occurs between this form and the nominate form but in the area of California, Nevada, Utah, and Colorado *dichroa* apparently occurs only at the higher elevations.

Collection dates: March 5 to September 28.

Recorded elevations: 2231 to 7200 ft. altitude.

Flower hosts of adults: Principally thistle (*Cirsium* spp.; *C. undulatum;* and *C. arvense*) but also *Helianthus* sp.; *Achillea* sp.; *Astralgalus* sp.; *Arnica;* Gandi thistle; and yarrow.

Bee hosts of larvae: Two females were reared from the cells of *Anthophora occidentalis* (Det: Krombein, 1946) at Corvallis, Ravalli County, Montana by W. L. Jellison, August 11, 1945. The specimens, with their exuviae, are in the U. S. National Museum. W. F. Barr also has reared this form from cells of *A. occidentalis.* The specimens are in the University of Idaho collections. Linsley and MacSwain (1952) suggest *Melissodes mysops* as a possible host.

N. (*Meganemognatha*) *lutea dubia* LeConte

(Figs. 4, 163)

Nemognatha dubia LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 346; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Davidson, 1907, Ent. News, vol. 18, p. 446; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 80; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 94.

Zonitis dubia, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha decipiens LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 347 (new synonymy); Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, pp. 374, 375 (as synonym of *lurida* but with exception); Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160 (as synonym of *lurida*).

Zonitis decipiens, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148 (as synonym of *lurida*); Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35 (as synonym of *lurida*); 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481 (as synonym of *lurida*).

Nemognatha lurida decipiens LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 212; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169.

Nemognatha nigra Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169 (new synonymy—error by Borchmann).

Zonitis nigra, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

This form resembles the two preceding but is characterized by greater variation in color pattern, moderately long galeae, subequal metatibial spurs, and restricted distribution.

Body surface moderately shining. Color patterns quite similar to those given for *soror* and in approximately the same frequencies.

The lectotype is entirely black; the lectoparatype is black except head, prothorax, and apical abdominal segments reddish-yellow. Pronotum shining, transverse, moderately densely punctate. Metatibial spurs characteristically subequal, elongate, flattened and concave, apices rounded. Galeae in repose extending to fourth abdominal sternum, rarely extending to apex of abdomen. Length 8-15 mm.

Male: Head moderately elongate, distance from vertex to base of labrum one sixth less than distance across tempora; tempora slightly inflated; vertex evenly rounded; surface moderately densely to densely punctate, punctures rather coarse, a short, dark seta arising from each; setae longer and denser on labrum and sides of mandibles; a small, median, glabrous area of varying extent on frons. Eyes large, elongate oval, moderately protruding, more so below than above, emarginate anteriorly. Clypeal area distinctly impressed. Labrum moderately large, one third wider than long, anterior margin evenly rounded. Mandibles stout, sides straight basally, distal halves moderately abruptly rounded to apices. Maxillary palpi long, exceeding mandibles a distance equal to length of third and fourth segments together, finely pubescent. Labial palpi long, slightly exceeding mandibles, slender, finely pubescent. Galeae stout, moderately long, in repose usually exceeding metacoxae but not attaining apex of abdomen, sparsely but uniformly clothed with erect, dark setae at least basally. Antennae about two and one-half times as long as pronotum, segments moderately flattened, each antenna with first segment moderately large, half as wide as long, moderately inflated, densely punctured and pubescent; second shorter than first, moderately inflated, punctured like first; third twice as long as second, filiform, length four times width, more densely punctate, shorter pubescent than first and second; fourth to tenth similar to third but progressively shorter than each preceding; eleventh about one third longer than tenth, apical third abruptly narrowed to apex which is subacute.

Pronotum almost quadrate, one sixth wider than long, sides almost parallel, anterior angles rounded, posterior angles slightly produced, disk usually evenly convex, feebly or not at all sulcate, moderately densely, uniformly punctate, punctures bearing setae as on head. Scutellum large, triangular, sides carinate, center impressed, densely punctate, apex broadly rounded. Elytra feebly rugose, shallowly, densely punctate clothed with short dark semirecumbent, stiff setae. Thorax and abdomen shining ventrally, moderately densely, finely punctate clothed with short, fine setae. Legs more deeply punctate and with longer setae than thorax; spurs of anterior and middle tibiae slender, moderately long, acute; outer metatibial spurs scarcely wider than inner, either thick, concave at apices, apices obliquely subtruncate or, more usually, flattened, concave, apices subacutely rounded; inner spurs flat, feebly concave, as long as outer, apices subacute. Fourth abdominal sternum broadly, triangularly impressed and punctulate medially; fifth broadly, medially impressed and punctulate, posterior margin broadly, shallowly emarginate with a small median glabrous area; sixth deeply cleft with a median, circular, punctulate impression.

Female: Similar to male but with abdominal sterna not modified except fifth which has a broad, moderately deep, triangular emargination medially; sixth usually not visible. Anterior tarsi with short to moderately long, erect hairs.

Types: Lectotype female (new designation), no. 4960 in the LeConte collection, Museum of Comparative Zoology, Harvard University. Lectoparatype (new designation) same collection, both specimens from Benicia, California (examined). Holotype female of *decipiens,* no. 4953, with a blue label (Oregon) in same collection as above (examined).

Specimens examined from numerous localities in CALIFORNIA and WASHINGTON. Marginal localities include Picture Rocks and Tieton, Wash.; Cajon Pass, Riverside, and San Diego, Calif. Some of the pale forms are exceedingly difficult to separate from *dichroa.*

Collection dates: March 20 to September 26.

Recorded elevations: Sea-level to 3000 ft. altitude.

Flower hosts of adults: Helianthus annuus; Helianthus sp.

Bee hosts of larvae: Davidson (1907) reported rearing this species from cells of *Anthidium emarginatum*; Linsley and MacSwain (1952) reported rearing it from cells of *Megachile* (*Anthemois*) *montivaga.*

I have examined the type of *decipiens* and cannot separate it from *dubia.* The specimen is a female in bad condition with both hind legs and the left middle leg missing, tarsus of the right middle leg missing, and only two tarsal segments of the left front leg remaining. The galeae and pronotum are more nearly as in *dubia* than *lurida* or *apicalis.* By LeConte's own description, the metatibial spurs were "equal and slender" which is like *dubia* but vastly different from *lurida.* Champion (1892) noted this same discrepancy.

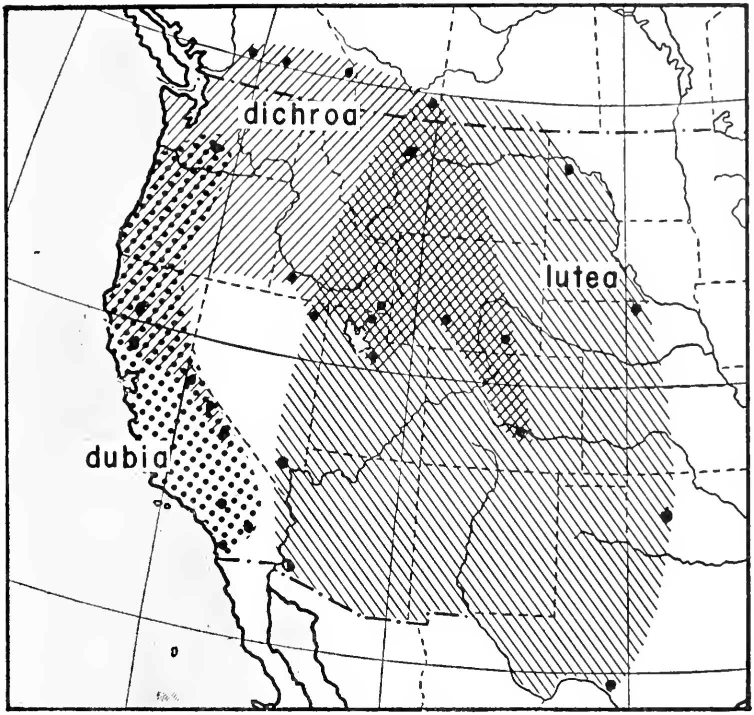

FIG. 4. Map showing the distribution of *Nemognatha* (*Meganemognatha*) *lutea*. The area of intergradation between the subspecies is indicated by the overlapping of types of shading.

Nemognatha (Meganemognatha) soror MacSwain

(Figs. 6, 167)

Nemognatha soror MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 78; Linsley & MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 100.

Nemognatha atra, Dillon, 1952, Amer. Midl. Nat., vol. 48, p. 340 (misidentification).

Closely resembling *N. dubia* but readily distinguished by its very short galeae which are only slightly longer than the head from vertex to apices of mandibles.

"Body surface shining. Six discontinuous coloration patterns are known; coloration of three commonest forms (condition of type first) with approximate frequency of each form expressed in percent: black, head, pronotum and apex of abdomen rufo-testaceous (45%); entirely black (25%); entirely brown (25%). Pubescence usually black moderately dense to sparse. . . . Legs with posterior tibial spurs unequal, outer spur slightly thicker than inner and obliquely truncate, inner spur stick-like, apically acute. . . .

Male with fifth sternite moderately and evenly convex, with a distinct median impression on posterior margin; sixth sternite deeply cleft. Female similar to male but . . . fifth sternite with a small feeble median emargination, the sixth not visible. Length 7.5-15 mm." (From original description.)

Types: Holotype male No. 6221 and allotype taken on flowers of *Achillea* sp., 4 mi. W of Quincy, Plumas Co., California, June 24, 1949, J. W. MacSwain collector (California Academy of Sciences). Ninety paratypes, same locality as holotype, various dates from June 19, 1949 to July 3, 1949 by the following collectors: P. D. Hurd, J. W. MacSwain, A. S. Deal, R. C. Bechtel, W. F. Ehrhardt, L. W. Isaak, E. I. Schlinger, H. A. Hunt, Claude I. Smith, D. Cox, and L. L. Jensen. Eighty-two paratypes representing all the color patterns and from all the type and paratype localities listed above have been examined.

Additional specimens examined: CALIFORNIA: 4 mi. W Quincy, Plumas Co.; Pinnacles, San Benito Co.; Salomon Canyon, 12 mi. SW Santa Maria, Santa Barbara Co.; Three Rivers, Tulare Co.; Blairsden, Plumas Co.; Hallelujah Jct., Lassen Co.; Graeagle, Plumas Co.; Meadow Valley, Plumas Co. BRITISH COLUMBIA: Princeton.

Collection dates: April 3 to August 12.

Flower hosts of adults: Achillea millefolium; Achillea sp.

Bee hosts of larvae: Unknown.

Dillon (1952) records a specimen of *N. atra* (Dugès) from "Texas." The specimen, which I have examined, is in the Cornell University collection. It is a female and I am unable to separate it from *N. soror* MacSwain. It is labeled "Tex.", "F. C. Bowditch collection." It is not uncommon to find specimens in old collections with only a state label and an indication of whose collection they were in. Such labels are extremely untrustworthy and I have no doubt that this specimen is correctly labeled. The specimen does not compare at all favorably with a specimen in the Champion collection labeled "*N. atra*" which agrees closely with the original description of that species.

Nemognatha (Meganemognatha) nitidula sp. nov.

(Figs. 5, 102, 166)

Related to and resembling *N. lutea* but readily distinguished by its reddish-testaceous ground color, usually vittate elytra, pale golden pubescence, more densely punctate pronotum and elytra, and male genitalia.

Body surface shining. Color uniformly reddish-testaceous except eyes, labrum, mandibles, galeae, antennae, center of scutellum, elytral vittae, and metasternum usually piceous, rarely with basal abdominal segments infuscate; tarsi, palpi, and first antennal segments fuscous. Galeae attaining apex of abdomen. Outer metatibial spurs moderately large, widened to apex, concave, moderately flared at apices; inner spurs shorter, concave, parallel-sided, apices acute or subacute. Length 7-11 mm.

Male: Head large, broadly triangular, distance from vertex to labroclypeal suture scarcely less than distance across tempora, vertex somewhat tumid, tempora moderately inflated; surface irregularly, moderately finely punctate, more coarsely so on frons, a short, suberect golden seta arising from each puncture, setae on labrum and sides of mandibles denser and longer. Clypeus moderately impressed, apical fourth glabrous, remainder coarsely punctate. Eyes large, oval, nearly twice as long as wide, feebly emarginate anteriorly. Labrum nearly one third wider than long, moderately densely punctate, apical margin evenly arcuate. Mandibles stout, moderately long, arcuate at about apical third. Palpi moderately long with sparse pale pubescence. Galeae slender, extremely long, attaining or exceeding apex of abdomen, piceous, sparsely clothed with pale setae basally. Antennae moderately long, about two and one-half times as long as pronotum, segments flattened, submoniliform, each antenna with first segment large, arcuate, inflated apically, reaching half way across eye behind emargination, shining, punctate, pale pubescent; second about one third shorter than first, inflated apically, feebly flattened, shining, punctured and pubescent like first; third one third longer than second, more flattened, feebly wider apically, densely punctulate, not shining, clothed with extremely short, fine pubescence, pubescence often absent; fourth scarcely shorter than third otherwise similar; fifth and sixth similar to fourth but scarcely shorter; seventh to tenth more moniliform otherwise like sixth; eleventh scarcely longer than tenth, widest at apical third, apex tapered, subacute.

Pronotum about one sixth wider than long, markedly convex, surface uneven, disk irregularly, rather sparsely punctate, anterior angles moderately abruptly angled from apical fourth to apex, sides somewhat rounded to basal fourth, posterior angles moderately produced, basal margin shallowly arcuate, a feeble trace of median sulcus present on basal third. Scutellum large, rather elongate, sides carinate, median portion between carinae piceous, moderately densely punctate, shining, impressed near apex, apex rounded. Elytra densely punctate, surface rugose, more densely rugose and indistinctly punctate apically, clothed with short, recumbent pale setae; margins and sutures moderately raised, vittae extending from apex almost to humeri, varying from slender and sinuate to broad and straight covering all but sutures and margins, rarely absent. Thorax and abdomen shining ventrally, moderately densely, coarsely scabrous-punctate, sparsely clothed with fine pale setae. Legs densely, coarsely punctate, finely pubescent; anterior and middle tibiae with slender, acute, spiniform spurs; metatibial spurs dissimilar, outer spurs concave, obliquely flared at apices; inner spurs parallel-sided, concave, apices acute or subacute. Fourth and fifth abdominal sterna with broad, finely pubescent punctulate areas medially; sixth medially cleft, deeply impressed at center.

Female: Similar to male but abdominal sterna not so modified, sixth with an extremely shallow, narrow, triangular emargination medially at apex. Anterior tarsi with long, erect hairs.

Types: Holotype male and allotype taken on *Cirsium* sp. in Coronado National Forest, Tucson, Arizona, 3800-4000 ft. altitude, April 3, 1953, George M. Bradt, collector. The holotype and allotype will be deposited in the American Museum of Natural History. Unless otherwise specified, paratypes of this species will be deposited in the collector's and in the author's collections and in the following institutions: U. S. National Museum; Museum of Comparative Zoology, Harvard University; University of Kansas; University of Missouri; California Insect Survey, University of California; and the California Academy of Sciences. Paratypes: Arizona: 30 males, 27 females, same data as holotype; 15 males, 10 females, Catalina foothills, Tucson, 3300 ft., April 1, 1953, on *Cirsium* sp., George M. Bradt collector; 2 males, 3 females, Tucson, May 8, 1941, R. H. Crandall collector; one female, Ash Fork, June 22, 1937, D. J. and J. N. Knull collectors; one female, Santa Catalina Mountains, May 10, 1941, R. H. Crandall collector, the above all in the Ohio State University collections; two females, Tucson, H. M. Klages collection, Carnegie Museum Acc. 11414, in Carnegie Museum; two males, one female, 32 mi. south of Prescott, June 10, 1942, H. A. Scullen collector, in Oregon State College collection; one male, Santa Catalina Mountains, 3200 ft. altitude, April 25, 1926, A8179, A. A. Nichol collector; one female, same locality, April 18, 1931 on *Carduus*, F. H. Parker collector, A8179; the last two specimens in the American Museum of Natural History; four males, eight females, Tucson, April 16, 1937, R. H. Crandall collector; three males, seven females, Santa Catalina Mts., May 10, 1941, R. H. Crandall collector; five males, Tucson, May 8, 1941, R. H. Crandall; three males, six females, Santa Rita Mts., May 15, 1941, R. H. Crandall, the preceding all in the collection of R. H. Crandall; two males, one female, Tucson, April 16, 1937, R. H. Crandall; one female, same locality and collector, March 6, 1937; two males, five females, Baboquivari Mts., 1923, O. C. Poling collector, the above all in the Cornell University collection; one male, Bright Angel Spring, Grand Canyon National Park, July 10, 1952, J. W. Tilden collector, in the San Josè State College.

Additional specimens examined but not included in the type material: ARIZONA, one female, Andreas Bolter collection, in the Illinois Natural History Survey collections; one male, Tucson, A8179, in the American Museum of Natural History.

Collection dates: March 6 to June 22.

Hosts of adults: Cirsium; Carduus.

Bee hosts of larvae: unknown.

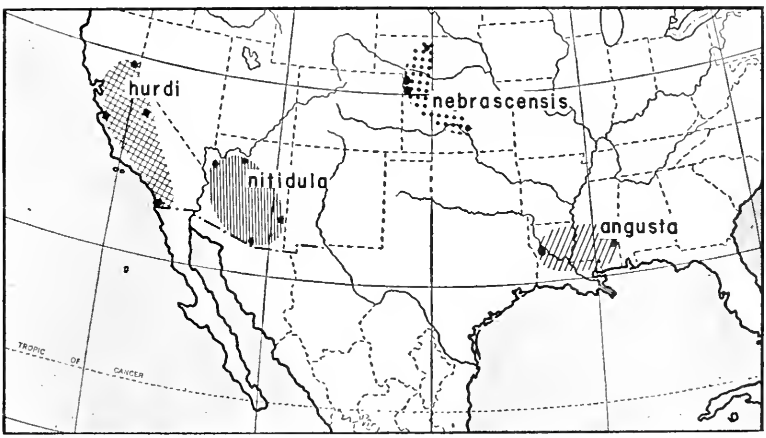

FIG. 5. Map showing the distribution of *Nemognatha* (*Meganemognatha*) *hurdi; N.* (*Meganemognatha*) *nitidula; N.* (*Pauronemognatha*) *nebrascensis;* and *N.* (*Meganemognatha*) *angusta.*

Nemognatha (Meganemognatha) explanata, sp. nov.

(Figs. 6, 66, 107, 165)

Resembles *N. lutea* but differs markedly in its reddish color; expanded posterior angles of the pronotum; fourth and fifth abdominal sterna of males tufted medially; and minor differences in the male genitalia.

Body surface moderately shining, uniformly reddish or reddish-testaceous except antennae, labrum, tips of mandibles, palpi, galeae, at least apices of femora and tibiae, and tarsi piceous. Pronotum large, transverse, posterior angles markedly explanate, basal margin broadly arcuate, disk unevenly convex, moderately densely punctate. Galeae variable but usually extending to apex of abdomen. Metatibial spurs dissimilar, outer spur usually distinctly broader and stouter than inner. Males with an erect, round or oval tuft of golden hairs medially on abdominal sterna four and five. Length 8-12 mm.

Male: Head large, varying from subtriangular to somewhat rounded (as in *nigripennis*) in cephalic aspect, distance from vertex to labroclypeal suture almost one fourth less than distance across tempora, tempora distinctly inflated, vertex feebly tumid; surface irregularly, moderately densely, coarsely punctate, a coarse semi-recumbent black seta arising from each puncture; frons usually impressed centrally. Eyes reniform, about two thirds as wide as long, protuberant, emarginate anteriorly, upper margins broadly rounded. Clypeus with base deeply impressed, coarsely punctate and hairy, apical third glabrous, shining. Labrum two thirds as long as wide, more densely punctate and hairy than clypeus. Mandibles large, stout, evenly arcuate from bases to apices, sides densely punctate and pubescent. Maxillary palpi slender, scarcely longer than mandibles; labial palpi shorter, more slender than maxillary; all palpal segments punctate and pubescent. Galeae slender, extremely long, in repose usually extending caudad as far as apices of elytra, but somewhat variable in length. Antennae moderately long, about two and one-half times as long as pronotum, segments submoniliform, somewhat flattened, each antenna with first segment stout, inflated, arcuate, extending to half the width of eye behind emargination; second more than half as long as first, inflated toward apex; first and second segments shining, moderately densely punctate and pubescent; third longer than first, twice as long as second, subcylindrical, densely punctate and pubescent, less shining than first and second; fourth to tenth similar to third but progressively shorter and feebly flattened; eleventh scarcely longer than tenth, distal third evenly, sharply tapered to apex.

Pronotum one sixth wider than long, apex shallowly emarginate; sides usually divergent or subsinuate from anterior angles to base, posterior angles broadly expanded and produced almost to margins of elytra (less markedly so in some specimens), anterior angles rounded, sides rapidly narrowed from apical fifth to apex; base broadly arcuate, feebly emarginate medially in some specimens;

disk shining, uneven, variably punctured but usually moderately densely, coarsely so, a stout black seta arising from each puncture; a short, shallow impression usually present medially on basal third, apical and basal margins narrowly but distinctly raised. Scutellum large, sides carinate; impressed, punctured and pubescent centrally, apex broadly rounded. Elytra finely, densely punctate, less densely so basally, inconspicuously clothed with short, fine, suberect, dark pubescence; sutures and margins raised except at extreme apices. Thorax and abdomen shining ventrally, moderately densely to sparsely punctate, clothed with fine, golden pubescence. Legs densely punctate and pubescent, at least inner sides, usually both sides of anterior tarsi with longer, more erect hair than remaining tarsi. Spurs of anterior and middle tibiae slender, spiniform, metatibial spurs almost similar but outer spur usually broader, stouter than inner, both concave, apices subacutely rounded or subtruncate. Fourth and fifth abdominal sterna each with a median punctulate area clothed with a tuft of moderately long, fine golden pubescence; fifth with a glabrous area medially at apex; sixth cleft to the base medially, narrowly emarginate at apex, centrally impressed.

Female: Similar to male but abdominal sterna not modified, sixth abdominal sternum usually concealed, narrowly triangularly emarginate medially at apex.

Types: Holotype male and allotype taken on *Grindelia inuloides* at Bishop, Texas, April 17, 1952, Michener, Beamers, Wille, and LaBerge collectors, in the Snow Entomological Museum, University of Kansas. Paratypes as follows: Texas: three males, five females, same data as holotype but taken on *Cirsium;* two males, same data, no host plant recorded; two females, 26 mi. SE of Eagle Pass, April 11, 1950, Beamers, Stephen, Michener and Rozens collectors; two males, two females, Brownsville, same data as holotype but no host plant recorded; one male, Lopeno, April 16, 1952, same collectors as holotype, no host plant recorded; one male, 8 mi. S of Concan, April 14, 1952, taken on *Phacelia* sp.; two males, two females, Southmost, Cameron Co., April 13, 1950, Beamers, Stephen, Michener, and Rozens collectors; four males, ten females, 21 mi. N of Laredo, April 15, 1952, on Thistle, same collectors as for holotype; three males, eleven females, San Patricia Co., April 1, 1938, W. Benedict (the above all in the Snow Entomological Museum, University of Kansas); one female, San Antonio, April 6, 1949, on *Argemone* sp., J. H. Robinson collector; one male, same locality and collector, May 19, 1949, the two preceding in the collection of R. B. Selander; one male, one female, Brownsville, April 16, 1919, E. L. Diven, sweeping; one female, "Texas", April 12, 1919, E. L. Diven; one male, Kenedy, May 4, 1896, Marlatt collector; one male, Hebronville, April 22, 1906, J. D. Mitchell, collector; the five preceding specimens in the U. S. National Museum; five females SW Hidalgo Co., locality "J", March 31, 1946, on flowers of *Verbesina encelioides*, George B. Vogt collector, in the George B. Vogt collection; one male, Austin, May 1, 1927, Carpenter collector, in the Museum of Comparative Zoology, Harvard; one female, Eagle Pass, March 28, 1946, C. D. Michener; three males, five females, McAllen, March 30, 1946, C. D. Michener, the preceding in the American Museum of Natural History; one male, one female, Eagle Pass, March 31, 1933, S. E. Jones; one female, Bexar County, April 20, 1932, H. B. Parks; one male, three females, various dates from April 20 to May 27, Taylor, Gaines and McCoy; one male, Catarina, April 11, 1933, S. E. Jones, on *Guajillo*, the preceding in Texas A. & M. College; one male, one female, Kingsville, Cornell Lot 912, C. T. Reed, in the L. S. Dillon collection; five males, two females, same data as preceding; one female, San Antonio, April 17, 1924, J. O. Martin, the preceding in Cornell University; two females, Brooks County, April 10, 1950, D. J. and J. N. Knull; one female, Comal County, May 4, 1922, Painter, the preceding in Ohio State University; one male, Corpus Christi, March 26, Spooner, in the Illinois Natural History Survey; one male, Burleson County, Summer 1931, J. K. G. Silvery; one female, Webb County, same data as preceding; one female, Edinburgh, Hidalgo County, April, 1939, S. Mulaik; one female SW Hidalgo County, locality "H", April 6, 1946, G. B. Vogt, on blossoms of *Carduus*, the preceding all in the University of Michigan; one male, "Texas", May, A. L. Melander collection; one male, "Texas", May 26, 1901, A. L. Melander collection, both in Washington State College; one male, 26 mi. SE Eagle Pass, April 11, 1950, Michener *et al.*, in the collection of J. G. Rozen.

Additional specimens: TEXAS (not included in the type material), Austin, Brownsville, Southmost, Edinburgh, Kingsville, Dryden, Brownwood, and Pharr. MEXICO, Saltillo, Coahuila.

Collection dates: March 26 to June 20.

Flower hosts of adults: Grindelia inuloides, Cirsium sp., *Phacelia* sp.; *Argemone* sp., *Verbesina encelioides, Guajillo, Carduus* sp.

Larval hosts: unknown.

Nemognatha (Meganemognatha) curta, sp. nov.

(Figs. 73, 101, 164)

Allied to *N. dubia* but readily distinguished by its smaller size, different color, and flared metatibial spurs. In addition the specimens are broader in proportion to their length.

Body surface shining. Flavo-testaceous above except for an apical, crescent-shaped, black spot at outer apex of each elytron which may be produced anteriorly into a dark vitta extending in an arc to humerus. Thorax and at least basal abdominal segments beneath piceous, some specimens with entire abdomen black. Legs testaceous becoming fulvous or black on tibiae and tarsi. Galeae in repose slightly exceeding metacoxae. Metatibial spurs dissimilar, inner spurs parallel sided, concave, rounded at tips; outer spurs broader than inner, concave, moderately flared and oblique at apices. Length 7-8 mm.

Male: Head short, broadly subtriangular, distance from vertex to labroclypeal suture slightly less than distance across tempora; tempora not inflated; surface irregularly, moderately densely punctate, punctures finer and denser near eyes and clypeal region, coarser and sparser medially on frons and tempora, often absent medially on frons, a moderately deep, median impression below vertex; a short, semirecumbent dark seta arising from each puncture. Eyes reniform, about half as wide as long, slightly protuberant, emarginate at anterior third, broadly rounded or subtruncate at apices. Clypeus transversely impressed basally, surface densely punctate except anterior margin shining, impunctate. Labrum half as long as wide, moderately densely punctate, hairy, anterior margin evenly rounded. Mandibles moderately long, stout, parallel-sided basally, abruptly angled at two thirds their length, sides densely punctured and clothed with pale hairs. Maxillary palpi long, exceeding tips of mandibles by a distance greater than length of two apical segments, moderately stout, clothed with short, fine pubescence. Labial palpi short, slender, barely exceeding mandibles. Galeae fuscous, moderately stout, in repose exceeding metacoxae. Antennae piceous, short, a little more than twice as long as pronotum each with first segment short, one third longer than wide, inflated, rather sparsely punctate and hairy; second as long as first, clavate, punctured and hairy like first; third twice as long as second, widened to apex, somewhat flattened, more densely punctured and hairy than first and second; fourth to tenth like third but successively shorter than each preceding; eleventh one third longer than tenth, widest at apical third, thence tapered to apex.

Pronotum shining, transverse, one third wider than long, evenly convex from side to side, sides evenly rounded to feebly sinuate, anterior angles more broadly rounded than posterior, apex broadly but feebly emarginate medially, base truncate, disk unevenly, sparsely punctate, punctures shallow furnished with setae similar to those on head, a feeble median sulcus on basal third. Scutellum moderately large, broad, variable in color, transversely impressed, finely punctate and with setae like those on pronotum, margins raised, apex subacutely rounded. Elytra rugose, sparsely clothed with short, dark recumbent setae, sutures and margins raised, usually flavous or testaceous with a black, crescent-shaped spot on outer apical angles which in some specimens is produced anteriorly into an arcuate vitta extending to humeri. Thorax and abdomen shining ventrally, variable in color, moderately densely, finely punctured, clothed with rather long, fine, silky pubescence which varies from pale to dark. Apical abdominal segments usually pale, at least medially. Legs variable in color but usually with coxae, trochanters, and femora testaceous, tibiae and tarsi fuscous or black; densely punctured and pubescent; spurs of anterior and middle tibiae slender, spiniform, acute; metatibial spurs dissimilar, inner spurs concave, parallel-sided, rounded at apices; outer spurs broader, concave, moderately flared at apices which are oblique, little if any longer than inner spurs. Third, fourth, and fifth abdominal sterna with median, broadly triangular, punctulate areas, sixth deeply cleft with a median basal impression.

Female: Similar to male but abdominal sterna not so modified, usually shining, moderately densely scabrous-punctate and pubescent; sixth sternum shallowly triangularly emarginate medially at apex.

Types: Holotype male, allotype, and nine paratypes (four males and five females) from Darwin, Inyo County, California, May 22, 1937, C. A. Hamsher collector, in the collection of the University of California at Davis on loan deposit at the California Academy of Sciences. Additional paratypes as follows: California: two males, Argus Mountains, Inyo County, May 22, 1937, in the California Insect Survey collections.

Hosts: unknown.

Nemognatha (Meganemognatha) meropa, sp. nov.

(Figs. 99, 168)

This species resembles *N. lutea* and *N. nitidula* but differs from both by its small size, fine pronotal punctation, pale color, usually vittate elytra, and form of the male genitalia.

Body surface moderately shining. Color flavous except eyes, antennal segments 2 to 11, labrum, apices of mandibles, extreme apices of distal palpal segments, galeae, variable proportion of thoracic sterna, tarsi, and elytral vittae when present, fuscous. Pubescence pale golden or reddish. Some specimens with scutellum and entire thoracic sternum fuscous; others entirely pale above and below except cephalic appendages. Galeae long extending beyond metacoxae almost attaining apex of abdomen. Metatibial spurs dissimilar, outer spurs larger and wider than inner spurs and moderately flared at apices; inner spurs concave, slender, parallel sided, apices subacute. Fourth abdominal sternum of males with a broad punctulate area occupying entire median area, clothed with fine silky pubesence; fifth with a similar triangular area medially broadest at base; both usually sunken in dry pinned specimens; sixth deeply cleft medially, centrally impressed. Females not so modified, sixth abdominal sternum feebly, triangularly emarginate medially at apex; anterior tarsi with short, inconspicuous erect hairs. Length 7-10 mm.

Male: Head subtriangular in cephalic aspect, distance from vertex to labroclypeal suture about one fourth less than distance across tempora, vertex evenly rounded, tempora usually not inflated; frons convex, surface moderately densely, rather uniformly, finely to coarsely punctate, most punctures separated by their own diameter, a short pale seta arising from each puncture, setae longer, denser, recumbent on labrum and sides of mandibles. Eyes oblique, reniform, less than half as wide as long, anteriorly emarginate almost at center, feebly protuberant. Clypeus triangularly impressed, densely moderately coarsely punctate except apical third glabrous, impunctate, more deeply impressed. Labrum small, transversely oval, one fifth wider than long, coarsely punctate, clothed with long pale setae, anterior margin evenly rounded. Mandibles rather short, stout, distal third of each abruptly angled mesad, sides densely punctate with long, recumbent pale setae. Maxillary palpi about as long as mandibles, moderately densely punctate and pubescent, segments flavous except extreme apices of distal segments. Labial palpi shorter than mandibles, otherwise similar to maxillary palpi.

Galeae slender, sparsely hairy, in repose extending beyond metacoxae but not attaining apex of abdomen. Antennae moderately long, about two and one-half times as long as pronotum, first segment of each pale, remainder black, all segments except first somewhat flattened; each antenna with first segment reaching half way across eye behind emargination, outer margin straight, inner arcuate, inflated, shining, sparsely punctured and pubescent; second about one fourth shorter than first, somewhat inflated distally, punctate and pubescent like first; third one third longer than second, feebly widened from base to apex, more densely punctate and pubescent, less shining than first and second; fourth to sixth subequal in length, similar to third but shorter; seventh to tenth subequal, shorter than sixth; eleventh one fourth longer than tenth, widened from base to apical third, thence sharply narrowed to apex.

Pronotum shining, usually about one sixth wider than long, widest at anterior third, outline somewhat variable, base irregularly arcuate from side to side, posterior angles moderately produced, sides constricted before base, thence widened to anterior third, broadly rounded to apex; surface moderately sparsely, finely punctate, with fine pale setae, disk evenly convex, with a feeble impression or short sulcus at basal third, apex feebly emarginate from side to side. Scutellum pale or dark, shining, sides rather sharply carinate, broadly, longitudinally impressed medially, sparsely punctate and pubescent, apex rounded. Elytra uniformly densely, moderately finely punctate and pubescent, sutures and side margins feebly raised, vittate or not, when vittate with vittae straight broadened at extreme apices to form a broad crescent shaped margin at apices extending medially from apices to basal region but not attaining bases.

Thorax and abdomen shining ventrally, thoracic sterna variable in color, fuscous to flavous, densely, finely punctate and pubescent; abdomen sparsely punctate and pubescent, fourth sternum with a broad median area densely punctulate and pubescent; fifth with a similar triangular area medially widest at base; sixth deeply cleft medially and impressed centrally. Legs densely punctate and pubescent except shallow coxal excavations glabrous. Spurs of anterior and middle tibiae slender, spiniform, acute, those of middle tibiae somewhat flattened in some specimens; spurs of posterior tibiae dissimilar, outer spurs stout, moderately flared and concave at apices; inner spurs narrower, concave, parallel-sided, apices subacute.

Female: Similar to male but abdominal sterna not so modified, sixth sternum narrowly, shallowly emarginate medially at apex. Anterior tarsi no more hairy than remaining tarsi, erect hairs short.

Types: Holotype male no. 62734, allotype, and eight paratypes, two males and six females, from Truxton Valley, Mohave County, Arizona, 4205 ft. elevation, June 15, 1906, J. Aug. Kusche collector, in the U. S. National Museum. A single female, from Yuma, Arizona, April 3, 1938, J. W. Tilden collector, is in the Tilden collection at San Jose State College, but is not included in the type material. The specimen appears to be teneral.

No host records are available for this species. Some of the specimens show varying degrees of injury from the attacks of demestids. The holotype lacks the elytral vittae.

Nemognatha (Meganemognatha) angusta, sp. nov.

(Figs. 5, 103, 169)

This species is allied to *N. explanata* but is abundantly distinct by its shorter galeae, basally narrowed pronotum, tawny color, and male genitalia.

Body surface feebly shining. Fulvous except eyes, antennae, tips of mandibles, palpi, galeae, at least extreme apices of femora and tibiae, tarsi, and variable portions of sternum fuscous or black. Galeae extending beyond metacoxae but not attaining apex of abdomen. Metatibial spurs subequal. Pronotum coarsely, irregularly punctate, sides convergent from anterior third to base. Mandibles slender, feebly arcuate. Males with feebly tufted punctulate areas medially on fourth and fifth abdominal sterna. Females with anterior tarsi bearing moderately long, erect hairs. Length 8-11 mm.

Male: Head in cephalic aspect rounded or transversely ovate, distance from vertex to labroclypeal suture subequal to distance across tempora, vertex feebly tumid, tempora feebly or not inflated; surface rather densely, coarsely punctate, a smooth carinate area medially between eyes, frons flattened or feebly concave; a short, erect, dark seta arising from each puncture. Clypeus moderately impressed, basal half punctate and setigerous, apical half glabrous. Eyes large, protuberant, less than half as wide as long, emarginate at anterior third. Labrum three fourths as long as wide, punctured, setigerous, anterior margin evenly rounded. Mandibles rather slender, long, evenly but only moderately arcuate from bases to apices, sides densely punctate and pubescent. Maxillary palpi about as long as mandibles, segments punctured and pubescent. Labial palpi scarcely more than half as long as maxillary palpi but similarly punctured and pubescent. Galeae slender, sparsely clothed with moderately long golden pubescence; in repose extending beyond metacoxae but not attaining apex of abdomen. Antennae rather short, little more than twice as long as pronotum, segments not flattened, submoniliform, each antenna with first segment reaching half way across eye behind emargination, inflated, arcuate, shining, moderately densely punctate and pubescent; second shorter than first, moderately inflated distally, punctured and pubescent like first; third nearly one third longer than second, densely punctured and pubescent, not shining; fourth to tenth similar to third but progressively shorter and somewhat narrower; eleventh one third longer than tenth, apical third sharply narrowed, apex subacute.

Pronotum nearly one fifth wider than long, widest at anterior fourth; base arcuate, feebly emarginate medially, posterior angles not produced or but feebly so, sides distinctly regularly divergent from base to anterior fourth, moderately abruptly rounded to apex which is shallowly emarginate medially; disk evenly convex, irregularly coarsely punctate, a moderately long, semirecumbent dark seta arising from each puncture, an indistinct depression medially on basal fourth. Scutellum moderately large, deeply impressed, densely punctate, clothed with long, dark setae, apex broadly rounded. Elytra densely, moderately finely punctate, clothed with short, semirecumbent reddish setae; sutures and margins raised, humeri distinct. Thorax and abdomen shining ventrally, moderately densely finely punctate, clothed with pale silky pubescence. Third abdominal sternum with an extremely small punctulate area medially at apex; fourth and fifth with a broad, transversely oval punctulate area clothed with a tuft of long, fine pubescence; sixth deeply cleft medially with a circular central impression. Legs more densely punctate and pubescent than thorax; spurs of anterior and middle tibiae long, slender, spiniform, acute; metatibial spurs somewhat dissimilar, outer spurs wider than inner, both concave, parallel-sided, apices rounded.

Female: Similar to male but abdominal sterna not so modified, sixth rather broadly, shallowly emarginate at apex. Anterior tarsi with moderately long erect hairs.

Types: Holotype male no. 3015, Leakesville, Mississippi, September 13, 1929, H. Dietrich collector, in Cornell University. Allotype, Lucedale, Mississippi, September 16, 1930, H. Dietrich collector, in Cornell University. Paratypes as follows: Mississippi: one male, same data as allotype; one male, Leaf, September 18, 1929, H. Dietrich collector; one female, Beaumont, October 2, 1930, H. Dietrich collector, the above all in Cornell University; two females, Hattiesburg, C. D. Michener collector, one dated September 17, 1944, the other October 24, 1943. Louisiana: four females, Vowell's Mill, Ac 5152, no other data. The preceding are in the American Museum of Natural History.

No host records are available.

Nemognatha (*Meganemognatha*) *bridwelli* Wellman

(Figs. 6, 93, 152)

Nemognatha bridwelli Wellman, 1912, Ent. News, vol. 23, p. 37; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 167; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis bridwelli, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Related to *N. hurdi*. This species is unique among North American nemognathine beetles in that it is densely clothed with a pale golden pilosity which almost entirely conceals the punctation especially on the elytra. The frontal interocular distance and the form of the galeae are somewhat similar to that of *N. nigripennis* but the metatibial spurs are dissimilar. In addition, the tempora are slightly inflated giving the head a more triangular appearance.

Body surface under pubescence moderately shining. Elytra flavous, galeae, scapes of antennae, and remainder of body pale testaceous except fourth and fifth abdominal sterna of males which are usually fuscous at least medially. Eyes, antennae, distal halves of mandibles, extreme apices of palpi, and last two (sometimes all but first) tarsal segments of each tarsus fuscous or piceous. Galeae attaining metacoxae. Metatibial spurs dissimilar. Length 8-10 mm.

Male: Head subtriangular, short, distance from vertex to labroclypeal suture slightly less than distance across tempora, vertex evenly rounded, tempora rounded, feebly inflated, frons convex, surface densely but finely punctate, punctation almost obscured by the long, pale recumbent pubescence, some specimens with a small glabrous area medially between eyes. Eyes moderately large, vertically oval, half as wide as long, feebly emarginate anteriorly, frontal interocular distance unusually long. Labrum short, about one third as long as wide, anterior margin evenly rounded. Mandibles moderately large, sides straight posteriorly, apical halves broadly rounded inward. Maxillary palpi relatively long, considerably exceeding mandibles, pubescent. Labial palpi short, slender, not exceeding mandibles. Galeae pale, slender, moderately long, about twice as long as pronotum, in repose barely attaining metacoxae. Antennae moderately long, about three times as long as pronotum, each with first segment moderately long, inflated; second scarcely shorter than first, somewhat enlarged apically, first and second shiny with longer, sparser pubescence than remaining segments; third twice as long as second; segments four to ten successively slightly shorter than each preceding segment, noticeably flattened; eleventh one fourth longer than tenth, flattened, tapered, apex subacutely rounded.

Pronotum transverse, one fifth wider than long, widest at anterior angles, sides slightly convergent nearly to base, then divergent; disk finely and densely punctured, more sparsely so medially, surface somewhat uneven, some specimens with a small, shallow impression on each side, pubescence like that on head. Scutellum moderately large, triangular, apex rounded, margins raised, moderately densely, finely punctate, pubescent like pronotum. Elytra densely, finely punctate or scabrous-punctate beneath the pubescence, punctation almost entirely obscured by denser, more uniform pilosity than on head or pronotum, two feebly raised longitudinal discal carinae discernible in some specimens. Thorax and abdomen shining ventrally, moderately densely, finely punctate, pubescent like pronotum but more sparsely so. Legs more densely punctured and with shorter, denser pubescence than thorax; spurs of fore and middle tibiae slender, equal, acute; metatibial spurs dissimilar, outer spurs broad, concave, slightly flared at apices, inner spurs narrow, stout, parallel-sided, bluntly rounded at apices, feebly concave. Fourth and fifth abdominal sterna with broad median punctulate impressions, sixth medially cleft and impressed.

Female: Similar to male but with abdominal sterna pale, not modified; anterior tarsi with long erect hair.

Type locality: Imperial Valley, California.

Types: "Three cotypes in the Wellman collection", location unknown to me. Described from Meloland, Imperial Valley, California, May, 1911, on Arrow-weed, taken by J. C. Bridwell.

Specimens examined: CALIFORNIA: two males, Bennett Wash, near Parker Dam, San Bernardino Co., C. D. MacNeill collector; one female, 8 mi. NW Imperial, Imperial Co., C. D. MacNeill collector; one male, Death Valley, April, 1926, J. D. Gunder collector, the above all in the California Insect Survey; one female, Death

Valley, Furnace Creek, April 6, 1936, H. Hultgren collector, in the California Academy of Sciences; one male, Indio, May 2, 1918, J. C. Bradley collector, in Cornell University; one male, Blythe, May 5, 1939, F. H. Parker collector, in F. G. Werner collection.

Collection dates: April 6 to May 5.

Flower hosts of adults: "Arrow-weed" (*Pluchea sericea* ?).

Bee hosts of larvae: unknown.

This species is rare in collections. The distribution records indicate that it is restricted to a small area in California.

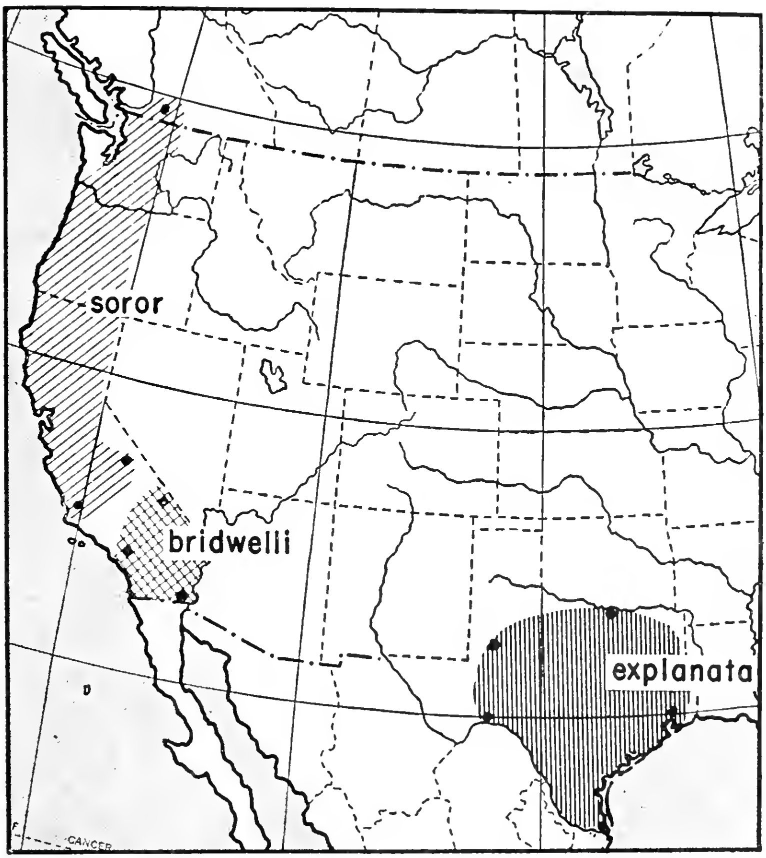

FIG. 6. Map showing the distribution of *Nemognatha (Meganemognatha) soror; N. (Meganemognatha) bridwelli;* and *N. (Meganemognatha) explanata.*

Nemognatha (Meganemognatha) hurdi MacSwain

(Figs. 5, 72, 91, 153)

Nemognatha hurdi MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 77; Linsley & MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 96.

Resembling *N. bridwelli* and *N. macswaini* but distinct from the former by the very short elytral pubescence, size, and coloration; from the latter by the pronotol characters cited in the key, the shorter galeae, usually depressed frons with vertex tumid, and stouter metatibial spurs.

Body surface feebly shining. Color flavo-testaceous to testaceous except antennae, palpi, apices of mandibles, galeae, scutellum, thoracic sterna, and variable portions of abdominal sterna fuscous or piceous. Some specimens entirely pale except appendages. Elytra densely punctulate, usually vittate or at least with apical black areas, rarely entirely testaceous. Pubescence extremely short, pale, recumbent. Galeae scarcely exceeding metacoxae. Metatibial spurs dissimilar, outer spurs thickened, feebly concave, apices rounded; inner spurs more slender, flat, apices subacute. Third, fourth, and fifth abdominal sterna of males with moderately broad, densely punctulate, finely pubescent areas medially; sixth sternum deeply cleft medially, feebly impressed. Female similar to male but abdominal sterna not so modified, sixth feebly emarginate medially at apex. Length 10-13 mm.

Types: Holotype male no. 6220, allotype, and one female paratype, taken on flowers of *Grindelia* sp., at Tesla, Alameda County, California, Sept. 18, 1945, J. W. MacSwain collector, in California Academy of Sciences. Five paratypes same data as holotype except Oct. 6, 1941 (all paratypes examined).

Specimens examined: CALIFORNIA: one male, Placerville, Eldorado County, June 30, 1949, W. F. Chamberlain; one male, Mormon Bar, Mariposa County, September 6, 1938, T. G. H. Aitken; one female, Strathmore, Tulare County, September 30, 1935, on *Hemizonia heermannii*, P. H. Timberlake, the preceding all in the California Insect Survey collections; one male, Warren, San Diego County, August 13, 1917, Ac 22618; two males, one female, Mt. Hamilton, Santa Clara County, July 21, 1933, Mont Cazier, the preceding in the American Museum of Natural History; two males, Auburn, Placer County, August 9, 1916, L. Bruner, in the University of Nebraska collection; one male, Warnersville, Stanislaus County, July, 1919, in Museum of Comparative Zoology, Harvard University; one male, Escondido, San Diego County, July 9, 1935, in University of Washington collection; one male, Marsh Creek Canyon, Contra Costa County, reared from cell of *Melissodes* sp., February 18, 1947, J. W. MacSwain and G. E. Bohart, in the California Insect Survey collections.

Collection dates: June 30 to October 6.

Flower hosts of adults: Grindelia sp.; *Hemizonia heermannii.*

Bee hosts of larvae: Melissodes robustior (Linsley & MacSwain, 1952).

Nemognatha (Meganemognatha) macswaini, sp. nov.

(Figs. 7, 63, 76, 97, 154)

Morpohologically similar to *N. hurdi* but distinguishable by its smaller average size, longer galeae, transverse pronotum usually with rounded sides, convex frons, narrower metatibial spurs, and the form of the male genitalia. In addition, its appearance early in the year sets it apart from *hurdi.*

Body surface shining, elytra of males less so due to dense punctulation. Color testaceous except elytra medially vittate in some specimens, eyes, antennae, palpi, apices of mandibles, galeae, tibial spurs, tibiae, and tarsi brown. Epimera varying from pale to brown. Pubescence pale, fine, moderately long but only moderately dense to sparse. Pronotum almost one fourth wider than long, side margins rounded or sinuate, disk sparsely finely punctate. Galeae slender, exceeding metacoxae but not attaining apex of abdomen. Metatibial spurs dissimilar, outer spurs wider, thicker than inner. Length 7-9 mm.

Male: Head in cephalic aspect subtriangular to ovate, distance from vertex to labroclypeal suture about one eighth less than distance across tempora, vertex evenly rounded, tempora feebly inflated; surface moderately densely finely punctate clothed with extremely fine pale setae, frons usually glabrous medially. Eyes large, reniform, less than twice as long as wide, emarginate anteriorly, upper margins broadly rounded. Clypeus impressed, coarsely punctured basally, apical half glabrous. Labrum one third wider than long, moderately densely, finely punctate, with a shallow fovea medially, anterior margin evenly rounded. Mandibles stout, rounded from bases to apices, in some specimens straight basally, distal third of each obliquely rounded inward; sides densely punctate, finely pubescent. Palpi slender, shining, sparsely punctate and pubescent. Galeae extremely slender, moderately long, in repose extending about midway between metacoxae and apex of abdomen, sparsely hairy basally. Antennae moderately long, almost three times as long as pronotum, segments feebly flattened, each antenna with first segment stout, inflated, reaching halfway across eye behind emargination, shining, punctate, clothed with long fine setae; second segment scarcely more than half as long as first, distal half enlarged; shining, punctured and pubescent like first; third segment twice as long as second, feebly widened from base to apex, more densely punctate, less shining, shorter pubescent than second; fourth to tenth similar to third but progressively shorter; eleventh a third longer than tenth, apical third narrowed to subacute apex.

Pronotum one fifth to one fourth wider than long, sides rounded, posterior angles feebly produced; base evenly arcuate from side to side; surface shining, irregularly sparsely, finely punctate, a long, fine, semirecumbent seta arising from each puncture, a feeble median sulcus usually extending from base to apex but variably abbreviated; some specimens with shallow fovea each side of median sulcus less than half way between base and apex, apex broadly, shallowly emarginate. Scutellum moderately large, lateral carinae distinct, surface moderately densely, finely punctate and pubescent, medially impressed; apex broadly rounded, elytra uniformly, extremely densely punctulate, clothed rather sparsely with fine, pale golden, semirecumbent setae; color usually testaceous, some specimens with broad median brown vittae extending from near subscutellar prominences to near apices, thence curving from outer margins to sutures (vittate specimens usually with scutellum also brown); sutures and margins raised except at apices. Thorax and abdomen shining ventrally, moderately densely scabrous-punctate, clothed with long, fine golden setae. Legs densely punctate, pubescent like thorax; spurs of anterior and middle tibiae moderately long, slender, spiniform; outer metatibial spurs stout, apices obliquely truncate and concave; inner spurs shorter, narrower than outer, acute, feebly concave. Fourth and fifth abdominal sterna with broad, median punctulate areas clothed with dense pubescence; sixth deeply cleft medially, centrally impressed.

Female: Similar to male but abdominal sterna not so modified; sixth feebly emarginate medially at apex; anterior tarsi with extremely short, erect hairs; elytra usually shining, shallowly punctate, not punctulate as in males.

Types: Holotype male, allotype, and five paratypes, two males and three females, Palm Springs, California, March 25, 1917, J. O.

Martin collector, in the California Insect Survey collection on loan deposit at California Academy of Sciences. Additional paratypes as follows: California: two males, Furnace Creek, Death Valley, March 3, 1951, J. W. MacSwain collector; two males same data except E. G. Linsley collector; one female, same locality, March 15, 1947, A. T. McClay collector; one male, same locality, April 1, 1951, P. D. Hurd collector; two males, one female, Andreas Canyon, Palm Springs, March 24, 1933, on *Larrea tridentata*, P. H. Timberlake collector; one male, 2 miles north of Palm Springs, March 7, 1936, on *Larrea divaricata*, P. H. Timberlake collector; one female, Mohave Desert, 10 miles south of Adelante, May 28, 1932 on *Larrea glutinosa*, P. H. Timberlake collector; one male, Palm Springs Canyon, March 7, 1924, H. S. Smith collector, the above all in the California Insect Survey collection; one male, Imperial Valley, March 17, 1919, in the U. S. National Museum; four males, Riverside County, March 27, 28, and 31, E. R. Leach collector, in the Carnegie Museum; one male, Borego Tub Canyon, March 3, 1947, John L. Sperry collector, in the F. H. Parker collection; one male, Death Valley, March 13, 1941, Van Dyke collection; one female, Little Rock, Mojave Desert, May 19, 1937, E. P. Van Duzee collector, both in the California Academy of Sciences; one male, Death Valley (Inyo County), March 28, 1950, C. D. Duncan collector, in the San Jose State College collection.

Additional specimens examined but not included in the type series distributed as follows: California: Desert Center, Edom, Hesperia, Kramer Hills, La Quinta, Needles, Oasis, Renoville, Vidal Junction, San Bernardino County. Arizona: Aztec, Congress Junction, Florence, Gila Bend, Huachuca Mts., Kingman, Sentinel, Tucson. Utah: Leeds. Texas: El Paso.

Collection dates: March 2 to May 28.

Flower hosts of adults: Larrea tridentata, L. divaricata, L. glutinosa, Encelia sp., *Covillea* sp.

Bee hosts of larvae: unknown.

In this species when the elytral vittae are incomplete they appear as vestigial stripes medially on the disks of the elytra. In *N. hurdi* when incomplete the vittae are confined to crescent shaped areas at the apices of the elytra.

Like *N. pallens*, this is a species adapted to desert conditions. It is named in honor of Dr. J. W. MacSwain of the University of California who graciously put his collection at my disposal. He had independently recognized this species, as well as two other new species here described, as being new to science.

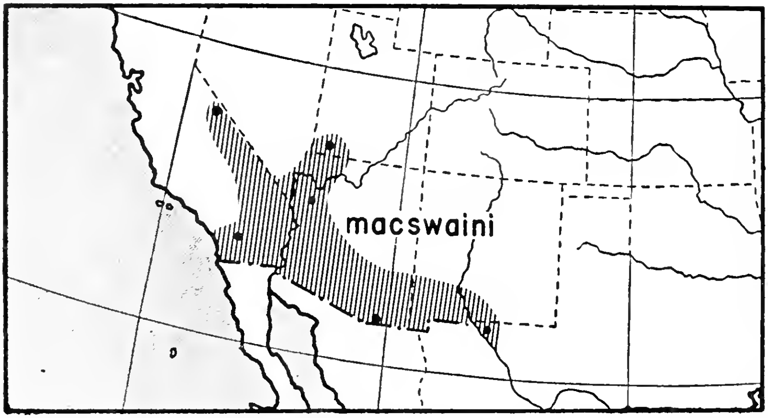

FIG. 7. Map showing the distribution of *Nemognatha (Meganemognatha) macswaini.*

Nemognatha (Meganemognatha) miranda, sp. nov.

(Figs. 8, 74, 95, 155)

Resembles *N. macswaini* but distinguishable by the shorter galeae, less rounded sides of pronotum, densely finely punctate elytra in both sexes, coarser pronotal punctation, tufted abdominal sterna of the males, and different form of male genitalia.

Body surface shining. Color pale testaceous to fulvous except eyes, antennae, apical halves of mandibles, maxillary palpi, distal labial palpal segments, tibial spurs, and tarsal segments except basal, black. Dark extremes with legs entirely black, thorax and part of abdomen and scutellum suffused with fuscous, palpi and galeae black. Galeae short, scarcely exceeding metacoxae. Metatibial spurs dissimilar, outer spurs broader than inner and with apices rounded. Males with transverse, tufted, punctulate areas medially on fourth and fifth abdominal sterna; females with moderately long erect hairs on anterior tarsi. Length 8-10 mm.

Male: Head in cephalic aspect elongate subtriangular to rounded, distance from vertex to labroclypeal suture scarcely less than distance across tempora, vertex feebly tumid, tempora moderately inflated, frons convex; surface rather uniformly, moderately coarsely punctate, an erect pale seta arising from each puncture, vertex usually somewhat less densely punctate and hairy. Eyes moderately large, protruding, markedly convex around sides of head, somewhat less than half as wide as long, emarginate at anterior third. Clypeus rather sharply impressed, irregularly coarsely punctate and hairy. Labrum about as wide as long, medially impressed, punctured and hairy like frons, anterior margin evenly rounded. Mandibles rather large, sides straight, distal half of each evenly arcuate inward, sides densely punctate and hairy. Palpi moderately long, relatively stout, densely finely punctate and pubescent. Galeae slender, sparsely hairy, in repose scarcely exceeding metacoxae. Antennae stout, short, scarcely two and one-half times as long as pronotum, segments somewhat flattened, each antenna with first segment inflated, arcuate, extending half way across eye behind emargination, shining, moderately densely punctate and pubescent; second half as long as first, moderately inflated distally, shining, punctured, and pubescent like first; third more than twice as long as second, widened from base to apex, densely punctate and pubescent, less shining than second; segments four to ten similar to third but progressively shorter; eleventh a third longer than tenth, distal third tapered, apex subacute.

Pronotum usually one fifth wider than long, sides straight but varying to feebly sinuate, widest at anterior fourth, feebly narrowed to base, sharply narrowed to apex, apex shallowly emarginate; basal margin arcuate, narrowly shallowly emarginate medially, extreme margin of base and apex raised; disk evenly convex, surface moderately densely, somewhat coarsely punctate, hairylike frons. Scutellum small, moderately densely punctate and pubescent, impressed medially, apex broadly rounded. Elytra densely, finely punctate, more sparsely so basally clothed with semirecumbent, yellow to reddish pubescence, sutures and margins raised. Thorax and abdomen shining ventrally, densely finely punctate and pubescent becoming less densely so from front to rear. Legs densely punctate and pubescent, posterior femora less so; spurs of anterior and middle tibiae slender, acute; inner spurs of posterior tibiae narrow, somewhat flattened, apices subacute; outer spurs broader and longer than inner, widened and concave distally in some specimens, apices bluntly rounded. Fourth and fifth abdominal sterna each with a transversely oval punctulate area clothed with a tuft of fine pale hairs; sixth deeply cleft medially, centrally impressed.

Female: Similar to male but elytra usually somewhat less densely punctate; abdominal sterna not so modified, sixth narrowly, moderately deeply emarginate; anterior tarsi with moderately long erect hairs.

Types: Holotype male, Madera Canyon, Santa Rita Mts., Arizona, August 26, 1952, J. W. Tilden collector. Allotype, same data as holotype except taken September 2, 1952. These will be deposited in the California Academy of Sciences. Paratypes as follows: Arizona: two males, same data as holotype except taken August 27, 1952 (Tilden collection). California: one male and one female, Indio, September 22, 1930; 14 males and 14 females, Fillmore, August 28, 1932, F. H. Parker; 11 males and 8 females, Cypress, Orange County, various dates from August 15 to October 30, 1932 to 1934, A. T. McClay collector; 5 males and 2 females, Anaheim, August 4, 1929, L. W. Saylor collector; 4 males and 4 females, Anaheim, September 15, 1930, the preceding all in the collection of Mr. F. H. Parker.

Collection dates: August 4 to October 30.

Hosts: unknown.

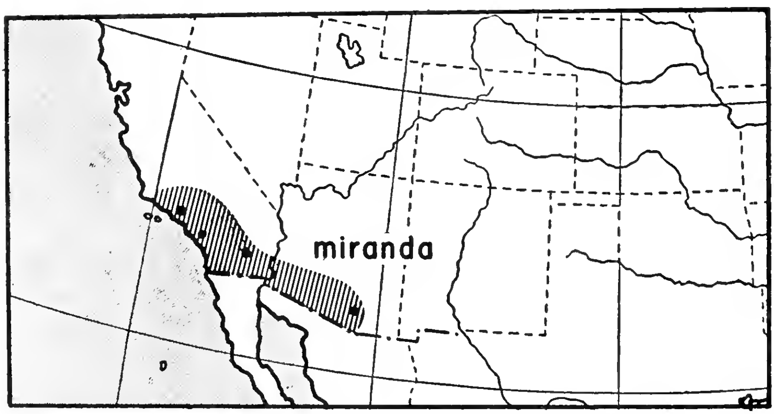

FIG. 8. Map showing the distribution of *Nemognatha (Meganemognatha) miranda.*

Subgenus PAURONEMOGNATHA, subg. nov.

North American Nemognathini, males with transversely oval punctulate areas on at least fourth abdominal sternum furnished with a tuft of fine hairs, tegmen slender, variable in outline from somewhat sinuate to straight; metatibial spurs usually slender, spiniform or somewhat flattened, apices usually acute; galeae moderately long to short.

Type: Nemognatha nigripennis LeConte, 1853.

KEY TO SPECIES OF PAURONEMOGNATHA

1. Occiput swollen, tempora broadly inflated; frons concave or flat; elytra finely extremely densely punctulate clothed with fine, short, yellow pubescence; southeastern U. S. *punctulata*
Occiput usually evenly rounded; frons convex; elytra coarsely or finely punctate, not punctulate 2
2(1). Metatibial spurs extremely slender, spiniform (rarely extremely feebly flattened and concave in *nigripennis*), apices acute; mandibles extremely short giving head in cephalic aspect a subglobose appearance 3
Metatibial spurs distinctly flattened, usually concave, apices acute or not; mandibles large, stout, head in cephalic aspect triangular or elongate ovate 4
3(2). Pronotum transversely oval, nearly a fourth wider than long; abdomen entirely piceous; eastern U. S. *nemorensis*
Pronotum scarcely wider than long, not oval; abdomen usually reddish, rarely fuscous; western U. S. *nigripennis*
4(2). Elytra uniformly finely and densely punctate clothed with long, extremely fine, suberect pale setae *capillaris*
Elytra differently punctate, pubescence dark 5
5(4). Entire ventral surface shining piceous; head piceous except vertex triangularly pale; elytra flavous or somewhat rufous usually with sutures and margins piceous at least apically *scutellaris*
Ventral surface at least partly pale; elytra with median vittae, or apical spots, margins pale 6
6(5). Second antennal segment extremely small, usually only one third as long as third; third segment longer than fourth; pronotum and elytra moderately sparsely punctate and pubescent, *cribraria*
Second antennal segment usually at least half as long as third; third segment subequal to or shorter than fourth; pronotum and elytra at least moderately densely punctate and pubescent *nebrascensis*

Nemognatha (Pauronemognatha) cribraria LeConte

(Figs. 9, 36, 111, 170)

This species resembles *N. scutellaris* but is readily distinguishable by its more uniformly colored head, irregularly punctured pronotum, blunt metatibial spurs, shorter galeae, differently modified abdominal sterna, and elytral color pattern. In addition the abdomen is pale to some extent in this species whereas it is usually entirely piceous or fuscous in *scutellaris*.

Two rather distinct geographic variants (see Fig. 9) occur and are here proposed as subspecies. The nominate form is primarily western in distribution. Aside from geographic distribution, the two forms may be distinguished as follows:

Elytra usually pale flavous each with an apical black spot, rarely with short discal vittae; elytral punctation coarse, shallow, sparse basally becoming denser apically; head usually fuscous with an oval testaceous area on frons, *cribraria cribraria*

Elytra usually vittate, often entirely black except narrow sutures and margins testaceous; elytral punctation moderately dense basally; head usually entirely piceous . . . . *cribraria fuscula*

N. (Pauronemognatha) cribraria cribraria LeConte

(Figs. 9, 36, 111, 170)

Nemognatha cribraria LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 348; 1859, The Coleoptera of Kansas and Eastern New Mexico, p. 56; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Snow, 1881, Trans. Kansas Acad. Sci., vol. 7, p. 70; 1883, *ibid.*, vol. 8, p. 43; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis cribraria, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Body surface shining. Color of head varying from fuscous to black, typically fuscous with an oval testaceous area below vertex on frons, rarely entirely testaceous above clypeus; labium and maxillae (except galeae) pale yellow. Second antennal segment extremely short, one third or less as long as third; third segment elongate, longer than fourth; segments 3 to 11 subequal, distinctly flattened. Galeae slender, short, scarcely or not exceeding metacoxae. Prothorax flavous, pronotum with or without fuscous spots on basal third, sides usually rounded from anterior angles to beyond middle, thence constricted to base, rarely sinuate. Elytra flavous with a stripe of varying length at apices, usually abbreviated into a cresent-shaped mark on apical fourth of each elytron. Fuscous or black ventrally except males with apical abdominal segments flavous, females usually with entire abdomen flavous. Metatibial spurs flattened, apices subacute, outer spurs scarcely wider than inner. Length 7-10 mm.

Male: Head above mandibles short, distance from vertex to base of labroclypeal suture one fifth shorter than distance across tempora, vertex slightly tumid, tempora somewhat inflated behind eyes; surface coarsely punctured, punctures dense on sides of mandibles and frons becoming moderately sparse on vertex, a moderately long dark seta arising from each puncture. Eyes large, convex, prominent, moderately finely faceted, twice as long as wide, emarginate at anterior third, upper margins subtruncate, extending almost to posterior angle of maxillae below. Labrum short, twice as wide as long, punctured, hairy, apex broadly, shallowly emarginate. Mandibles moderately long, sides evenly rounded from bases to apices. Maxillary palpi short, segments stout, hairy. Labial palpi extremely short, hairy. Galeae slender, hairy, short, in repose usually extending to metacoxae, scarcely more than twice as long as pronotum. Antennae stout, two and one-half times as long as pronotum, each with first segment somewhat arcuate and inflated, shining, punctured, hairy; second segment shining, punctured, hairy, half as long as first; third segment almost four times as long as second; segments four to ten subequal in length, shorter than third; segments three to eleven feebly shining, densely pubescent, distinctly flattened; eleventh segment a third longer than tenth, apex subacutely rounded.

Pronotum one fifth wider than long, widest at anterior third, anterior angles moderately abruptly rounded, sides rounded, gradually narrowed basally, varying to sinuate, base with a weak transverse impression; disk irregularly, moderately coarsely punctured, a long black seta arising from each puncture; fuscous spots when present usually on irregular, feebly raised callosities. Scutellum moderately large, shining, sparsely coarsely punctured, hairy, broadly impressed basally, apex broadly rounded. Elytra shining, sparsely, shallowly coarsely punctate basally, more finely and densely so apically, rarely becoming rugose, a black semierect seta arising from each puncture, setae usually missing; side margins raised to apex, sutures raised except at apex. Thorax and abdomen shining ventrally, finely, moderately sparsely punctured with fine dark setae arising from punctures. Legs shining, hairy, punctured except inner sides of posterior femora and shallow external excavations of coxae smooth, shining. Spurs of anterior and middle tibiae moderately long, spiniform, acute; posterior tibiae each with inner spur slightly flattened, subacute at apex, outer spur scarcely wider, more cylindrical. All spurs widely separated at bases. Third abdominal sternum usually with a small tuft of longer hairs medially at apex; fourth and fifth with median tufts of hair in large, shallow, broadly oval, punctulate impressions; fifth with a distinct deep impression medially at apex; sixth cleft medially, centrally impressed.

Female: Similar to male except fourth and fifth abdominal sterna not modified, sixth feebly emarginate at apex. Anterior tarsi somewhat more hairy than in male.

Types: Holotype male (new designation), no. 4965 from Santa Fe (New Mexico), Mr. Fendler, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Neallotype (new designation), from Santa Fe Canyon, New Mexico, 7000 ft. altitude, August, 1880, F. H. Snow, in the collection of Harvard University.

Specimens examined: NEW MEXICO: Fort Wingate; Jemez Springs; Silver City; Taos, Taos County. ARIZONA: Walnut Canyon, Coconino County. CALIFORNIA: Mt. Pinos, Ventura County. OREGON: Hereford; Summer Lake, Lake County. NEVADA: Pyramid Lake. UTAH: Eureka; Little Salt Lake; Maryvale; Parowan. COLORADO: Denver; Durango; Fort Garland; Great Sand Dunes National Monument; Ute Creek, Sage Flats. KANSAS: Gove County.

Collection dates: July 7 to September 9.

Flower hosts of adults: *Chrysothamnus* sp.

Bee hosts of larvae: unknown.

This species apparently does not occur in large numbers and is only infrequently taken. The outline of the pronotum is remarkably variable.

N. (Pauronemognatha) cribraria fuscula, ssp. nov.

(Figs. 9, 36, 110, 171)

Extremely similar to the nominate form but differing in that the elytra are usually somewhat more densely punctate, especially basally; the sides of the pronotum are straighter; the head is usually entirely piceous; the elytra usually have somewhat sinuous vittae extending from bases to apices, in some specimens the elytra are almost entirely black; the pronotum usually has two, sometimes three, basal fuscous maculae which in a few specimens are united into a transverse bar; the male genitalia are somewhat different; the host plants are different, and the range is eastern.

Types: Holotype male no. 3014, and allotype taken on Golden Aster *(Chrysopsis mariana)* at Riverhead, Long Island, New York, by Mr. Roy Latham, September 5, 1952. These will be deposited in the Cornell University collection. Paratypes as follows: New York: 10 males, 19 females, same data as holotype; 8 males, 10 females, same locality and collector, various dates from May 19 to October 7; one female, Flanders, Long Island, August 4, 1949, Roy Latham, the above distributed among the Cornell University, the collector's, and the writer's collections; one female, Yaphank, Long Island, Sept. 1, 1912, from the L. B. Woodruff collection, Acc. no. 26824, in the American Museum of Natural History; one male, one female, same localtiy, Sept. 2, 1916, Enns collection; a male, same locality, Sept. 3, 1916, from the C. W. Leng collection in the California Insect Survey collections. Virginia: two females, Falls Church, Sept. 2 and 20 respectively, from the Nathan Banks collection in the Museum of Comparative Zoology, Harvard University; three males, one female, Alexandria, Arlington County, Sept. 9, 1928, C. E. Mickel, in the University of Minnesota; one female, Great Falls, Aug. 24, H. F. Wickham, in the U. S. National Museum. Pennsylvania: two females, Jeanette, Aug. 18, H. G. Klages, Acc. no. 11414, in the Carnegie Museum. North Carolina: one male, Raleigh, mid-September, F. Sherman; one male, one female, Raleigh, early October, 1917, J. E. Eckert, both in the North Carolina Department of Agriculture collections. Michigan: one male, Cheboygan County, Aug. 14, 1931, Will Irwin collector, in the University of Michigan collections; two females, same locality, Aug. 13, 1934, in the Kansas State College collections; one male, two females, same locality, Aug. 4, 13, and 17; one female, Douglas Lake, "Sedge Pond," 1925, H. B. Hungerford, in the Snow Entomological

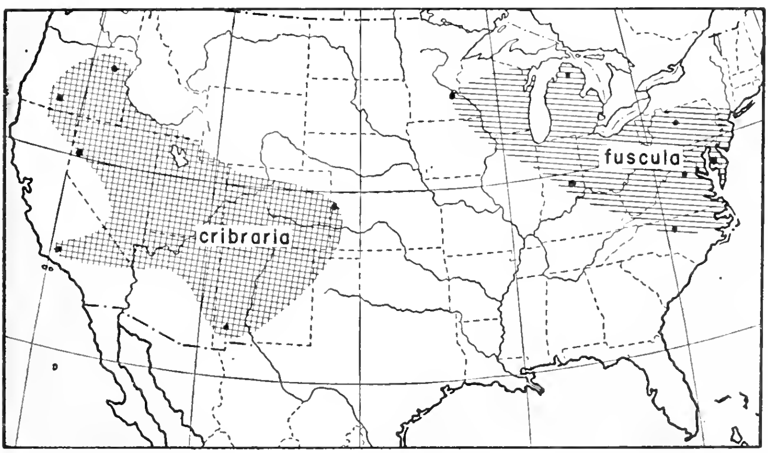

FIG. 9. Map showing the distribution of *Nemognatha (Pauronemognatha) cribraria*. The subspecies are indicated by different types of shading.

Museum, University of Kansas. Indiana: one male, Hessville, Aug. 13, 1912, E. Liljeblad, in the University of Michigan collections.

Additional specimens, not included in the type material, have been examined from the following localities: DISTRICT OF COLUMBIA: Washington. MARYLAND: "Md." MINNESOTA: Hennepin County.

Collection dates: May 19 to October 7.

Flower hosts of adults: Chrysopsis mariana.

Bee hosts of larvae: unknown.

Mr. Roy Latham of Long Island, New York, has informed me *(in litt.)* that he has on rare occasions taken this form on flowers of goldenrod (*Solidago* sp.).

Nemognatha (Pauronemognatha) nebrascensis, sp. nov.

(Figs. 5, 112, 176)

Related to and superficially resembling *N. cribraria* but easily distinguished from that species by its longer second antennal segment; more densely punctate pronotum and elytra; pronotal form; and stout galeae.

Body surface moderately shining. Color variable, usually flavo-testaceous except eyes, antennae, palpi, galeae, scutellum, thoracic sterna, and legs fuscous or reddish-black or black. Apical portions of mandibles reddish-testaceous. Elytra variable either entirely pale testaceous, or testaceous with fuscous discal vittae, or entirely black. Galeae stout, apices blunt, scarcely attaining metacoxae. Metatibial spurs similar and equal, short, widely separated at bases, feebly concave, apices bluntly rounded. Males with tufts of fine hairs on broadly oval, median punctulate areas on fourth and fifth abdominal sterna, fifth with a feeble median impression at apex; sixth deeply cleft medially with a deep, central impression. Females with abdominal sterna not so modified. Length 7-9 mm.

Male: Head short, subtriangular, distance from vertex to labro-clypeal suture scarcely shorter than distance across tempora; vertex evenly rounded or extremely feebly bicallose; surface moderately densely, coarsely punctate, more finely and densely so near eyes and antennal bases; dark, erect setae arising from punctures, an indistinct tubercle on frons between eyes, some specimens with a feeble median sulcus running from vertex to middle of frons; a feeble broad ridge connecting bases of antennae. Eyes relatively large, protuberant, little more than half as wide as long, moderately deeply emarginate at anterior third. Clypeus moderately impressed, coarsely punctate, anterior margin glabrous. Labrum about one and one-half times as wide as long, punctate, setigerous, anterior margin evenly rounded. Mandibles moderately long, stout, feebly arcuate at apical third, sides basally densely, finely punctate and pubescent. Maxillary palpi about as long as mandibles, segments stout, densely punctate and pubescent. Labial palpi about half as long as mandibles, more slender than maxillary palpi, otherwise similar. Galeae stout, short, scarcely reaching metacoxae, parallel-sided, apices bluntly rounded. Antennae about two and one-half times as long as pronotum, segments stout, mostly submoniliform, feebly flattened, each antenna with first segment not reaching half way across eye behind emargination, curved, distally inflated, shining, punctured and pubescent; second one third shorter than first, apically inflated, otherwise like first; third twice as long as second, enlarged, densely punctate and pubescent, considerably less shining than first and second; fourth similar to third but shorter, submoniliform; fifth scarcely longer than fourth otherwise similar; sixth to tenth similar to each other, subequal in length; eleventh one third longer than tenth, widest at apical third, abruptly tapered to apex.

Pronotum about a sixth wider than long, apex shallowly emarginate, sides gently rounded from apical fourth to base, posterior angles feebly or not produced, abruptly rounded to apex at anterior fourth; disk irregularly convex, surface moderately densely, finely punctate, erect dark setae arising from punctures, a distinct sulcus medially on basal half usually with a fuscous macula at its apex; posterior margin narrowly but distinctly raised, a narrow, extremely shallow emargination medially at base. Scutellum short and broad, medially impressed, sparsely punctate and finely pubescent, apex broadly rounded. Elytra moderately densely punctate becoming rugose-punctate apically, clothed with fine, dark, suberect pubescence; moderately prominent subscutellar prominences present separated from humeral ridges by a shallow furrow; sutures and margins distinctly raised except around apices. Thorax and abdomen shining ventrally, shallowly, moderately densely, finely punctate, clothed with fine usually recumbent reddish pubescence; legs more densely punctate and with shorter pubescence than thorax; anterior and middle tibiae with both spurs extremely slender, spiniform, acute; metatibial spurs similar and equal, short, stout, somewhat concave, apices bluntly rounded. Fourth abdominal sternum with a broad, transversely oval punctulate area on apical two thirds clothed with a tuft of long, fine hairs; fifth with an extremely small impression medially at apex, a broad, transversely oval punctulate area occupying basal three fourths; tufted like fourth; sixth deeply cleft medially with a round central impression.

Female: Similar to male but abdominal sterna not so modified, sixth moderately broadly, shallowly emarginate medially at apex. Pubescence of sternum usually pale. Anterior tarsi little if any more hairy than other tarsi.

Types: Holotype male, Halsey, Nebraska, July 26, 1912, J. T. Zimmer collector. Allotype, Haigler, Nebraska, July 6, 1911, J. T. Zimmer collector, both in the Snow Entomological Museum, University of Kansas. Paratypes as follows: one male, same data as allotype; one male, Imperial, Nebraska, July 1, 1911, J. T. Zimmer collector, the preceding all in the University of Nebraska; one male and one female, Sand Dunes, Medora, Kansas, July 4, 1931, R. H. Painter; one female, same data as preceding except no collector's label and dated July 4; one female, July 3, 1926, Medora, Reno County, Kansas, McColloch collector, Ac 5904, the preceding all in the Kansas State College collections.

Collection dates: July 1 to July 26.

Hosts: Unknown.

Nemognatha (Pauronemognatha) capillaris sp. nov.

(Figs. 114, 172)

This species belongs with the *scutellaris-cribraria* complex of species. The characters cited in the key will suffice to distinguish it from all others.

Body surface moderately shining. Color typically pale flavous except eyes, antennal segments 3 to 11, inner margins of mandibles, palpi, galeae, thoracic sterna, legs, and elytral vittae reddish-brown or fuscous. Elytra except vittae paler than head and pronotum. Galeae stout, scarcely exceeding metacoxae. Metatibial spurs slender, elongate triangular, concave, acute. Fourth and fifth abdominal sterna of males with median, tufted, punctulate areas. Anterior tarsi of females with short erect hairs. Length 6-8 mm.

Male: Head short, subtriangular in cephalic aspect, distance from vertex to labroclypeal suture scarcely, about one eighth, less than distance across tempora, vertex broadly, evenly rounded, tempora moderately inflated; surface rather coarsely punctate, more densely so on transverse area between eyes which is somewhat depressed, a rather long, silky seta arising from each puncture. Clypeus trapezoidal, distinctly impressed, base arcuate, apex truncate, basal half punctured and pubescent, apical half glabrous. Eyes large, protuberant, almost transverse, about as wide as long, emarginate at anterior third. Labrum scarcely wider than long, finely punctured and pubescent, anterior margin evenly rounded. Mandibles long, slender, arcuate from bases to apices, distal halves more markedly so, apices rather acute, sides basally densely punctate and pubescent. Maxillary palpi slender, as long as mandibles, segments shining but finely punctate and pubescent. Labial palpi less than half as long as maxillary palpi but similarly punctate and pubescent. Galeae stout, extremely finely pubescent, in repose extending slightly beyond metacoxae, apices moderately acute. Antennae relatively long, about three times as long as pronotum, first two segments pale, remainder dark, all segments submoniliform, not flattened; each antenna with first segment arcuate and inflated, scarcely reaching half way across eye behind emargination, shining, sparsely punctate and pubescent; second segment scarcely shorter than first, constricted basally, inflated distally, shining, punctured and pubescent like first; third almost twice as long as second, gradually widened from base to apex, extremely densely, finely punctured and pubescent, not shining; fourth to tenth similar to third but progressively shorter; eleventh scarcely longer than tenth, widened to apical fourth, thence sharply narrowed to apex.

Pronotum transverse, a fourth wider than long, base irregularly arcuate, posterior angles feebly or not produced, sides feebly divergent (sinuate in some specimens) from posterior angles to anterior third, thence broadly rounded to apex, apex broadly but shallowly emarginate; disk evenly convex except a broad shallow impression medially on basal third, surface moderately densely finely punctate, clothed with long, fine pubescence. Scutellum large, deeply impressed, moderately densely punctate and pubescent, apex broadly rounded. Elytra uniformly finely and densely punctate, clothed with long, extremely fine, suberect pale, setae, sutures and margins raised, humeri distinct, subscutellar areas somewhat inflated, vittae when present extending medially from apices to about half the length of elytra, broadest at apices, attenuate basally. Thorax and abdomen shining ventrally, moderately densely, extremely finely punctate and pubescent, fourth and fifth abdominal sterna with broad, transversely oval punctulate areas each clothed with a tuft of long, erect silky pubescence; sixth deeply cleft medially, centrally impressed. Legs shining, somewhat more densely punctate and pubescent than sternum; spurs of anterior and middle tibiae extremely slender, spiniform, acute; metatibial spurs similar and equal, elongate triangular, divergent, concave, apices acute.

Female: Similar to male but abdominal sterna not so modified, sixth moderately deeply, narrowly emarginate medially at apex. Anterior tarsi with short, erect hairs.

Types: Holotype male, allotype, and twenty-one paratypes, twelve males and nine females, from Bluff, Utah, July 7, 1935, "Gift of C. T. Brues", in the Museum of Comparative Zoology, Harvard University.

Hosts: unknown.

The dark color on the ventral surfaces is quite variable in extent.

Nemognatha (Pauronemognatha) punctulata LeConte

(Figs. 11, 42, 65, 113, 177)

Nemognatha punctulata LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 347; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1355; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis punctulata, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha flavipennis Uhler, 1855, Proc. Acad. Nat. Sci., Philadelphia, vol. 7, p. 418 (new synonymy).

Nemognatha punctulata var. *flavipennis*, LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis punctulata var. *flavipennis*, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha piezata, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 337.

The vittate members of this species, in general size and form, superficially resemble *N. piazata.* The species apparently is not very closely related to any of our other known nemognathines. Its affinities are with the *nigripennis* complex which includes *N. nigripennis; N. nemorensis; N. cribraria;* and *N. scutellaris.* It is readily distinguishable from all other forms by its extremely densely punctulate elytra, depressed frons, tumid vertex, moderately inflated tempora, only moderately long galeae, transverse pronotum, and similar, subacute metatibial spurs. LeConte's type is dark beneath, elytra with dark vittae. Uhler's *flavipennis* is apparently only a light colored form, indistinguishable from the darker forms except by the variable color pattern.

Body surface feebly shining. Color variable, head and pronotum usually testaceous. Elytra varying from yellowish-testaceous to testaceous, with or without median dark vittae, in some specimens pale tinged with fuscous apically. Eyes, tips of mandibles, antennae except basal segments, distal segments of palpi, apices of femora, bases and apices of tibiae, and entire tarsi fuscous or black. Thorax and abdomen beneath varying in color from fuscous to flavous.

Basal abdominal sterna usually dark with distal sterna pale. Some specimens with entire abdomen pale. Galeae attaining metacoxae. Metatibial spurs similar, slender, acute or subacute. Length 7.5-15 mm.

Male: Head short, broad and rounded, distance from vertex to labrum three fourths distance across tempora, vertex markedly tumid, deeply foveate in some specimens, feebly bicallose, tempora moderately inflated, margins rounded, frons markedly depressed, a feebly raised, broad, transverse ridge connecting bases of antennae, surface of head moderately densely, finely punctate becoming finely punctulate on clypeal area and labrum. Head clothed with fine, short, erect, pale setae which are longer becoming pilose on clypeal area, labrum, and sides of mandibles. Eyes large, oblong, moderately protruding, broadly but feebly emarginate at anterior third, very feebly constricted posteriorly opposite anterior emargination, finely faceted. Labrum one fourth wider than long, anterior margin evenly rounded. Mandibles stout, moderately long, evenly rounded from bases to apices. Maxillary palpi long, the two distal segments of each extending beyond tips of mandibles, slender, sparsely pubescent. Labial palpi long, extending beyond mandibles, slender, hairy. Galeae pale, at least basally, often darker distally, stout, sparsely clothed with short, erect setae, moderately long extending in repose to or slightly beyond metacoxae. Antennae stout, about four times as long as pronotum, slightly flattened, each with first segment pale, moderate in length, not attaining posterior edge of eye, gradually enlarged distally, uniformly but only moderately densely punctured and clothed with short, pale setae; second segment half as long as first, punctured like first and with short, dark setae; third twice as long as second, densely punctulate with dense, short, dark pubescence; fourth to tenth progressively slightly shorter, punctured and pubescent like the third; eleventh longer than tenth, somewhat ensiform, subacutely pointed at tip.

Pronotum transverse, about a fourth wider than long, sides feebly sinuate to straight, anterior angles rounded, disk sparsely to moderately densely, irregularly punctate, surface irregularly raised in some specimens, a feeble postmedian impression often present, clothed with extremely short, erect, pale setae. Scutellum moderately large, moderately densely punctate and pubescent, feebly transversely impressed, apex subacute to narrowly rounded. Elytra finely, densely punctulate appearing finely rugose in some specimens, clothed with short, fine, erect setae. Thorax and abdomen moderately shining ventrally, moderately densely scabrous-punctate and clothed with extremely fine, short, pale setae. Legs scabrous-punctate, densely clothed with pale setae on pale areas, dark setae on dark areas. Inner sides of middle and posterior femora, and excavations of coxae shining, glabrous. Tibial spurs usually all long, slender, acute or subacute, widely separated at bases, outer metatibial spurs in some specimens slightly broader, less acutely pointed than inner. Second, third, fourth, and fifth abdominal sterna usually with small, pale, punctulate areas medially at apices densely clothed with pale setae; sixth sternum medially cleft almost to the base with a central semicircular impression.

Female: Similar to male but with second, third, fourth, and fifth abdominal sterna not modified; sixth rather broadly, moderately deeply emarginate. Anterior tarsi little if any more hairy than others.

Types: Lectotype female (new designation), no. 4963, from Georgia, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Neallotype (new designation), same collection and data (examined). The third specimen mentioned in LeConte's original description is missing. Uhler's type of *flavipennis,* from Virginia, is not known to me.

Specimens examined: GEORGIA: Dallas; Kennesaw Mt.; St. Simons; Yonah Mt. FLORIDA: Brickell Hammock, Miami; Goulds; Key Largo; Matheson Hammock, Dade Co.; Miami, Dade Co.; Paradise Key; Stemper; Upper Matecumbe Key. ALABAMA: Delchamps; Magazine Point; Spring Hill. MISSISSIPPI: Lucedale; N. Augusta. OHIO: Buchtel, Athens Co. INDIANA: Crawford Co.; Jackson Co. MISSOURI: St. Louis.

Dates of collection: April 2 to September 27.

Flower hosts of adults: Compositae.

Bee hosts of larvae: unknown.

This is a very distinct species restricted to southeastern United States. Certain species from the West Indies and South America appear to be more closely related to it than are any of the North American species.

Judging by its size, its larval hosts must be moderately large bees although it is probably not very host specific. Not infrequently the adults are heavily laden with what appears to be their own primary larvae. Although not rare, the adults are only infrequently taken and probably never in large series. However, this may be due to inadequate collecting.

Nemognatha (Pauronemognatha) nigripennis LeConte

(Figs. 10, 46, 60, 115, 174)

Nemognatha nigripennis LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 347; 1859, Coleoptera of Kansas and Eastern New Mexico, p. 56; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Snow, 1883, Trans. Kansas Acad. Sci., vol. 8, p. 43; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 377; Schwarz, 1903, Proc. Ent. Soc. Washington, vol. 5, p. 138; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, p. 174; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Carruth, 1931, Ent. News, vol. 42, p. 55; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 98.

Zonitis nigripennis, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Resembles *N. nemorensis* but is readily distinguishable by its more elongate pronotum and short mandibles. Furthermore, this is a western species whereas *nemorensis* is eastern in distribution. The very short, evenly rounded mandibles which give the head in cephalic aspect a distinctly rounded appearance, in addition to the characters given in the key, suffice to separate this species from all others. The elytra occur in two principal color phases, reddish-black and reddish-testaceous (rufous). Intermediates also occur, principally with black areas of varying extent at the apices of the elytra.

Body surface moderately shining. Head, thorax, and abdomen testaceous to reddish-testaceous, rarely fuscous. Eyes, antennae, tips of mandibles, palpi, galeae, apices of femora, tibiae, and tarsi black. Elytra and scutellum varying from black to reddish-testaceous. Femora of some specimens entirely black. Galeae attaining metacoxae. Metatibial spurs similar, slender, acute. Length 5-10 mm.

Male: Head relatively wide, round, distance from vertex to labroclypeal suture one sixth shorter than distance across tempora, vertex somewhat tumid, tempora slightly or not at all inflated; an indistinct transverse ridge connecting bases of antennae; surface rather uniformly, moderately densely, coarsely punctate, a moderately long dark seta arising from each puncture, setae denser and longer on postocciput and sides of mandibles. Eyes reniform, two thirds as wide as long, moderately coarsely faceted, moderately protruding, emarginate anteriorly, broadly rounded at each end, frontal interocular distance unusually long. Labrum small, hairy, slightly wider than long, sides oblique, evenly rounded anteriorly. Mandibles short, evenly rounded from bases to apices. Maxillary palpi moderately long, stout, hairy. Labial palpi short, hairy. Galeae slender, attenuate, hairy, in repose attaining or surpassing metacoxae. Antennae relatively stout, three times as long as pronotum, segments somewhat flattened, filiform; each antenna with first segment moderately swollen, shining, sparsely hairy; second slightly shorter than first, shining, hairy; third to eleventh feebly shining, pubescent, third slightly more than three times as long as second; fourth to tenth subequal in length, slightly shorter than third; eleventh one third longer than tenth, tapered apically.

Pronotum one sixth wider than long, anterior angles rounded, widest at anterior angles, very slightly narrowed basally, posterior angles rounded, disk shining, rather sparsely, finely punctate, a moderately long, dark seta arising from each puncture. Scutellum moderately large, sparsely punctured, punctures bearing setae as on pronotum, shallowly impressed at center, broadly rounded at apex. Elytra shining, indistinctly shallowly rugose-punctate, clothed with moderately sparse setae which are longer and denser at apices, side margins and sutures slightly raised. Thorax and abdomen shining ventrally, finely and sparsely punctured, clothed with short fine setae of variable color. Basal abdominal sterna piceous in some males. Coxae pubescent, shallowly excavated externally, excavations smooth, glabrous. Trochanters, femora, tibiae, and tarsi shining, punctured, pubescent except middle and posterior femora which are smooth and glabrous on inner sides. Tibial spurs all short, spiniform, acute, distinctly separated at bases. Fourth and fifth abdominal sterna with median tufts of hair in broadly oval, punctulate impressions, sixth sternum medially cleft with a circular central impression.

Female: Similar to male but anterior tarsi with longer, denser hair, fourth and fifth abdominal sterna not modified, sixth broadly, shallowly emarginate.

Types: Holotype female (new designation), no. 4964, Santa Fe, New Mexico, Mr. Fendler, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Neallotype (new designation) near Hot Springs, Las Vegas, New Mexico, 7000 ft. altitude, August, F. H. Snow, in the Snow Entomological Museum, University of Kansas.

Specimens examined: Numerous localities including OREGON, CALIFORNIA, ARIZONA, NEW MEXICO, TEXAS, COLORADO, NEVADA, UTAH, and BAJA CALIFORNIA. The following localities are marginal: Mayville, Oregon; Colorado Springs, El Paso County, and Regnier, Baca County, Colorado; and Brewster County, Texas.

Collection dates: March 15 to October 21.

Recorded elevations: Sea level to 7500 ft.

Flower hosts of adults: Eriogonum sp., *E. fasciculatum, E. umbellatum, E. elongatum, Gerea canescens, Pluchea sericea, P. sericans, Erigeron stenophyllum, Aster* sp., *Solidago californica, Cirsium californicum, Chrysothamnus* sp., *Grindelia patens, G. camporum, Petalonyx thurberi, Baileya multiradiata, Chaenactis carphoclinia, Bahia pedata, Asclepias* sp.

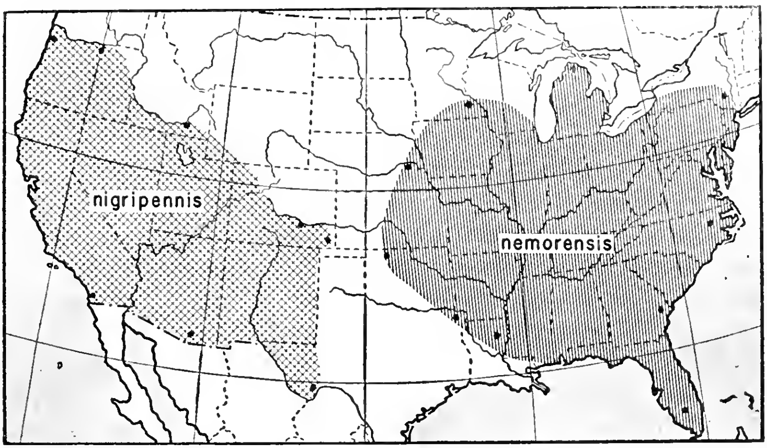

FIG. 10. Map showing the distribution of *Nemognatha (Pauronemognatha) nigripennis* and *N. (Pauronemognatha) nemorensis.*

Bee hosts of larvae: Adults have been reared from cells of *Dianthidium* sp., *Megachile pratti,* and *Megachile brevis* (Linsley & MacSwain, 1952). One female (rufous phase) was sent to me by Dr. G. E. Bohart which had emerged from a cell of *Hoplitis biscutellae* taken by Dr. Bohart from a sand cliff near Mesquite, Nevada, March 20, 1953.

This is perhaps the most commonly collected western species of the genus and is represented in practically all of the numerous collections examined. Its wide range of host plants and occurrence at considerably different elevations would seem to indicate a wider range of bee hosts than is at present known.

Nemognatha (Pauronemognatha) nemorensis Hentz

(Figs. 10, 33, 70, 175)

Nemognatha nemorensis Hentz, 1830, Trans. Amer. Phil. Soc., Series 2, vol. 3, p. 258, pl. 2, fig. 8; Le Conte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 348; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Hentz, 1884, Bull. Brooklyn Ent. Soc., vol. 6, p. 112 (reprint of original description); Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 376; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1355; Graenicher, 1910, Ent. News, vol. 21, p. 72; Sherman, 1913, Ent. News, vol. 24, p. 246; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Mutchler & Weiss, 1924, New Jersey Dept. of Agr. Circ. 76, pp. 13, 14, 17; Leonard, 1928, Cornell Univ. Memoir 101, p. 338; Brimley, 1938, The Insects of North Carolina, p. 162.

Zonitis nemorensis, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha bimaculata Melsheimer, 1847, Proc. Acad. Nat. Sci. Philadelphia, vol. 3, p. 54.

This species is related to *N. nigripennis* but is readily distinguishable by its transversely oval pronotum, totally black or fuscous abdominal sterna, and eastern distribution. In addition the males usually have a median tuft of hair in the punctulate depression on the third, fourth, and fifth abdominal sterna while in *nigripennis* these usually occur only on the fourth and fifth abdominal sterna. The females have longer erect hairs on the fore tarsi than do the females of *N. nigripennis.*

Body surface moderately shining. Head varying from flavous to ferruginous to black above, flavous to testaceous below. Eyes, labrum, tips of mandibles, palpi, and galeae black. Clypeal area, maxillae, labium, and basal half of mandibles flavous. Prothorax flavous to testaceous usually with three black spots placed transversely in a row on basal third of pronotum, spots in some specimens coalescing to form an irregular transverse fascia, or absent. Scutellum varying from black to yellow. Coxae and trochanters usually paler than remaining leg segments. Mesothorax, metathorax, legs, abdomen, and elytra black or piceous. Galeae exceeding metacoxae. Spurs of posterior tibiae slender, acute, similar. Length 5 to 9 mm.

Male: Head short, round, distance from vertex to labroclypeal suture subequal to distance across tempora; vertex evenly rounded, tempora slightly inflated; head, labrum, and sides of mandibles densely, moderately coarsely punctured, a short dark seta arising from each puncture, setae paler on pale areas and longer on labrum and mandibles. Eyes prominent, one fifth longer than wide, feebly emarginate at anterior third. Labrum small, scarcely more than half as long as wide, apex evenly rounded. Mandibles stout, evenly arcuate from bases to apices. Maxillary palpi moderately long, robust, punctured and hairy. Labial palpi short, scarcely exceeding closed mandibles, punctured and hairy like maxillary palpi. Galeae slender, hairy, in repose exceeding first abdominal segment, about three times as long as pronotum. Antennae filiform, hairy, about three times as long as pronotum, segments closely articulated, scarcely or not flattened, each antenna with first segment scarcely reaching half way across eye behind emargination, arcuate, distally swollen, moderately densely punctate and pubescent; second about half as long as first, enlarged from base to apex, punctured and pubescent like first; third scarcely more than twice as long as second, almost parallel-sided, more densely punctate and pubescent than second; fourth to tenth subequal in length, shorter than third, otherwise similar to third; eleventh scarcely longer than tenth, apex subacutely pointed.

Pronotum a fourth wider than long, side margins rounded, widest at anterior third, somewhat narrowed basally, base feebly transversely arcuate, disk moderately densely, shallowly punctured, punctures finer and denser at posterior angles, a moderately long dark seta arising from each puncture, a feeble transverse impression at apex and base. Scutellum moderately large, visible portion usually extremely small, transversely impressed near apex, finely, sparsely punctured and pubescent, apex rounded. Elytra finely rugose, moderately densely uniformly clothed with dark hairs, sutures and margins slightly raised, disk with three feebly raised costae about equi-distantly arranged on each elytron, not attaining apex. Thorax and abdomen shining ventrally, shallowly, finely, moderately densely punctate, thinly clothed with fine, moderately long pubescence. Legs shining, punctured, hairy, except inner sides of middle and posterior femora and shallow external excavations of coxae which are smooth, shining. Tibial spurs all slender, spiniform, apices acute, bases widely separated. Third, fourth, and fifth abdominal sterna with median tufts of hair in shallow, broadly oval, densely punctulate impressions, fifth feebly impressed medially at apex; sixth deeply cleft medially, broadly impressed at center.

Female: Similar to male except abdominal sterna not so modified, sixth feebly emarginate medially at apex. Anterior tarsi with long erect hairs.

Types: The present location of the type is unknown to me and presumably lost. The species was described from a single specimen and the type locality as given in the original description is "the woods of North Carolina . . . found in May." The type of *bimaculata* also is lost.

Neotype male, neallotype, and two neoparatypes, one male and one female (new designations), taken at Adel, Georgia, August 11, 1939, R. H. Beamer collector, in the Snow Entomological Museum, University of Kansas.

Distribution records of specimens examined: NORTH CAROLINA: Raleigh; Moncure. SOUTH CAROLINA: "S. C." GEORGIA: Adel; Okefenokee Swamp. FLORIDA: Clearwater; Dunedin; Enterprise; Gainesville; Gulfport; Jacksonville; Lake Mary; Melbourne; Orlando; Sanford; Tampa. ALABAMA: Calvert; Grand Bay; Magazine Pt., Mobile. VIRGINIA: "Va." PENNSYLVANIA: Allegheny; Pittsburgh; Jeanette. MARYLAND: "Md." NEW JERSEY: Lakehurst; N. Lisbon; Tuckahoe. OHIO: Swann Twnp., Lucas Co. MICHIGAN: Isabella Co.; Cheboygan Co.; Midland Co. MINNESOTA: "Min." ILLINOIS: Kahokia. MISSOURI: Big Spring State Park; Branson; Columbia; Edgar Springs; Eldon; Fern Glen; Florence; Forsythe; Jefferson City; Noel; Ranken; St. Louis; Shannon Co.; Van Buren; Vichy. NEBRASKA: "Neb." INDIANA: Crawford Co. ARKANSAS: Fayetteville; Washington Co. KENTUCKY: Crail Hope. MISSISSIPPI: Lucedale. LOUISIANA: Vernon Ph.; Vowell's Mill. TEXAS: Karnack. OKLAHOMA: Alfalfa Co.; Atoka; Bryant; So. McAlester.

Collection dates: April 10 to September 8.

Flower hosts of adults: Rudbeckia sp.; *Erigeron* sp.; *Eupatorium* sp.; *Helianthus* sp.

Bee hosts of larvae: Unknown.

As its name indicates, this species is most frequently collected near wooded areas. Little is known of its life history. In the Harvard University collection is a single female specimen from the Banks collection labeled "Florida," and on the pin is included a pupal case in a resinous bee cell.

Four clusters of eggs of this species were obtained July 2, 1954 near St. Louis, Mo.; they were laid on the bracts of *Rudbeckia.* The clusters average about 25 eggs each. Two clusters hatched in four days, the other two in five days. The eggs are pale yellow in color, otherwise quite similar to those of *N. lurida* except perhaps somewhat smaller.

Nemognatha (Pauronemognatha) scutellaris LeConte

(Figs. 11, 44, 57, 116, 173)

Nemognatha scutellaris LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 347; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 377; Davidson, 1907, Ent. News, vol. 18, p. 446; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 160; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 91.
Zonitis scutellaris, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.
Nemognatha apicalis, Linsley and MacSwain, 1942, Amer. Midland Nat., vol. 27, pp. 403, 405, 414 (misidentification).

This species is most closely related to *N. cribraria* but is readily distinguishable by its uniform, moderately sparse pronotal punctation, piceous legs and abdomen, black elytral margins, predominantly black head, and abdominal modifications of the males.

Body surface moderately shining. Color variable but usually with head black except for an occipital area of varying extent which is luteous or pale ferrugineous. Labium, except palpi, pale. Pronotum pale yellow to reddish testaceous, some specimens with vague indications of darker spots on disk. Scutellum dark brown or black. Elytra pale yellow to reddish testaceous usually with apical margins and suture narrowly black for two thirds their length, some specimens with no black markings on elytra. Legs and entire ventral surface piceous or fuscous. Galeae attaining metacoxae. Spurs of posterior tibiae slender, similar, feebly concave, apices acute. Length 5-10 mm.

Male: Head triangular, short, distance from vertex to labrum subequal to distance across tempora; vertex evenly rounded or very slightly inflated, tempora usually distinct; head uniformly, moderately densely and moderately coarsely punctate, punctures coarser and sparser between antennal bases with a fine, moderately long dark seta arising from each puncture. Eyes moderately large, three times as long as wide, prominent, feebly emarginate at anterior third. Labrum moderately large, one third wider than long, apex evenly rounded or feebly impressed. Mandibles straight for two thirds their length basally, abruptly rounded inward for one third their length distally. Maxillary palpi long, one and one-half times as long as mandibles, hairy, punctured and pubescent. Labial palpi about as long as mandibles, hairy, punctured and pubescent. Galeae moderately long, about two and one-half times as long as pronotum, in repose attaining metacoxae, hairy, moderately slender. Antennae filiform, moderately slender, about two and one-half times as long as pronotum, each with first segment swollen, moderately long, two times as long as second, shining, clothed with long, fine setae; second segment small, one third as long as third, shining, similarly setigerous; third slightly longer than fourth, more feebly shining than first and second and with denser, shorter setae; segments four to ten subequal, each slightly shorter than third, hairy like third; eleventh longer than tenth, apical third tapering to a subacute tip.

Pronotum transverse, one sixth wider than long, angles rounded, disk uniformly, moderately sparsely, moderately coarsely punctate, a fine dark moderately long seta arising from each puncture, feeble indications of transverse impressions at base and apex. Scutellum moderately large, medially impressed, densely punctured, hairy, apex rounded. Elytra moderately densely, uniformly, shallowly rugose-punctate, a short dark, semirecumbent seta arising from each puncture, humeri distinct, margins and suture slightly raised. Thorax and abdomen shining ventrally, finely moderately sparsely punctate, thinly clothed with short, fine setae. Legs shining, finely, moderately densely punctured, clothed with short, appressed hairs which are longer on posterior margins of femora and trochanters. Coxal excavations smooth, shining, punctured, not hairy. All tibial spurs moderately long, slender, spiniform, acute, spurs of posterior tibiae on some specimens with outer spur slightly broader than inner. Second abdominal sternum with a very small median tuft of hairs at base; third with a larger tuft of hairs on a central punctulate area; fourth broadly triangularly emarginate medially at apex with a broader tufted punctulate area occupying apical two thirds; sixth usually largely concealed but sharply arcuate downward, medially cleft, deeply impressed centrally.

Female: Similar to male but with abdominal sterna not so modified, and usually more shining, less densely punctate. Anterior tarsi little if any more hairy than in male.

Types: Lectotype female (new designation) no. 4966, from Sacramento, California, J. Child collector, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). This specimen is somewhat rufotestaceous, the black elytral margins extremely narrow. The right hind leg is missing. Neallotype (new designation) Placer County, California, June, Koebele collection, in the California Academy of Sciences.

Specimens examined: Numerous localities including CALIFORNIA, OREGON, WASHINGTON, IDAHO, NEVADA, UTAH, ARIZONA, COLORADO, WYOMING, NEBRASKA, and SOUTH DAKOTA. The following localities are marginal: Miner's Ridge, Mt. Baker National Forest, Washington; Moscow, Idaho; Pine Bluff, Wyoming; Custer, South Dakota; Dawes and Sioux Counties, Nebraska; Denver, Colorado; Littlefield and Santa Catalina Mountains, Arizona; Imperial and San Diego Counties, California. This species is most abundant in California, relatively scarce in other states, but nonetheless widely distributed.

Collection dates: February 27 to October 27.

Recorded elevations: sea-level to 9000 ft.

Flower hosts of adults: Eriogonum sp.; *Calyptridium umbellatum; Malacothrix sonchoides; M. glabrata; Layia glandulosa; L. elegans; Godetia* sp.; *Achillea millefolium; Erysimum* sp.; *Ericameria cooperi; Asclepias* sp.; *Monardella exilis; Anisocoma acaulis; Eriophyllum lanatum; Chaenactis fremontii; C. glabriuscula.*

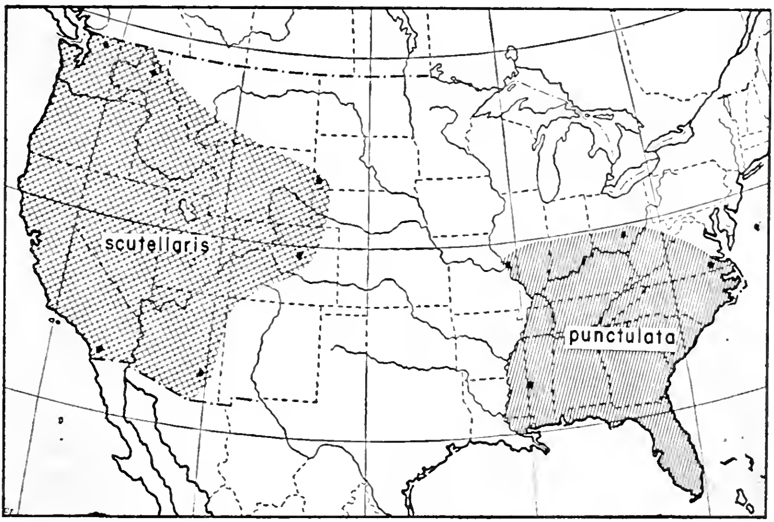

FIG. 11. Map showing the distribution of *Nemognatha (Pauronemognatha) scutellaris* and *N. (Pauronemognatha) punctulata.*

Bee hosts of larvae: Anthophora linsleyi; Ashmeadiella sp.; *Callanthidium illustre; Osmia laeta; Hoplitis producta* ssp.; *Hoplitis sambuci; Hoplitis uvalalis; Osmia lignaria; Osmia pikei; Osmia* sp.; *Alcidamea* sp.; *Xylocopa* (?) sp. (*Cf.* Linsley and MacSwain, 1952).

The females are remarkable in having the styli of the genitalia sclerotized to form a distinct ovipositor, visible in some pinned specimens when extruded. Linsley and MacSwain (1952) have recorded the fact that this species is unusual in that the eggs are inserted among the florets of the host plants rather than on the phyllaries where most other members of the genus deposit their egg masses.

The distribution appears to be considerably more extensive than Linsley and MacSwain indicated.

Subgenus NEMOGNATHA Illiger

North American Nemognathini, males with fourth and fifth abdominal sterna medially excavated; tegmen stout, apex recurved; metatibial spurs elongate, concave, similar and equal or feebly dissimilar; galeae moderately to extremely long.

Type: Nemognatha piazata (Fabricius), 1798.

KEY TO SPECIES OF NEMOGNATHA

Black above and below except pronotum and upper half of head flavous; elytra densely clothed with long, erect pubescence; galeae moderately long; males with deep, elongate oval excavations medially on fourth and fifth abdominal sterna . . . . *bifoveata*

Elytra usually at least in part testaceous, often vittate, moderately densely clothed with short recumbent pubescence, galeae often extremely long; males with parallel-sided median excavations on fourth and fifth abdominal sterna, *piazata*

Nemognatha (Nemognatha) bifoveata, sp. nov.

(Figs. 12, 61, 117, 182)

Allied to *N. piazata* but readily distinguished from that species by its shorter galeae, shorter metatibial spurs, erect elytral pubescence and sparser punctation, different color pattern, and deep, elongate oval foveae on the fourth and fifth abdominal sterna of the males.

Body surface moderately shining. Piceous or black except occiput and pronotum which are flavous; distal two thirds of head fuscous. Galeae attaining metacoxae; metatibial spurs subequal, short; male with fourth and fifth abdominal sterna each with a large, deep fovea medially, foveae densely clothed with long fine setae; sixth sternum deeply cleft medially with a basal impression. Female abdominal sterna not modified. Length 6-12 mm.

Male: Head narrowly triangular, distance from vertex to labroclypeal suture slightly less than distance across tempora, tempora only moderately inflated; surface moderately densely, coarsely punctate, punctures finer and denser on clypeus and near eyes, sparser or absent medially on frons, a moderately long, fine dark seta arising from each puncture, setae erect except on labrum and sides of mandibles where they are denser, paler, and recumbent. Eyes reniform, protuberant, oblique, less than half as wide as long, feebly emarginate at anterior third. Clypeus as in *piazata*. Labrum a third wider than long, moderately densely, coarsely punctate, anterior margin evenly rounded. Mandibles moderately long, stout, outer margins evenly rounded from bases to apices. Maxillary palpi long, slender, hairy, exceeding tips of mandibles a distance equal to combined length of last two palpal segments. Labial palpi small, short, barely attaining tips of mandibles. Galeae slender, in repose attaining or slightly exceeding metacoxae. Antennae long, about two and one-half times as long as pronotum, slightly flattened, each with first segment short, barely attaining one third width of eye, slightly inflated, moderately densely punctured and clothed with short, dark pubescence; second subequal to first but not inflated, similarly pubescent; third slightly more than twice as long as second, more densely punctulate and with shorter pubescence than second; fourth similar to third but slightly shorter; fifth to tenth subequal to fourth but progressively barely shorter than each preceding; eleventh almost one and one-half times as long as tenth, apex rounded.

Pronotum shining, somewhat variable in outline but usually about one fifth wider than long, sides subparallel at middle, oblique from anterior fourth to apex, abruptly rounded at posterior angles; disk sparsely but rather uniformly coarsely punctate, a long, fine erect seta arising from each puncture; usually subcarinate medially on apical half, some specimens with a feeble sulcus medially on basal third. Scutellum usually pale basally becoming shiny, piceous apically, a dark median impression basally, a circular impression subapically, more finely punctured than pronotum but with similar pubescence, apex broadly rounded to subtruncate. Elytra moderately densely but shallowly punctate, punctures not contiguous, becoming scabrous-punctate at extreme apices; densely clothed with erect, dark setae; sutures and margins raised. Thorax and abdomen shining ventrally, moderately densely, finely punctate, clothed with short, fine pubescence. Coxae sparsely punctured, shining, cavities glabrous; remainder of legs densely punctured, densely clothed with short dark pubescence. Spurs of anterior and middle tibiae slender, acute, equal; metatibial spurs short, subequal, somewhat flattened, apices subacute. Fifth and sixth abdominal sterna with deep, circular median cavities densely lined with long, fine hairs projecting inward to a common center; sixth deeply cleft medially with a round, basal impression, lobes finely and densely punctulate, hairy.

Female: Similar to male but fourth and fifth abdominal sterna not modified, sixth not visible. Thorax and abdomen ventrally only indistinctly punctate. Anterior tarsi of both sexes similar, very slightly, if any more hairy than other tarsi.

Types: Holotype male taken at College Station, Brazos County, Texas, May 20, 1933, by H. J. Reinhard, deposited with the allotype and several paratypes in the collection of Texas A. & M. College; allotype and three paratypes, two males and one female, same data as holotype. Thirty-three additional paratypes as follows: Texas: six males, five females, same locality as holotype, various dates from May 13 to June 19, 1919 to 1933, H. J. Reinhard and J. C. Gaines, collectors; three males, four females, Taylor, Williamson Co., various dates, May 4 to June 20, 1928, Gaines and McCoy collectors, all the above in the collection of Texas A. & M. College. One male, two females, Eastland Co., Grace O. Wiley, collector, June 3-12, 1921, in the University of Minnesota collections. One male, Harris Co., May, 1909, R. Oertel collector; one female, Mexia, Limestone Co., May 17, 1908, R. A. Cushman collector; one male, one female, Mineral Wells, Palo Pinto Co., June 9, 1908, on *Monarda,* C. R. Jones collector; one male, Grand Prairie, Dallas Co., June 19, 1905, C. R. Jones collector ("Hunter no. 692"), the preceding five specimens in the U. S. National Museum; one female, Fedor, Lee Co., June, H. Klages collection, C. M. Acc. 11414, in the Carnegie Museum collection; one female, Dallas, in the Rutgers University collection; one male, Brazos County, June 27, 1929, K. L. Maehler collection; one female, Liberty Hill, Williamson Co., June 17, 1936; K. L. Maehler collection, the preceding two specimens in the California Insect Survey collections; two males, one female, Romney, Eastland Co., June 30, 1936, R. H. Beamer collector, in the Snow Entomological Museum, University of Kansas; one female, Fedor, Lee Co., June 18, 1899, in the G. W. Bock collection, at the University of Missouri; one male, Quemado, Maverick Co., May 25, 1952, Cazier, Gertsch, Schrammel, in American Museum of Natural History.

The following additional specimens of this species were examined but are not included in the type series: TEXAS: Dimmit Co., Bexar Co., Clarendon, Sabinal, Goliad Co., Camp Wolters, Corpus Christi, Raymondsville, Goliad. UTAH: Emory Co. CALIFORNIA: "Cal." NEW MEXICO: East of Rowe. KANSAS: Belvidere, Cowley Co., 1114 ft., Chautauqua Co., 841 ft.

Collection dates: April 17 to August 8.

Flower hosts of adults: Monarda sp.; *Monarda citriodora; Monarda pectinata; Monarda punctata;* Cats Claw; Daisy; Horsemint.

Bee hosts of larvae: unknown.

This species seems to be quite distinct. It is unusual among nemognathines in two respects, first, that there is extremely little color variation, and second, that the adults occur on *Monarda.* This is the only species known to me which feeds on that genus of plants.

The specimens labeled "Cal." and "Ari." in the Minnesota collection may have been mislabeled. Further collecting in those States and in Mexico is needed before the range can be accurately delimited.

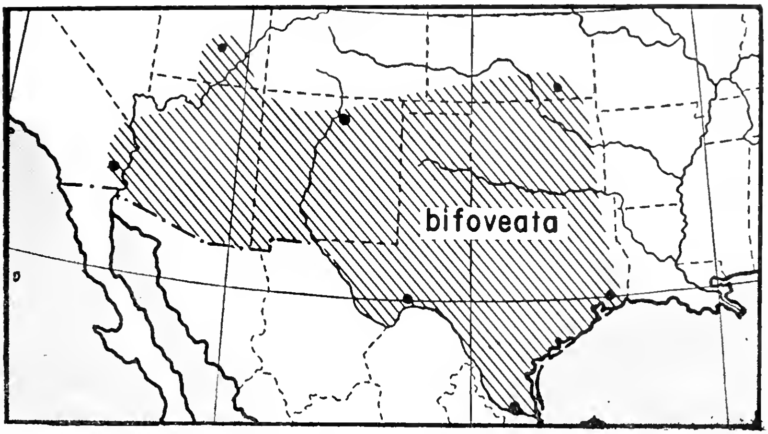

FIG. 12. Map showing the distribution of *Nemognatha (Nemognatha) bifoveata.*

Nemognatha (Nemognatha) piazata (Fabricius)

(Figs. 13, 35, 41, 56, 89, 118, 178)

This species is the type of the genus, Illiger specifically stating that the genus was erected for Fabricius' *Zonitis vittata (= Z. piazata).*

The species seems to be divided into three geographic variants here treated as subspecies. In 1853 LeConte described three forms as species *(bicolor, palliata, texana)* and in 1858 another *(discolor),* the last two named proving to be color variants. In 1880 LeConte himself reduced these two to the status of "variety" and indicated that the remainder were probably the same as *piazata.* The remaining two names are here used to designate the subspecies.

Nominate *piazata* appears to be restricted to the southeastern Atlantic States and is a member of the peculiar fauna found in that region. A midwestern form *(palliata)* occurs in a narrow zone from Missouri to Minnesota. The westernmost form *(bicolor)* occupies the most extensive range extending from Mexico to Canada, principally west of the 100th meridian, but apparently does not occur on the West Coast.

The three subspecies are readily distinguishable, aside from their geographic distribution, by Table IV.

TABLE IV. Key to subspecies of *N. (Nemognatha) piazata*

Form	Length of galeae	Metatibial spurs	Pronotal form	Elytral color	Frons
piazata	between metacoxae and apex of abdomen	similar and equal	irregularly quadrate, usually transverse	entirely pale to vittate	feebly impressed; usually convex
palliata	between metacoxae and apex of abdomen	dissimilar; inner narrower than outer	short; evenly widened from anterior to posterior angles	entirely pale to vittate	impressed
bicolor	to apex of abdomen	similar and equal	irregularly quadrate, usually transverse	entirely pale to entirely black; head reddish	feebly impressed; usually convex

N. (Nemognatha) piazata piazata (Fabricius)

(Figs. 13, 35, 41, 56, 89, 118, 178)

Zonitis piazata Fabricius, 1798, Supplementum Entomologiae Systematicae, p. 104.
Zonitis vittata Fabricius, 1801, Systema Eleutheratorum, vol. 2, p. 24; Coquebert, 1804, Illustratio Iconographica Insectorum, vol. 3, p. 128, t. 29, fig. 5; Latreille, 1804, Histoire naturelle, générale et particuliere des Crustacés et des Insectes, part 10, p. 407.
Nemognatha vittata, Illiger, 1807, Magazin für Insektenkunde, vol. 6, p. 333; LaPorte, 1840, Histoire naturelle des Insectes Coléoptères, vol. 2, p. 380; LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 347.
Nemognatha piezata, LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 347; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1355; Graenicher, 1910, Ent. News, vol. 21, p. 74; Sherman, 1913, Ent. News, vol. 24, p. 247; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Brimley, 1938, Insects of North Carolina, p. 162.
Zonitis piezata, Weber, 1801, Observationes Entomologicae, p. 60; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.
Nemognatha vittigera, Brimley, 1938, Insects of North Carolina, p. 162 (misidentification).

Body surface somewhat shining. Color pattern variable, typically testaceous except elytra with black median vittae, ventral surface extremely variable from entirely pale testaceous to piceous.

Elytra varying from entirely pale to vittate. Head and pronotum varying from entirely pale to entirely black. Galeae long but usually not attaining apex of abdomen, often quite short scarcely exceeding second abdominal sternum. Metatibial spurs similar and equal. Males with fourth and fifth abdominal sterna excavated medially. Females with long erect hairs on fore tarsi, sixth abdominal sternum narrowly, moderately deeply, triangularly emarginate medially at apex. Length 7-13 mm.

Male: Head large, triangular, distance from vertex to labroclypeal suture one sixth less than distance across tempora; tempora moderately inflated; vertex slightly tumid; frons between eyes usually shallowly impressed; surface moderately densely, coarsely punctate, punctures finer and denser on vertex and clypeus, sparser on tempora; a short dark seta arising from each puncture, setae longer and denser on labrum and sides of mandibles, some specimens with a median impunctate area on frons, clypeus impressed, with a narrow, glabrous, transverse area above labro-clypeal suture. Eyes elongate oval, somewhat oblique, less than half as wide as long, emarginate anteriorly at upper third, feebly protuberant, finely faceted. Labrum two thirds as long as wide, rather sparsely, finely punctate, anterior margin evenly rounded. Mandibles stout, sides densely punctate and pubescent basally two thirds their length, apical third of each glabrous, abruptly rounded to apex. Maxillary palpi slender, sparsely pubescent, in repose exceeding apices of mandibles by part of second and entire third and fourth segments. Labial palpi shining, sparsely, finely punctate and pubescent, exceeding mandibles by length of apical segment. Galeae variable in length, in repose usually not attaining apex of abdomen, moderately slender, clothed basally at least with sparse, suberect, pale setae. Antennae almost three times as long as pronotum, segments distinctly flattened, each antenna with first segment slightly inflated, half as wide as long, densely punctate, short pubescent; second scarcely shorter than first, punctured and pubescent like first; third almost twice as long as second; fourth to tenth like third but progressively shorter than each preceding; eleventh one fourth longer than tenth, widest at apical third, thence tapered to apex which is subacute.

Pronotum variable, usually almost a sixth wider than long, usually widest at anterior angles, almost imperceptibly narrowed to base, anterior fourth of sides oblique to apex which is feebly emarginate, posterior angles abruptly rounded, base subtruncate; disk evenly or somewhat irregularly convex, more convex from side to side than from apex to base, moderately densely, rather coarsely, uniformly punctate, punctures shallow, each with a short, erect dark seta; a shallow median sulcus on basal third. Scutellum moderately large, triangular, densely punctate, finely pubescent, medially impressed, apex rounded. Elytra moderately densely, finely punctate or scabrous-punctate clothed with short semirecumbent dark setae. Thorax and abdomen shining ventrally, finely and sparsely punctate and pubescent, more densely so anteriorly on thorax. Legs densely punctate and pubescent except coxal excavations and middle and posterior femora internally glabrous. Spurs of anterior tibiae moderately long, spiniform, acute. Spurs of middle tibiae somewhat flattened, slightly curved, acute. Metatibial spurs subequal, somewhat flattened, concave, apices subacute or rounded. Fourth and fifth abdominal sterna with broad, median elongate parallel-sided excavations which are densely punctulate and lined with long, silky hairs; fifth with a small, median triangular area at apex which is glabrous; sixth deeply cleft medially with a semicircular impression at base.

Female: Similar to male but with fourth and fifth abdominal sterna not modified, sixth usually not visible; anterior tarsi with long erect hairs.

Types: Dr. S. L. Tuxen of the Universitetes Zoologiske Museum, Copenhagen, has informed me *(in litt.)* that the type is probably in the Bosc collection in the Paris Museum. In the original description (1798) Fabricius only states the name of the collector but in 1801 he states "Mus. Dom. Bosc" indicating that it is or was in Bosc's collection. Dr. Tuxen further informs me that in Fabricius' own collection in the Museum of Kiel are two specimens of this species, labeled presumably in Fabricius' own handwriting with the specific epithet spelled "*piazata*". I propose, in accordance with Article 19 of the International Rules, to retain the original orthography as it appears in the original description.

Dr. Pierre E. L. Viette of the Museum National d'Histoire Naturelle, Paris, in cooperation with coleopterists at that museum, at my request instituted a search for the type specimen but they were unable to locate it. Presumably it is there but misplaced. A very old specimen is there (he informs me) but it is "certainly" not the type.

Type locality: "Carolina".

Specimens examined: WEST VIRGINIA: White Sulphur. NORTH CAROLINA: Goldsboro; Lake Toxaway; Southern Pines; "N. C.".

SOUTH CAROLINA: Beaufort Co.; Camden; McClennanville; "S. C.". GEORGIA: Atlanta; Augusta; Clark Co.; Dallas; Dawsonville; Kennesaw Mt.; Savannah; Tybee Islands; Unadilla; Yonah Mt.; "Ga.". FLORIDA: Alachua Co.; Allen River to Deep Lake; Bermont; Big Pine Key, Monroe Co.; Brighton; Coronado Beach; DeFuniak Springs; Enterprise; Fort Myers; Gainesville; Grant; Homestead; Indian Town; Kissimmee; La Belle; Liberty Co.; Miami; Milton; Orange Grove; Royal Palm State Park; Sanford; Sarasota; St. Cloud; South Bay, Lake Okeechobee; Tarpon Springs. ALABAMA: Chickasaw; Cowarts; Grand Bay; Mobile Co. MISSISSIPPI: Leakesville; Lucedale.

Collection dates: March 11 to September 21.

Flower hosts of adults: Cirsium sp.; *Tetragonotheca helianthoides.*

Bee hosts of larvae: unknown.

Some specimens have the pronotum infuscate and a few have it entirely fuscous bordering on piceous. This is most evident in the specimens from Georgia, particularly those from the Tybee Islands.

N. (Nemognatha) piazata palliata LeConte

(Figs. 13, 35, 56, 118, 179)

Nemognatha palliata LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 346; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 375; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.
Zonitis palliata, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149.

Similar to the nominate form and with no tendency to melanism of elytra; metatibial spurs dissimilar, the inner usually shorter and narrower, more spiniform than the outer; frons usually impressed; pronotum short usually evenly divergent from anterior to posterior angles, side margins straight. Length 7-12 mm.

Types: Holotype male, no. 4961, with a white label, described from "the upper Mississippi" in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined).

Specimens examined: MINNESOTA: New Brighton; Ramsey Co. MISSOURI: Mountain View; Tyrone; "Mo."

Collection dates: June 15 to July 1.

Flower hosts of adults: Rudbeckia.

Bee hosts of larvae: unknown.

This form intergrades with *bicolor* in Minnesota. It is rare in collections.

N. (*Nemognatha*) *piazata bicolor* LeConte

(Figs. 13, 35, 56, 89, 118, 181)

Nemognatha bicolor LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 345; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 375; Graenicher, 1910, Ent. News, vol. 21, p. 74; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Porter, 1951, Iowa State College Journal of Science, vol. 26, p. 23; Dillon, 1952, Amer. Midl. Nat., vol. 48, p. 337.

Zonitis bicolor, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha piezata, LeConte, 1859, The Coleoptera of Kansas and Eastern New Mexico, p. 46; Snow, 1878, Trans. Kansas Acad. Sci., vol. 6, p. 69; LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, pp. 373, 375; Linsley and MacSwain, 1952, Wasmann Jour. Biol., vol. 10, pp. 92, 98; Dillon, 1952, Amer. Midl. Nat., vol. 48, p. 337.

Zonitis piezata, Blackwelder, 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 482; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, p. 8.

Nemognatha texana LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 347; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213.

Nemognatha discolor LeConte, 1858, Proc. Acad. Nat. Sci., Philadelphia, vol. 10, p. 77; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 213.

Nemognatha stellaris Beauregard, 1890, Les Insectes Vésicants, p. 465; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170.

Zonitis stellaris, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148.

Similar to the nominate form except galeae extremely long, usually extending to apex of abdomen; color variable, melanistic forms piceous above and below except head and prothorax reddish-testaceous. Length 7-15 mm.

Types: Holotype female (new designation), no. 4951, pale green label, described from "Missouri Territory" (= Kansas), in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Holotype male of *discolor* from "Texas" (new designation), no. 4958 (examined). Holotype female of *texana* from "Texas" (new designation), no. 4962 (examined), both in the LeConte collection, Museum of Comparative Zoology, Harvard University.

Specimens examined from numerous localities including the following states and provinces: MINNESOTA, IOWA, NORTH DAKOTA, SOUTH DAKOTA, NEBRASKA, KANSAS, OKLAHOMA, TEXAS, MEXICO, NEW MEXICO, COLORADO, WYOMING, MONTANA, ALBERTA, IDAHO, UTAH, and ARIZONA. The following localities are marginal: Medicine Hat, Alberta; Moscow, Idaho; Monticello, Utah; Mormon Lake, Arizona; Brownsville, Texas; Sioux City, Iowa; Worthington, Minnesota; and Sentinel Butte, North Dakota.

Dates of collection: March 23 to August 25.

Flower hosts of adults: Cirsium arvense; Cirsium sp.; *Carduus ochrocentrus; Grindelia inuloides.* Porter (1951) reports adults feeding on "wavy-leaved thistle."

Bee hosts of larvae: Anthophora occidentalis (Porter, 1951; Linsley and MacSwain, 1952).

Linsley and MacSwain *(loc. cit.)* record seven species of bees which were taken in New Mexico carrying larvae of this species. Of these, they suggest that certain anthophorid bees, including *Centris caesalpiniae, Diadasia rinconis,* and *Anthophora californica texana* might serve as hosts in addition to *Anthophora occidentalis.*

The entire range of color forms of the adults is frequently taken in the same local population. The beetles are usually almost concealed within the flowers at least during the daytime.

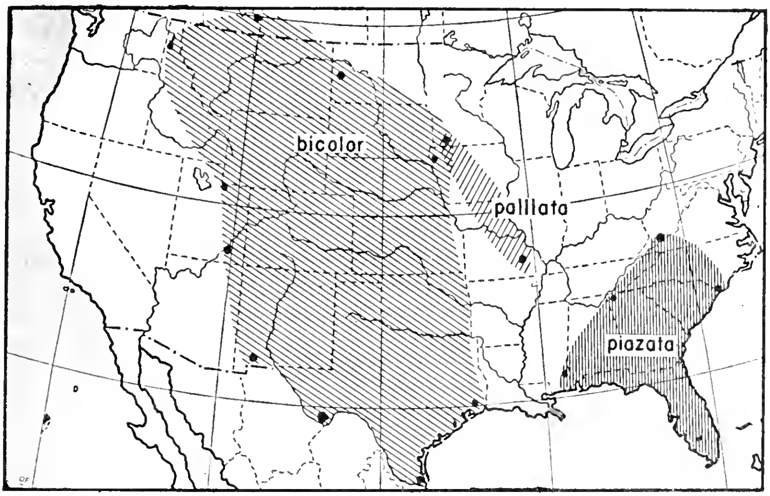

FIG. 13. Map showing the distribution of *Nemognatha (Nemognatha) piazata.* The zone of intergradation between the subspecies is indicated by the overlapping of types of shading.

GENUS *Rhyphonemognatha,* gen. nov.

(Figs. 14, 106, 108, 109, 183, 184)

The members of this genus may be distinguished from other meloids by the following combination of characters: wings functional; elytra entirely covering abdomen, not attenuate; head rather elongate, flattened, tempora not inflated, supraocular area elongate; antennae filiform or feebly subserrate, segments not progressively larger distally; eyes small, almost transverse, moderately protuberant, feebly emarginate anteriorly; galeae scarcely modified, usually feebly lobiform, extremely short, scarcely as long as labial palpi; tarsal claws cleft, upper portion with two rows of dentes, lower portion reduced to a slender lobe; spurs of posterior tibiae moderately short, slender, concave, apices subacute; six abdominal sterna visible, fifth sternum of males usually broadly, shallowly emarginate, medially impressed at apex; sixth deeply cleft medially, centrally impressed, emarginate at apex; females with sixth abdominal sternum broadly shallowly emarginate at apex; tegmen and aedeagus semimembranous, aedeagus not bilobed, apex of tegmen compressed.

Type species: Zonitis sanguinicollis Champion, 1892.

This genus belongs in the tribe Nemognathini as defined by MacSwain (1951) on the basis of the structure and form of the male genitalia. The tribe includes the genera *Nemognatha, Tricrania,* and *Hornia* of which *Nemognatha* is the genus most closely allied to *Rhyphonemognatha.* The peculiarly flattened prothorax and head (Fig. 109) in addition to the lobiform galeae readily separate the two genera. The form of the antennal segments and pronotum is somewhat as in *Pseudozonitis.* The galeae are almost as in *Zonitis.* The head and eyes are more like *Gnathium.* The metatibial spurs are more nearly like *Nemognatha.*

This genus appears to be primarily Mexican in distribution with but one species extending into the United States and another into Central America.

So far as the material at hand is concerned, in addition to the type species the following species also belong in *Rhyphonemognatha*: *Zonitis rufa* LeConte; *Zonitis tenebrosa* Champion; and *Zonitis flavicollis* Dugès. *R. rufa* extends well into the United States; *R. sanguinicollis* extends from Mexico through Nicaragua into Panamá. The type of *sanguinicollis* is in the British Museum (Natural History) and is labeled Dueñas, Guatemala, G. C. Champion; Godman-Salvin collection, Biologia Centrali-Americana, "sp. fig." A colored figure is given by Champion (1892, Tab. XVII, fig. 20).

Rhyphonemognatha rufa (LeConte) new combination

(Figs. 14, 106, 184)

Zonitis rufa LeConte, 1854, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, p. 85; 1859, Coleoptera of Kansas and Eastern New Mexico, p. 56; Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Snow, 1883, Trans. Kansas Acad. Sci. vol. 8, p. 43; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 383; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, p. 186; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 163; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481.

Nemognatha rufa, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 341.
Zonitis rubra Dugès, 1870, La Naturaleza, vol. 1, p. 166, tab. 2, fig. 13; Dugès, 1889, Ann. Mus. Michoacana, vol. 2, p. 107; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 383; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 163; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481.

This species does not closely resemble any other member of the genus. The form of the head approaches that which is found in some species of *Gnathium.* Its bright rufous color when comparatively fresh is unmistakable but may fade to pale rufo-testaceous in old specimens.

Body surface feebly shining except head and pronotum strongly shining. Characteristic color bright red except eyes, antennae, labrum, tips of mandibles, palpi, apices of femora, tibiae, and tarsi black; coxae and femora brown. Galeae lobiform, extremely short, usually concealed. Head markedly elongated, somewhat flattened, partly glabrous. Pronotum shining, sparsely, finely punctate, with a narrow median impression from base almost to apex. Elytra densely punctulate and pubescent. Metatibial spurs short, dissimilar, the outer broader than inner, both concave, apices subacute. Length 7-9 mm.

Male: Head narrow, elongate rectangular, distance from vertex to labroclypeal suture scarcely greater than distance across tempora, tempora rather abruptly rounded, not inflated, vertex not inflated, feebly arcuate from side to side; surface irregularly, moderately densely, finely punctate, a median area on frons usually impunctate, often feebly inflated between eyes, an extremely short, reddish seta arising from each puncture. Eyes small, oblique, one and one-half times as long as wide, almost imperceptibly emarginate anteriorly, finely faceted, apices subtruncate, fringed with long, fine, red setae at least posteriorly below. Clypeus impressed, transverse, very short, moderately densely punctate, anterior margin narrowly declivous and glabrous. Labrum almost one and one-half times as wide as long, shining, sparsely finely punctate, widened from base to apex, anterior angles rounded, feebly impressed and emarginate medially at apex, sparsely clothed with long, fine, red setae. Mandibles moderately long and stout, feebly angulate between bases and apices, sides densely punctate and pubescent. Maxillary palpi moderately long, about as long as mandibles, apices subtruncate; all segments shining, punctured, pubescent. Labial palpi extremely short, apices subtruncate; shining, punctured and pubescent like maxillary palpi. Galeae not extending beyond mandibles, usually concealed, lobiform, length equal to that of first three maxillary palpal segments together. Antennae moderately long, about twice as long as pronotum, each with first segment short, stout, not attaining half the width of eye, feebly inflated and arcuate, sparsely punctured and pubescent; second subequal to first, but more constricted basally; third equal to second but more densely punctate and pubescent, less shining; fourth, fifth, and sixth scarcely longer than third, otherwise similar, sixth twice as long as wide; seventh scarcely shorter than sixth; eighth to tenth subequal to seventh; eleventh one third longer than tenth, inner margin almost straight, outer margin evenly arcuate from base to apex, apex subacute.

Pronotum variable, usually scarcely longer than wide, widest at anterior third, where it is wider than head, base subtruncate, posterior angles not produced, sides feebly divergent to anterior third, thence rapidly narrowed to apex, apex truncate, not margined, base with a distinct raised margin, disk rather sharply convex from side to side, extreme base in side view feebly declivous, surface smooth, shining, sparsely but irregularly finely punctate, a short reddish seta arising from each puncture, a thin median impressed line extending from base almost to apex. Scutellum moderately large, punctate and pubescent except at apex, center impressed, apex impunctate, broadly rounded. Elytra uniformly, densely punctulate, clothed with short, appressed, red pubescence, sutures and margins raised, humeri distinct. Thorax and abdomen ventrally feebly shining, densely, finely punctate, clothed with moderately long red pubescence, fifth abdominal sternum extremely feebly impressed medially at apex, apex evenly, shallowly emarginate from side to side; sixth deeply cleft medially with a broad, deep central impression. Leg segments distinctly flattened, densely punctate and pubescent, tibiae more densely so; anterior and middle tibiae with both spurs short, slender, spiniform; metatibial spurs dissimilar, the outer broader with apex rounded; inner acute; both short, concave. Tarsal claws with 11 or 12 teeth in inner row.

Female: Similar to male but fifth abdominal sternum not impressed; sixth broadly, shallowly emarginate at apex.

Types: Holotype female (new designation), no. 4976, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). The specimen bears a small green label indicating New Mexico. The original description cites "Frontera (Rio Grande)" as the type locality. This is in Texas hence either the label is wrong or it is not the type specimen. Neallotype (new designation) no. 62728, labeled Lyford, Texas, March 31, 1920 "feeding on wildflowers," M. M. High collector, in the U. S. National Museum. The type of *rubra* Dugès is lost.

Specimens examined: TEXAS: Brazos County; Dallas; Lyford. ARIZONA: Baboquivari Mts.; Sabina Canyon; Santa Rita Mts.; Sonoita, Sta. Cruz County. NEW MEXICO: Estancia; Jemez Springs; Las Vegas; Mountain Park. KANSAS: Franklin County; Lawrence; Manhattan; Mount Hope; Onaga; Pottawatomie County; Salina; Wichita. IOWA: Shenandoah. ILLINOIS: Roseville. MISSOURI: Atchison County; Maryville. NEBRASKA: Garland. Specimens from MEXICO also have been examined.

Collection dates: March 31 (Texas) to September 13.

Recorded elevations: 3000 to 7000 ft. (8000 in Mexico).

Flower hosts of adults: Physalis subglabrata; Physalis heterophylla.

Bee hosts of larvae: unknown.

The writer is indebted to Dr. Wilfred S. Craig of Iowa State College for the host plant records. He has informed me *(in litt.)* that the beetles taken at Shenandoah, Iowa were found deep in the corollas of the flowers and were quite difficult to see.

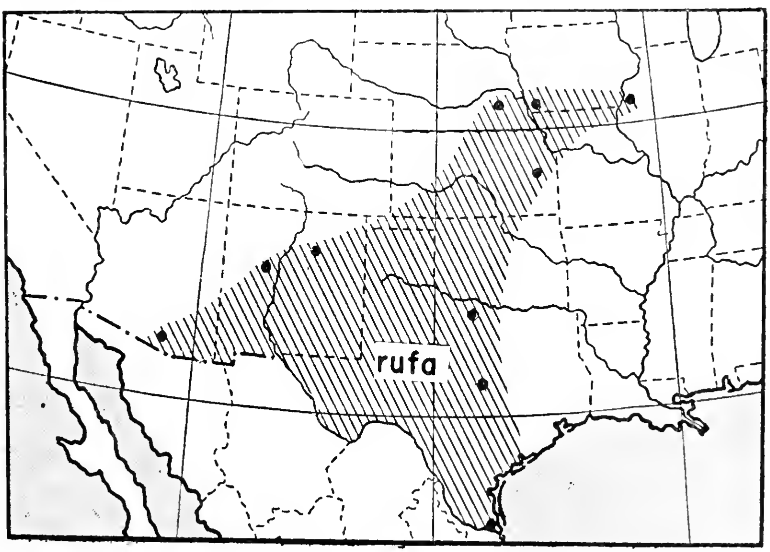

FIG. 14. Map showing the distribution of *Rhyphonemognatha rufa.*

GENUS ZONITIS[1] Fabricius

(Figs. 134, 135, 204, 205)

Zonitis Fabricius, 1775, Systema Entomologiae, I, p. 48. Type species: *Zonitis praeusta* Fabricius, 1792.

Zonitis, Latreille, 1804, Histoire naturelle, générale et particuliere des Crustacés et des Insectes, vol. 10, p. 407; Say, 1817, Jour. Acad. Nat. Sci. Philadelphia, Ser. 1, vol. 1, p. 22; Guérin-Méneville, 1833-39, Dict. pitt. d'Hist. nat., vol. 9, part 2, p. 593; Mulsant, 1857, Histoire naturelle des Coléoptères de France, VIII, p. 60; Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Beauregard, 1890, Les Insectes Vésicants, pp. 396, 469; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 382; Escherich, 1897, Verhandlungen Naturforschender Verein, Brunn, p. 104; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynechophora) Known to Occur in Indiana, p. 1357; Wellman, 1910, Ent. News, vol. 21, p. 220; Wellman, 1910, Canadian Ent., vol. 42, p. 393; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 155; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Parker and Böving, 1924, Proc. U. S. Natl. Mus., vol. 64, p. 33; Van Dyke, 1928, Univ. California Publ. Ent., vol. 4, p. 403; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; Blackwelder, 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, p. 6; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72; MacSwain, 1952, Wasmann Jour. Biol., vol. 10, p. 205.

The members of this genus may be distinguished from other meloids by the following combination of characters: wings functional; elytra entirely covering abodmen, not attenuate; head usually triangular or somewhat elongate; tempora feebly inflated; antennae filiform or submoniliform, segments usually not progressively larger distally; eyes variable in size, rarely produced beneath head; galeae lobiform or produced into a short sucking organ; tarsal claws cleft, upper portion with two rows of dentes, lower portion reduced to a slender lobe; spurs of posterior tibiae usually spatulate but somewhat variable; six abdominal sterna visible, fifth and sixth usually modified in the males; aedeagus a sclerotized, bilobed structure, apex of tegmen usually compressed, sides not sclerotized.

KEY TO THE SUBGENERA OF NORTH AMERICAN ZONITIS

Galeae scarcely modified or produced into a short, broad, lobiform structure, Subgenus *Neozonitis*

Galeae produced into a sucking tube Subgenus *Parazonitis*

Subgenus NEOZONITIS, subg. nov.

North American Zonitini with galeae feebly modified or lobiform; cephalic outline rounded to subquadrate; eyes variable, small to feebly to markedly produced beneath head; pronotum elongate, transversely oval or angulate; elytra feebly to distinctly punctate, often vermiculate or almost smooth.

Type: Zonitis bilineata Say, 1817.

1. Greek, *zone*, "band"; *itis*, suffix, feminine, "of the nature of."

KEY TO SPECIES OF NEOZONITIS

1.	Eyes produced below head at least to outer margin of maxillae		2
	Eyes not produced below head, rarely exceeding lower margin of mandibular condyle		5
2(1).	Elytra entirely pale golden yellow	*aurea*	
	Elytra blue, purplish, or brown		3
3(2).	Elytra brownish, nearly smooth, metatarsal claws with less than ten teeth in inner row	*hesperis*	
	Elytra bluish or faintly bronze, distinctly vermiculate or rugose-punctate, metatarsal claws with more than ten teeth in inner row		4
4(3).	Eyes finely faceted, not produced below head beyond outer margin of maxillae; elytra vermiculate, not punctate	*vermiculata*	
	Eyes coarsely faceted, produced below head beyond inner margin of maxillae; elytra distinctly rugose-punctate	*interpretis*	
5(1).	Elytra moderately densely punctate, intervals smooth	*atripennis*	
	Elytra rugose or feebly rugose-punctate		6
6(5).	Vertex usually brown, densely punctate, pronotum with a median sulcus	*sulcicollis*	
	Vertex usually pale, impunctate, pronotum feebly or not sulcate	*bilineata*	

Zonitis (Neozonitis) bilineata Say

(Figs. 15, 79, 121, 185)

Zonitis bilineata Say, 1817, Jour. Acad. Nat. Sci., Philadelphia, Series 1, vol. 1, p. 22; Say, 1818, American Entomology, tab. 3; Say, 1818, Jour. Acad. Nat. Sci., Philadelphia, Series I, vol. 2, p. 3; LeConte, 1853, Proc. Acad. Nat. Sci., Philadelphia, vol. 6, p. 349; Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Snow, 1883, Trans. Kansas Acad. Sci., vol. 8, p. 43; Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 170; Pierce, 1904, (Nebraska) Univ. Studies, vol. 4, p. 24; Snow, 1907, *loc. cit.*, vol. 20, no. 2, p. 186; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of the Rhynchophora) Known to Occur in Indiana, p. 1356; Wickham, 1911, Univ. Iowa, Lab. Nat. Hist., vol. 6, p. 35; Sherman, 1913, Ent. News, vol. 24, p. 247; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 157; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Britton, 1920, Check List of the Insects of Connecticut, State Geological and Natural History Survey Bulletin 31, p. 238; Mutchler and Weiss, 1924, New Jersey Department of Agriculture Circular 76, pp. 14, 17; Leonard, 1928, Cornell University Memoirs 101, List of the Insects of New York, p. 338; Carruth, 1931, Ent. News, vol. 42, p. 54; Böving and Craighead, 1931, Ent. Amer., vol. 11 (n. s.), p. 278; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Brimley, 1938, Insects of North Carolina, p. 162; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; Schwitzgebel and Wilbur, 1942, Jour. Kansas Ent. Soc., vol. 15, p. 43; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Zonitis lineata Melsheimer, 1847, Proc. Acad. Nat. Sci., Philadelphia, vol. 3, p. 53.

Zonitis mandibularis Melsheimer, 1847, Proc. Acad. Nat. Sci., Philadelphia, vol. 3, p. 53.

This species morphologically resembles *Z. atripennis* and *Z. vermiculata* but may be distinguished from either of these species by the form and punctation of the pronotum. Its closest relative is *Z. sulcicollis* from which it differs in the form of the pronotum, sculpture of the elytra, color and distribution.

Body surface moderately shining. Color and punctation variable, usually with head, prothorax, scutellum, abdomen, and legs except tibiae reddish-brown; elytra pale gray or white, females usually with discal black vittae, rarely entirely black; males with vittae obsolete or absent; remainder of body brown or black. Elytral sculpture variable, usually rugose-punctate, rarely with sharp abrupt punctures, intervals smooth. Galeae extremely short, lobiform, usually not exceeding mandibles in length. Metatibial spurs equal, broad and concave. Males with abdominal sterna densely, finely punctate, extremely short pubescent. Females with abdominal sterna sparsely punctate. Length 6.5-13 mm.

Male: Head short, broad, distance from vertex to labroclypeal suture one sixth less than distance across tempora; tempora moderately inflated, vertex evenly rounded or feebly tumid; surface densely, coarsely punctate, more finely and sparsely so on tempora, an impunctate median area usually extending from vertex to a point midway between eyes, this area feebly impressed in some specimens; a short, erect, pale seta arising from each puncture. Frons often impressed, a prominent transverse ridge between bases of antennae in some specimens. Eyes moderately large, feebly protuberant, almost transverse, about two and one-half times as long as wide, feebly emarginate anteriorly, widely separated above and below. Clypeus triangularly impressed, coarsely punctured basally, glabrous apically. Labrum one third wider than long with a narrow median glabrous area extending from base to apex, remainder of surface shining but clothed with long, fine, pale setae, anterior margin almost truncate. Mandibles short, stout, abruptly rounded forming nearly a 45° angle at a point slightly more than half their length, sides punctured clothed with pale hairs. Palpi moderately long, pale, clothed with moderately sparse, pale pubescence, an impressed area at apical third of ultimate segments, apices obliquely truncate. Galeae shorter than labial palpi, usually concealed, lobiform with a fringe of pale, coarse hairs. Antennae short, about twice as long as pronotum, first and second segments of each often pale, remainder fuscous or black, first segment arcuate, moderately inflated, reaching half way across eye, shining, moderately densely pale pubescent; second segment scarcely shorter than first, apical half feebly swollen, shining and pubescent like first; third scarcely longer than second, more densely punctured and pubescent than second; fourth to tenth similar to third, progressively shorter than each preceding except sixth and seventh which are equal in length and longer than fifth and eighth; eleventh one third longer than tenth, apex subacutely, evenly pointed.

Pronotum shining, one sixth wider than long, sides usually evenly rounded, in some specimens feebly expanded at posterior angles; disk evenly convex, some specimens with irregular, feebly raised areas, others with faint to deep foveae on either side, usually coarsely, moderately densely punctate but varying from densely to sparsely punctate, an extremely short, pale seta (often rubbed off) arising from each puncture; some specimens with a feeble median sulcus at base. Scutellum moderately large, short, moderately densely punctate and pubescent, shallowly impressed at center, apex broadly rounded. Elytra exceedingly variable in color and sculpture but usually feebly rugose, distinctly punctate, but varying to smooth intervals with abrupt, moderately coarse punctures or distinctly rugose with punctures almost obliterated; ground color white to testaceous, some specimens with a narrow discal vitta on each elytron, three or four feebly raised costae on each elytron in some specimens, usually absent. Thorax ventrally smooth, shining, usually sparsely punctate, metepisternum usually piceous, remainder of thorax brown but variable. Abdomen reddish testaceous, finely and densely punctulate, densely clothed with short, pale pubescence. Legs shining, moderately sparsely, coarsely punctate and pubescent, tibiae and tarsi more densely so; anterior and middle tibiae with moderately long slender spurs, the outer ones usually broader than inner, inner spurs spiniform, usually feebly arcuate; metatibial spurs large, concave, similar and equal. Abdominal sterna finely, densely punctate clothed with fine, short, pale pubescence. Sixth abdominal sternum medially cleft with a moderately deep, central impression.

Female: Similar to male but with abdomen much less densely punctate, shining; sixth sternum not so modified, apex shallowly, broadly emarginate. Color usually darker than male, with distinct, broad elytral vittae, some specimens with elytra entirely black except narrow sutures and margins; antennae, palpi, thorax (except prothorax), and tibiae often piceous or fuscous.

Types: Say's types no longer exist. Type locality according to the original description: "Inhabits the plains of the Missouri. On thistles (*Cardui*) Nuttall." Melsheimer's types of *lineata* and *mandibularis* also are lost.

Neoholotype male and neallotype taken on *Helianthus annuus* in Callaway County, Missouri, one mile north of U. S. Highway 40 on Callaway Route P, August 10, 1953, W. R. Enns, P. J. Spangler, and M. C. Grabau collectors, deposited in the Snow Entomological Museum, University of Kansas. Paratypes: three males and eighteen females, same data as neoholotype (eggs from which larvae [slides numbered 81053-5] subsequently hatched were also obtained from this series).

Specimens exclusive of type material examined: Numerous localities in an area delimited by Torrington, Connecticut; Bell's Corners and Brittania, Ontario; Twin Falls, Idaho; Glendale, California; Tallulah, Louisiana; Birmingham, Alabama; and Clemson, South Carolina. Specific states and provinces represented include: ONTARIO, CANADA; ALABAMA, ARIZONA, ARKANSAS, CALIFORNIA, COLORADO, CONNECTICUT, IDAHO, ILLINOIS, INDIANA, IOWA, KANSAS, KENTUCKY, LOUISIANA, MARYLAND, MICHIGAN, MINNESOTA, MISSOURI, MONTANA, NEBRASKA, NEW JERSEY, NEW MEXICO, NEW YORK, NORTH CAROLINA, NORTH DAKOTA, OHIO, PENNSYLVANIA, SOUTH CAROLINA, SOUTH DAKOTA, UTAH, and VIRGINIA.

Collection dates: June 11 to September 16.

Flower hosts of adults: Helianthus; Vernonia; Cirsium; Solidago; Asclepias; Ambrosia; Medicago.

Bee hosts of larvae: unknown. It seems probable that bees of the genera *Megachile*, *Melissodes*, and *Nomia* may serve as hosts for this species since these bees commonly visit the same flowers.

This is a widely distributed and extremely variable species. In addition to the males having the abdominal sterna modified and densely punctate, they usually have the elytral vittae slender or absent, whereas in the females they are usually broad.

The eggs of this species vary in color from one cluster to another. Some are white, some are reddish-orange, but most of the clusters are yellowish-orange. On sunflower *(Helianthus)* they are laid at the junctures of the ribs with the main vein on the undersides of the leaves. Several times females of this species were taken resting on the sides of unopened buds of thistles (*Cirsium* sp.). What this behavior means is not clear at present. Hatching time of eggs in the laboratory ranged from seven to sixteen days. Of ten clusters examined, the average number of eggs per cluster was 265. The white eggs exhibited no difference in hatching time or viability compared with the yellow or orange eggs.

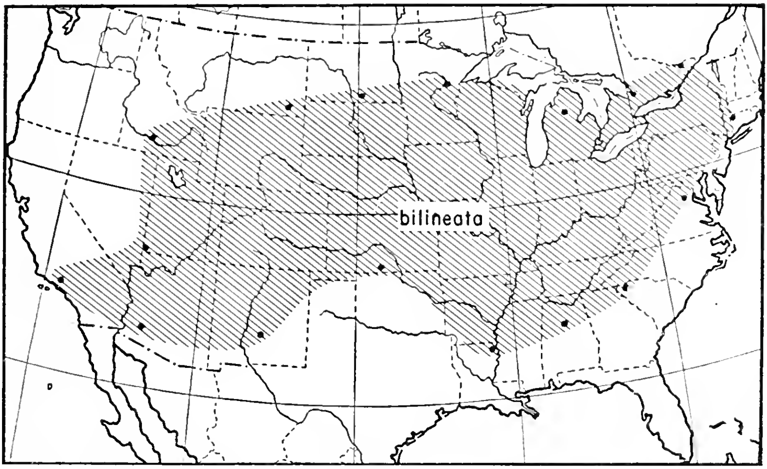

FIG. 15. Map showing the distribution of *Zonitis (Neozonitis) bilineata.*

Zonitis (Neozonitis) sulcicollis Blatchley

(Figs. 17, 120, 186)

Zonitis sulcicollis Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of the Rhynchophora) Known to Occur in Indiana, p. 1357; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 164; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Similar to *Z. bilineata* but distinguished by its smaller average size, sulcate pronotum, and dark vertex. The pronotum is somewhat different in outline compared to that of *bilineata* and the elytra are more deeply rugose and considerably less distinctly punctate. In the holotype the median pronotal sulcus extends only two thirds the length of the pronotum but in most specimens it extends from base to apex. The proportions of pale and dark areas on the elytra are variable. The vertex varies from reddish-testaceous to fuscous or black.

Body surface moderately shining. Fulvous or testaceous except elytra, eyes, antennae, apices of mandibles, palpi, metasternum, tibiae and tarsi fuscous or black. Apices of femora and vertex usually fuscous or reddish-testaceous. Head above antennal bases extremely coarsely punctate. Galeae extremely short, not as long as labial palpi, lobiform. Pronotum transverse, usually widest just before middle, sides almost evenly rounded in some specimens, or more abruptly rounded to apex than to base; disk usually distinctly sulcate medially, rather shallowly, sparsely punctate. Elytra rugose-punctate, in some specimens almost smooth; color variable, testaceous with broad dark vittae or entirely dark except sutures and margins, usually with no marked difference between sexes. Metatibial spurs similar and equal, slender, concave, scarcely divergent. Males with abdominal sterna extremely densely, finely punctate, fifth sternum with a moderately deep impression medially at apex; sixth cleft medially, deeply impressed at center. Female similar to male but abdominal sterna less densely punctate, not modified, fifth and sixth extremely broadly, shallowly emarginate. Length 7.5-10 mm.

Types: Holotype male, taken in Lake County, Indiana, on "Yellow-flowered Thistle", *Cnicus (= Cirsium) Pitcheri*, July 29, 1903, W. S. Blatchley collector, in the Blatchley collection, Purdue University (examined). The specimen bears a label with the numbers 2-6/1-33. The left metatarsus is missing. Neallotype (new designation) Cheboygan County, Michigan, July 20, 1936, Ruth Grove collector, in the Snow Entomological Museum, University of Kansas.

Specimens examined: MICHIGAN: Cheboygan Co. MINNESOTA: Itasca State Park. ILLINOIS: "Ill." An additional female in the LeConte collection bears a yellow label indicating the Upper Mississippi Valley.

Collection dates: July 8 to August 3.

Flower hosts of adults: Cirsium Pitcheri.

Bee hosts of larvae: unknown.

Zonitis (Neozonitis) atripennis (Say)

(Figs. 16, 48, 68, 119, 187, 188, 189)

Resembles *Z. vermiculata* but is readily distinguished by the more elongate pronotum and sharply punctured, variably colored elytra. From *Z. sayi* and its allies, this species differs in that it has short galeae and usually has the pronotum moderately densely punctate.

Z. atripennis is divisible into three easily recognizable infra-specific forms which I propose to designate as subspecies. When plotted on a map (see Fig. 16), the distribution of these three forms proves them to be reasonably allopatric. The color forms are remarkably distinct and intergrades are extremely scarce or not recognizable. The following table separates the forms:

1. Elytra entirely black . . . *atripennis atripennis*
   Elytra partly or wholly testaceous . . . 2
2. Elytra entirely pale . . . *atripennis flavida*
   Elytra with apices piceous . . . *atripennis terminalis*

Z. (Neozonitis) atripennis atripennis (Say)

(Figs. 16, 48, 68, 119, 187)

Nemognatha atripennis Say, 1823, Jour. Acad. Nat. Sci., Philadelphia, series 1, vol. 3, p. 306.

Zonitis atripennis, LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 349; Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Snow, 1878, Trans. Kansas Acad. Sci., vol. 6, p. 349; 1881, *ibid.*, vol. 7, p. 70; Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, no. 1, p. 174; 1907, *ibid.*, vol. 20, no. 2, p. 186; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 156; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Carruth, 1931, Ent. News, vol. 42, p. 54; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72; Selander and Bohart, 1954, Wasmann Jour. Biol., vol. 12, p. 227.

Body surface shining. Head, prothorax, scutellum, coxae, trochanters, greater portion of femora, basal halves of tibiae, and at least apical abdominal segments pale testaceous or flavous. Elytra, antennae, tips of mandibles and palpi, apices of femora and tibiae, and tarsi black or very dark reddish brown. Ventral surfaces variable, usually with at least mesothorax and metathorax suffused with black, males usually with abdominal sterna black except sides of fourth and entire fifth and sixth which are flavous; females usually with entirely flavous abdominal sterna. Antennae long, subserrate; galeae short, lobiform, not produced into an elongate sucking organ; pronotum longer than wide or at least as long as wide, shining, irregularly, moderately sparsely punctured, intervals between punctures usually smooth. Metatibial spurs unequal, obliquely concave. Length 6-12 mm.

Male: Head elongate ovate, distance from vertex to labroclypeal suture equal to distance across tempora; tempora distinct, moderately inflated, vertex produced above eyes a distance equal to width of eye behind emargination, evenly rounded or feebly tumid; surface moderately densely punctured, more densely so near eyes, tempora, and clypeal region, more sparsely on vertex and medially on frons, a short, pale seta arising from each puncture. Eyes moderately large, reniform, finely faceted, less than half as wide as long, emarginate, widely separated above and below. Clypeus coarsely punctured, apical half glabrous. Labrum as wide as long, sparsely punctured, apical margin evenly rounded and clothed with long, coarse hairs. Mandibles moderately long, distal half of each broadly curved inward, sides clothed with moderately coarse, pale hairs. Palpi long, moderately slender, sparsely clothed with short, pale pubescence, last segment of each with an external glabrous impression at apical third, apices truncate. Galeae pale, lobiform, short, scarcely exceeding mandibles, densely fringed with short, pale hairs. Antennae long, feebly flattened basally, more distinctly so apically, each with first segment moderately large, reaching halfway across eye, moderately inflated, shining, moderately densely punctate and pubescent; second as long as first but less inflated, more densely punctate and pubescent than first; third about one fourth longer than second, more densely punctate and pubescent than second; fourth to tenth subequal to third, similarly punctate and pubescent; eleventh longer than tenth, widest at apical third, apex subacute.

Pronotum shining, longer than wide, widest at posterior angles which are feebly produced at extreme base, sides parallel to apical fourth, broadly rounded to apex, apex feebly, broadly emarginate, base more feebly emarginate medially than apex, disk markedly convex from side to side, feebly so from base to apex, irregularly, sparsely punctate, an extremely short, pale, inconspicuous seta arising from each puncture, usually a feeble median impression just behind center but in some specimens extending from base to apex. Scutellum moderately large, densely punctured and pubescent with a moderately deep, subapical impression. Elytra shining, irregularly punctured, punctures deep, moderately coarse, sparser on disk basally than at apices, each puncture with a short, reddish seta arising from it, sutures and margins feebly raised, some specimens with disk feebly costate, intervals between punctures usually smooth, glabrous. Thorax and abdomen shining ventrally, finely and densely punctured, clothed with fine, moderately long, pale pubescence, punctures and pubescence denser than on thorax; anterior and middle tibiae with both spurs moderately long, slender, spiniform; metatibial spurs large, unequal, the outer about one third wider than inner, obliquely concave, apex flared; inner spur narrow, obliquely concave, apex not flared. Fifth abdominal sternum with a feeble median impression at apex; sixth cleft medially with a large, deep central excavation.

Female: Similar to male but abdominal sterna not modified, less densely punctate, sixth sternum feebly emarginate medially.

Types: Say's types are lost. According to the original description, this species "inhabits Arkansa . . . Found near the base of the Rocky Mountains, and between the rivers Arkansa and Platte".

Neoholotype male and neallotype (new designation) taken on *Cleome serrulata* at Lakin, Kearny County, Kansas, August 19, 1951, W. R. Enns collector, deposited in the Snow Entomological Museum, University of Kansas. Neoparatypes (new designation) as follows: one male, one female, same data as neoholotype, in the writer's collection; two males, three females, Bison, Kansas, August 20, 1951, on *Cleome serrulata*, W. R. Enns collector; seven males, thirteen females, Medicine Lodge, Kansas, August 16, 1951, on *Cleome serrulata*, W. R. Enns collector; two females, Wallace County, Kansas, August 4, one male, same locality, September 2, in Cornell University; one male, one female, Hamilton County, Kansas, Aug. 27, Ac 2157 in Kansas State College; one male, Lakin, Kansas, to Pueblo, Colorado, July 8-9, 1877, 3000-4500 feet, F. C. Bowditch collection, in Museum of Comparative Zoology, Harvard University; one male, "Ks.", H. Ulke collector, in the C. V. Riley collection, U. S. National Museum; one female, Wallace County, Kansas, 3000 ft., L. L. Dyche collector, Brooklyn Museum collection, in the U. S. National Museum.

Specimens from the following localities, not included in the type material, were also examined: COLORADO: Alamosa; Bear Creek Canyon; Berkeley; Buffalo Creek; Canfield; Cañon City; Cascade; Clear Creek; Colorado Springs; Denver; Estes Park; Fremont County; Garden of the Gods; Glen Haven; Golden; Great Sand Dunes National Monument; Hoehne; La Junta; Lincoln County; Manitou; Mishawauka; Chalk Creek, Nathrop; Pleasant Valley; Poudre River; Pueblo; Robinson; Salida; San Miguel; Trinidad; Walsenburg; West Las Animas; White Rocks; Wray. KANSAS: Bison; Cheyenne County; Dodge City; Finney County; Ford County; Garden City; Gove County; Graham County; Greeley County; Lane County; Liberal; Meade; Medicine Lodge; Medora; Otis; Russell County; Seward County; Sherman County; Wallace County. NEBRASKA: Bridgeport; Cambridge; Crawford; Glen; Haigler; Imperial; Kearney; Mitchell; Monroe Cañon; North Platte; Pine Ridge. NEW MEXICO: Albuquerque; Gallup; Jemez Mountains; Sandia Mountains; Santa Fe; Socorro County; Thoreau. WYOMING: Bosler; Casper; Cheyenne; Diamond Ranch, Platte County; Glen Rock; Laramie County. OKLAHOMA: Beaver County; Dunlap; Gate; Grand; Shattuck. ARIZONA: Flagstaff; Prescott; Tucson; Walnut. SOUTH DAKOTA: Custer County; Hill City; Hot Springs. IDAHO: Juliaetta. TEXAS: Canadian; El Paso. UTAH: Bluff. One female, labeled "Ill." in the Andreas Bolter collection, Illinois Natural History Survey. Selander and Bohart (1954) state that they have a record of this species from West Virginia.

Collection dates: May 3 to October 2.

Flower hosts of adults: Cleome serrulata.

Bee hosts of larvae: unknown.

The western subspecies live at the expense of bees of the genus *Nomia.*

Z. (Neozonitis) atripennis flavida LeConte

(Figs. 16, 188)

Zonitis flavida LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 349; Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Snow, 1881, Trans. Kansas Acad. Sci., vol. 7, p. 70; 1907, *ibid.*, vol. 20, p. 186; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 158; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Zonitis atripennis flavida, MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72; Selander and Bohart, 1954, Wasmann Jour. Biol. vol. 12, p. 227.

Morphologically extremely similar to the nominate form differing principally in color and distribution. The color is entirely pale testaceous but the ventral surfaces vary from that to fuscous. Sexual differences are as noted for *atripennis* except the color of the abdomen. Distribution is west of the Great Plains but east of California.

Types: Holotype male no. 4975, New Mexico, in LeConte collection, Museum of Comparative Zoology, Harvard University (examined). Only the two basal segments of each antenna remain on the type specimen. Neallotype (new designation), San Juan Valley, Taos County, New Mexico, August 1-4, 1885, Roland Hayward collection, Museum of Comparative Zoology, Harvard University (examined). There are four females in the U. S. National Museum marked "Topotypes" and labeled Santa Fe Canyon, New Mexico, 7000 ft., Aug., 1880, F. H. Snow, in the C. V. Riley collection.

Specimens examined: NEW MEXICO: Albuquerque; Belen; Gallup; Glorietta; Grants; Jemez Springs; Las Cruces; Las Vegas; Magdalena; Mountainair; Omega, Catron County; Rita or Los Frijoles; Sandia Mts.; San Juan Valley, Taos County; Santa Fe Cañon; Satan Pass, McKinley County; Scholle; Shiprock; Socorro County; Thoreau. UTAH: Blue Creek; Cedar City Canyon, Iron County; Clear Creek; Cove Fort; Delta; East Promontory; Flur; Glendale; Halbert; Hurricane; Jensen; Lewiston; Logan; Logan Canyon; Lyndyl; Oak City; Ogden Canyon; Orr's Ranch, Skull Valley; Parowan Canyon; Pintura; Promontory; Salt Lake City; Silver City; Slaterville; St.

George; Stockton; Timpie; Uintah County; Utah Lake. ARIZONA: Chambers; Flagstaff; Fredonia; Holbrook; Lowell Ranger Station, Santa Catalinas; McNary; Navajo County; Oak Creek Canyon; San Carlos; San Simon; Seligman; Skull Valley, Yavapai County; Springerville; Tuba City; Walnut; White Mts.; Wilcox; Williams; Winona. COLORADO: Caisson; Chalk Creek, Nathrop; Delta; Grand Junction; Great Sand Dunes National Monument; Hoehne; Salida; San Luis Valley. NEVADA: Carson City; Coulder; Pyramid Lake, Washoe County. IDAHO: Schiller, Power County; Strevell. TEXAS: El Paso. Specimens also examined from Baja California and Chihuahua, Mexico.

Collection dates: June 1 to September 28.

Flower hosts of adults: Cleome serrulata; Cleome lutea.

Bee hosts of larvae: Nomia melanderi. (Selander & Bohart, 1954.) These authors suggest *Anthophora* and *Melissodes* as possible hosts.

Z. *(Neozonitis) atripennis terminalis*, ssp. nov.
(Figs. 16, 189)

Morphologically almost identical to *flavida* but differing in that approximately the apical fourth of each elytron is black. The distribution is far western, this being the only form I have seen from California. Sexual differences are like those given for *flavida.*

Types: Holotype male, California, in the LeConte collection, Museum of Comparative Zoology, Harvard University. The label on this specimen has the right margin colored purple. Allotype, same collection, labeled New Mexico.

In addition to the type material, specimens from the following localities have been examined: CALIFORNIA: Barstow; Fresno; Greenfield; Hodge; Sequoia National Park; Victorville; Yermo. NEVADA: Carson City; Emigrant Pass; Nixon; Pyramid Lake, Washoe County; Yerington, Lyon County. NEW MEXICO: Albuquerque; Omega, Catron County; Pinedale; Thoreau. UTAH: East Promontory. WYOMING: Casper. ARIZONA: Flagstaff; McNary. COLORADO: "Col." Specimens have also been examined from Baja California, Mexico.

Collection dates: May 23 to September 28.

Flower hosts of adults: Cleomella obtusifolia; Cleome sp.; *Astragalus* sp.; *Solidago occidentalis.*

Bee hosts of larvae: Probably *Nomia* sp. or related species of bees.

There is a distinct gap between all three of the subspecies here recognized in that no recognizable intermediate forms have come to my attention except one specimen which appears to be intermediate between the nominate form and *flavida*. As has been pointed out to me, the color differences may be due to the effect of single genes or may be responses to varying environmental factors, but an analysis of the geographic distribution segregates the forms within moderately broad limits. The region of overlap is broad between the two westernmost forms but *terminalis* appears to fare only indifferently well in the range of *flavida* and vice versa, while the ranges of *flavida* and the nominate form are more sharply delineated. In a group which is parasitic in the sense that *Zonitis* is, it is not unusual to find stragglers at some distance from the more characteristic range.

Without an extensive series of all three forms at hand, it appears at first glance that the dark form represents the eastern population and that the form with the black elytral apices should be the intermediate form between the black and pale forms. Additional specimens demonstrate that the latter two forms are reversed and that the species seems to extend from the extreme southwestern United States northeast to the plains states. Further biological information will undoubtedly be available in the future to support or refute the arrangement here proposed.

Concerning Fig. 16 showing the distribution of the subspecies of *Z. atripennis*, it is desirable to point out that this distribution is based on a study of over 1700 specimens. The breakdown of the forms involved may be tabulated thus:

Form	No. Specimens	% of Total
atripennis atripennis	683	38.85
atripennis flavida	796	45.28
atripennis terminalis	279	15.87
	1758	100.00

The distribution is indicated by states because that appears to be as convenient and valid as any for such a small area. It will be noted that the specimens from Oklahoma, Kansas, Nebraska, and South Dakota are all of the nominate form. Of the specimens from California, 100% are *atripennis terminalis*. Although the map shows Nevada as 100% *terminalis*, the actual figures show that about 2% are *flavida;* in Utah, one percent are *atripennis* and 3% are *terminalis*. The map does not show this because the portions of the shaded circles involved would not show in the printed reproduction. Of the states showing two forms, in New Mexico in addition to *atripennis* and *flavida*, slightly more than 2% are *terminalis*, and in Wyoming, besides *atripennis*, almost 3% are *terminalis*.

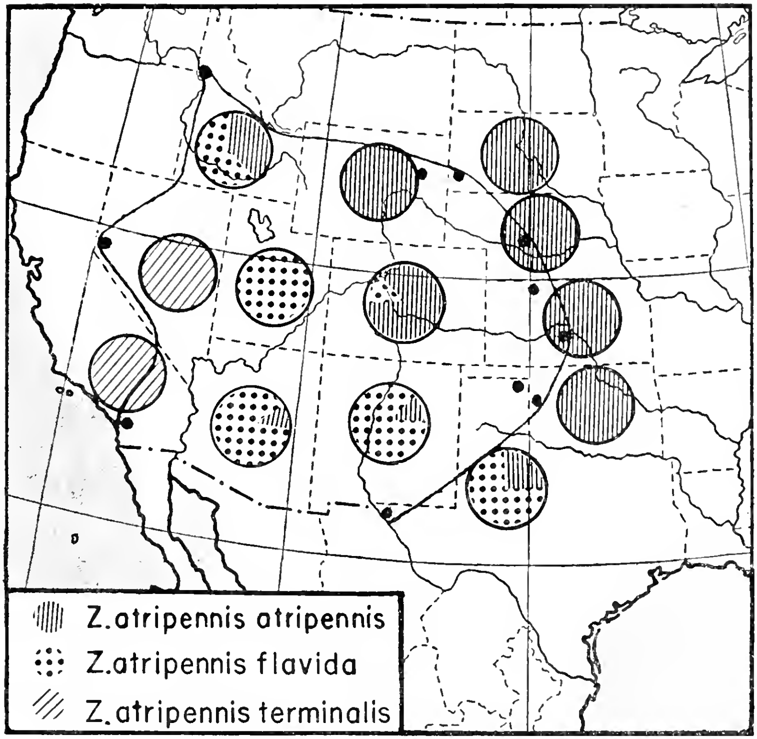

FIG. 16. Map showing the distribution of *Zonitis (Neozonitis) atripennis*. The size of the sectors in each circle indicates the relative frequency of the subspecies, by states, in the material studied. See discussion following description of the forms.

Zonitis (Neozonitis) vermiculata Schaeffer

(Figs. 17, 30, 51, 124, 190)

Zonitis vermiculatus Schaeffer, 1905, Bull. Brooklyn Inst. Arts & Sci., vol. 1, p. 138; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 164; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, pp. 72, 73.

Zonitis vermiculata, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150 (emendation); Selander, 1952, Jour. Kansas Ent. Soc., vol. 25, p. 131.

Related to *Z. aurea* and *Z. hesperis* but distinguished from the former by its larger size, bluish elytra, and angulate pronotum;

from the latter chiefly by the bluish, more deeply vermiculate elytra, more elongate form, and tarsal claws with thirteen or more teeth.

Body surface shining. Color yellow or orange-yellow except elytra feebly metallic blue or purplish, or brownish-blue; eyes, antennae, tips of mandibles, palpi, apices of femora, entire tibiae and tarsi piceous. Head large, subquadrate above clypeus, finely punctate between bases of antennae. Eyes moderately large, two and one-half times as long as wide, feebly emarginate anteriorly, produced beneath head to outer margins of maxillae. Sixth antennal segment scarcely two and one-half times as long as broad. Mandibles short, stout, sharply angulate inward at half their length. Galeae short, pale, lobiform. Pronotum wider than long, sparsely, finely punctate, sides divergent from base to apical third, sharply convergent to apex. Elytra shallowly vermiculate. Metatibial spurs dissimilar, outer spurs broader and longer than inner, apices oblique, concave; inner spurs parallel-sided, concave, apices rounded. Males with 15 or 16 teeth in claws, fifth abdominal sternum impressed medially at apex, sixth deeply cleft medially and with a deep central impression. Females with 13 or 14 teeth in claws, fifth abdominal sternum not modified, sixth evenly rounded at apex. Length 8-12 mm.

Types: The type is a male labeled "Type", no. 42336, Beaver Creek Hills, Beaver County, Utah, Aug. 15, 1904, in the U. S. National Museum (examined). Three additional males labeled "Cotype", same number and data as holotype; eight males and three females, labeled "Paratype", same number and data as holotype; one female, similarly labeled but herewith designated as lectoallotype, all in the U. S. National Museum (examined). One male, same data, marked "Topotype", in California Academy of Sciences (examined). I am indebted to Dr. Richard B. Selander for pointing out to me that the original description is erroneous in that it states the type locality as Beaver Hills, "Jackson County", Utah. The type series was taken by Messrs. Doll and Engelhardt.

Specimens examined, exclusive of type material: ARIZONA: Holbrook; Houserock Valley. UTAH: Emory County; Ogden; St. George. COLORADO: Poncha. MONTANA: "Mont." NEVADA: Austin; Elko; Pyramid Lake. IDAHO: Boise City. WASHINGTON: Kahlotus; Richland. OREGON: Bend; Durkee; Grizzly Butte; Klamath Falls; Summer Lake, Lake County. CALIFORNIA: Anaheim; Cypress, Orange County; Grant Lake, Mono County; Mammoth, Mono

County; Palm Springs; Sierraville, Sierra County; Stockton; Vallyermo; Weed; Whittier.

Collection dates: June (?) to Sept. 22.

Flower hosts of adults: Isocoma vernonioides; "Yellow Cleome".

Bee hosts of larvae: unknown.

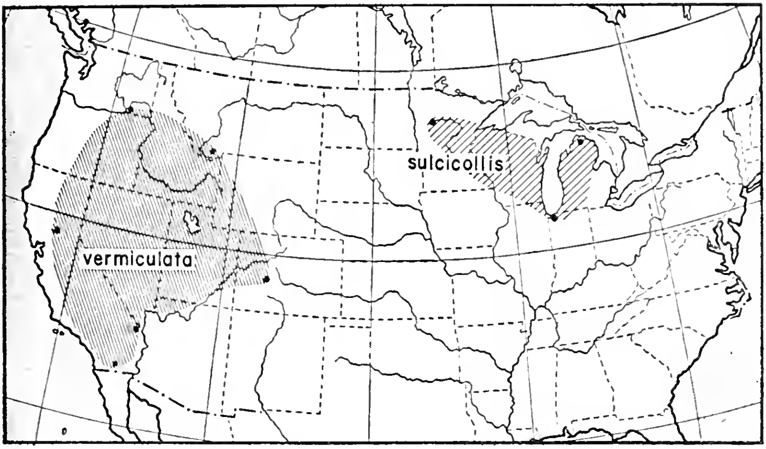

FIG. 17. Map showing the distribution of *Zonitis (Neozonitis) vermiculata* and *Z. (Neozonitis) sulcicollis.*

Zonitis (Neozonitis) hesperis Selander

(Figs. 20, 122, 191)

Zonitis hesperis Selander, 1952, Jour. Kansas Ent. Soc., vol. 24, p. 130.

Morphologically similar to *Z. vermiculata* and *Z. aurea* but differs from the former in the smoother elytra which are brownish rather than purplish; shorter, stouter body form; and more robust femora and tibiae. From *aurea* by its larger size, dark elytra and legs. In addition it differs in that the tarsal claws have only five or six teeth in the inner row in the females and seven or eight in the males, instead of the 13 or 14 found in both *vermiculata* and *aurea.*

Body surface shining. Fulvous with elytra, eyes, distal parts of mandibles, palpi, antennae, and legs piceous or deeply fuscous; coxae, trochanters, bases of femora and extreme bases of first tarsal segments flavous. Eyes small, widely separated above and below. Galeae short, scarcely extending beyond mandibles, lobiform. Sixth antennal segment scarcely twice as long as wide. Pronotum smooth, shining, disk shallowly impressed on either side near base. Elytra almost smooth, feebly rugose. Metatibial spurs slender, subequal, outer spurs concave, inner spurs flattened, sticklike. Males with fifth abdominal sternum broadly, shallowly emarginate, sixth deeply cleft medially, centrally impressed. Females similar to males except fifth sternum not emarginate, sixth convex, apex truncate. Length 8-8.5 mm.

This species was described from two females taken at Wild's Ranch, Hill Creek, Uintah County, Utah, August 5 and 6, 1937, elevation 6,000 ft., George E. Wallace collector. Both specimens are in the Carnegie Museum at Pittsburgh, Pennsylvania.

I have examined the female paratype and in addition, one male herewith designated as the neallotype, in the Snow Entomological Museum, University of Kansas, taken at Palm Springs, California, October 9, 1924. It is exactly similar to the females except as noted above.

No hosts of this species are known.

Zonitis (Neozonitis) aurea MacSwain

(Figs. 18, 123, 193)

Zonitis aureus MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 73.

This species is morphologically similar to *Z. vermiculata* and to *Z. hesperis* but is easily and amply distinguished from either of these by its small size, smooth elytra, and golden color.

Body surface shining. Antennae, apices of femora, tibiae, and tarsi usually piceous, remainder of body golden yellow. Pronotum transverse, sides evenly rounded. Elytra almost smooth, impunctate. Metatibial spurs dissimilar, outer spurs wider than inner, apices oblique; inner spurs flattened, parallel-sided, apices rounded. Males with fifth abdominal sternum broadly emarginate, sixth deeply cleft medially with a deep central impression. No females seen. Length 7.5-9 mm.

Types: Holotype male no. 6216, in the California Academy of Sciences, from Grant Lake, Mono County, California, taken on flowers of *Chrysothamnus* sp., August 3, 1950 by J. W. MacSwain. Four paratypes, all males, one same data as holotype, three same locality as holotype, August 5, 1948, P. D. Hurd and J. W. MacSwain collectors.

Specimens examined: CALIFORNIA: one male paratype, Grant Lake, Mono County, August 3, 1950; two male paratypes, same locality, August 5, 1948, in California Insect Survey collection. UTAH: Axtel, San Pete County, three males, August 11, 1950, on

Chrysothamnus nauseosus, R. B. Selander collector, in the Selander collection; one male, same data, in California Insect Survey collection.

Flower hosts of adults: Chrysothamnus sp.; *Chrysothamnus nauseosus.*

Bee hosts of larvae: unknown.

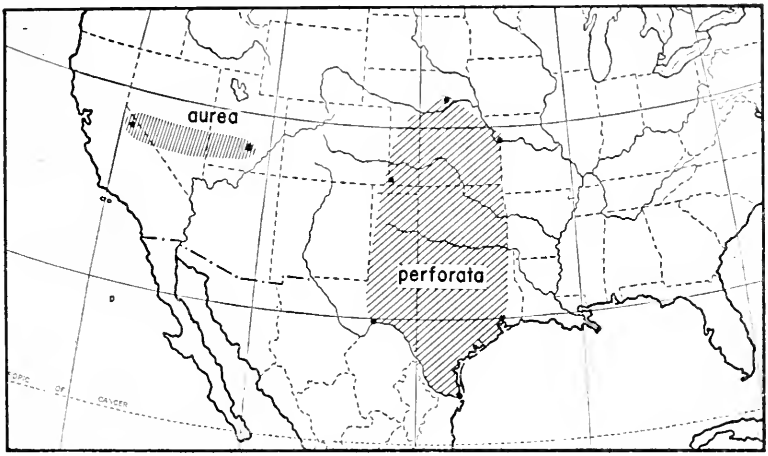

FIG. 18. Map showing the distribution of *Zonitis (Neozonitis) aurea* and *Z. (Parazonitis) perforata.*

Zonitis (Neozonitis) interpretis, sp. nov.

(Figs. 32, 81, 125, 192)

Related to *Z. vermiculata* but easily distinguished by the protruding coarsely faceted eyes which are produced beneath the head; the punctate elytra; the elongate antennal segments; and the infuscate abdomen.

Body surface moderately shining. Head, prothorax, scutellum, mesosternum, metasternum, coxae, trochanters, and femora except extreme apices, bright flavous. Eyes, antennae, palpi, tips of mandibles, tibiae, and tarsi piceous. Abdomen fuscous or dark testaceous. Elytra deep fuscous, almost piceous. Eyes below head separated a distance less than half that separating them on frons. Sixth antennal segment three times as long as wide. Inner spurs of posterior tibiae shorter and less than half as wide as outer spurs. Length 10 mm.

Male: Head in cephalic aspect subquadrate or rounded above bases of mandibles, distance from vertex to labroclypeal suture slightly less than distance across tempora; tempora feebly swollen; vertex feebly tumid; surface shining, sparsely irregularly punctate, punctures denser and coarser on frons between antennal bases; an inconspicuous, short, pale seta arising from each puncture. Eyes large, coarsely faceted, emarginate, separated above by a distance almost twice the length of the second antennal segment, below by slightly less than half this distance. Clypeus feebly punctured on basal half, shining, impunctate on apical half. Labrum short and broad, about one fourth wider than long, sparsely coarsely punctate with long, pale setae, apex almost truncate. Mandibles short, stout, abruptly arcuate inward at half their length, sides moderately densely punctate and pubescent. Palpi moderately long, shining, sparsely pale pubescent, distal segments with paler impressed areas on apical third, apices truncate. Galeae shorter than labial palpi, stout, lobiform, shining. Antennae long, filiform, each with first segment attaining half the width of eye behind emargination, moderately inflated, shining, sparsely punctate and pubescent; second subequal to first in length, feebly enlarged from base to apex, otherwise similar to first; third almost one third longer than second, more densely punctate and pubescent, hence less shining than second, slightly flattened; fourth longer, more flattened than third, otherwise similar to it; fifth subequal and similar to fourth; sixth three times as long as wide, slightly longer than fifth otherwise similar to it; seventh similar to sixth but shorter, somewhat enlarged at middle; eighth and ninth subequal to seventh; tenth similar but shorter; eleventh more than one third longer than tenth, inner margin evenly arcuate from base to apex, outer straight, apex subacute.

Pronotum shining, posterior angles not divergent, sides evenly divergent to anterior third, thence rapidly narrowed to apex, widest at anterior third; surface irregularly, sparsely and finely punctate, a shallow fovea each side of median line on basal third, a feeble median sulcus on basal third, extreme base somewhat declivous, margin raised. Scutellum small, densely, finely punctate, clothed with pale pubescence, transversely depressed before apex, apex subacutely rounded. Elytra moderately densely, shallowly punctate becoming shallowly rugose-punctate apically, clothed with short, fuscous pubescence, sutures narrowly raised, side margins extremely thin, also raised. Thorax and abdomen ventrally shining, moderately densely punctate, finely pale pubescent. Coxae and trochanters punctured and pubescent like thorax, femora more sparsely punctate, tibiae and tarsi densely punctate and pubescent. Spurs of anterior and middle tibiae long, slender, spiniform; inner spurs of posterior tibiae half as wide as outer, slender, parallel-sided, concave, apices subacute; outer similar but broader and feebly widened to apex. Fifth abdominal sternum broadly, shallowly emarginate, impressed medially at apex; sixth cleft to the base medially with a large, deep central impression.

Female: unknown.

Types: Holotype male, Chisos Mountains, Texas, July 17, 1946, D. J. and J. N. Knull, collectors (in Ohio State University collection).

Hosts: unknown.

This is a remarkable species in that the characters of the eyes and antennae are quite similar to those of *Pseudozonitis.* The genitalic characters, however, place it in *Zonitis.* The form of the head, pronotum, and metatibial spurs in addition to the color pattern support this classification.

Subgenus PARAZONITIS, subg. nov.

North American Zonitini with galeae modified into a sucking organ; cephalic outline triangular to elongate triangular; eyes small, not produced below head; pronotum quadrate or transverse; elytra usually densely, finely or coarsely punctate.

Type: Zonitis vittigera (LeConte), 1853.

KEY TO SPECIES OF PARAZONITIS

1.	Pronotum extremely sparsely punctate	2
	Pronotum at least moderately densely punctate	5
2(1).	Galeae slender, longer than mandibles, usually attaining metacoxae	3
	Galeae no longer than mandibles, rarely exceeding mesocoxae	4
3(2).	Elytra densely rugose-punctate	*punctipennis*
	Elytra sparsely, coarsely punctate	*sayi*
4(2).	Elytra entirely black or fulvous, or black with fulvous borders; galeae extremely slender	*tarasca*
	Elytra pale greenish or testaceous; galeae stout	*dunniana*
5(1).	Pronotum coarsely, moderately densely punctate, sides rounded,	*cribricollis*
	Pronotum uniformly densely and finely punctate, sides subparallel	6
6(5).	Galeae stout, no longer than maxillary palpi; elytra rufous, coarsely rugose-punctate basally	*perforata*
	Galeae distinctly longer than maxillary palpi; elytra fulvous or testaceous, often vittate, densely punctate basally	*vittigera*

Zonitis (Parazonitis) vittigera (LeConte)

(Figs. 19, 31, 49, 78, 126, 196)

This appears to be a polytypic species represented by two subspecies. Nominate *Z. vittigera* is distinguishable from *vittigera propinqua* by the fulvous ground color, usually vittate elytra, sparser elytral pubescence, longer galeae, and more eastern distribution. It is also closely related to *Z. perforata* but that species has reddish elytra which are coarsely punctate basally, and extremely short stout galeae. *Z. cribricollis* also belongs in this group but is distinguishable by the coarsely punctured pronotum, densely punctate elytra, variable elytral color, elongate head, and smaller size.

Zonitis (Parazonitis) vittigera vittigera (LeConte)

(Figs. 19, 31, 49, 78, 126, 196)

Nemognatha vittigera LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 348; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 215; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1355; Graenicher, 1910, Ent. News, vol. 21, p. 72; Wickham, 1911, Univ. of Iowa, Lab. of Nat. Hist., vol. 6, p. 35; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 171; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Dillon, 1952, Amer. Midland Nat., vol. 48, p. 338.

Zonitis vittigera, Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 171; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, pp. 72, 76.

Body surface feebly shining. Color variable but typically fulvous except eyes, antennae, tips of mandibles, palpi, galeae, apices of femora, entire tibiae and tarsi, a broad discal vitta on each elytron black or piceous. Varies to pale testaceous with elytra not vittate or rarely with elytra entirely black except narrow sutural and lateral margins fulvous. Galeae produced into a sucking organ, in repose usually attaining anterior margin of metacoxae. Metatibial spurs subequal, the outer somewhat wider and longer than inner, both stout, obliquely concave, apices rounded. Length 7-12 mm.

Male: Head broadly triangular, distance from vertex to labroclypeal suture scarcely less than distance across tempora, tempora usually distinctly inflated, vertex evenly rounded or feebly tumid; surface moderately densely punctate, punctures finer and denser between antennal bases and near eyes, coarser and sparser on frons, often absent on median line, a short, fine, reddish seta arising from each puncture. Eyes moderately large, nearly transverse, about twice as long as broad, emarginate at anterior third, anterior margin evenly convex, fringed at least posteriorly with long, fine setae. Clypeus with a moderately broad, transverse impression on basal half which is coarsely punctate, apical half glabrous, shining. Labrum large, one fifth wider than long, surface moderately densely punctate, clothed with longer setae at least anteriorly, sides feebly rounded, apex broadly rounded, a broad, shallow impression medially extending from base to apex. Mandibles long and stout, somewhat convergent from bases to apical third, thence broadly arcuate inward, sides densely punctate and pubescent. Maxillary palpi long, slender, all segments except basal punctate and pubescent. Labial palpi moderately long, segments punctate and pubescent like maxillary palpi. Galeae stout, sparsely hairy, in repose extending to metacoxae. Antennae stout, about twice as long as pronotum, segments submoniliform, each antenna with first segment reaching more than half way across eye behind emargination, arcuate, moderately inflated, constricted just before base, shining but punctate and pubescent; second scarcely two thirds as long as first, widened from base to apex, shining, punctured and pubescent like first; third one third longer than second, sides subparallel, punctation and pubescence denser, hence less shining than second; fourth, fifth, and sixth similar and subequal to third, sixth about two and one-half times as long as broad; seventh and eighth similar, each scarcely shorter than sixth; ninth and tenth similar to eighth but progressively shorter, feebly flattened; eleventh almost one third longer than tenth, apical third evenly tapered to apex which is subacute.

Pronotum scarcely wider than head, about one sixth wider than long, base feebly emarginate above scutellum, posterior angles scarcely divergent, sides almost parallel to apical fourth, thence broadly rounded to apex; surface densely, finely punctate, clothed with short, erect pubescence; disk evenly convex from side to side, in side view declivous at extreme base, a feeble median impression at basal fourth. Scutellum large, coarsely punctate, impressed near apex, apex broadly rounded. Elytra moderately densely punctate, feebly rugosely so at base, most punctures separated by about their own diameters; pubescence short, fine, semierect; humeri and irregular subscutellar areas moderately inflated; sutures and margins distinctly raised; black discal vittae present, obsolete, or absent. Thorax and abdomen ventrally shining, densely punctate, clothed with longer pale pubescence than on elytra. Legs densely punctate, pubescent, color of pubescence similar to that of integument; protibial spurs usually two, short, slender, spiniform; mesotibial spurs two, dissimilar, outer usually broader, less acute than inner; metatibial spurs stout, broad, obliquely concave, apices rounded, the outer usually somewhat longer and broader than inner. Fifth abdominal sternum with a small, shallow, somewhat transparent impression medially at apex; sixth medially deeply cleft, center impressed.

Female: Similar to male but abdominal segments scarcely less densely punctate; fifth abdominal sternum not modified, sixth broadly, extremely shallowly emarginate; both fringed apically with long, fine hairs.

Types: LeConte's type is lost. The original description cites Georgia as the type locality. The single specimen in the LeConte collection, a male, no. 4969, is probably not the type as it bears a yellow label indicating "Western States". LeConte's label for Georgia was brick red in color.

Neoholotype male, neallotype, and three female neoparatypes (new designations) taken on *Rudbeckia* sp. at Sedalia, Missouri, July 4, 1940, W. R. Enns collector. With the exception of two female neoparatypes which are in the University of Missouri collection, the specimens will be deposited in the Snow Entomological Museum, University of Kansas.

Specimens examined from numerous localities including FLORIDA, GEORGIA, ALABAMA, MISSISSIPPI, LOUISIANA, OKLAHOMA, ARKANSAS, KANSAS, MISSOURI, ILLINOIS, INDIANA, IOWA, NEBRASKA, MINNESOTA, WISCONSIN, and MICHIGAN. The following localities are marginal: Unadilla, Ga.; Labelle, Fla.; Baton Rouge, La.; S. McAlester, Okla.; Sioux Co., Neb.; Brainerd, Minn.; Kenosha, Wis.; East Lansing, Mich.; "Ind."; Cheyenne Co.; Kan. Additional collecting should reveal its presence in Tennessee, Kentucky, and possibly western Ohio.

Collection dates: April 13 to September 6.

Flower hosts of adults: Rudbeckia sp.; *R. hirta; Helianthus annuus; H. occidentalis; Helianthus* sp.; *Heliopsis* sp.; *Vernonia* sp.; *V. baldwinii interior; Ratibida pinnata; R. columnifera; Silphium speciosum; Coreopsis grandiflora; Solidago graminifolia; Psoralea floribunda.* Specimens have also been taken in Japanese beetle traps at St. Louis, Mo.

Bee hosts of larvae: unknown.

Brimley (1938) records this species from Raleigh, North Carolina, but the record appears to be based on an incorrectly determined specimen. A specimen so labeled is in the North Carolina Department of Agriculture collection but it belongs to *Nemognatha piazata* (Fabr.).

Zonitis (*Parazonitis*) *vittigera propinqua* MacSwain (new combination)

(Figs. 19, 197)

Zonitis propinqua MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 74.
Nemognatha vittigera (in part), Dillon, 1952, Amer. Midland Nat., vol. 48, p. 338.

Morphologically extremely similar to the nominate form but recognizable by the denser elytral pubescence, shorter galeae, paler color, and distribution.

Body surface feebly shining. Testaceous except antennae, galeae, palpi, apices of femora, greater portion of tibiae, and tarsi piceous. Galeae one and one-fourth times as long as mandibles. Metatibial spurs as in *vittigera*. Males with fifth abdominal sternum medially impressed at apex, sixth deeply cleft and impressed. Females similar to males but fifth sternum not impressed, sixth triangularly emarginate medially at apex. Length 10-18 mm.

Holotype male no. 6217, and allotype, Alpine, Brewster Co., Texas, July 2, 1942, E. C. Van Dyke, collector, in the California Academy of Sciences; sixteen paratypes, same locality as holotype, various dates from May 19 to July 11 (examined).

Additional specimens have been examined from numerous localities including TEXAS, NEW MEXICO, OKLAHOMA, KANSAS, NEBRASKA, MISSOURI, and ARKANSAS. The map shows the distribution and region of intergradation. One specimen labeled "Ut." and another labeled "Col.", no other data, appear to belong to this form. The following localities are marginal: Brownsville, Texas; Springdale, Arkansas; New Hartford, Missouri; Lincoln, Nebraska; Oakley, Kansas; and Garfield, New Mexico. Leng (1920), lists *vittigera* from "Ariz." but I have found no specimens so labeled.

Collection dates: April 13 (Texas) to August 15 (Kansas).

Flower hosts of adults: Rudbeckia sp.; *Gaillardia* sp.; *Helianthus annuus; Vernonia fasciculata; Cacalio* sp.

Bee hosts of larvae: unknown.

As in other species of North American nemognathine beetles, the two subspecies of *vittigera* exhibit a broad region of intergradation. The characters separating these two subspecies vary somewhat over the entire range but are more constant at the extremes. The length of the galeae of each individual varies somewhat, as does also the presence or absence of elytrae vittae, and the density of the pubescence, but in most specimens at least two of the characters conform to the typical pattern so that they may be placed in the proper category. The male genitalia of *propinqua* are morphologically quite similar to those of *vittigera* and both are obviously very close to *perforata*. Intergrades between *vittigera* and *propinqua* occur most frequently in the five state area including Nebraska, Kansas, Oklahoma, Arkansas, and Missouri.

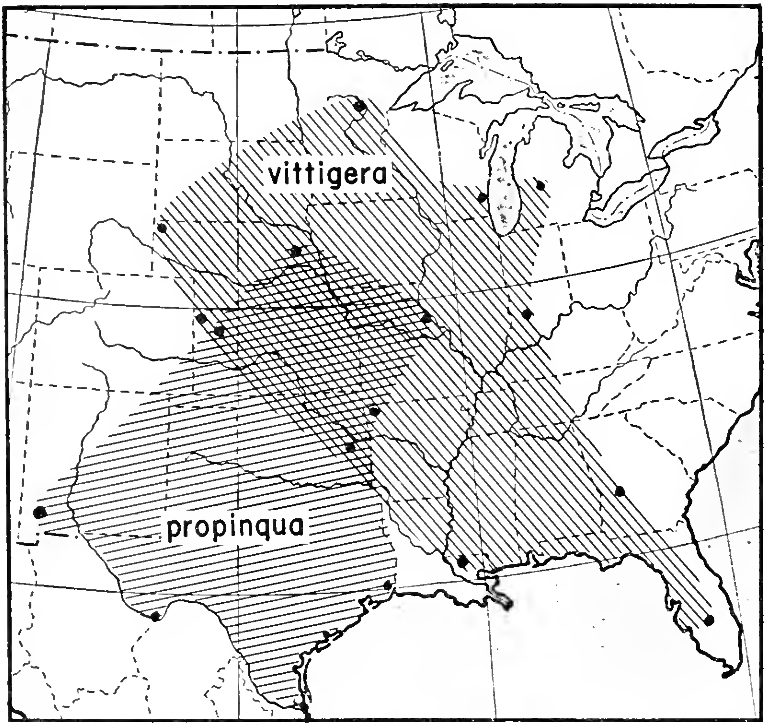

FIG. 19. Map showing the distribution of *Zonitis (Parazonitis) vittigera*. The zone of intergradation of the subspecies is indicated by the overlapping of types of shading.

Zonitis (Parazonitis) perforata Casey

(Figs. 18, 132, 194)

Zonitis perforata Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 170; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, pp. 72, 76.
Nemognatha perforata, Schaeffer, 1905, Bull. Brooklyn Inst. Arts & Sci., vol. 1, p. 138; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.
Nemognatha vittigera, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 338.

Closely related to *Z. vittigera* but distinguishable by the shorter galeae, more coarsely punctate, basally rugose elytra, size, and color.

Body surface moderately shining. Head and pronotum flavous, densely, finely punctate, clothed with short, erect, pale pubescence. Elytra rufous, moderately sparsely, coarsely rugose or rugose-punctate basally becoming coarsely punctate apically, clothed with pubescence similar to but sparser than that on pronotum. Eyes, antennae except basal segments, apical palpal segments, galeae, distal halves of mandibles, extreme apices of femora, tibiae in variable proportion, and tarsi black. Anterior tibial spurs usually absent. Middle tibiae each with two strong, slender spurs which are concave, subacutely pointed. Metatibial spurs usually similar and equal, inner spurs scarcely more slender than outer in some specimens, large, obliquely concave, apices rounded. Sternum testaceous, shining, densely punctate, more sparsely pubescent, than notum. Abdomen of male densely punctulate and pubescent, fifth sternum feebly impressed medially at apex, sixth medially cleft to base with a moderately broad, central impression; female with abdomen no more densely punctate and pubescent than thorax, fifth sternum not impressed, sixth shallowly, triangularly emarginate medially at apex. Length 10-14 mm.

Types: Holotype male (new designation), no. 49208, in the Casey collection at the U. S. National Museum (examined). It is labeled "Tex." The original description cites Austin, Texas, as the type locality. Only the two basal segments remain of the left antenna.

Specimens examined from numerous localities in TEXAS and KANSAS. In addition specimens from Liberty, MISSOURI, and Halsey and Cambridge, NEBRASKA, extend the range eastward and northward. Marginal localities include Sanderson, Brownsville, and Liberty, Texas; Liberty, Missouri; Lincoln, Nebraska; and Liberal, Kansas.

Collection dates: Texas: April 16 to Dec. 11. Remainder of range: May 1 to August 8.

Flower hosts of adults: Rudbeckia sp.; *Ratibida pinnata; R. columnaris; Helenium microcephalum; Vernonia* sp.; *Cirsium* sp.; *Argemone* sp.; *Gaillardia* sp.; and "Compositae sp."

Bee hosts of larvae: unknown.

This robust species is readily spotted in the field by the bright rufous appearance of the elytra, flavous head and pronotum, and short galeae. The eggs are laid on the phyllaries of the host plant and vary in color from white to yellow. No counts were obtained but the clusters are large and an average of about 300 eggs would be a fair estimate. The females lay more than one cluster of eggs.

Zonitis (Parazonitis) cribricollis (LeConte)

(Figs. 20, 77, 130, 195)

Nemognatha cribricollis LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 348; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 215; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 380; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, p. 186; Blatchley, 1910, A Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1354; Graenicher, 1910, Ent. News, vol. 21, p. 74; Wickham, 1911-13, Univ. Iowa, Lab. Nat. Hist., vol. 6, p. 35; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Dillon, 1952, Amer. Midland Nat., vol. 48, p. 339.

Zonitis cribricollis, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Nemognatha porosa LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 349; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 215; Snow, 1883, Trans. Kansas Acad. Sci., vol. 8, p. 43; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 380; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis porosa, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Nemognatha fuscipennis LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 349; 1880, Trans. Amer. Ent. Soc., vol. 8, p. 215; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 380; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis fuscipennis, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35.

Related to *Z. vittigera* but distinguishable at once by the elongate head and transversely oval, coarsely punctured pronotum. Its average size is smaller than that of *vittigera*. Smaller than average specimens bear a marked resemblance to some species of *Gnathium* but the elytral punctation in addition to the filiform antennae readily serves to distinguish them. The punctate elytra and general color distinguishes it from *Nemognatha sparsa* which it somewhat resembles.

Body surface moderately shining. Color variable, usually testaceous or fulvous except antennae, eyes, palpi, galeae, tips of mandibles, metasternum, tibiae, and tarsi fuscous varying to piceous. Head often dark brown in specimens that have not been degreased. Elytral color varying from pale testaceous to entirely fuscous, often with disks fuscous, the sutures and margins narrowly pale. Pronotum with sides rounded, disk coarsely, irregularly punctate. Elytra moderately coarsely, extremely densely and uniformly punctate. Galeae produced into a short sucking organ, about twice as long as labial palpi, not attaining metacoxae. Metatibial spurs large, elongate, concave, equal. Length 5-11 mm.

Male: Head short, rounded, labrum and mandibles elongate; distance from vertex to labroclypeal suture about one sixth less than distance across tempora; tempora usually evenly rounded, not inflated; vertex evenly rounded, feebly tumid in some specimens; surface coarsely, moderately densely punctate, an irregular, narrow median area impunctate, a short pale seta arising from each puncture. Eyes large, one fourth longer than wide, moderately protruding, feebly emarginate at anterior third, widely separated above and below. Clypeus poorly defined, densely and coarsely punctate basally, apical third glabrous. Labrum as long as wide, moderately sparsely punctured and pubescent, apex subtruncate. Mandibles extremely long, slender, each broadly arcuate inward at apical third, sides densely punctured and pubescent. Palpi moderately long, slender, sparsely pubescent, ultimate segment of each with a glabrous, impressed area at apical third, apices subtruncate. Galeae slender, hairy, tapering to an acute point, short, not attaining metacoxae. Antennae moderately long, about two and one-half times as long as pronotum, each with first segment short, not reaching half way across eye, moderately inflated, moderately densely punctured and pubescent but shining; second almost as long as first, feebly enlarged to apex, punctured and pubescent like first; third about one-third longer than second, more densely punctate and pubescent than first and second; fourth to tenth similar to third but shorter; eleventh one fourth longer than tenth, apex subacutely pointed.

Pronotum transverse, about one fifth wider than long, sides usually evenly rounded from base to apex, posterior angles feebly produced in some specimens, disk convex with irregular raised areas, basal fifth abruptly sloping downward to base, a median sulcus on basal fourth; punctures coarse, irregular, setigerous. Scutellum moderately large, sparsely punctate and pubescent, a median impressed area at extreme base, apex subacutely pointed. Elytra uniformly densely, moderately coarsely punctate, punctures each bearing an extremely short, pale seta; sutures and margins moderately raised, humeri prominent. Thorax shining ventrally, moderately densely, finely punctate and pubescent. Legs punctured and pubescent like thorax except tibiae and tarsi more densely so; anterior and middle tibiae with both spurs slender, spiniform, acute, outer spurs usually straight, inner somewhat arcuate; metatibial spurs similar and equal, rather long, concave, feebly flared or parallel-sided. Abdomen densely, finely punctate and pubescent, fifth abdominal sternum feebly impressed medially at apex, sixth medially cleft with a deep, central, funnel-shaped impression.

Female: Similar to male but average size larger, abdomen much less densely punctate and pubescent, fifth and sixth abdominal sterna not modified, sixth truncate at apex.

Types: Holotype male (new designation), no. 4970 labeled "Texas," Haldeman collector (examined); of *fuscipennis* LeConte, lectotype female, (new designation), no. 4971 from St. Louis, Missouri; of *porosa* LeConte, lectotype male (new designation), no. 4972 from Georgia (examined), all in the LeConte collection, Museum of Comparative Zoology, Harvard University.

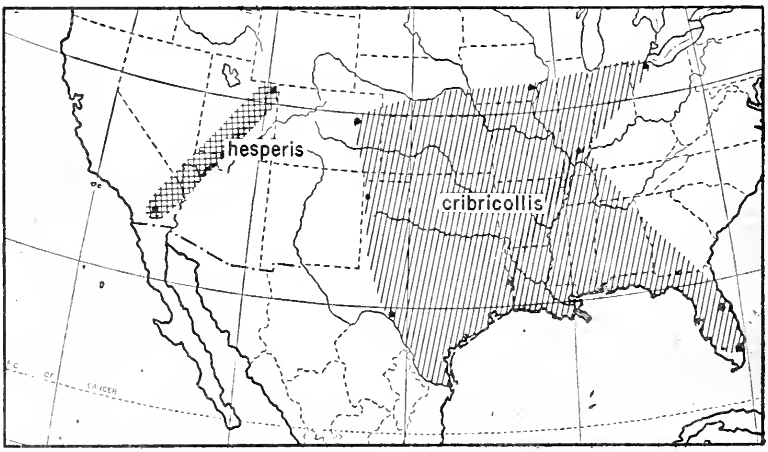

FIG. 20. Map showing the distribution of *Zonitis (Neozonitis) hesperis* and *Z. (Neozonitis) cribricollis.*

Specimens examined: TEXAS: Bastrop; Brazos Co.; Brownwood; College Station; Colorado County; Comal County; Cypress; Dallas County; Denton; Fedor; Jonesville; Mercedes; Rock Island; Sabinal; San Antonio; San Patricia County; Uvalde County; Waco. OKLAHOMA: Cherokee; Salt Plains; Ft. Sill; Lawton; Medford; Oklahoma City; South McAlester. KANSAS: Arkansas City; Baxter Springs; Belle Plaine; Ft. Hays; Gove County; Hutchinson; Lawrence; McPherson; Mt. Hope; Newton; Reno County; Sylvia; Wichita. COLORADO: Denver. FLORIDA: Miami; Orlando. ARKANSAS: Hot Springs; Knobel; Springdale. MISSOURI: Carthage; Creve Coeur; Columbia; Holden; Joplin; Liberty; Middlebrook; Mountain View; Neosho; New Hartford; Rosati; Sedalia; St. Louis; Tyrone; Wentzville.

IOWA: Ft. Madison; Iowa City; LeClair. ILLINOIS: Dolson; Fall Springs; Galesburg; Milo; Oregon; Rock Island. INDIANA: Elkhart; Lake County. OHIO: Swann Township, Lucas County. NEBRASKA: "Neb." PENNSYLVANIA: "Penn." (?)

Collection dates: April 1 to July 25 (extreme southern Texas, November and December; Florida, March.)

Flower hosts of adults: Rudbeckia amplexicaulis; Rudbeckia sp.; *Coreopsis tinctoria; Helianthus petiolaris.* A few adults taken in Japanese Beetle Traps at St. Louis, Missouri.

Bee hosts of larvae: unknown.

Zonitis (Parazonitis) sayi Wickham

(Figs. 21, 75, 131, 199)

Nemognatha immaculata Say, 1817, Jour. Acad. Nat. Sci. Philadelphia, vol. 1, p. 22; (*nec Apalus (= Zonitis) immaculata* Olivier, 1789); Say, 1817, American Entomology, vol. 1, tab. 3; LeConte, 1853, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, p. 348; 1859, The Complete Writings of Thomas Say, vol. 1, p. 13; *ibid.*, vol. 2, p. 3; Snow, 1878, Trans. Kansas Acad. Sci., vol. 6, pp. 69, 77; LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Snow, 1881, Trans. Kansas Acad. Sci., vol. 7, p. 70; 1883, *ibid.*, vol. 8, p. 43; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, pp. 378, 379; Pierce, 1904, (Nebraska) Univ. Studies, vol. 4, p. 24; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, no. 1, p. 174; *ibid.*, vol. 20, no. 2, p. 186; Graenicher, 1910, Ent. News, vol. 21, p. 74; Wellman, 1912, Ent. News, vol. 23, p. 38; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 169; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Carruth, 1931, Ent. News, vol. 42, p. 55; Dillon, 1952, Amer. Midland Nat., vol. 48, p. 339.

Zonitis immaculata, Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 170; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 481; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, pp. 6, 12, 13; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Zonitis sayi Wickham, 1905, Canadian Ent., vol. 37, p. 171; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Nemognatha sayi, Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

This is the nominate species of the Sayi group which, in addition to *sayi*, includes *Z. punctipennis, Z. dunniana,* and *Z. tarasca. Z. sayi* is most closely related to *Z. dunniana* but differs from it by its longer galeae, shorter mandibles, usually impunctate pronotum, smaller average size, and extensive range.

Body surface shining. Color variable, greenish to pale testaceous except eyes, antennae, palpi, tips of mandibles, galeae, apices of femora and tibiae, and entire tarsi fuscous or black. Some specimens with metathoracic sternum fuscous. Galeae moderately long, almost attaining metacoxae, longer than maxillary palpi. Spurs of posterior tibiae unequal, the outer broader than inner, both concave, flared at apices in most specimens. Elytra irregularly, sparsely and coarsely punctured, more densely so toward apices, intervals glabrous. Length 8-12 mm.

Male: Head moderately large, subtriangular, distance from vertex to labroclypeal suture slightly less than distance across tempora, tempora feebly to moderately inflated, vertex evenly rounded; surface sparsely, finely punctate, more densely so on apical half of frons, clypeus, and labrum, a short pale seta arising from each puncture. Eyes moderately large, oval, emarginate at anterior third, widely separated above and below. Clypeus feebly impressed, anterior margin glabrous. Labrum slightly wider than long, moderately sparsely punctured, hairy, usually with a shallow median fovea, absent in some specimens. Mandibles moderately long, slender, each broadly rounded inward at apical third, sides punctate clothed with fine pale hairs. Palpi long, slender, clothed with sparse brown pubescence, last segment of each with a glabrous impressed area at apical fourth, apices subtruncate. Galeae usually dark, slender, in repose almost attaining metacoxae. Antennae moderately long, about two and one-half times as long as pronotum, third to eleventh segments somewhat flattened, each antenna with first segment reaching half way across eye, feebly swollen and arcuate, moderately densely, finely punctate and pubescent; second two thirds as long as first, swollen near apex, punctured and pubescent like first; third segment one third longer than second, feebly broadened from base to apex, more densely punctured and pubescent than first and second; fourth to tenth similar to third but progressively shorter than each preceding; eleventh one third longer than tenth, apical third tapered to a subacute point.

Pronotum shining, scarcely broader than long, widest at posterior angles which are feebly produced, sides parallel to subsinuate, anterior angles abruptly rounded, apex subtruncate, base feebly arcuate; disk evenly convex from side to side, impunctate except a few fine, sparse punctures at sides; some specimens with a more or less distinct fovea each side of disk and sub-basal median impression. Scutellum moderately large, moderately densely punctate and pubescent except at apex, a feeble to moderately deep median impression present, apex subacutely rounded. Elytra shining, humeri slightly elevated, glabrous, remainder irregularly, sparsely punctate, punctures coarse, moderately deep, separated basally by intervals of irregular extent, becoming confluent at apices, sutures and margins feebly but distinctly raised. Thorax ventrally shining, moderately densely punctate clothed with short, fine pubescence, punctures and pubescence denser medially and at margins. Legs uniformly densely punctate and pubescent except coxae which are almost glabrous; spurs of fore and middle tibiae moderately long, slender, spiniform; metatibial spurs moderately large, apices broadened, concave, inner spurs narrower than outer and usually shorter. Abdomen extremely densely, finely punctate, clothed with pale, appressed pubescence; sixth abdominal sternum medially deeply cleft with a central, circular impression.

Female: Similar to male except abdomen more shining, less densely punctate and pubescent than in male, appearing scabrous-punctate, sixth sternum not modified, apex with a feeble median, emargination.

Types: Say's types, hence also Wickham's, lost. The original description cites the type locality thus: "Inhabits the plains of the

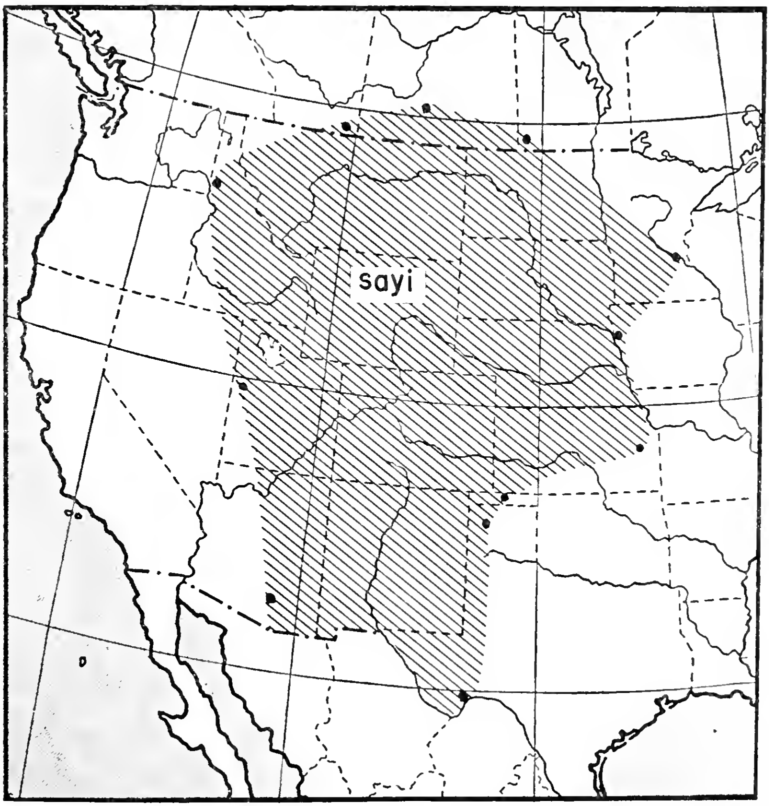

FIG. 21. Map showing the distribution of *Zonitis (Parazonitis) sayi.*

Missouri. Found on thistles *(Cardui)* by Mr. Nuttall." Neoholotype male, neallotype, and eight neoparatypes, one male and seven females, taken at Cambridge, Nebraska, August 17, 1921, A. P. Morse collector, in the Museum of Comparative Zoology, Harvard University.

Specimens examined from numerous localities extending from Mexico to Canada including the following states and provinces: ARIZONA, NEW MEXICO, TEXAS, OKLAHOMA, KANSAS, COLORADO, UTAH, WYOMING, NEBRASKA, IOWA, MINNESOTA, SOUTH DAKOTA, NORTH DAKOTA, MONTANA, ALBERTA, MANITOBA, SASKATCHEWAN. The following localities are marginal: Tucson, Arizona; Juab Co., Utah; Lewiston, Idaho; Medicine Hat, Alberta; Elbow, Saskatchewan; Lyleton, Manitoba; St. Paul, Minnesota; Sergeant Bluff, Iowa; Lawrence, Kansas; Guymon, Oklahoma; Lockney, Texas. This species also occurs in Mexico.

Collection dates: May 21 to September 19.

Recorded elevations: 1150 to 7500 ft. altitude.

Flower hosts of adults: Helianthus lenticularis; Helianthus sp.; *Grindelia squarrosa; Grindelia* sp.; *Solidago* sp.; *Haplopappus* sp.; *Sphaeralcea* sp.; *Chrysopsis hispida; Englemannia pinnatifida;* and *Silphium* sp.

Bee hosts of larvae: one adult male labeled "*Nomia* nests," 6 mi. W Smithfield, Utah, Aug. 20, 1949, G. E. Bohart, is in the Utah State Agricultural College collection.

Zonitis (Parazonitis) dunniana Casey

(Figs. 22, 128, 198)

Zonitis dunniana Casey, 1891, Ann. New York Acad. Sci., vol. 6, p. 170; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Nemognatha dunniana, Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 379; Schaeffer, 1905, Bull. Brooklyn Inst. Arts & Sci., vol. 1, p. 138; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 168; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Nemognatha immaculata, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 339.

Similar to *Z. sayi* but distinguishable by its larger average size; galeae only as long as or shorter than maxillary palpi, not attaining metacoxae; mandibles longer and stouter, less markedly arcuate than in *sayi;* pronotum usually with fine sparse punctures on sides at least basally, disk bifoveate in some specimens; elytra usually with three feebly raised costae; metatibial spurs almost equal, the inner ones narrower than outer; distribution restricted to the Mexican plateau region of southeastern United States and northern Mexico.

Body surface shining. Color principally uniformly pale flavous, elytra frequently with a greenish caste; eyes, antennae (except first two segments), distal portions of mandibles, usually terminal palpal segments, and terminal segments of tarsi fuscous or black. Abdominal sterna testaceous. Pronotum smooth, shining, extremely finely punctate at posterior angles, some specimens impunctate. Elytra smooth, shining, sparsely, extremely coarsely punctate, three discal costae usually present. Galeae produced into a slender sucking organ, short, about as long as maxillary palpi. Metatibial spurs large, scarcely dissimilar, outer spurs triangular-spatulate, concave, apices subacutely rounded; inner spurs somewhat narrower, more parallel-sided, concave, apices rounded. Males with abdominal sterna finely, densely punctate and pubescent; fifth sternum feebly or not impressed medially at apex; sixth cleft to base with a deep, circular impression at center. Females with abdominal sterna sparsely, finely punctate and pubescent, shining, fifth sternum extremely broadly, shallowly emarginate; sixth with apex evenly rounded. Length 7.5-14 mm.

Types: Lectotype female (new designation), no. 49207, El Paso, Texas, G. W. Dunn; lectoallotype, and one male, one female lectoparatypes (new designations) same data as lectotype, in the Casey collection, U. S. National Museum (examined).

Additional specimens examined: TEXAS: El Paso; Fedor; McNary, Hudspeth County. NEW MEXICO: Dona Ana Co.; Las Cruces; Loving, Eddy Co.; Mesquite; Roswell, Chaves Co. ARIZONA: Benson; Bisbee; Continental, Pima Co.; Coyote Mts.; Douglas; Ft. Huachuca; Kits Peak, Baboquivari Mts.; Madera Canyon, Santa Rita Mts.; Maricopa Co.; McNeal, Cochise Co.; Oracle, Pinal Co.; Pearce, Cochise Co.; Ramsay Canyon, Huachuca Mts.; San Bernardino Ranch, Cochise Co.; Sonoita; Santa Rita Range Reserve; Tombstone; Tucson. CALIFORNIA: "Cal." (?). COLORADO: Boulder (?).

Collection dates: August 4 to October 7.

Flower hosts of adults: Chrysothamnus sp.; *Baileya multiradiata; Verbesina exauriculata; Sideranthus* sp.; *Verbesina encelioides; Eriogonum* sp.

Bee hosts of larvae: unknown.

There has been some question as to the distinctness of this species. It seems to fulfill the requirements for recognition as a species, however, since its range is distinct (Sonoran), all specimens seem to be easily recognized, and no intermediates between it and its nearest relative, *Z. sayi*, have appeared in the material examined. It would seem that reproductive isolation may therefore be assumed, the more so since no recognizable hybrids appear in the area where both species occur. The host plants and collection dates of the adults are also somewhat different.

Casey's observation that the males of this species are "very much larger" than the females was based on insufficient specimens. There does not appear to be any consistent difference in size between the sexes, either sex being variable in size depending probably on the amount of food available to the larva.

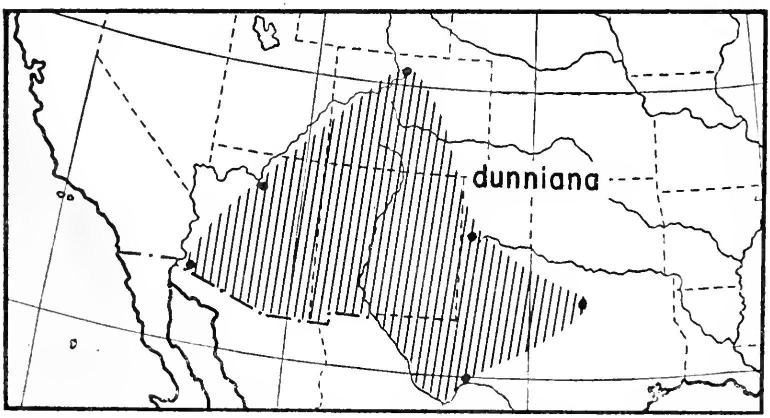

FIG. 22. Map showing the distribution of *Zonitis (Parazonitis) dunniana.*

Zonitis (Parazonitis) punctipennis (LeConte)

(Figs. 23, 133, 200, 201)

Resembles *Z. sayi* but readily distinguished from that species by its densely, coarsely punctate elytra, color, and more southern distribution. It is a member of the Sayi group.

Two infraspecific forms of this species are recognizable. The nominate form appears to occupy the greater part of the range with the new form here proposed confined to extreme southern California where intergrades also occur (*vide* Fig. 23). The color dimorphism of the sexes is remarkably constant over the range except in California where it becomes less distinct and disappears.

The forms are easily recognizable as the following table indicates:

Males with elytra entirely pale testaceous; females with elytra medially vittate or entirely fuscous or black; range east of California, *punctipennis punctipennis*

Both sexes with elytra medially vittate or entirely fuscous or black; range restricted to southern California *punctipennis californica*

Zonitis (*Parazonitis*) *punctipennis punctipennis* (LeConte)

(Figs. 23, 133, 200)

Nemognatha punctipennis LeConte, 1880, Trans. Amer. Ent. Soc., vol. 8, p. 214; Snow, 1885, Trans. Kansas Acad. Sci., vol. 9, p. 69; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 379; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, p. 186; Wellman, 1912, Ent. News, vol. 23, p. 38; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 170; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160.

Zonitis punctipennis, Casey, 1891, Ann. New York Acad. Sci. vol. 6, p. 170; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement to Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

Nemognatha brunneopennis (in part) Dillon, 1952, Amer. Midland Nat., vol. 48, p. 341.

Body surface moderately shining. Sexually dimorphic, males usually entirely pale testaceous with antennal segments 3 to 11, distal palpal segments, and tarsi brown or black; abdomen ventrally densely punctulate; females usually with elytra entirely piceous or fuscous or broadly vittate; abdomen ventrally scarcely or not more densely punctate than thorax, ventral surface and appendages black in part. Galeae slender, usually just attaining metacoxae, color variable usually pale golden. Pronotum shining, sparsely finely punctate. Elytra densely, coarsely rugose-punctate with three feebly raised discal costae, the outermost branched in some specimens. Metatibial spurs usually subequal, stout, concave, often flared, apices rounded. Length 8-14 mm.

Male: Head moderately large, broad, subtriangular in cephalic aspect, distance from vertex to labroclypeal suture subequal to distance across tempora, tempora rounded, not inflated, vertex evenly rounded; surface moderately densely punctate, punctures finer and denser between bases of antennae, coarser and sparser medially on frons, a short, pale seta arising from each puncture, vertex and narrow median area on frons often impunctate and subcarinate. Eyes relatively small, twice as long as wide, oblique, finely faceted, feebly emarginate at anterior third, with a fringe of long fine setae at least posteriorly below, widely separated above and below. Clypeus sparsely punctate basally, apical half glabrous. Labrum about as wide as long, usually deeply impressed medially at base, impression foveate in some specimens, elongate in others, sparsely punctate, clothed with long fine setae, anterior margin evenly rounded, declivous in some specimens. Mandibles moderately long, sides densely punctured and pubescent, subparallel basally, apical halves evenly arcuate inward. Palpi moderately long, slender, punctured and pubescent, ultimate segment of each somewhat inflated apically, a glabrous impressed area at apical third, extreme apices subtruncate. Galeae slender, moderately densely hairy, nearly twice as long as maxillary palpi. Antennae twice as long as pronotum, segments submoniliform, feebly flattened except two basal segments, each antenna with first segment moderately long, reaching beyond middle of eye behind emargination, distinctly inflated, feebly arcuate, shining, sparsely punctured and pubescent; second scarcely more than half as long as first, almost as wide as long, shining, punctured and pubescent like first; third scarcely one third longer than second, broadened from base to apex, somewhat more densely punctate and pubescent than second; fourth slightly longer than third, more densely punctate and pubescent, less shining than third, otherwise similar; fifth distinctly shorter than fourth, subequal to second; sixth shorter than fifth, scarcely more than twice as long as wide; seventh to tenth subequal to fifth; eleventh scarcely longer than tenth, apex subacutely rounded; segments five to eleven punctured and pubescent like fourth.

Pronotum shining, less than one sixth wider than long, usually widest at anterior fourth where it is scarcely wider than head, posterior angles not divergent, sides evenly rounded or, in some specimens, feebly divergent to apical fourth thence more sharply rounded to apex, base and apex with an extremely narrow raised margin, base broadly arcuate from side to side, apex almost truncate; disk evenly convex from side to side, in side view somewhat declivous at extreme base, surface sparsely, finely punctate, some specimens with a fovea each side of median line basally, often also with a median impression on basal third. Scutellum yellow, short and broad, feebly or not punctate apically, densely, finely punctate across extreme base, entire center deeply impressed, apex broadly rounded. Elytra densely, deeply and coarsely rugose-punctate, humeri, sutures, margins, and three or four discal costae feebly raised, pubescence usually absent. Thorax and abdomen ventrally shining, thorax moderately densely punctate, clothed with fine, pale pubescence; abdomen extremely densely, finely punctate and pubescent, fifth abdominal sternum feebly impressed medially at apex; sixth medially cleft to the base with a broad, deep central impression. Legs densely, moderately coarsely punctate, tibiae and tarsi more finely so, clothed with short pubescence which varies in color to agree with integumental color. Spurs of anterior tibiae short, spiniform; middle tibiae with outer spur longer, broader than inner, concave, apex rounded; inner spur slender, spiniform; posterior tibiae with spurs subequal in length, short, stout, concave, apices rounded, outer spur usually distinctly wider than inner, apex feebly pointed in some specimens.

Female: Similar to male but abdomen ventrally no more densely punctate and pubescent than thorax; fifth abdominal sternum not impressed; sixth evenly rounded.

Types: Holotype female (new designation), no. 4967, Arizona, in the LeConte collection, Museum of Comparative Zoology, Harvard University (examined). The elytra are dark brown in the type specimen.

Specimens examined: ARIZONA: Carr; Chiricahua Mts.; Chiricahua National Monument; Cottonwood Springs; Douglas; Huachuca Mts.; Kirkland; Nicks; Oak Creek Canyon; Phoenix; Portal; Prescott; Ramsey; San Bernardino Ranch, Cochise County; Sierra Ancha Mts.; Sonorita; Tucson; Walnut; Willcox. NEW MEXICO: Acme; Broadview; Dona Ana County; Tatum. TEXAS: Davis Mts.; Ware. OKLAHOMA: Boise City; Grand; Osage County; Ramsey; Woodward. KANSAS: Gove County. COLORADO: Pueblo. UTAH: St. George; Zion Canyon; Zion National Park.

Collection dates: July 12 to September 15.

Recorded elevations: 2500 to 6000 feet.

Flower hosts of adults: Helianthus sp.

Bee hosts of larvae: unknown.

Dillon's paratype of *brunneopennis*, in Dillon's collection, is a female of the present species, comparing very favorably with the holotype in the LeConte collection.

Z. *(Parazonitis) punctipennis californica*, ssp. nov.

(Figs. 23, 201)

Similar to the nominate form but differing in that the elytra of the males have a moderately broad fuscous discal vitta on each elytron or the elytra are entirely fuscous or black; the galeae are almost imperceptibly shorter; and the distribution is limited to southern California (Orange and San Diego Counties southward).

Types: Holotype male and allotype, Warner's, San Diego County, California, August 3, 1925, G. H. Field collector, in the J. W. Green collection, California Academy of Sciences. Paratypes: California: one male, Yorba Linda (Orange County), August 14, 1920, P. H. Timberlake, in the collection of Prof. Timberlake at Riverside, Cal.; one male, Huntington Beach, July 28, 1927, K. L. Maehler collection, California Academy of Sciences; four males, one female, Warner's, San Diego County, August 2, 1925, F. E. Blaisdell, in the Blaisdell collection, California Academy of Sciences; one male, same data as preceding, August 3, 1925, in the California Insect Survey; one male, same data as preceding, in the California Academy of Sciences; two males, four females, same data as preceding, in the Cornell University collection; two females, same data as preceding, Geo. H. Field, in the collection of Mr. C. A. Frost, Framingham, Mass.; one male, Elysian Park, Los Angeles, August 27, G. Grant and L. J. Muchmore, in the Los Angeles County Museum.

Collection dates: July 28 to August 14.

Hosts: unknown.

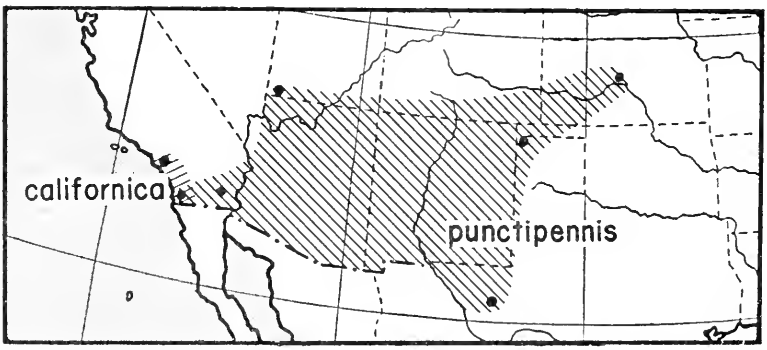

FIG. 23. Map showing the distribution of *Zonitis (Parazonitis) punctipennis* and *Z. (P.) californica.* The zone of intergradation of the subspecies is indicated by the overlapping of types of shading.

Zonitis (Parazonitis) tarasca (Dugès)

(Figs. 127, 129, 202, 203)

Morphologically extremely similar to *Z. punctipennis* but distinguishable by the shorter galeae, form of the head, less densely punctate elytra, fulvous ground color, and different form of the male genitalia.

Originally described from Morelia, Michoacán, Mexico, this species has heretofore been known only from Mexico and Central

America. Among the material taken north of Mexico I have found three specimens of this species, two males taken at Ruby, Arizona, July 14, 1947, and one female taken at Sonoita, Arizona, August 17, 1947, all three specimens collected by Mr. F. H. Parker of Tucson, Arizona and in Mr. Parker's collection. They agree closely with the original description except that the palpi are pale, and the color of the labrum, frons, thoracic sterna, and femora is uniformly fulvous instead of black. The inner metatibial spurs are narrower than the outer but both are spatulate. The labrum appears elongate but by actual measurement is as wide as long.

Two forms, here proposed as subspecies, are recognizable, the nominate form occurring principally in Mexico and Central America, the remaining form occurring at higher altitudes in northern Mexico and southern Arizona. They may be distinguished by the following key:

Elytra fulvous often with a brassy sheen, medially vittate in some specimens, moderately deeply punctate *tarasca tarasca*

Elytra piceous, rarely narrowly bordered with fulvous basally; punctures deep, coarse *tarasca borealis*

Zonitis (Parazonitis) tarasca tarasca (Dugès)

(Figs. 127, 202)

Nemognatha tarasca Dugès, 1888, Ann. Mus. Michoacano, vol. 2, p. 112; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 379, tab. 17, fig. 14; Borchmann, 1917, Coleopterorum Catalogus, pars. 69, p. 171.

Zonitis tarasca, Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder, 1945, U. S. Natl. Mus. Bull. 185, part 3, p. 482.

Body surface moderately shining. Head, scutellum, thorax, coxae, trochanters, femora except apices, and abdomen fulvous, testaceous, or reddish-testaceous but often with variable portions of ventral surface and appendages black. Eyes, antennae, tips of mandibles, palpi, tips of femora, tibiae in part, and tarsi fuscous or piceous. Elytra fulvous, some specimens with moderately broad fuscous discal vittae. Metatibial spurs subequal, large, concave. Galeae testaceous to black, slender, scarcely exceeding labial palpi in length. Sexual differences as in *punctipennis*. Length 8-10 mm.

Male: Head elongate triangular, distance from vertex to labroclypeal suture scarcely greater than distance across tempora; vertex evenly rounded; tempora feebly inflated; surface moderately densely, coarsely punctate, more finely so at sides, short pale setae arising from punctures, a median impunctate area extending from vertex to center of frons. Eyes elongate oval, oblique, one fourth longer than wide, widest just below anterior emargination, moderately protruding, finely faceted, widely separated above and below. Clypeus irregularly impressed, coarsely punctate basally, apical third glabrous. Labrum as wide as long, moderately sparsely punctured, apical margin evenly rounded, clothed with long pale hairs. Mandibles long, slender, feebly rounded at apical third giving the entire oral region a slender, elongate appearance, sides moderately densely punctured, clothed with short pale setae. Palpi long, slender, sparsely punctured, clothed with short, pale setae, terminal segment of each with a glabrous impressed area at apical third, impression indistinct on labial palpi, apices subtruncate. Galeae pale, slender, hairy, scarcely exceeding labial palpi in length. Antennae long, flagellar segments somewhat flattened, first segment of each antenna moderately large reaching half way across eye, moderately inflated, shining, sparsely punctured and pubescent; second three-fourths as long as first, evenly enlarged from base to apex, shining, punctured and pubescent like first; third one third longer than second, more densely punctured and pubescent than first and second otherwise similar to second; fourth to tenth similar to third but progressively shorter than each preceding except sixth which is longer than fifth or seventh; eleventh longer than tenth, apex subacutely pointed.

Pronotum shining, scarcely wider than long, basal angles feebly expanded, sides almost parallel to apical fourth, anterior angles abruptly rounded; disk evenly convex from side to side, almost level from base to apex but abruptly declivious at extreme base, sparsely to moderately densely, shallowly punctured medially, more densely so at sides, some specimens almost entirely impunctate; base markedly arcuate from side to side. Scutellum small, moderately sparsely punctured, feebly impressed medially, apex rounded. Elytra shining, irregularly, moderately densely punctured, most punctures separated by at least their own diameters; subsutural, discal, and submarginal costae distinct but usually not attaining bases or apices; humeri distinct, very sparsely, finely punctured or impunctate; sutures and margins distinctly raised. Thorax beneath shining, moderately densely punctured, finely pale pubescent. Abdomen reddish-testaceous, moderately shining, extremely densely, finely punctate, clothed with fine pale pubescence. Coxae sparsely punctured, excavations glabrous, femora, tibiae, and tarsi more densely punctate, finely pubescent except tarsi which are hairy. Inner surfaces of middle and posterior femora glabrous. Anterior and middle tibiae with both spurs spiniform; metatibial spurs large, concave, inner spurs narrower than outer. Sixth abdominal sternum cleft medially with a large central impression.

Female: Similar to male except sixth abdominal sternum not modified, apex evenly rounded or feebly emarginate medially; abdomen usually more flavous, moderately densely scabrous-punctate.

Types: Dugès' type is lost. As Champion (1892) has pointed out, the description was apparently based on a single specimen.

Type locality: Morelia, Michoacán, Mexico.

Neoholotype male and neallotype (new designations) taken at Palos Colorados, Durango, Mexico, 8000 ft. elevation, August 5, 1947, D. Rockefeller Expedition, Michener collector, in the American Museum of Natural History. Forty neoparatypes (new designation) as follows: 9 males and 12 females, same data and in same collection as neotype except various collectors including Michener, Gertsch, Schramel, and Spieth; 6 males and 10 females, Temax, N. Yucatán, Gaumer collector, in the Godman-Salvin Biologia Centrali-Americana collection, British Museum (Natural History) including a single male labeled "sp. figured"; one male and one female, same data as preceding, in the Museum of Comparative Zoology, Harvard; one male, same data, in the American Museum of Natural History, labeled "Donated by F. DuC. Godman, 1907."

Specimens examined: MEXICO: COAHUILA—Saltillo; DURANGO—Canutillo, El Salto, Nombre de Dios, Otinapa, Palos Colorados; GUERRERO—Chilpancingo; MORELOS—Alpuyeca; NAYARIT—Navarette, Tepic, Tuxpan; OAXACA—Valeria Trujano, Etla (*fide* Champion); TABASCO—Jalapa; VERACRUZ—Orizaba, Tuxtla, Vera Cruz; YUCATAN—Temax, "Yucatán." GUATEMALA: Rabinal, San Geronimo. NICARAGUA: Chontales. COSTA RICA: Las Canas. PANAMA: Panamá. UNITED STATES: ARIZONA—Ruby, Sonoita. Blackwelder (1945) records COLOMBIA also.

Collection dates: June 13 to August 17.

Recorded elevations: 50 to 8500 ft.

Hosts: unknown.

This species is very easily mistaken for *punctipennis*. The pronotum is variable in form and density of punctation. The galeae vary considerably in length but are always shorter than in *punctipennis*. The color, as Champion (1892) suggests may be greenish when alive and indeed the two specimens he mentions from San

Geronimo, "variety alpha," are greenish but they may represent a different species. All the other specimens I have examined are coppery in color. Although about half of the specimens in the series from Temax have the elytra vittate, the over-all proportion of vittate specimens is less in the specimens I have studied. Of 101 specimens, only 26 are vittate. This feature does not appear to be correlated with the sex of the specimens since both sexes occur with and without vittae. The neoholotype and neallotype are in part black beneath as Dugès stated in the original description.

In Champion's key (1892) to the species of *Nemognatha* there is an obvious typographical error in the way he separates *tarasca* and *sayi*. It states that *sayi* has raised elytral costae while *tarasca* does not. This is reversed and Champion was aware of it as shown by his discussion of the species in question.

Z. (Parazonitis) tarasca borealis, ssp. nov.

(Figs. 129, 203)

Zonitis punctipennis, Selander, 1954, Jour. Kansas Ent. Soc., vol. 27, p. 96 (misidentification by Enns).

This is a northern form of Dugès' Mexican species, easily distinguishable from the nominate form by the totally black, deeply punctured elytra, flavous pronotum, similar metatibial spurs, northerly distribution, and difference in the form of the male genitalia.

Types: Holotype male, taken at Cochise Stronghold, Dragoon Mountains, Arizona, elevation 4850 feet, oak-juniper zone, July 21, 1948, Floyd G. Werner and W. Nutting, collectors. Allotype same data as holotype except August 2, 1948. These will be deposited in the Museum of Comparative Zoology at Harvard. Paratypes as follows: three males, six females, same data as allotype, in Werner collection; one male, 32 mi. SE Wilcox, Arizona, July 11, 1953, on Thistle Poppy *(Argemone platyceras)*, George M. Bradt collector, in Mr. Bradt's collection; one male, Cochise Co., Arizona, R. Hopping collection, in the California Insect Survey; one male, Sonoita, Arizona, August 17, 1947, F. H. Parker collector, in Mr. Parker's collection; one female, 10 mi. N El Entronque, Durango, Mexico, Sept. 5, 1952, R. K. Selander collector, in the collection of R. B. Selander.

Selander (1954) reports this form from Durango, Mexico, under the name *Z. punctipennis.* This was an error in determination on my part. The specimen shows a small degree of intergradation towards nominate *tarasca* in having the elytra narrowly bordered with brown at the extreme basal margins.

GENUS PSEUDOZONITIS Dillon

(Figs. 39, 47, 84, 213)

Pseudozonitis Dillon, 1952, Amer. Midland Nat., vol. 48, p. 342. Type species *Zonitis longicornis* Horn (Dillon, 1952).
Zonitis, Horn, 1870, Trans. Amer. Ent. Soc., vol. 3, p. 93; 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 386; Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Blatchley, 1922, Canadian Ent., vol. 54, p. 28; Van Dyke, 1929, Bull. Brooklyn Ent. Soc., vol. 27, p. 132; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.

The members of this genus may be distinguished from other meloids by the following combination of characters: Wings functional, elytra entirely covering abdomen, not attenuate; head large, usually elongate-triangular, tempora not inflated; antennae usually extremely long and attenuate, sixth segment usually three or more times as long as wide; eyes extremely large, protuberant, strongly produced beneath head, rather coarsely faceted; galeae lobiform, usually distinctly penicillate at apices; tarsal claws cleft, upper portion with two rows of dentes, lower portion reduced to a slender lobe; spurs of posterior tibiae broad, spatulate, variable in size; six abdominal sterna visible, males with fifth sternum emarginate, sixth medially cleft, impressed, often with small lobes at base of cleft; sixth sterna of females usually with a deep U-shaped emargination medially; aedeagus bilobed, heavily sclerotized, apex of tegmen broad, recurved, side margins sclerotized.

KEY TO THE SPECIES OF PSEUDOZONITIS DILLON

1.	Eyes separated below by a distance half or less than half the distance between eyes on frons	2
	Eyes separated below by a distance more than half the distance between eyes on frons	11
2(1).	Femora dark at middle, pale at apices and bases	3
	Femora pale at middle, apices always dark or femora entirely pale or entirely dark (except bases pale in some specimens)	4
3(2).	Labrum with a shallow median, glabrous sulcus; pronotum usually with two fuscous maculae, one on either side of median line, often fused	*labialis*
	Labrum without median impression; pronotum with a single, median reddish or reddish-fuscous macula	*longicornis*
4(2).	Inner metatibial spurs shorter, narrower than outer	*vigilans*
	Inner metatibial spurs equal to or larger than outer	5
5(4).	Elytra entirely pale, length 11 mm. or more	6
	Elytra partly or entirely black or fuscous, usually vittate; or if pale, then length less than 10 mm.	7

6(5). Integument of antennal segments 1 to 10 and of tarsal segments 1 to 3 entirely fulvous or fuscous with only extreme bases yellow; mandibles arcuate .... *arizonica*
Integument of antennal segments 1 to 10 and of tarsal segments 1 to 3 fuscous but each with a distinct yellow band at least at apex, usually at both base and apex; mandibles straight basally .... *pallida*
7(5). Elytra feebly rugose, impunctate, shining, usually vittate, *vittipennis*
Elytra densely, moderately deeply punctate or distinctly rugose-punctate, not shining, vittate or not 8
8(7). Smaller species, 10 mm. or less in length 9
Larger species, 11 mm. or more in length 10
9(8). Pronotum with a distinct median reddish macula; head suddenly narrowed below eyes (see Fig. 147) .... *stroudi*
Pronotum unicolorous, head not suddenly narrowed below eyes (see Fig. 139) .... *brevis*
10(8). Pronotum at least partly rosaceous .... *vaurieae*
Pronotum uniformly flavous .... *pallida*
11(1). Femora dark at middle, pale at apices and bases *roseomaculatis*
Femora unicolorous pale or dark, or with apices at least dark 12
12(11). Inner metatibial spurs longer and usually more robust than outer 13
Inner and outer metatibial spurs similar and equal 14
13(12). Elytra bright grayish-brown .... *castaneis*
Elytra fuscous or black .... *martini*
14(12). Elytra uniformly pale testaceous .... *vogti*
Elytra uniformly dark or vittate 15
15(14). Sixth antennal segment no more than twice as long as greatest width; elytra usually vittate or dark with pale sutures and margins .... *schaefferi*
Sixth antennal segment at least three times as long as greatest width; elytra uniformly dark 16
16(15). Head deep fuscous or black except at bases of mandibles, densely coarsely punctate .... *martini*
Head pale, shining, sparsely and finely punctate, usually with a fuscous macula on frons .... *maculicollis*

Pseudozonitis schaefferi (Blatchley)

(Figs. 24, 55, 86, 138, 207)

Zonitis schaefferi Blatchley, 1922, Canadian Ent., vol. 54, p. 28; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.
Pseudozonitis schaefferi, Dillon, 1952, Amer. Midland Nat., vol. 48, pp. 343, 344.

This species does not closely resemble its congeners when judged by its visible external morphology. Its inclusion in *Pseudozonitis* is here based on the morphology of the male genitalia. The rosaceous color pattern on the pronotum is more like that of *Ps. vaurieae* than any other species examined. Its true affinities are not clear. It is readily distinguishable from all other species by the form and sculpture of the head, pronotum, and antennae. The antennae are peculiar in that the segments are submoniliform, the sixth segment scarcely twice as long as wide and only slightly longer than the first; the antennae are neither filiform nor setiform but comparatively short, about two and one-half times as long as the pronotum. The eyes are slightly farther apart above than below the head. Some specimens, including the neallotype, have a median carina, sometimes reduced to a tubercle, on the frons, the occiput feebly tumid, the frons somewhat depressed.

Body surface moderately shining. Head flavous except eyes, antennae, labrum, palpi, galeae, distal half of each mandible, and two areas on frons fuscous or black. Prothorax flavous except disk of pronotum largely rosaceous except very restricted oblique pale areas extending from hind angles toward center of disk, in some specimens (including the neallotype) transversely connected across base by a very narrow pale area. Elytra brown or fuscous with narrow sutural, discal, and marginal stripes yellowish, the former two stripes not attaining apices of elytra, sutural stripe in some specimens interrupted near apices with a small yellow area at extreme apices of elytra. Beneath black or fuscous except apices of coxae, portions or all of trochanters, and lateral margins of abdominal sterna flavous. In some specimens an extremely small pale area occurs at extreme bases of antennal segments, femora, tibiae, first tarsal segments, and basal third of claws.

Male: Head above mandibles subquadrate, distance from vertex to base of labrum subequal to distance across tempora, vertex evenly rounded, tempora rather large, rounded, temporal angles of head abrupt, surface coarsely, moderately densely punctate, a small triangular temporal area glabrous, shining; pubescence sparse, pale, extremely short but with a fringe of longer, darker, coarser hairs around apical margin of labrum and inner sides of galeae. Eyes longer than wide, moderately coarsely faceted, feebly emarginate anteriorly, frontal interocular distance slightly greater than interocular distance below, lower corners of eyes produced below slightly beyond edge of labium, a fringe of long, pale hairs around posterior margins of eyes. Labrum twice as wide as long, apical margin evenly rounded, shallowly, sparsely punctate. Mandibles stout, moderately long, each with basal half pale, clothed with moderately dense pale setae, apical half dark, externally broadly rounded to apex which is acute. Maxillary palpi long, two distal segments of each extending beyond tips of mandibles. Labial palpi long extending beyond tips of mandibles. Galeae short, broad, lobiform. Antennal bases noticeably protruding. Antennae moderately long, about two and one-half times as long as pronotum, each with first segment moderately large, somewhat inflated, reaching half way across eye, moderately shining, moderately finely pubescent; second subequal in length to first but more slender than first and less shining but more pubescent; third slightly longer than first and as wide as first; fourth to tenth subequal to third, segments 2 to 11 distinctly flattened, eleventh one third longer than tenth, distinctly constricted at apical third, in some specimens with tip appearing as a separate segment, apex subacute.

Pronotum as wide as long, widest at anterior third, very slightly narrowed to base, anterior third of sides oblique to apex, disk evenly convex from side to side, surface coarsely, uniformly but only moderately densely punctate with a short, fine, pale seta arising from each puncture, a shallow median impression on basal third, base truncate, feebly transversely impressed. Scutellum moderately large, triangular, medially impressed near apex, punctured and pubescent like pronotum but more finely and densely so, apex rounded, anterior angles usually pale, remainder fuscous. Elytra varying from rugose-punctate to vermiculate-rugose, clothed with fine pale setae, humeri prominent, apices subacute at sutures. Thorax, abdomen, and legs moderately shining ventrally, moderately densely, finely punctate, clothed with fine, pale setae except coxal excavations and inner sides of middle and posterior femora glabrous. Fore and middle tibial spurs slender, acute; metatibial spurs broad, concave, equal, subacute at apices. Fifth abdominal sternum broadly, deeply triangularly, impressed medially from base to apex; sixth cleft to base medially, flattened, with a feeble central, circular impression.

Female: Similar to male but with fifth abdominal sternum not modified, sixth with a deep, broad, U-shaped emargination medially at apex.

Types: Holotype male, Dunedin, Florida, Feb. 9, 1921, W. S. Blatchley collector, in the Blatchley collection, Purdue University (examined). In addition to the locality label, the specimen bears one of Blatchley's labels with the number 1524.

Neallotype (new designation) no. 62730, Enterprise, Florida, May 30, Kaeber collection, in the U. S. National Museum.

Additional specimens examined: FLORIDA: Enterprise, one male, May 5, J. C. Warren; and "Florida," one male, same collector, no other data, both in the Chicago Natural History Museum; Enterprise, one male, April 22, in Cornell University; "Fla.," one male, Andreas Bolter collection, in Illinois Natural History Survey collections; Enterprise, one male, in J. W. Green's collection, California Academy of Sciences; St. Augustine, one female, April 19, 1919; Enterprise, two males, April 16, the above in the Fall collection, Museum of Comparative Zoology, Harvard University; "Fla.," one male (labeled "*longicornis*"); Capron, one male, one female, April 14, the two preceding in the LeConte collection, Museum of Comparative Zoology, Harvard University; Enterprise, two males, April 21, Liebeck collection, also in Harvard University.

One male, labeled "Tyngs, Massachusetts," in the Blanchard collection at Harvard is probably erroneously labeled.

Collection dates: February 9 to May 30.

Hosts: unknown. The holotype was ". . . beaten . . . from dead vines by the side of a roadway running through Skinner's hammock . . ."

This species is probably a member of the relict group of insects peculiar to a small area in Florida.

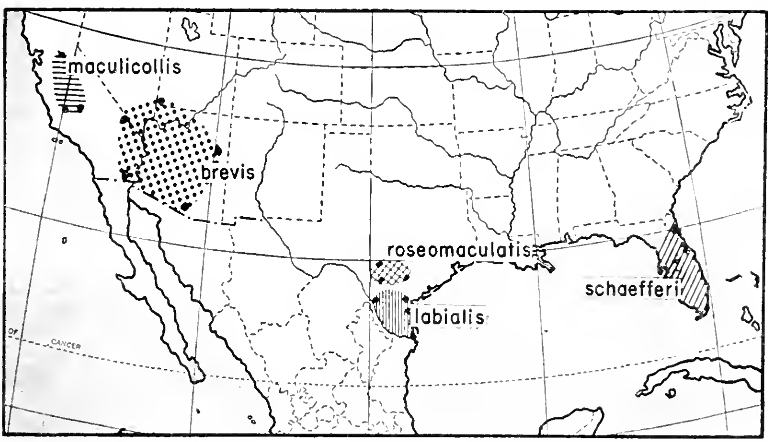

FIG. 24. Map showing the distribution of *Pseudozonitis maculicollis; Ps. brevis; Ps. roseomaculatis; Ps. labialis;* and *Ps. schaefferi.*

Pseudozonitis martini (Fall)

(Figs. 25, 55, 86, 138, 207)

Zonitis martini Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 160; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 149; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, pp. 72, 74.
Pseudozonitis martini, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 342.

Related to *Ps. maculicollis* and *Ps. vigilans* but easily distinguished from the former by the coarse punctation of the head and pronotum, larger eyes, and more slender elytra which are darker and less shining; from the latter by the eyes being proportionally more distant below the head than above; the dark head, a median spot before the middle of the pronotum; and the dark ventral surfaces. Contrary to the original description, the inner metatibial spurs are usually longer and wider than the outer.

Body surface feebly shining. Head usually entirely fuscous except bases of mandibles, surface densely coarsely punctate. Pronotum wider than long, reddish-testaceous, usually with a dark spot of variable size medially on anterior third, surface densely, moderately coarsely punctate. Scutellum small, black. Elytra black or fuscous, densely finely punctate or rugose-punctate. Sternum and legs entirely black or fuscous. Antennal segments 3 to 11 flattened, sixth segment only three times as long as wide. Eyes separated below head by a distance greater than half the distance separating them on frons. Spurs of anterior and middle tibiae slender, long, somewhat flattened; of posterior tibiae long, slender, parallel-sided, concave, subequal in length in some specimens, inner longer than outer in most specimens. Male with fifth abdominal sternum broadly feebly emarginate; sixth medially cleft to the base with a central impression. Female similar to male but with fifth abdominal sternum not modified, sixth with a moderately deep, relatively broad U-shaped emargination medially at apex. Length 8-12 mm.

Types: Holotype male, no. 24310, labeled Engle, New Mexico, May, 1902, in the Fall collection, Museum of Comparative Zoology, Harvard University (examined). The head is quite dark in this specimen with the clypeus and labrum ivory colored. The metatibial spurs are subequal. In the original description Fall states that it was taken by Miss Nora Newberry and sent him by Prof. Cockerell. Lectoallotype (new designation) no. 62729, in the U. S. National Museum (examined). It is labeled Mesilla Park, New Mexico, May 14, on mesquite, Martin D. Cockerell.

Specimens examined: ARIZONA: Chiricahua Mts., one male, Aug. 8, 1908, E. C. Van Dyke, in the California Insect Survey collections; Peloncilleo Mts., one male, April 27, 1924, J. O. Martin, in the California Insect Survey collections; Huachuca Mts., one male, July 24, in the U. S. National Museum; Gila Bend, one female, April 17, 1938, F. H. Parker, on flowers of *Tamarix* in Mr. Parker's collection. CALIFORNIA: Death Valley, Furnace Creek Camp, one female, April 3, 1939, K. S. Hagen, in California Insect Survey collections; Harper's Well, one male, March 18, 1926, Blaisdell collection in the California Academy of Sciences collections; San Diego, one male, June 23, 1890, Blaisdell collection, California Academy of Sciences.

This species also occurs in Mexico.

Collection dates: March 18 to August 8.

Flower hosts of adults: mesquite and *Tamarix.*

Bee hosts of larvae: unknown.

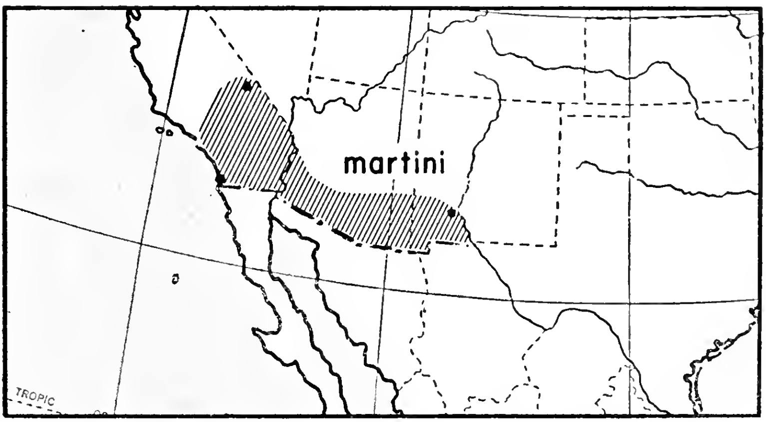

FIG. 25. Map showing the distribution of *Pseudozonitis martini.*

Pseudozonitis castaneis Dillon

Pseudozonitis castaneis Dillon, 1952, Amer. Midland Nat., vol. 48, p. 345.

This is a doubtful species. It was described from a unique female taken from foliage of *Sphaeralcea angustifolia* at Presidio, Texas, April 2, 1945, by George B. Vogt. I have examined the specimen, which is in the U. S. National Museum, and find that I cannot separate it from *Ps. martini* (Fall) except by the color of the elytra as indicated in the key. When and if a series becomes available it will be possible to determine more accurately what its true status is. Meanwhile this name is retained provisionally.

Pseudozonitis vogti Dillon

Pseudozonitis vogti Dillon, 1952, Amer. Midland Nat., vol. 48, p. 343.

This is a doubtful species. It was described from a unique male taken by beating flowers and foliage of *Prosopis juliflora* near El Sauz, Starr County, Texas, April 6, 1947, by George B. Vogt. I have examined the specimen, which is in the U. S. National Museum, and find that I am unable to separate it from *Ps. martini* (Fall) except by the pale elytra. The pronotal spot is large but I have seen equally large ones in typical *martini*. This name is therefore retained provisionally until more specimens are available for study.

Pseudozonitis vigilans (Fall)

(Figs. 26, 54, 142, 208)

Zonitis vigilans Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 164; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 72.
Pseudozonitis vigilans, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 342.

Related to *Ps. martini* but distinguishable by the eyes which are proportionally closer together below the head, the pale head, immaculate pronotum, and pale ventral surfaces.

Body surface feebly shining. Head, prothorax, scutellum, and entire sternum usually flavous or pale testaceous, feebly shining. Elytra, antennae, palpi, tips of mandibles, tips of femora, entire tibiae and tarsi dark reddish-brown. Front of head moderately densely, coarsely punctate, pronotum more sparsely, finely punctate, often with a deep puncture each side of middle of basal third. Eyes separated below by a distance slightly less than half that separating them on frons. Mandibles moderately short, stout, abruptly angled inward at half their length. Antennal segments 3 to 11 distinctly flattened, sixth segment almost four times as long as wide. Spurs of anterior and middle tibiae slender, spiniform, subacute; inner metatibial spurs larger than outer, both inner and outer obliquely concave and flared at apices. Male with fifth abdominal sternum feebly, triangularly impressed medially at apex; sixth cleft to base medially with a broad central impression. Female similar to male but fifth abdominal sternum not impressed, sixth with a moderately deep, U-shaped emargination medially at apex. Length 10-13 mm.

Types: Holotype male, no. 24311, from California, in the Fall collection, Museum of Comparative Zoology, Harvard University (examined). The last three segments of the left antenna are missing.

Neallotype (new designation), San Diego, California, Aug. 18, 1917, same collection as holotype.

Specimens examined: CALIFORNIA: one male, San Diego, F. R. Blaisdell collection; one male, San Diego, no. 1866; one male, San Diego, August 10, 1891, F. E. Blaisdell; one male, San Diego, G. H. Field, small square green label; one male, Mission Dam, June 21, small square green label, the above all in the California Academy of Sciences; one male, same data as neallotype and in same collection; and one female, "Calif.," no date, Hardy collector, is in the LeConte collection, both in the Museum of Comparative Zoology, Harvard.

Collection dates: June 21 to August 18.

Hosts: unknown.

Pseudozonitis maculicollis (MacSwain)

(Figs. 24, 141, 210)

Zonitis maculicollis MacSwain, 1951, Pan-Pac. Ent., vol. 27, p. 73.

Related to *Ps. martini* and *Ps. vigilans* but readily distinct from either by the characters noted in the key. In addition, the eyes are smaller and the color is quite different. The antennae, elytra, legs, and spots on the head and pronotum are piceous; the remainder of the body is yellow or reddish yellow.

Body surface moderately shining. Head, prothorax, scutellum, and greater portion of sternum yellow or pale reddish-yellow except eyes, antennae, apical halves of mandibles, palpi, and a median discal macula on apical third of pronotum (often divided into two smaller spots, occasionally absent) and spot between eyes piceous or fuscous. Head and pronotum shallowly, irregularly finely punctate. Elytra and legs except coxae piceous, densely finely punctate. Antennal segments 3 to 11 moderately flattened, sixth segment four times as long as wide. Eyes separated below head by a distance greater than half that separating them on frons. Spurs of anterior and middle tibiae long, slender, parallel-sided, somewhat flattened, apices subacute; metatibial spurs large, broad, concave, subequal. Male with fifth abdominal sternum broadly emarginate with median line sharply impressed; sixth cleft to base with a broad, deep, central impression. Female similar to male except fifth abdominal sternum not modified, sixth with a deep, U-shaped emargination medially at apex. Length 6-12 mm.

Types: Holotype male no. 6218, allotype, and 20 paratypes in the California Academy of Sciences taken at Tracy, San Joaquin County, California, July 29, 1949, on *Frankenia grandifolia,* J. W. MacSwain collector. Sixty-five paratypes, same data as holotype, in the California Insect Survey collections (examined). Additional specimens examined: California: one male, Mugu Pt., Ventura County, sea-level marsh, Aug. 13, 1937, Rehn, Pate, and Rehn collectors, in the Academy of Natural Sciences, Philadelphia; one male, Kern County, June, 1935, F. T. Scott collector, in the Fall collection, Museum of Comparative Zoology, Harvard University; one male, three females, Cypress, June 25, 1935, A. T. McClay collector, in the F. H. Parker collection.

Collection dates: June (?) to August 13.

Flower hosts of adults: Frankenia grandifolia.

Bee hosts of larvae: unknown.

Pseudozonitis vittipennis (Horn)

(Figs. 26, 137, 211)

Zonitis vittipennis Horn, 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 164; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Van Dyke, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 132; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 150; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan.-Pac. Ent., vol. 27, p. 72.

Pseudozonitis vittipennis, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 342.

Resembles *Ps. brevis* but differs by the proportionally longer elytra, transversely ovate head, elytral sculpture, dissimilar metatibial spurs, finer pubescence, and color.

Body surface moderately shining. Head, thorax, and abdomen pale testaceous, except eyes, antennae, distal portions of mandibles, and palpi black or fuscous, the palpi pale in some specimens. Elytra almost smooth, feebly punctate basally, shallowly, coarsely rugose apically, ground color pale testaceous or flavous, a moderately narrow fuscous subsutural vitta and a broader submarginal vitta on each elytron, neither attaining apex. Legs pale testaceous except extreme apices of femora, greater portion distally of tibiae, and tarsi fuscous or black. Antennae and tarsi feebly annulate with yellow at segmental articulations. Metatibial spurs dissimilar, the inner distinctly longer than outer. Length 8-10 mm.

Male: Head in cephalic view elongate oval, short, distance from vertex to labroclypeal suture distinctly, about one fifth, shorter than distance across tempora; tempora not inflated; vertex evenly rounded; surface moderately densely, coarsely punctate, more densely and finely so near eyes, a short, pale, fine seta arising from each puncture, a narrow, feebly raised glabrous median line extending from clypeus to vertex, a shallow transverse depression between bases of antennae. Eyes large, coarsely faceted, rather widely separated above, separated below by a distance less than half that above, emarginate. Clypeus very short, deeply impressed, base sparsely, coarsely punctate, apex glabrous. Labrum short, almost twice as wide as long, sparsely punctate, furnished with long, pale hairs, apex declivous, subtruncate, entire. Mandibles long, stout, rather sharply arcuate inward at half their length, sides densely punctate and pubescent. Palpi slender, longer than mandibles, terminal segments of each with a glabrous, impressed area at apical fourth, moderately shining, punctured and pubescent, apices somewhat constricted, truncate. Galeae pale, lobiform, shorter than labial palpi. Antennae long and slender, more than three times as long as pronotum, tapered toward apices, each with first segment attaining half the width of eye behind emargination, arcuate, inflated, shining, rather sparsely punctate and pubescent; second subequal to first in length, similarly shining, punctured, and pubescent, gradually widened from base to apex; third one third longer than second, much more robust, somewhat flattened, more densely punctate and pubescent, less shining than second; fourth and fifth longer than third, otherwise similar; sixth as long as fifth, less than four times as long as wide; seventh as long as sixth but more slender and flattened; eighth to tenth similar to seventh but progressively slightly shorter and more slender; eleventh scarcely longer than tenth, tapered to apex which is subacute.

Pronotum slightly wider than long, posterior angles feebly divergent, sides almost straight or feebly rounded from base to anterior third, thence sharply convergent to apex; surface shining, sparsely, coarsely punctate, most punctures separated by twice their diameter, a fine, pale seta arising from each puncture; a median impressed sulcus present usually interrupted near apex and at basal third; basal margin distinctly raised, apical margin extremely feebly or not raised. Scutellum moderately large, finely punctured and pubescent, centrally impressed, apex rather broadly rounded. Elytra feebly, sparsely punctate near base, shallowly rugose to apex, sparsely clothed with short, extremely fine, pale setae, sutures and margins distinctly raised, each elytron almost four times as long as wide and of constant width from base to apex. Thorax and abdomen ventrally rather densely, finely punctate, sparsely and finely pale pubescent, pubescence longer and denser on abdomen. Legs densely punctate and pubescent; spurs of anterior and middle tibiae long, slender, spiniform; inner metatibial spurs distinctly longer, slightly wider than outer, otherwise both obliquely concave, stout, apices rounded. Fifth abdominal sternum deeply, triangularly emarginate with a median impressed line at base; sixth cleft to base with a deep oval central impression.

Female: Similar to male but fifth abdominal sternum not modified, sixth with a moderately deep, U-shaped emargination medially at apex.

Types: Holotype male, no. 8296, Arizona, in Museum of Comparative Zoology, Harvard University (examined). Neallotype (new designation), 15 mi. W of Lordsburg, New Mexico, in grassy desert, August 30, 1949, F. Werner and W. Nutting, in the Werner collection but will be deposited in the Museum of Comparative Zoology at Harvard.

Specimens examined: ARIZONA: Tucson, one male, Sept. 28, 1932, F. H. Parker, in the California Insect Survey; Tucson, one female, Sept. 5, 1932, in the University of Arizona collection; Globe, one male, Sept. 14, D. K. Duncan; one female, Sept. 3, 1925, D. K. Duncan, in the California Academy of Sciences; two males, "Ariz.," Otto Lugger collection at the University of Minnesota; San Bernardino Ranch, Cochise County, one male, August, 3750 ft., F. H. Snow, in the Snow Entomological Museum, University of Kansas; Phoenix, two males, 12 females, various dates from Sept. 10 to Oct. 6, R. H. Crandall, in the Crandall collection; Tucson, one female, August, D. K. Duncan; Navajo County, one female, August, D. K. Duncan, both in Mr. Duncan's collection; Globe, four females, various dates July to September, one on *Guiterrezia,* Duncan, Parker, and Cutter collectors; Willcox, one female, August 27, 1933, Bryant 280; Holbrook, one female, August 13, 1939, F. H. Parker; Phoenix, one female, September 29, 1940, F. H. Parker, the preceding all in Mr. Parker's collection. NEW MEXICO: one female, "N. M." (small red square), Andreas Bolter collection in the Illinois Natural History Survey; one male, same data as neallotype in the Werner collection. NEVADA: Las Vegas, Lincoln County, one female, Sept. 2, 1909, 2026 ft., Liebeck collection in the Museum of Comparative Zoology, Harvard.

Collection dates: June 14 to October 6.

Recorded elevations: 2026 ft. to 3750 ft.

Flower hosts of adults: Guiterrezia.

Bee hosts of larvae: unknown.

The series of beetles in the Crandall collection exhibit an interesting variation in the approximation of the eyes above and below the head. Of the fifteen specimens measured, the distance of separation below the head varied from 0.296 mm. to 0.465 mm. with an average of 0.380 mm.; distance of separation on frons varied from 0.761 mm. to 0.972 mm. with an average of 0.866 mm. The variation appears to be independent of locus, that is, there is no correlation between distance above and that below except within broad limits. Those most widely separated above are as likely to be more widely separated below within the limits given as they are to be near the limits of approximation.

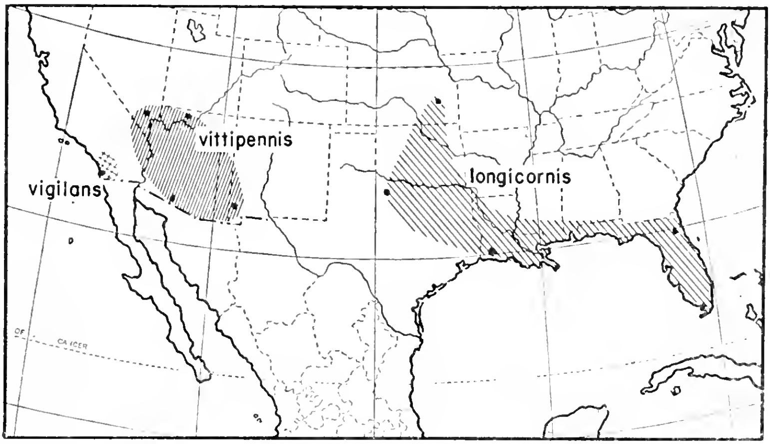

FIG. 26. Map showing the distribution of *Pseudozonitis vigilans; Ps. vittipennis;* and *Ps. longicornis.*

Pseudozonitis brevis, sp. nov.

(Figs. 24, 38, 80, 139, 212)

Morphologically somewhat similar to *Ps. stroudi* and superficially resembling *Ps. longicornis* but distinct from the former by the slender, gently arcuate mandibles; head in cephalic aspect not narrowed between eyes and mandibular articulations; short, robust form, and color, particularly of the pronotum which is uniformly testaceous or flavous and immaculate; from the latter by its color; robust form; pubescence; and antennal structure. This species is probably related to *Ps. vittipennis.*

Body surface shining or feebly shining. Head and pronotum pale testaceous or flavous, immaculate. Elytra less shining than head and pronotum, ground color fuscous with sutures, margins, and narrow sinuous discal vittae flavous or with elytra entirely pale fuscous or testaceous, moderately densely clothed with appressed white pubescence. Antennae, tips of femora, tibiae, and tarsi fuscous, antennae and tarsi feebly or not annulate with yellow. Entire ventral surface pale testaceous or flavous. Elytra comparatively short, only about three times as long as their basal width together. Length 7-10 mm.

Male: Head in cephalic aspect ovate triangular vertically, distance from vertex to labroclypeal suture slightly more than distance across tempora; tempora not inflated; vertex evenly rounded; surface irregularly, moderately densely punctate, punctures often sparse on frons between antennal bases, an extremely short, fine, pale seta arising from each puncture. Eyes large, coarsely faceted, closely approximated below head, separation below head less than half that on front of head, emarginate. Clypeus feebly impressed, shining, sparsely, coarsely punctate. Labrum distinctly wider than long, medially impressed, sparsely punctured and with longer setae than clypeus, anterior margin evenly rounded. Mandibles moderately long, slender, evenly but gently arcuate from bases to apices, apical third of each dark brown or black, bases pale, sides densely punctate and pubescent. Palpi moderately long and stout, apical segments of each much the longest, round in cross section at tips but truncate, shining, sparsely punctured and pubescent. Galeae lobiform, as long as maxillary palpi. Antennae as long as the entire body, filiform, each with first segment reaching more than half way across eye behind emargination, feebly inflated, shining, sparsely punctured and pubescent; second slightly shorter than first, widened at apex, shining, puctured and pubescent like first; third slightly longer than second, as long as first, gradually widened from base to apex, more densely punctured and pubescent, less shining than second, feebly flattened; fourth to tenth subequal to third, sixth four times as long as wide; eleventh one fourth longer than tenth, apex subacute.

Pronotum shining, as wide as long and as wide as head, widest at anterior third, sides feebly rounded and narrowed to before base, posterior angles feebly divergent, sides moderately abruptly convergent from apical third to apex; surface rather uniformly, moderately densely, finely punctate, more sparsely so on median line which is feebly raised on anterior third, a feeble, median sulcus on basal third, a fine pale seta arising from each puncture. Scutellum pale, moderately large, somewhat elongate, sides carinate, with a median sulcus which is deep basally, shallower apically, surface rather densely punctate and pubescent, apex rounded. Elytra moderately densely punctate or rugose-punctate, clothed with short, white, appressed setae not concealing ground color, sutures and margins feebly but distinctly raised. Thorax shining ventrally, moderately densely, finely punctate, clothed with short white setae. Abdomen ventrally less shining than thorax, usually somewhat darker in color, more densely punctate and with longer white setae than thorax, fifth abdominal sternum deeply, triangularly emarginate almost to base; sixth medially cleft to base with a broad deep central impression. Coxae, trochanters, and femora flavous, shining, moderately densely punctured and pubescent, extreme apices of femora often fuscous; tibiae sculptured like femora, pale basally becoming fuscous apically or fuscous only near apex; tarsi fuscous; spurs of anterior and middle tibiae slender, spiniform; of posterior tibiae usually slender, parallel-sided, excavated posteriorly, similar and equal.

Female: Similar to male but abdomen usually no darker than thorax, fifth abdominal sternum not modified, sixth moderately deeply, triangularly emarginate medially at apex.

Types: Holotype male and allotype, Tucson, Arizona, July 20, 1933, "Bryant 127" and "Bryant 128" respectively, in the Chicago Natural History Museum (*ex* F. W. Nunenmacher collection). Paratypes as follows: Tucson, Arizona, one male, July 1, 1932, F. H. Parker, in California Academy of Sciences; one male, same data, in California Insect Survey; one male, same data; one male, same data except June 20, 1932, one female, same data except July 5, 1932, the preceding in A. T. McClay collection; one female, same locality, July 19, 1942, H. A. Scullen, in Oregon State College; one male, same locality, July 21-23, 1916, in the American Museum of Natural History; Geronimo, one female, July 4, 1937, T. Dinkle, in Los Angeles County Museum; Yuma, one female, August (pink circular label), A. Fenyes collection, in California Academy of Sciences (this specimen with elytra entirely pale); Phoenix, one female, June 19, 1935, E. D. Ball, in the University of Arizona; Benson, one female, July 16, 1947, at light, F. Werner, in Werner collection; Ehrenberg, two males, June 14 and June 24, 1938, F. H. Parker (both specimens pale) in collection of R. H. Crandall; Gila Valley, 3 mi. SE of Bylas, five females (two pale), 2000 ft. altitude, July 18, 1952, at light, R. B. and R. K. Selander collectors, in R. B. Selander collection; Santa Catalina Mts., one male, August, D. K. Duncan collector, in Mr. Duncan's collection; Tucson, three males, six females, various dates June 20 to August 12, 1932, F. H. Parker; Tucson, one male, one female, June 25, 1933 "Bryant 128" (one male and one female pale), all in F. H. Parker collection; Ehrenberg, nine males, eight females, various dates, June 18 to July 31, 1938, F. H. Parker (all entirely pale), in F. H. Parker collection; Ehrenberg, two males, June 21, 1938 and June 24, 1938, F. H. Parker, in F. G. Werner collection (both with pale elytra). California: Death Valley, one female, April, 1926, J. D. Gunder; Imperial County, one female, July 26, Blaisdell collection, both in California Academy of Sciences. Utah: St. George, one male, Ac 5409, Chas. Palm, in American Museum of Natural History (elytra pale).

Collection dates: April (?) to August 12.

Hosts: unknown.

Pseudozonitis longicornis (Horn)

(Figs. 26, 39, 84, 143, 213)

Zonitis longicornis Horn, 1870, Trans. Amer. Ent. Soc., vol. 3, p. 93; 1875, Trans. Amer. Ent. Soc., vol. 5, p. 155; Champion, 1892, Biologia Centrali-Americana, vol. 4, part 2, p. 387; Fall, 1907, Trans. Amer. Ent. Soc., vol. 33, p. 257; Snow, 1907, Trans. Kansas Acad. Sci., vol. 20, p. 149; Blatchley, 1910, An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of Rhynchophora) Known to Occur in Indiana, p. 1356; Borchmann, 1917, Coleopterorum Catalogus, pars 69, p. 160; Leng, 1920, Catalogue of the Coleoptera of America, North of Mexico, p. 160; Blatchley, 1922, Canadian Ent., vol. 54, p. 28; Van Dyke, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 132; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 148; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; Vaurie, 1950, Amer. Mus. Novitates, no. 1477, p. 10; MacSwain, 1951, Pan-Pac. Ent., vol. 27, pp. 72, 74.
Pseudozonitis longicornis, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 344.
Pseudozonitis roseomaculatis (in part), Dillon, 1952, Amer. Midland Nat., vol. 48, p. 344 (misidentification).

Most closely related to *Ps. roseomaculatis* and *Ps. labialis* but readily distinguishable from the former by the eyes being separated on the under side of the head by a distance less than half that between the eyes on the frons; from the latter by the head in cephalic view being abruptly narrowed above the mandibular articulations, the galeae shorter than the labial palpi, and the differently colored head, pronotum, and femora.

Body surface dull or feebly shining. Head fuscous except pale spot on frons between eyes. Pronotum flavous or pale testaceous with a median reddish macula. Elytra predominently fuscous or brown with sutures, margins, and narrow discal vittae pale yellow. Thorax and abdomen beneath brown, coxae and trochanters pale, femora fuscous except apices and bases pale, tibiae fuscous except basal third pale, tarsal segments fuscous annulate with yellow at least at bases, often also at apices. Antennae similarly annulate. Length 10-12 mm.

Male: Head elongate subtriangular, in cephalic aspect narrowed between eyes and mandibular articulations, distance from vertex to labroclypeal suture somewhat greater than distance across tempora; tempora not inflated; vertex evenly rounded; surface densely, moderately coarsely punctate, a short inconspicuous pale seta arising from each puncture, usually subtuberculate between eyes, often only feebly so; a moderately broad transverse ridge between bases of antennae. Eyes large, feebly emarginate, moderately coarsely faceted, separated below by less than half the distance of separation above. Clypeus shallowly, coarsely punctate, feebly impressed at center, apex glabrous. Labrum one third wider than long, moderately densely, coarsely punctate, clothed with longer pale setae, apex feebly emarginate at center. Mandibles stout, moderately long, evenly arcuate from bases to apices, sides densely punctured and pubescent, basally pale, apical halves black. Maxillary palpi moderately robust, labial palpi more slender, both longer than mandibles, dark brown, densely punctured and pubescent, apices subtruncate. Galeae triangular lobiform, short, not as long as labial palpi, inner margins with a dense fringe of coarse hairs. Antennae more than three times as long as pronotum, filiform, slightly tapered to apices, each with first segment almost attaining half the width of eye behind emargination, moderately inflated, feebly arcuate, rather sparsely punctured and pubescent, shining; second shorter than first, feebly flattened, gradually widened to apex, scarcely less shining than first; third one fourth longer than second, almost parallel sided, less shining, more densely punctulate and pubescent than second; fourth longer than third, otherwise similar; fifth and sixth subequal to fourth, sixth more than four times as long as wide; seventh to tenth similar but scarcely shorter; eleventh one fourth longer than tenth, apex subacute; integument of segments 3 to 11 narrowly yellow annulate at extreme bases and apices.

Pronotum distinctly wider than long, feebly shining, uniformly moderately densely, coarsely punctate, ground color pale yellow, median macula irregularly rectangular, often constricted at middle, color usually bright red; posterior pronotal angles divergent, sides subparallel to apical third, thence sharply convergent to apex, widest at apical third, wider than head, much narrower than bases of elytra. Scutellum moderately large, densely punctate and pubescent, apex rounded. Elytra elongate oblong, more than four times as long as wide, densely, moderately coarsely punctate or rugose-punctate, ground color fuscous, sutures and margins narrowly yellow, a narrow, sinuate yellow vitta on each elytron extending from humeral angle to near apex. Thorax and abdomen beneath usually dark brown, shining, thorax shallowly, moderately densely punctate, abdomen rather sparsely scabrous-punctate, clothed with short pale setae. Legs densely punctate, pubescent, spurs of anterior and middle tibiae slender, acute, subequal; metatibial spurs short, equal, or with inner spurs almost imperceptibly larger than outer, broad, concave, apices rounded. Fifth abdominal sternum medially impressed, apex emarginate at center; sixth medially cleft to base with a broad, deep, central impression.

Female: Similar to male except fifth abdominal sternum not modified, sixth with a deep, U-shaped emargination medially at apex.

Types: Holotype male, no. 8073, labeled "Ill.", in the Horn collection at the Academy of Natural Sciences, Philadelphia (examined). The type specimen has darkened and the colors are a bit dingy but the reddish color of the pronotal macula is discernible under the microscope. Neallotype (new designation) in the Carnegie Museum labeled Topeka, Kansas, VII, H. Klages collection, C. M. Acc. 11414.

Specimens examined: KANSAS: Riley County, one male, June, Popenoe collector, in Kansas State College; "Kan.", one female, T. B. Ashton, in Purdue University. TEXAS: Dimmitt County, one male, May 1, 1933, S. E. Jones, labeled "Paratype *Pseudozonitis roscomaculatis*", in Texas A. and M. College; "Tex.", one male, F. A. Eddy collection, in Museum of Comparative Zoology, Harvard; Uvalde County, one female, May 20, 1938, J. H. Robinson, in R. B. Selander collection; San Antonio, one female, May 25, 1936, C. D. Orchard, in F. H. Parker collection. FLORIDA: Biscayne Bay, one specimen, abdomen missing, Ac. 26226, Mrs. A. T. Slosson, no date, in American Museum of Natural History; Royal Palm Park, one female, March 22, 1930, W. S. Blatchley, in Blatchley collection, Purdue University; Paradise Key, one female, at light, April 11, 1951, H. & A. Howden, in H. F. Howden collection.

Collection dates: March 22 to July (?).

Hosts: unknown.

Dillon's paratype of *Ps. roscomaculatis* from Dimmit County, Texas (*op. cit.* p. 344) is a male of *Ps. longicornis* as above defined.

Although lacking tangible proof, it appears to me that the locality label on the type specimen is erroneous and that the specimen probably came from a more southern region. At the same time it must be acknowledged that typically southern forms do occur occasionally along major watercourses and other favorable habitats at considerable distances north of their normal ranges. This is likely to be more pronounced in parasitic species such as those treated in this paper. In spite of this argument, I am not convinced that the label is correct. The same may be said for a female specimen of *Pseudozonitis roseomaculatis* in the Illinois Natural History Survey collection labeled simply "Ill.", "Andreas Bolter collection".

Pseudozonitis roseomaculatis Dillon

(Figs. 24, 140, 214)

Pseudozonitis roseomaculatis Dillon, 1952, Amer. Midland Nat., vol. 48, p. 343.

Resembles *Ps. longicornis* but readily distinguished from that species by the eyes being separated below the head by a distance greater than half that separating the eyes on the frons. In addition the color differences seem remarkably constant, the head in the present species being largely yellow above and below the interocular area on the frons with the interocular area fuscous or black but often the head is entirely black except the clypeus and basal halves of the mandibles which are yellow. The head in cephalic aspect is not as abruptly narrowed between the eyes and mandibular articulations; the mandibles are rather parallel-sided basally for slightly more than half their length thence rather abruptly arcuate inward; the sternum is darker in general, almost always black or deep fuscous; the elytra often lack the discal vittae and are quite dark; the galeae are slightly longer; and the median pronotal macula extends all the way to the narrow raised anterior margin of the pronotum while in *longicornis* it does not attain the margin by a conspicuous distance.

Body surface moderately shining, elytra less so. Head largely black except bases of mandibles, labrum, and clypeus yellow. Antennal segments 3 to 11 distinctly flattened, sixth segment slightly more than four times as long as wide, all segments with narrow yellow annulations at apices. Pronotum subcampanulate, wider than long, densely, coarsely punctured, with a median bright rufous macula of irregular shape, usually broadest on basal third, narrower on apical two thirds, extending from base to apex except the narrow raised anterior and posterior margins. Scutellum usually pale with a broad median black vitta. Elytra uniformly densely, finely punctate, usually fuscous or black, each elytron usually with a narrow sutural, marginal, and sinuous discal pale vitta, some specimens with elytra entirely fuscous. Prothorax pale beneath, remainder of sternum black with varying amounts of yellow. Coxae and trochanters usually pale, femora fuscous except bases and apices pale. Tibiae pale basally becoming black distally. Tarsi black with or without yellow annulations at articulations of segments. Spurs of anterior and middle tibiae slender, spiniform, acute; metatibial spurs alike, inner scarcely longer than outer, both large, concave. Male fifth abdominal sternum with median line deeply impressed, and with a deep, subtriangular emargination medially at apex; sixth cleft medially to base with an oval, central impression. Female similar to male but fifth abdominal sternum not modified, sixth with a deep, U-shaped emargination medially at apex. Length 8-13 mm.

Types: Holotype male and allotype, Bexar County, Texas, 1951, H. B. Parks collector, in the Texas A. & M. College collection. Paratypes: four males, nine females, same data as holotype (examined). Six additional paratypes cited in the original description not examined.

Specimens examined: TEXAS: one female, 1 mi. east San Antonio, June 6, 1942, E. S. Ross collector, in the California Academy of Sciences collection; two females, New Braunfels, June 7, 1942, E. S. Ross collector, in the California Academy of Sciences collection. ILLINOIS: one female, "Ill.", Andreas Bolter collection, in the Illinois Natural History Survey collections.

Collection dates: June 6 and 7.

Hosts: unknown.

As mentioned after the discussion of *Ps. longicornis,* I am not convinced that the Illinois specimen is correctly labeled.

The paratype mentioned in Dillon's paper (1952) from "Dimmit County", Texas, is a male of *Ps. longicornis* taken May 1, 1933, by S. E. Jones. It is in the Texas A. & M. College collections.

The two paratypes Dillon cites from "College Station", Texas, are a male and a female of *Ps. pallida* taken September 14, 1932. They are in the Cornell University collection. All three of the above mentioned paratypes bear Dillon's paratype labels.

The paratype from "Kingsville", Texas, I have not seen although I believe that all of the Cornell University specimens have been sent to me. It was reported by Dillon in the original description as being in the Cornell University collections.

When our collections and knowledge of the group become more extensive, *Ps. roseomaculatis* may have to be reduced to infraspecific status under *longicornis* but at the present writing appears to be specifically distinct and practically sympatric with the latter. It is certainly not closely related to *Zonitis* (=*Pseudozonitis*) *schaefferi* as Dillon (1952) thought possible.

Pseudozonitis labialis, sp. nov.

(Figs. 24, 37, 85, 144, 217)

Morphologically closely resembling *Ps. longicornis* but distinct from that species by the galeae being longer than the labial palpi, subequal in length to the maxillary palpi; the head in cephalic aspect not distinctly narrowed between the eyes and mandibular articulations; the labrum with a median longitudinal sulcus or impression; the mandibles more sharply arcuate; the frons more distinctly tuberculate or subcarinate; thorax and abdomen ventrally more densely punctate and pubescent; the head testaceous or flavous in great part except a black or fuscous spot of variable size on the front of the head between the eyes; disk of pronotum with two fuscous or reddish-fuscous maculae, one on either side, in some specimens united; a distinct broad impression anteriorly on the pronotum on either side of the median line; a distinct median sulcus on the basal third of the pronotum; tarsal segments usually entirely fuscous, not annulate with yellow except posterior tarsi in some specimens which may be almost entirely pale. Length 10-15 mm.

Male: Head short, triangular to ovate, distance from vertex to labroclypeal suture subequal to distance across tempora, tempora not inflated; vertex evenly rounded or feebly tumid; surface moderately densely, coarsely punctate, an inconspicuous pale seta arising from each puncture; frons distinctly tuberculate or carinate between eyes, transversely impressed just above ridge connecting bases of antennae. Eyes large, distinctly emarginate, moderately coarsely faceted, separated below by less than half the distance separating them above. Clypeus with basal half feebly rugose, apical half glabrous, shining, declivous. Labrum one third wider than long, moderately densely punctate, clothed with long hairs, divided medially its entire length by a broad, glabrous sulcus, a feeble median impression at base, apex evenly rounded. Mandibles moderately stout, rather abruptly arcuate inward at half their length, sides densely punctured and pubescent, bases pale, apices black. Palpi moderately slender, longer than mandibles, punctured and pubescent, segments black, apices of terminal segments subtruncate. Galeae pale, lobiform, as long as labial palpi. Antennae more than three times as long as pronotum, filiform, tapered to apices; black, annulate with yellow at articulations of segments; apical segments entirely pale in some specimens; each antenna with first segment just attaining half the width of eye behind emargination, feebly curved and inflated, moderately shining, punctured and pubescent; second subequal to first in length, otherwise similar but straight, feebly widened to apex; third segment one fourth longer and considerably wider than second, more densely punctured and pubescent, less shining, moderately enlarged to apex; fourth segment one third longer, more slender than third, slightly flattened; fifth shorter than fourth, otherwise similar; sixth shorter than fifth, four times as long as wide; seventh to tenth subequal to sixth, tapered to apices; eleventh longer than tenth, evenly tapered to apex which is subacute.

Pronotum slightly longer than wide, moderately shining, densely coarsely punctate, ground color yellow, maculae fuscous; posterior angles not divergent or extremely feebly so, sides feebly divergent half way to apex, thence rapidly convergent to apex, basal and apical margins feebly raised. Scutellum black, moderately large, densely punctate and pubescent, subapically impressed, apex subacutely rounded. Elytra densely rugose-punctate, distal halves becoming somewhat explanate; sutures, margins, and sinuous discal vittae pale yellow, remainder fuscous or black, discal vittae obsolete in some specimens. Thorax and abdomen varying from fuscous to black, coxae and trochanters yellow, femora black except at bases and apices, tibiae black except extreme bases yellow, tarsi black; thorax and abdomen ventrally densely punctate becoming scabrous-punctate on abdomen, clothed with pale golden pubescence which is longer and denser on abdomen. Legs densely punctate and pubescent, spurs of anterior and middle tibiae slender, spiniform; metatibial spurs large, concave, similar and equal, apices somewhat pointed. Fifth abdominal sternum broadly, deeply, triangularly emarginate and impressed with a median glabrous area at center of emargination; sixth cleft medially to the base, deeply impressed centrally.

Female: Similar to male but fifth abdominal sternum not so modified, sixth triangularly emarginate medially at apex.

Types: Holotype male, allotype, and one male paratype, Cameron County, Texas, June 12, 1947, J. G. Edwards collector, in the California Insect Survey collections on loan deposit at the California Academy of Sciences. Additional paratypes as follows: Texas:

three females, Brownsville, June 5, 1932, J. O. Martin collector; one female, Brownsville, June 9, 1932, all in the California Academy of Sciences; one female, Brownsville, June; one female, Weslaco, May 20, 1930, S. W. Clark, "Tex. Exp. Sta. Light Trap", both in the Cornell University collection; two females, Brownsville, June 29, 1938, R. I. Sailer, in the Snow Entomological Museum, University of Kansas; one female, Weslaco, May 20, 1930, S. W. Clark, "Tex. Exp. Sta. Light Trap"; one male, same data except May 30, 1930, both in the Texas A. & M. College collection; two females, Kingsville, C. T. Reed, Cornell University Lot 912, Sub. 640, in the Cornell University collection; two males, Brownsville, June 11-16, 1933, Darlington collector, in the Museum of Comparative Zoology, Harvard University collection; one female, Weslaco, May 30, 1930, S. W. Clark, "Tex. Exp. Sta. Light Trap", in the collection of F. G. Werner; one female, Lake Corpus Christi State Park, San Patricio County, June 17, 1948, in the Werner collection; one female, On Rio Grande, Hidalgo, June 23-25, 1948, G. E. Ball collector, in the Werner collection; one male, one female, Brownsville, June 23-25, 1930, E. G. Linsley, in the collection of F. H. Parker.

Collection dates: May 20 to June 29.

Hosts: unknown. Like several of its congeners, adults are attracted to lights.

An additional male, not included in the type series, has been examined. The head and prothorax are missing in this specimen but nevertheless it is recognizable as belonging to this species. It is labeled Hidalgo County, Texas, May, 1930, J. C. Gaines, "Tex. Exp. Sta. Light Trap", and is in the Texas A. & M. College collection.

Pseudozonitis arizonica (Van Dyke)

(Figs. 27, 145, 216)

Zonitis arizonica Van Dyke, 1929, Bull. Brooklyn Ent. Soc., vol. 27, p. 132; Denier, 1935, Rev. Soc. Ent. Argentina, vol. 7, p. 147; Blackwelder, 1939, 4th Supplement, Leng's Catalogue of the Coleoptera of America, North of Mexico, p. 35; MacSwain, 1951, Pan-Pac. Ent. vol. 27, p. 72.
Pseudozonitis arizonica, Dillon, 1952, Amer. Midland Nat., vol. 48, p. 342.

Related to *Ps. pallida* but distinguishable by the similar and equal metatibial spurs, uniformly pale pronotum and elytra, and smaller number of teeth in the inner rows of the tarsal claws.

Body surface moderately shining. Entirely pale testaceous or flavous except eyes, antennae, distal halves of mandibles, distal palpal segments, apical fourth of each femur, at least distal halves of tibiae, and tarsal segments (except extreme bases of first tarsal segments) fuscous or black. Abdomen darker testaceous in some specimens. Metatibial spurs similar and equal. Tarsal claws with no more than 24 teeth in inner rows. Head narrow, eyes extremely closely approximated above and below. Length 10-12 mm.

Types: Holotype male, no. 2605, in California Academy of Sciences, taken six miles south of Florence, Arizona, July 23, 1924, by E. P. Van Duzee. Allotype (new designation for Van Dyke's "paratype"), Tucson, Arizona, August 11, 1924, E. P. Van Duzee, in the California Academy of Sciences (examined).

Specimens examined: ARIZONA: Tucson, July 24, 1952, one female, at light, 2389 ft. altitude, R. B. and J. M. Selander collectors, in the R. B. Selander collection; Tucson, one female, July 8, 1932, F. H. Parker; Tucson, one female, August, 1935, Bryant; Superior, one female, August 2, 1937, G. P. Englehardt, all in F. H. Parker collection. NEW MEXICO: Belen, July 20, 1936, one male, R. H. Beamer collector, in the Snow Entomological Museum, University of Kansas. CALIFORNIA: Andrade, September 4, 1941, one male, E. Myers collector, in the San Jose State College collection; Death Valley, April 27, 1925, two females nos. 4395 and 4399, R. E. Blackwelder collector, in the U. S. National Museum.

Collection dates: July 20 to September 4.

Hosts: unknown. One specimen was taken at lights.

It is possible that this species and *Ps. pallida* may be subspecies of the same species but the lack of information on their biologies and distribution precludes such action although they appear to be allopatric.

Van Dyke's "paratype" is a female which is similar to the male except the fifth abdominal sternum is not impressed and the sixth has a deep, moderately broad, triangular emargination medially at apex.

Pseudozonitis pallida Dillon

(Figs. 27, 148, 215)

Pseudozonitis pallidus Dillon, 1952, Amer. Midland Nat., vol. 48, p. 344.

Related to *Ps. arizonica* but differing by its larger size, usually pallidly vittate elytra, distinctly annulate antennae and tarsi, inner metatibial spurs usually longer than outer; denser punctation of elytra; different color pattern, and greater number of teeth in the inner rows of the tarsal claws.

Body surface feebly shining. Head, thorax, legs, scutellum, and abdomen pale testaceous except eyes, distal halves of mandibles, palpi (except basal segments), extreme apices of femora, and distal portions of tibiae black or fuscous. Antennae and tarsi black or fuscous, annulate with yellow at articulations of segments. Elytra usually testaceous with broad, pale fuscous subsutural and submarginal vittae usually united near apices leaving only narrow sutural, discal, and marginal area pale, in some specimens entirely pale testaceous. Inner metatibial spurs longer than outer. Tarsal claws with 30 or more teeth in inner row. Length 14-17 mm.

Types: Holotype male, allotype, and three paratypes, College Station, Texas, June 5-17, 1934, H. J. Reinhard. One male paratype of this series, labeled June 17, 1933, is in the Werner collection (the latter only examined), the others presumably in the Texas A. & M. collection. Four paratypes, Morris County, Texas, June 27, 1937, of which one male and two females are in the Texas A. & M. collection, one female in the Werner collection (all examined). Three paratypes, Madison County, Texas; one male, one female, July 20, 1931, Bibby and Tate collectors; one female, July 11, same collectors, in Texas A. & M. collections (examined). One male paratype, Dimmit County, Texas, May 30, 1934, "Tex. Exp. Sta. Light Trap", S. E. Jones collector, in Texas A. & M. collections (examined). One female paratype, Tyler, Texas, October 5, 1937, in Texas A. & M. collections (examined).

Specimens examined: TEXAS: College Station, one female, Sept. 14, 1932, in Cornell University collection, labeled "Paratype *Pseudozonitis roseomaculatis* Dillon"; one male, same locality, date crossed out, in Cornell University collection, also labeled "Paratype *Pseudozonitis roseomaculatis* Dillon"; Dallas, one female, June 19, 1948, at light, G. E. Ball, in Werner collection; Leon County, one male, April 30, 1937, J. H. Robinson, at light, in California Academy of Sciences; one female, same data, in R. B. Selander collection; Terrell, Kaufman County, one male, one female, July 11, 1950, 500 ft., Cohn, Boone, Cazier, in American Museum of Natural History collection; El Paso, no other data, one female, in Snow Entomological Museum, University of Kansas. LOUISIANA: Ruston, Lincoln County, one female, July 10, 1950, 300 ft., Cohn, Boone, Cazier, in the American Museum of Natural History collection; Alexandria, one male, July 23, 1938, W. Stehr, in South Dakota State College collection. FLORIDA: Branford, one female, Aug. 4, 1939, R. H. Beamer, in Snow Entomological Museum, University of Kansas; Plant City, one female, Aug. 15, 1930, J. O. Nottingham, in Snow Entomological Museum, University of Kansas; Old Town, one female, July 11, 1939, D. E. Hardy, in

Snow Entomological Museum, University of Kansas; Cross City, one male, August 22, 1938, in U. S. National Museum; Old Town, one male, July 11, 1939, R. H. Beamer, in R. B. Selander collection. Georgia: Adel, one female, August 11, 1939, A. T. Hardy, in Snow Entomological Museum, University of Kansas. Arkansas: Hope, two females, July 25, 1931, Blaisdell collection, California Academy of Sciences.

Collection dates: May 30 to October 5.

Recorded elevations: 300-500 ft.

Hosts: unknown. Several specimens taken in trap lights.

The specimens from Florida and Georgia show some variation from the others in that the pronotum is more shining and less densely punctate and may be worth subspecific designation but the scarcity of specimens does not warrant such action at present. The specimen from Alexandria, Louisiana, has remarkably dark elytral vittae.

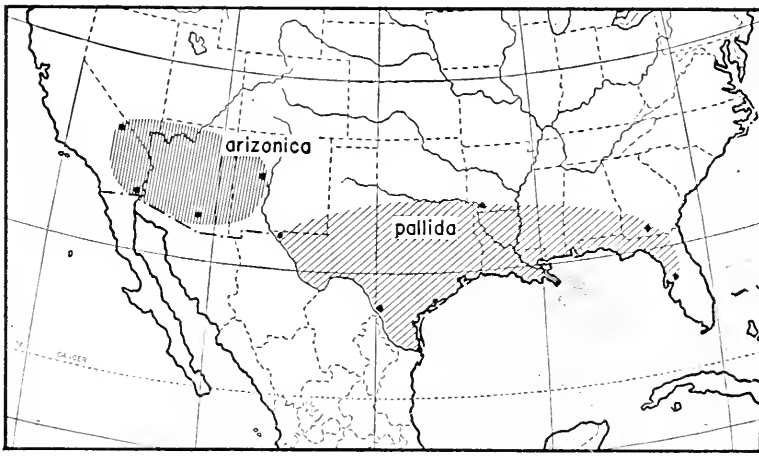

Fig. 27. Map showing the distribution of *Pseudozonitis arizonica* and *Ps. pallida.*

Pseudozonitis stroudi, sp. nov.

(Figs. 28, 37, 85, 144, 217)

This species is most nearly related to *Ps. vauricae* but is readily separable from that species by the characters cited in the key. In addition the elytral punctation is somewhat coarser; the average size considerably smaller; the pronotum of different form; and the distribution quite different.

Body surface feebly shining. Head yellow, eyes, antennae (except narrow yellow annulations at segmental articulations), distal two thirds of mandibles, and palpi black or fuscous. Prothorax yellow except median rectangular macula deep red. Scutellum yellow. Elytra fuscous except sutures, margins, and sinuous discal vittae yellow. Sternum yellow. Legs yellow except extreme apices of femora, distal two thirds of tibiae, and tarsal segments (the latter feebly yellow annulate in some specimens) black. Metatibial spurs similar and equal. Length 7-11 mm.

Male: Head in cephalic aspect spherical above labrum and mandibles; distance from vertex to labroclypeal suture equal to distance across tempora; tempora not inflated; vertex evenly rounded; surface rather densely, coarsely punctate, irregularly carinate low on frons, an extremely short, pale seta arising from each puncture; no transverse ridge between bases of antennae. Eyes extremely large, coarsely faceted, emarginate, separated below by a distance less than half that separating them above. Antennae slender, filiform, three times as long as pronotum, slightly tapered to apices, each with first segment reaching halfway across eye behind emargination, inflated and curved, sparsely punctured and pubescent, shining; second shorter than first, gradually widened at apex, otherwise similar to first; third almost one third longer than second, somewhat flattened, feebly widened to apex, more densely punctate and pubescent hence less shining than second; fourth similar to third but slightly longer; fifth similar to fourth but longer; sixth subequal to fifth, more than three times as long as wide; seventh to tenth subequal to sixth but progressively more slender; eleventh one fourth longer than tenth but more slender, outer margin straight, inner margin evenly curved from base to apex, widest at middle, apex subacute. Clypeus distinctly impressed, feebly, coarsely punctate basally, apical fourth glabrous. Labrum small, one third wider than long, feebly or not punctate, clothed with rather sparse, long golden setae, a shallow fovea medially at base, apex broadly rounded or subtruncate. Mandibles short, stout, basally straight for one third their length, thence sharply arcuate inward, sides basally densely punctate and pubescent. Palpi moderately long and slender, segments somewhat flattened, sparsely punctured and pubescent, shining, an impressed glabrous area near tips, apices of terminal segments feebly constricted, extreme tips subtruncate. Galeae pale, lobiform, shorter than labial palpi.

Pronotum as wide as long, somewhat shining, moderately densely, coarsely punctate, most punctures separated by at least their diameters; color yellow with a broad, red, median macula usually rectangular but often with sides gradually, evenly convergent on basal third; posterior angles distinctly divergent, sides subparallel or rounded from constriction just before base to apical third, thence rapidly convergent to apex; basal and apical margins feebly raised. Scutellum small, triangular, densely punctate and pubescent, feebly or not impressed, apex rather broadly rounded. Elytra moderately densely rugose-punctate, clothed with short, pale, recumbent setae, sutures and margins raised. Thorax and abdomen ventrally shining, moderately densely punctate and pubescent, pubescence fine, pale, denser and longer on abdomen. Legs shining, densely punctate and pubescent, spurs of anterior and middle tibiae long, slender, spiniform; metatibial spurs similar and equal, rather short, obliquely concave, apices rounded. Fifth abdominal sternum deeply impressed on median line with a triangular emargination medially at apex; sixth medially cleft to the base with a deep, central impression.

Female: Similar to male but fifth abdominal sternum not modified, sixth with a shallow subtriangular emargination medially at apex.

Types: Holotype female and one female paratype taken at Ridingers Motel near White Sands National Monument, Otero County, New Mexico, August 8, 1947, at light (trap), Clyde P. Stroud collector, holotype in the Snow Entomological Museum, University of Kansas; the paratype in the author's collection. Allotype no. 62731, at lights, Presidio, Texas, October 10, 1947, J. H. Russell collector, in the U. S. National Museum.

Additional paratype specimens as follows: NEW MEXICO: Pyramid Peak, Dona Ana County, one female, July 12, 1930, F. R. Fosberg, in the Los Angeles County Museum; one female, same data except August 26, 1930, in the California Academy of Sciences. ARIZONA: Tucson, one female, July 30, 1940, J. W. Tilden, in the Tilden collection; Tucson, one female, August 8, 1939, R. H. Crandall, in the Crandall collection; Globe, one female, July, D. K. Duncan, in the Kansas State College collection; Cottonwood, one female, August 16, 1931, K. L. Maehler, in the California Insect Survey collection; San Bernardino Ranch, Cochise County, one female, 3750 ft. altitude, August, F. H. Snow, in the Snow Entomological Museum, University of Kansas; one female, same locality, 3600 ft., sycamore-willow in valley, August 16, 1949, at light, F. Werner and W. Nutting, in the Werner collection; Globe, one female, D. K. Duncan, Blaisdell collection, in the California Academy of Sciences; two females, same data, July, in the collection of D. K. Duncan;

Roosevelt Lake, one female, September 2, 1935, F. H. Parker; Tucson, two females, August 12, 1932, F. H. Parker; Phoenix, one female, August 31, 1935, F. H. Parker; Globe, one female, July 20, 1933, F. H. Parker; three females, same data except August 10, 1933; Base of Pinal Mts., one female, 4000 ft., August, 1930, the above all in the collection of F. H. Parker.

Also examined but not included in the type series is a single female labeled "Liebeck Collection", in the Museum of Comparative Zoology, Harvard University.

Collection dates: July 2 to October 10.

Recorded elevations: 3600 ft. to 4000 ft. altitude.

Hosts: unknown.

This species is named in honor of the late Clyde P. Stroud who first sent me specimens of it in 1947 which were subsequently reported by him as a probable new species (Amer. Midland Nat., vol. 44, p. 668, 1950).

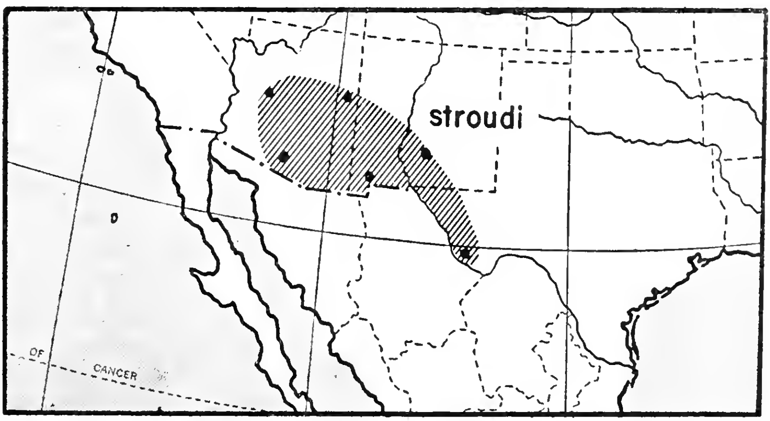

FIG. 28. Map showing the distribution of *Pseudozonitis stroudi.*

Pseudozonitis vaurieae, sp. nov.

(Figs. 29, 40, 146, 218)

Zonitis megalops, Vaurie, 1950, Amer. Mus. Novitates, no. 1477, pp. 1, 6, 10.
Pseudozonitis megalops, Selander, 1954, Jour. Kansas Ent. Soc., vol. 27, p. 92.

Related to *Ps. stroudi* but readily distinguished by its larger size, form of the male genitalia, and pronotal characteristics. It has been mistaken for *Ps. megalops* (Champion) by Vaurie (1950) and by myself (*in* Selander, 1954). Since the publication of Selander's paper it has been my privilege to examine Champion's type specimen through the courtesy of Mr. J. Balfour-Browne and the British Museum (Natural History). The type, so labeled, is a female rather than a male as stated by Champion (1892) and with it is another female from Chontales, Nicaragua (presumably collected by Janson), Fry collection, no. 1905-100, bearing a small green label no. 54476. The latter specimen is somewhat paler and smaller than the type but otherwise quite similar. Champion's description is accurate for the most part and both specimens differ from *vaurieae* in the following characteristics: the punctation of the pronotum and vertex is extremely dense and fine; the disk of the pronotum is more flattened (as in *labialis*); the red median pronotal macula is long, slender, widest about one third its length from base; no transverse fasciae or other red suffusion on the pronotum; the scutellum is bright red medially from base to apex between the lateral carinae; apex of scutellum is rather narrow; the elytra are more densely, shallowly punctate, entirely pale testaceous except extreme bases infuscate; the cephalic outline is more as in *brevis,* with little or no narrowing of the head at base of mandibles; the entire head is pale except an irregular fuscous macula between bases of antennae on frons; the mandibles are very gradually arcuate from bases to apices; the coxae and femora of the fore and middle legs are dark except at apices but the tibiae are pale basally becoming dark apically; the hind legs are entirely pale except apices of tibiae which are dark; all the tarsi are fuscous except the narrow yellow annulations at apices of the segments; metatibial spurs are similar and equal; the legs finely, densely punctate; all pubescence is short, pale, appressed; the entire sternum is infuscate except the fifth and sixth abdominal sterna are flavous. Length from 10 to 12.5 mm.

No males from the type locality of *megalops* (Volcán de Atitlán, Guatemala, 3000 ft. altitude) are available to me for comparative studies of the genitalia. It is quite possible that *megalops* may prove to be not congeneric with *Pseudozonitis* when males are available for study.

Within moderately broad limits, the color of the pronotum in *vaurieae* is a remarkably constant feature. It is flavous or pale testaceous with a reddish area which consists of a broad median longitudinal vitta crossed before the middle by a broad, transverse fascia which continues onto the sides of the prothorax. The reddish area varies from this cross-shaped form to an area covering all but the posterior angles and in some specimens suffusing the entire pronotum. A similar feature occurs in *Ps. stroudi* and *Ps. schaefferi.*

Body surface feebly shining. Head flavous or testaceous except eyes, antennae, tips of mandibles, and palpi which are black. Pronotum flavous usually with at least anterior third and broad median line bright rufous. Elytra varying from entirely pale testaceous to black, usually with sutures, margins, and a sinuous discal vitta on each elytron pale. Thoracic sterna and legs flavous except apices of femora, tibiae except basal fourth, and tarsal segments which are black, the latter rarely annulate with yellow. Abdominal sterna varying from flavous to black. Tarsal claws with 30 or more teeth in inner row. Inner metatibial spurs equal to or larger than outer. Eyes separated below by width of gula, above by scarcely more than twice this distance. Length 10-18 mm.

Male: Head large, subtriangular or elongate oval, distance from vertex to labroclypeal suture about one sixth longer than distance across tempora; tempora not inflated, vertex evenly rounded or feebly tumid; surface moderately densely, coarsely punctate, punctures finer and denser behind eyes, an irregular median raised line and often an indistinct tubercle on frons between eyes and bases of antennae, a short, very fine, pale seta arising from each puncture. Eyes extremely large, coarsely faceted, separated below by only width of gula, above by slightly more than twice this distance, moderately deeply emarginate. Clypeus with a deep transverse impression on basal third which is coarsely punctate, distal two thirds glabrous, shining, with a median longitudinal impression. Labrum as wide as long, sparsely, irregularly punctate, clothed with long pale hairs, medially impressed, apex evenly rounded and somewhat declivous. Mandibles moderately long, stout, sides subparallel basally, apical halves moderately abruptly arcuate inward, sides densely punctate and pubescent. Palpi moderately long, slender, densely punctate and pubescent except apices of distal segments which are smooth, shining, tips subacutely rounded or subtruncate. Galeae lobiform, not as long as labial palpi. Antennae black, feebly annulate at articulations with yellow, exceedingly long and attenuate, each with first segment stout, moderately inflated, extending more than half way across eyes behind emargination, shining, moderately densely punctate, clothed with sparse short pubescence; second scarcely shorter than first, feebly widened at apex, shining, punctured, and pubescent like first; third slightly longer than second, equal to first, densely punctured and pubescent, not shining, distinctly flattened and widened to apex; fourth one third longer than third, otherwise similar to third but not as wide;

fifth minutely longer than fourth, less flattened, otherwise similar; sixth longer than fifth but more rounded, about seven times as long as wide; seventh shorter, narrower than sixth; eighth shorter, narrower than seventh; ninth and tenth narrower otherwise subequal to eighth; eleventh slightly, about one sixth, longer than tenth, almost round in cross section, apex subacutely rounded.

Pronotum shining, nearly as wide as long, widest at extreme base which is as wide as head, posterior angles divergent, sides constricted just before base, thence widened but rounded to apical third, gradually narrowed to apex, base feebly emarginate medially; surface irregularly densely punctured, punctures coarse, moderately sparse on median line, finer and denser on sides of disk, a short, fine, pale seta arising from each puncture, a sharp median sulcus present often interrupted before base, a feeble, transverse impression just before base, a broad, shallow depression each side of median line on anterior third, basal margin distinctly raised, anterior margin not so. Scutellum large, broadly triangular, feebly impressed, surface densely, moderately finely punctate, apex rounded. Elytra more than twice as long as combined width at base, surface densely, shallowly rugose-punctate, clothed with extremely short, fine appressed pale pubescence, sutures and margins feebly raised, humeri inflated. Thorax and abdomen feebly shining ventrally, moderately densely, finely punctate, clothed with short pale pubescence, longer and denser on abdomen, fifth abdominal sternum deeply, triangularly emarginate medially at apex, sixth cleft to the base with a deep, elongate impression either side of cleft. Legs moderately to feebly shining, densely punctate and pubescent, tibial spurs of anterior and middle legs long, slender, feebly arcuate, parallel-sided, flattened and concave, recessed into tibiae almost half their length, apices rounded; posterior tibiae with inner spurs at least as large, usually larger than outer, both with distal halves large, concave, obliquely flattened, apices rounded.

Female: Similar to male but fifth abdominal sternum broadly emarginate, sixth with a deep, U-shaped emargination medially at apex.

Types: Holotype male and allotype, Pedricena, Durango, Mexico, August 19, 1947, 4500 ft., Cazier and Gertsch respectively collectors (D. Rockefeller Exped.), in the American Museum of Natural History.

Paratype specimens as follows: MEXICO: DURANGO: 35 mi. S El Entronque, two females, July 21, 1952, 5000 ft., R. K. and B. J.

Selander, in R. B. Selander collection. NUEVO LEÓN: Vallecillo, one female, June 2-5, 1951, P. D. Hurd, in California Insect Survey collection. CHIHUAHUA: Delícias, three females, July 11, 1947, 4150 ft., Gertsch, Schramel, and Michener respectively, D. Rockefeller Exped., in American Museum of Natural History. SONORA: 42 mi. S Hermosillo, one female, August 12, 1952, Cazier, Schramel, C. & P. Vaurie, in the American Museum of Natural History; Guaymas, one female, August 5, 1940, R. P. Allen, in California Academy of Sciences. GUERRERO: Acapulco, one female, June 21, 1935, M. A. Embury, in the California Academy of Sciences. SINALOA: Los Mochis, one male, June 9, 1922, Van Dyke collection, in the California Academy of Sciences; one female, July 7, 1922, C. T. Dodds, in the California Academy of Sciences. NAYARIT: Acaponeta, one female, August 4, 1953, C. & P. Vaurie, in the American Museum of Natural History. BAJA CALIFORNIA: San Felipe, two males, twelve females, June 15, 1952, Cazier, Gertsch, and Schramel, in the American Museum of Natural History; 6 mi. N Triunfo, one male, one female, July 15, 1938, Michelbacher and Ross; 20 mi. N Comondú, one female, July 23, 1938, same collectors; Venancio, two males, July 17, 1938, same collectors; Mesquital, one male, July 28, 1938, same collectors; San Domingo, one female, July 19, 1938, same collectors, the preceding seven specimens in California Academy of Sciences. UNITED STATES: ARIZONA: Kits Peak, Rincon, Baboquivari Mts., one female, August 1-4, 1916, about 4050 ft., in American Museum of Natural History; Safford, one male, July 14, 1940, S. L. Green, in R. H. Crandall collection; Benson, one male, two females, July 16, 1947, at light, F. Werner; 1 mi. W Gleeson, one female, July 26, 1949, on *Larrea*, F. Werner and W. Nutting; San Bernardino Ranch, Cochise County, one male, six females, July 25, 1949, 3600 ft., at light, sycamore-willow in valley; one female, same data except August 16, 1949, the preceding twelve specimens in F. G. Werner collection; St. Xavier Mission, Tucson, one male, July 29, 1924, E. P. Van Duzee, in California Academy of Sciences; Benson, one female, August 2, 1946, F. H. Parker; San Bernardino Ranch, Cochise County, two females, August 16, 1949, F. H. Parker, the three preceding in F. H. Parker collection. CALIFORNIA: Blythe, one male, August 9, 1937, M. A. Embury, in the American Museum of Natural History; two females, same data, in the California Insect Survey; one female, same data, in the California Academy of Sciences. NEW MEXICO: Mesquite near Mesilla Park, one male, July 12, 1917, in Cornell University; "New Mexico", one male, two females, 1930,

F. R. Fosberg, in Los Angeles County Museum; Las Cruces, Dona Ana County, one female, August 8, 1950, on *Chrysothamnus* sp., J. W. MacSwain, in the California Insect Survey.

Collection dates: June 2 to August 19.

Flower hosts of adults: Larrea; Chrysothamnus sp.

Bee hosts of larvae: unknown.

Adults are attracted to lights.

This species is named in honor of Mrs. Patricia Vaurie of New York who has been very helpful in the present study.

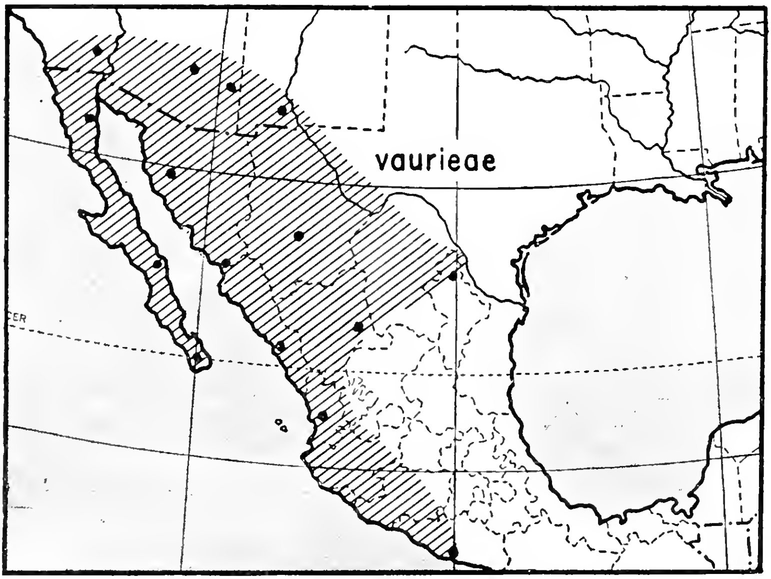

FIG. 29. Map showing the distribution of *Pseudozonitis vaurieae.*

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- Fig. 30. *Zonitis vermiculata* Schaeffer
- Fig. 31. *Zonitis vittigera vittigera* (LeConte)
- Fig. 32. *Zonitis interpretis* sp. nov.
- Fig. 33. *Nemognatha nemorensis* Hentz
- Fig. 34. *Nemognatha sparsa* LeConte
- Fig. 35. *Nemognatha piazata piazata* (Fabricius)
- Fig. 36. *Nemognatha cribraria fuscula* ssp. nov.
- Fig. 37. *Pseudozonitis schaefferi* Blatchley
- Fig. 38. *Pseudozonitis brevis* sp. nov.
- Fig. 39. *Pseudozonitis longicornis* (Horn)

Metatibial spurs of:
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- Fig. 43. *Nemognatha lutea lutea* LeConte
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- Fig. 46. *Nemognatha nigripennis* LeConte

Abdominal sterna of:
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- Fig. 48. *Zonitis atripennis atripennis* (Say)

Metatibial spurs of:
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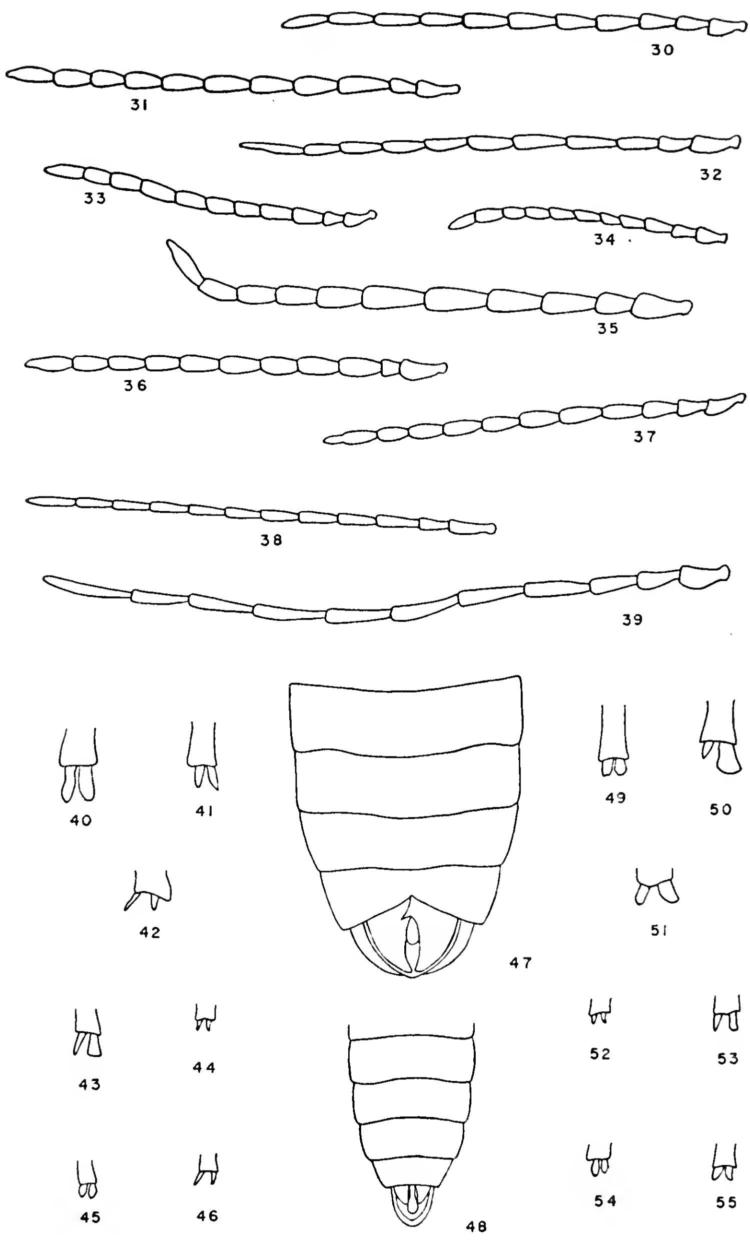
- Fig. 50. *Nemognatha lurida lurida* LeConte
- Fig. 51. *Zonitis vermiculata* Schaeffer
- Fig. 52. *Nemognatha bifoveata* sp. nov.
- Fig. 53. *Nemognatha lutea dichroa* LeConte
- Fig. 54. *Pseudozonitis vigilans* (Fall)
- Fig. 55. *Pseudozonitis martini* (Fall)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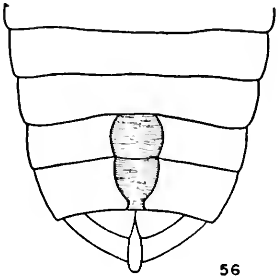
EXPLANATION OF FIGS. 56-65

Abdominal sterna of:

Fig. 56. *Nemognatha piazata piazata* (Fabricius)
Fig. 57. *Nemognatha scutellaris* LeConte
Fig. 58. *Nemognatha lurida lurida* LeConte
Fig. 59. *Nemognatha lutea lutea* LeConte
Fig. 60. *Nemognatha nigripennis* LeConte
Fig. 61. *Nemognatha bifoveata* sp. nov.
Fig. 62. *Nemognatha sparsa* LeConte
Fig. 63. *Nemognatha macswaini* sp. nov.
Fig. 64. *Nemognatha explanata* sp. nov.
Fig. 65. *Nemognatha punctulata* LeConte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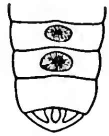
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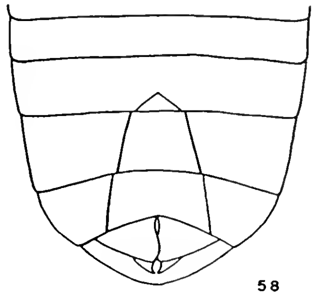
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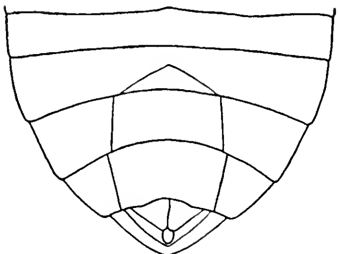
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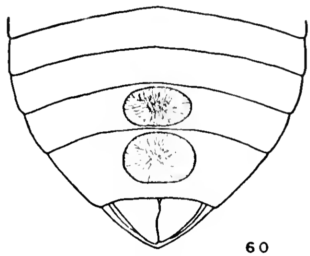
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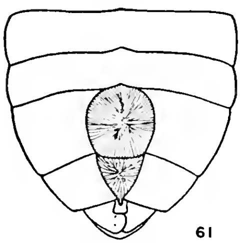
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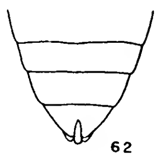
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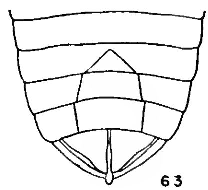
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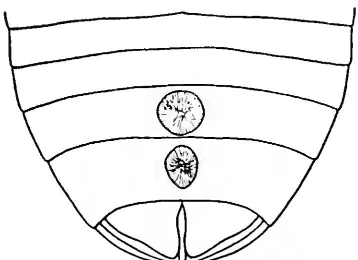
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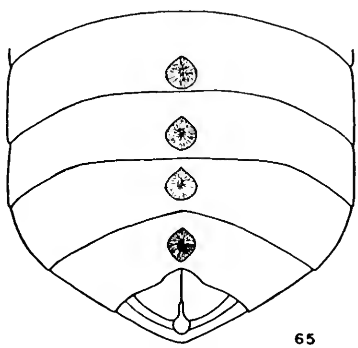
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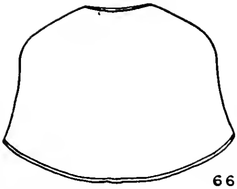
EXPLANATION OF FIGS. 66-89

Pronotal outlines of:

Fig. 66. *Nemognatha explanata* sp. nov.
Fig. 67. *Nemognatha sparsa* LeConte
Fig. 68. *Zonitis atripennis atripennis* (Say)
Fig. 69. *Nemognatha lutea lutea* LeConte
Fig. 70. *Nemognatha nemorensis* Hentz
Fig. 71. *Nemognatha selanderi* sp. nov.
Fig. 72. *Nemognatha hurdi* MacSwain
Fig. 73. *Nemognatha curta* sp. nov.
Fig. 74. *Nemognatha miranda* sp. nov.
Fig. 75. *Zonitis sayi* Wickham
Fig. 76. *Nemognatha macswaini* sp. nov.
Fig. 77. *Zonitis cribricollis* (LeConte)
Fig. 78. *Zonitis vittigera vittigera* (LeConte)
Fig. 79. *Zonitis bilineata* Say
Fig. 80. *Pseudozonitis brevis* sp. nov.
Fig. 81. *Zonitis interpretis* sp. nov.
Fig. 82. *Pseudozonitis schaefferi* (Blatchley)
Fig. 83. *Pseudozonitis stroudi* sp. nov.
Fig. 84. *Pseudozonitis longicornis* (Horn)
Fig. 85. *Pseudozonitis labialis* sp. nov.
Fig. 86. *Pseudozonitis martini* (Fall)
Fig. 87. *Nemognatha lurida lurida* LeConte
Fig. 88. *Nemognatha lurida apicalis* LeConte
Fig. 89. *Nemognatha piazata piazata* (Fabricius)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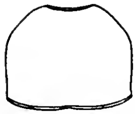
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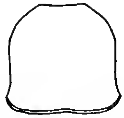
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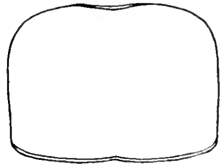
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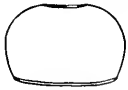
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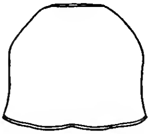
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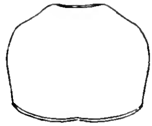
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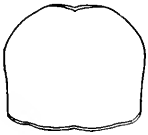
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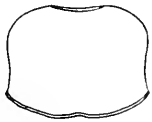
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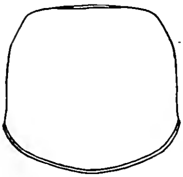
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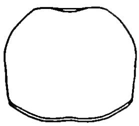
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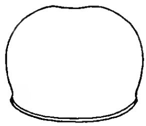
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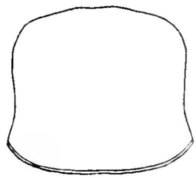
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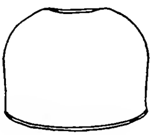
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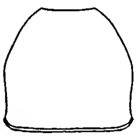
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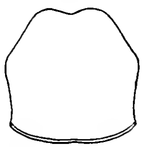
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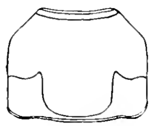
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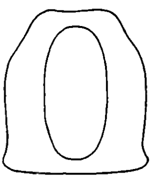
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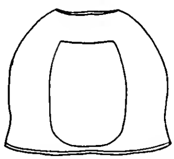
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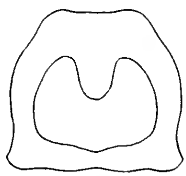
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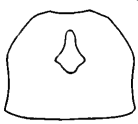
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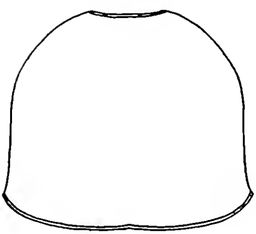
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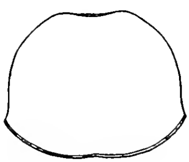
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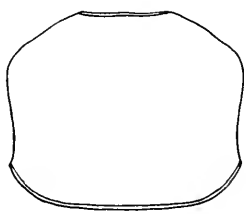
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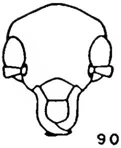
EXPLANATION OF FIGS. 90-104

Cephalic outline of the head of:

FIG. 90. *Nemognatha sparsa* LeConte
FIG. 91. *Nemognatha hurdi* MacSwain
FIG. 92. *Nemognatha selanderi* sp. nov.
FIG. 93. *Nemognatha bridwelli* Wellman
FIG. 94. *Nemognatha cantharidis* MacSwain
FIG. 95. *Nemognatha miranda* sp. nov.
FIG. 96. *Nemognatha pallens* LeConte
FIG. 97. *Nemognatha macswaini* sp. nov.
FIG. 98. *Nemognatha lutea lutea* LeConte
FIG. 99. *Nemognatha meropa* sp. nov.
FIG. 100. *Nemognatha lurida lurida* LeConte
FIG. 101. *Nemognatha curta* sp. nov.
FIG. 102. *Nemognatha nitidula* sp. nov.
FIG. 103. *Nemognatha angusta* sp. nov.
FIG. 104. *Nemognatha werneri* sp. nov.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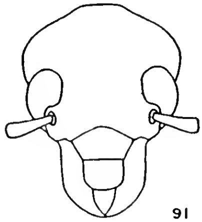
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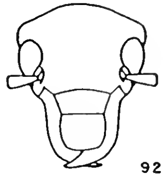
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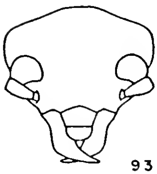
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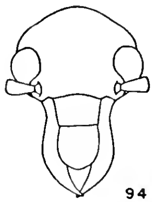
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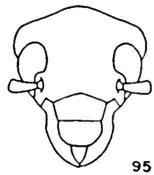
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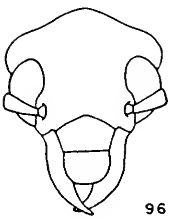
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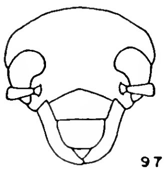
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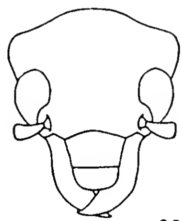
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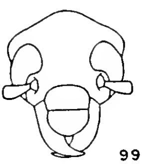
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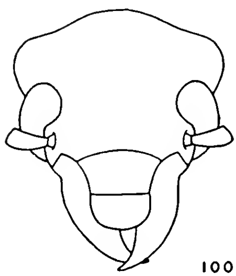
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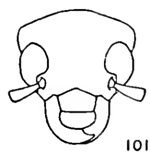
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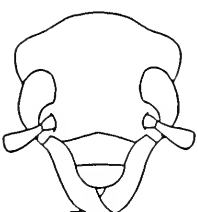
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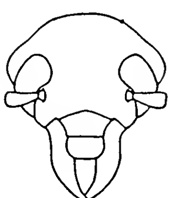
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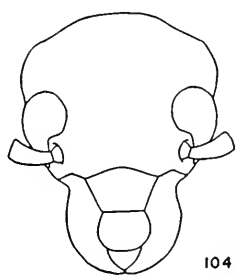
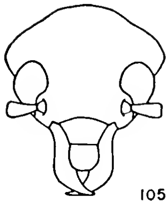

104

EXPLANATION OF FIGS. 105-118

Cephalic outline of the head of:

FIG. 105. *Nemognatha brevirostris* sp. nov.
FIG. 106. *Rhyphonemognatha rufa* (LeConte)
FIG. 107. *Nemognatha explanata* sp. nov.
FIG. 108. *Rhyphonemognatha sanguinicollis* (Champion)
FIG. 109. Lateral view, head and pronotum of *Rhyphonemognatha sanguinicollis* (Champion)
FIG. 110. *Nemognatha cribraria fuscula* ssp. nov.
FIG. 111. *Nemognatha cribraria cribraria* LeConte
FIG. 112. *Nemognatha nebrascensis* sp. nov.
FIG. 113. *Nemognatha punctulata* LeConte
FIG. 114. *Nemognatha capillaris* sp. nov.
FIG. 115. *Nemognatha nigripennis* LeConte
FIG. 116. *Nemognatha scutellaris* LeConte
FIG. 117. *Nemognatha bifoveata* sp. nov.
FIG. 118. *Nemognatha piazata piazata* (Fabricius)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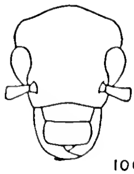
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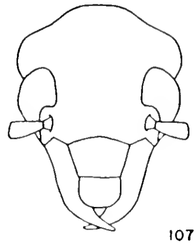
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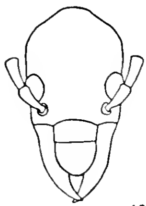
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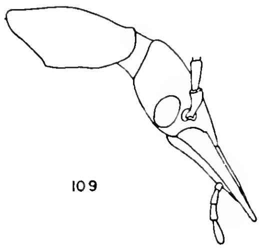
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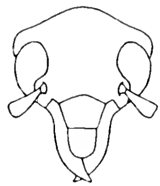
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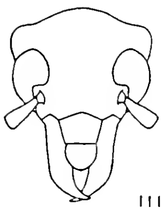
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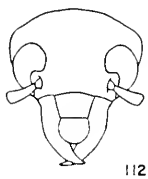
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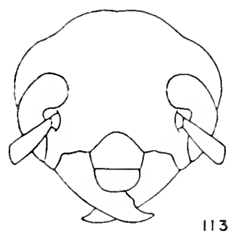
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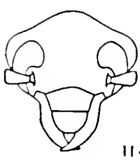
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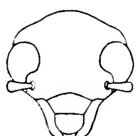
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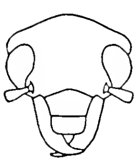
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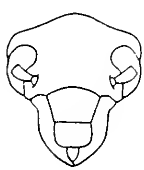
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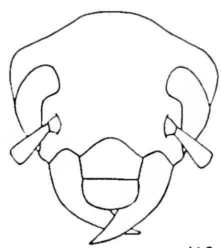
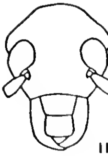

118

EXPLANATION OF FIGS. 119-133

Cephalic outline of the head of:

FIG. 119. *Zonitis atripennis atripennis* (Say)
FIG. 120. *Zonitis sulcicollis* Blatchley
FIG. 121. *Zonitis bilineata* Say
FIG. 122. *Zonitis hesperis* Selander
FIG. 123. *Zonitis aurea* MacSwain
FIG. 124. *Zonitis vermiculata* Schaeffer
FIG. 125. *Zonitis interpretis* sp. nov.
FIG. 126. *Zonitis vittigera vittigera* (LeConte)
FIG. 127. *Zonitis tarasca tarasca* (Dugès)
FIG. 128. *Zonitis dunniana* Casey
FIG. 129. *Zonitis tarasca borealis* ssp. nov.
FIG. 130. *Zonitis cribricollis* (LeConte)
FIG. 131. *Zonitis sayi* Wickham
FIG. 132. *Zonitis perforata* Casey
FIG. 133. *Zonitis punctipennis punctipennis* (LeConte)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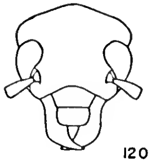
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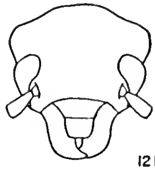
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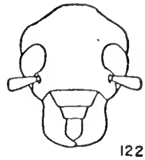
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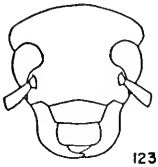
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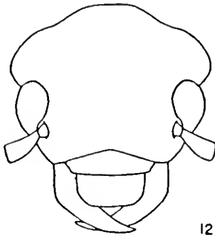
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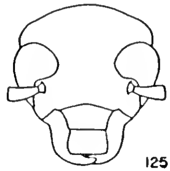
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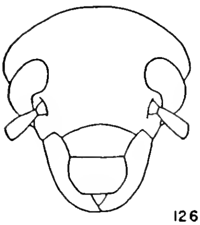
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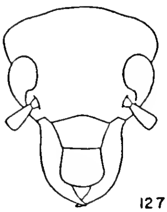
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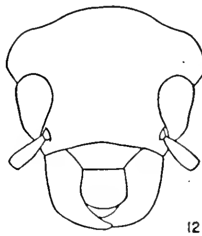
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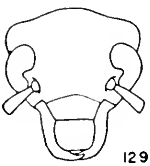
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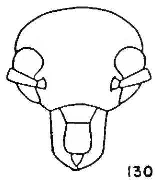
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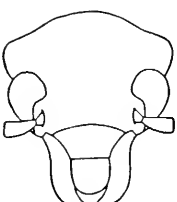
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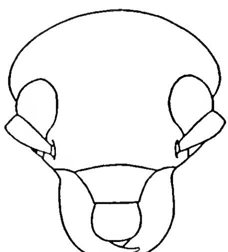
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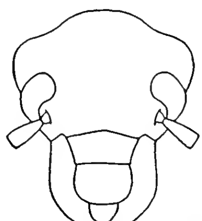
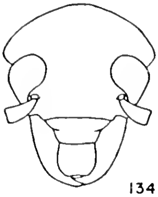

133

EXPLANATION OF FIGS. 134-148

Cephalic outline of the head of:

FIG. 134. *Zonitis praeusta* Fabricius
FIG. 135. *Zonitis immaculata* (Olivier)
Fig. 136. *Pseudozonitis schaefferi* (Blatchley)
Fig. 137. *Pseudozonitis vittipennis* (Horn)
Fig. 138. *Pseudozonitis martini* (Fall)
Fig. 139. *Pseudozonitis brevis* sp. nov.
FIG. 140. *Pseudozonitis roseomaculatus* Dillon
Fig. 141. *Pseudozonitis maculicollis* (MacSwain)
Fig. 142. *Pseudozonitis vigilans* (Fall)
Fig. 143. *Pseudozonitis longicornis* (Horn)
Fig. 144. *Pseudozonitis labialis* sp. nov.
Fig. 145. *Pseudozonitis arizonica* (Van Dyke)
Fig. 146. *Pseudozonitis vaurieae* sp. nov.
Fig. 147. *Pseudozonitis stroudi* sp. nov.
Fig. 148. *Pseudozonitis pallida* Dillon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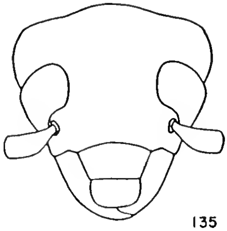
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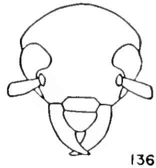
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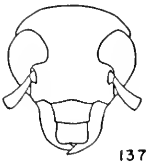
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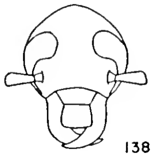
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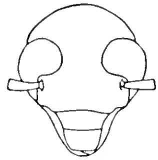
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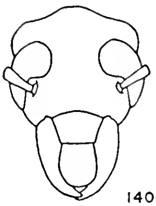
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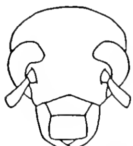
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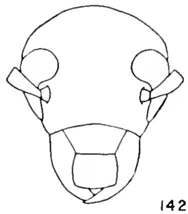
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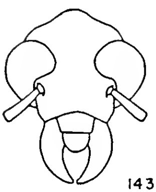
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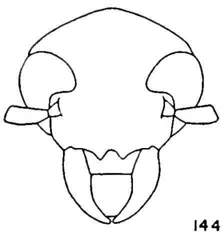
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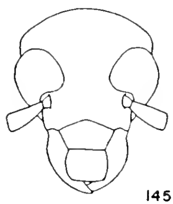
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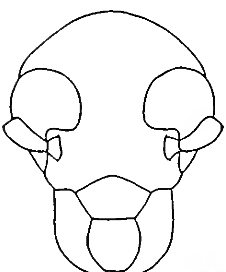
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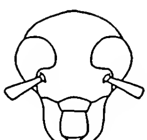
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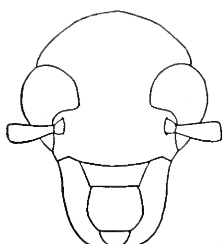
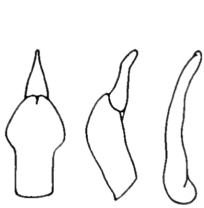

148

Explanation of Figs. 149-163

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 149. *Nemognatha sparsa* LeConte
Fig. 150. *Nemognatha cantharidis* MacSwain
Fig. 151. *Nemognatha selanderi* sp. nov.
Fig. 152. *Nemognatha bridwelli* Wellman
Fig. 153. *Nemognatha hurdi* MacSwain
Fig. 154. *Nemognatha macswaini* sp. nov.
Fig. 155. *Nemognatha miranda* sp. nov.
Fig. 156. *Nemognatha lurida lurida* LeConte
Fig. 157. *Nemognatha lurida apicalis* LeConte
Fig. 158. *Nemognatha pallens* LeConte
Fig. 159. *Nemognatha werneri* sp. nov.
Fig. 160. *Nemognatha brevirostris* sp. nov.
Fig. 161. *Nemognatha lutea lutea* LeConte
Fig. 162. *Nemognatha lutea dichroa* LeConte
Fig. 163. *Nemognatha lutea dubia* LeConte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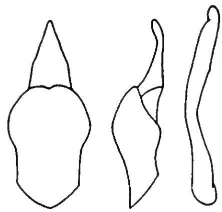
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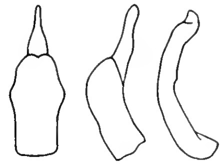
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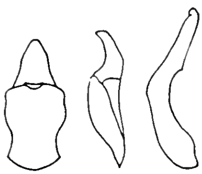
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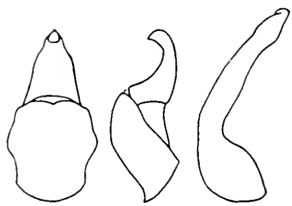
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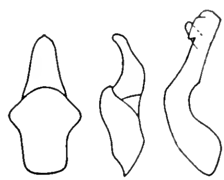
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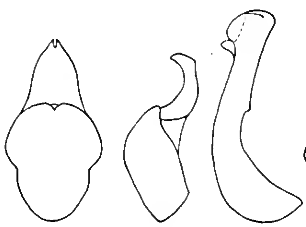
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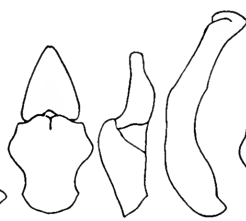
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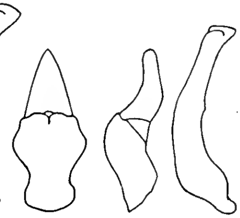
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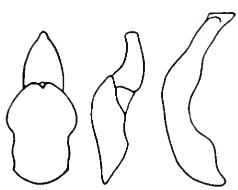
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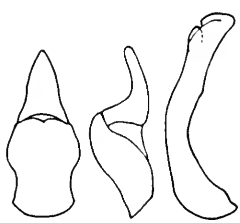
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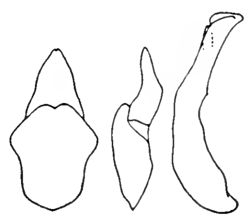
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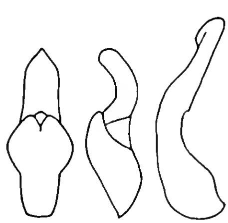
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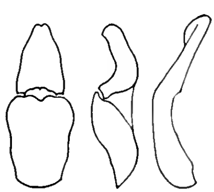
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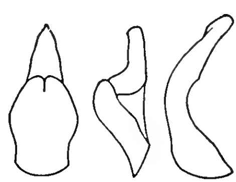
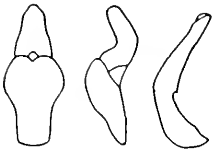

163

EXPLANATION OF FIGS. 164-177

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 164. *Nemognatha curta* sp. nov.
Fig. 165. *Nemognatha explanata* sp. nov.
Fig. 166. *Nemognatha nitidula* sp. nov.
Fig. 167. *Nemognatha soror* MacSwain
Fig. 168. *Nemognatha meropa* sp. nov.
Fig. 169. *Nemognatha angusta* sp. nov.
Fig. 170. *Nemognatha cribraria cribraria* LeConte
Fig. 171. *Nemognatha cribraria fuscula* ssp. nov.
Fig. 172. *Nemognatha capillaris* sp. nov.
Fig. 173. *Nemognatha scutellaris* LeConte
Fig. 174. *Nemognatha nigripennis* LeConte
Fig. 175. *Nemognatha nemorensis* Hentz
Fig. 176. *Nemognatha nebrascensis* sp. nov.
Fig. 177. *Nemognatha punctulata* LeConte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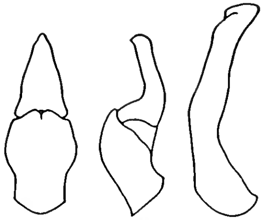
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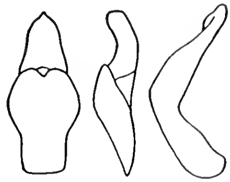
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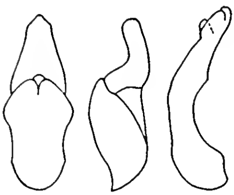
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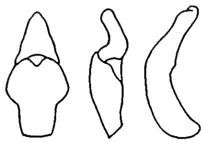
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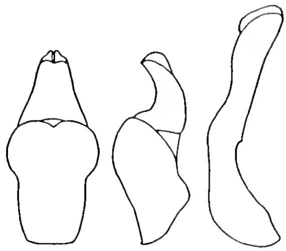
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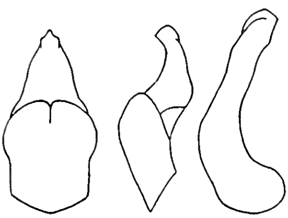
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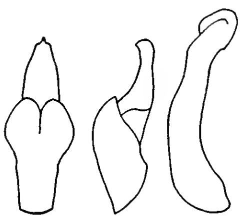
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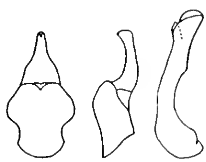
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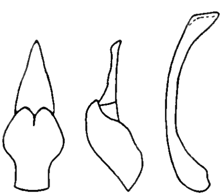
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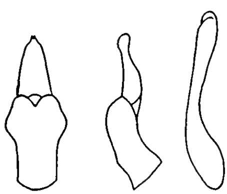
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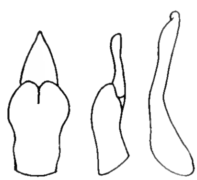
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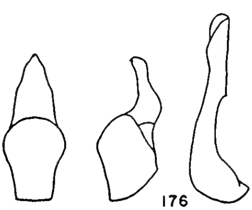
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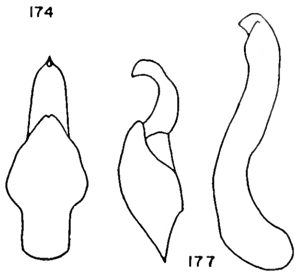
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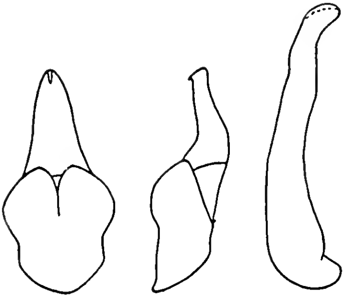
EXPLANATION OF FIGS. 178-186

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 178. *Nemognatha piazata piazata* (Fabricius)
Fig. 179. *Nemognatha piazata palliata* LeConte
Fig. 180. *Nemognatha chrysomelina* Fabricius
Fig. 181. *Nemognatha piazata bicolor* LeConte
Fig. 182. *Nemognatha bifoveata* sp. nov.
Fig. 183. *Rhyphonemognatha sanguinicollis* (Champion)
Fig. 184. *Rhyphonemognatha rufa* (LeConte)
Fig. 185. *Zonitis bilineata* Say
Fig. 186. *Zonitis sulcicollis* Blatchley



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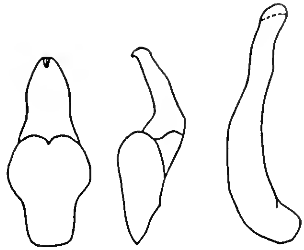

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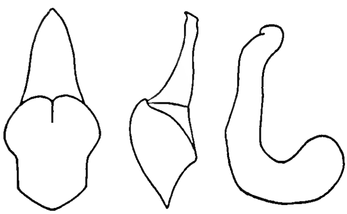

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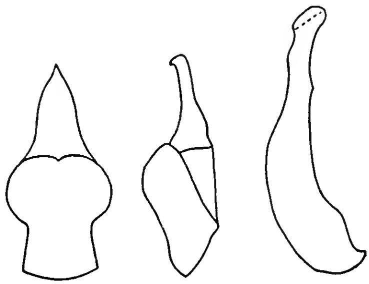

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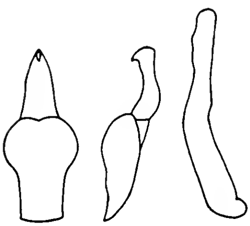

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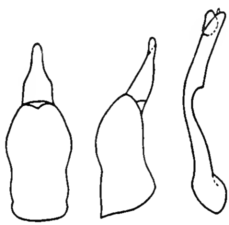

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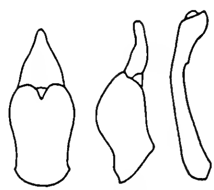

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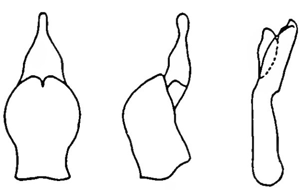

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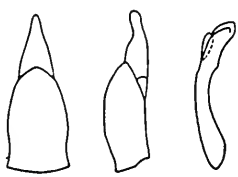

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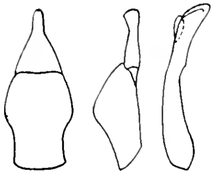
EXPLANATION OF FIGS. 187-199

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 187. *Zonitis atripennis atripennis* (Say)
Fig. 188. *Zonitis atripennis flavida* LeConte
Fig. 189. *Zonitis atripennis terminalis* ssp. nov.
Fig. 190. *Zonitis vermiculata* Schaeffer
Fig. 191. *Zonitis hesperis* Selander
Fig. 192. *Zonitis interpretis* sp. nov.
Fig. 193. *Zonitis aurea* MacSwain
Fig. 194. *Zonitis perforata* Casey
Fig. 195. *Zonitis cribricollis* (LeConte)
Fig. 196. *Zonitis vittigera vittigera* (LeConte)
Fig. 197. *Zonitis vittigera propinqua* MacSwain
Fig. 198. *Zonitis dunniana* Casey
Fig. 199. *Zonitis sayi* Wickham



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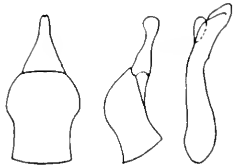

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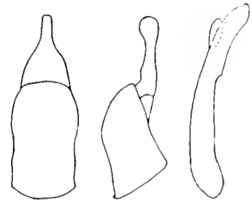

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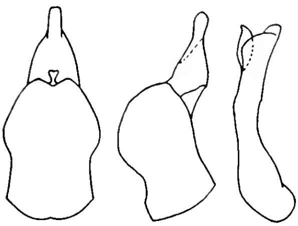

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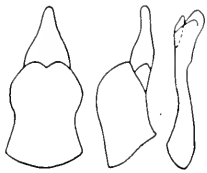

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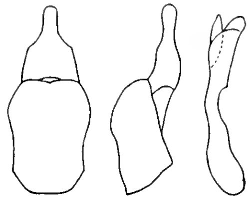

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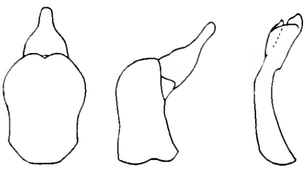

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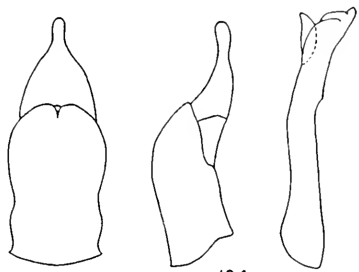

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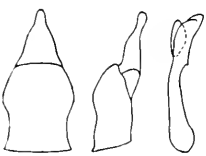

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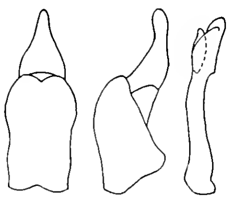

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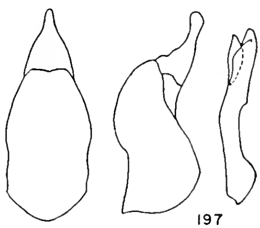

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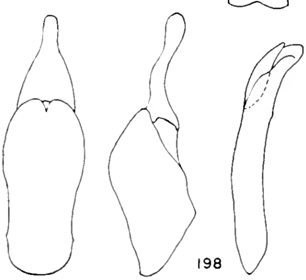

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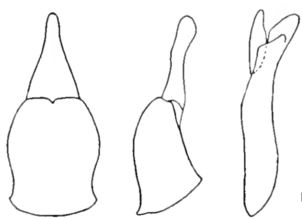

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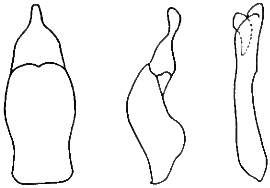
EXPLANATION OF FIGS. 200-210

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 200. *Zonitis punctipennis punctipennis* (LeConte)
Fig. 201. *Zonitis punctipennis californica* ssp. nov.
Fig. 202. *Zonitis tarasca tarasca* (Dugès)
Fig. 203. *Zonitis tarasca borealis* ssp. nov.
Fig. 204. *Zonitis immaculata* (Olivier)
Fig. 205. *Zonitis praeusta* Fabricius
Fig. 206. *Pseudozonitis schaefferi* (Blatchley)
Fig. 207. *Pseudozonitis martini* (Fall)
Fig. 208. *Pseudozonitis vigilans* (Fall)
Fig. 209. Aedeagus of *Pseudozonitis stroudi* sp. nov.
Fig. 210. *Pseudozonitis maculicollis* (MacSwain)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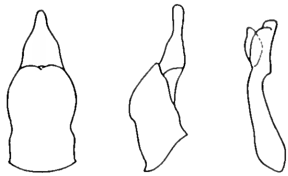
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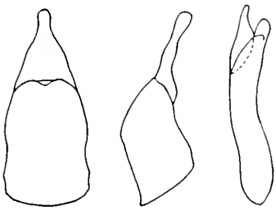
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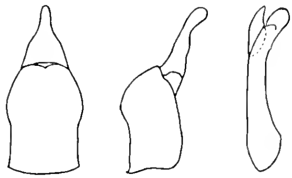
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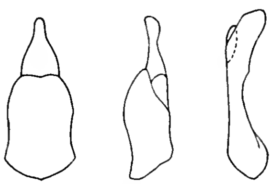
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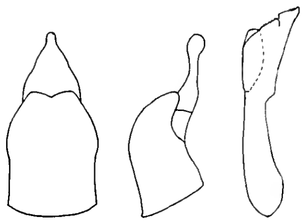
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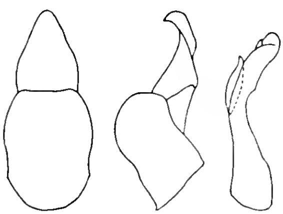
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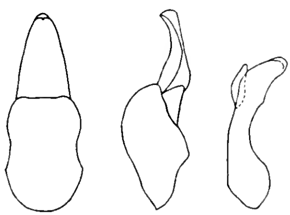
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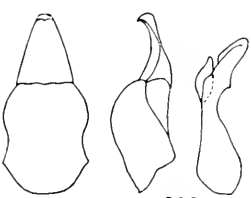
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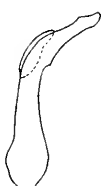
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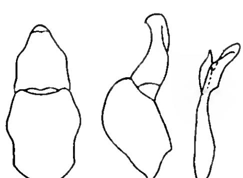
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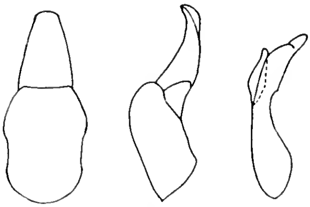
EXPLANATION OF FIGS. 211-218

From left to right, dorsal and lateral view of tegmen and lateral view of aedeagus of:

Fig. 211. *Pseudozonitis vittipennis* (Horn)
Fig. 212. *Pseudozonitis brevis* sp. nov.
Fig. 213. *Pseudozonitis longicornis* (Horn)
Fig. 214. *Pseudozonitis roseomaculatis* Dillon
Fig. 215. *Pseudozonitis pallida* Dillon
Fig. 216. *Pseudozonitis arizonica* (Van Dyke)
Fig. 217. *Pseudozonitis labialis* sp. nov.
Fig. 218. *Pseudozonitis vaurieae* sp. nov.



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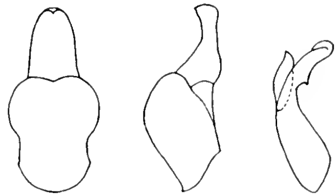

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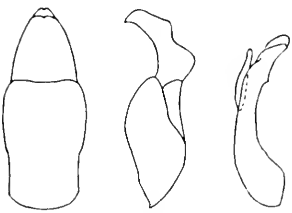

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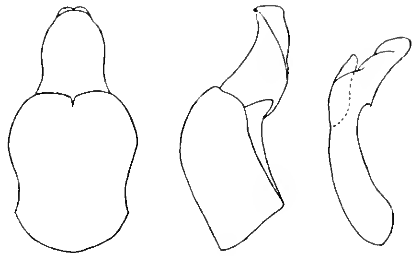

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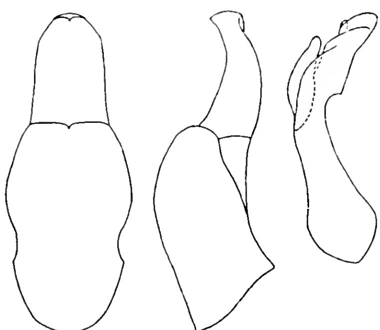

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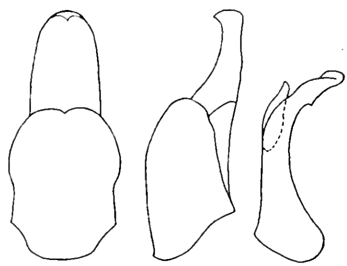

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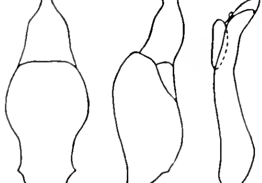

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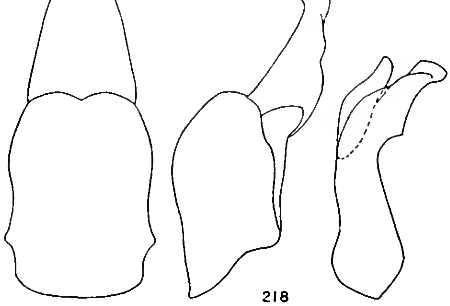

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THE UNIVERSITY OF KANSAS

SCIENCE BULLETIN

VOL. XXXVII, PT. II] JUNE 29, 1956 [NO. 18

A Revision of the Bees of the Genus Melissodes in North and Central America. Part I. (Hymenoptera, Apidae)[1]

WALLACE E. LABERGE

ABSTRACT: This paper is the first part of a monographic revision of the bee genus *Melissodes* in North and Central America. Although primarily a taxonomic study, this work brings together available data concerning phylogeny, distribution, biologies of several species and flower preferences.

Ten subgenera are recognized, including the following newly described: *Brachymelissodes, Idiomelissodes, Apomelissodes, Eumelissodes, Heliomelissodes, Psilomelissodes, Tachymelissodes.* This paper deals with 39 species, ten of which are polytypic, so that 53 species or subspecies are recognized. A total of 29 names is relegated to synonymy and 13 species are moved to other genera. About 15,500 specimens were examined.

Ten new species are described: *M. minima, M. aegis, M. nitida, M. sila, M. blanda, M. cubensis, M. elusa, M. flexa, M. maesta* and *M. tessellata.* Seven new subspecies are named: *M. atripes atrimitra, M. sabinensis nubila, M. texana eluta, M. bimaculata nulla, M. gilensis crenata, M. tepida yumensis* and *M. thelypodii stulta.*

TABLE OF CONTENTS

1. Contribution No. 906, Department of Entomology, University of Kansas.

INTRODUCTION

This paper is the first part of a systematic revision of the eucerine bees of the genus *Melissodes* Latreille occurring in North and Central America. An attempt has been made to elucidate the phylogeny of the group. This has led to the conclusion that the genus, as presented here, is probably polyphyletic. However, the recognition as separate genera of certain phyletic lines included in this genus has not been attempted in this work, but has been left to a proposed generic revision of the tribe Eucerini which is now in progress.

In the region covered by this revision, the genus includes more than 100 species, many of which are polytypic. Ten subgenera are recognized and described and the species of five of these subgenera are described in full in this part of the revision, while the species of the remaining subgenera will be dealt with in future parts of the revision. The present work includes a total of 39 species; ten of these have two or three subspecies each, so that 53 forms are described.

A paper by Cockerell (1906) is the only extensive treatment of the genus and consists mainly of keys to most of the known species occurring in North America. The species are almost impossible to recognize by using Cockerell's keys. He lacked access to the types of species described by Charles Robertson and most of these were omitted from the keys. Cockerell used color characters almost exclusively and, although the color pattern remains important in the present work, he did not recognize the great variability of certain of these characters. Also, many species were unrecognized at the time Cockerell's key was published. The only other papers published concerning the genus are descriptions of new forms, brief biological notes, lists of species and short works on the faunas of limited areas.

The genus *Melissodes* was proposed by Latreille (1829) to include the American eucerine bees having only four segments in the maxillary palpi and having three submarginal cells. Latreille included no species in this genus. Romand (1841) described *Melissodes fonscolombei* from a female from Chile and a male from the West Indies. For reasons discussed fully by Lutz and Cockerell (1920), and by the present author in a note which has been sent to the Secretary of the International Commission on Zoological Nomenclature for publication in the Bulletin of Zoological Nomenclature, *M. fonscolombei* Romand should be considered as a *nomen dubium*. *Melissodes leprieuri* Blanchard, 1849, is then the first included species and the type species of the genus.

Because the genus as currently recognized is probably polyphyletic and because there are many parallelisms within the tribe Eucerini in the Western Hemisphere (parallelisms which are not completely understood at present), a detailed description of the genus is not attempted at this time. A generic revision of the tribe is now in progress and it is hoped that a description of this genus can be presented in the near future. The four-segmented maxillary palpi separate the genus from other North and Central American genera except that in the subgenus *Apomelissodes* there is a single species with three-segmented palpi and in the subgenera *Melissodes* and *Epimelissodes* there are occasionally individuals, especially males, with five-segmented palpi.

A few characters common to all or most of the species of the genus, and to some other eucerine genera, are as follows: the malar space of both sexes is always absent or extremely short; the propodeum of both sexes has a distinct dorsal face, never being completely declivous; the scopal hairs of the female have at least one or two branches on each side (except in the one species of *Apomelissodes* having three-segmented maxillary palpi); the last exposed sternum of the male is flat or shallowly grooved medially, not with a large median protuberance or large flanges on each side; the gonostyli of the male are straight or slightly curved and never distinctly elbowed; the eighth sternum of the male is testaceous, never wholly piceous; the last flagellar segment of the male is rounded or truncate apically, never attenuate.

Several species of *Melissodes* are of widespread occurrence in North America and are of some importance in the pollination of such agricultural crops as alfalfa and cotton. The genus as a whole, because of the great number of species and because of the abundance of a number of these, must play an important role in pollination of many plants in nature.

DISTRIBUTION AND PHYLOGENY

The North American subgenera can be placed in two groups which probably represent two phyletic lines. The subgenera *Epimelissodes, Brachymelissodes* and *Idiomelissodes* constitute group 1 and the remaining subgenera (*Melissodes, Ecplectica, Eumelissodes, Heliomelissodes, Apomelissodes, Psilomelissodes* and *Tachymelissodes*) make up group 2.

In the first group the dorsal carina of the gonocoxite of the male genital capsule is drawn out into a blunt process directed more or less medially. The median plates of the seventh sternum of the male are small, undeveloped lobes. The male antennae are usually short or moderately long (long in *Idiomelissodes*). Both sexes usually have spatuloplumose hairs at least between the mesoscutum and the scutellum and in the basal pubescent band of the second tergum (lacking in *Brachymelissodes*). The metanotum usually has a distinct, low, densely punctate, median eminence bearing relatively long hairs, in contrast to the relatively flat, sparsely punctate, short-haired, lateral areas (not well developed in *Brachymelissodes*). The tegulae of both sexes are broadly rounded anteriorly, not narrowed and flattened in the anterior halves. The subgenus *Idiomelissodes* has, in addition, greatly enlarged penis valves and small gonostyli in the male, hooked tibial spurs and certain other peculiarities described below which may result in its eventually being considered as a distinct, monotypic genus.

Species of group 2 have the tegulae narrowed and flattened anteriorly with the result that the lateral border of each tegula is concave or straight rather than convex in the anterior half. A single species (in the subgenus *Tachymelissodes*) is exceptional in this regard in that the tegulae are gently convex anteriorly, although still somewhat narrowed and flattened. In general, group 2 is characterized by lacking the structural peculiarities described above for group 1, and in having the median plates of the seventh male sternum enlarged or modified in various fashions.

Group 1, as far as is now known, has no representatives in South America. Moure (1944) believed that he had a species of *Epimelissodes* from Brazil, but the three-segmented maxillary palpi and certain other features clearly relate this species to the genus *Ptilomelissa* which is not closely related to *Epimelissodes,* so far as is known at present. *Svastra* Holmberg of South America is related to *Epimelissodes* and, perhaps, should be included in the phyletic line described above as group 1.

Both group 1 and group 2 seem not to occur in Europe, and probably arose independently in the Western Hemisphere, possibly in South America. The subgenera occurring in North America may have arisen from representatives of both groups which reached the Mexican plateau area. Both groups range as far north as extreme southern Canada, but are rare (group 1) or poorly represented (group 2) in Canada.

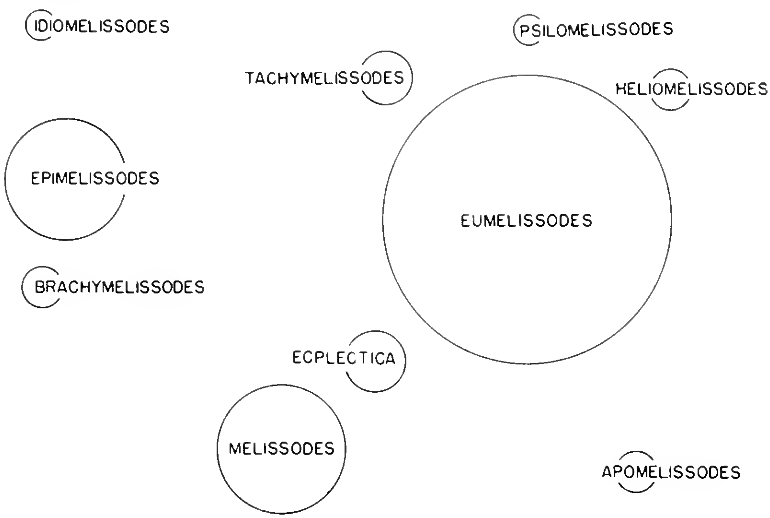

FIG. 1. Diagrammatic representation of the relationships of the subgenera of *Melissodes* Latreille. The area of each circle indicates the approximate number of species in each subgenus, *Psilomelissodes* being unity. The distances between the perimeters of adjacent circles represent degree of relationship. The subgenera *Epimelissodes*, *Idiomelissodes* and *Brachymelissodes* form a distinct group and are not closely related to any one of the remaining subgenera.

The genus *Florilegus* Robertson (not treated in this report) apparently is related to both of these groups and bears the primitive character of five-segmented maxillary palpi. The subgenus *Ecplectica* of group 2 of the genus *Melissodes* resembles *Florilegus* in external appearance. Both *Florilegus* and *Ecplectica* are abundant and diversified in South America and have a few representatives in Central America and the West Indies, while *Florilegus* has one species entering southeastern United States. The other subgenera of group 2 do not enter South America, so far as is now known, but two of the subgenera (*Melissodes* and *Eumelissodes*) are distributed as far south as Panamá and the Leeward Islands in the West Indies. Both of these subgenera are probably derivatives of

Ecplectica, as indicated by the form of the seventh sternum of the male and certain other characters, while the remaining subgenera of group 2 are specialized derivatives of the subgenus *Eumelissodes* and are restricted to North America. Figure 1 presents schematically the relationships outlined above.

Parallelisms existing between certain of these ten subgenera are striking. *Brachymelissodes* of group 1 parallels *Tachymelissodes* of group 2 in the following respects: apical pubescent bands on the metasomal terga; extremely short male antennae; relatively long first flagellar segments of the male antennae. In this case there is no apparent environmental reason for the parallel characters. Neither subgenus is particularly oligolectic and they do not have similar distributions.

Heliomelissodes and *Apomelissodes* of group 2 each have a protruding clypeus in both sexes. This is apparently a parallel adaptation to certain flowers. Each group consists of a few species which are oligolectic on flowers which require relatively long mouthparts to reach the nectar sources. The protruding clypeus is evidently an adaptation to contain the longer mouthparts when these are folded and not in use. This character reaches an extreme (for this genus) in *M.* (*Apomelissodes*) *fimbriata* which seemingly is restricted to plants of the genus *Oenothera*. In addition, *Apomelissodes* parallels *Brachymelissodes* and *Tachymelissodes* in having apical tergal bands of pubescence, again with no apparent reason.

Psilomelissodes has unusually short male antennae and long first flagellar segments similar to *Brachymelissodes* and *Tachymelissodes*. Groups in which the male antennae are moderately long, such as *Epimelissodes* and *Heliomelissodes* (also several species of *Eumelissodes*) have moderately long first flagellar segments as well, whereas species with long antennae have the first flagellar segments extremely short. This negative correlation, which is followed rather rigidly even within each subgenus, suggests that there is probably a functional relationship between the length of the antennae and the length of the first flagellar segments.

GEOGRAPHICAL VARIATION

Several of the species described below are widespread and polytypic, each consisting of two or three subspecies. These subspecies differ in the color pattern of the pubescence and in a few cases by minor differences in punctation. The subspecies are discussed in some detail under each species in a section on geographical variation.

On the basis of the distribution of the polytypic species of *Melissodes* an ecological rule could be established that the paler forms occur in the west and southwest and the darker forms in the east in North America. Additional support for such a rule comes from certain largely allopatric pairs of closely related species (especially in the subgenus *Epimelissodes*). Within each of these pairs of species (*M. machaerantherae* and *M. comanche*, *M. helianthelli* and *M. grandissima*, *M. grandissima* and *M. aegis*), the palest occurs west of the darkest species.

However, the situation in three of the polytypic species (and in certain species of the subgenus *Eumelissodes* which have not been critically studied as yet) suggests a different explanation. *M. thelypodii* and *M. gilensis* each consist of two subspecies which are distributed with the paler subspecies north of the darker subspecies. In these species the darker subspecies occur in middle and southern Mexico in somewhat moister climates than the paler subspecies to the north. *M. tepida* is composed of three subspecies in which the darkest is distributed from central California north to Oregon, the palest occurs in the intermontane region north to western Oregon and the third subspecies occurs south of the other two and is dark in some respects and pale in others. These facts, together with the east-west distribution of the species and subspecies described above, suggest that the ecological rule should be that the pale forms (subspecies or closely related species) occur in areas with drier climates than the darker related forms.

In many fossorial Hymenoptera, particularly bees, the prepupae and pupae are present during the dry seasons in the southwest. The adults appear shortly before or during the rainy season and the larvae often complete their development quickly while the earth is still moist. If such is true of *Melissodes*—and at least the seasonal appearance of the adults is usually correlated with such a cycle—the precipitation or moisture conditions are probably operative in selection during the prepupal (or pupal) stage.

M. (*Epimelissodes*) *atripes* presents an interesting exception to this rule. This species is divisible into three subspecies, two of which follow the rule, while the third occurs in eastern Florida and Georgia in contact with and intergrading with the darkest subspecies to the north and west, but is the palest of the three subspecies. This Florida subspecies (*M. atripes georgica*) perhaps can be explained by additional selective factors, such as an adaptation to the white coralline sands so abundant in eastern Florida.

M. (*Melissodes*) *tepida* presents a similar sort of situation. As explained above, one of the three subspecies occurs to the south of the others. This subspecies (*yumensis*) occurs in a region drier than the other two, but is not paler. It is thought to have originated while isolated from the other two subspecies and this isolation could have allowed selective factors to operate which are unrecognizable at the present time.

The correlation of melanism with humidity which occurs in these bees may be a result of selection by vertebrate (birds) or insect (Asilidae) predators, rather than a direct effect of the environment. The pale subspecies of *M. atripes* in Florida mentioned above seems to support such an hypothesis. However, a great deal remains to be learned concerning the biology of these bees and, especially, concerning their parasites and predators.

An ecological rule similar to the rule described above has been applied to warm-blooded vertebrates and is known as Gloger's rule. Temperature, as well as humidity, is correlated with the distribution of melanism in warm-blooded vertebrates according to Gloger's rule, and in this way the latter differs from the ecological rule here applied to the distribution of *Melissodes*.

A similar correlation has been described in several insect groups: in the Vespid genus *Polistes* by Zimmermann (1931), in the Bembidiine wasps by Netolitsky (1931), in the Sphecine wasps by Fernald (1926), in Coccinellid beetles by Dobzhansky (1933) and for California butterflies by Hovanitz (1941). Mr. Earle A. Cross has found a similar rule in the bee genus *Nomia* (unpublished Master's thesis).

In the subgenus *Epimelissodes* a number of species and subspecies show a series of steps from subspecies through closely related allopatric species. *M. petulca* consists of two subspecies which intergrade in a broad zone across Texas. *M. grandissima* and *M. helianthelli* probably are distinct, closely related species, but may be only subspecies with a relatively narrow zone of intergradation in western Texas. *M. machaerantherae* and *M. comanche* are closely related species which are allopatric as far as is now known. These three pairs of species and subspecies suggest that some sort of a north-south barrier separated populations that are now subspecies or closely related species, and that the species or subspecies differentiated while the barrier existed. At any rate, the above forms show a succession of situations within one genus which illustrate a few probable steps in allopatric speciation.

DESCRIPTIVE METHODOLOGY

In describing species and subspecies below, measurements are given for each species. In a few polytypic species measurements are given instead for each subspecies. The average and standard error is given for each measurement and ratio, except where fewer than 3 specimens were available in which cases the ranges are given. The number (N) of individuals measured applies to all measurements and ratios of the particular sex of each species. In a few instances where it was impossible to take certain measurements owing to the condition of the specimens, the N is given in parentheses immediately before the measurement in question. The total length and width of the bees are given as ranges, since exact measurements were not feasible. The width is the greatest width of the metasoma. For accuracy, the length of the wing was measured from the base of cell 1st M to the apex of the marginal cell. The length of the second flagellar segment of the female and of the first flagellar segment of the male is the shortest length. The method of making these measurements, together with those of the protrusion of the clypeus and relative width of the eye and genal areas, are illustrated in Figures 21 to 23.

References to all known published records are included in the synonymies, except in the case of catalogues, such as Cresson (1879), Dalla Torre (1896), Lutz and Cockerell (1920), Sandhouse (1943) and Michener (*in* Muesebeck *et al.*, 1951), which are omitted in order to avoid undue repetition.

The terminology proposed by Michener (1944) for the male genitalia is followed. Certain descriptive terms are introduced for parts of the genitalia and hidden sterna of the male and these are summarized in Figures 24-27. In the keys and often throughout the various descriptions the terms tergum or terga stand alone without reference to a region of the body. These always refer to the metasoma.

For convenience, a distinction is made between the terms "hair" and "pubescence". The former refers to the erect or suberect, plumose pilosity or to the appressed, relatively simple pilosity, whereas the latter refers to the highly plumose, closely appressed pilosity usually occurring in bands or fasciae, or in an evenly diffuse pattern over the surfaces of the terga. A somewhat special usage of the terms "apical" and "distal" is also introduced when referring to the pubescent bands or fasciae of the terga. The latter is a general term applying to the second of the two pubescent bands of any tergum but especially of the second tergum, whereas the former term refers to the same bands or fasciae when these are distinctly on or reach the apical margins of the terga. A distinction is made between "pubescent bands" and "pubescent fasciae" of the terga. The latter term refers to the lateral parts of a band when it is interrupted medially, whereas the former term refers to the band as a whole (whether interrupted or not). Of course, these situations are not always exclusive within a species, so that one may speak of interrupted bands and of lateral fasciae which occasionally fuse medially to form a band. The various areas of the tergal vestiture of *Melissodes communis* are diagramed in Figure 20.

In the figures of the male terminalia (Figs. 24-129) the seventh and eighth metasomal sterna are always depicted in ventral view, whereas the spatha, when this is drawn separate from the genital capsule, is always shown in dorsal view. The genital capsules are drawn in either ventral or dorsal view, or both, depending on the need for showing certain structures clearly. With the exception of those of *Melissodes obliqua* (Figs. 24-27) only half of the terminalia are drawn (left half when in dorsal view and right half when in ventral view) in order to conserve space.

TAXONOMIC TREATMENT

KEY TO THE NORTH AND CENTRAL AMERICAN SUBGENERA OF MELISSODES

MALES

1. Last exposed tergum with small apical teeth on side of pygidial plate . . . 4
   Last exposed tergum without lateral teeth . . . 2

2(1). Minimum length of first flagellar segment equal to more than half of maximum length of second segment; antennae short, not reaching or barely reaching scutellum in repose; scapes bright yellow below . . . *Brachymelissodes*
   Antennae of moderate length, reaching beyond scutellum; minimum length of first flagellar segment usually equal to half or less of maximum length of second segment, rarely slightly more than half; scapes not marked with yellow below . . . 3

3(2). Hairs near margin of lateral third of fifth metasomal sternum in two groups, curved evenly away from sternum and sharply bent posteriorly so as to form a semicircle of hooked hairs overlapping last exposed sternum laterally . . . *Idiomelissodes*
   Hairs near margin of fifth sternum all straight, not hooked. *Epimelissodes*

4(1). Clypeus protruding beyond eye from ½ to ¾ width of eye in profile; metasomal terga 2-5 fringed with narrow marginal bands of appressed white pubescence, bands much narrower than basal areas of erect or suberect hairs; antennae long, minimum length of first flagellar segment equals less than 1/3 of maximum length of second segment . *Apomelissodes*

Clypeus usually not protruding beyond eye by as much as half width of eye in profile, *if* clypeus protrudes as much as or more than half width of eye, *then* minimum length of first flagellar segment equals 1/3 or more of maximum length of second segment; terga usually not fringed by pubescent bands, *if* so, *then* antennae short and marginal bands as wide as or wider than basal areas of terga . 5

5(4). Clypeus strongly protruding beyond eye by 3/4 or more of width of eye in profile; maximum length of first flagellar segment equals 0.4 or more of maximum length of second segment. *Heliomelissodes*

6(5). Maximum length of first flagellar segment as long as or almost as long as maximum length of second segment and longer than third segment; clypeus wholly black *Psilomelissodes*

Maximum length of first flagellar segment much shorter than maximum length of second segment and distinctly shorter than third segment; clypeus usually pale, occasionally all or partly black 7

7(6). Minimum length of first flagellar segment distinctly more than half of maximum length of second segment; pubescent bands on terga 2 - 5 all apical, subequal in width across each tergum and subequal in width to each other . *Tachymelissodes*

Minimum length of first flagellar segment half of maximum length of second segment or less; pale pubescent bands of terga 2 - 4 usually not all apical or subequal in width 8

8(7). Characters of genitalia and hidden sterna . . 9

External characters 11

9(8). Median apical plates of sternum 7 without hairs on ventral surfaces, usually small, curled ventrally along an oblique axis to form half or more of an oblique cylinder or scroll, but often secondarily flattened and expanded, or reduced in size. *Melissodes*

Median plates of sternum 7 thin, membranous, with short to moderately long hairs on ventral surfaces, not curled ventrally, relatively large 10

10(9). Gonostylus short, less than half as long as gonocoxite, in lateral view twice as broad or more near base than near apex, narrowing abruptly near middle, not capitate; median plates of sternum 7 relatively small, with several short hairs on ventral surfaces . . . . *Ecplectica*

Gonostylus short, usually as long as or longer than half of length of gonocoxite, in lateral view not twice as broad near base than near apex, often capitate; median plates of sternum 7 large, with abundant minute to moderately long hairs ventrally. *Eumelissodes*

11(8). Posterior margin of fourth and usually third sternum broadly convex or produced, often forming a broad, thin, hyaline flap. *Eumelissodes*

Posterior margins of third and fourth sterna straight or slightly concave . . . 12

12(11). Terga 2-5 without pale pubescent bands or these all interrupted medially, *if* one or two bands are complete, *then* thorax with hairs mostly black or black and white mixed and labrum all or almost all pale . . . *Melissodes*

Terga 2-5 usually with complete bands, occasionally one or more absent or interrupted medially, *if* only one or two are complete, *then* thorax with bright ferruginous hairs and labrum all or almost all black . . . 13

13(12). Labrum wholly pale; mandibles usually with basal yellow spots; last two metasomal terga with dark brown to black hairs . . . 17

Labrum with at least a dark margin and mandibles often without pale basal spots, *or* last two metasomal terga with pale hairs only, *or* both . . . 14

14(13). Galeae smooth and shiny, without tessellation or shagreening except at tips . . . 15

Galeae dulled by tessellation or shagreening in at least apical half. *Eumelissodes*

15(14). Last two terga with dark brown to black hairs . . . 16

Last two terga with pale hairs only . . . *Eumelissodes*

16(15). Margins of terga 2-4 broadly hyaline, colorless or nearly so, *or* labrum entirely dark brown to black *or* pale spot covers less than half of surface or both . . . *Eumelissodes*

Margins of terga 2-4 opaque, black to reddish-brown; labrum mostly pale-colored, at most with narrow apical margin brown to black . . . *Melissodes*

17(13). Tergum 2 with distal pale band complete or only narrowly interrupted medially, *if* broadly interrupted, *then* basal pale band indistinct, consisting of diffuse pubescence or partly or wholly dark pubescence . . . *Melissodes*

Tergum 2 with distal pale band absent or broadly interrupted medially, each fascia equal to ⅓ or less of width of tergum; basal pale band of tergum 2 distinct . . . *Ecplectica*

FEMALES

1. Clypeus protruding anteriorly beyond eye in profile by ⅔ width of eye; scopal hairs simple or with few branches; postpalpal parts of galeae one and a half times as long as clypeus, *if* shorter, *then* bearing abundant hooked hairs . . . *Apomelissodes*

Clypeus not protruding, or *if* protruding anteriorly beyond eye in profile by as much as ⅔ width of eye, *then* scopal hairs highly plumose and galeae less than 1½ times as long as clypeus; galeae usually without hooked hairs . . . 2

2(1). Clypeus protruding anteriorly beyond eye in profile by half to two-thirds width of eye; inner orbits of eyes often parallel;

hairs of inner surfaces of hind basitarsi dark brown to black (scopal hairs highly plumose) . . . *Heliomelissodes*

Clypeus protruding less less than half width of eye in profile, *if* protruding as much as half width of eye, *then* inner orbits of eyes distinctly converging towards mandibles and/or hairs of inner surfaces of hind basitarsi bright red to yellow (scopal hairs variable, but never simple) . . . 3

3(2). Scopal hairs weak, with few branches, not hiding outer surfaces of hind basitarsi and tibiae; metasomal terga very sparsely and weakly punctate, dulled by dense, fine shagreening and clothed with sparse pubescence and hairs . . . *Psilomelissodes*

Scopal hairs strong, highly plumose, effectively hiding outer surfaces of hind basitarsi and tibiae; or, *if* weak and with few branches, *then* metasomal terga coarsely punctate at least basally, often moderately shiny to shiny and with abundant hairs and pubescence . . . 4

4(3). With basally plumose and apically spatulate hairs in bands between the mesonotum and scutellum and at extreme base of second metasomal tergum; metanotum with thick median tuft of hairs arising from confluent punctures, laterally with short, more or less appressed hairs arising from scattered shallow punctures, *or* lateral areas impunctate . . . 5

Without spatuloplumose hair band between mesonotum and scutellum and usually without spatuloplumose hairs at base of second tergum; without a dense tuft of long hairs medially on metanotum . . . 6

5(4). Middle tibial spur sharply bent or hooked near tip; eye less than twice as long as widest width in facial view . . . *Idiomelissodes*

Middle tibial spur not hooked and only weakly bent, if at all, near tip; eye at least twice as long as wide and usually longer in facial view . . . *Epimelissodes*

6(4). Apical pale pubescent bands on metasomal terga 2-4 reach apical margins of terga, of about same width across terga and subequal in width to each other; plumose hairs of distal pubescent bands arise from distinct round punctures separated by less than one puncture width *or* distal bands as narrow as or narrower than basal area of dark pubescence . . . 7

Apical pale pubescent bands on at least tergum 2 and usually tergum 3 not reaching apices of terga, or, *if* reaching apices of terga, *then* diffuse over entire tergum and not subequal in width to each other and/or not of about the same width across each tergum; tergal punctation and width of distal pale bands variable . . . 8

7(6). Pubescence of apical bands of terga 2-4 arises from distinct round punctures separated by less than one puncture width; posteromedian area of mesoscutum coarsely punctate, punctures separated by one or less puncture width . . . *Brachymelissodes*

Pubescence of apical bands on terga 2-4 not arising from distinct punctures; posteromedian area of mesoscutum sparsely punctate, punctures mostly separated by 2 to 3 or more puncture widths . . . . *Tachymelissodes*

8(6). Small bees, 8 to 10 mm. in length; galeae with abundant hooked hairs above, or with short sparse straight hairs and dulled by dense, coarse, regular tessellations . . . . . *Eumelissodes*

Small to large bees, *if* 10 mm. or less in length, *then* galeae without hooked hairs and either smooth and shiny, except at tips, or only moderately dulled by shagreening or irregular tessellation 9

9(8). Last flagellar segment as short as preceding segment or shorter and about as long as it is wide . . . . . *Eumelissodes*

Last flagellar segment distinctly longer than the preceding and longer than wide 10

10(9). First tergum with sparse punctures separated mostly by 3 puncture widths or more, except basal fourth or less with more crowded punctures . . . . . *Eumelissodes*

First tergum with abundant punctures separated by two puncture widths or less in basal half or more 11

11(10). Lateral and ventral surfaces of thorax with dark brown hairs (including propodeum); lateral raised areas of terga 2 and 3 (lateral third of area basal to pale pubescent fasciae) with large, irregular, piliferous punctures, ground areas very shiny, with no tessellation or shagreening; ground areas of supraclypeal area smooth and shiny . . . . . *Eumelissodes*

Lateral surfaces of thorax with pale hairs at least in some restricted area, or raised areas of terga 2 and 3 with ground areas at least delicately shagreened; supraclypeal area often dulled by dense shagreening or tessellation 12

12(11). Eye narrower than genal area in profile, widest part of eye equals half or less of length; lateral and ventral surfaces of thorax with black hairs . . . . . *Eumelissodes*

13(12). Hairs of thorax all or almost all black; galeae shiny, without shagreening or tessellation, except at tips.
Melissodes and *Ecplectica*

Hairs of thorax largely pale at least dorsally, *or* galeae moderately shiny to dull due to dense shagreening or tessellation, or both. 14

14(13). Second flagellar segment longer than wide ventrally; hairs of inner surfaces of hind basitarsi brown to black . *Eumelissodes*

Second flagellar segment as long as wide or shorter, or hairs of inner surfaces of hind basitarsi red to yellow, or both 15

15(14). Vestiture of metasomal terga entirely black or dark brown, except long hairs on first tergum and occasionally a thin median pale pubescent band on tergum 2; dorsum of thorax with rufescent to ochraceous hairs . . . *Eumelissodes*

Terga with various amounts and arrangements of pale pubescense, never entirely dark except first and second terga, *or* dorsum of thorax with abundant dark hairs, or both . . 16

16(15). Metasomal tergum 3 either (a) with marginal area covered by the pale pubescent band or nearly so (except median triangular notch less than ⅓ width of tergum), *or* (b) with an impunctate apubescent margin which either markedly narrows laterally from a median notch or is narrower than the pale pubescent band of tergum 2 across the entire tergum. *Eumelissodes*

Metasomal tergum 3 with (a) dark hairs apical to the pale band across median third or more of the tergum, *or* (b) with pale hairs in apical area which do not completely hide surface and which differ from those of the pale pubescent band by having no or fewer and shorter branches and usually being erect or suberect (note: punctures when these are worn), *or* (c) with apical apubescent area wider than apical pale band of tergum 2 across the entire tergum 17

17(16). First tergum with broad apical hyaline colorless margin; clypeus with large shiny median boss just below center; hairs of inner surfaces of hind basitarsi dark brown to black *Eumelissodes*

Apical margin of first tergum usually opaque or only narrowly hyaline, *if* broadly hyaline, *then either* without a large shiny boss on clypeus *or* inner surfaces of hind basitarsi with red to yellow hairs, or both 18

18(17). Galeae above moderately shiny to dull, with shagreening or tessellation in at least apical half 19

Galeae above smooth and shiny, without shagreening or tessellation except at tips 20

19(18). Metanotum as long as dorsal face of propodeum medially or longer; distal pale band of tergum 2 almost never interrupted medially, with straight anterior margin and evenly curved posterior margin; galeae shiny or moderately shiny, smooth or slightly shagreened . . . . *Melissodes*

Metanotum distinctly shorter than dorsal face of propodeum medially; *or, either* distal pale band of tergum 2 interrupted medially or notched along posterior margin, *or* galeae dulled by dense shagreening or tessellation, or both . . *Eumelissodes*

20(18). Dorsal face of propodeum usually without distinct punctures, irregularly rugose, occasionally with small scattered punctures apically but these obscured by dense tessellations and basal half to three fourths irregularly rugose. . . . . . *Eumelissodes*

Dorsal face of propodeum with distinct punctures in at least apical half, ground areas tessellate but not so densely as to obscure punctures, basal half (or less) punctate or reticulo-rugose, not irregularly so 21

21(20). Distal pale pubescent band of tergum 2 uninterrupted medially, evenly curved along posterior margin and of about the same width across tergum . . . . *Melissodes*

Distal pale pubescent band of tergum 2 absent or interrupted medially, *or* not evenly curved along posterior margin but conspicuously notched medially 22

22(21). Distal pale band of tergum 2 absent or broadly interrupted medially, the lateral fasciae thus formed well separated from apical margin of tergum and each fascia no broader medially than half the width of apical area. . . . *Melissodes* and *Ecplectica*

Distal pale band of tergum 2 at most narrowly interrupted and lateral fasciae thus formed each much broader than half width of apical area medially . . . . . . *Eumelissodes*

Brachymelissodes, subgenus nov.

Type species. Eucera cressonii Dalla Torre, 1896.

Female. Integument black; tarsi and often tibiae and distal ends of femora rufescent; distal areas of terga somewhat translucent; antennae dark brown above, red or paler below; clypeus, labrum and mandibles often with red or yellow maculae; wing membranes not infumate, slightly milky, veins deep reddish-brown. *Eyes bulbous, width usually considerably more than one third length in facial view, never less;* clypeus evenly convex, width about twice length, with dense, coarse punctures mostly separated by less than one puncture width, ground shiny, with little or no shagreening; second flagellar segment distinctly shorter than broad ventrally and shorter than third segment. Mesoscutum and scutellum with deep round punctures separated by less than one puncture width, ground shiny and smooth; lateral faces of mesepisterna with large, shallow, often confluent punctures, ground delicately shagreened; *tegulae with lateral margins evenly rounded, not narrowed anteriorly;* dorsal face of propodeum densely reticulopunctate, becoming more distinctly punctate posteriorly, often dulled by dense shagreening, declivous face with large median upper impunctate triangle which is smooth and shiny or delicately shagreened, lateral faces and lateral part of declivous face with coarse punctures, ground dulled by dense tessellation; *metanotum with median prominence undeveloped and punctures in lateral areas more distinct than in Epimelissodes.* Metasoma broad, usually about two thirds as wide as long or wider; pygidial plate V-shaped, about as broad basally as long or slightly narrower; *terga 2-4 with small, round, distinct punctures mostly separated by less than one puncture width;* tergum 1 with large deep crowded punctures in basal area, with small punctures in distal area except impunctate marginal fifth or less.

Hairs generally short, more or less appressed on head and dorsum of thorax and metasoma; brown hairs of basal areas of metasomal terga 2-4 and distal area of tergum 1 appressed, extremely short; *terga 2-4 with apical white pubescent bands subequal in width to each other, subequal in width across each tergum and consisting of short diffuse pubescence;* tergum 2 with basal pale band of appressed pubescence connected at sides with apical pale band of appressed pubescence, *hairs of basal band plumose, not spatulate apically;* erect or suberect bristlelike hairs absent or very sparse on terga 2 and 3, more abundant on terga 4 and 5; *hairs between mesoscutum and scutellum plumose, not spatulate apically; scopa relatively small, hairs with 6 to 12 long thin branches,* pale; hairs of inner surfaces of basitarsi yellow to red.

Male. Color generally as in female; tarsi, usually tibiae and often distal ends of femora rufescent; *antennal scapes wholly yellow or with dark lines dorsally,* flagella dark below and yellow or reddish above. *Eyes very large, width equals half length in facial view or almost so; narrowest part of face about at level of antennal fossae or above; antennae very short, not reaching scutellum, first flagellar segment dorsally equals second segment or slightly less, ventrally equals two thirds of second segment.* Characters of structure and vestiture as in female.

Genitalia and hidden sterna much as in *Epimelissodes*; gonostyli with short sparse hairs; *spatha large, length one third to one half width,* apical margin not evenly rounded—angulate or emarginate. Seventh sternum with lateral excavations of lateral plates usually equal to slightly less than half length of plates; *median apical plates small, without hairs apically;* lateral apodemes gradually tapered, much shorter than median length of sternum. Eighth sternum with lateral apodemes directed somewhat anteriorly.

KEY TO THE SPECIES OF THE SUBGENUS *Brachymelissodes*

MALES

1. Terga 3 and 4 with apical pale pubescent bands about twice as broad medially as basal areas of dark brown hairs; tergum 2 with pale apical band broadly connected with basal pale band laterally; mesoscutal hairs white to pale ochraceous . . . . *minima*
   Terga 3 and 4 with pale apical bands much narrower than basal areas of brown hairs; tergum 2 with pale apical band rarely connected with pale basal band laterally; mesoscutal hairs ochraceous to rufescent . . . . *cressonii*

FEMALES

1. Terga 2 to 4 with pale pubescent bands about as wide as basal areas of dark brown hairs; scopal hairs bright yellow; pale mesoscutal hairs usually rufescent . . . . *cressonii*
   Terga 2 to 4 with pale bands much broader than basal areas of brown hairs (about twice as broad medially); scopal hairs white; pale mesoscutal hairs white to pale ochraceous . . . *minima*

Melissodes (Brachymelissodes) cressonii (Dalla Torre), new combination

Melissodes brevicornis Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 281; Crawford, 1903, Can. Ent., vol. 35, p. 334; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 113.

Eucera cressonii Dalla Torre, 1896, Catalogus Hymenopterorum, vol. 10, p. 229 (*n. nov.* for *Melissodes brevicornis* Cresson, 1872, *non Tetralonia brevicornis* Smith, 1854).

Xenoglossa brevicornis, Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 73, 102; 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 367; 1915, Ent. News, vol. 26, p. 364.

Melissodes petulciformis Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 364 (new synonymy); 1928, Univ. Colorado Studies, vol. 16, p. 114.

This species is easily distinguished from *minima* by the larger size, the rufescent thoracic hairs, the bright yellow scopal hairs and the narrower pubescent bands on metasomal terga 2 to 4.

Female. Measurements and ratios: N, 20; length, 10-13 mm.; width, 4.0-5.5 mm.; wing length, $M = 3.62 \pm 0.186$ mm.; hooks in hamulus, $M = 13.20 \pm 0.213$; flagellar segment 1/segment 2, $M = 2.30 \pm 0.046$.

Structure and color: Clypeus usually all black, occasionally with two round or oval, orange or yellow maculae near margin; mandibles usually black basally, rufescent distally with an elongate golden-yellow median mark in distal half, often basal triangle translucent orange; labrum black, occasionally with a rufescent median spot; eyes gray to blue-green. Supraclypeal triangle coarsely punctate, upper part somewhat shagreened; lateral faces of mesepisterna with ground areas shagreened; tergum 1 with ground areas of apical area and tergum 2 with basal area dulled by dense coarse shagreening.

Hair: On head and sides of thorax pale ochraceous; dorsum of thorax with pale hairs ochraceous to ferruginous, often with dark reddish-brown patches on mesoscutum and scutellum. Terga 2-4 with pale pubescent bands about as wide as basal areas of dark brown hairs; pale apical band of tergum 2 connected with pale basal band only at extreme sides or not at all; terga 5 and 6 with long appressed hairs mostly dark brown, white at extreme sides; sternal hairs usually reddish-brown; scopal hairs yellow.

Male. Measurements and ratios: N, 20; length, 9.0-13.5 mm.; width, 3-5 mm.; wing length, $M = 3.52 \pm 0.188$ mm.; hooks in hamulus, $M = 12.25 \pm 0.228$; flagellar segment 2/segment 1, $M = 1.32 \pm 0.020$.

Structure and color: Clypeus, mandibular bases and ventral halves or more of scapes bright yellow, black of face usually extending down over extreme posterior margin of clypeus; labrum pale yellow to white. Sculpturing as in female.

Sternum 7 with lateral excavation of lateral plate equal to or slightly less than half length of plate, broadly open; laterodistal projection of lateral plate acute. Sternum 8 not much narrower medially than apically. Gonocoxite with dorsal projection directed posteriorly, acute; spatha with evenly rounded apical margin except for slight median emargination (Figs. 62-64).

Hair: Generally as in female; thorax usually with rufescent hairs, rarely with brown patches on mesoscutum and scutellum; occasionally with short dark brown suberect hairs at extreme apices of terga 2-4; pale distal band on tergum 2 rarely connected with pale basal band at sides; terga 3-5 with pale distal bands much narrower than basal areas of dark brown hairs; terga 6 and 7 with dark brown hairs, except at sides of tergum 6; sternal hairs brown; legs with hairs golden-yellow.

Bionomics. Little is known of the flower preferences of this species, but females have been collected on widely different sorts of flowers—*Helianthus, Cardia, Vernonia, Polygonum, Euphorbia.* I have observed females collecting pollen from *Euphorbia marginata* in Kansas. A female collected on *Vernonia* in Texas has pollen seemingly from this plant on its scopae. From this evidence *cressonii* can be considered as being polylectic.

Cockerell (1915) has described a resting cluster of a dozen males of this species observed by the Rev. G. Birkmann of Fedor, Texas. The bees grasped the leaves' petioles with their mandibles, swung clear, brushed themselves and remained thus until morning when they were killed.

Type material. Male lectotype of *brevicornis* from Bosque Co., Texas, collected by G. W. Belfrage, is in the Academy of Natural Sciences of Philadelphia. The female holotype of *petulciformis* from Fedor, Lee Co., Texas, is the property of the California Academy of Sciences on temporary deposit at the Citrus Experiment Station, Riverside, California.

Distribution. Southern Nebraska and eastern Colorado south through Kansas and western Oklahoma to Durango, Mexico (Fig. 2). *M. cressonii* has been collected from June 28 to October 2, most abundantly in August and September. From the localities listed below (published records are included) 101 males and 85 females have been examined.

COLORADO: Eads; Holly; Horse Creek (S. of Buckeye); La Junta; Two Buttes Reserve. KANSAS: Burdette; Clay Co.; Coolidge; Decatur Co.; Dickinson Co.; Dodge City (8 miles S. E.); Ellis Co.; Grant Co.; Hugoton (4 miles S. E.); Jetmore (4 miles W.); Lawrence; Manhattan; Meade Co.; Morton Co.; Nickerson; Norton Co.; Randolph; Riley Co.; Stafford Co. NEBRASKA: Lincoln; McCool; Malcolm. OKLAHOMA: Beaver Co. TEXAS: Bexar Co.; Bosque Co.; Clarendon; College Station; Conlen; Corsicana; Cypress Mill, Blanco Co.; Dalhart; Dallas; Dawn; Fedor, Lee Co.; Friona (10 mile N.); Greenville; Hereford (5 miles S.W.); Llano; Olivia; Rosser; Kaufman Co.; Victoria. DURANGO: Tlahualilo.

A single specimen in the U. S. National Museum labeled "Camd. Co., N. J." with no date or collector is presumably mislabeled.

Flower records. Cardia sp., *Euphorbia marginata, Gossypium herbaceum, Helianthus annuus, Medicago sativa, Polygonum* sp., *Prionopsis* sp., *Teucrium canadense, Vernonia* sp.

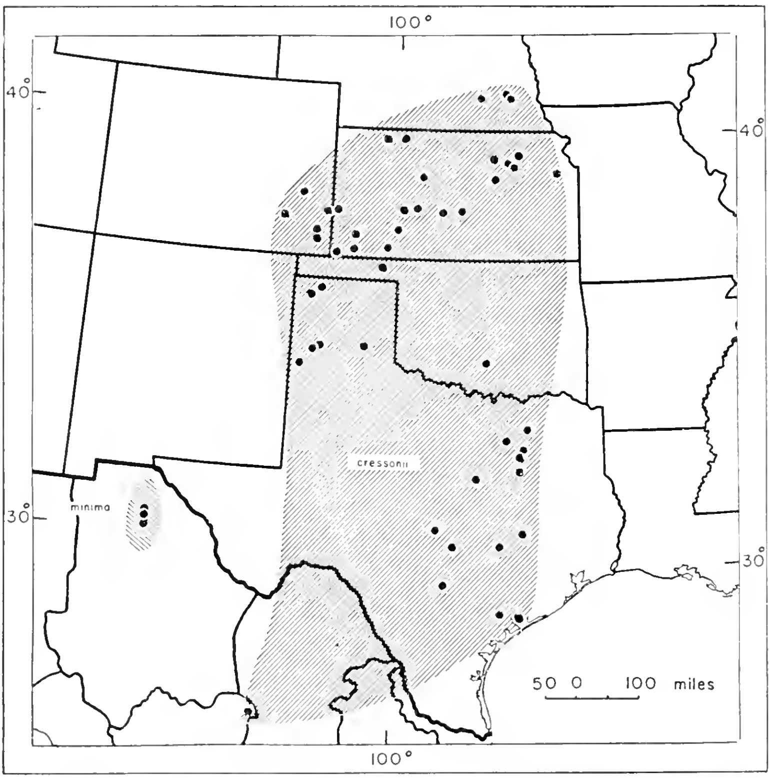

FIG. 2. Map showing the distribution of *M.* (*Brachymelissodes*) *cressonii* and *M.* (*B.*) *minima.*

Melissodes (Brachymelissodes) minima, sp. nov.

This species is readily separated from *cressonii* on the basis of its smaller size, paler color and the broader apical bands on terga 2 to 4.

Female. Measurements and ratios: N, 2; length, about 10 mm.; width about 3.5 mm.; wing length, 3.06-3.15 mm.; hooks in hamulus, 11; flagellar segment 1/segment 2, 2.17.

Structure and color: Clypeus black with a pale yellow, three-lobed macula immediately above the constricted, testaceous, apical margin; labrum and bases of mandibles pale yellow; distal part of mandibles rufescent with a median golden-yellow spot along distal half; eyes grayish-brown; distitarsi rufescent, basitarsi, tibiae and femora dark. Supraclypeal triangle coarsely punctate, ground shiny; lateral faces of mesepisterna with ground smooth and shiny or only delicately shagreened; tergum 1 with ground area of distal area and tergum 2 with ground of basal area delicately shagreened, scarcely dulled; tergum 2 with punctures of basal area small and crowded.

Hair: On head, sides of thorax, legs except distitarsi, inner surfaces of basitarsi and basitibial plates, and pale pubescence of metasoma white; dorsum of thorax with pale ochraceous hairs, scutellum with a few rufescent hairs medially; distitarsi and inner surfaces of basitarsi with yellowish-red hairs; basitibial plates with ferruginous hairs; terga 2-4 with distal pale bands much broader than basal areas of dark brown hairs, about twice as broad medially; tergum 2 with distal pale band broadly connected with basal pale band laterally; terga 5 and 6 with long appressed hairs mostly white, pale brown apically and medially; sternal hairs pale ferruginous; scopal hairs white.

Male. Measurements and ratios: N, 13; length, 8.5-9.5 mm.; width, 3-4 mm.; wing length, $M = 2.95 \pm 0.191$ mm.; hooks in hamulus, $M = 10.23 \pm 0.122$; flagellar segment 2/segment 1, $M = 2.38 \pm 0.035$.

Structure and color: Clypeus, labrum, bases of mandibles and ventral half or more of scapes pale yellow; clypeus not dark posteriorly; flagella pale yellow ventrally and brown dorsally. Other characters of color and structure as in female.

Dorsal projections of gonocoxites curve dorsally and somewhat mesad, blunt apically; spatha about twice as wide as long, with angular apical margin. Sternum 7 with lateral excavations of lateral plates small and deep, slightly constricted by an upturning of the proximal angle, distal projection blunt, forming an obtuse angle. Sternum 8 much narrowed at apical one third (Figs. 65-68).

Hair: Generally as in female; tergum 2 with distal pale band much broader than basal area of dark brown hairs, broadly connected with basal pale pubescent band laterally; terga 3-5 with distal pale bands narrower than basal area; sternal hairs mostly pale but brown medially and on last exposed sternum; legs, including distitarsi and basitibial plates, with white hairs, but rufescent on inner surfaces of basitarsi.

Type material. Holotype male, allotype female and three paratype males from Villa Ahumada, Chihuahua, Mexico, July 28, 1953, at 3,700 feet altitude on *Cleome* sp., collected by a University of Kansas Mexican Expedition. Nine paratype males and one paratype female from 10 and 13 miles north of Villa Ahumada, Chihuahua, Mexico, July 28, 1953, 3,700 feet altitude, collected by a University of Kansas Mexican Expedition. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the Snow Entomological Museum, the U. S. National Museum and in the author's collection.

Distribution. Known only from the type material, but probably widespread at moderate altitudes on the Mexican plateau (Fig. 2).

Subgenus EPIMELISSODES Ashmead

Epimelissodes Ashmead, 1899, Trans. Amer. Ent. Soc., vol. 26, p. 63; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 79, 82; Robertson, 1918, Ent. News, vol. 29, p. 92; 1926, Ecology, vol. 7, p. 380; 1928, Flowers and Insects, p. 8; Sandhouse, 1943, Proc. U. S. National Museum, vol. 92, p. 548; Moure, 1944, Papéis Avulsos, Dept. Zool., São Paulo, Brasil, vol. 6, p. 115.

Type species. *Melissodes atripes* Cresson, 1872, monobasic.

Ashmead placed *Melissodes atripes* in the new genus *Epimelissodes* on the basis of the relative lengths of the submarginal cells (cells one and two being subequal and considerably shorter than the third along their posterior margins) and on the number of segments in the maxillary palpi (three in *atripes*). Robertson (1918) has shown that the venation character is not constant and that Ashmead was in error regarding the palpi which are usually 4-segmented as in most *Melissodes*. Robertson retained the name as a subgenus, including in it three species (*atripes, obliqua* and *illinoensis*) which all lack the lateral apical spines on the seventh tergum in the male. *Epimelissodes*, as interpreted here, includes those forms in which the metanotum has a low, rounded, median eminence densely set with long plumose hairs (three to five times as long as the hairs on the lateral parts of the metanotum) arising from coarse confluent punctures. In addition the males have antennae of moderate length and lack lateral apical spines on the seventh tergum.

Female. Clypeus densely punctate, punctures separated mostly by less than one puncture width and much less near apical margin, ground usually densely tessellate, surface flat, especially posteromedially, projecting forward beyond eye by less than half width of eye in profile, posteromedian area often arising abruptly in a short step from supraclypeal triangle; eyes large, often bulbous, always wider than genal areas in profile; galeae longer than clypeus, usually smooth and shiny with scattered punctures; maxillary palpi 4-segmented, segments 2 and 3 often subequal and usually longer than segments 1 or 2, sometimes with a minute fifth segment. Mesoscutum, scutellum and lateral surfaces of mesepisterna densely and coarsely punctate, ground usually equal to half or less of one puncture width; *metanotum with median rounded eminence densely set with coarse confluent punctures bearing a dense tuft of long plumose hairs and with lateral flat areas with no or smaller and less distinct punctures and short appressed hairs; tegulae oval, not acuminate anteriorly, with lateral margins convex;* dorsal face of propodeum punctate or reticulorugose, ground densely tessellate, declivous face with large distinct punctures and often with a median upper impunctate triangle dulled by dense tessellation, lateral faces with shallow, often more or less confluent punctures and usually entirely tessellate. Pygidial plate V-shaped, rounded apically, as broad basally as long and often broader; sterna densely punctate, with erect or suberect hairs apically, these becoming shorter and more appressed basally. Hairs variable, generally of moderate length, short and more or less recumbent on dorsum of thorax, longer on sides, extremely short and usually appressed on anterior, lower part of lateral face of propodeum; *thick hair band between mesoscutum and scutellum and basal appressed hair band on tergum 2 consist of basally plumose and apically spatulate hairs* (spatuloplumose hairs); scopae large, usually with highly plumose hairs.

Male. Clypeus, labrum and bases of mandibles usually pale cream to bright yellow; clypeus usually slightly longer than half its width, not protruding more than half width of eye in profile, usually much less; eyes large, bulbous, wider in profile than genal areas; *antennae of moderate length, scarcely reaching tergum 1 in repose; maximum length of first flagellar segment equals more than one third of second segment along same side* (dorsal) and often more than half; galeae and punctation as in female. Thorax much as in female, but often lower lateral and anterior surfaces of mesepisterna covered with a mat of dense appressed hairs. Metasoma much as in female, but often with pubescent fasciae more obscure and erect bristlelike hairs usually more abundant, especially on terga 4-7; *tergum 6 and often tergum 5 with lateral spines, but spines absent on tergum 7*; pygidial plate broad as in female, but often notched laterally near apex; sterna as in female, but less punctate and less piliferous; sternum 7 flat, broadly V-shaped, evenly rounded apically and much broader at base than long, shiny and largely bare, but with short suberect hairs arising from distinct punctures in subtriangular basal area and near apex.

Gonostyli usually with abundant long hairs, often barbed; *dorsal carinae of gonocoxites each produced into a long fingerlike process directed posteriorly and inward; inner apical brush of gonocoxites (below gonostyli) small and composed entirely of short, thick, blunt hairs. Seventh sternum with a deep semicircular emargination near apex of lateral margin of lateral plate; median plate small* with few or no hairs at apex. Eighth sternum broadly truncate and slightly emarginate apically (Figs. 24-27).

This subgenus is divisible into four more or less distinct species groups which are described below. *M. atripes* and *M. albocollaris* are distinct and each forms one of these groups by itself.

KEY TO THE SPECIES OF THE SUBGENUS *Epimelissodes*

MALES

1. Clypeus entirely black . . . *albocollaris*
   Clypeus all or almost all pale . . . 2

2(1). Apical areas of terga with distinct piliferous punctures equal in diameter to several times the width of the simple hairs arising from them (except extremely narrow impunctate margin), ground shiny with little or only delicate shagreening . . . *atripes*
   Apical areas of terga without distinct punctures, *if* punctures present, these small and obscured by dense, diffuse, pale pubescence, ground usually dulled by dense shagreening . . . 3

3(2). Terga 2 and 3 with pale pubescence diffuse, extending to apical margins (unless worn); anterior faces of mesepisterna with mats of closely appressed, dense, pale pubescence which hide surfaces completely on at least lower halves . . . 12
   Terga 2 and 3 with pale pubescence in distinct arched bands well separated from margins, in lateral fasciae which are well separated from margins, or absent; mesepisterna often without dense mats of pale pubescence anteriorly . . . 4

4(3). Mesepisterna with mats of dense pale pubescence completely hiding anterior surfaces at least on lower halves . . . 5

Mesepisterna without mats of pale pubescence anteriorly, with short sparse pubescence which does not hide surfaces completely 10

5(4). Mesepisterna with area of small indistinct punctures obscured by dense tessellation extending from anterior faces posteriorly over median half or more of lateral surfaces, upper halves or less and lower parts of lateral surfaces with distinct punctures and smooth shiny interpunctural spaces *texana*

Mesepisterna with uniform punctation laterally, not with lateral surfaces sharply divided into two types of sculpturing, punctures distinct, ground areas usually shiny, if dulled, punctures not obscured 6

6(5). Tergum 2 with distal pale band fused with basal spatuloplumose hair band; inner surfaces of hind basitarsi with yellow to pale red hairs; terga 2 and 3, beneath pale pubescence, with sparse scattered punctures, ground dulled by fine regular tessellation . . . . *machaerantherae*

Tergum 2 with distal pale band not usually fused with basal band of spatuloplumose hairs; *if* fused, *then either* inner surfaces of hind basitarsi with dark reddish-brown to black hairs, *or* terga 2 and 3 with distinct punctures separated by less than one puncture width beneath the pale pubescent bands 7

7(6). Tergum 2 with distal pale band fused with basal spatuloplumose hair band at least across median half of tergum and usually completely; terga 3 to 5 with complete pale bands, that of tergum 3 broader medially than apical area of short brown hairs. *helianthelli*

Tergum 2 with distal pale band not fused with basal band, with dark brown hairs or erect pale hairs separating these bands; at least tergum 5 with pale pubescent band interrupted medially by short brown hairs and often pale bands of terga 3 and 4 interrupted as well; tergum 3 with pale band narrower than apical area when not interrupted medially . . 8

8(7). Tergum 2 with interband zone with coarse punctures separated by less than half a puncture width and about half the size of the coarse punctures in basal half of tergum 1; minimum length of first flagellar segment equals about half of maximum length of second segment and occasionally more, always equal to more than a third of second segment; inner surfaces of hind basitarsi with yellow to pale red hairs . . . . *comanche*

Tergum 2 with interband zone with shallow and indistinct punctures *or* with punctures much smaller than half size of punctures of basal half of tergum 1; minimum length of first flagellar segment equals about a third of maximum length of second segment, occasionally slightly more; inner surfaces of hind basitarsi with hairs usually dark reddish-brown to black 9

9(8). Mesoscutum with few or no brown hairs, *if* these present, ***then*** covering an area smaller than dark patch on scutellum; inner surfaces of hind tibiae and inner and outer surfaces of hind basitarsi with brown hairs . . . . *grandissima*

Mesoscutum with patch of dark brown hairs at least as large as dark scutellar patch and usually larger; inner surfaces of hind tibiae and outer surfaces of hind basitarsi with pale hairs, inner surfaces of hind basitarsi with hairs red to dark brown. ***aegis***

10(4). Clypeus with posterior margin unevenly marked with brown; inner surfaces of hind basitarsi with orange-red hairs; mesepisterna with punctures on lateral surfaces coarse, slightly larger than those in middle of posterior half of mesoscutum. ***nitida***

Clypeus entirely pale in color, except spots at anterior tentorial pits; inner surfaces of hind basitarsi with variable hairs; mesepisterna with punctures on lateral surfaces coarse, but usually of same size as those in middle of posterior half of mesoscutum 11

11(10). Wings usually deeply infumate, or infumate at least basally and anteriorly; inner surfaces of hind basitarsi with dark reddish-brown to black hairs; terga 2 and 3 usually with short appressed brown simple hairs in apical areas (bare only in worn specimens) . . . . *obliqua*

Wings clear or somewhat milky, not infumate; inner surfaces of hind basitarsi with yellow to pale red hairs; terga 2 to 4 usually with apical areas bare, or with short appressed plumose white hairs . . . . ***sila***

12(3). Sternum 7 with lateral excavations of lateral plates half length of plates; sternum 8 without fanlike verticle row of several median apical hairs; mesepisterna with white hairs of lower anterior halves, or more conspicuously more abundant than elsewhere on lateral surfaces, hiding surfaces completely and as thick as pubescence on anterior and ventral surfaces or almost so . . . . *sabinensis*

Sternum 7 with lateral excavations of lateral plates slightly shorter than half length of plates; sternum 8 with a verticle row of several stout hairs in median apical emargination forming a fanlike structure; mesepisterna with white hairs on lower anterior halves, or more, of lateral surfaces not conspicuously more abundant than elsewhere on lateral surfaces. *petulca*

FEMALES

1. Scopal hairs all or almost all pale, highly plumose 2

Scopal hairs all or almost all black or dark brown, with few branches and with rachises of hairs extending considerably beyond plumose part so as to form what appears to be a layer of simple guard hairs . . . . *atripes*

2(1). Mesepisterna with dark brown to black pubescence on anterior faces, surfaces not greatly obscured; thorax with dark brown to black hairs on sides at least on lower fifth . . . *obliqua*

Mesepisterna with pale pubescence on anterior faces, surfaces often completely obscured on at least lower halves; thorax without dark hairs laterally 3

3(2). Tergum 2, and usually terga 3 and 4 as well, with pale pubescence short, evenly diffused and reaching apical margin 12

Tergum 2, and usually terga 3 and 4, with pale pubescence in arched bands or lateral fasciae and well separated from apical margin by an area of sparse appressed dark hair or by an apubescent area 4

4(3). Terga 2 and 3 with apical areas with short white hairs or entirely bare; inner surfaces of hind basitarsi with yellow to red hairs; mesoscutum without patch of brown hairs, with ground areas shiny, delicately or not at all shagreened .... *sila*

Terga 2 and 3 with reddish-brown to black, short, appressed hairs (sometimes worn away, especially medially) in apical areas; inner surfaces of hind basitarsi with dark reddish-brown to black hairs *or*, if pale, *then* mesoscutum *either* with a conspicuous patch of dark hairs *or* ground areas dulled by dense shagreening ... 5

5(4). Tergum 2 with distal pale band fused with basal spatuloplumose hair band across entire tergum; tergum 2, beneath pale pubescence in lateral third, with only a few to several large punctures, surface dulled by regular fine tessellation; supraclypeal area with round large punctures medially; inner surfaces of hind basitarsi with hairs yellow to red. *machaerantherae*

Tergum 2 with pale distal band separated from basal spatuloplumose hair band by zone of short brown hairs, *if* latter are pale as the pale pubescence, *then* spatuloplumose band remains sharply defined by virtue of the obvious difference in hair length; tergum 2, beneath or basal to pale pubescent fasciae in lateral third with small punctures separated by less than one puncture width in addition to the large sparse punctures, surface usually dulled by dense irregular tessellation or shagreening; *if* tergum 2 with indistinct punctures, *then* supraclypeal area with indistinct, small, shallow punctures; inner surfaces of hind basitarsi with variable hairs 6

6(5). Mesoscutum with punctures of median half of posterior third (that area immediately before the mesoscutum slants down to the scutoscutellar suture) conspicuously smaller than punctures immediately mesad of parapsidal lines, separated often by more than one puncture width; clypeus rather shiny, with large, deep, rounded punctures and smooth or delicately shagreened ground areas; tergum 4 with white pubescent band not interrupted medially by a patch of brown pubescence. *texana*

Mesoscutum with punctures of posteromedian area not conspicuously smaller than those just inside of parapsidal lines; clypeus with small shallow punctures and usually ground dulled by dense shagreening or fine tessellation; tergum 4 with pale pubescent band often interrupted by a median patch of dark brown pubescence 7

7(6). Clypeus with punctures separated by less than half of one puncture width and becoming confluent especially laterally and posteriorly, ground areas and often bottoms of punctures dulled by dense tessellation 8

Clypeus with discrete punctures separated mostly by half a puncture width and usually more in median half of posterior third, at least bottoms of punctures mostly smooth and shiny . 9

8(7). Sternal hairs ochraceous to white; pale pubescent fasciae of tergum 2 subtriangular in shape, as wide as apical area laterally; tergum 4 without dark brown pubescence interrupting pale apical band, or only a few dark hairs present *nitida*

Sternal hairs at least partly dark brown; pale pubescent fasciae of tergum 2 narrow, no wider than half of apical area laterally, not subtriangular in shape; tergum 4 with abundant dark brown pubescence interrupting pale apical band medially. *comanche*

9(7). Tergum 4 with median patch of dark brown pubescence as wide as one fourth of tergum and usually much wider; mesoscutum with dark brown hair patch usually larger than that on scutellum, narrowly separated from tegulae laterally; outer surfaces of middle basitarsi with ochraceous hairs . *aegis*

Tergum 4 without median patch of dark brown pubescence or this patch not as wide as one fourth of width of tergum; mesoscutum with dark brown hair patch usually rounded anteriorly, well separated from tegulae and scarcely larger than dark scutellar patch, if any; outer surfaces of middle basitarsi with variable hairs 10

10(9). Outer surfaces of middle tarsi with dark brown hairs; scopal hairs of lower half of hind basitarsus brown . . . . *grandissima*

Outer surfaces of middle tarsi with pale ochraceous to pale ferruginous hairs; scopal hairs of lower half of hind basitarsus pale ochraceous to white 11

11(10). Clypeus with punctures large and shallow, in posterior third of median half separated mostly by one puncture width or more; tergum 2 with distal pale band uninterrupted or only narrowly so; tergum 3 with pale band uninterrupted, medially as wide as apical area or almost so . . . . *helianthelli*

Clypeus with punctures smaller and deeper, in posterior third of median half separated mostly by half a puncture width or less, rarely by as much as one puncture width; tergum 2 with distal pale band broadly interrupted medially (by ¼ to ⅓ width of tergum); tergum 3 with pale band narrowly interrupted medially, or thinned to less than ⅓ width of apical area medially . . . . *nitida*

12(3). Mesoscutum without brown hairs and scutellum usually without brown hairs; tergum 2 with apical band of diffuse pubescence not reaching margin of tergum and on tergum 3 not reaching margin at least medially . . . . *sila*

Mesoscutum often with brown hairs in posteromedian area; terga 2 and 3 with apical bands of diffuse pubescence reaching apices of terga (unless worn away) 13

13(12). Terga 2 and 3 with punctures of lateral raised areas (interband zone immediately mesal to lateral arms of graduli) coarse, deep, scarcely obscured by tessellation; terga 3 and 4 with brown hairs basal to apical pale bands of diffuse pubesence. *petulca*

Terga 2 and 3 with punctures of interband zone (laterally) shallow and obscured by dense tessellation, those of tergum 3 distinctly separated into smaller, shallower punctures bearing plumose hairs and larger, sparser punctures bearing bristlelike hairs; terga 3 and 4 often with only pale hairs and tomentum basally . . . . *sabinensis*

THE ATRIPES GROUP

Melissodes (Epimelissodes) atripes Cresson.

This species is readily distinguished from the other *Epimelissodes*, except *M. albocollaris*, by the distinct, large, shallow punctures separated by one or less puncture width in the apical areas of metasomal terga 2 and 3 of both sexes. The pale yellow clypeus and labrum serve to distinguish the males from those of *albocollaris*. In addition the females are readily recognized by the dark brown or black scopae which have peculiar hairs as described below.

Female. Measurements and ratios: N, 51; length, 15-20 mm.; width, 6-8 mm.; wing length, $M = 6.18 \pm 0.064$ mm.; hooks in hamulus, $M = 19.06 \pm 0.654$; length of flagellar segment 1/segment 2, $M = 1.74 \pm 0.034$.

Structure and color: Integument black, except for distitarsi and apical spurs of middle and fore tibiae which are rufescent, mandibles which are black in basal triangle and red distally with a longitudinal golden-yellow macula extending over distal half to one third; eyes dull bluish-gray to yellowish-green; tegulae testaceous in pale forms to clear brown in dark forms; wing membranes infumate, deep brown with violet reflections in dark forms to a rather clear brown in pale forms, veins dark red to blackish-brown, being usually paler basally; antennae black except for an elongate reddish spot on outer half of ventral surfaces of flagellar segments 2 to 10, occasionally entire ventral surface reddish-brown, or all brown in dark forms.

Second flagellar segment almost always longer than broad ventrally, never shorter; clypeus slightly more than half as long as width of face between lower ends of eyes; supraclypeal area with large deep punctures, ground usually densely tessellate; eyes slightly more than one third as wide as long in facial view, essentially parallel, narrowest space between eyes at vertex usually equal to or only slightly wider than narrowest space just above mandibles, face slightly wider about one third of distance from top of eyes; clypeus equals five eighths of postpalpal parts of galeae; maxillary palpi usually 4-segmented in ratio of about 2.5:4:4:1.5. Mesoscutum, scutellum and lateral surfaces of mesepisterna densely and coarsely punctate, ground more or less dulled by shagreening, densely so on posterior third to half of mesoscutum; dorsal face of propodeum reticulopunctate, entire propodeum dulled by dense tessellation. First metasomal tergum less than half as long as wide, with deep dense punctures separated by half or less of one puncture width on anterior half and extending almost to apex laterally, with smaller and shallower but distinct punctures on distal half, ground dulled by shagreening, but less so on basal half; terga 2, 3 and 4 similar, but punctures shallower and more irregular in size in basal areas; each tergum with a narrow, impunctate apical zone.

Hair: Pale ochraceous on head in pale forms; labrum and vertex often with some brownish hairs, this brown progressively spreading onto face and genal areas until all hairs of head dark brown to black in darkest forms. Dorsum of thorax, propodeum, tegulae and lateral faces of mesepisterna with pale ochraceous hairs in pale forms, brown hairs of anterior and ventral faces of mesepisterna in pale forms progressively cover mesepisterna and appear on scutellum, posteromedian area of mesoscutum and tegulae in dark forms; thick hair band between mesoscutum and scutellum with few spatuloplumose hairs and occasionally none. Metasomal tergum 1 with long pale ochraceous hairs in basal half, short dark brown appressed hairs in distal half and with rather short ephemeral lateral fasciae of dark brown plumose hairs medially, with appressed pale ochraceous or dark brown hairs at extreme sides and with whitish spatuloplumose hairs in appressed basal band, often the latter hidden under apex of first tergum; tergum 3 similar, but pubescent fasciae often white and without basal spatuloplumose hair band; tergum 4 similar, but pubescent fasciae broad, apical and usually continuous across tergum, sometimes white laterally; sternal hairs coarse, erect, dark brown to black, shorter appressed basal hairs brown, sparse. Scopae with dense long dark brown to black hairs, median area of tibial scopae with pale ochraceous to pale brown hairs in pale forms; scopal hairs of metatarsi and lateral and distal hairs on tibiae with few branches (8 to 12) and with rachises extended to form stiff unbranched apical projections about as long as branched parts of hairs, these form a layer over the exterior of the scopae appearing like a layer of simple guard hairs. Hind basitarsi with dark brown to black hairs on inner surfaces; fore and middle legs and hind femora usually with dark brown to black hairs.

Male. Measurements and ratios: N, 51; length, 13-18 mm.; width, 4.5-7.0 mm.; wing length, $M = 5.76 \pm 0.054$ mm.; hooks in hamulus, $M = 17.10 \pm 0.205$; length of flagellar segment 2/segment 1, $M = 2.14 \pm 0.016$.

Structure and color: Black, sterna and distitarsi often rufescent; antennal scapes dark brown to black, flagella dark brown beneath and reddish above; eyes gray to yellowish-green; tegulae testaceous; wing membranes and veins as in female.

Clypeal width about 1.3 times length or slightly more; sculpturing of head similar to female, but obscure on clypeus; eyes bulbous, about half as wide as long in facial view or slightly wider, converging below, narrowest facial width about at level of tentorial pits; galeae equal to about half length of clypeus; maxillary palpi as in female, but often fourth segment shorter and often with extremely short fifth segment. Punctation of thorax and metasoma as in female, but sterna with fewer hairs and punctures.

Gonostyli with abundant long hairs, ventrally all plumose, dorsally about half plumose and half simple; dorsal projections (= carinae) of gonocoxites blunt and curving inwards; spatha evenly curved apically; sternum 7 with lateral excavation of lateral plate small, about one third as long as plate; posterior apodemes equal to median length of sternum or slightly less; median plate with abundant long hairs. Sternum 8 with lateral apodemes acute, directed somewhat anteriorly; central apical carina blunt, not extending forward to surpass apical margin medially (Figs. 39-41).

Hair: Much as in female, but generally paler; clypeus and vertex with dark hairs only in darkest forms, head never wholly dark. Lateral faces of mesepisterna always with pale hairs, anterior faces often with pale hairs, but dark in dark forms, ventral faces with a small patch of appressed dark hairs usually present; pronotum, mesoscutum and scutellum without dark hairs; tegulae with brown hairs in dark forms. Metasomal terga as in female with the following differences: tergum 2 often with short thin white pubescent fasciae laterally, terga 3 and 4 as in tergum 3 of female, but white fasciae often continuous, tergum 5 never with white pubescence laterally. Legs with pale ochraceous hairs except dark brown hairs on outer surfaces of basitarsi and inner surfaces of hind tibiae in pale forms, becoming entirely dark brown to black in dark forms; inner surfaces of basitarsi with rufescent to dark brown hairs.

Bionomics. According to the evidence from published records, from the locality records of bees studied and from the author's own collecting experience, *M. atripes* is restricted in nesting sites to sandy areas.

Robertson (1914 and 1926) regarded this bee as oligolectic on *Cassia chamaecrista.* This is erroneous, since it has not been collected on *Cassia* in any part of the country except Illinois. In Kansas *atripes* has been observed collecting pollen from *Dalea lanata* and *Cleome serrulata* and Brimley (1938) reports it as being polytropic in North Carolina. However, this species, unlike most *Melissodes* (and especially unlike other species of the subgenus *Epimelissodes*), seemingly does not collect pollen from and only rarely visits composites. Thus far only two females have been collected visiting composites by the author (one on *Gaillardia* and one on *Thelesperma megapotamicum* near Portales, N. Mex.), but in neither case was there any evidence of pollen collecting by the bees. In addition, Robertson (1928) has recorded the female on *Bidens aristosa* and *Vernonia fasciculata* in Illinois, again not collecting pollen. The modified scopal hairs of the female may be involved in this habit of visiting flowers of the non-Compositae. However, since these bees collect from very different flowers and since we know nothing of the details of pollen gathering, the relationship is obscure.

Hart and Gleason (1907) in their study of the biology of the sand areas of Illinois report that this species was found apparently resting in large numbers clustered on dead weed stems along the roadside. Unfortunately, they do not record whether both sexes were involved, or only males as has been recorded in other species of *Melissodes.*

Geographical variation. The fact mentioned above that *atripes* is dependent upon sandy areas for nesting sites has strongly affected its distribution. These bees are perhaps most abundant in eastern Texas where there are large sandy areas and sufficient precipitation to provide the bees with the proper plants to serve as food sources. They are also common along the Atlantic coast from Florida as far northwards as New Jersey. They are less common in the Gulf States where sandy areas are less common. Elsewhere the species is most common along rivers and streams. In Kansas it is common in the sand dunes along the Arkansas River and has been taken in sandy areas in the upper reaches of the Cimarron and Canadian rivers and in one locality along the Kaw River. In western Texas and eastern New Mexico it has been taken in sandy areas along the Canadian River. In Illinois it is common in the sand dunes along the Illinois River and its tributaries northward to about the middle of the State. This dependence on sand results in a spotty distribution which makes difficult the study of clines and related phenomena.

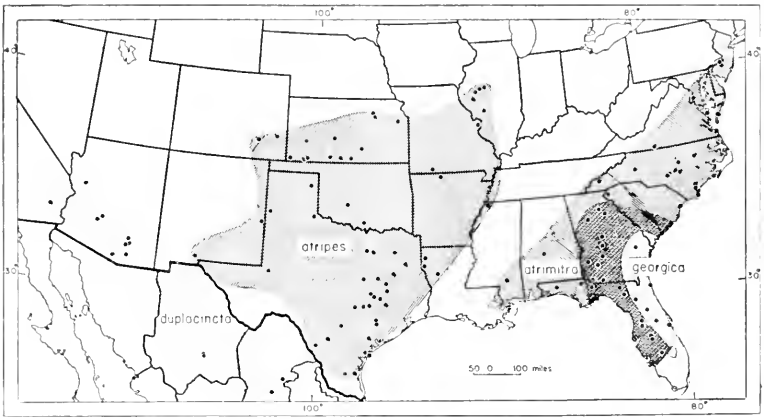

FIG. 3. Map showing the distribution of *M. (Epimelissodes) atripes* and *M. (Idiomelissodes) duplocincta*. In *M. atripes* the zone of intergradation between the subspecies *atrimitra* and *georgica* is indicated by the overlapping type of shading, whereas the zone between the subspecies *atripes* and *atrimitra* is left unshaded due to a lack of specimens from that area.

This species varies geographically with regard to the number and arrangement of the white pubescent fasciae on the metasoma and of the dark brown hairs on the metasoma, thorax and head. In Tables I and II are tabulated percentages of several of these characters for females and males. The data have been grouped rather roughly because of the lack of sufficient material, because of discontinuous distribution and because of the haphazard nature of the collections. The grouping, although unrefined, is logical. Drainage was taken into consideration as well as major breaks in distribution.

In spite of these difficulties a cline can be seen in the western part of the range of this species. The cline shows especially well in the white fasciae of the metasoma. The palest forms are most abundant in Kansas and Colorado and become less abundant to the east in Illinois and Missouri and to the south in Texas. The Oklahoma, New Mexico and western Texas specimens were found to be very similar and, together or separately, they are intermediate between the Kansan and Texan populations.

A sharp break can be seen between the above populations and the populations along the Gulf coast. The transition zone between the western and the Gulf States' populations cannot be studied because of the lack of material from critical areas. However, the cline in the western populations indicates that a rather narrow zone of intergradation must exist across Louisiana. I have seen only three males from Louisiana and these are from near the eastern edge of the state. These males are easily assignable to the Texan population. Two males from the extreme northwestern corner of Mississippi (DeSoto County) also belong with the western populations. The bees may well be rare across this hypothetical zone of intergradation because of a lack of suitable sandy habitats, resulting in restricted gene flow across the area.

TABLE I.—Percentages of females of *Melissodes atripes* exhibiting certain characters of vestiture (see text).

CHARACTERS	COLORADO AND KANSAS (33 specimens)	OKLAHOMA, NEW MEXICO, WESTERN TEXAS (20)	TEXAS (east and central) (79)	ILLINOIS AND MISSOURI (33)	MISSISSIPPI (5)	MARYLAND, NEW JERSEY AND VIRGINIA (18)	NORTH CAROLINA AND SOUTH CAROLINA (24)	GEORGIA (north and central) (5)	GEORGIA (southwest), FLORIDA (western) AND ALABAMA (9)	FLORIDA (eastern) (11)
A	0	0	2.5	18.2	100.0	100.0	95.8	40.0	100.0	9.1
B	18.2	25.0	73.4	72.7	0	0	4.2	60.0	0	9.1
C	81.8	75.0	24.1	9.1	0	0	0	0	0	81.8
D	75.0	70.0	27.8	24.2	0	0	33.3	20.0	22.2	0
E	6.9	10.0	0	0	0	0	0	60.0	11.1	90.0
F	8.3	30.0	34.2	57.6	100.0	100.0	91.7	80.0	88.9	0
G	0	0	1.3	12.1	100.0	100.0	41.7	0	100.0	0
H	69.4	55.0	49.4	18.2	0	16.7	29.2	100.0	55.6	100.0
I	0	5.0	0	9.1	100.0	94.4	45.8	0	100.0	0

TABLE II.—Percentages of males of *Melissodes atripes* exhibiting certain characters of vestiture (see text).

CHARACTERS	COLORADO AND KANSAS (43 specimens)	OKLAHOMA, NEW MEXICO, WESTERN TEXAS (20)	TEXAS (east and central) (149)	ILLINOIS AND MISSOURI (54)	MISSISSIPPI (14)	MARYLAND, NEW JERSEY AND VIRGINIA (10)	NORTH CAROLINA AND SOUTH CAROLINA (32)	GEORGIA (north and central) (5)	GEORGIA (southwest), FLORIDA (western) AND ALABAMA (10)	FLORIDA (eastern) (40)
A	0	0	2.0	0	85.7	80.0	43.8	0	20.0	5.0
B	18.6	35.0	42.9	52.9	0	10.0	25.0	60.0	60.0	17.5
C	0	15.0	2.7	1.9	7.1	0	21.5	0	0	5.0
D	55.8	35.0	45.0	39.6	0	10.0	9.7	20.0	20.0	2.5
E	25.6	10.0	7.4	5.6	7.1	0	0	20.0	0	70.0
F	0	0	0	0	0	0	0	0	0	52.5
G	58.1	35.0	83.2	92.6	35.8	30.0	84.4	60.0	80.0	20.0
H	41.9	50.0	11.4	7.4	7.1	0	5.9	40.0	20.0	77.5
I	0	5.0	0	0	0	0	0	0	10.0	47.5
J	62.8	65.0	40.3	12.9	14.3	20.0	71.9	20.0	90.0	50.0
K	34.9	30.0	1.3	0	0	10.0	9.7	0	30.0	80.0

The dark form of the Gulf States is seen to intergrade in western Florida and southwestern Georgia with another pale population occupying eastern Florida and southeastern Georgia. Again the paucity of material from critical areas makes the study of the zone of intergradation difficult. However, specimens from extreme western Florida and those from southwestern Georgia are more like the dark specimens from the Gulf States than like the pale eastern specimens. A relatively long series of specimens from Suwanee Springs in northern Florida contains all intergrades from one extreme to the other. Intergrades also occur down the western half of the Florida Peninsula.

The dark form of the Gulf States probably has a continuous range with the dark forms appearing in North Carolina, Maryland, New Jersey and Virginia. From the material now before me the range is broken by intergrades between the dark specimens and the southeastern pale specimens. The population in northcentral Georgia is intermediate in character. It should be noted that the generally darker specimens from southwestern Georgia are not separated by much distance from the intermediate forms from northcentral Georgia, but these occupy different drainage systems. The southwestern specimens were all collected in the drainage area of the Apalachicola River which empties into the Gulf of Mexico, whereas the specimens from northcentral Georgia were all collected in the drainage systems of the Altamaha and Savannah rivers which both empty into the Atlantic Ocean in southern Georgia. The differences between the populations is thus explainable, assuming that migration and resulting gene flow is made possible, or at least aided, by sandy areas along the courses of these streams. To the north evidence of gene flow from the south is present in collections from North Carolina, but as one can see from Table I, a large majority of the females are assignable to the dark form. The seemingly more extensive intergradation to the north rather than to the west is perhaps due to the ease of migration along the sandy areas along the coast. In the northern part of the range of the dark form, both males and females tend to have yellow-green eyes, rather than the usual gray or blue-gray. Eye-color of museum specimens is a notoriously poor character and the significance of this observation must await confirmation from live bees.

The pale southeastern form (subspecies *georgica*) may have evolved while isolated from the mainland populations on one or more islands which now form the Florida peninsula. The dark form (subspecies *atrimitra*) probably has become differentiated from the western form (subspecies *atripes*) due to the restriction of gene flow across the state of Louisiana because of the lack of sandy habitats resulting from the muddy deposits of the Mississippi River. This species has not yet been collected in Tennessee, Kentucky, northern Alabama and the states bordering the Ohio River to the north. Collections from those areas, if the bees occur there, may well change the results of this study (Fig. 3).

Each of the characters listed in Tables I and II is an all or nothing situation. Several of these "characters", however, may be grouped as steps in a single broadly variable character. Thus, characters A, B, and C of Table I are mutually exclusive and are steps in a progression from darkest (A) to palest (C). Such groupings are indicated by the double horizontal lines in the tables. The characters, represented only by letters in the tables, are listed below:

TABLE I—Females.

A. Without white pubescent fasciae on metasoma.
B. Tergum 3 with white fasciae (but not tergum 4).
C. Terga 3 and 4 with white fasciae.
D. Tergum 2 with pale hairs present at extreme sides (but not tergum 3).
E. Terga 2 and 3 with pale hairs at extreme sides.
F. Face with 10% or more of hairs dark brown to black.
G. Face with 50% or more of hairs dark.
H. Mesepisterna with upper triangular area of pale hairs extending half way or more from wing bases to middle coxae.
I. Pronotum (posterior lobes and/or dorsally) and mesoscutum with some dark brown or black hairs.

TABLE II—Males.

A. Metasoma without white pubescent fasciae or bands.
B. Tergum 2 with white fasciae (but not terga 3 or 4).
C. Terga 3 and 4 with white fasciae (but not tergum 2).
D. Terga 2 and 3 with white fasciae (but not tergum 4).
E. Terga 2, 3 and 4 with white fasciae (tergum 3 with or without a complete white band).
F. Both terga 3 and 4 with complete bands of white pubescence (tergum 2 with white fasciae).
G. Tergum 2 with pale hairs at extreme sides (but not tergum 3).
H. Terga 2 and 3 with pale hairs at extreme sides.
I. Mesepisternal hairs all pale.
J. Mesepisterna with dark hairs below and often anteriorly.
K. Hind femora without dark hairs above.

One notices in Tables I and II that the males in all of the populations are much more variable than the females in the characters studied. The cline existing in the western subspecies and the areas of intergradation are nonetheless recognizable. This variability of the males may be due to the haploid nature of the males in contrast to the diploidy of the females. Recessive genes are thus always expressed in the males, but may be hidden in the heterozygous state in the females. The percentage of males in which such recessive genes are expressed is equal to the frequency of the genes in the population, whereas it is somewhat less in females from the same population.

Because of the variation described above, three subspecies of *atripes* are recognized and described below. A fourth subspecies may possibly exist in the northern part of the range of *atrimitra,* but this decision must await further material and field studies. The females of these three subspecies are rather easily separated, but the males on account of their greater variability cannot be easily recognized.

Melissodes (Epimelissodes) atripes atripes Cresson.

Melissodes atripes Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 275; Cragin, 1886, Trans. Acad. Sci. St. Louis, vol. 8, p. 54; Cockerell, 1899, Ent. News, vol. 10, p. 4; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 211; Robertson, 1900, Trans. Acad. Sci. St. Louis, vol. 10, p. 53; 1905, Trans. Amer. Ent. Soc., vol. 31, p. 369; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 79, 82; Hart and Gleason, 1907, Bull. Illinois State Lab. Nat. Hist., vol. 7, p. 257; Robertson, 1914, Ent. News, vol. 25, p. 73; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 112; Cockerell, 1934, Amer. Mus. Nov., no. 697, p. 10.

Epimelissodes atripes, Ashmead, 1899, Ent. News, vol. 10, p. 245; Robertson, 1918, Ent. News, vol. 29, p. 92; 1926, Ecology, vol. 7, p. 380; 1928, Flowers and Insects, p. 8.

Female. Differing from females of *atrimitra* by the paler hairs of the face (almost always with less than 50 percent dark brown hairs and most with less than 10 percent dark brown hairs on face exclusive of clypeus and vertex) and by usually having white pubescent fasciae on metasoma (usually on both terga 3 and 4, but often on tergum 3 only). Less easily distinguished from females of *georgica,* but a majority of females of *atripes* can be distinguished as follows: usually with pale hairs at sides of metasomal tergum 2 only; pale hairs on mesepisterna usually form a triangle on upper half or less of each mesepisternum; usually without pale ochraceous scopal hairs on hind tibiae. Additional characters can be seen in Table I.

Male. M. atripes atripes may be separated from *atrimitra* by almost always having some white pubescent fasciae on metasoma and by never having dark brown hairs on face, clypeus or tegulae. Separable from paler forms of *georgica* by only rarely having continuous bands of white pubescence on metasomal terga (only that on tergum 3 complete, if any) and by usually not having lateral white fasciae on more than two of the terga. Additional characters can be seen in Table II.

Type material. Holotype female collected by G. W. Belfrage from Texas, in the U. S. National Museum (USNM Type No. 24,615).

Distribution. From New Mexico northwards to eastern Colorado, east to central Illinois and south to northwestern Mississippi, Arkansas and Texas (Fig. 3). These bees have been collected from May 2 to October 30 in the southern part of the range and from July 21 to September 3 in the northern part of the range. Specimens examined from the localities listed below include 275 males and 218 females. Localities referred to in the literature are included.

ARKANSAS: Marion Co. COLORADO: Lamar; Rocky Ford. ILLINOIS: Bath; Havanna; Manito; Meredosia; Carlinville. KANSAS: Coldwater; Comanche Co.; Garden City; Harper Co.; Larned; Lawrence (8 miles S.); Liberal; Manhattan; Morton Co.; Riley Co.; Sedgwick Co.; Seward Co.; Barber Co. LOUISIANA: Keatchie; Natchitoche Co.; Shreveport. MISSISSIPPI: DeSoto Co. MISSOURI: Branson; St. Louis. NEW MEXICO: Dona Ana Co.; Portales. OKLAHOMA: Anadarko; Ardmore. TEXAS: Austin; Bexar Co.; Brazo Co.; Brooks Co.; Calvert; Canadian; Friona; Grapevine; Groesbeck; Laredo; Lee Co.; Madison Co.; McDade; Metz, Ector Co.; Mifflin; Mineola; Navasota; Overton; Padre Island, San Patricio Co.; Palestine; Peeler; Rock Island; San Gabriel River; Skull Creek, Colorado Co.; Victoria; Waco.

Flower records. Except for the few exceptions mentioned above, the females have not been collected from composites. *Asclepias incarnata, Bidens aristosa, Cassia fasciculata, Cleome serrulata, Dalea lanata, Gaillardia* sp., *Gonolobus laevis, Gossypium herbaceum, Helianthus annuus, Ipomoea pandurata, Lythrum alatum, Melilotus alba, Pycnanthemum virginianum, Thelesperma megapotamicum, Verbena hastata, V. stricta, Vernonia fasciculata.*

Melissodes (Epimelissodes) atripes atrimitra, subsp. nov.

Melissodes atrifrons, Cockerell (*non* Smith, 1854), 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 79, 82; Smith, 1910, Ann. Report New Jersey State Museum, 1909, p. 693 (Fox det.).
Melissodes atripes, Smith (*non* Cresson, 1872), 1910, Ann. Report New Jersey State Museum, 1909, p. 693 (Fox det.).
Melissodes carolinensis, Brimley (*non* Dalla Torre, 1896), 1938, Insects of North Carolina, p. 462; Michener, 1947, Amer. Mid. Nat., vol. 38, p. 454.

Smith (1854, pp. 307 and 308) proposed the name *atrifrons* for two species of *Tetralonia,* the first a male from Chile and the second a female from Warm Springs, North Carolina (R. Foster, collector). Dalla Torre (1896) proposed the name *carolinensis* for the North Carolina female, after having placed all of the species of *Tetralonia* and *Melissodes* in the genus *Eucera.* Since then, this subspecies has been known variously as *atripes, atrifrons* or *caro-*

linensis following the lead of Cockerell (1906). Dr. I. H. H. Yarrow of the British Museum in a recent communication (dated September 17, 1954) has informed me that the female type of Smith's *Tetralonia atrifrons* (from North Carolina) is indeed a *Tetralonia* and not a *Melissodes.* The name *atrimitra* is therefore proposed for this subspecies of *M. atripes.*

Female. Almost always with more than 50 percent dark brown hairs on face, hairs of head all dark brown in darkest specimens; often with less than 50 percent pale hairs on lateral surfaces of mesepisterna; usually with dark brown hairs on posterior lobes of pronotum, along extreme anterior margin of mesoscutum and often on tegulae; small posteromedian patch of brown hairs on mesoscutum and median patch on scutellum in dark specimens; usually with no white pubescent fasciae on metasomal terga and without pale hairs at extreme sides of tergum 3 and usually absent at sides of tergum 2; scopal hairs always dark brown to black.

Male. Darkest forms without pale hairs at sides of metasomal terga and without white pubescent fasciae; often with dark brown hairs on clypeus, vertex and tegulae; usually with dark brown hairs on anterior as well as lower surfaces of mesepisterna; hind legs usually without pale hairs. The tabulation in Tables I and II give additional information regarding both sexes.

Type material. Holotype male, allotype female, 2 female and 4 male paratypes from Hattiesburg, Mississippi, August 6, 1944, C. D. Michener. Two female and nine male paratypes from Hattiesburg, Mississippi, collected by C. D. Michener are as follows: 5 males, July 23, 1944; 2 males, July 29, 1944; 2 males and 2 females, August 13, 1944. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the Snow Entomological Museum, the American Museum of Natural History, the Citrus Experiment State, Riverside, California, and in the author's collection.

Distribution. Gulf States from Mississippi to Alabama, northeast across western Georgia to North Carolina and north to New Jersey (Fig. 3). This subspecies has been collected from July 29 to November 30. Specimens examined from the localities listed below include 95 males and 52 females (including type material).

ALABAMA: Selma. FLORIDA: * Bartow; * Branford; Crestview; * Fort Meade; * LaBelle; *Lacooche; Marianna; * Suwanee Springs; * Tallahassee; * Wildwood. GEORGIA: * Albany; * Athens; * At-

* Localities considered to be in the zone of intergradation.

lanta; * Bainbridge; * Butler's Ferry, * Decatur Co.; * Cordele; * Fort Valley; * Macon; * Perry; * Shellman; * Spring Creek, Decatur Co.; * Thomasville; * Thomson's Mills. MARYLAND: Indianhead. MISSISSIPPI: Hattiesburg. NEW JERSEY: Rancocas Park; Haddenfield; Camden County. NORTH CAROLINA: Boque; Bryson City; Burgaw; Carolina Beach; Castle Haymes; Harnett; Hickory; Kingsboro; Lakeview; Overhills; Raleigh; Southern Pines; Spout Springs; Wilmington. SOUTH CAROLINA: Jocassee; * Myrtle Beach. VIRGINIA: Camp Peary; Henry Co.; Seven Pines; Virginia Beach.

Flower records. Bradburya virginiana, Buddleia sp., *Gerardia* sp., *Gossypium herbaceum, Hibiscus* sp., *Koellia hysopifolia, Kuhnistera* sp., *Monarda punctata, Passiflora incarnata, Primula vulgaris.*

Melissodes (Epimelissodes) atripes georgica Cresson.

Melissodes georgica Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 200; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 79; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 119; Fattig, 1945, Emory Univ. Mus. Bull., no. 3, p. 5.

Female. Face with more than 10 percent pale hairs; tegulae, posterior lobes of pronotum and anterior margin of mesoscutum usually without brown hairs; posteromedian area of mesoscutum and median area of scutellum with a small patch of brown hairs; pale hairs on lateral surface of mesepisternum not forming a dorsal triangle, but covering entire lateral surface or almost so; metasomal terga 3 and 4 usually with white pubescent fasciae and usually with pale ochraceous hairs at extreme sides; scopae of hind tibiae with pale, almost colorless hairs medially.

Male. Males distinguished from both other subspecies by usually having complete white pubescent bands on terga 3 and 4, or at least on tergum 3, and usually having white lateral fasciae on tergum 2 in addition; clypeus, vertex and tegulae usually without brown hairs; usually with only pale hairs on anterior faces of mesepisterna and often those on ventral surfaces also pale; hairs of middle and fore legs and of outer surfaces of hind tibiae and femora pale ochraceous. Additional characters tabulated in Tables I and II for both sexes.

Type material. Holotype male from Georgia in the Academy of Natural Sciences of Philadelphia.

Distribution. Eastern half of Florida and coastal region of Georgia (Fig. 3). The subspecies *georgica* has been collected flying from July 3 to October 16 (these dates include the inter-

* Localities considered to be in the zone of intergradation.

grading series from western Florida). Specimens studied include 11 females and 16 males from the localities listed below. The type specimen from Georgia is presumably from the coastal area, probably from near Savannah. In addition to those listed below, many specimens, especially males, from localities in the zone of intergradation listed under *atrimitra* could be assigned to *georgica*, but are not because they were collected in series containing all forms from one extreme to the other.

FLORIDA: Cocoa; Gainesville; Jacksonville Beach; Ocala National Forest, Marion Co.; Orlando; Ortega. GEORGIA: Belleville; ?Savannah.

THE ALBOCOLLARIS GROUP

Melissodes (Epimelissodes) albocollaris Cockerell.

Melissodes albocollaris Cockerell, 1918, Trans. Amer. Ent. Soc., vol. 44, p. 30.

This species is known only from the males which can be recognized by the totally black clypeus and labrum and by the distinct punctures in the apical areas of metasomal terga 2 to 5. This punctation is coarser and less regular than the punctation in *M. atripes.*

Male. Measurements and ratios: N, 6; length 13-14 mm.; width, 4.5-5.5 mm.; wing length, $M = 5.16 \pm 0.387$ mm.; hooks in hamulus, $M = 15.00 \pm 0.316$; length of flagellar segment 2/segment 1, (N, 4) $M = 3.27 \pm 0.116$.

Structure and color: Integument black, except last two tarsal segments which are rufescent; mandibles black except for a longitudinal golden spot over distal half; eyes black with violaceous reflections; tegulae black; wing membranes deeply infumate, veins dark reddish-black; antennal scapes black, flagella black above, reddish below on segments 2-11. Maximum length of first flagellar segment equals half or slightly more of minimum length of second segment; galeae slightly shagreened, but not enough to dull surface, almost twice as long as clypeus; clypeal width 1.5 times length or more; maxillary palpal segments in ratio of about 3:3:3:1, minute fifth segment sometimes present; eyes bulbous, converging slightly towards mandibles, narrowest facial width at level immediately below tentorial pits. Dorsal face of propodeum with coarse punctures, reticulorugose only anteriorly, if at all. Dorsal face of first metasomal tergum with round distinct punctures separated by one or more puncture widths in basal half, with smaller, more crowded punctures in distal half, ground spaces somewhat dulled by delicate shagreening, especially basally; terga 2-5 distinctly punctate in area apical to lateral fasciae of white pubescence as well as basally, punctures separated by one or more puncture widths distally, by less basally, ground minutely shagreened, moderately shiny.

Gonostyli long, with sharply truncate apices, narrowest in basal third, apices about as wide as bases; spatha about 3 times as wide as long, with a median apical emargination. Lateral excavation of lateral plate of sternum 7 equals half length of lateral plate, or slightly less; median plate with few simple hairs near apex or none; anterior apodemes about equal to median length of sternum. Sternum 8 broadly emarginate distally, with rounded lateral apical angles; transverse ventral carina blunt, well separated from apex of sternum, weak; ventrally with one or two pairs of short stout hairs below middle of sternum of each side (Figs. 42-44).

Hair: Largely black and sparse; whitish on face and genal areas, but black on vertex and a few dark hairs on clypeus; whitish on pronotum, in a narrow band thinning laterally at anterior margin of mesoscutum, in a thin line immediately mesad of tegulae, on extreme posterior and lateral margins of scutellum, usually in a vertical band on anterior half or less of lateral faces of mesepisterna and on tegulae. Basal area of tergum 1 with long plumose hairs largely black medially and pale ochraceous to white laterally; terga 2-5 with oblique lateral fasciae of short sparse appressed white pubescence, usually connected medially on terga 4 and 5; terga 6 and 7 and sterna with black hairs, somewhat rufescent on tarsi; inner surfaces of basitarsi with bright rufescent to reddish-brown hairs.

Type material. Holotype male from Veracruz, Mexico, 1896, collected by H. Heyde (C. F. Baker collection), in the U. S. National Museum (U. S. N. M. Type No. 22,817).

Distribution. Central and eastern Mexico. Specimens examined in addition to the holotype are as follows:

MICHOACAN: Acahuato, altitude 3000 feet, August 19, 1941, Hoogstraal collector, 1 male. PUEBLA: Atlixco, 7 miles S., altitude 4000 feet, July 13, 1953, University of Kansas Mexican Expedition, 4 males.

THE OBLIQUA GROUP

This is the largest group of North American *Epimelissodes*. The group consists of nine species and four subspecies. They can be readily separated from *atripes* and *albocollaris* by the characters described for the latter two species. They are distinguished from members of the *suffusa* group by the form of the pale pubescent bands on terga 2 and 3. This pale pubescence is either restricted to oblique lateral fasciae or to more or less discrete bands which are well separated from the apical margins of the terga.

Female. Apical areas of terga 2 and 3 without distinct punctures, usually impunctate or with minute punctures obscured by dense shagreening. Hairs variable; pale pubescence on terga 2 and 3 restricted to lateral oblique fasciae which may meet at midline (especially on tergum 3); pale pubescence on terga 2 and 3, if not restricted to lateral fasciae, at least well separated from apical margins of terga; apical margins of terga 2 and 3 bare or with minute appressed hairs which are usually dark in color and which scarcely obscure the surfaces; in one form entire metasoma covered with dark brown to black hairs; scopal hairs pale, highly plumose.

Male. Clypeus, labrum and bases of mandibles always pale in color; punctation of terga as in female. Pale pubescent bands on terga 2-4 as in female, but usually in complete bands; tergum 2, and in one form the entire metasoma, occasionally without pale pubescence.

Gonostyli various, but never with sharply truncate apices; spatha about 3 times as wide as long, often with a slight median apical emargination. Sternum 7 with lateral excavation of lateral plate equal to about half of length of plate and often more. Sternum 8 without short stout hairs on ventral surface (Figs. 24-27).

Melissodes (Epimelissodes) grandissima Cockerell.

Melissodes grandissima Cockerell, 1905, Can. Ent., vol. 37, p. 334; 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 361; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 88.

Melissodes atripes var. *acomanche* Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 109 (new synonymy).

This species can be separated from other members of the *obliqua* group by the characters summarized in the key. It is closely related to *aegis* and to *helianthelli* from which it is distinguished chiefly by the color of the hairs of the legs, terga and thorax. *M. grandissima* superficially resembles *comanche,* but can be easily separated from the latter on the basis of color and the punctation of the clypeus.

Female. Measurements and ratios: N, 20; length, 16-20 mm.; width, 5.5-8.0 mm.; wing length, $M = 6.15 \pm 0.796$ mm.; hooks in hamulus, $M = 19.90 \pm 0.886$; flagellar segment 1/segment 2, $M = 2.08 \pm 0.087$.

Structure and color: Integument generally black; distitarsi and occasionally apical sixth of clypeus and basal half of mandibles rufescent; distal half of mandibles with a large golden macula almost as broad as mandible distally and tapering basally; tibial spurs dark red to reddish-brown; antennal scape and first two flagellar segments black, remaining segments usually rufescent on lower, outer surfaces; eyes usually yellowish-green; wing membranes moderately infumate, veins dark reddish-brown. Eyes bulbous, usually slightly shorter than width of face between upper inner angles of eyes; maxillary palpal segments in ratio of about 3.5:4:3:1.5, occasionally with minute fifth segment; at least median third of posterior half of clypeus with punctures separated mostly by one puncture width, ground areas tessellate; supraclypeal area with small punctures obscured by dense tessellation. Thorax densely punctate, ground dulled by shagreening; punctures of scutellum conspicuously smaller and denser than those of posteromedian area (in middle of patch of dark brown hairs) of mesoscutum; punctures of mesepisterna generally larger than those of mesoscutum and often confluent, with shagreened bottoms; dorsal face of propodeum reticulorugose laterally, with well-separated punctures in medial third. Basal half or less of first tergum with coarse punctures extending distally at extreme sides; terga 2 and 3 with areas basad of oblique pale fasciae (interband zone laterally) with minute punctures obscured by dense tessellation; apical areas of terga 1 to 3 dulled by dense shagreening.

Hair: Head with pale ochraceous to white hairs, becoming pale ferruginous on vertex, short hairs between lateral ocelli and apices of compound eyes dark red to brown. Pale hairs of thorax pale ferruginous; mesepisterna with ochraceous hairs; mesoscutal patch of dark hairs well separated from tegulae, rounded anteriorly, little or no larger than patch of dark hairs on scutellum; axillae with large tufts of brown hairs. Basal half of first tergum with long pale ochraceous hairs; tergum 2 with very narrow, oblique, lateral, pubescent fasciae often meeting medially; tergum 3 with pale pubescent band usually narrowly interrupted; tergum 4 with broad band of white pubescence interrupted medially usually by only a narrow stripe of dark brown pubescence and at most by a patch of dark pubescence less than one fourth as wide as tergum; tergum 5 usually without pale hairs at extreme sides; terga 2 and 3 with pale ochraceous appressed hairs laterally; sternal hairs dark brown to black. Distitarsi with reddish-brown to brown hairs; fore and middle basitarsi with dark brown hairs on outer surfaces; inner surfaces of basitarsi with dark reddish-brown to black hairs; fore and middle tibiae and hind femora with brown to ochraceous hairs; scopal hairs mostly ochraceous to dark buff-colored, becoming brown on lower half of basitarsi and on basitibial plates.

Male. Measurements and ratios: N, 4; length, 16-20 mm.; width, about 6.0 mm.; wing length, $M = 5.91 \pm 0.595$ mm.; hooks in hamulus, $M = 19.25 \pm 0.629$; flagellar segment 2/segment 1, (N, 3) $M = 2.97 \pm 0.053$.

Structure and color: With characters of color and punctation as in female; clypeus, labrum and bases of mandibles pale yellow to cream-colored; maxillary palpi as in female; minimum length of first flagellar segment equals about one third of maximum length of second segment, occasionally longer, but never as long as half of second segment.

Genitalia and hidden sterna similar to *M. obliqua.* Gonostyli usually more capitate than in *obliqua* and usually with longer and more abundant hairs. Sternum 7 much as in *obliqua,* with hairs on ventral surface below inner margin of emargination and with several long plumose hairs on dorsal surface mesad of lower half of heavily sclerotized lateral plates; lateral apodemes shorter than medial length of sternum. Sternum 8 with long apical hairs more clearly separated into medially stout and laterally fine hairs on each side than in *obliqua,* with or without hairs medially at apex; transverse carina well separated from apex and with or without short stout appressed hairs.

Hairs: Head and thorax as in female, but mesoscutal patch of brown hairs usually smaller; anterior and lower surfaces of mesepisterna with pads of dense, closely appressed, ochraceous hairs. First metasomal tergum with long pale hairs on basal half to three fifths; terga 3-5 with white pubescent bands more or less narrowly interrupted medially; terga 6 and 7 with dark hairs only; sternal hairs dark brown; holotype male of *M. acomanche* with considerably narrower fasciae on terga 2 to 4 than usual, fasciae well separated from pale lateral hairs on terga 2 and 3 and without pale pubescence on tergum 5 in this specimen. Hairs of legs ochraceous except ferruginous to brown on distitarsi, dark reddish-brown to black on inner surfaces of basitarsi and tibiae, and dark brown to black on outer surfaces of hind basitarsi (and often middle basitarsi as well).

Remarks. Cockerell in 1906 gave the name of *acomanche* to an especially dark male specimen. The reduced pale fasciae of the terga of this specimen and the dark hairs of the hind basitarsi led

Cockerell to consider it as a variety of *M. atripes*. Characters of punctation and of the genitalia and hidden sterna show that this male is conspecific with males associated with females of *M. grandissima*. *M. grandissima* may eventually be considered as a subspecies of *M. helianthelli* from which it is distinguished chiefly on the basis of color. Two females of *grandissima* from Glen Rose, Texas (the northwestern boundary of the range of this species as now known), are somewhat paler than usual, but are not pale enough to be considered as intergrades between *grandissima* and *helianthelli*. These two species are completely allopatric, as far as existing collections show, therefore, it is perhaps best to consider them as distinct species rather than subspecies until further collecting can conclusively resolve the problem. Another fact that appears to separate them is the difference in flight dates, *grandissima* apparently being principally a late season bee and *helianthelli* an early bee.

M. grandissima is also clearly related to *aegis*, but the evidence for considering these two species as being distinct rather than as subspecies is stronger than in the case of *grandissima* and *helianthelli*. This problem is discussed below under *M. aegis*.

In two of the four males studied, nematodes were found to be protruding from the external opening of the membranous penis. These were cleared, together with the genitalia, in lactophenol and, thus, gave the appearance of a fringe of membranous filaments at the tip of the penis. The penis of one specimen was tightly packed with these small worms.

Type material. Holotype female of *grandissima* from Fedor, Texas, collected by G. Birkmann, in the collection of the University of Colorado Museum, Boulder. Holotype male of *acomanche* from Fedor, Texas, June 11, 1896, G. Birkmann, property of the California Academy of Sciences, but on temporary loan to the Citrus Experiment Station, Riverside, California.

Distribution. Southeastern Texas. Specimens of *grandissima* have been collected from June 6 through November 6, but most often in September and October (Fig. 4). In addition to the type material 32 females and 4 males were examined from the localities listed below. One female specimen labeled "Camd. Co., N. J." from the W. J. Fox collection is presumably mislabeled.

TEXAS: Atascosa Co.; Austin; Bexar Co.; Corpus Christi; Fedor, Lee Co.; Frio Co.; Glen Rose (2.8 miles N.), Somervell Co.; Sommerset, Bexar Co.; Victoria.

Flower records. Both females and males have been collected on *Ximenesia encelioides.* A single female from Bexar Co., Texas, has the cryptic label "A. lig." which presumably refers to another flower.

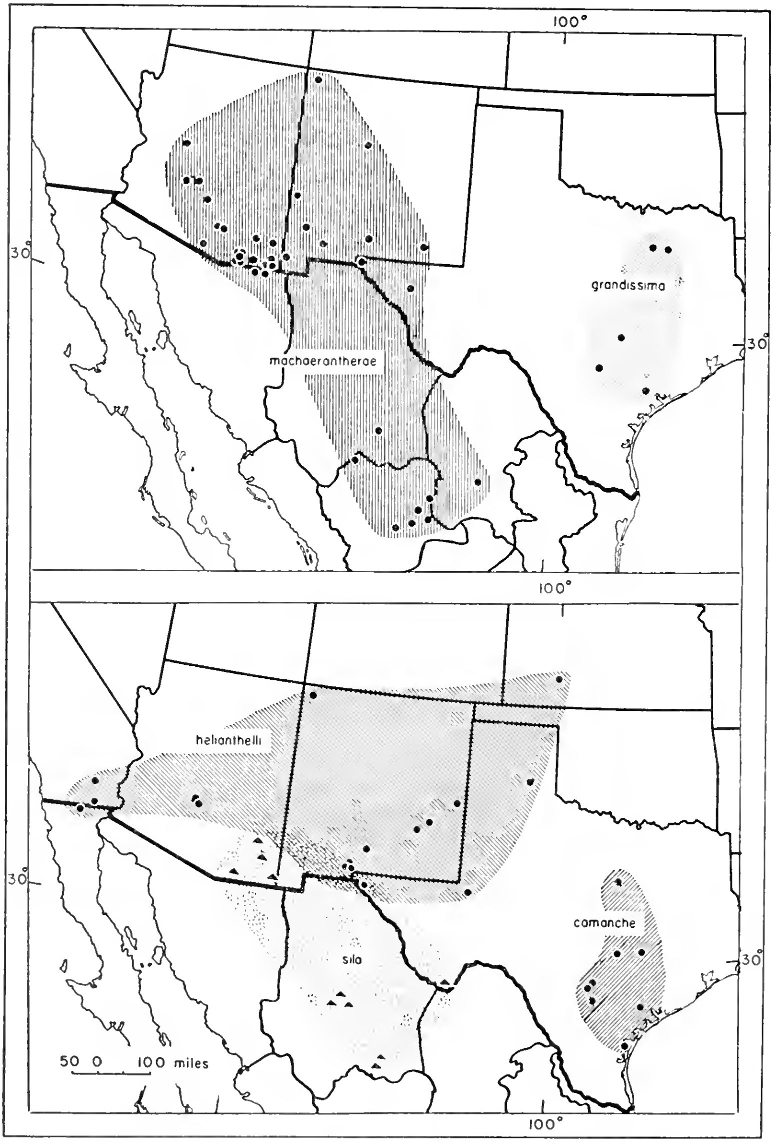

FIG. 4. Map showing the distribution of *M. (Epimelissodes) machaerantherae* and *M. (E.) grandissima* (above), and *M. (E.) comanche, M. (E.) helianthelli* and *M. (E.) sila* (below). Localities of *helianthelli* (dots) and *sila* (pyramids) can be distinguished by the different types of symbols.

Melissodes (Epimelissodes) aegis, sp. nov.

Melissodes texana, Michener, 1947, Amer. Mid. Nat., vol. 38, p. 453 (misidentification).

This species is closely related to *M. obliqua* and to *M. grandissima*. It is distinguished from *obliqua* by absence of dark brown hairs on the mesepisterna in the female and by having a dense pad of closely appressed hairs on the anterior surfaces of the mesepisterna in the male. *M. aegis* can be separated from *grandissima* chiefly on the basis of color and average size, as summarized in the key.

Female. Measurements and ratios: N, 20; length, 14-18 mm.; width, 5.0-6.5 mm.; wing length, $M = 5.86 \pm 0.446$ mm.; hooks in hamulus, $M = 18.65 \pm 0.357$; flagellar segment 1/segment 2, $M = 2.09 \pm 0.026$.

Structure and color: Anterior margin of clypeus and distitarsi rufescent; bases of mandibles and labrum more often translucent yellow or orange than in *grandissima;* eyes usually bluish-gray, occasionally bluish-green. Length of eyes generally equal to or slightly more than width of face at upper inner angles of eyes; maxillary palpi as in *grandissima.* Sculpturing in detail much as in *grandissima*; punctures of scutellum about equal in size to those in middle of dark mesoscutellar hair patch; propodeum with upper impunctate triangular area smaller than in *grandissima,* often entire declivous face punctate.

Hair: Head as in *grandissima,* but often with at least a few long dark brown hairs on vertex in addition to the short brown hairs between lateral ocelli and apices of compound eyes. Mesoscutal patch of dark brown hairs with a relatively straight anterior margin, narrowly separated from tegulae and usually considerably larger than the scutellar dark patch, otherwise hairs of thorax as in *grandissima.* Hairs of metasoma much as in *grandissima* but oblique lateral fasciae of tergum 2 usually wider, basal area of long ochraceous hairs on tergum 1 slightly narrower than the apical area, dark patch of brown pubescence on tergum 4 at least as wide as one fourth of tergum and usually much wider, sternal hairs dark reddish-brown to red and usually with a tuft of paler hairs laterally on tergum 5. Hairs of legs ochraceous except dark brown hairs of fore tarsi, ferruginous hairs of inner surfaces of middle and hind tarsi and hind tibiae and brown hairs on basitibial plates; scopal hairs on outer surfaces of hind basitarsi ochraceous, not largely black or brown as in *grandissima.*

Male. Measurements and ratios: N, 20; length, 13-17 mm.; width, 4.5-6.5 mm.; wing length, $M = 5.19 \pm 0.298$ mm.; hooks in hamulus, $M = 16.10 \pm 0.228$; flagellar segment 2/segment 1, $M = 2.96 \pm 0.043$.

Structure and color: Punctation, integumental color, maxillary palpi and flagellar segments as in *grandissima.*

Genitalia as in *obliqua,* gonostyli more distinctly capitate and thinner medially. Sternum 7 as in *obliqua,* but without short hairs on ventral surfaces near lower margin of apical emargination and sometimes with a few long plumose hairs on dorsal surface mesad to lower half of lateral plate as in *grandissima.* Sternum 8 as in *obliqua* and *grandissima,* but lateral apodemes directed somewhat anteriorly and ventral transverse carina very blunt so that it forms a bilobed ventral eminence rather than a distinct bidentate carina.

Hair: As in *grandissima* with the following differences: mesoscutal patch of brown hairs somewhat larger and white pubescent fasciae and bands on terga usually wider; legs with paler hairs than *grandissima,* ochraceous except for hairs of inner surfaces of tarsi which are ferruginous (often reddish-brown to brown on inner surfaces of hind basitarsi) to yellow.

Remarks. This species is exceedingly close to *grandissima.* Both sexes of *aegis* average smaller than those of *grandissima* and there are a few average structural differences described above; however, a combination of color characters serves to definitely distinguish the two species. Considering the large amount of geographic variation in regard to color existing in other species of *Epimelissodes,* it appears that *aegis* and *grandissima,* which are largely allopatric, might be subspecies of one species. However, the color changes from east to west in these two forms do not present a cline of any sort and one species is not consistently darker than the other in all characters. For instance, *aegis* is darker than *grandissima* in the patch of brown pubescence on the fourth tergum, in the mesoscutal patch of dark hairs and in the brown hairs of the vertex of the head. However, *grandissima* has darker legs and darker hairs on the metasomal sterna and on the last two terga than *aegis.* At least three typical females of *aegis* have been collected in eastern Texas well within the range of *grandissima.* For these reasons *M. aegis* and *M. grandissima* are considered as close, but distinct, species.

Type material. Holotype male, allotype female, 2 male paratypes and 2 female paratypes from one mile north of Citronelle, Alabama, August 21, 1952, on *Helenium tenuifolium* (L. H. Shinners). Seven additional male and twelve female paratypes as follows: ALABAMA: Cowarts, August 1-3, 1916, 2 females; Mobile, July 15, 1909, 1 male. FLORIDA: Branford, July 31, 1930, 2 males, 1 female; Monticello, October 4-8, 1914, 1 male; Gainesville, August 17, 1931, 1 male. MISSISSIPPI: Hattiesburg, September 26, 1943, 2 females, September 12, 1943, 1 female, September 17, 1944, 1 female, September 24, 1944, 1 female, October 1, 1944, 1 female; Camp Shelby near Hattiesburg, September 17, 1944, 3 females. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the Snow Entomological Museum, the American Museum of Natural History, the U. S. National Museum, the T. B. Mitchell collection at the North Carolina College of Agriculture and Engineering and in the author's collection.

Distribution. Eastern Texas through the Gulf States to Florida and north to North Carolina (Fig. 8). These bees have been collected from July 10 through October 14. In addition to the type material listed above, a total of 40 females and 20 males have been examined from the following list of localities.

ALABAMA: labeled "Alab.". FLORIDA: Blountstown; Pensacola; Yankeetown. GEORGIA: Adel; Bainbridge; Butler's Ferry, Decatur Co.; Cordele, Decatur Co.; Spring Creek, Decatur Co.; Thomasville; Vidalia. NORTH CAROLINA: Cape Fear River (mouth of); Southern Pines; Tarheel. SOUTH CAROLINA: St. Mathews; Summerville; Sumter. TEXAS: College Station, Brazos Co.; Houston; Lee Co.

Flower records. Aster sp., *A. pruinosa, Gaillardia* sp., *Helenium tenuifolium, Helianthus* sp., *H. annuus, H. radula, Vernonia glauca.*

Melissodes (Epimelissodes) comanche Cresson.

Melissodes comanche Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 276; 1875, *in* Wheeler, Report upon geographical and geological explorations and surveys west of the one hundredth meridian, vol. 5, p. 726; Birkmann, 1899, Ent. News, vol. 10, p. 245; Cockerell, 1906, Trans. Amer. Ent. Soc., vol, 32, pp. 78, 83, 89; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 115.

This species resembles *grandissima* and *aegis,* but can be separated from these by the much denser and finer punctation on the clypeus. It is distinguished from *obliqua* by the same character, by lacking dark hairs on the mesepisterna in the female and by having a pad of dense appressed hairs on the anterior surfaces of the mesepisterna in the male. *M. comanche* also resembles *helianthelli* closely, but is darker and has more distint punctures in the narrow area anterior to the oblique lateral fasciae on tergum 2.

Female. Measurements and ratios: N, 9; length, 17-20 mm.; width, 6-7 mm.; wing length, $M = 6.32 \pm 0.344$ mm.; hooks in hamulus, $M = 20.89 \pm 0.485$; flagellar segment 1/segment 2, $M = 2.40 \pm 0.047$.

Structure and color: Integument generally black; legs, apical areas of terga and sterna usually rufescent; apical margin of clypeus and bases of mandibles occasionally rufescent; mandibles with a wide median golden macula over apical half or slightly less; scape, pedicle and first two flagellar segments dark brown to rufescent, remaining flagellar segments reddish-yellow below and dark reddish-brown above; tibial spurs pale red to yellow; wing membranes moderately infumate, veins dark red; tegulae translucent brown. Clypeus finely and densely punctate, ground areas reduced to ridges equal to half a puncture width, densely shagreened; supraclypeal area with abundant coarse punctures distinctly larger than those on clypeus, moderately shiny; maxillary palpi as in *aegis;* eyes in facial view about one-third as wide as long or slightly wider, not bulbous as in *aegis* and *grandissima,* about equal in length to facial width between inner upper angles of eyes; first flagellar segment generally slightly longer than wide on ventral surfaces, never broader than long. Punctation on mesoscutum and scutellum coarse and dense, punctures rarely separated by as much as half a puncture width, ground shagreened, moderately shiny; dorsal face of propodeum reticulorugose, declivous face densely punctate, dorsal impunctate area of declivous face small and oval. Anterior punctate area of tergum 1 equal to about half of length of tergum medially; terga 2-4 in areas basad of pale pubescent bands or fasciae and beneath these pubescent areas (interband zone of tergum 2) with distinct deep punctures separated by less than one puncture width; apical areas of terga 1-3 with minute shallow punctures obscured by shagreening, moderately shiny.

Hair: Long, mostly erect on dorsum of thorax; color much as in *aegis,* but with the following differences: no dark brown hairs on vertex of head; oblique lateral fasciae on terga 2 and 3 well separated medially; dark median patch of brown pubescence on tergum 4 equals about one fourth of width of tergum, rarely more; hairs of sterna usually brown; hairs of inner surfaces of hind basitarsi reddish-orange to yellow.

Male. Measurements and ratios: N, 11; length, 16-19 mm.;

width, 5-7 mm.; wing length, $M = 6.00 \pm 0.458$ mm.; hooks in hamulus, $M = 18.64 \pm 0.388$; flagellar segment 1/segment 2, $M = 2.27 \pm 0.018$.

Structure and color: Color as in female except clypeus and bases of mandibles yellow and labrum whitish; flagellum mostly reddish-orange except reddish-brown first segment and reddish-brown dorsal stripe on remaining segments. Punctation as in female, but clypeus appears less punctate; eyes bulbous, less than 3 times as long as broad; minimum length of first flagellar segment equals half or more of maximum length of second segment, occasionally less, but never as short as one third of second segment (ratio in allotype male equals about 9.0:21.5).

Genitalia and hidden sterna similar to those of *machaerantherae*. Gonostyli strongly S-shaped, thinnest about one third of distance from base, thickest at base; spatha gently and broadly emarginate, bidentate on lower angle of piceous lateral process. Sternum 7 as in *machaerantherae* but hairs on medial plates fewer and finer. Sternum 8 as in *machaerantherae* but lateral apodemes directed less anteriorly, without thick median apical hairs and apical lateral hairs longer, fewer and thinner.

Hair: Much as in *aegis*, but with the following differences: hairs generally longer and weaker; mesonotal patch of brown hairs often reduced to a few hairs; metasoma darker, pale pubescent fasciae thin, usually forming complete bands, without pale hairs at extreme sides of tergum 3 and usually not on tergum 2, tergum 5 usually without pale pubescence, sternal hairs dark brown, inner surfaces of hind basitarsi with orange to yellow hairs.

Remarks. The closest relative of *comanche* is *machaerantherae*, as shown by the generally longer hairs and by the similarity of the male genitalia and hidden sterna. The two forms, as far as is known at present, are sympatric over a large area of New Mexico, if specimens of *comanche* from New Mexico and Colorado were correctly identified by Cresson (1875). Even if proved to be completely allopatric, the difference in punctation of clypeus and metasoma are such that I would not hesitate in regarding them as distinct species.

Type material. Lectotype female, lectoallotype male and four female paratypes from Texas are in the Academy of Natural Sciences of Philadelphia.

Distribution. Eastern Texas and, perhaps, west to New Mexico and Colorado (Fig. 4). This species has been taken from July 19 to Nov. 2. In addition to the type material, 13 females and 12 males were examined from localities listed below (this list includes published records).

TEXAS: Austin; Bexar Co.; Dallas; Terrell; Victoria; Waco. NEW MEXICO and COLORADO: two females not examined by the author but reported by Cresson (1875) as collected in these states by Dr. H. C. Yarrow.

Flower records. Males have been collected on flowers of *Ximenesia encelioides.* No flower records exist for the females.

Melissodes (Epimelissodes) machaerantherae Cockerell.

Melissodes machaerantherae Cockerell, 1904, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 21; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 90; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310.

M. machaerantherae is similar to *helianthelli* in color, being perhaps slightly paler, but can be separated easily from the latter by its longer hair and pubescence and by the punctation of the clypeus and supraclypeal area, as described below. Furthermore, the males of these two species can be easily separated by the longer first flagellar segment in *machaerantherae.* The closest relative of this species is *M. comanche,* from which it is distinguished by its less punctate metasomal terga and by its paler coloration.

Female. Measurements and ratios: N, 20; length, 15-17 mm.; width, 6-7 mm.; wing length, $M = 6.13 \pm 0.397$ mm.; hooks in hamulus, $M = 19.65 \pm 0.372$; flagellar segment 1/segment 2, $M = 2.38 \pm 0.098$.

Structure and color: Integument generally black; tarsi, occasionally tibiae and rarely femora rufescent; sterna and occasionally apical areas of terga rufescent; apical half or more of mandibles with elongate golden maculae; eyes usually pale greenish to yellowish-brown; antennae wholly black, flagella occasionally somewhat reddened beneath; wing membranes yellowish, scarcely infumate, veins dark red to reddish-brown; tegulae testaceous. Clypeus densely punctate as in *comanche,* but median third of posterior half with punctures larger and shallower than in *comanche,* often confluent, ground and bottoms of punctures dulled by coarse tessellation; supraclypeal area with large round deep punctures as in *comanche,* ground shagreened, moderately shiny; first flagellar segment about as long as broad ventrally; maxillary palpal segments in ratio of about 3:3:3:1, third segment sometimes longer. Mesoscutal and scutellar punctures coarse, about equal in size, separated mostly by half or less of one puncture width, ground on mesoscutum dulled by tessellation, on scutellum lightly shagreened but scarsely dulled; lateral faces of mesepisterna with sculpturing as on mesoscutum; dorsal face of propodeum reticulorugose at extreme base, with distinct punctures over apical two thirds, coarsely tessellate, impunctate dorsomedial area of declivous face small, oval. First tergum with basal half densely punctate, punctures small shallow and extending nearly to margin of tergum laterally, entire surface dulled by fine shagreening; tergum 2 with only a few scattered punctures in interband zone laterally, these punctures large and separated by variable length but mostly by two puncture widths or more, entire tergum dulled by dense shagreening which is reticular in basal area; terga 3 and 4 similar to tergum 2.

Hair: Generally paler than in *comanche* and similar to *helianthelli*; hairs and pubescence generally long and weak, prone to be rubbed off or matted; head and thorax generally with pale ochraceous hairs tending to be paler on head, episterna and propodeum, and rufescent on anterior half of mesoscutum; scutellum with distinct patch of brown hairs; mesoscutum with at most several brown hairs in posteromedian area and usually none. Long hairs in basal area of tergum 1 pale ochraceous; terga 2, 3 and 4 usually with complete pale ochraceous bands, rarely extremely narrowly interrupted on tergum 2, pale ochraceous, but tending to be white especially on tergum 4; hairs composing pale pubescent fasciae long and weak, those on tergum 2 confluent with basal pale band of spatuloplumose hairs, the latter not sharply delimited posteriorly as in other species of this group; terga 5 and 6 with long appressed pale ochraceous hairs laterally, tending to be rufescent and occasionally pale brown medially; apical areas of terga 1-3 with short appressed hairs usually dark brown; sternal hairs orange to ochraceous, becoming pale ochraceous to white laterally. Legs with pale ochraceous hairs except reddish-brown on fore tarsi and orange to yellow on inner surfaces of middle and hind basitarsi; scopal hairs pale ochraceous to white.

Male. Measurements and ratios: N, 20; length, 11-16 mm.; width, 4.0-6.5 mm.; wing length, $M = 5.59 \pm 1.014$ mm.; hooks in hamulus, $M = 17.05 \pm 0.373$; flagellar segment 2/segment 1, $M = 2.37 \pm 0.097$.

Structure and color: Integumental color as in female except clypeus, bases of mandibles and labrum cream-colored; eyes yellowish-brown to slightly greenish; antennae usually wholly black, flagella occasionally dark reddish-brown beneath; wing membranes faintly infumate apically, yellowish, veins red to reddish-brown. Sculpturing as in female, but usually more than half of tergum 1 with dense punctation; minimum length of first flagellar segment equal to half of maximum length of second segment and usually slightly more, occasionally slightly shorter, but never as short as one third of second segment; maxillary palpi as in female, but occasionally a minute fifth segment present.

Genitalia and hidden sterna similar to those of *M. comanche.* Gonostyli thinnest about one third of distance from base, distinctly S-shaped, thickest at base; spatha bidentate on lower angle of lateral process, not emarginate apically. Sternum 7 with lateral apodemes slightly longer than median length of sternum; hairs of median plates thick and simple. Sternum 8 with lateral apodemes directed anteriorly; apical emargination with 1-3 median hairs slightly barbed near tips and much thicker than lateral apical hairs which are relatively thin and almost all simple (Figs. 51-54).

Hair: Much as in female, but with the following differences: head usually with almost wholly white hairs; scutellum with only a few brown hairs; mesoscutum without brown hairs; tergum 3 with pale pubescent band as wide as or wider than apical area medially, unless rubbed off; last two metasomal terga with pale ochraceous hairs only; sternal hairs mostly pale ochraceous, somewhat rufescent medially and apically; legs with pale ochraceous hairs, except for orange to yellow hairs on inner surfaces of tarsi and hind tibiae. In what seemed to be newly emerged specimens all hairs and pubescence may be somewhat rufescent.

Type material. Holotype male from White Sands, New Mexico, September 30, T. D. A. Cockerell, property of the California Academy of Sciences, temporarily deposited in the collections of the Citrus Experiment Station, Riverside, California.

Distribution. Arizona eastward to extreme southwestern Texas and south through Sonora, Chihuahua and western Coahuila to southern Durango in Mexico (Fig. 4). These bees have been collected from July 10 to November 1, but mostly in the latter part of August and September. In addition to the holotype, 41 females and 59 males have been examined from the localities listed below (this list includes localities referred to in the literature).

ARIZONA: Baboquivari Mts.; Bisbee (12 and 18 miles W.); Buckeye, Mariposa Co.; Carr Canyon (Huachuca Mts.); Chiricahua Mts., Cochise Co.; Douglas; Huachuca Mts.; Kirkland, Yavapai Co.; Lee Siding (Pedregosa Mts.), Cochise Co.; Phoenix;

Pima Co.; Ramsey Canyon (Huachuca Mts.); Sacaton; San Bernardino Ranch, Cochise Co.; Sonoita (10 miles E.); Tucson; Turner; Willcox. NEW MEXICO: Alma, Catron Co.; Albuquerque; Carlsbad (5 miles W.); Deming; Mule Creek, Grant Co.; Rodeo, Hidalgo Co.; Shiprock; White Sands. TEXAS: El Paso. CHIHUAHUA: Jiménez (10 miles W.). COAHUILA: Paila. DURANGO: Canutillo (8 miles S.); La Loma; Nombre de Dios; Pedriceña; Yerbanís, Cuencamé District. SONORA: Naco; Aqua Prieta.

Flower records. The holotype male and one male paratype were collected on *Machaeranthera* (= *Aster*) and one male paratype on *Cucurbita palmata.* Additional males have been taken on *Asclepias* sp., *Helianthus* sp., *H. annuus, Verbesina* sp., and *V. encelioides.* Females have been collected on *Helianthus* sp. and on *Wislizenia refracta.*

Melissodes (Epimelissodes) helianthelli Cockerell.

Melissodes helianthelli Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 15, pp. 525-526; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 89; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310.

Melissodes comanche, Stroud, 1947, Amer. Mid. Nat., vol. 44, p. 673 (misidentification).

M. helianthelli superficially resembles *machaerantherae* closely, but it can be easily separated from the latter on the basis of the male genitalia, relative lengths of the first two flagellar segments of the male, sculpturing of the supraclypeal area in both sexes and sculpturing of the clypeus in the female. These differences are described below and summarized in the key. The closest relative of *helianthelli* is *grandissima.* These two species are distinguished chiefly on the basis of color, *helianthelli* being paler than *grandissima.* The male of *helianthelli* can be easily confused with the male of *M. obliqua expurgata,* but the male of *helianthelli* has a pad of closely appressed hairs on the lower half of the anterior face of each mesepisternum which is absent in *obliqua.*

Female. Measurements and ratios: N, 11; length, 16-18 mm.; width, 6-7 mm.; wing length, $M = 6.31 \pm 0.319$ mm.; hooks in hamulus, $M = 20.09 \pm 0.436$; flagellar segment 1/segment 2, $M = 2.10 \pm 0.021$.

Structure and color: Legs and apical areas of metasomal terga 1 to 3 often rufescent; scape, margin of clypeus and bases of mandibles often rufescent or yellowish; flagella usually dark brown to black, only slightly paler beneath; wing membranes scarcely infumate, veins reddish-brown to red. In structure and punctation identical with *M. grandissima.*

Hair: Color generally as in *grandissima,* but much paler; hairs on tegulae pale; mesoscutal patch of dark brown hairs usually absent, or very small; axillae without brown hairs. Metasomal tergum 2 with pale oblique fasciae meeting medially, or almost so, short hairs in area anterior to pale fasciae and posterior to basal band of spatuloplumose hairs pale ochraceous to pale brown; tergum 3 with broad pale pubescent band, as wide as or wider than apical area medially; tergum 4 with pale band never interrupted medially by dark brown pubescence; terga 5 and 6 with tufts of ochraceous hairs laterally; terga 3 and 4 with dense basal tomentum (usually partially or wholly hidden under apices of preceding terga) usually dark brown, occasionally that on tergum 3 pale rufescent as in the holotype; hairs of sterna pale brown to ochraceous, usually orange-red. Hairs of legs ochraceous except on inner surfaces of basitarsi red to orange, on outer surfaces of fore and occasionally middle basitarsi brown and on basitibial plates and distitarsi rufescent; scopal hairs entirely pale and highly plumose.

Male. Measurements and ratios: N, 15; length, 14-18 mm.; width, 5-6 mm.; wing length, $M = 5.74 \pm 0.445$ mm.; hooks in hamulus, $M = 17.40 \pm 0.966$; flagellar segment 2/segment 1, $M = 2.04 \pm 0.367$.

Structure and color: Color of integument as in *grandissima,* but flagella usually entirely dark, black above and black or dark reddish-brown beneath. Structure and punctation as in *grandissima;* minimum length of first flagellar segment usually longer than one third and always less than one half of maximum length of second segment.

Genitalia and hidden sterna much as in *grandissima.* Sternum 7 as in *obliqua,* with few short hairs on ventral surface below inner margin of emargination, without, or with only one or two, long hairs on dorsal surface mesad of lower half of dark, piceous lateral plates.

Hair: Generally as in *grandissima,* but much paler; mesocutum without dark brown hair patch, but a few dark hairs may be present; scutellar patch of dark hairs small or absent; axillae without brown hairs. Terga 2-5 with pale bands complete, broad, that on tergum 3 wider than apical area medially, that on tergum 2 with pale hairs between it and the basal spatuloplumose band; sternal hairs usually brown medially and pale laterally. Legs with pale ochraceous hairs except those on inner surfaces of tarsi bright red to yellow, but often brown on hind basitarsi; distitarsi usually with rufescent hairs.

Type material. Holotype female from Mesilla, New Mexico, June 26, T. D. A. Cockerell, property of the California Academy of Sciences, temporarily deposited in the collections of the Citrus Experiment Station, Riverside, California.

Distribution. Extreme western Texas north to southwestern Kansas, west across New Mexico and Arizona to extreme southern California and northern Baja California (Fig. 4). This species has been collected from June 26 to September 21, the majority in July and August. Including the holotype, 2 females and 16 males have been examined from the following localities.

ARIZONA: Phoenix; Tempe. BAJA CALIFORNIA: Mexicali (35 miles W.); one female labeled "Districto Federal, Baja California." CALIFORNIA: Calexico, Imperial Co. (8 miles N.); Westmoreland. KANSAS: Dodge City. NEW MEXICO: Acme; Mesilla; Mesilla Park; Mesquite; Portales; Roswell; Shiprock; White Sands National Monument. TEXAS: Clarendon; El Paso; Metz.

Flower records. Both sexes have been taken on *Helianthus* sp. and on *Helianthus ciliarus.*

Melissodes (Epimelissodes) nitida, sp. nov.

This species, known only from Mexico, is closely related to *M. obliqua.* The males of *nitida* can be distinguished from the latter by the dark posterior margin of the otherwise lemon-yellow clypeus, by the markedly oblique fasciae which are interrupted medially on terga 2-5, by the smaller size and by the pale red to yellow hairs on the inner surfaces of the hind basitarsi. The males can be easily distinguished from most of the remaining species of the *obliqua* group by the lack of a dense pad of appressed hairs on the anterior face of each mesepisternum. The females differ from those of *obliqua* by having only pale hairs on the sides of the thorax and by having a more densely punctate clypeus and/or by the color combination as described below and summarized in the key.

Female. Measurements and ratios: N, 2; length, 14 mm.; width, 5 mm.; wing length, 4.63 mm.; hooks in hamulus, 15-16; flagellar segment 2/segment 1, 1.22.

Structure and color: Integument black; distitarsi and under surfaces of flagella rufescent; mandibles with large median golden maculae in apical halves or thirds; eyes grayish-brown; wing membranes slightly infumate, brownish, veins dark brown to black. Sculpturing as in *obliqua* with the following differences: clypeus with regular small crowded punctures separated by less than one puncture width and mostly by about half of one puncture width posteromedially; supraclypeal area with small round deep punctures separated by less than one puncture width. Punctation of thorax coarse and crowded, ground surfaces shiny, unshagreened or only slightly so, except metanotum which is dulled by dense tessellation; propodeum densely punctate, ground opaque, dulled by dense tessellation. Tergum 2 with interband zone with small shallow punctures separated by one puncture width or slightly less laterally and becoming shallower, less distinct and sparser medially.

Hair: Pattern and color very much as in *texana,* but with the following differences: vertex with long hairs ferruginous, with abundant short dark brown hairs between apices of compound eyes and a few long brown hairs posterior to these. Mesoscutum with pale hairs ferruginous, with dark brown posteromedian hair patch small, oval, within the parapsidal lines anterolaterally and not extending forward to a transverse line at anterior margins of tegulae medially; scutellum with abundant dark brown hairs, fringed with ochraceous hairs; propodeum and sides of thorax with hairs pale ochraceous to ochraceous. Mesosoma with vestiture essentially as in *M. texana texana,* but apical areas of terga 2 and 3 with minute, dark brown, closely appressed, simple hairs much more abundant and tergum 3 with apical area broader, as broad medially as apical pale band of tergum 4 or broader; tergum 4 without brown hairs medially near apex, or with only a few. Legs with ochraceous hairs except as follows: inner surfaces of tarsi and hind tibiae yellow to orange; scopal hairs yellowish-white.

Male. Measurements and ratios: N, 6; length, 11-13 mm.; width, 4-5 mm.; wing length, $M = 4.09 \pm 0.211$ mm.; hooks in hamulus, $M = 14.00 \pm 0.516$; flagellar segment 2/segment 1, $M = 2.57 \pm 0.515$.

Structure and color: Integument generally black; distitarsi and apices of basitarsi rufescent; labrum white; mandibles with large lemon-yellow basal triangles and with elongate golden maculae over apical halves or slightly less; clypeus lemon-yellow except for black notches at anterior tentorial pits and narrow, black, irregular area at posterior margin between anterior tentorial pits; eyes yellowish-brown; antennae black except for dark reddish-brown ventral surfaces of flagella. Clypeus coarsely punctate and tessellate with larger punctures than in *obliqua,* but this obscured by color; supraclypeal area with large deep abundant punctures, ground dulled by tessellation; minimum length of first flagellar segment equals one third or slightly more of maximum length of second segment; maxillary palpal segments in ratio of about 3:3:3:1, fourth segment being quite variable; eyes bulbous, but not so much as in *aegis*, somewhat less than 3 times as long as wide. Mesoscutum coarsely punctate with large deep round punctures separated mostly by less than one puncture width, ground shiny, very slightly shagreened; scutellum similar, punctures about same size as on mesoscutum; lateral faces of mesepisterna similar, punctures larger and more crowded than on mesoscutum; basal face of propodeum with large punctures, becoming crowded at extreme base so as to appear reticulorugose, ground with extremely coarse tessellation. Basal half to three fifths of first tergum coarsely punctate, punctures extending almost to margin laterally, ground dulled by dense shagreening; terga 2-3 with punctures separated mostly by one puncture width in small interband zone laterally, with minute, very shallow, inconspicuous punctures in apical areas, ground dulled by dense shagreening.

Gonostyli somewhat more slender, with rather sparse hairs which are much shorter than in *obliqua;* spatha distinctly emarginate apically. Sternum 7 shaped as in *obliqua,* but with only a few hairs on median plates and no short hairs on ventral surfaces below median emargination. Sternum 8 as in *obliqua*, but median apical emargination sharper and with only 5 or 6 stout hairs on either side and several smaller hairs laterad to these; with no or only one small apical hair arising just above median emargination; lateral apodemes directed somewhat anteriorly (Figs. 45-47).

Hair: Head and thorax with rather long, weak hairs; head with pale ochraceous to almost white hairs, becoming rufescent on vertex and with short brown or reddish-brown hairs between lateral ocelli and eyes. Thorax with bright rufescent or orange hairs above, except patch of dark brown hairs on scutellum and occasionally a few dark hairs near posterior margin of mesoscutum; sides of thorax and propodeum with pale ochraceous hairs, becoming paler below. Basal area of tergum 1, spatuloplumose band of tergum 2 and extreme sides of terga 2 and 3 with pale ochraceous hairs; terga 2 to 5 with oblique lateral fasciae of pale ochraceous to white pubescence; tergum 6 with a few pale hairs at extreme sides, otherwise with long dark brown hairs as in tergum 7; apical areas of terga 2 to 4 with closely appressed, dark brown hairs, considerably longer than comparable hairs in any other species of the *obliqua* group, but not so long or abundant as to hide surfaces; sterna with brown hairs medially, especially on apical sterna, and pale hairs laterally. Legs with pale ochraceous to white hairs except bright orange to yellow hairs on inner surfaces of basitarsi.

Type material. Holotype male from 4 miles east of Tapanatepec, Oaxaca, Mexico, 700 feet altitude, July 9, 1953 (Univ. of Kansas Mexican Expedition). Allotype and one paratype female from Puente Grande, Jalisco, Mexico, 5000 feet altitude, August 20, 1954 (Univ. of Kansas Mexican Expedition). One male paratype from 7 miles northeast of Tapanatepec, Oaxaca, Mexico, 1300 feet altitude, July 9, 1953 (Univ. of Kansas Mexican Expedition); three male paratypes from Villa Guadalupe, Jalisco, Mexico, July 26, 1951, on *Asclepias* (P. D. Hurd); one male paratype from San Juan de los Lagos, Jalisco, Mexico, July 27, 1951, on *Eysenhardtia polystachya* (H. E. Evans). The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collection at the University of California, Berkeley, California, in the Snow Entomological Museum and in the author's collection.

Melissodes (Epimelissodes) obliqua (Say).

This species is highly variable in color; nonetheless, females are easily separated from all other species of this group by having black or dark brown hairs on at least the lower third of the lateral surface of each mesepisternum. The males are recognized through the lack of a dense pad of closely appressed hairs on the anterior surfaces of each mesepisternum and by having dark brown to black hairs on the hind basitarsi. Other characters of punctation, structure and color are useful in recognizing *obliqua* and these are summarized in the key and described below.

Female. Measurements and ratios: N, 20; length, 13-19 mm.; width, 5.5-7.5 mm.; wing length, $M = 5.57 \pm 0.398$ mm.; hooks in hamulus, $M = 18.25 \pm 0.298$; flagellar segment 1/segment 2, $M = 2.15 \pm 0.025$.

Structure and color: Integument generally black; distitarsi usually rufescent; margin of clypeus and bases of mandibles occasionally rufescent; mandibles with large golden maculae over distal halves; antennal scapes usually black, occasionally red, first two flagellar segments and dorsal surfaces of remaining segments dark brown to black, ventral surfaces of segments 3-12 paler, orange to dark red; eyes greenish-gray to purplish-black; wing membranes infumate, clear brown to dark brown with metallic reflections, veins dark brown to black. Second flagellar segment usually slightly but distinctly shorter than broad ventrally, rarely as long as broad; clypeus with small round punctures usually separated in median third of posterior half by half of one puncture width, ground dulled by dense tessellation; supraclypeal area with abundant small round punctures about the diameter of those on clypeus or smaller, ground dulled by dense tessellation; eyes more than one third as wide as long in facial view; maxillary palpal segments in ratio of about 3:3:3:1, second segment often longer. Mesoscutum with coarse punctures separated mostly by half of one puncture width or less, ground shiny, slightly shagreened; scutellum with distinctly smaller, more crowded punctures than those in middle of mesoscutal dark hair patch, ground shiny; lateral faces of mesepisterna coarsely punctate, punctures larger and shallower than those on mesoscutum, often confluent, ground shiny, rarely shagreened, but bottoms of punctures usually somewhat dulled; dorsal face of propodeum reticulopunctate to punctate with very coarse punctures, declivous face usually with large impunctate median triangle, ground coarsely tessellate. Basal half or less of tergum 1 with coarse punctures which extend almost to apical margin of tergum laterally; tergum 2 with small shallow punctures obscured by dense shagreening in lateral raised areas of interband zone (or in comparable position when distal pale band or fasciae are lacking); apical areas of terga 1-3 with extremely minute punctures obscured by dense shagreening, these punctures scarcely visible except under high magnification.

Hair: Color extremely variable; mesepisterna always with considerable black or dark brown hair on at least posteroventral third of lateral surfaces and ventrally; anterior faces of mesepisterna with dark hairs and pubescence, which scarcely or not at all hides the surface; apical areas of terga 1-3 with extremely short, closely appressed, dark brown to black, simple hairs, but some pale hairs often present at sides; scopal hairs pale ochraceous to yellow, occasionally brown on lower halves of basitarsi; inner surfaces of hind basitarsi with dark brown to bright ferruginous hairs; basitibial plates with brown hairs. Additional color characters are described below under each subspecies.

Male. Measurements and ratios: N, 20; length, 12-18 mm.; width, 4.5-6.5 mm.; wing length, $M = 5.22 \pm 0.468$ mm.; hooks in hamulus, $M = 15.75 \pm 0.025$; flagellar segment 2/segment 1, $M = 2.63 \pm 0.046$.

Structure and color: Integument generally black; bases of mandibles, labrum and clypeus pale yellow to cream-colored; distitarsi, occasionally basitarsi and often apical areas of terga rufescent; antennal scapes dark brown to red; ventral surfaces of flagella bright red to yellow, dorsally dark brown to black; tegulae dark brown to translucent red; wings infumate, veins red to black; eyes as in female, usually yellowish-green or grayish-green. Punctation as in female; minimum length of first flagellar segment as long as one third of maximum length of second segment or longer, but never as long as half of second segment.

Genitalia and hidden sterna with characters of the subgenus (Figs. 24-27). Gonostyli narrowest at about half of distance from base, widest at base, with abundant long plumose hairs on lower half or more, especially on dorsolateral surfaces, only slightly bent, scarcely S-shaped; spatha 3 times as broad as long or slightly broader, usually slightly emarginate medially at apex, with blunt, simple lateral processes. Sternum 7 with abundant plumose hairs on median plates, with short hairs on ventral surface below median emargination; lateral apodemes about equal to median length of sternum. Sternum 8 with lateral apodemes directed laterally; apical transverse carina distinct, bilobed, well separated from apex; abundant apical plumose hairs laterally, usually with one or more strong barbed hairs medially as well.

Hair: Anterior faces of mesepisterna with long pale hairs and sparse, closely appressed pubescence which scarcely obscures the surfaces, without pad of dense appressed pubescence; hairs of hind basitarsi usually dark brown to black; hairs of metasomal sterna red to dark brown, usually dark.

Bionomics. An account of the nesting habits of this species in Colorado has been given by Custer (1928). He found eight entrances in an area of four square meters of earth which was devoid of vegetation and packed by automobiles. Four of the entrances were being used by one female each, two by two females each, one by three females and the last by eight females. Those nests occupied by more than one female were very complicated at the level at which cells were being constructed. Where single females were using individual entrances about 15 cells were present per nest.

The entrance gallery consisted of a short vertical burrow about one to three centimeters deep, a sharp angle in which an antechamber was located and a long gallery slanting down and branching into other burrows leading to the cells. The cells were placed with their long axes vertical and consisted of a shell of dried mud, a semitransparent membranous lining and a top of unpolished clay arranged in concentric rings.

The parasites observed by Custer were several species of *Triepeolus*, among which the large *T. concavus* was considered by him to be the logical parasite of *obliqua*. An interesting observation made by Custer was that, in addition to more than one female of *obliqua* using the same nest entrance, another species of the same genus (perhaps *M. agilis* Cresson) was also making use of one of these entrances (the one being used by eight *obliqua* females). Custer also observed that there was no animosity displayed towards the *Triepeoli*, these parasites occupying the nests at the same time as the *obliqua* females.

On August 28, 1953, one mile west of Lawrence, Kansas, while studying some halictine bees, Dr. C. D. Michener, Alvaro Wille and Howell V. Daly found a single nest of *M. obliqua*. The entrance to this nest was situated beside a large rock in dry, clayey and rather rocky soil. The nest could not be excavated without disturbing nests of *Augochlorella* and *Halictus* which were being studied and so nothing was learned concerning its architecture. This female, when leaving the nest to forage, left quickly without any apparent orientation flight, flew south over the rock and left the vicinity of the rock in a southeasterly direction. From fourteen to twenty two minutes were spent in the field after which the female consistently returned to the nest from due east, circling during the last eighteen to twenty four inches of flight to enter the nest from the northwest. This pattern was probably produced by the wind which was from the southeast at the time. The bee was obviously foraging in a dense stand of *Helianthus annuus* situated a few hundred yards to the southeast of the nest locality.

Out of over 4,000 specimens available for study, 1,128 have flower labels attached. This allows one to study the flower preferences of this species with some confidence. In Table III are tabulated some of the significant facts concerning these flower records. It is obvious from this tabulation that this species has a decided preference for composites. Of importance is the fact that the proportion of males to females taken is much larger on the non-Compositae than on the Compositae. This indicates that the non-Compositae are of greater importance as sources of nectar than as sources of pollen, an indication that can be readily verified in the field and has been by Charles Robertson (1928) and others. The Leguminosae are visited by *obliqua* more often than any other family of non-Compositae, but the proportion of males to females is even larger than in the latter. One cannot conclude from this data, however, that *obliqua* uses only composites as pollen sources. Linsley (1946, p. 25) in connection with pollination of alfalfa by this bee states, "It works very fast, is an effective pollinator, but presumably only turns to alfalfa as a pollen source when suitable Compositae are unavailable." The data also show that, among the many plants visited, *M. obliqua* prefers composites of the tribes Heliantheae, Vernonicae, Astereae and Helenieae in that order.

TABLE III.—Summary of floral records for *Melissodes obliqua*.

Family	Number of Families	Number of Genera	Approximate Number of Species	Number of Collections	Number of Females	Number of Males	Total Number of Bees
Compositae	1	26	54	296	682	340	1,022
Leguminosae	1	7	9	22	15	26	41
Others	13	14	15	27	33	32	65
Totals	15	47	78	345	730	398	1,128

Geographical variation. *M. obliqua* is one of the most abundant species of the genus in the United States. Its range as now known covers virtually the whole of the United States, parts of southern Canada and a large part of northcentral Mexico. Over this area *obliqua* is divisible into three subspecies, *expurgata, obliqua* and *caliginosa,* on the basis of hair color (Fig. 7). The palest of these (*expurgata*) occupies the western part of the range from Washington to Baja California and east through Idaho in the north and through Arizona in the south. Across New Mexico there is a rather even cline grading into the darker subspecies (*obliqua*) of the central states. This cline contracts into a narrow zone of intergradation in the high mountains of Colorado. Specimens from northeastern New Mexico and eastern Colorado are typically *obliqua* and those from western Colorado and most of the remaining area of New Mexico are *expurgata* or intergrades between these subspecies. There are, unfortunately, not enough specimens available from Wyoming or Montana to describe the zone of intergradation which must occur in those areas. Perhaps the intergrading area widens out again on the high plains of Wyoming. It is quite certain, however, that this species is quite rare in this area, probably because the climate more nearly approaches the limits of tolerance of the species due to the combination of latitude and altitude.

In the east *obliqua* grades into the darker Atlantic Coast subspecies (*caliginosa*) across the Appalachian Mountains. Two males from Tennessee (labeled "Tenn.") are indistinguishable from *caliginosa* and many specimens from extreme western North Carolina bear evidence of gene flow from the paler *obliqua* to the west. In the north *obliqua* and *caliginosa* have both been reported from New Jersey (Smith, 1910), but only one female specimen has been available from this state for study by the present author. This female is a typical specimen of *caliginosa*. A single female from Long Island, New York, is definitely *obliqua*. The intergrading zone must occur in New Jersey, but lack of specimens from that state does not permit adequate description of the zone. It should be mentioned here that this species has not been reported from the New England states and is apparently rare in New York State. In the south typical *obliqua* extends its range along the Gulf Coast to southern Florida and intergrades with *caliginosa* in southern and western Georgia.

There is a great deal of variation in color within the range of each of the subspecies, each locality being characterized by slightly different populations. This can be seen in the percentages of melanism given for various localities in the histograms of figure 6. Each subspecies is characterized by a range of color and this range overlaps that of the neighboring subspecies. Because of this overlap a small percentage of individuals of each subspecies cannot be confidently placed except by locality. The pattern of color characters, however, is quite constant for each subspecies and over the range of each about 80 to 90% of the individuals are readily distinguished from all of the individuals of the neighboring subspecies, except in the zones of intergradation.

All characters studied involved paleness, or rather melanism, and were stated as "either-or" situations, so that the change measured from locality to locality is a change in the percentage of individuals bearing each character. Stated differently for emphasis, there is no well-marked cline for any individual character because the features studied were "either-or" situations. The variation noted, therefore, is in the percent of individuals bearing the particular character, or, when all characters were combined, it is a gradient of the percent of melanism which is exhibited within the populations. The percentages were obtained by grouping more or less contiguous localities; care was taken to group specimens logically, taking into consideration topography, numbers of specimens available, etc. The groupings of localities from which specimens were studied for this analysis are shown on the map (Fig. 7). It should be emphasized that not all the individuals available from within the areas delimited on the map were used, nor were specimens from all the localities within every area used. Many of the localities plotted on the map as being in the area from which the data were taken were obtained from specimens which became available several months after the analysis was completed. The newer material would not change the histograms materially, however, especially where sufficient material was originally available. In addition, many specimens available were in too poor a condition to be used in this analysis.

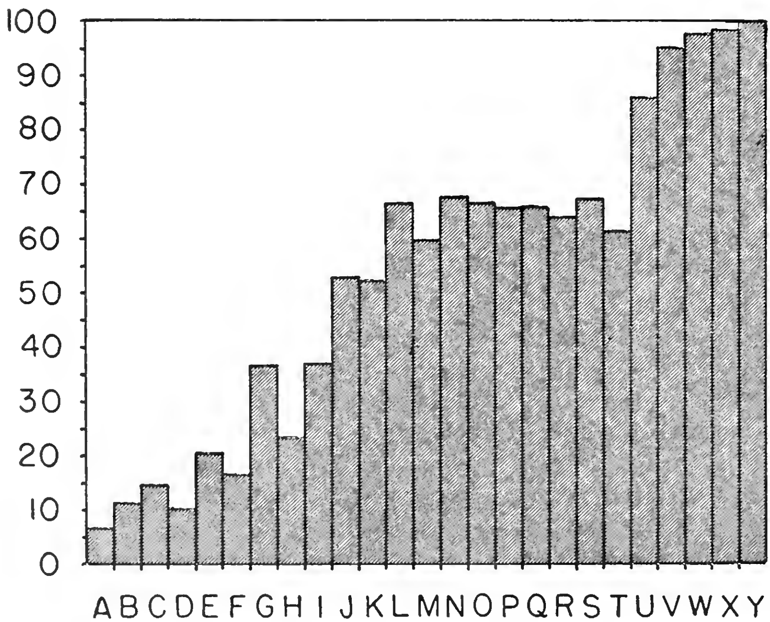

FIG. 5. Histograms for *M.* (*Epimelissodes*) *obliqua* showing the average percentage of melanism of females (ordinate) within each of several localities (abscissa). The derivation of these percentages is explained in the text. The localities are lettered in accord with the graphs in Figure 6 and the areas delimited on the maps (Figs. 7A and 7B). The numbers of specimens are listed in the explanation of Figure 7B.

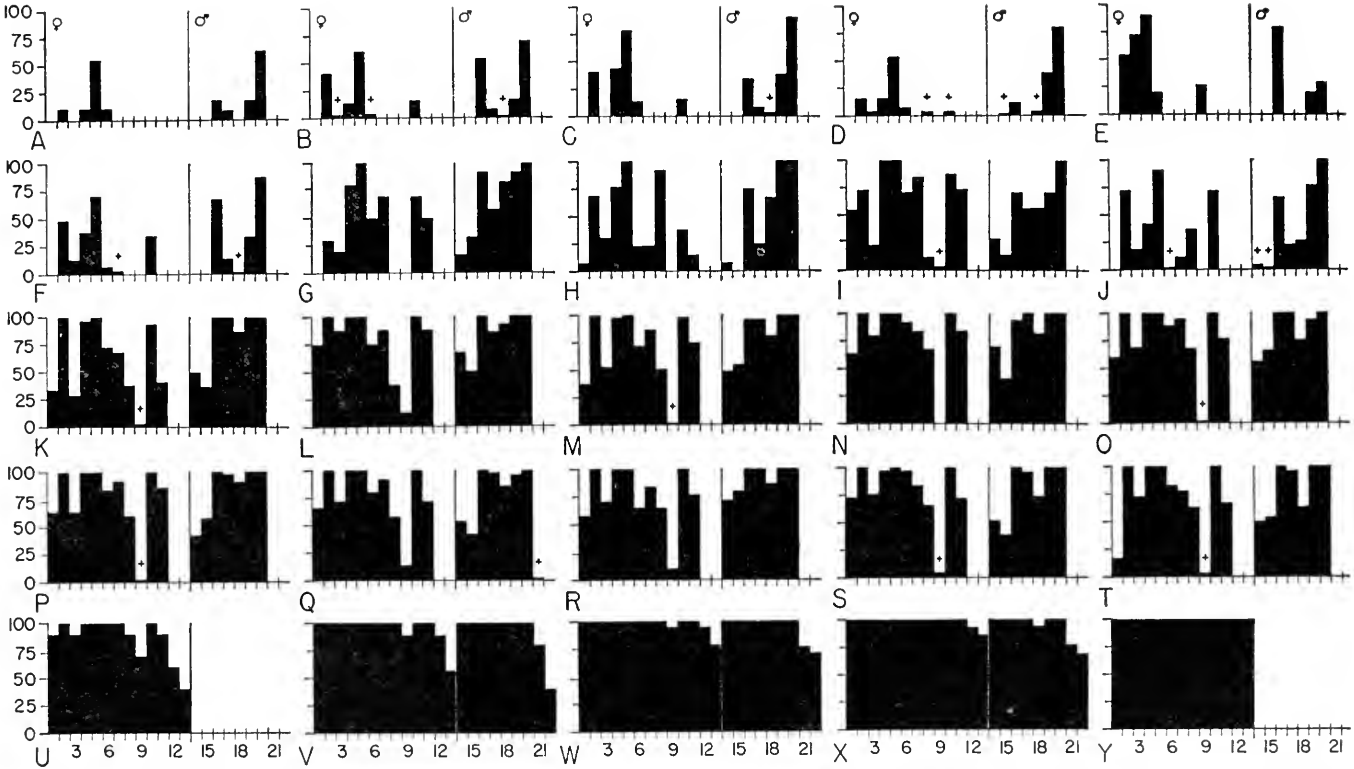

FIG. 6. Histograms showing the percentages of individuals (ordinates) of *M. (Epimelissodes) obliqua* bearing certain characters (abscissas). Characters 1 through 13 refer to females and 14 through 22 refer to males. Each graph is lettered in accord with the areas delimited on the map (Figs. 7A and 7B). The derivation of the percentages and the characters is explained in the text. A small plus mark above a bar indicates less than five percent.

The percentages of melanism for each character and each locality are represented by the bargraphs in Figure 6. General melanism factors for each area were devised from the average of all of the characters studied and are shown in Figure 5 (females only). The differences between the three subspecies can be greatly emphasized by dropping from the graphs all but the three or four characters which are described as diagnostic for each subspecies.

The characters corresponding to the numbers below each bar in the histograms (Fig. 6) are listed below. The first thirteen characters refer to the females, while the remaining nine refer to the males, although they are numbered consecutively. Only the dark alternative is listed for each character. These correspond to the black bars of the histograms.

Female:

1. Pale fasciae absent on tergum 2.
2. Pale fasciae of tergum 2 separated from pale hairs at extreme sides of tergum.
3. Pale hairs absent at extreme sides of both terga 2 and 3.
4. Axillae with more than 50 percent dark hairs.
5. Mesoscutal dark patch reaches a transverse line at middle of tegulae or beyond.
6. Mesoscutal dark patch reaches a transverse line at anterior margins of tegulae or beyond.
7. Tergum 4 with a median triangle, or at least a vertical line, of dark pubescence.
8. Posterior pronotal lobes with dark hairs.
9. Mesoscutum with dark hairs at least medially near anterior margin.
10. Pale pubescent band of tergum 3 narrower than apical area laterally.
11. Tergum 3 with pale pubescent fasciae separated medially by a distance equal to half of one fascia or more.
12. Tergum 4 without pale pubescence, or with pale pubescence reduced to lateral fasciae equal to less than one third of width of tergum.
13. Tergum 3 without lateral fasciae of pale pubescence.

Males:

14. Pale band of tergum 2 interrupted medially by brown pubescence.
15. Pale band on terga 2 and 3 separated from pale appressed hairs at extreme sides.

16. Interband zone of tergum 2 with brown hairs at least laterally.
17. Pale band of tergum 3 narrower medially than apical area.
18. Axillae with at least one or two reddish-brown hairs.
19. Mesoscutum with at least a few reddish-brown hairs posteromedially.
20. Scutellum with brown hairs medially.
21. Tegulae with brown hairs.
22. Mesepisterna with brown hairs at least above.

At least three genetically distinct characters are involved in this "general melanism." In the widening of the pubescent bands on tergum 3 of both sexes not only is color involved, but also a change in form of the hairs from the simple short dark brown hairs of the apical areas of the terga to the longer, highly plumose, white hairs of the pubescent band. Also, there seemingly is one factor operating on the thorax and another on the metasoma, since color changes within any one subspecies are not correlated to any high degree between these body regions, whereas they are highly correlated within either of the body regions. Here, then, is a case wherein at least three characters are highly concordant, although not perfectly so, across a rather long cline between two forms (subspecies *obliqua* and subspecies *expurgata*). This conclusion is considered to be valid, although the genetic picture is probably much more complicated than suggested above.

One can only guess at the reason why most of the specimens from Mexico closely resemble the intermediate forms from New Mexico and do not show a well-marked cline from east to west. Perhaps irrigation on the central plateau area (southern Chihuahua and northern Durango) has permitted the species to extend its range far to the south. Since this area is contiguous with the range of the New Mexico intermediate populations, these would populate the new area. It is more likely that a cline could be shown to exist across this area similar to that across the New Mexico-Arizona area, if more specimens were available from eastern Sonora, from certain areas of Chihuahua and from the more eastern states. A single male from Tamaulipas, two females from Puertas de la Goriona, Coahuila, and two females from Cabos, Coahuila, are the only specimens available from eastern Mexico. The male is probably a typical *obliqua* and is here considered as such, but is so badly worn as to be almost unrecognizable. Of the two females from Puertas de la Goriona, one is a typical *obliqua*, while the other could

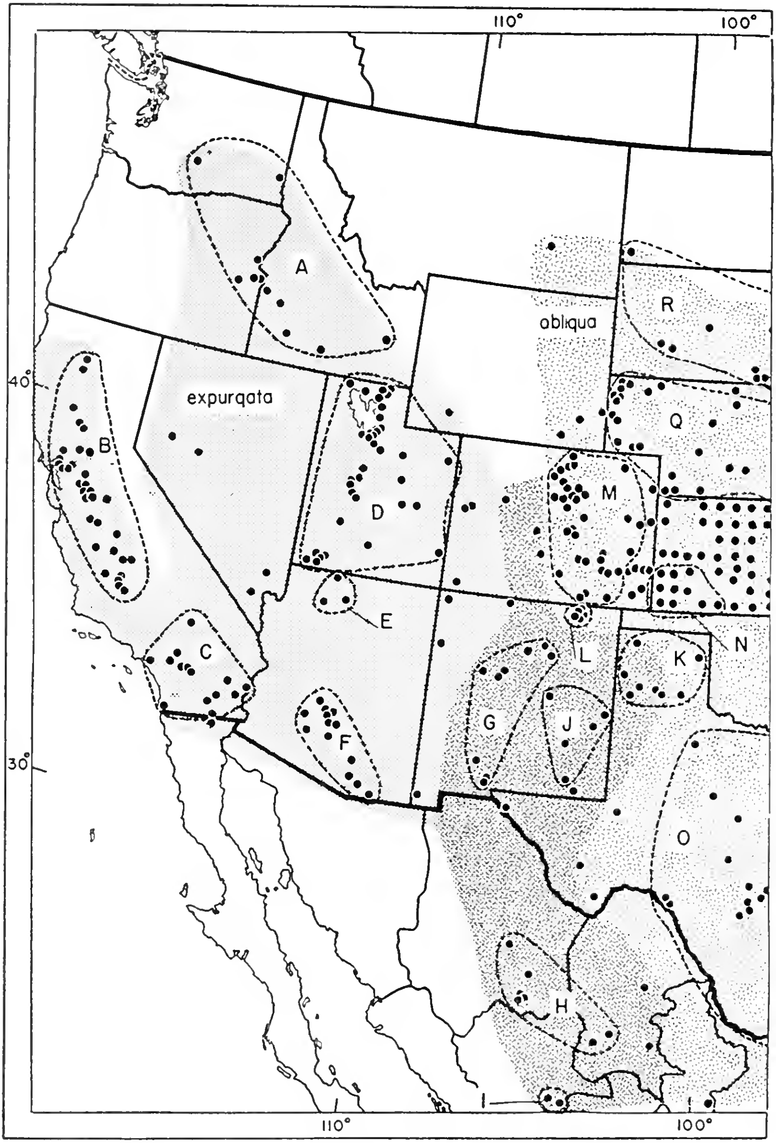

FIG. 7A. Map showing the distribution of *M. (Epimelissodes) obliqua.* Zones of intergradation between the subspecies are indicated by overlapping types of shading. Areas outlined by broken lines include localities from which specimens were taken to produce an analysis of characters. These areas are lettered in accord with the histograms of Figures 5 and 6. Facts such as the conditon of specimens and the numbers of specimens available did not

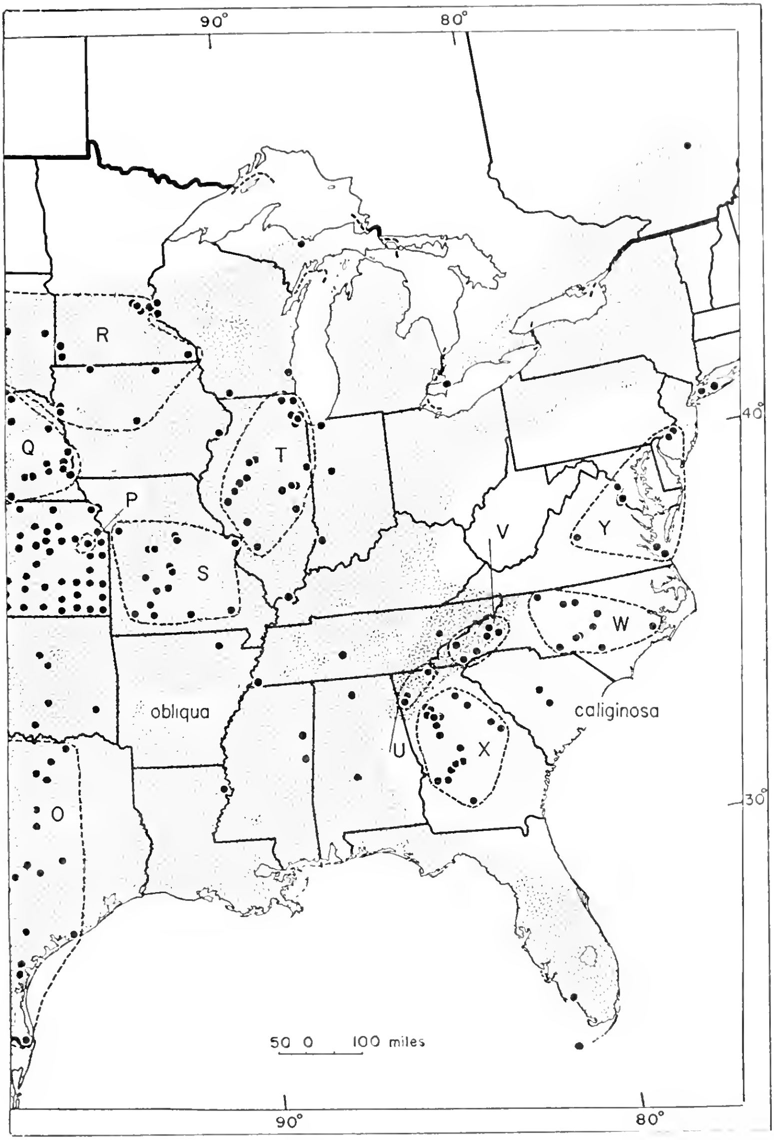

FIG. 7B. permit use of all specimens from some localities, nor all localities within some areas outlined on the map. The following is a list of numbers of specimens used to produce each graph (female precedes male in each case): A 9, 11; B 100, 100; C 29, 23; D 26, 51; E 11, 5; F 89, 56; G 10, 12; H 43, 44; I 13, 12; J 34, 7; K 34, 8; L 8, 14; M 47, 47; N 25, 17; O 65, 32; P 50, 45; Q 50, 50; R 31, 15; S 38, 23; T 30, 24; U 10, 0; V 28, 10; W 19, 17; X 14, 16; Y 9, 0.

be referred to *expurgata.* The two females from Cabos clearly represent an intermediate population. *M. obliqua obliqua* will probably be found throughout Tamaulipas and eastern Coahuila and *M. obliqua expurgata* throughout Sonora.

The descriptions of these three subspecies which follow are based entirely on hair color, since no other characters have been found separating these forms.

Melissodes (Epimelissodes) obliqua caliginosa Cresson.

Melissodes caliginosa Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 192; Smith, 1910, Ann. Rept. New Jersey State Museum, 1909, p. 693; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 114; Cockerell, 1917, Can. Ent., vol. 49, p. 212; Brimley, 1938, Insects of North Carolina, p. 462; Fattig, 1945, Emory Univ. Mus. Bull., no. 3, p. 5.

This subspecies is distinguished from *expurgata* and *obliqua* by being much darker. The females of *caliginosa* can be separated from those of *obliqua* by a combination of any three of the following four characters: median patch of dark brown pubescence on tergum 4 equals at least one third of the tergum in width and usually more; tergum 2 without oblique pale pubescent fasciae; tergum 1 with long brown hairs mixed with ochraceous in basal half of dorsal face, or all of these hairs brown; with at least a few long brown hairs near anterior margin of mesoscutum mixed with the rufescent hairs. The males can be separated from those of *obliqua* by usually having brown hairs on at least the lower parts of the lateral faces of the mesepisterna and by usually not having pale fasciae on tergum 2 and often not on terga 4 or 5.

Female. Darkest specimens entirely black except for the yellow scopal hairs of the hind tibiae and upper half of hind basitarsi and a few ochraceous hairs in the thick band of spatuloplumose hairs between mesoscutum and scutellum. Palest forms retain dark brown hairs on labrum, anterior third or more of clypeus, vertex between lateral ocelli and apices of compound eyes, and a mixture of brown and ochraceous hairs on face, genae, vertex and occiput. Two spots of ochraceous hairs appear near anterior mesoscutal margin together with a thin line of ochraceous hairs laterally on mesoscutum and ochraceous hairs dorsally on propodeum in paler specimens; these pale thoracic patches of hairs expand until thorax is colored essentially as in *obliqua*, but always with abundant dark brown hairs on posterior pronotal lobes and at least a few long brown hairs medially near anterior margin of mesoscutum; tegulae with dark brown appressed hairs; mesepisterna and lateral faces of propodeum with dark brown hairs. On metasoma pale hairs appear first in pale basal band of spatuloplumose hairs of tergum 2 and as short oblique lateral fasciae of ochraceous hairs on tergum 3; tergum 4 in next palest specimens acquires lateral maculae of ochraceous pubescence which spread inwards on still paler forms; basal half of tergum 1 in palest specimens with about 50% brown hairs mixed with ochraceous, without tufts of pale hairs at extreme sides of terga 5 and 6. Legs always with dark brown hairs except yellow scopal hairs and red to dark reddish-brown hairs on inner surfaces of hind basitarsi and tibiae.

Male. Head usually with ochraceous to white hairs except short dark brown hairs between lateral ocelli and apices of compound eyes; darkest specimens with brown hairs mixed with ochraceous on vertex, occiput, genal areas and clypeus. Mesoscutum, scutellum and tegulae always with abundant dark brown hairs; axillae with mixed ochraceous and brown hairs; pale hairs of thorax yellow to ochraceous; mesepisterna and metepisterna covered with reddish-brown hairs in darkest specimens, ochraceous hairs first appearing dorsally and extending down to cover lateral surfaces in paler specimens. In darkest individuals metasoma entirely covered with dark brown hairs except for basal hairs of tergum 1 and basal spatuloplumose hair band of tergum 2; pale lateral oblique fasciae appear first on tergum 3, 4, 5 and 2 in that order, these fasciae expanding inwards and laterally until they form complete bands on terga 2 and 3, never with appressed ochraceous hairs at extreme sides. Fore and middle distitarsi and inner surfaces of fore and middle basitarsi with rufescent hairs; inner surfaces of hind basitarsi with dark reddish-brown to black hairs; in darkest individuals fore and middle coxae with ochraceous hairs, outer surfaces of fore basitarsi, fore and middle femora and tibiae with mixed brown and pale hairs, outer surfaces of middle and hind basitarsi and hind femora and tibiae with reddish-brown to black hairs; hairs of legs become paler until hind basitarsi with brown hairs, hind tibiae with brown hairs mixed with ochraceous and ochraceous elsewhere.

Remarks. The concept here presented of *M. obliqua caliginosa* is somewhat different from that entertained up to the present. This form was described by Cresson as a distinct species from some of the darker individuals which exist throughout the range. Paler individuals, a few indistinguishable from the darker specimens of *M. obliqua obliqua,* also have been taken almost everywhere throughout the range of *caliginosa.* A good many of the paler specimens can be separated from *obliqua* on the basis of the combination of characters given above. The zone of intergradation is limited to that area within which only less than 90% of the females and less than 75% of the males can be distinguished using this combination. The difference in percentage between the sexes was considered necessary because the males of this species, as in most *Melissodes* (see *M. atripes*), are more variable in color and are generally paler than the females.

Type material. Lectotype female and lectoallotype male from Georgia are in the Academy of Natural Sciences of Philadelphia.

Distribution. Atlantic coast states from New Jersey south through Georgia (Fig. 7). This subspecies has been collected from June 17 to November 17, but mostly in July, August and September. Including intermediates * between this subspecies and *obliqua s. str.*, 82 females and 50 males were examined. The localities of these together with those reported in the literature are listed below.

GEORGIA: Americus; Athens; Atlanta; Austell; * Fannin Co.; Griffin; Jonesboro; Kennesaw Mt.; * Lavender, Floyd Co.; Macon; Marshallville; Marietta; Neal Gap; Oglethorpe; Perry; Preston; * Rome; Stone Mt.; Thomson's Mills; Tifton; Warrenton; Wrens. MARYLAND: Indianhead. NEW JERSEY: Gloucester; Westville. NORTH CAROLINA: Aberdeen; Black Mts.; Brevard; * Bryson City; Burlington; Greensboro; Harnett Co.; Highlands; Lake James; Lake View; Marion; McDowell, Yancey Co.; New Bern; Penderlea; Pilot Mount; Raleigh; Southern Pines; Tarheel; Wadesboro. SOUTH CAROLINA: Columbia; Pinnacle; St. Matthews. VIRGINIA: Camp Perry; Falls Church; Lynnhaven; Nelson Co.

Flower records. Both females and males have been taken on the following composites: *Borrichia frutescens, Helenium* sp., *H. tenuifolium, Helianthus* sp., *H. atrorubens, H. microcephalum, H. zonatus, Vernonia* sp., *V. glauca, V. noveboracensis.*

Melissodes (Epimelissodes) obliqua obliqua (Say).

Macrocera obliqua Say, 1837, Boston J. Nat. Hist., vol. 1, pp. 403-404.
Melissodes obliqua, Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 275; 1875, *in* Wheeler, Report upon geographical and geological explorations and surveys west of the one hundredth meridian, vol. 5, p. 726 (in part); Provancher, 1888, Additions et Corrections au Vol. II de la Faune entomologique du Canada traitant des Hyménoptères, vol. 2, p. 299; Robertson, 1892, Trans. Acad. Sci. St. Louis, vol. 6, pp. 451-476; Townsend, 1896, Can. Ent., vol. 28, p. 140; Cockerell, 1896, Can. Ent., vol. 28, p. 305; 1897, Bull. Agric. Exp. Stat. New Mexico Coll. Agric. and Mech. Arts,

* Localities in western Georgia and North Carolina considered as in, or on the margin of, the zone of intergradation between *caliginosa* and *obliqua*.

no. 24, pp. 20, 28; 1898, Bull. Sci. Labs. Denison Univ., vol. 11, pp. 66-67; 1898, Bull. Univ. New Mexico, vol. 1, pp. 66-67; Robertson, 1898, Botanical Gazette, vol. 25, p. 244; Cockerell, 1899, Entomologist, vol. 32, p. 157; 1899, Ent. News, vol. 10, p. 3; Birkmann, 1899, Ent. News, vol. 10, p. 245; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 211; Cockerell, 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 337; 1904, Entomologist, vol. 37, p. 8; Robertson, 1905, Trans. Amer. Ent. Soc., vol. 31, pp. 368, 370; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 78, 83; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 309; 1907, Univ. Colorado Studies, vol. 4, pp. 254, 255; Hart and Gleason, 1907, Bull. Illinois State Lab. Nat. Hist., vol. 7, p. 257; Tucker, 1909, Trans. Kansas Acad. Sci., vol. 22, p. 278; Graenicher, 1911, Bull. Publ. Mus. Milwaukee, vol. 1, p. 247; Smith, 1910, Ann. Rept. New Jersey State Mus., 1909, p. 693; Cockerell, 1911, Can. Ent., vol. 43, p. 390; Gibson, 1913, Forty-fourth Ann. Rept. Ent. Soc. Ontario, p. 20; Cockerell, 1914, Can. Ent., vol. 26, p. 411; Viereck, 1916, Connecticut Geol. Nat. Hist. Surv., Bull. 22, p. 733; Rau, 1922, Trans. Acad. Sci. St. Louis, vol. 24, p. 34; Cockerell, 1923, Ent. News, vol. 34, p. 48; 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 230; Custer, 1928, Can. Ent., vol. 60, pp. 28-31; Cockerell, 1934, Amer. Mus. Nov., no. 697, p. 10; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 304; Cockerell, 1936, Amer. Mus. Nov., no. 831, p. 5; Stevens, 1951, North Dakota Agric. Exp. Stat. Bull., no. 14, p. 30.

Epimelissodes obliqua, Robertson, 1918, Ent. News, vol. 29, p. 92; 1928, Flowers and Insects, p. 8; Pearson, 1933, Ecol. Monographs, vol. 3, p. 380.

M. obliqua obliqua can be separated from *expurgata* and *caliginosa* as described in the diagnoses of each of the latter two subspecies.

Female. Hairs of face and genal areas pale ochraceous becoming rufescent on occiput and vertex; vertex with short dark brown hairs between lateral ocelli and apices of compound eyes and usually at least a few long dark brown hairs mixed with the rufescent above ocelli; labrum with brown hairs. Mesoscutum with large dark brown hair patch extending forward at least beyond a line at middle of tegulae and usually beyond anterior margins of tegulae, hairs anterior to dark hair patch ochraceous to red, occasionally with a few long brown hairs in middle and/or at lateral angles near anterior margin; scutellum covered with dark brown to black hairs, but with pale hairs on margin; band of spatuloplumose hairs between mesoscutum and scutellum white to pale ochraceous; tegulae usually covered with short dark brown hairs; dorsum of pronotum with pale ochraceous to rufescent hairs, posterolateral lobes often with abundant dark brown hairs and usually with a few mixed with the ochraceous; mesepisterna with dark brown hairs, dorsoanterior area of lateral surfaces often with an inverted triangle of ochraceous hairs, often entire surface dark brown; metepisterna and lateral faces of propodeum usually with dark hairs. Metasoma as in species description, but pale oblique pubescent fasciae on tergum 3 usually broadly separated medially by at least half of length of one fasciae, usually distinctly narrower than apical area laterally; tergum 4 almost always with at least a narrow stripe of dark brown pubescence interrupting the broad apical pale band and often with a diamond-shaped patch of dark pubescence, but this rarely as wide as half width of tergum; tergum 5 and often tergum 6 with tufts of ochraceous hairs laterally; terga 2 and 3 with pale appressed hairs at extreme sides in about half of specimens. Hairs of legs usually all brown except hairs of inner surfaces of middle and hind tibiae red-brown to red, hairs of inner surfaces of hind basitarsi dark reddish-brown to black, occasionally ochraceous on upper part of outer surfaces of middle tibiae and mixed ochraceous and brown on femora; scopal hairs yellow to pale ochraceous, often dark brown on lower halves of basitarsi.

Male. Head usually with ochraceous to yellow hairs, paler on face and genal areas; vertex between lateral ocelli and apices of compound eyes usually with short dark brown hairs; occasionally vertex behind ocelli with a few long brown hairs. Mesoscutum usually with abundant reddish-brown hairs in posteromedian area, but this patch usually more restricted than in *caliginosa* and occasionally absent as in *expurgata;* axillae usually with at least one or two and usually several long brown hairs mixed with the pale; pale hairs of thorax pale ochraceous to yellow, occasionally somewhat rufescent dorsally, but never bright red as in female. Apical area of tergum 1 always with sparse short dark brown pubescence; tergum 2 always with lateral fasciae of pale pubescence which sometimes meet medially, but usually at least narrowly separated by brown pubescence; area basal to pale pubescent fasciae and apical to spatuloplumose band of tergum 2 with dark brown hairs at least laterally; tergum 3 usually with a complete pale band, almost always slightly but distinctly narrower than apical area medially; pale fasciae and bands of terga 2 and 3 confluent with ochraceous appressed hairs at extreme sides of terga in about half of specimens, in others either not confluent or pale hairs absent at sides of one or both terga; terga 4 and 5 with complete ochraceous bands usually well separated from apices; terga 6 and 7 with long dark brown to black hairs; sternal hairs usually all dark brown to black, occasionally pale hairs present on basal sterna and laterally on all sterna. Legs with pale ochraceous hairs except for rufescent hairs on inner surfaces of fore distitarsi and basitarsi, of middle and hind distitarsi and of hind tibiae, dark brown to black on inner surfaces of middle and hind basitarsi, on outer surfaces of hind basitarsi in a majority of specimens and on outer surfaces of hind tibiae in about half of specimens.

Type material. Male types from Indiana lost or destroyed.

Distribution. From Montana in the northwest, east to southern Ontario, south through eastern Wyoming and eastern Colorado to southern Texas and Tamaulipas, Mexico, in the west, south to New Jersey east of the Appalachians and through Pennsylvania, Tennessee and Alabama to southern Florida west of the Appalachians (Fig. 7). This subspecies has been collected from April 5 to the beginning of October. Specimens examined include 1,520 females and 880 males. These, together with records reported in the literature, are listed below. Since well over 1000 specimens are from many localities in Kansas, these are recorded by county only in order to conserve space.

Alabama: Decatur; Selma. Arkansas: Imboden; Knob Hill Reservation. Colorado: Avondale; Benta Fort (near Prowers), Bent Co.; Berkeley; Boulder; Boulder Co.; Boxelder Creek (E. of Aurora), Adams Co.; Brighton; Burlington; Chimney Gulch, Jefferson Co.; Clear Creek; Colorado Springs; Crowley Co.; Denver; Dixon Canyon; Eads, Kiowa Co.; Elbert; Flagler; Fort Collins; Gardner; Granada; Hoehne; Holly; Horsecreek (S. of Buckeye); Koyt's Ranch; La Junta; Lamar; Landaman Creek (S. of Stratton); Las Animas; Lone Rock Draw (near Springfield), Baca Co.; Manitou; Masonville; Midway (5 miles E.); Montclair; Ordway; Platte Canyon (near Waterton); Pingree Park, Larimer Co.; Pueblo; Rock Creek (Colorado Springs); Rocky Ford, Otero Co.; South Park; Sterling; Tobe, Las Animas Co.; Trinidad; Two Buttes Reserve, Baca Co.; White Rock (near Boulder); Wray. Florida: Everglades; Flamingo; Yankeetown. Illinois: Bath; Berkeley; Carlinville; Champagne; Charleston; Chicago; Downers Grove; Havana; Lake Forest; Macoupin Co.; Manito; McHenry; Meredosia; Metropolis; Monticello; Palos Park; Peoria; Spring Bay; Trenton; Urbana; Wellington; Willow Springs. Indiana: Lafayette; McAllister; Mineral Springs; Rush Branch; Vincennes. Iowa: Ames; Davenport; Lake Okoboji; Osage; Sergent Bluff; Sioux City. Kansas: Counties: Allen; Anderson; Barber; Barton; Bourbon; Butler; Chautauqua; Cherokee; Cheyenne; Clark; Clay; Comanche; Cowley; Crawford; Decatur; Dickinson; Doniphan; Douglas; Edwards; Elk; Ellis; Finney; Franklin; Geary; Graham; Grant; Greeley; Greenwood; Hamilton; Harper; Harvey; Haskell; Hodgeman; Jewell; Johnson; Kearny; Kingman; Labette; Lane; Leavenworth; Marion; Marshall; Meade; Miami; Mitchell; Montgomery; Morris; Morton; Neosho; Ness; Norton; Osborne; Ottawa; Pawnee; Phillips; Pottawatomie; Pratt; Reno; Republic; Riley; Rooks; Rush; Russell; Saline; Scott; Sedgwick; Seward; Shawnee; Sheridan; Sherman; Smith; Stafford; Stanton; Stevens; Sumner; Trego; Wabaunsee; Wallace; Wichita; Wilson; Woodson. LOUISIANA: Tallulah. MICHIGAN: Onota Township, Alger Co. MINNESOTA: Fort Snelling; Hennepin Co.; Houston Co.; Minneapolis; Mound Springs State Park, Rock Co.; Pipestone; Washington Co. MISSISSIPPI: Shuqualak; West Point. MISSOURI: Atherton; Barlow; Buffalo; Columbia (12 miles E.); Kaiser; Lebanon (12 miles E.); Ozark; Ozark Lake; Sedalia; Smithton; Springfield; St. Louis; Verona; Wheatland; Willow Springs. MONTANA: Forsyth. NEBRASKA: Agate; Benkelman; Carns; Child's Point; Crawford; Fairmont; Friend; Gering; Glen, Sioux Co.; Gordon; Haigler; Halsey; Hardy; Hay Springs; Imperial; Jim Creek, Sioux Co.; Kearney; Kimball; Lexington; Lincoln; Lodgepole; Louisville; Malcolm; McCook; Meadow; Mitchell; Monroe Canyon, Sioux Co.; Nebraska City; Neligh; Niobrara; North Platte; Omaha; Rock Co.; Sidney; Sioux Co.; Weeping Water; West Point. NEW MEXICO: Cimarron; Koehler; Maxwell; Raton; Springer. NEW YORK: New York City (West Farms); Long Island. NEW JERSEY: ?Camden Co.? (Fox det.) NORTH DAKOTA: Rhame, Bowman Co. OKLAHOMA: Ada; Ardmore; Perkins; Stroud; Tuskahoma. SOUTH DAKOTA: Badlands; Brookings; Cedar Pass (Badlands); Fort Pierre; Huron; Platt; Ravinia; Wheeler Bridge. TENNESSEE: Maury Co.; Memphis. TEXAS: Abilene; Alpine; * Adrian (10 miles W.); Austin; Bexar Co.; Bonham; Brewster Co.; Brownwood; Canadian; Clarendon; College Station; Comfort; * Dalhart (10 miles S. W.); Dallas; * Dawn; Del Rio; Devils River (near Del Rio); *Fabens; Fedor, Lee Co.; Grapevine; Guthrie; * Hereford; Hill Co.; Loyal Valley; Lytle, Atascosa Co.; Matagordo; McKinney; * Metz; New Braunfels; Nueces Co.; * Palo Duro Canyon; * Palo Duro State Park, Randall Co.; Presidio; San Antonio; San Marcos; Sinton; Southmost, Cameron Co.; Taylor; Waco; Weser. WISCONSIN: Hudson, St. Croix Co.; Milwaukee; Maiden Rock; Prescott, Pierce Co.; Shullsburg. WYOMING: Diamond Ranch, Platte Co.; Laramie; Torrington. COAHUILA: Puertas de la Goriona, Sierra del Carmen. TAMAULIPAS: Santa Cruz. ONTARIO: Chatham. QUEBEC: Cap Rouge (Provancher det.).

Flower records. Abutilon theophrasti, Ambrosia sp., *Asclepias incarnatus, A. syriaca, Aster ericoides, Bidens involucrata, B. aris-*

* Localities from northwestern Texas on the margin of the zone of intergradation between *expurgata* and *obliqua*.

tosa, Blephia hirsuta, Boltonia asteroides, Carduus crispus, Cassia sp., *Cephalanthus occidentalis, Chrysopsis* sp., *Cirsium* sp., *C. discolor, C. lanceolatum, C. undulatus, Cleome* sp., *C. serrulata, Coreopsis* sp., *C. tinctoria, C. tripteris, Echinacea pallida, Erigeron philadelphus, Euphorbia* sp., *Gaillardia* sp., *Gossypium herbaceum, Grindelia* sp., *G. squarrosa, Helenium altissimum, H. autumnale, Helianthus* sp., *H. annuus, H. divaricatus, H. grosse-serratus, H. laetiflorus, H. maximillianus, H. mollis, H. petiolaris, H. scaberimus, H. strumosus, H. tuberosus, Heliopsis helianthioides, H. laevis, Ipomoea pandurata, Kuhnistera purpurea, Lacinaria pycnostachys, Lactuca floridana, Lobelia leptostachys, L. siphillitica, Lythrum alatum, L. salicaria, Medicago sativa, Melilotus alba, Monarda fistulosa, Nepeta cataria, Oenothera biennis, Petalostemum* sp., *P. candidens, P. oligophyllum, Prionopsis* sp., *P. ciliata, Psoralea tenuiflora, Pycnanthemum* sp., *P. flexuosum, P. pilosum, Ratibida* sp., *R. columnaris, R. pinnata, Rudbeckia* sp., *R. hirta, R. laciniata, R. subtomentosa, R. triloba, Schrankia uncinata, Silphium* sp., *S. integrifolium, S. laciniatum, S. perfoliatum, S. speciosum, S. terebinthinaceum, Solidago* sp., *S. missouriensis, S. rigida, S. serotina, Teucrium canadense, Trifolium pratense, Verbena* sp., *V. stricta, Vernonia* sp., *V. baldwinia, V. b. interior, V. fasciculata, Verbesina helianthoides, Zinnia* sp.

Melissodes (Epimelissodes) obliqua expurgata Cockerell.

Melissodes obliqua var. *expurgata* Cockerell, 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 230; 1928, Univ. Colorado Studies, vol. 16, p. 114 (*obliqua* var.); 1936, Amer. Mus. Nov., no. 831, p. 5 (*obliqua* var.).

Melissodes obliqua, Cresson, 1875, *in* Wheeler, Report upon geographical and geological explorations and surveys west of the one hundredth meridian, vol. 5, p. 726 (in part); Fowler, 1902, Univ. California Agric. Exp. Stat., p. 322; Cockerell, 1903, Psyche, vol. 10, p. 77; Linsley, 1946, J. Econ. Ent., vol. 39, pp. 20-22, 25; Bohart, Knowlton and Bailey, 1950, Utah State Agric. Coll., mimeo. ser. 371, p. 5.

The subspecies *expurgata* is the palest of the three subspecies of *M. obliqua.* The females of *expurgata* can be separated from those of *obliqua* by a combination of the first of the following four characters plus any two of the next three: lateral oblique pale fasciae present on tergum 2; hairs of axillae 50 percent or more pale ochraceous; pale fasciae on tergum 3 as wide as or wider than apical area laterally; tergum 4 without brown pubescence medially. The males of *expurgata* are less reliably separated from those of *obliqua* than are the females, but a majority can be recognized by a combination of the first of the following four characters plus any two of the next three: pale pubescent band on tergum 2 complete, not narrowly interrupted by brown pubescence medially; tergum 3 with pale band medially at least as wide as apical area and usually wider; axillae without brown hairs; mesoscutum without brown hairs. Additional characters are given below and their relative worth can be judged from the histograms in figure 6.

Female. Wings somewhat less infumate than in *obliqua* or *caliginosa.* Head with ochraceous hairs, paler on face and genal areas; vertex between lateral ocelli and apices of compound eyes with short pale brown to brown hairs. Thorax above with ochraceous hairs, occasionally somewhat rufescent on anterior part of mesoscutum; mesoscutum usually with at least a few brown hairs posteromedially, these becoming more abundant in darker specimens, but brown patch only rarely exceeds level of anterior margin of tegulae; scutellum with large patch of dark brown hairs medially, but usually less than in *obliqua;* axillae usually with less than half of hairs brown; tegulae usually with dark brown appressed hairs medially; mesepisterna as in *obliqua,* but often with more pale hairs above; pronotum with ochraceous hairs only. Basal half of metasomal tergum 1 with long ochraceous hairs; tergum 2 always with lateral oblique fasciae of white or pale ochraceous pubescence; terga 2 and 3 usually with appressed ochraceous hairs at extreme sides and usually these join with pale pubescent fasciae of tergum; tergum 3 with large pale pubescent fasciae which often join medially, or separated medially by less than half of length of one fascia and wider than apical apubescent area of tergum laterally; tergum 4 with broad band of pale pubescence only rarely interrupted medially by a thin, incomplete line of brown pubescence; terga 6 and 7 always with tufts of pale hairs at sides. Legs with dark brown hairs except dark reddish-brown hairs on inner surfaces of hind tibiae, mixed ochraceous and brown hairs of hind femora, dark reddish-brown to red hairs on inner surfaces of hind basitarsi and pale ochraceous to white hairs of scopae.

Male. Head with white to ochraceous hairs, rarely with short brown hairs between lateral ocelli and apices of compound eyes. Thorax in palest specimens completely covered with white to ochraceous hairs; often with reddish-brown hairs on scutellum and a few in posteromedian area of mesoscutum; axillae rarely with a few brown hairs present. In palest specimens all hairs of tergum 1 white or pale ochraceous, usually with short simple brown hairs in apical third to one half; tergum 2 with complete band of white or pale ochraceous pubescence, not interrupted medially by brown pubescence, usually fused with basal band of spatuloplumose hairs, sometimes with brown hairs between these bands at least laterally, almost always pale band fused with pale appressed hairs at extreme sides of tergum; tergum 3 like tergum 2, but pale basal hairs not spatuloplumose, pale band usually as wide as or wider than apical area medially; terga 4 and 5 with broad complete pale bands; terga 6 and 7 with ochraceous hairs in palest specimens to dark brown in darkest individuals; sternal hairs paler than in *obliqua*, but brown at least medially on last 2 or 3 sterna. Legs with white to ochraceous hairs except rufescent hairs on inner surfaces of fore and middle tarsi and hind distitarsi, dark reddish-brown to black on inner surfaces of hind basitarsi and occasionally brown on outer surfaces of hind basitarsi.

Remarks. This subspecies has a range extending over a considerable area. Specimens from different localities are often quite different from one another. A rather long series of specimens from Davis, California, are among the palest and largest examined, whereas those from the San Francisco area and the central valley south to Riverside, California, average smaller and considerably darker. On the other hand, specimens from the Colorado Desert area, not far south and east of Riverside, average small in size, but pale in color and include the palest specimen seen. Specimens from Arizona definitely show some evidence of gene flow from the darker populations to the east, but most are identifiable as *expurgata*.

Type material. Holotype male from Glenwood Springs, Colorado, July 22-29, F. E. Lutz, is the property of the California Academy of Sciences, deposited temporarily at the Citrus Experiment Station, Riverside, California.

Distribution. This subspecies ranges from Washington in the northwest, south into northern Baja California, east through Idaho in the north and into western Colorado and through Arizona in the south (Fig. 7). It has been collected from May 31 to September 27. Including the specimens from the zone of intergradation in Colorado, New Mexico and Mexico, 697 females and 685 males have been examined from the localities listed below. This list includes localities reported in the literature.

ARIZONA: Casa Grande; Chandler; Fredonia; Gila Bend (23 miles E.); Graham Mts.; Grand Canyon; Hassayampa, Maricopa Co.; Havaisu Canyon; Huachuca Mts.; Marinette; Mesa; Olberg; Phoenix; Phoenix (6 and 12 miles N.); Sahuarita; Sonoita; Supai; Tempe; Tucson. CALIFORNIA: Anaheim; Antioch; Artois, Glenn

Co.; Bakersfield (6 miles E.); Bard; Barstow (20 miles E.); Blythe; Calexico; Coalinga; Coachella Valley; Colorado Desert; Colusa; Davis; Dos Palos; Fresno; Indio; Lake Curry, Napa Co.; Lemongrove; Lemoore, Kings Co.; Lerdo; Lindsay; McFarland; Meridian; Modesto; Niland; Oakley; Oxalis; Palm Springs; Palo Verde Valley; Patterson; Redding; Redlands; Rio Vista; Riverside; Ryer Island; Sacramento; Shafter; Snelling; Tracy; Tulare; Turlock; Vallejo; Vernalis; Westley; Westmorland; Weston, San Joaquin Co. COLORADO: * Glenwood Springs; Grand Junction; * Jim Creek; Mesa Verde; Palisade; Utah Junction. IDAHO: Boise; Fort Hall (near Blackfoot); Hot Springs, Owyhee Co.; Parma; Twin Falls. NEVADA: Desatoya Mts.; Fallon; Las Vegas; Logandale. NEW MEXICO: * Albuquerque; * Eddy Co.; * Elida; * Gallup; * Garfield; * Isleta; * Las Cruces; * Las Vegas; * Malaga; * Mesilla; * Portales; * Rito; Rodeo, Hidalgo Co.; * Roswell; * Santa Fe; * Sapello; Shiprock, San Juan Co.; * Vaughn; Willow Creek, Rio Arriba Co. OREGON: Huntington; Juntura (20 miles E.); Ontario; Vale. UTAH: Beaver Valley; Bountiful; Corinne; Cornish; Cove Fort; Delta; Emery Co.; Erda; Escalante; Fillmore; Grantsville; Greenriver; Harper; Hunter; Hurricane; Ioka; Jensen, Uintah Co.; Jericho; Kings Station, Davis Co.; La Verkin; Lehi; Logan; Lynndyl; Magna; Monticello; North Delta; Ogden; Pahvant; Park Valley; Petersboro; Promontory; Provo; Salt Lake; Salt Lake City; Santa Clara; Tooele; Topaz; Toquerville; Zion National Park; Zion Park Junction. WASHINGTON: Morgan's Ferry, Yakima River; Pullman. WYOMING: Green River. BAJA CALIFORNIA: Mexicali (35 kilometers S. W.). CHIHUAHUA: * Catarinas; * Charcos; * Delicias; * Jiménez; * Salaícas. COAHUILA: * Cabos; * San Pedros de Colonias; * Torreón. DURANGO: * Durango; * Nombre de Dios.

Flower records. The subspecies *expurgata* has been taken on flowers of the following plants: *Achillea* sp., *Artemisia* sp., *Asclepias* sp., *Brassica adpressa, Centaurea* sp., *Centromadia pungens, Chrysopsis grandifolia, C. lanceolata, Engelmannia pinnatifida, Gaillardia* sp., *Geranium atropurpureum, Gilia capitata, Grindelia* sp., *G. camporum, G. nana, Helianthus* sp., *H. annuus, H. bolanderi, H. ciliaris, H. petiolaris, Heliotropium* sp., *Isocoma vernonioides, Medicago sativa, Melilotus alba, Petalostemum flavescens, Pluchea sericea, Ratibida columnaris, Scabiosa* sp., *Solidago* sp., *Verbesina encelioides, Wislizenia refracta.*

* Localities from areas of intergradation.

Melissodes (*Epimelissodes*) *texana* Cresson.

This species is distinguished from the other members of the *obliqua* group by the coarser punctation of the clypeus and the shiny surfaces of the posteromedian area of the mesoscutum. In addition, the females have pale yellow to orange hairs on the inner surfaces of the hind basitarsi, short triangular lateral fasciae on tergum 2 and very coarsely punctate supraclypeal area. The males are easily recognized by the thick pad of dense appressed hairs on the anterior surface of each mesepisternum and by the sculpturing on the lateral surfaces of the mesepisterna as described below.

Female. Measurements and ratios: N, 20; length, 13-17 mm.; width, 5.0-6.5 mm.; wing length, $M = 5.12 \pm 0.247$ mm.; hooks in hamulus, $M = 16.70 \pm 0.828$; flagellar segment 1/segment 2, 2.43 ± 0.028.

Structure and color: Integument of body usually black; legs usually red, femora occasionally dark red to black, ventral and lateral areas of mesepisterna and usually anterior surfaces of mesepisterna bright red; labrum and bases of mandibles translucent orange; mandibles with short golden maculae in apical half; antennae often wholly bright red, scapes and lower surfaces of flagella usually dark red, occasionally black; metasomal sterna and ventrolateral parts of terga red; propodeum often dark red medially; eyes usually blue, occasionally gray or greenish-blue; wing membranes generally clear, somewhat brownish at tips, veins dark reddish-brown to black. Clypeus with large deep rounded punctures separated by half or less of one puncture width in median third of posterior half, ground moderately shiny, finely tessellate; supraclypeal area covered with large crowded deep punctures; eyes bulbous, in facial view about as long as facial width between inner upper angles of eyes; maxillary palpal segments in ratio of about 3:3.5:2.5:1, never with a fifth segment. Posteromedian area of mesoscutum with rather small rounded punctures separated by from half to one puncture width, ground very shiny, only slightly shagreened; scutellum similar but punctures average smaller; lateral surfaces of mesepisterna with large deep punctures twice as wide as those on posteromedian area of mesoscutum, ground reduced to ridges between punctures, slightly or not at all shagreened; dorsal surface of propodeum coarsely reticulopunctate, upper part of declivous face and posterior part of dorsal face with distinct diamond-shaped impunctate area medially, ground densely tessellate. Tergum 1 with coarse punctures separated by less than one puncture width in basal half or less of dorsal surface; tergum 2 with sparse scattered large punctures and abundant small indistinct punctures in interband zone laterally, the smaller punctures abundant at extreme sides and obsolete or minute and sparse medially; apical areas of terga 1-3 impunctate, dulled by dense shagreening.

Hair: Head with ochraceous hairs on vertex behind ocelli, becoming paler on face and genal areas. Thorax with ochraceous hairs above, becoming paler on sides and beneath; mesoscutum usually with patch of brown hairs; scutellum usually with brown hairs medially. Tergum 1 with pale ochraceous to white hairs on basal half and laterally; tergum 2 with broad white spatuloplumose hair band basally, with white appressed hairs laterally and with strongly oblique, short, lateral fasciae of white pubescence; tergum 3 with long broad oblique fasciae which meet medially or almost so, with white pubescence at extreme sides and with brown tomentum basally; tergum 4 with broad apical band of white pubescence and dark brown tomentum basally. Legs with ochraceous to white hairs, except as follows: fore basitarsi often pale brown; inner surfaces of fore and middle basitarsi reddish or orange; inner surfaces of hind basitarsi and tibiae red to yellow; scopal hairs white to pale ochraceous.

Male. Measurements and ratios: N, 20; length, 11-17 mm.; width, 3.5-6.0 mm.; wing length, $M = 4.94 \pm 0.396$ mm.; hooks in hamulus, $M = 15.30 \pm 0.291$; flagellar segment 2/segment 1, $M = 2.58 \pm 0.036$.

Structure and color: Integumental color as in female; clypeus, labrum and bases of mandibles white to cream-colored; entire metasoma often red. Eyes bulbous, often half as broad as long in facial view and always almost so; minimum length of first flagellar segment longer than one third of maximum length of second segment but distinctly less than half of second segment; maxillary palpi as in female. Punctation much as in female; lateral surfaces of mesepisterna with median areas somewhat depressed, with very small punctures, dulled by dense tessellation and often red in color, these areas somewhat variable in size, but always distinct, confluent with anterior surfaces and enclosed above, posteriorly and usually below by normally coarsely punctate areas similar to the mesepisterna of the female; metasomal tergum 1 with punctate basal areas equal to much more than half of median length of tergum; with distinct punctures separated by less than one puncture width across entire tergum 2 in interband zone.

Gonostyli with much shorter, mostly simple and sparser hairs than in *obliqua;* spatha distinctly emarginate medially, about 4 times as wide as long. Sternum 7 with dense fine simple hairs along inner margins of median plates; with a few short hairs on ventral surface below median emargination. Sternum 8 with transverse carina sharp, reaching apex of sternum and partially hiding median emargination when ventral surface of sternum is perpendicular to line of sight; hairs at apex and in median emargination simple, finer and shorter than in *obliqua* (Figs. 48-50).

Hair: Head and thorax as in female, but usually with less brown hairs on dorsum of thorax; anterior surfaces of mesepisterna with dense pads of closely appressed, ochraceous to orange hairs. Hairs of metasoma and legs variable, described below under each subspecies.

Geographical variation. Cockerell in 1906 named a female collected at Roswell, New Mexico, as *M. texana flaveriae.* Unfortunately, Cockerell gave a very poor description of this female. The holotype has bright red legs, as is often the case in this species, not black as Cockerell stated; the hairs of the sterna and the last two terga are as pale as the paler specimens of this species; the hairs of the axillae and of the laterobasal areas of tergum 2 are dark brown, as in the darker specimens of this species. In short, this female is intermediate in color and more like the Texan than like the Californian and Chihuahuan specimens. Also it is from a locality which is presumably near the eastern margin of the zone of intergradation between the two subspecies described below, if not within the range of *texana* itself. Another complication is the

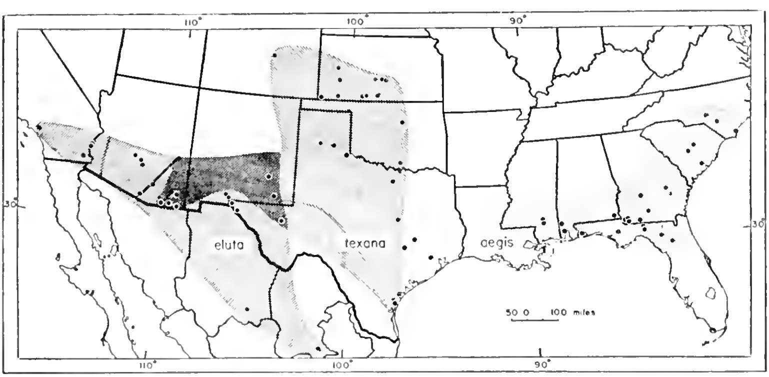

FIG. 8. Map showing the distribution of *M. (Epimelissodes) texana* and *M. (E.) aegis.* The overlapping type of shading indicates the known zone of intergradation between the two subspecies of *M. texana.*

fact that the lectotype of *texana* is rather paler than usual and, thus, the holotype of *flaveriae* and the lectotype of *texana* are indistinguishable. For these reasons *flaveriae* has been synonymized with *texana* and a new name proposed for the pale western subspecies.

The eastern subspecies (*M. texana texana*) is darker, larger and more coarsely punctate than the southwestern subspecies (*M. texana eluta*). Specimens from southwestern Kansas and northwestern Texas show some evidence of becoming paler, but most of these are readily referable to *texana*. Two females from Roswell, New Mexico, are intermediate in character. A single male from Carlsbad, New Mexico, however, is dark. This specimen is considered as being in the zone of intergradation, since dark specimens, especially males, can be expected to occur in the zone of intergradation. Specimens from Las Cruces, New Mexico, and El Paso, Texas, as well as six specimens from Chihuahua, Mexico, are typically *eluta*. Specimens from the extreme southwestern corner of Arizona, however, are intermediate in character and a tendency towards darkness is exhibited in a long series of males from Phoenix, Arizona. Of fourteen females and thirteen males from southern California, all are typically *eluta* save for one male which is slightly darker than usual, but nevertheless referable to *eluta*.

The distribution of these subspecies as described above (Fig. 8) leads to the conclusion that *eluta* is a desert form and that an extensive area of intergradation exists between *eluta* and *texana*. Unfortunately, there are only a few specimens from this large area. A cline may exist across this zone in hair color, but local conditions probably affect color strongly, producing aberrant populations such as those from southeastern Arizona. Until more specimens become available, this zone of intergradation cannot be adequately described.

Melissodes (*Epimelissodes*) *texana texana* Cresson.

Melissodes texana Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 276; Uhler, 1877, Bull. U. S. Geol. Surv., no. 3, p. 783; Birkmann, 1899, Ent. News, vol. 10, p. 245; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 77, 86, 108; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 132.

Melissodes texana flaveriae Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 108 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310.

This subspecies is paler and larger than *eluta*. Females of *texana* can be separated from those of *eluta* by a combination of at least three of the following five characters: axillae with 80% or more dark brown hairs; mesoscutal patch of brown hairs extends forward at least to a transverse line across anterior margins of tegulae; raised areas between pale fasciae and pale spatuloplumose hair bands of tergum 2 covered with short dark brown appressed hairs laterally except at extreme sides; tergum 5 with dark chocolate-brown hairs in medial half or more; sternal hairs at least partly brown. Males of *texana* are more easily separated from males of *eluta* than are the females. Males of *texana* have a rectangular apical dark area on metasomal tergum 1, or this area is narrower medially than laterally, and the pale pubescent band of tergum 2 is as wide as or narrower than the apical area medially and is usually narrowly interrupted medially.

Female. Structure and color: Femora, coxae and lower lateral surfaces of thorax with a tendency to be black; eyes usually bluish-gray, without a greenish tint. Raised lateral areas of interband zone of tergum 2 somewhat more coarsely punctate than in *eluta.*

Hair: With the color characters given above in the diagnosis and in the species description; apical hair band of tergum 4 narrower than in *eluta;* tergum 3 with pale lateral fasciae usually not meeting medially and narrower at extreme sides than in *eluta.*

Male. Structure and color: Metasoma rarely entirely red; eyes usually gray or yellowish, rarely green; clypeus and bases of mandibles usually cream-colored; supraclypeal area never with a triangular pale spot.

Hair: Mesoscutum always with some brown hairs in postero-median area; scutellum always with a large median patch of brown hairs. First metasomal tergum with long ochraceous hairs laterally and basally, apical median area with a broad zone of short appressed dark brown hairs, this area narrowest medially and with lateral anterior lobes, or quite rectangular in outline, not forming a wide arc anteriorly as in *eluta;* tergum 2 with pale band always separated from basal spatuloplumose band by a narrow zone of dark brown pubescence, band narrowly interrupted medially by brown pubescence and as wide as or narrower than apical area medially; tergum 3 with pale pubescent band usually very narrowly interrupted medially and usually not much wider than apical area medially; pale band of tergum 4 often interrupted medially; terga 4-7 with abundant long dark brown to black bristlelike hairs; terga 6 and 7 with abundant dark brown to black appressed hairs at least medially; sterna usually covered with black or brown hairs, occasionally reddish basally and laterally. Legs pale except red hairs of inner surfaces of distitarsi and basitarsi of fore and middle legs; hairs of inner and posterior surfaces of hind basitarsi often dark reddish-brown to black.

Type material. Lectotype female and lectoallotype male, one female paratype and one male paratype of *texana* in the Academy of Natural Sciences of Philadelphia. Holotype female of *flaveriae* from Roswell, New Mexico, August, on *Flaveria angustifolia,* T. D. A. Cockerell, is the property of the California Academy of Sciences, temporarily deposited at the Citrus Experiment Station, Riverside, California.

Distribution. Eastern Colorado and Kansas, south through Oklahoma and Texas (Fig. 8). Specimens examined from the localities listed below include 40 females and 23 males, in addition to the type material. This list includes localities recorded in the literature.

COLORADO: Colorado Springs. KANSAS: Coldwater, Comanche Co.; Comanche Co.; Elkhart, Morton Co.; Garden City, Finney Co.; Hudson; Hutchinson; Medicine Lodge; Reno Co.; Scott Co.; Seward Co. NEW MEXICO: * Roswell; * Carlsbad. OKLAHOMA: Ardmore; Stillwater. TEXAS: Clarendon; Corpus Christi; Greenwood; Lake Childress, Childress Co.; Palo Duro State Park; * Pecos; Waco.

Flower records. Females have been collected on the following flowers: *Chrysothamnus* sp., *Flaveria angustifolia, Helianthus* sp., *Prionopsis* sp. and *P. ciliatus.*

Melissodes (Epimelissodes) texana eluta, subsp. nov.

This subspecies can be separated from *texana* on the basis of the characters described in the diagnosis of the latter. In addition, the males of *eluta* often have the supraclypeal triangle cream-colored.

Female. Structure and color: Legs, thorax and metasoma with a tendency towards maximal red coloration; laterobasal raised areas of tergum 2 usually less punctate than in *texana.*

Hair: Mesoscutum with no brown hairs in palest specimens and usually with a much restricted patch of dark hairs in darker specimens; scutellum usually with brown hairs medially; axillae usually with only pale hairs, but a few to several brown hairs often present. Laterobasal raised areas of tergum 2 with hairs all or almost all white so that lateral oblique fasciae appear to fuse with basal spatuloplumose hair band; tergum 3 with white hairs basally at extreme sides, pale oblique fasciae usually meeting in midline; tomentum

* Localities considered to be in the zone of intergradation in New Mexico and Texas.

at bases of terga 3 and 4 often pale brown or orange; tergum 4 with broader apical white band than in *texana;* tergum 5 with orange or pale brown hairs in small median area, white laterally; sternal hairs orange to white, paler apically and laterally on each sternum.

Male. Structure and color: Metasoma with a tendency to be all red; supraclypeal area often with a triangular cream-colored spot; clypeus usually white. Punctures in interband zone of tergum 2 less distinct and less abundant than in *texana.*

Hair: Mesoscutum usually without brown hairs; apical area of metasomal tergum 1 with short brown hairs, narrow, evenly attenuate laterally so that anterior margin of area forms wide arc, never rectangular or lobed anterolaterally as in *texana;* pale band of tergum 2 usually wider than apical area medially, usually with pale pubescence in interband zone, rarely pale band interrupted medially; terga 3 and 4 with pale bands broader than in *texana;* tergum 5 with pale band not interrupted medially; terga 5-7 often with white or pale ochraceous bristlelike hairs and terga 6 and 7 with at most brown hairs medially, often all hairs white or pale ochraceous; sternal hairs usually pale reddish, often reddish-brown medially on last 2 or 3 sterna; legs always with white to ochraceous hairs except yellow to orange hairs on inner surfaces of tarsi, including hind basitarsi.

Type material. Holotype male, allotype female, six female paratypes and four male paratypes collected at Ripley, Riverside Co., California, August 19, 1946, by P. D. Hurd on wild asparagus; six female and six male paratypes collected at Blythe, Riverside Co., California, August 19, 1944, by J. W. MacSwain. The holotype and allotype are in the California Academy of Sciences. Paratypes are in the collections of the California Academy of Sciences, the U. S. National Museum, the American Museum of Natural History, the Snow Entomological Museum and in the author's collection.

Distribution. Desert areas of southern California, Arizona and northern Mexico (Fig. 8). This subspecies has been collected from July 11 to October 15. Including the type material, 44 females and 64 males have been examined from the localities listed below.

ARIZONA: Baboquivari Mts.; Chandler; * Dos Cabeza (16 miles S. E.); * Douglas; * Hereford; * Huachuca Mts.; Phoenix; Sacaton;

* Localities from the zone of intergradation in Arizona.

Tucson. CALIFORNIA: Blythe; Imperial Co.; Ripley; Yerba Linda, Orange Co. NEW MEXICO: Mesquite, Dona Ana Co. TEXAS: Between La Tuna and Vinton, El Paso Co.; Ysleta. CHIHUAHUA: Delicias. COAHUILA: Cabos.

Flower records. Both sexes have been taken visiting flowers of wild asparagus, one male on *Asteraginus* sp., and one male on *Helianthus* sp. in southern California, and females have been taken on *Helianthus annuus* and *Heterotheca subaxillaris* in Arizona.

Melissodes (Epimelissodes) sila, sp. nov.

Melissodes sila is distinguished from all other species of the *obliqua* group by not having the pale pubescence on metasomal tergum 2 restricted to lateral fasciae, but continuous across the tergum and separated from the apex by only a narrow bare margin equal to about one fifth of the length of the tergum in unworn specimens. The pale pubescence is easily rubbed off of the apical area of the tergum and most specimens have either a thinner band or only lateral fasciae remaining. The female of *sila* is also recognizable by its very pale color. The mesoscutum is without brown hairs and the scutellum has only a small median patch of dark hairs at most. The pale hairs of the head and thorax are white to pale yellowish-ochre, and are not at all rufescent. The males of *sila* are similar to those of *obliqua* in that there is no dense pad of closely appressed hairs on the anterior surface of each mesepisternum. They can be separated from the males of *obliqua* by being paler than the palest specimen of the latter species and by having yellow to orange hairs on the inner surfaces of the hind basitarsi and ochraceous hairs on the last two metasomal terga.

Female. Measurements and ratios: N, 15; length, 13-14 mm.; width, 5-6 mm.; wing length, $M = 4.80 \pm 0.313$ mm.; hooks in hamulus, $M = 17.67 \pm 0.333$ mm.; flagellar segment 1/segment 2, $M = 2.48 \pm 0.044$.

Structure and color: Integument generally black; distitarsi, apical sixth of clypeus and labrum rufescent; occasionally basitarsi, tibiae, coxae, lower lateral surfaces of propodeum and bases of mandibles rufescent; apical margin of metasomal tergum 1 usually piceous, never sharply delimited as a completely transparent margin; sterna usually rufescent, especially basal sterna; mandibles with elongate golden maculae over apical half to three fifths; antennae occasionally all dark brown to black, but usually red to dark reddish-brown below on flagellar segments 3-12; eyes gray to bluish-gray; wing membranes clear or slightly milky, never infumate, veins dark reddish-brown to black; tegulae somewhat translucent, reddish-brown to red; clypeus with moderate-sized, round punctures separated by half or less of one puncture width in median third of posterior half of clypeus, but not as crowded in this area as in *comanche,* ground tessellate, moderately shiny; supraclypeal area with shallow scattered punctures much smaller than those of adjacent area of clypeus, ground shagreened; eyes short, width in facial view equals three eighths length or more, distinctly shorter in facial view than width of face at inner upper angles of eyes; second flagellar segment on ventral surface short and broad, length equals about three fourths width, much shorter than third segment; maxillary palpal segments in ratio of about 3:3:2.5:1, small fifth segment present in most specimens examined and sometimes almost as long as fourth segment. Flattened posteromedian area of mesoscutum with moderate-sized punctures separated by one to one half of a puncture width, ground shagreened, moderately shiny; scutellum coarsely punctate, punctures distinctly smaller than those on mesoscutum, ground shiny, only slightly shagreened; lateral surfaces of mesepisterna coarsely punctate, punctures larger and more crowded than those on mesoscutum; dorsal face of propodeum with large coarse scattered punctures medially and apically, reticulopunctate basally and laterally, ground coarsely tessellate; declivous face with large impunctate inverted triangular area dorsally, ground coarsely tessellate; lateral faces coarsely punctate and tessellate dorsoposteriorly and with fine round punctures and fine shagreening anteroventrally. Metasomal tergum 1 with punctures in basal half of dorsal surface, but anterior half or more of punctate area with shallow punctures separated by one to three puncture widths; apical area finely shagreened, moderately shiny; tergum 2 with interband zone with large shallow sparse punctures, at least laterally, ground dulled by dense shagreening.

Hair: Generally very pale in color; head with white hairs, often very pale ochraceous on vertex and behind ocelli and paler on face and genal areas. Thorax with pale yellowish-ochre hairs above and whitish to white hairs on sides, becoming paler ventrally; scutellum occasionally with pale brown hairs medially. First metasomal tergum with pale ochraceous hairs basally and laterally, apubescent apically; tergum 2 with white basal spatuloplumose hair band, area apical to spatuloplumose band completely covered with white or pale ochraceous pubescence in fresh specimens except apical fifth of tergum which is bare, this pubescence divided into three areas by a thick median band of longer pubescence which lies about 3 hairs thick, this thick median band being comparable to the oblique lateral fasciae of other members of the *obliqua* group, shorter pubescence of the apical area sparse, the hairs scarcely overlapping each other and easily rubbed off, but the extent of the pubescent area versus the relatively apubescent margin can be easily determined by presence of exceedingly minute punctures on the former; tergum 3 covered by whitish pubescence which reaches apex of tergum at least in lateral fifth, also divided into basal area of thick pubescence and apical area of sparser pubescence which is readily rubbed off at least medially; tergum 4 with broad apical band of white pubescence; terga 3 and 4 with brown tomentum basally; terga 5 and 6 with hairs white laterally and pale rufescent to pale brown medially. Legs with white hairs except rufescent hairs of inner surfaces of distitarsi, yellow to orange hairs of outer surfaces of fore basitarsi and middle tibiae; scopal hairs white.

Male. Measurements and ratios: N, 6; length, 13-14 mm.; width, 4-5 mm.; wing length, $M = 4.42 \pm 0.382$ mm.; hooks in hamulus, $M = 15.33 \pm 0.459$; flagellar segment 2/segment 1, $M = 3.09 \pm 0.179$.

Structure and color: Color as in female; labrum white; bases of mandibles and clypeus cream-colored to pale yellow. Punctation as in female, but punctate basal area of tergum 1 equals three fifths or more of dorsal face of tergum; maxillary palpi as in female; minimum length of first flagellar segment equals one third or more of maximum length of second segment, but always distinctly less than one half of second segment; eyes bulbous, little more than twice as long as broad in facial view.

Gonostyli more S-shaped and with shorter, sparser and less plumose hairs than in *obliqua;* spatha not emarginate medially. Sternum 7 as in *obliqua* but hairs of median plates simple and stout, without hairs on ventral surfaces below median emargination and without hairs on dorsal surface of lateral plates as in *grandissima.* Sternum 8 as in *obliqua* but apical hairs simple or with few barbs and apical margin gently sloping inwards to the median emargination, without truncated apical margin on each side of emargination.

Hairs: Much as in female; hairs of head, thorax and metasoma entirely pale ochre in presumably younger individuals, as in the holotype, becoming almost white in older individuals; without dense pad of closely appressed hairs on anterior face of each mesepisternum, but with a thin layer of appressed pubescence which effectively screens surface on at least lower half; hairs of inner surfaces of basitarsi yellow to orange.

Remarks. This species is apparently primitive in that the maxillary palpi are usually 5-segmented. It is intermediate in character between *obliqua* and *suffusa* groups in several respects, but is, perhaps, more closely related to *M. obliqua* than to any other species of *Epimelissodes.*

Type material. Holotype male and allotype female collected near San Simon, Arizona, July 12, 1952, by R. H. and L. D. Beamer, W. E. LaBerge and Cheng Liang, on *Psilostrophe cooperi.* Three male paratypes and three female paratypes were taken with the holotype and allotype. In addition, 4 male and 11 female paratypes are as follows: Turner, Arizona, 1 male, August 9, 1940, on *Baileya* sp., P. H. Timberlake; ten miles southwest of Apache, Arizona, 1 male, August 11, 1940, on *Kallstroemia grandiflora,* P. H. Timberlake; Graham Mountains, Arizona, 1 female, August 15, 1953, on "crown beard," G. D. Butler; Tenapin Banks, Big Bend National Park, Brewster Co., Texas, 1 male, July 15, 1950, Ray F. Smith; Charcos, Allende District, Chihuahua, 6 females, July 27, 1947, on "yellow composite," C. D. Michener; 16 miles southeast of Chihuahua, Chihuahua, 1 female, July 11, 1947, W. J. Gertsch; Catarinas, Chihuahua, 2 females, July 26, 1947, Mont A. Cazier; 27 miles west of Chihuahua, Chihuahua, 1 female, August 15, 1950, Ray F. Smith; south of Parrita, Chihuahua, 1 male, August 13, 1950, Ray F. Smith. The holotype and allotype are in the Snow Entomological Museum. Paratypes are in the collections of the California Academy of Sciences, the Citrus Experiment Station, Riverside, California, the American Museum of Natural History and in the author's collection. (Figure 4.)

THE PETULCA GROUP

This group consists of two very closely allied species with two and three subspecies each. The group is characterized by having broad apical bands of pubescence on metasomal terga 2 to 4 in the females and on at least tergum 2 in the males (often on terga 3 to 5 as well). The bands are composed of diffuse, plumose, closely appressed hairs which are usually pale in color. In the males of one form this diffuse pubescence is reddish-brown apically so that there appears to be a median pale band as in the members of the *obliqua* group. However, the darker apical hairs are long, largely plumose, diffuse, effectively obscure the surface of the integument and are quite unlike the short, simple, dark hairs in a comparable position in species of the *obliqua* group.

Female. Clypeus with small punctures, in posteromedian area often sparated by one or slightly more puncture widths, more crowded elsewhere, densely tessellate; supraclypeal area with very shallow, small, sparse punctures, ground usually densely tessellate but quite often shiny and smooth; maxillary palpal segments in ratio of about 3:3:3:1, first segment occasionally somewhat shorter and minute fifth segment rarely present; second flagellar segment always broader than long ventrally and shorter than third segment. Mesoscutum coarsely punctate, punctures in posteromedian area usually separated by half or less of one puncture width, occasionally by more, ground moderately shiny, usually shagreened; punctures in median area of scutellum distinctly smaller and more crowded than on posteromedian area of mesoscutum, ground shiny, shagreening slight or absent; dorsal face of propodeum reticulopunctate basally and laterally, punctures distinct apically; declivous face of propodeum coarsely punctate, with irregular oval impunctate dorsomedian area; lateral faces of propodeum coarsely punctate posterodorsally and finely punctate anteroventrally; propodeum dulled by dense tessellation; lateral surfaces of mesepisterna with coarse punctures of about same diameter as those on posteromedian area of mesoscutum or slightly larger, more crowded, ground shiny, scarcely or not at all shagreened. Metasomal tergum 1 with coarse punctures in basal half or less medially, extending to margin laterally, punctures small, crowded, ground dulled by dense shagreening basally and shagreened but moderately shiny in apical impunctate area; terga 2 and 3 with punctures in raised lateral areas of interband zone obscured by dense tessellation or shagreening, surface beneath apical hair bands dulled by fine shagreening, with extremely minute punctures no wider than the bases of appressed hairs which they bear, an arched row of coarse punctures separate apical area from interband zone.

Hairs generally of moderate length; head and thorax generally with pale ochraceous hairs, often white on face, genal areas and lower lateral surfaces of thorax, usually with abundant brown hairs on scutellum and posteromedian area of mesoscutum; terga 2 to 4 with broad apical bands of closely appressed, diffuse, pale pubescence. Scopal hairs highly plumose, white to pale ochraceous.

Male. Sculpturing as in female; punctures on clypeus obscured by color; usually more than half of basal area of tergum 1 coarsely punctate; maxillary palpi as in female; minimum length of first flagellar segment equals slightly less than half of maximum length of second segment and always more than one third of second segment; eyes bulbous, in facial view almost half as wide as long as always much more than one third as wide as long.

Gonostyli always somewhat S-shaped, capitate and with fewer and shorter hairs than in *obliqua;* spatha usually broadly emarginate medially and sinuate laterally, 3 to 4 times as wide as long. Sternum 7 as in *obliqua.* Sternum 8 as in *obliqua;* transverse carina well separated from apex of sternum and usually blunt; hairs at apex shorter and sparser than in *obliqua.*

Hair much as in female; anterior surfaces of mesepisterna covered by dense pads of closely appressed pale pubescence; metasomal tergum 1 with long pale hairs on basal three fifths or more; pale pubescent band on tergum 2 apical, if with reddish-brown hairs apically, these largely plumose, long and effectively screen surface of tergum; terga 3-5 usually with apical pale hair bands, but occasionally with a very narrow apical fringe of brown hairs, especially on terga 4 and 5.

Melissodes (*Epimelissodes*) *petulca* Cresson.

This species can be separated from *sabinensis* by its usually nonhyaline metasomal terga, often darker hair color, more coarsely punctate metasomal terga, shorter and usually dark appressed hairs in the apical area of tergum 1 of the female and the more plumose and shorter hairs in a comparable position in the male. In addition, the male of *petulca* usually has a peculiar vertical fan of several rather stout hairs in the apical emargination of the eighth sternum, has the lateral excavation of the lateral plate of the seventh sternum distinctly shorter than half of the length of the lateral plate, and lacks the patch of close-set hairs on the lateral surfaces of the mesepisterna. Certain females of *M. petulca suffusa* are indistinguishable from some specimens of each of the three subspecies of *sabinensis* on the basis of color characters. These are discussed more fully below. The only morphological characters found which will separate the females of the two species in all cases are very subtle and to some extent depend on the condition of the specimens.

Female. Measurements and ratios: N, 20; length, 10-15 mm.; width, 4-6 mm.; wing length, $M = 4.46 \pm 0.306$ mm.; hooks in hamulus, $M = 16.15 \pm 0.062$; flagellar segment 1/segment 2, $M = 2.32 \pm 0.031$.

Structure and color: Integument generally black; distitarsi rufescent, remainder of legs dark reddish-brown to black; bases of mandibles, labrum and apical sixth or less of clypeus often translucent yellowish-red; scape and flagellar segments 1 and 2 dark brown to black, remainder of flagella dark red below and dark reddish-brown to black above; eyes yellowish-green to brownish-gray; wing membranes clear, slightly infumate apically, veins dark reddish-brown to black, darker apically; first metasomal tergum with very narrow hyaline margin which is usually sharply delimited basally, occasionally more broadly hyaline, but only rarely as much as half of tergum hyaline; sterna often red, especially basally and laterally. Mesoscutal punctures often separated by one puncture width or more in posteromedian area; tergum 2 with raised areas of interband zone with abundant punctures at least laterally; terga 3 and 4 similar, punctures in lateral areas coarse, separated by less than one puncture width, those bearing long bristlelike hairs not conspicuously larger than those bearing shorter plumose hairs, ground dulled by dense shagreening, but moderately shiny at extreme sides just mesad of lateral arms of graduli.

Hair: Apical impunctate area of tergum 1 with minute, usually dark brown or golden-brown, sparse, appressed hairs which are distinctly shorter than the plumose hairs near margin of tergum 2; terga 3 and 4 with brown tomentum at extreme bases; additional color characters described below for each subspecies.

Male. Measurements and ratios: N, 20; length, 9.5-14.5 mm.; width, 3.5-5.5 mm.; wing length, $M = 4.18 \pm 0.331$ mm.; hooks in hamulus, $M = 14.70 \pm 0.252$; flagellar segment 2/segment 1, $M = 2.77 \pm 0.046$.

Structure and color: Labrum white; clypeus and bases of mandibles pale yellow, white in faded specimens; scape usually dark brown to black, occasionally red; flagellum dark brown to black above, clear red below; eyes yellowish-green, often brownish when faded; wing membranes clear, veins red to brownish-black, darker apically. Sculpturing and structure as in female; raised lateral areas of terga 2-6 (especially 3 and 4) as in female, but often less punctate.

Spatha gently emarginate apically. Sternum 7 with abundant plumose hairs at apices of median plates; lateral excavations of lateral plates distinctly shorter than half of length of lateral plates; apodemes not expanded nor curved anteriorly in apical third or fourth, inner margins quite straight (Fig. 57). Sternum 8 usually with a median vertical row of six or more stout barbed hairs, in lateral view these hairs form a fanlike structure within the apical emargination.

Hair: Tergum 1 with appressed hairs in apical impunctate area not reaching margin of tergum, short, mostly plumose (or at least plumose basally with simple rachis extending out beyond plumose part); lower half of lateral surface of each mesepisternum with hairs no thicker than elsewhere on lateral surface and punctures bearing these hairs not much crowded; additional color characters are described below for each subspecies.

Geographical variation. Melissodes petulca is divisible into two subspecies mainly on the basis of color and slight differences in punctation. The darker eastern subspecies (*petulca*) is distributed over a considerable area east of Texas. The paler subspecies (*suffusa*) ranges over the southwestern states and northern Mexico and intergrades with *petulca* through a cline in the eastern half of Texas.

The zone of intergradation in Texas is illustrated on the map (Fig. 9) by pie-graphs. North of Texas the two subspecies probably meet and intergrade in the eastern half of Oklahoma and eastern Kansas or western Missouri. There are too few specimens from these states to be able to describe the zone in this area. There is some indication of gene flow from *petulca* southward along the eastern coast of Mexico. Two females from the state of Tamaulipas are almost perfectly intermediate in color between the two forms. The large majority of specimens from Mexico are typically *suffusa*, however.

The pie-graphs (Fig. 9) were derived by an analogous method to that used in obtaining the average melanism percentages in the graph (Fig. 5) for *M. obliqua*. In this case three states for each of four characters were tabulated (rather than "either-or" situations): dark, intermediate and pale. An average percent for each was then obtained and these results were used to produce the pie-graphs. As a check, the same specimens were classified as *petulca*,

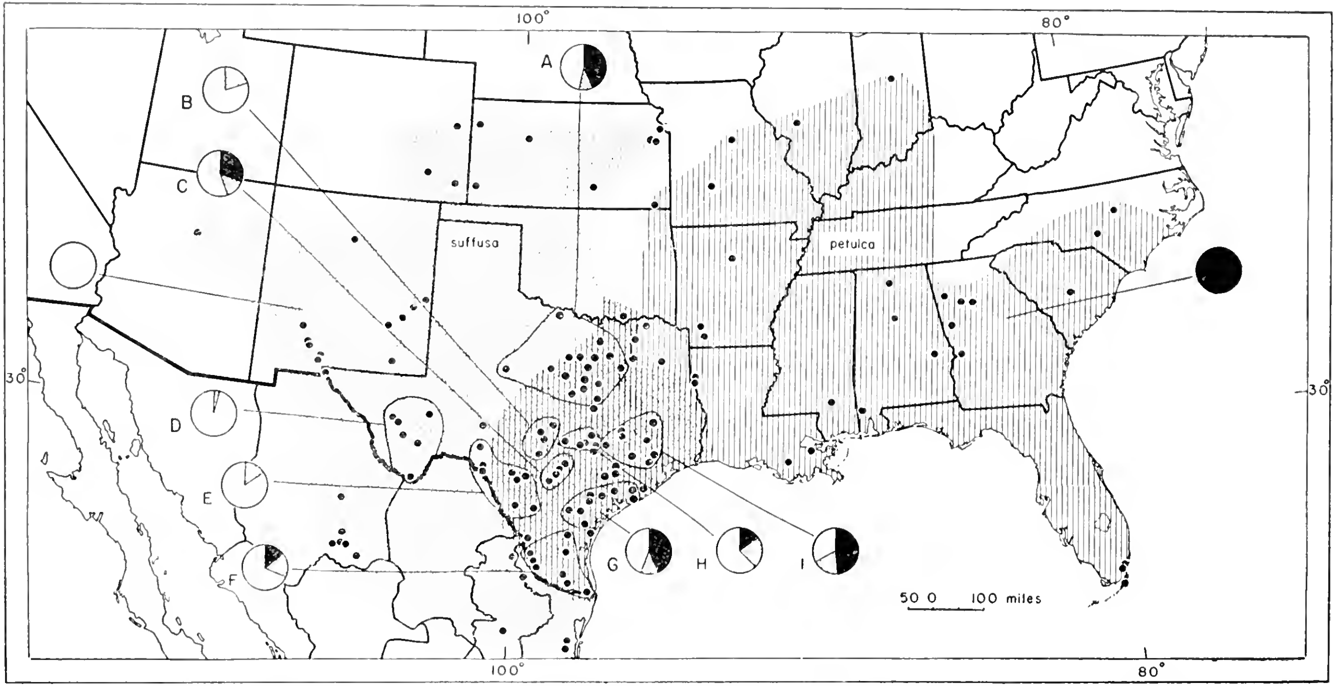

FIG. 9. Map showing the distribution of *M.* (*Epimelissodes*) *petulca.* The overlapping type of shading indicates the known zone of intergradation between the two subspecies. Localities from which specimens were taken to produce the pie-graphs are outlined with a solid line. The graphs represent average melanism of females based on four characters (see text). *M. petulca petulca* is represented by a complete black circle to the right and *M. petulca suffusa* by a white circle to the left.

suffusa or intermediates, according to the three characters given in the diagnoses of the subspecies. The results were again put into the form of pie-graphs and compared with the previous work. No important differences were found to exist between the two methods. In the second method, however, the intermediate classes were generally diminished in favor of one or both of the other classes, since classifying on the basis of only two out of three characters tended to hide the expression of some of the intermediate characters. These pie-graphs are for females only, since the males are more variable. The males, however, follow the results shown in Figure 9 quite closely in average percent of melanism.

The characters used are listed below. The darkest alternatives (*a*) are listed first and correspond to the black parts of the graphs. The intermediate conditions (*b*) correspond to the stippled portion of the graphs and the pale alternatives (*c*) correspond to the white parts of the graphs.

1a. Black mesoscutal hair patch extends anteriorly beyond a transverse line at anterior margins of tegulae and near anterior margin extends laterally beyond parapsidal lines.

1b. Black mesoscutal hair patch extends anteriorly from a transverse line at middle of tegulae to one at anterior ends of tegulae and near anterior margin is contained within parapsidal lines.

1c. Black mesoscutal hair patch small, not extending forward to a transverse line at middle of tegulae, or rounded anteriorly and well within parapsidal lines anteriorly, or both.

2a. Axillae with more than 50% of hairs dark brown.

2b. Axillae with dark hairs, but less than 50% dark.

2c. Axillae without dark hairs.

3a. Tergum 2 with brown hairs extending posteriorly beyond the row of coarse punctures which separated the apical area from the basal area.

3b. With few brown hairs medially extending posteriorly beyond the median row of coarse punctures on tergum 2.

3c. Without dark hairs extending posteriorly beyond the median transverse row of coarse punctures on tergum 2.

4a. Terga 5 and 6 with dark, chocolate-brown hairs and small lateral tufts of pale erect or suberect hairs.

4b. Terga 5 and 6 with brown hairs medially and with pale hairs in about lateral third (at least on tergum 5).

4c. Terga 5 and 6 with hairs all pale—pale brown to orange medially and ochraceous to white laterally.

The localities from which specimens were taken for the analysis are listed below in lettered groups. Immediately following each letter (corresponding to the lettered pie-graphs on the map) the total number of females available and in condition for this study appears in parentheses.

A. (18) Cresson; Dallas; Denton; Eastland Co.; Hamilton; Highland; Mineral Wells; Rosser; Wills Point; Wolfe City.

B. (32) Cherry Springs; Kerrville.

C. (27) Bexar Co.; Lytle; San Antonio.

D. (21) Del Rio; Devils River; Fort Stockton; Juno; Ozona.

E. (18) Carrizo Springs; Cotula; Laguna; Sabinal; Uvalde.

F. (27) Ben Bolt; Brownsville; Edinburg; Lopeno; San Ygnacio; Zapata Co.

G. (40) Bay City; Goliad; Sinton; Weser.

H. (18) Austin; Cypress Mills; Manor; Taylor.

I. (26) College Station; Brazos Co.; Fedor; Lee Co.; Giddings; Humble; Trinity.

Melissodes (Epimelissodes) petulca petulca Cresson.

Melissodes petulca Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 201; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 86, 92; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 127; Graenicher, 1930, Ann. Ent. Soc. Amer., vol. 23, p. 160; Michener, 1947, Amer. Mid. Nat., vol. 38, p. 453.

Melissodes illinoensis Robertson, 1895, Trans. Amer. Ent. Soc., vol. 22, p. 126; 1899, Botanical Gazette, vol. 28, p. 38; 1905, Trans. Amer. Ent. Soc., vol. 31, p. 367; 1914, Ent. News, vol. 25, p. 70; Michener, 1947, Amer. Mid. Nat., vol. 38, p. 453.

Epimelissodes illinoensis, Robertson, 1918, Ent. News, vol. 29, p. 92; 1926, Ecology, vol. 7, p. 380; 1928, Flowers and Insects, p. 8.

Melissodes suffusa, Birkmann, 1899, Ent. News, vol. 10, p. 245 (misidentification); Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 360 (misidentification).

This subspecies can be reliably separated from *suffusa* only on the basis of hair color. The females of *petulca* can be distinguished by a combination of two out of three of the following characters: mesoscutal patch of brown hairs extends forward beyond a line at the anterior margins of the tegulae and laterally beyond the parapsidal lines; metasomal tergum 2 with brown hairs extending posteriorly beyond the row of coarse punctures which separates the apical pale band from the basal area at least medially; terga 5 and 6 with mostly dark chocolate-brown hairs, with tufts of pale hairs at extreme sides but these not each equaling one third of the width of the tergum. The males of these subspecies are more variable and less reliably separated than are the females. Males of *petulca* are typically characterized as follows: with abundant brown hairs on mesoscutum; sternal hairs mostly dark brown; metasomal terga with pale pubescent bands narrower than in *suffusa.*

Female. Structure and color: First metasomal tergum very rarely with more than an extremely narrow hyaline margin; punctures on mesoscutum usually separated by from half to one puncture width in posteromedial area, ground usually very shiny, scarcely shagreened.

Hair: Face and genal areas with pale ochraceous to white hairs, rufescent hairs on vertex behind ocelli, short hairs between lateral ocelli and apices of compound eyes and a few hairs behind ocelli dark brown. Mesoscutal patch of dark brown hairs extending forward beyond a line between anterior margins of tegulae and extending laterally beyond parapsidal lines so that anterior width of patch considerably greater than posterior width; scutellum with large patch of dark brown hairs; propodeum and lateral surfaces of thorax with pale ochraceous hairs; mesoscutal hairs anterior to dark hair patch bright rufescent. First metasomal tergum with long pale hairs in basal half or less and appressed pale hairs at extreme sides; tergum 2 with spatuloplumose hair band usually fused with pale ochraceous apical band at extreme sides, pale ochraceous apical band with irregular anterior margin, usually wider laterally than medially, with brown pubescence extending from interband zone onto apical area at least medially; terga 3 and 4 with narrower apical bands than in *suffusa,* usually equal to less than basal area of brown pubescence medially; terga 5 and 6 with dark chocolate-brown hairs medially and ochraceous tufts laterally, lateral tufts of tergum 5 each equal to less than one third of width of tergum; sternal hairs red to dark brown medially, paler at extreme sides of each sternum, usually darker than in *suffusa.* Legs with ochraceous hairs except rufescent hairs on distitarsi and inner surfaces of basitarsi and brown hairs on outer surfaces of fore basitarsi and basitibial plates.

Male. Structure and color: Much as in female, except usual sexual differences.

Hair: Head with hairs as in female but usually with fewer or no brown hairs at vertex. Mesoscutum usually with square patch of reddish-brown hairs; scutellum with abundant dark hairs; axillae usually with a few brown hairs; tegulae often with brown hairs; pale hairs of thorax white to ochraceous, never bright rufescent on mesoscutum as in female. First tergum with basal three fifths covered with long pale hairs medially and pale hairs extending to margin laterally; tergum 2 with broad arched apical band of pale pubescence, usually consisting of sparser hairs than in *suffusa,* usually separated from basal spatuloplumose hair band across entire tergum except at extreme sides by brown hairs; terga 3-6 with narrower pale bands than in *suffusa,* narrower than basal area of dark pubescence and often with extremely narrow zone of short brown hairs at margin; terga 6 and 7 with abundant brown hairs at least medially; sternal hairs mostly reddish-brown to brown, usually paler at sides of each sternum and on basal few sterna. Legs with pale ochraceous to white hairs except rufescent on distitarsi and inner surfaces of basitarsi and hind tibae.

Type material. Female lectotype of *petulca* from Georgia at the Academy of Natural Sciences of Philadelphia. Lectotype female of *illinoensis,* here designated (Robertson's coll. no. 14971), and male lectoallotype, here designated (Robertson's coll. no. 14889), of *illinoensis,* from Carlinville, Illinois, July 26 and 13, respectively, 1893, on *Lepachys pinnata,* Charles A. Robertson, in the collection of the Illinois Natural History Survey, Urbana.

Distribution. From eastern Texas northward through eastern Kansas, northeast through Missouri to southern Illinois, eastward through the Gulf States to Florida and northward through the Atlantic States to New Jersey (Fig. 9). This subspecies has been collected from April 10 to September 30, but mainly in June and July. In addition to the type material, 237 females and 257 males were examined from the localities listed below. This list includes localities reported in the literature.

ALABAMA: Citronelle; Decatur; Edgewood; Birmingham; Tuskegee. ARKANSAS: Chessman Ferry; Clinton; Hope; Lewisville. FLORIDA: Cocoplum Beach (near Miami); Key Largo; Larkins; South Miami. GEORGIA: Atlanta; Cusseta; Hogansville; Rockmart; Rome; Stone Mountain. ILLINOIS: Carlinville. INDIANA: South McAlester. KANSAS: Labette Co. (intergrade ?). LOUISIANA: Greenwell Springs; Keatchie; Logansport; New Orleans; Schriever. MISSISSIPPI: Hattiesburg. MISSOURI: Buffalo; Columbia. NEW JERSEY: Camden County. NORTH CAROLINA: Aberdeen; Lake James; Raleigh. OKLAHOMA: * Durant. SOUTH CAROLINA: St. Mathews. TEXAS: * Austin; * Bastrop; * Bay City; * Beeville; * Ben Bolt; * Jim Wells Co.; * Bexar Co.; * Brazos Co.; * Calvert;

* Localities from the eastern part of the zone of intergradation.

* College Station, Brazos Co.; * Columbus; * Cypress Mills, * Dallas; * Denton; * Edna; * Falfurrias; * Fedor, Lee Co.; * Giddings; * Goliad (16 miles E.); * Hallettsville; * Hempstead; * Hillsboro; * Humble; * Lee Co.; * Lytle; * Manor; * Matagorda; * McDade; * New Braunsfels; Paris; * Plano; * Riviera; * Rock Island; *Rosser; * Salada Creek, Bexar Co.; * San Antonio; * Taylor; * Three Rivers; Trinity; Upshure Co.; *Victoria; * Weser; * Willis; Wills Point; Wolfe City.

Flower records. These bees have been collected from flowers of the plants listed below. They appear to prefer Compositae of the tribes Heleniae and Helianthiae in that order. Females have been collected only on *Monarda* and *Pycnanthemum* among the non-Compositae.

Borrichia frutescens, Coreopsis cardaminefolia, Gaillardia sp., *G. pulchella, Gossypium herbaceum, Helenium* sp., *H. tenuifolium, Helianthus* sp., *Lepachys pinnata, Lithospermum canescens, Monarda* sp., *M. citriodora, M. punctata, Pycnanthemum, flexuosum, Pyrrhopappus geiseri, Ratibida columnaris, R. columnifera pulcherrima, Rudbeckia* sp., *R. amplexicaulis, R. bicolor, R. subtomentosa, Verbesina helianthoides.*

Melissodes (Epimelissodes) petulca suffusa Cresson

Melissodes suffusa Cresson, 1878, Proc. Acad. Sci. Philadelphia, vol. 30, p. 203; Fox, 1893, Proc. California Acad. Sci., vol. 2, p. 21; 1894, Proc. California Acad. Sci., vol. 2, p. 118; Cockerell, 1899, Catalogo de las Abejas de Mexico, p. 14; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 78, 89, 90, 92 (*petulca* subsp.); 1914, Can. Ent., vol. 46, pp. 411, 416; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 131; Cockerell, 1923, Can. Ent., vol. 55, p. 80; 1923, Proc. California Acad. Sci., ser. 4, vol. 12, p. 73; 1928, Univ. Colorado Studies, vol. 16, p. 114.

Melissodes townsendi Cockerell, 1896, Entomologist, vol. 29, p. 304 (new synonymy); 1897, Bull. Exp. Stat. New Mexico Coll. Agric. and Mech. Arts, no. 24, p. 28; 1898, Bull. Sci. Labs. Denison Univ., vol. 11, p. 66; 1898, Bull. Univ. New Mexico, vol. 1, p. 66; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 78; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310.

This paler, western subspecies can be distinguished from *petulca* by the characters listed in the diagnosis of the latter. As in the subspecies *petulca,* the males are more variable than the females and can be identified only with difficulty, especially in and near the zone of intergradation.

Female. Structure and color: First metasomal tergum usually with at least a narrow hyaline apical margin and rarely broadly hyaline, terga 2-4 usually completely dark, occasionally broadly hyaline apically; punctures on mesoscutum usually separated by one

* Localities from the eastern part of the zone of intergradation.

or more puncture widths in posteromedian area, ground dull to moderately shiny, shagreened.

Hair: Face and genal areas with pale ochraceous to white hairs; vertex with ochraceous to pale rufescent hairs, with only a few or no long brown hairs on vertex behind ocelli. Mesoscutal patch of dark brown hairs not extending forward beyond a transverse line at anterior margins of tegulae and usually not reaching such a line, anterior end rounded, anterolateral margins contained within parapsidal lines so that patch is quite oval in shape and not much if any larger than the dark patch on the scutellum; axillae usually with less than 50% of hairs dark brown; tegulae usually with yellow to white hairs, rarely pale brown; hairs of propodeum and lateral surfaces of thorax pale ochraceous to white. First metasomal tergum with long pale ochraceous hairs in basal half or slightly more and with long appressed pale hairs laterally to margin; tergum 2 with spatuloplumose hair band fused with pale apical band at extreme sides, pale apical band of diffuse pubescence with evenly arched anterior margin, usually wider medially than laterally, usually with brown pubescence between apical band and basal pale band but these hairs pale in palest specimens; terga 3 and 4 with apical pale pubescent bands usually equal to or wider than basal areas of brown hairs medially, with dense brown tomentum at extreme bases of terga, in palest specimens this tomentum pale ochraceous to rufescent; terga 5 and 6 with dark hairs medially and with lateral tufts of white hairs which on tergum 5 each equals about one third of width of tergum, no dark hairs in palest specimens but medial hairs pale brown to rufescent; sternal hairs red medially and white laterally and apically. Legs with white to pale ochraceous hairs except for the following: outer surfaces of anterior basitarsi often with pale brown hairs, distitarsi and inner surfaces of basitarsi and hind tibiae with rufescent hairs.

Male. Structure and color: As in female except usual sexual differences; metasomal terga more often broadly hyaline than in female (especially in worn specimens).

Hair: Head with ochraceous to white hairs, without brown hairs on vertex. Mesoscutum with ochraceous to white hairs, often with small posteromedian patch of reddish-brown hairs; scutellum usually with median patch of brown hairs fringed with ochraceous hairs; axillae without brown hairs; propodeum and lateral surfaces of thorax with pale ochraceous to white hairs. First metasomal tergum with pale ochraceous hairs over basal three fifths to four fifths medially and reaching margin laterally; tergum 2 with pale apical band usually fused with basal spatuloplumose band across entire tergum, or at least across median third of tergum, area of brown hairs between these two bands being reduced to lateral oval spots, rarely connected medially, often entirely absent; terga 3-5 with wide apical pale bands which on tergum 3 usually equals basal area of brown hairs medially, occasionally with extremely narrow zone of apical brown hairs (one or two hairs wide); terga 6 and 7 with few or no brown hairs medially, but these usually rufescent, with white or pale ochraceous hairs laterally and apically. Legs with white to pale ochraceous hairs except rufescent hairs on inner surfaces of basitarsi and hind tibiae.

Remarks. In the west a few specimens of this subspecies approach both *M. sabinensis sabinensis* and *M. s. laterufa* in color. Two out of eight females from Delicias, Chihuahua, collected on July 13, 1947, by C. D. Michener are very pale and much like *sabinensis s. str.* The punctation and the form of the hairs on the metasomal terga place all of these as *M. petulca suffusa.* Of the two females from Carlsbad, New Mexico, collected on July 29, 1953, by the author, one is also very similar to *M. sabinensis s. str.*, but identifiable as *suffusa* on the same basis as the above two specimens. It is worth noting that all three of these females are in a rather worn condition and their extreme paleness can be at least partially attributed to fading with age. A series of four males from Hatch, New Mexico, collected on July 15, 1952, by R. H. and L. D. Beamer, Cheng Liang and the author, and another series of nine males collected by the same persons on the same date near Mesilla, New Mexico, are very badly worn, but presumably were pale individuals with little or no brown pubescence basally on terga 3 to 5 and with rather broad hyaline margins on all of the terga. These are, therefore, superficially very much like *M. sabinensis laterufa.* The male genitalia and hairs of the lateral surfaces of the mesepisterna place these males with *M. petulca suffusa.* Another male collected at Del Rio, Texas, June 22-27, 1899, by H. F. Wickham is also very pale, much less worn than the above mentioned New Mexico specimens and have very broad hyaline margins on the terga, but can also be recognized as a male of *suffusa* by the genitalia and hairs of the mesepisterna. The paler females of *suffusa* from New Mexico and western Texas also resemble closely the females of the Californian subspecies of *sabinensis* in color. However, these can be easily separated by the metasomal punctation which is at a minimum in the Californian specimens.

Type material. Lectotype female and lectoallotype male of *suffusa* from Texas, are in the Academy of Natural Sciences of Philadelphia. Male holotype of *townsendi* collected by C. H. T. Townsend, August, Las Cruces, New Mexico, lost or destroyed.

Distribution. From northern Mexico northwards through New Mexico and eastern Colorado, west to northern Arizona, east to northcentral and southeastern Texas in the south and to northeastern Kansas in the north (Fig. 9). This subspecies has been collected from April 12 to August 20, but mainly in June and July. In addition to the type material, 130 females and 209 males have been examined from the localities listed below. This list includes localities reported in the literature.

ARIZONA: Flagstaff. COLORADO: La Junta; Landaman Creek (S. of Stratton); Two Buttes Reserve. KANSAS: Eureka; Lawrence; Leavenworth; Sherman Co.; Stanton Co.; Sunflower, Douglas Co.; Trego Co.; Wichita. NEW MEXICO: Carlsbad; Elida; Elkins; Garfield; Hatch; Hot Springs; Las Cruces; Mesilla; Portales; Roswell; Santa Fe. TEXAS: Alpine; * Babyhead; Brewster Co. (on Rio Grande River); * Brownsville; * Carrizo Springs; * Cherry Springs; * Cisco; * Cotula; * Cresson; Davis Mountains; Del Rio; Devil's River (near Del Rio); * Eastland Co.; * Edinburg; El Paso; Fort Stockton; * Hamilton; *Hidalgo Co.; * Highland; Juno; * Kerrville; * Laguna (Nueces River); * Lopeno; * Loyal Valley; Marathon; * Mineral Wells; * Ozona; * Sabinal; * San Ygnacio; * Sinton; * Sweetwater; * Uvalde; * Weatherford; White Rose Canyon, Davis Co.; *Wichita Falls; * Zapata Co. CHIHUAHUA: Balleza; Catarinas; Delicias; Huejotitlán; Jiménez (17 and 18 miles W.); Parral; Salaíces. NUEVO LEÓN: Montemorelos; Vallecillo. TAMAULIPAS: Las Norias; San Fernando.

Flower records. As in *M. petulca s. str.*, this subspecies prefers flowers of the Compositae and especially the tribes Heleniae and Helianthiae in that order. The males have been more frequently collected on the non-Compositae than the females.

Aster sp., *Bacharris* sp., *Borrichia frutescens, Chrysopsis hispida, Coreopsis* sp., *Gaillardia* sp., *G. pulchella, G. suavis, Helenium* sp., *H. autumnale, H. microcephalum, Helianthus* sp., *H. annuus, Medicago sativa, Monarda* sp., *M. citriodora, M. punctata, Nepeta cataria, Opuntia* sp., *Phacelia* sp., *Ratibida* sp., *R. columnaris, R. tagetes, Rudbeckia hirta, Sphaeralcea* sp., *Tetragonotheca ludoviciana, Thelesperma megapotamicum.*

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* Localities from the zone of intergradation in eastern Texas.

Melissodes (Epimelissodes) sabinensis Cockerell

This species is characterized by being generally paler in color than *petulca.* The females are very difficult to separate from the paler females of *M. petulca suffusa*; however, the lateral raised areas of the interband zone of tergum 2 and of the basal areas of terga 3 and 4 are less punctate in *sabinensis.* The males of *sabinensis* are easily recognized by the area of more abundant long white hairs on the lower lateral surfaces of the mesepisterna and by the differences in the genitalia and hidden sterna as described below. Additional characters which are more or less restricted to each subspecies of *sabinensis* will aid in separating these from *suffusa.*

Female. Structure and color: Integument as in *petulca,* but metasomal terga often broadly hyaline apically. Punctation as in *petulca* except as follows: punctures in posteromedian area of mesoscutum always small, round and separated by less than one puncture width; raised lateral areas of terga 2-4 anterior to the median arched row of coarse punctures which separated the apical diffuse pubescent bands from the basal areas and just mesad of lateral arms of graduli less punctate than in *petulca,* punctures small, extremely shallow and obscured by dense, coarse shagreening or tessellation, sparse large scattered punctures bearing bristle-like hairs distinct, especially on tergum 3, much larger than small, shallow, indistinct punctures bearing plumose hairs.

Hair: On head generally white, vertex usually with ochraceous hairs. Pale hairs of mesoscutum ochraceous to somewhat rufescent, usually with at least a few dark hairs in posteromedian area and with a large patch of brown hairs equal to that on scutellum in darkest subspecies; scutellum with dark brown hairs, fringed with pale ochraceous hairs and with a few appressed ochraceous hairs in middle; lateral surfaces of thorax and propodeum with pale ochraceous to white hairs. First metasomal tergum with long pale hairs basally; apical impunctate area of tergum 1 with appressed hairs more abundant and longer than in *petulca,* about half as long as plumose hairs near margin of tergum 2 and usually white or yellow in color, rarely pale brown; tergum 2 without dark hairs in interband zone, rarely with a few dark hairs present in median third of interband zone; terga 3-5 usually without dark brown hairs in basal areas; thick tomentum at extreme bases of terga 3 and 4 always pale red or ochraceous in color, never dark brown; terga 6 and 7 with pale ochraceous hairs, often somewhat rufescent medially but never dark brown; sternal hairs red to yellow medially and white laterally and apically. Legs with pale ochraceous to white hairs except rufescent hairs on inner surfaces of tarsi and hind tibiae.

Male. Structure and color: Color generally as in *M. petulca* but clypeus and bases of mandibles usually cream-colored; occasionally clypeus narrowly darkened posteriorly. Minimum length of flagellar segment 1 equals half or slightly less of maximum length of segment 2. Sculpturing as in female; raised lateral areas of terga 2-5 less punctate than in *petulca*; often with smaller, more crowded punctures on lower lateral surfaces of mesepisterna than in *petulca*. Genitalia as in *petulca*. Sternum 8 as in *petulca* but never with vertical fan of several stout hairs in apical emargination, with no hairs medially at apex or with from one to four weak hairs arranged haphazardly. Sternum 7 as in *petulca* but with lateral excavations of lateral plates equal to at least half of length of plates and usually slightly more (Figs. 55-56).

Hair: On head and thorax generally pale ochraceous to white, paler on face, genal areas and sides of thorax than above; scutellum usually with distinct patch of dark brown hairs with a few shorter median pale hairs; mesoscutum usually with at least a few dark hairs in posteromedian area, often these as well as scutellar hairs all pale. Apical impunctate area of tergum 1 with hairs long, largely simple at least apically, usually pale in color; terga 2-7 with variable hairs, described below for each subspecies; sternal hairs rufescent to yellow medially and white apically and laterally. Legs with white to pale ochraceous hairs except rufescent or yellowish hairs on inner surfaces of tarsi and tibiae.

Geographical variation. The concept of *Melissodes sabinensis* presented here is that of a species with three largely allopatric subspecies (Fig. 10). No intergradation can be recognized at present because of the lack of material from critical areas. Three quite distinct solutions are possible besides the one proposed in this work. First, the three forms could be considered as distinct, but closely allied, species. However, the three forms agree with each other in so many respects that this does not seem likely. Second, the Californian form may be a subspecies of *sabinensis*, or these two forms may be separate species, while *laterufa* may be merely a rather common variant of either *sabinensis* or *suffusa*. This does not appear likely, since at least the males of *laterufa* are quite distinctly more similar to *sabinensis* than to *suffusa*, and *laterufa* appears to be at least largely allopatric with *sabinensis* (if not entirely so).

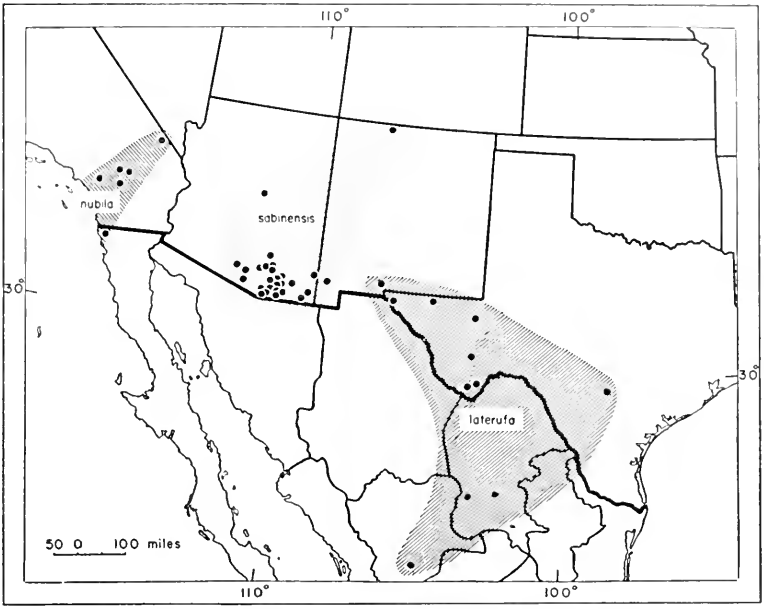

FIG. 10. Map showing the distribution of *M.* (*Epimelissodes*) *sabinensis*. The probable zones of intergradation between the three subspecies are left unshaded since little or nothing is known concerning bees from these areas.

The third possibility is that the California form and *sabinensis* are western subspecies of *petulca*, while *laterufa* is a rather common variant of *suffusa*. This does not appear likely on the same grounds as oppose the second hypothesis and also because of the several common characters which tie the three western forms together and separate them from *petulca*.

The two most likely solutions are, then, that the three forms are distinct species or that they are subspecies of one species. The latter solution has been accepted here because of the apparent similarity of the three forms. Additional collections will undoubtedly resolve this problem in the future.

Melissodes (*Epimelissodes*) *sabinensis laterufa* Cockerell.

Melissodes suffusa var. *laterufa* Cockerell, 1934, Amer. Mus. Nov., no. 697, p. 10.

This subspecies can be separated from *sabinensis s. str.* by its larger average size and by the peculiar hyaline metasomal terga as described below.

Female. Measurements and ratios: N, 12; length, 14-16 mm.; width, 5.5-6.0 mm.; wing length, $M = 4.93 \pm 0.820$ mm.; hooks in hamulus, $M = 17.08 \pm 0.379$; flagellar segment 1/segment 2, $M = 2.37 \pm 0.089$.

Structure and color: Average larger than *sabinensis;* first metasomal tergum medially with apical half (or more) hyaline, clear to yellowish; terga 2-4 with almost entire exposed areas hyaline, clear to yellowish; metasomal punctation as in species description, usually somewhat more coarsely punctate than in *sabinensis s. str.*

Hair: Generally pale ochraceous or white hair and pubescence; mesoscutal patch of dark brown hairs absent or much reduced; metasomal terga without dark brown hairs; sternal hairs yellowish-red to white.

Male. Measurements and ratios: N, 14; length 12-15 mm.; width, 4.5-6.0 mm.; wing length, $M = 4.60 \pm 0.370$ mm.; hooks in hamulus, $M = 15.29 \pm 0.245$; flagellar segment 2/segment 1, $M = 2.38 \pm 0.035$.

Structure and color: As in female, first metasomal tergum broadly hyaline, medially hyaline area covers at least half of tergum; terga 2-5 with broadly hyaline margins as in female; punctation as in female, but usually somewhat coarser.

Hair: As in female, pubescence generally white or ochraceous; mesoscutal patch of dark hairs reduced or absent; metasomal terga without brown hairs, but pubescence bright rufescent on at least one specimen; sternal hairs rufescent to yellow medially, white apically and laterally.

Remarks. Two male specimens from Baboquivari Mts., Arizona, collected on August 15, 1923, by C. L. Fox, and on August 15, 1924, by O. C. Poling, are well within the range of *sabinensis s. str.* but are typically *laterufa* in character. However, these are rather well worn specimens and they are perhaps large males of *sabinensis* which have become faded with age. A single male is known from New Mexico. One of two males collected six miles west of Governor Springs, Big Bend National Park, Texas, on July 16, 1950, by Ray F. Smith, is typically *sabinensis,* except for its large size, and the other is typically *laterufa.* These specimens suggest that *laterufa* may well be a distinct species. However, considering the scarceness of material representing *laterufa* and the great variability of specimens in other forms of *Epimelissodes,* the author is inclined to discount these specimens until further collections can be made.

Type material. Holotype female from Bexar Co., Texas, October

11, 1932, H. B. Parks, in the American Museum of Natural History, New York City.

Distribution. Southern New Mexico and Texas and northern Mexico to southwestern Arizona(?) (Fig. 10). In addition to the holotype, 12 females and 14 males have been examined from the localities listed below. This subspecies has been collected from July 7 to October 11.

ARIZONA: Baboquivari Mts. (?). NEW MEXICO: Las Cruces. TEXAS: Bexar Co.; El Paso; Chisos Mts., Big Bend National Park; Governor Springs, Big Bend National Park; Marathon; Pecos River; Pine Springs, Culberson Co. COAHUILA: Guadelupe; San Pedro de Colonias. DURANGO: San Juan del Río.

Melissodes (Epimelissodes) sabinensis sabinensis Cockerell.

Melissodes sabinensis Cockerell, 1924, Amer. Mus. Nov., no. 113, p. 1.

This subspecies is characterized by having the same metasomal punctation as in *laterufa,* or slightly less punctate, but lacking the broadly hyaline margins of the terga of the latter. Both sexes are on the average smaller than either *laterufa* or *nubila.* The males have an entirely pale clypeus and lack the reddish-brown hairs on the margins of the terga which are characteristic of *nubila.*

Female. Measurements and ratios: N, 20; length, 11-14 mm.; width, 4-5 mm.; wing length, $M = 4.21 \pm 0.170$ mm.; hooks in hamulus, $M = 14.90 \pm 0.191$; flagellar segment 1/segment 2, $M = 2.37 \pm 0.033$.

Structure and color: Punctures in raised areas of terga 2-4 as in *laterufa,* slightly more punctate than in *nubila;* margins of metasomal terga usually not broadly hyaline as in *laterufa,* margin of tergum 1 usually narrowly hyaline and occasionally tergal margins somewhat faded and reddish-brown to bright red, but never clear or yellowish as in *laterufa.*

Hair: Rarely with large rectangular mesoscutal patch of brown hairs and, if present, shorter hairs in middle of dark patch ochraceous; large scutellar patch of dark brown hairs with shorter appressed ochraceous hairs medially as in *laterufa;* pale hairs of mesoscutum ochraceous to white, never bright rufescent as in *petulca.* Metasoma without dark brown hairs; basal areas of terga 3-4 with pale ochraceous to golden-brown hairs; extreme bases of terga 3-4 with white to pale orange tomentum; sternal hairs ochraceous to white. Legs with pale ochraceous to white hairs except yellow or rufescent on inner surfaces of tarsi and hind tibiae.

Male. Measurements and ratios: N, 20; length, 10-13 mm.; width, 3-5 mm.; wing length, M = 3.87 ± 0.223 mm.; hooks in hamulus, M = 13.60 ± 0.234; flagellar segment 2/segment 1, M = 2.31 ± 0.035.

Structure and color: Size and punctation as in female; clypeus all cream-colored as in *laterufa;* without broadly hyaline margins on metasomal terga.

Hair: Mesoscutum often without brown hairs, but often with at least a few reddish-brown hairs in posteromedian area; metasomal terga without brown hairs apically, or rarely with a few reddish-brown hairs present at extreme apices of terga 3-5 (one or two apical rows of brown hairs in medial half of tergum); hairs of basal areas of terga 3-5 usually ochraceous or white, occasionally pale golden-brown.

Type material. Holotype male from the Sabino Basin, Santa Catalina Mountains, Arizona, July 8-20, 1916, F. E. Lutz, in the American Museum of Natural History, New York City.

Distribution. Southwestern Arizona and western New Mexico (Fig. 10). These bees have been collected from April 4 to October 1, but mainly in July and August. In addition to the holotype, 36 females and 109 males have been examined from the localities listed below.

ARIZONA: Benson; Bisbee (12 miles W.); Carr Canyon, Huachuca Mts.; Cochise Co.; Douglas; Harshaw; Kits Peak, Baboquivari Mts.; Lee Siding, Pedregosa Mts.; Mescal; Mogollon Rim; Nogales; Oracle; Patagonia; Pearce; Pepper Sauce Canyon, Santa Catalina Mts.; Quijotoa (30 miles E.); Pima Co.; Ramsay Canyon, Huachuca Mts.; Roble's Pass, Tucson Mts.; Sabino Basin, Santa Catalina Mts.; San Carlos; San Simon; Santa Catalina Mts.; Santa Cruz Co.; Santa Cruz Village, Comobabi Mts.; Santa Rita Mts.; Tucson; Tombstone; Turner. NEW MEXICO: Lisbon; Willow Creek, Rio Arriba County.

Flower records. Acacia sp., *Dalea albiflora, Happlopappus* sp., *Heterotheca* sp., *Isocoma* sp., *Kallstroemia grandiflora, Petalostemum* sp., *Psilostrophe cooperi, Sida diffusa, Sphaeralcea* sp., *Verbesina,* sp.

Melissodes (*Epimelissodes*) *sabinensis nubila,* n. subsp.

The males of this subspecies are easily separated from those of both *sabinensis* and *laterufa* by either the presence of brown or reddish-brown hairs apically on metasomal terga 2-5 or by the obfuscated posterolateral angles of the clypeus or both. Both sexes often have reddish-brown hairs basal to the apical pale bands on terga 3 and 4 and occasionally on tergum 2. The lateral raised areas of terga 2-4 of both sexes are less punctate than in either of the other two subspecies. The females usually have a large square mesoscutal patch of dark brown hairs. In color and size the females closely resemble *M. petulca suffusa,* whereas the males resemble certain pale members of the *obliqua* group.

Female. Measurements and ratios: N, 9; length, 13-14 mm.; width, 5.0-5.5 mm.; wing length, $M = 4.65 \pm 0.276$ mm.; hooks in hamulus, $M = 16.33 \pm 0.471$; flagellar segment 1/segment 2, $M = 2.29 \pm 0.310$.

Structure and color: Ground spaces on mesoscutum dulled by dense shagreening; punctures in raised lateral areas of terga 2-4 absent or very much obscured by dense fine tessellation, smaller punctures bearing plumose hairs extremely shallow and indistinct, a few larger punctures bearing the bristlelike hairs present and distinct.

Hair: Face and genal areas with white hairs, pale ochraceous on vertex. Mesoscutum with ochraceous hairs and patch of brown hairs in posteromedian area often rectangular and as large as or larger than dark scutellar hair patch, but usually with ochraceous hairs mixed with the brown anteriorly and laterally; lateral surfaces of thorax and propodeum with white to pale ochraceous hairs. First metasomal tergum with long pale hairs in basal half, long appressed to suberect hairs laterally and short, closely appressed, simple, ochraceous to brown hairs in apical impunctate area; remaining terga with hair pattern as in *sabinensis* but occasionally with brown hairs in basal areas of terga 3-5 and occasionally with brown hairs in median third of narrow zone between spatuloplumose hair band and median arched row of coarse punctures on tergum 2; extreme bases of terga 3 and 4 with thick tomentum pale brown to ochraceous; sternal hairs and hairs of legs as in *sabinensis.*

Male. Measurements and ratios: N, 20; length, 11-16 mm.; width, 3.5-5.0 mm.; wing length, $M = 4.16 \pm 0.226$ mm.; hooks in hamulus, $M = 14.45 \pm 0.246$; flagellar segment 2/segment 1, $M = 2.28 \pm 0.028$.

Structure and color: Extreme posterior margin of clypeus darkened, especially laterally between anterior tentorial pits and subantennal sutures. Sculpturing as in female; ground areas on mesoscutum dulled by shagreening and punctures in basal raised areas of terga 2-5 indistinct or absent as in female.

Hair: Face and genal areas with white hairs, pale ochraceous to white on vertex. Mesoscutum usually with patch of reddish-brown hairs in posteromedian area, but usually smaller than dark scutellar patch; dorsum of thorax with pale hairs ochraceous to white. Metasoma with hairs and pubescence as in female, but usually with marginal zones of reddish-brown appressed pubescence on terga 2-4, on tergum 2 this dark zone occasionally equal to pale portion of apical pubescent band in width; basal areas of terga 3-5 usually with dark brown to reddish-brown hairs; sternal hairs mostly white or pale ochraceous.

Type material. Male holotype collected on *Helianthus annuus* on July 8, 1927, at Riverside, California, by P. H. Timberlake. Female allotype collected on *Gutierrezia sarothrae* on July 25, 1929, at Riverside, California, by P. H. Timberlake. Seven female and forty five male paratypes were collected at Riverside, California, by P. H. Timberlake as follows: September 25, 1924, 1 male on *Encelia farinosa*; August 14, 1925, 1 female on *Heterotheca grandiflora*; July 22, 1927, 4 males on *Senecio douglasii*; July 25 and 26, 1927, 7 males on S. *douglasii*, 1 male on *Gutierrezia sarothrae*; August 3, 1927, 1 male on G. *sarothrae*, 2 males on S. *douglasii*; August 11, 1927, 1 male on S. *douglasii*; July 5, 1928, 1 male on G. *sarothrae*; July 12, 1928, 1 male on G. *sarothrae*; July 17, 1928, 6 males on *Chrysanthemum segetum*, 2 males on S. *douglasii*; July 18, 1928, 1 male on G. *sarothrae*; July 19, 1928, 1 male on C. *segetum*; July 20, 1928, 2 males on *Corethrogyne filaginifolia*, 1 female on G. *sarothrae*; July 26, 1928, 1 female on G. *sarothrae*; July 11, 1929, 2 females on G. *sarothrae*; July 22, 1929, 1 male resting in shade, 1 male on G. *sarothrae*; July 26, 1929, 1 female and 2 males on *Coreopsis lanceolata*; July 12, 1932, 1 male on *Hemizonia paniculata*; September 19, 1932, 1 female on *Stephanomeria exigua*; August 2, 1933, 1 male on S. *douglasii*; September 8, 1933, 1 male on G. *sarothrae*; September 18, 1933, 1 male on *Isocoma vernonioides*; September 11, 1934, 2 males on G. *sarothrae*; August 12, 1936, 1 male on *Gutierrezia californica*; July 28, 1942, 1 male on *I. vernonioides*. Two additional male paratypes were collected by G. E. Bohart at Riverside, California, July 6-7, 1933. The holotype and allotype are in the collection of P. H. Timberlake at the Citrus Experiment Station, Riverside, California. Paratypes are in the collections of the Snow Entomological Museum, the U. S. National

Museum, the American Museum of Natural History, the California Academy of Sciences, the Timberlake collection at Riverside and in the author's personal collection.

In addition to the type material one female was collected in San Bernardino Co., California, by Cocuillett; one male in the Ivanpah Mts., San Bernardino Co., California, by L. M. Marrin on September 5, 1936; one male from Whitewater Canyon, California, September 11, 1935, by P. H. Timberlake on *Bebbia juncea*; and one male from Las Parras, Baja California, Mexico, February, 1922, by W. M. Mann (Fig. 10). A single male bearing the label "Sweetwater River, San Diego Co., Cal. W. J. Chamberlin" is presumably a male of *sabinensis s. str.* Perhaps this specimen was mislabeled and rightly belongs with the short series of males of *sabinensis* collected in the Santa Rita Mts., Arizona, by W. J. Chamberlin which are now before me. The Californian male is identical in every respect with the latter and the labels on all four specimens are of the same type, size and age, although none are dated.

Idiomelissodes, subgenus nov.

Type species. Melissodes duplocincta Cockerell, 1905.

Female. Clypeus very flat in posterior three fifths, or even slightly depressed posteromedially, highest point at about three fifths of length from base, *protruding forward beyond eyes,* but by less than half width of eyes due to great width of eyes, flat area with distinct coarse punctures separated by one to two puncture widths, *ground very shiny, not at all shagreened*; supraclypeal area without or with very few coarse punctures medially, ground very shiny; *eyes large, bulbous, more than twice as wide as genal areas in profile*; galeae smooth and shiny, with sparse, small, scattered punctures, almost twice as long as median length of clypeus; maxillary palpi 4-segmented, fourth segment minute. Mesoscutum, scutellum and sides of thorax coarsely punctate, ground smooth and shiny, scarcely or not at all shagreened; *tegulae oval* with lateral margins evenly rounded, not acuminate anteriorly; metanotum densely punctate in median third, punctures in median area separated by only thin ridges, laterally punctures separated by at least one puncture width; propodeum densely punctate or reticulorugose dorsally, declivous face coarsely punctate but with large impunctate inverted triangle in upper median area, lateral surfaces coarsely punctate posterodorsally and finely punctate anteroventrally, ground moderately shiny, somewhat dulled by shagreening.

Metasoma relatively narrow; pygidial plate V-shaped, rather pointed apically; sterna densely and coarsely punctate. Strigilis with short thin nonpectinate malus; *tibial spurs of middle legs distinctly hooked or sharply curved near tips.*

Hairs generally short; long hairs of mesoscutum rather closely appressed except near margins; *with thick band of white spatuloplumose hairs between mesoscutum and scutellum; basal band on tergum 2 consisting largely of spatuloplumose hairs; anterior face of tergum 1 with spatuloplumose hairs mixed with normally plumose hairs and with long flattened hairs on basal half of dorsal face,* the latter appearing intermediate between the shorter spatuloplumose type and the longer normal plumose type present in this area in other subgenera; scopal hairs white, sparsely plumose, with two to six lateral branches, rachises stout and extending well beyond plumose part of hairs giving the appearance of a layer of simple guard hairs.

Male. Bases of mandibles, labrum and distal half or slightly more of clypeus yellow; *clypeus distinctly protruding from face, flattened posteriorly as in female; eyes bulbous, large,* distinctly converging towards bases of mandibles, *more than twice as wide as genal areas in profile*; antennae long, reaching second metasomal tergum in repose; *maximum length of first flagellar segment equals no more than one third of second segment along same side (dorsal) and usually less*; galeae, maxillary palpi, tegulae and punctation of head and thorax as in female. Metasoma narrow; pygidial plate large, truncate apically and not much wider at base than at apex, notched laterally near apex; sterna coarsely and densely punctate; *fifth sternum with shallow emarginations laterally, long thin hairs arising from near margin of lateral emarginations curve downward in basal three fifths and then bend sharply posteriorly to form a curved row of long hooked hairs overlapping sixth sternum*; last exposed sternum (sixth) rounded apically, with a shallow hairless median groove and two shallow oval impunctate depressed areas laterally near base and beneath hooked hairs of fifth sternum, elsewhere with punctures bearing long hairs directed posteriorly. *Strigilis with long malus which reaches or almost reaches distal tip of fore basitarsus, pectinate; middle tibial spurs hooked near tips; fore basitarsi slightly twisted, inner surface distal to emargination of strigilis divided into two distinct halves—basal half densely set with long, thin, slightly flat-tipped hairs and distal half which is smoothly depressed, thinner, impunctate, mostly hair-*

less and bears a small tuft of ten to twelve stout, flat-tipped hairs about half as long as those in basal half; inner surfaces of hind basitarsi with long triangular apical impunctate shiny area bordered posteriorly by a dense row of short highly plumose weak hairs and anteriorly by an oblique row of simple stout hairs as elsewhere on inner surface, these hairs of inner surface become much longer apically and along anterior border of basitarsus. *Distribution of spatuloplumose hairs as in female. Seventh metasomal tergum without lateral teeth*; lateral teeth present on sixth tergum.

Genitalia distinctive, relatively large. *Gonostylus exceedingly thin, long, slightly capitate, attached to gonocoxite ventrally,* bearing a small tuft of hairs at tip and a few along shaft. *Gonocoxite produced dorsally and apically into a long, stout, incurved, truncate process almost half as long as gonostylus; spatha as long as wide or longer,* slightly emarginate medially at apex and *constricted about half distance from apex to base; penis valve very much enlarged,* with sharp apical process directed laterally, rather membranous with several indistinct longitudinal folds dorsally and ventrally, lateral process short and blunt, *ventral surface just below apical process with a large oval pad which is somewhat narrowed distally and covered with minute transverse striations,* with very long, weak hairs directed laterally from lateral surface of valve below lateral process. *Sternum 7 with lateral plates not emarginate laterally* but with strong median apical processes directed posteriorly; with two small median plates without hairs. Sternum 8 with lateral apodemes extremely short and thick, as wide as one fourth of length of sternum or wider, and center of lateral apodemes lie immediately below center of sternum; pointed apically, with strong apically directed, longitudinal ventral, median carina.

Melissodes (Epimelissodes) duplocincta Cockerell.

Melissodes duplocincta Cockerell, 1905, Pysche, vol. 12, p. 103; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 78, 88; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 137.

Female. Measurements and ratios: N, 20; length, 10-12 mm.; width, 3.5-4.5 mm.; wing length, $M = 3.52 \pm 0.164$ mm.; hooks in hamulus, $M = 12.45 \pm 0.135$; flagellar segment 1/segment 2, $M = 1.87 \pm 0.022$.

Structure and color: Integument generally black; distitarsi, apex of first metasomal tergum and lower surfaces of flagella rufescent; in palest specimens metasomal terga 1 and 2, legs, sterna, apex of propodeum, median areas of scutellum and mesoscutum, metepisterna and posterior part of mesepisterna, bases of mandibles, labrum and clypeus all red or brownish-red. Punctures in posterior half of clypeus round, separated by one to two puncture widths; maxillary palpal segments in ratio of about 4:2:2:1. Punctures in posteromedian area of mesoscutum separated mostly by one or more puncture widths, small, round; lateral faces of mesepisterna and scutellum with punctures of same size as on mesoscutum, but more crowded. Basal half of dorsal face of first metasomal tergum with small round distinct punctures with shiny bottoms and separated by half to one puncture width, apical area impunctate, ground moderately shiny, delicately shagreened; terga 2-4 with extremely small but distinct punctures separated by about one puncture width beneath pale pubescent bands, in basal areas of black hairs punctures of same size but sparser medially and more crowded laterally in raised areas.

Hair: On head white except a few long pale grayish-brown hairs on vertex. Thoracic hairs white except black hairs on scutellum and pale grayish-brown hairs mixed with the white over most of mesoscutum producing a curious mottled or streaked appearance. First tergum with long white hairs in basal half and laterally, leaving a rectangular apical area which is hairless medially but with short, closely appressed, black hairs in lateral thirds or less; tergum 2 with white basal spatuloplumose bands connected at extreme sides with broad white distal pubescent band which is of about same width across entire tergum, with short, dark brown to black, suberect hairs in interband zone and this dark area medially equal in width to less than half of and laterally to three fourths or more of apical band, with a fringe of short dark brown hairs on margin across most of tergum; tergum 3 similar to tergum 2 but without basal white band and apical band slightly wider than that on tergum 2; tergum 4 similar to tergum 3 but pale band even wider and without apical fringe of dark hairs except in median fifth or less; terga 5 and 6 with dark brown to black hairs, tufts of white hairs laterally on tergum 5; sternal hairs dark brown to reddish-brown. Legs with white hairs except the following: fore tarsi pale brown, inner surfaces of fore and middle tibiae and middle tarsi pale brown; inner surfaces of hind basitarsi and basitibial plates dark brown.

Male. Measurements and ratios: N, 20; length, 10-12 mm.; width, 3-4 mm.; wing length, $M = 3.41 \pm 0.221$ mm.; hooks in hamulus, $M = 11.45 \pm 0.114$; flagellar segment 2/segment 1, $M = 4.44 \pm 0.069$.

Structure and color: Integumental color as in female; labrum pale yellow; bases of mandibles and trilobed macula covering anterior half or somewhat more of clypeus bright yellow; flagella yellow or orange below except first and last segments, brownish-red above; wings as in female. Laterodorsal surfaces of last four or five flagellar segments with longitudinal impunctate shallow grooves or flattened depressed areas; maxillary palpi and galeae as in female; punctation of head, thorax and metasoma as in female. Genitalia as in subgeneric description (Figs. 58-61).

Hair: On head and thorax as in female, but without pale grayish-brown hairs on vertex of head and area of mottled hairs of mesoscutum less extensive (not extending forward beyond a transverse line at anterior margins of tegulae). Basal area of white hairs on tergum 1 covers more than half of tergum medially and apical rectangular area covered with short appressed black hairs arising from small distinct punctures; distal white pubescent bands on terga 2-5 equal to one another in width, that on tergum 2 about equal to basal area of black hairs laterally and not much wider than apical fringe of black hairs medially; apical fringe of dark hairs narrower on terga 3 and 4 and absent or reduced to less than one fifth of width of tergum on tergum 5; hairs of last two terga dark brown with small tufts of white hairs laterally on tergum 6; hairs of sterna reddish-brown to black. Legs with white hairs except red or yellowish-red on inner surfaces of tarsi and fore tibiae.

Type material. Lectotype male, here designated, and lectoallotype female, here designated, from Bill William's Fork, Arizona, August, F. H. Snow, are in the Snow Entomological Museum at the University of Kansas.

Distribution. This is a rather widespread, but relatively rare, desert species of extreme southern California, southern Arizona and northern Mexico (Fig. 3). This species has been collected from June 15 to August 23. Including the type material, 30 females and 31 males have been examined from localities listed below.

ARIZONA: Bill William's Fork; Black Dike Prospect, Sierrita Mts.; Buckeye; Madera Canyon, Santa Catalina Mts.; Oracle (5 miles W.); Phoenix; Santa Rita Mts.; Tucson. CALIFORNIA: Colorado Desert. CHIHUAHUA: Camargo (20 miles S.W.); La Cruz. COAHUILA: Guadelupe; Paila.

Flower records. This species seemingly does not visit composites. However, the flower records are too meager to infer any definite conclusions regarding flower preferences. Males have been collected on *Cevalia sinuata, Eriogonum* sp., *Gossypium herbaceum* and *Sphaeralcea* sp., and females have been taken on *Cevalia sinuata* and *Echinocactus* sp.

Subgenus MELISSODES Latreille

Melissodes Latreille, 1829, *in* Cuvier, Le Règne Animal, ed. 2, vol. 5, p. 354 (no species included); Romand, 1841, *in* Guérin, Mag. Zool., ser. 2, ann. 3, p. 5, pl. 70; Blanchard, 1849, *in* Cuvier, Le Règne Animal, (ed. 3), insectes, vol. 2, p. 216, atlas pl. 128 *bis*, fig. 4; Cresson, 1878, Trans. Amer. Ent. Soc., vol. 7, pp. 224-226; Ashmead, 1899, Trans. Amer. Ent. Soc., vol. 26, pp. 62, 63; Cockerell, 1901, Ann. Mag. Nat. Hist., ser. 7, vol. 7, p. 49; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 74-93, 102-104, 107-114; Robertson, 1905, Trans. Amer. Ent. Soc., vol. 31, p. 365; Cockerell, 1910, Univ. Colorado Studies, vol. 7, pp. 184, 193; 1911, Proc. U. S. National Museum, vol. 43, pp. 262, 267; Viereck, 1916, Connecticut Geol. Nat. Hist. Surv. Bull., no. 22, p. 730; Cockerell, 1918, Trans. Amer. Ent. Soc., vol. 44, pp. 29-31; Lutz and Cockerell, 1920, Bull. Amer. Mus. Nat. Hist., vol. 42, pp. 595-614.

Type species. Melissodes leprieuri Blanchard, 1849 (first recognizable included species).

Female. Small to medium-sized bees; color various, but rarely with metallic reflections on metasomal terga. Clypeus relatively flat to slightly protuberant, never protruding beyond face as much as half of width of eye in profile, rising gradually from plane of supraclypeal area, not forming a distinct step from supraclypeal area to a flattened clypeal plane; *galea smooth and shiny, sparsely punctate above, ground rarely delicately shagreened above, but usually somewhat dulled at tip;* maxillary palpi 4-segmented, fourth segment always shortest and second segment usually longest; minimum length of second flagellar segment usually less than apical width, occasionally as long as wide, but never longer, always slightly shorter than third segment; eyes always more than one third as wide as long and less than half as wide as long in facial view, converging towards mandibles, wider than genal area in profile. Thorax variously sculptured, but *dorsal face of propodeum always with discrete punctures in at least apical half and usually with ground areas shiny or moderately so,* finely tessellate or shagreened; *metanotum as long medially as dorsal face of propodeum and usually longer; tegulae acuminate anteriorly, lateral margins concave or straight in anterior third or more,* each tegula thus in two portions, a flat, narrow, anterior section and a bulbous, wide, posterior section. Terga variously sculptured; first tergum usually half as long as greatest width, occasionally shorter and often longer.

Thorax never with spatuloplumose hairs. First tergum with long plumose hairs basally, short appressed or subappressed, relatively simple hairs apically; *tergum 2 rarely with spatuloplumose hairs in basal pubescent band and, when these are present, the spatulate tips are narrower than in Epimelissodes,* with basal and distal bands separated by a more or less narrow zone of suberect to appressed, simple hairs, *distal pale band never reaches apical margin of tergum except rarely at extreme sides,* apical area with short, suberect to appressed, simple hairs, *distal band usually not interrupted medially except by wear, of approximately the same width across tergum (not abruptly notched medially along posterior margin); tergum 3 with a usually broad pubescent band separated from apex across entire tergum except occasionally at extreme sides,* apical area as in tergum 2; tergum 4 with a broad apical pale pubescent band often interrupted medially by a patch of suberect simple hairs. *Inner surfaces of hind basitarsi usually with yellow to dark red hairs*; scopal hairs usually pale, highly plumose.

Male. Labrum usually all pale colored, occasionally with a narrow brown margin; clypeus yellow; mandibles usually with broad basal yellow spots. Clypeus never protruding from face by as much as half of width of eye in profile, arising gradually from plane of supraclypeal area; *galeae smooth and shiny,* not dulled by tessellation or shagreening except at tips; maxillary palpi as in female, rarely with a minute fifth segment; *minimum length of first flagellar segment equals one third to one tenth of maximum length of second segment,* usually about one sixth as long as second segment; antennae long to moderately long, reaching at least to first metasomal tergum and usually to apex or beyond; eyes less than half as wide as long in facial view, converging towards mandibles. Structural characters of thorax and metasoma as in female with the following additions: tergum 7, as well as 6 and usually 5, with short apical spines on each side; pygidial plate always notched a little before apex on each side, usually longer than basal width; last exposed sternum subtriangular, truncate apically but not sharply so, shallowly grooved medially, bare or almost so.

Genitalia and hidden sterna are distinctive; *gonocoxite with dorsal carina not produced dorsally and inwards to form an obtuse process; gonostylus* short, equal to half length of gonocoxite, often somewhat capitate, with abundant, often long, simple hairs on outer surface, *never twice as wide near base as near apex. Sternum 7 with lateral plate large, testaceous and without a sharp, laterally directed, apical process, apex rounded, directed apically or slightly laterally, well separated from median plate; median* *plate completely devoid of hairs, relatively small, curved ventrally to form an oblique, scroll-like or partial-cylinderlike* structure, occasionally reduced to a small simple structure curved ventrally and well separated from base of median emargination, often with ventral fold of scroll flattened and greatly expanded to resemble superficially the large transparent plate of *Eumelissodes* and *Ecplectica,* but the hairlessness and the derivation from the oblique, scroll-like plate is obvious. Sternum 8 with a long median ventral keellike carina which may be expanded at apex; usually with apical hairs; apex not truncate as in *Epimelissodes.*

Hair pattern as in female with the following additions: tergum 4 with pubescent band similar to that of tergum 3 but closer to apical margin; tergum 5 usually with apical band similar to that on tergum 4 of female, but narrower and often interrupted medially or absent; *terga 6 and 7 with brown to black, long, appressed hairs at least medially.*

Remarks. Melissodes fonscolombei Romand, 1841, is considered to be a *nomen dubium,* hence unavailable for taxonomic purposes. *M. leprieuri* Blanchard then becomes the first species included in this genus. The reasons for considering *fonscolombei* as a *nomen dubium* have been outlined in a note sent to the secretary of the International Commission on Zoological Nomenclature to be published in the Bulletin of Zoological Nomenclature.

In order not to be repetitious, the first description below, that of *M. communis,* is relatively more detailed than those following. This species will serve as a model with which to compare subsequently described forms. Additional characters of the subgenus, mostly negative, are included in the key to the subgenera of *Melissodes* given above.

There are certain species groups within the subgenus *Melissodes* which are characterized by similarities in the male genitalia and hidden sterna and to some extent in punctation and/or color pattern. The species involved in these groups are often extremely similar and difficult to separate. Some of these could justifiably be termed sibling species. A stable character in one or more species often becomes quite variable in another species. This occurs with most of the characters employed as specific characters. There is considerable geographic variation also complicating the situation. Often this variation in one species is paralleled in one or more additional species. For these reasons the keys provided to separate these species are less reliable than usual and one must depend a great deal on the detailed descriptions and particularly on the discussions of variation provided with each description. The groups mentioned above are often not distinct and grade into one another and, therefore, are not named here. The relationships of the various species can be inferred from their arrangement below and from statements in the text.

The key to species given below includes the two species of the subgenus *Ecplectica* which occur within the region covered by this revision. The key to the males is especially difficult to use and a few couplets probably will cause a certain amount of misidentification. Several species, however, can be recognized readily by certain characters of the terminalia (*tessellata, raphaelis, trifasciata, rufodentata, tepaneca, gilensis, paroselae*). Since identification of some of these species depends upon the terminalia and since the most troublesome couplets in the key involve separating certain of these from the remaining species, the author feels that all males belonging to these subgenera should be dissected by anyone not thoroughly familiar with these groups. To facilitate identification of the males, the several species listed above can be removed from the key to the males given below and readily identified by means of the short key which follows immediately below.

1. Gonostylus very short, less than half as long as gonocoxite, twice as broad basally as near apex or broader in lateral view, not capitate; median plate of sternum 7 relatively small, with several short hairs on ventral surface (Figs. 104-106) (to couplet 7 of the key to males given below). .... *Ecplectica*
   Gonostylus usually as long as or longer than half length of gonocoxite, not twice as wide basally as near apex in lateral view, often somewhat capitate; median plate of sternum 7 without hairs ventrally 2

2(1). Sternum 7 with median plate reduced to a small process curved ventrally and separated from middle of median emargination of the sternum by twice the length of the plate or more (Fig. 89) (to couplet 26 of the key to males given below).
   Sternum 7 with median plate large, curled or folded ventrally and forming an oblique scroll-like structure separated from middle of median emargination by the length of the plate or less, *or* expanded into large flattened plates 3

3(2). Mesoscutum, scutellum and mesepisterna with ground areas dulled by dense, regular tessellations; sternum 7 with median plate bidentate apically (Fig. 102) .... *tessellata*
   Mesoscutum, scutellum and mesepisternum with ground areas smooth and shiny or somewhat dulled by shagreening or irregular tessellation; sternum 7 with median plate variously formed, not bidentate apically 4

4(3). Sternum 7 with median plate flattened and expanded so that medially it is as broad as or broader than lateral plate at the same level, *if* slightly narrower, *then either* apex of plate bent dorsally *or* apex of gonocoxite separated from apex of its dorsal carina by one third length of gonostylus or more (Figs. 94, 97, 98) . . . 5

Sternum 7 with median plate in the form of elongate, oblique, scroll-like structure which may be slightly flattened ventrally, but ventral fold of "scroll" never as wide medially as lateral plate at the same level, tip of plate not bent dorsally; gonocoxite with apex not far removed from apex of its dorsal carina (to couplet 2 of the key to males given below, omitting all couplets ending with the species referred to in this key).

5(4). First flagellar segment very short, minimum length equals one eighth or less of maximum length of second segment and scarcely, if any, longer than pedicle . . . *paroselae*

First flagellar segment longer, minimum length equals about one fifth of maximum length of second segment, often longer and never shorter than one seventh of second segment, distinctly longer than pedicle . . . 6

6(5). Medium-sized bees; tergum 2 with interband zone distinctly punctate; sternum 7 with median plate bent dorsally at tips and with inner apical margin curved, apex rounded (Fig. 94). *gilensis*

Small bees; tergum 2 with interband zone obscurely punctate; sternum 7 with flattened ventral surfaces obliquely rhomboidal in outline, tips not bent dorsally and not rounded (Fig. 97). *blanda*

KEY TO THE SPECIES OF THE SUBGENERA ECPLECTICA AND MELISSODES

MALES

1. Mesoscutum with small shallow punctures separated by one to two puncture widths anteriorly and two to four puncture widths in posteromedian area; mesoscutum, scutellum and mesepisternum with dense regular tessellations completely dulling surfaces . . . *tessellata*

Mesoscutum with punctures usually deeper, larger and more crowded; mesoscutum, scutellum and mesepisternum without dense regular tessellation dulling surfaces, occasionally shagreened or irregularly tessellate in one or more of these areas, but not regularly so in all of them . . . 2

2(1). Metasomal hairs and pubescence all black or with bands of pale pubescence interrupted medially on all terga, except, perhaps, the third; mesepisternal hairs all or almost all dark brown to black . . . 3

Metasomal hairs and pubescence forming complete bands of pale pubescence on at least two terga, *if* all pale bands interrupted medially, *then* mesepisternal hairs all pale, except for a few brown hairs in lower posterior angles . . . 5

3(2). Head with white hairs at least surrounding antennal fossae and usually all or almost all hairs of head white; mesoscutum often with sparse white hairs laterally and anteriorly; terga 2 to 5 usually with at least a few white hairs laterally . . . 4

Hairs of head, mesoscutum and terga all black . . *leprieuri*

4(3). Terga 2 and 3 with sparse but distinct punctures separated by one or more puncture widths in basal half or less of apical areas, these punctures about equal in diameter to those of basal areas of terga; wing membranes somewhat infumate, yellowish (Mexico) . . . *labiatarum*

Terga 2 and 3 with abundant punctures separated by one puncture width or less in basal three fifths of apical areas (especially laterally), punctures distinctly smaller than those of basal areas of terga; wing membranes usually deeply infumate, brown (United States) . . . *bimaculata*

5(2). Tergum 2 with distal pale band absent or interrupted medially 6

Tergum 2 with distal pale band complete, interrupted medially only in worn specimens and then former presence indicated by crowded row of punctures . . . 12

6(5). Gonostylus very short, less than half as long as gonocoxite, in lateral view twice as broad near base as near apex, not capitate; median plate of sternum 7 relatively small, with several short hairs on ventral surface (*Ecplectica*) . . . 7

Gonostylus usually as long as half length of gonocoxite or longer, not twice as wide basally as near apex in lateral view, often somewhat capitate; median plate of sternum 7 without hairs ventrally . . . 8

7(6). Tergum 2 with distal pale band absent; mandibles often without basal yellow spots or these reduced in size; tergum 3 with apical area with small indistinct punctures basally . *trifasciata*

Tergum 2 with distal pale band present but interrupted medially; mandibles with large yellow basal spots; tergum 3 with apical area coarsely punctate basally . . . *raphaelis*

8(6). Tergum 2 with distal pale band reduced to short lateral fasciae equal in length to one third or less of width of tergum; legs with sparse, weak hairs; outer surfaces of hind tibiae with hairs weakly plumose, not hiding surfaces, median third with punctures bearing hairs separated from their nearest neighbors above and below by two to four puncture widths or more. *foxi*

Tergum 2 usually with distal pale band only narrowly interrupted medially, lateral fasciae usually equal to more than one third of width of tergum; legs with hairs abundant; outer surfaces of hind tibiae effectively hidden by long, highly plumose hairs, median third with punctures bearing hairs separated above and below mostly by one puncture width or less . . . 9

9(8). Terga 2 and 3 with apical areas densely punctate, punctures separated mostly by one puncture width, often by less and occasionally by more, but rarely by more than two puncture widths (Texas) . . . *maesta*

Terga 2 and 3 with apical areas impunctate or with punctures separated mostly by two or more puncture widths . . . 10

10(9). Tergum 4 with pale pubescent band reaching apical margin laterally, strongly notched medially along posterior margin; tergum 5 with a complete or narrowly interrupted pale band; hairs of head and thorax ferruginous, pale metasomal bands white (Mexico) . . . *elusa*

Tergum 4 with pale pubescent bands separated from apical margin across entire tergum; tergum 5 with pale pubescence absent or restricted to lateral fasciae equal to one third or less of width of tergum; hairs of head and thorax white or pale ochraceous, or, *if* ferruginous, *then* pale metasomal bands also ferruginous . . . 11

11(10). Head and thorax with pale hairs white to pale ochraceous; terga with pubescent bands white; tegulae dark brown to black (Mexico) . . . *labiatarum*

Head and thorax with pale hairs ferruginous; terga with pale pubescent bands ferruginous; tegulae red to reddish-brown (Cuba) . . . *cubensis*

12(5). Minimum length of first flagellar segment equals one sixth of maximum length of second segment or more, occasionally slightly less, but *if* equal to as little as one seventh of second segment, *then* terga 2 and 3 with apical areas impunctate or with minute punctures equal to less than two times basal width of hairs arising from them . . . 13

Minimum length of first flagellar segment equals less than one sixth of maximum length of second segment, usually one seventh or less, *if* as long as one sixth, *then* terga 2 and 3 with distinctly punctate apical areas, punctures equal to about three times basal width of hairs arising from them . . . 21

13(12). Tergum 2 with broad distal band equal to apical area medially or almost so; tergum 4 with broad pale band equal to four times apical area medially or more . . . 14

Tergum 2 with distal band narrow, half as wide as apical area medially or less, or, *if* as wide as apical area or almost so, *then* tergum 4 with pale band distinctly narrower than four times apical area medially . . . 15

14(13). Medium-sized bees, 10.0-13.0 mm. in length; terga 2-4 with apical areas broadly hyaline, yellow to colorless; tergum 2 with interband zone and terga 2-4 with apical areas with surfaces dulled by fine transverse shagreening; sternum 7 with median plate enlarged, flattened, with tips bent dorsally and with inner margin curved and apices rounded in ventral view (Fig. 94) . . . *gilensis*

Small bees, 7.5-11 mm. in length; terga 2-4 with apical areas usually piceous or at least infumate, occasionally colorless, rarely yellow; tergum 2 with interband zone and terga 2-4 with apical areas shiny to moderately so, with transverse shagreening relatively coarse; sternum 7 with median plate forming a slightly flattened, ventral fold, inner margin straight, transverse or nearly so (forming much more than a 45 degree angle with the vertical), not bent dorsally at tips (Fig. 77). *tepida*

15(13). Hairs of head and thorax very long and weak, lower halves of lateral surfaces of mesepisterna with hairs seen from front considerably longer than third flagellar segment; minimum length of first flagellar segment equals one third to one fourth of longest length of second segment; apical margin labrum brown . . . *flexa*

Hairs of head and thorax shorter, those of lower halves of lateral surfaces of mesepisterna equal to third flagellar segment or less; minimum length of first flagellar segment usually less than one fourth of maximum length of second segment; labrum usually entirely pale in color . . . 16

16(15). Terga 1 to 4 and often 5 with apical areas translucent brownish-yellow to transparent and colorless; tergum 2 with distal band often almost as wide as apical area medially . *communis*

Terga 1 to 4 with apical areas opaque dark brown to black; tergum 2 with distal pale band distinctly narrower than apical area medially . . . 17

17(16). Sternum 8 with median plate flattened, broad, ventral surface obliquely rhomboidal in outline; gonocoxite extends posteriorly beyond apex of dorsal carina of gonocoxite by almost half length of gonostylus, dorsal carina of gonocoxite angular (Figs. 96-97); pale pubescent band of tergum 5 complete; with little or no dark hairs on mesonotum or scutellum . *blanda*

Sternum 8 with median plate usually not flattened, not rhomboidal in outline ventrally, very narrow; dorsal carina of gonocoxite smoothly rounded, with apex not much separated from apex of gonocoxite (Figs. 69-72); often tergum 5 with pale band interrupted medially or absent; mesoscutum and scutellum often with abundant dark hairs . . . 18

18(17). Tergum 5 with pale band absent or broadly interrupted medially, *if* present and uninterrupted or only narrowly so, *then either* mesoscutum with abundant dark brown hairs posteromedially *or* tergum 2 with median third of interband zone impunctate or with small shallow punctures separated mostly by more than one puncture width and obscured by dense regular shagreening . . . *communis*

Tergum 5 with pale band complete or only narrowly interrupted medially, *if* absent or broadly interrupted, *then* mesoscutum without brown hairs and tergum 2 with median third of interband zone distinctly punctate, punctures separated by one puncture width or less and ground areas moderately shiny, not densely shagreened . . . 19

19(18). Vertex of head with abundant dark brown hairs; mesoscutum with brown hairs posteromedially . . . *martinicensis*

Vertex of head without dark hairs; mesoscutum without dark hairs or with a very small posteromedial patch of brown hairs . . . 20

20(19). Tergal bands white; tergum 5 with pale band complete or very narrowly interrupted .... *elusa*

Tergal bands ferruginous; tergum 5 with pale band restricted to lateral thirds of tergum or completely absent .... *cubensis*

21(12). Interband zone of tergum 2 with bristlelike hairs ochraceous, erect or almost so, long and stiff, long pubescence of basal pale band bent upwards by adjacent hairs of interband zone; tergum 2 with hairs of apical area long, ochraceous .... *panamensis*

Interband zone of tergum 2 with bristlelike hairs usually dark brown at least medially, suberect to subappressed, never so erect and stiff as to bend upwards the adjacent pubescence of the basal pale band; tergum 2 with hairs of apical areas usually brown at least medially 22

22(21). Terga 2 and 3 usually with apical areas (at least basally near pubescent bands) with punctures equal in diameter to three or more times basal width of hairs arising from them; tergum 5 with pale pubescent band absent or broadly interrupted medially; lateral areas of vertex between summits of compound eyes and lateral ocelli with abundant punctures separated mostly by less than one puncture width, ground areas delicately shagreened 23

Terga 2 and 3 with apical areas impunctate or with punctures much less than three times as wide as basal width of hairs arising from them; tergum 5 with pale band complete or very narrowly interrupted medially, *if* absent or broadly interrupted, *then* lateral areas of vertex with small punctures separated mostly by more than one puncture width, ground areas smooth and shiny 24

23(22). Tergum 2 with distal pale band usually equal to half or less of apical area medially, never as broad as three fourths of apical area; mesoscutum with abundant punctures, usually becoming smaller and more crowded posteromedially (United States). .... *comptoides*

Tergum 2 with distal pale band equal to about three fourths of apical area medially; mesoscutum with punctures becoming slightly sparser posteromedially, or evenly spaced (Bahama Islands) .... *cestus*

24(22). Minimum length of first flagellar segment rarely equals more than one seventh of maximum length of second segment (and then in a West Indies species); tergum 2 with distal pale band usually half as broad as apical area medially or less, relatively straight across tergum, appearing quite straight in median third and curving posteriorly in lateral thirds or less, apical area medially about twice as broad as apical area laterally 25

Minimum length of first flagellar segment often equals much more than one seventh of maximum length of second segment; tergum 2 with distal pale band much broader than half of apical area medially, *if* narrower than this, *then* considerably broader laterally than medially and/or strongly curved so that pale band reaches apex of tergum at extreme sides, or almost so, apical area being medially less than twice as wide as apical area laterally . . . 27

25(24). Terga 2-4 with apical areas dulled by very dense, fine, transverse shagreening; minimum length of first flagellar segment equals one eighth or less of maximum length of second segment; sternum 7 with median plate flattened and expanded (Fig. 98). . . . *paroselae*

Terga 2-4 with apical areas moderately shiny, only slightly dulled by fine, transverse shagreening; minimum length of first flagellar segment often equals more than one eighth of second segment; sternum 7 with median plates reduced to small, ventrally curled processes (Fig. 91) . . . 26

26(25). Mesoscutum never with small posteromedian area of small crowded punctures, evenly punctate or posteromedian area sparsely punctate; sternum 8 with apical margin straight or almost so, lateral apodemes with smoothly rounded posterior margins (Fig. 89) (West Indies) . . . *rufodentata*

Mesoscutum usually with small posteromedian area of punctures which are smaller and more crowded than on median flattened area; sternum 8 with apical margin emarginate, lateral apodemes with sinuate posterior margins (Fig. 92); (Southeastern United States to Panamá) . . . *tepaneca*

27(24). Tergum 2 with distal pale band broad, equal to three fourths of apical area medially or more; pale hairs of head and thorax white to pale ochraceous; mesoscutum with posteromedian area impunctate or sparsely punctate . . . *tepida*

Tergum 2 with distal pale band equal to half or less of apical area medially, *if* equal to three fourths of apical area, *then either* pale hairs of head and thorax ferruginous *or* mesoscutum with posteromedian area with punctures as crowded or more crowded than anteriorly, or both . . . 28

28(27). Tergum 5 with pale band absent or broadly interrupted medially, *if* complete or narrowly interrupted, *then* pale band of tergum 4 not sharply notched posteriorly but evenly curved. *thelypodii*

Tergum 5 with pale band complete or very narrowly interrupted; tergum 4 with pale band sharply notched posteromedially, almost cutting the band into two . . . *elusa*

FEMALES

1. Thoracic hairs entirely black or dark brown . . . 2

Thoracic hairs not all black or dark brown, with at least a few pale hairs on posterior lobes of pronotum and usually with pale hairs surrounding wing bases and on propodeum, or thoracic hairs all or largely pale . . . 5

2(1). Tergum 2 with distal pubescent band absent or reduced to short, thin, lateral fasciae of dark brown pubescence less than one third of width of tergum; terga 2 and 3 with apical areas with abundant punctures separated mostly by one to two puncture widths and about equal in diameter to those of basal areas. ***bimaculata***

Tergum 2 with distal pubescent band present, complete or narrowly interrupted medially, usually dark brown but often yellowish or white at least laterally; terga 2 and 3 with indistinct, widely separated, small punctures, or with larger punctures separated mostly by more than two puncture widths 3

3(2). Tergum 4 with apical white pubescent band present, often interrupted medially by dark brown hairs; terga 2 and 3 with white pubescent bands often present at least laterally; scopal hairs yellow to pale ochraceous; inner surfaces of hind basitarsi with orange to dark red hairs (United States or Mexico) 4

Tergum 4 without white pubescent band; tergum 3 without pale pubescence; tergum 2 with distal pubescent band usually dark brown, occasionally yellow laterally; scopal hairs usually black or dark brown, occasionally orange medially; inner surfaces of hind basitarsi with black hairs (Cuba) ..... *leprieuri*

4(3). Terga 2 and 3 with apical areas with 2 to 4 irregular rows of sparse, long, simple, dark brown hairs; tergum 2 with distal pubescent band dark brown or brown at least medially (Mexico) .... *morrilli*

Terga 2 and 3 with apical areas with 6 or more irregular rows of abundant, short, simple, dark brown hairs; tergum 2 with distal white pubescent band complete, unless worn away (United States) .... *communis*

5(1). Posterior pronotal lobes with abundant dark brown hairs; mesepisterna with abundant dark brown hairs at least on ventral and lower lateral surfaces; mesoscutal patch of dark hairs extending forward and laterally to fuse with posterior pronotal dark hair patch, or almost so 6

Posterior pronotal lobes with few or no dark hairs, *if* with abundant dark hairs, *then* mesepisternal hairs all pale and/or mesoscutal patch of dark hairs not extending forwards and laterally, but separated from posterior pronotal dark hairs by a band of pale hairs on mesoscutum 9

6(5). Tergum 2 with distal pale pubescent band absent or reduced to thin lateral fasciae each less than one third of width of tergum; tergum 3 often with short simple golden-yellow hairs on apical margin in at least lateral fourths; terga 2 and 3 with apical areas shiny, usually with violaceous reflections; wing membranes clear or almost so .... *Ecplectica* 7

Tergum 2 with distal pale band complete, *if* interrupted medially, *then* each lateral fascia equals one third or more of width of tergum; tergum 3 without fringe of golden-yellow hairs; terga 2 and 3 with apical areas moderately shiny, without violaceous reflections; wing membranes infumate, brownish 8

7(6). Tergum 2 with distal pale band absent; tergum 4 with a broad apical, median, triangular patch of dark brown simple hairs with its base on margin of tergum; tergum 3 without golden hairs fringing margin laterally .... *trifasciata*

Tergum 2 with distal pale band reduced to short lateral fasciae; tergum 4 with a transversely diamond-shaped patch of dark brown hairs touching apical margin medially; tergum 3 with at least several golden-yellow hairs fringing apical margin laterally . . . . *raphaelis*

8(6). Inner hind basitarsi and tibiae with yellow to orange-red hairs; terga 2 and 3 with apical areas minutely and sparsely punctate. *rufodentata*

Inner hind basitarsi and tibiae (usually) with dark reddish-brown to black hairs; terga 2 and 3 with apical areas densely and coarsely punctate . . . . . . *comptoides*

9(5). Scopal hairs brown; inner surfaces of hind basitarsi and tibiae with black to dark brown hairs; apical areas of terga 2 and 3 with coarse punctures separated by one to three puncture widths, ground dulled by dense, coarse tessellation. *negligenda*

Scopal hairs mostly yellow to white; inner surfaces of hind basitarsi and tibiae with variously colored hairs, but usually yellow to dark red; terga 2 and 3 with apical areas usually impunctate or with minute punctures, *if* coarsely punctate, *then* ground areas usually moderately shiny and only delicately shagreened 10

10(9). Mesoscutum with minute punctures separated by two to three puncture widths or more, ground spaces opaque, densely and regularly tessellate . . . . *tessellata*

Mesoscutum with large punctures separated by one puncture width or less at least anteriorly and laterally, ground spaces smooth and shiny or somewhat dulled by shagreening, not densely tessellate 11

11(10). Tergum 2 with distal pale band absent or reduced to lateral fasciae equal in length to a third or less of width of tergum, *if* narrowly interrupted medially, *then* terga 2 and 3 with abundant punctures in apical areas and lateral surfaces of thorax with hairs all or almost all black to dark brown . . 12

Tergum 2 with distal pale band usually complete, unless worn away, *if* narrowly interrupted medially (not due to wear), *then* apical areas of terga 2 and 3 impunctate or with minute punctures and lateral surfaces of thorax with hairs pale in upper halves or more 14

12(11). Inner surfaces of hind basitarsi and tibiae with yellow to orange-red hairs; mesepisternal hairs pale 13

Inner surfaces of hind basitarsi and usually hind tibiae with reddish-brown to black hairs; mesepisternal hairs dark brown to black except pale hairs surrounding wing bases and behind posterior pronotal lobes . . . . *maesta*

13(12). Tergum 2 with distal pale band absent; thorax with pale hairs grayish-white; mesepisterna with dark brown hairs ventrally and in upper fourth or more; posterior pronotal lobes usually with at least a few dark hairs . . . . . . *Eeplectica trifasciata*

Tergum 2 with distal pale band reduced to short lateral fasciae; thorax with pale hairs ochraceous to ferruginous; mesepisternal hairs all pale; posterior pronotal lobes without dark hairs. *foxi*

14(11). Tergum 2 with basal pubescent band with many basally plumose and apically spatulate hairs mixed with the normally plumose hairs; clypeus relatively flat, distinctly less than half as long as wide in facial view; mesepisterna without dark hairs. *paroselae*

Tergum 2 with basal pubescent band consisting of normally plumose hairs, *if* with some hairs narrowly spatulate apically, *then* mesepisterna with dark brown hairs ventrally and usually on lower lateral and anterior surfaces; clypeus often relatively bowed outwards and half as long as wide or longer in facial view 15

15(14). Mesepisterna with dark brown hairs at least ventrally, usually anteriorly and often on lower lateral surfaces as well 16

Mesepisternal hairs all pale 22

16(15). Terga 2 and 3 with apical areas with abundant coarse punctures separated mostly by one puncture width or less, *if* sparser, *then* three times basal width of short hairs arising from them or wider; tergum 2 with interband zone as broad as distal pale band or broader and with dark brown hairs at least in median third 17

Terga 2 and 3 with apical areas impunctate, with minute punctures two times basal width of short hairs arising from them or less, *if* with sparse coarse punctures, *then* tergum 2 with interband zone distinctly narrower than distal pale band and often without brown hairs 18

17(16). Tergum 2 with interband zone with punctures separated mostly by less than half a puncture width, with suberect to erect hairs which are stiff and bend tips of pubescence of basal band upwards, with distal pale band usually equal in width to half of apical area medially or almost so (Panamá)... *panamensis*

Tergum 2 with interband zone with punctures separated by half or more of a puncture width, with appressed or subappressed hairs which do not bend tips of pubescence of basal band upwards, with distal pale band equal to about one third of apical area medially or less 20

18(16). Tergum 2 with interband zone much broader than distal pale band across most of tergum 21

Tergum 2 with interband zone obliterated or no broader than distal pale band across most of tergum 19

19(18). Medium-sized bees; vertex with flattened areas extending medially and somewhat posteriorly from apices of compound eyes with round punctures separated mostly by one puncture width, ground shiny, without or with only sparse delicate shagreening; posterior pronotal lobes without dark hairs . . . . . . *elusa*

Small bees; vertex with lateral flattened areas with coarse, irregular punctures separated mostly by less than one puncture width, ground dulled by dense, irregular, coarse shagreening, *if* sparsely punctate and shiny, *then* posterior pronotal lobes with abundant dark brown hairs 28

20(17). Wing membranes clear or only slightly infumate; tergum 2 with distal pale band not much arched, about equal in width across tergum, often ochraceous in color, usually equal in width to more than one third of apical area medially; terga 2 and 3 with punctures of apical areas equal to two to three times basal width of hairs arising from them or less . *tepaneca*

Wing membranes infumate, yellowish-brown to brown; tergum 2 with distal pale band evenly arched forwards, usually slightly thinner medially, white, usually equal in width to one third of apical area medially or less; terga 2 and 3 with coarse punctures equal to three to four times width of hairs arising from them or more . . . . *comptoides*

21(18). Clypeus relatively flat, slightly shorter medially than half of width in facial view; tergum 2 with distal pale band not evenly arched forwards, relatively straight across tergum, usually broader than one third of width of apical area medially, usually ochraceous in color, with interband zone distinctly and evenly punctate across entire width of tergum . . *tepaneca*

Clypeus strongly bowed outwards from face, slightly longer medially than half of width in facial view; tergum 2 with distal pale band evenly arched forwards, usually one third as wide as apical area medially or less, usually white in color, with interband zone impunctate medially or with punctures small, shallow and obscured by dense shagreening medially. *communis*

22(15). Anterior halves of tegulae and posterior pronotal lobes usually with dark brown to black hairs mixed with the pale, occasionally pronotal lobes without and tegulae with dark hairs, *rarely* with dark hairs absent on both pronotal lobes and tegulae *and then* pale pubescent bands of terga (especially terga 3 and 4) conspicuously yellower than pale thoracic hairs 23

Anterior halves of tegulae and posterior pronotal lobes usually without dark hairs mixed with the pale, occasionally pronotal lobes with and tegulae without dark hairs, *rarely* with dark hairs on tegulae and without dark hairs on posterior pronotal lobes *and then* pale tergal bands concolorous with pale ochraceous thoracic hairs, or tergal bands whiter than thoracic hairs 24

23(22). Terga 2 and 3 with apical areas with small, but distinct, punctures separated mostly by one puncture width or less; tergum 2 with punctures of interband zone round, distinct across entire tergum (Bahama Islands) . . . . *cestus*

Terga 2 and 3 with apical areas impunctate or with minute punctures separated mostly by two or more puncture widths; tergum 2 with punctures of interband zone becoming minute medially (United States) . . . . *gilensis*

24(22). Pale mesoscutal and scutellar hairs orange-red; tergum 2 with distal pale band relatively straight, not markedly thinned medially, equal in width to half of interband zone; posterior pronotal lobes often with long dark hairs mixed with the pale (West Indies) . . . . *rufodentata*

Pale mesoscutal and scutellar hairs ochraceous to white, occasionally somewhat ferruginous anteriorly, *if* orange-red, *then* tergum 2 with distal pale band strongly arched forward, markedly thinned medially and/or narrower than interband zone across most of tergum; posterior pronotal lobes without dark hairs (United States) 25

25(24). Mesoscutum with large posteromedian patch of dark brown hairs; pale mesoscutal and scutellar hairs ochraceous to white, occasionally somewhat ferruginous anteriorly; tergum 2 with distal pale band equal to half or more of apical area medially . . . 26

Mesoscutum with no brown hairs or with small posteromedian patch, *if* this patch extends forward to a transverse line at middle of tegulae or more, *then* pale hairs of thorax orange-red and tergum 2 with distal pale band much narrower than half of apical area medially . . . . *thelypodii*

26(25). Terga 2 and 3 with narrow apical area minutely, but distinctly, punctate, ground spaces shiny to moderately so, delicately shagreened . . . . *tepida*

Terga 2 and 3 with apical areas impunctate, ground spaces dulled by fine, but very dense shagreening 27

27(26). Tergum 1 with margin piceous or yellowish in apical eighth or less of dorsal surface; head, mesoscutum, scutellum and terga with pale hairs white or grayish-white; tergum 2 with interband zone without distinct punctures . . . . *blanda*

Tergum 1 with apical margin translucent or yellowish in apical sixth or more of dorsal surface; head, mesoscutum, scutellum and terga with pale hairs usually ochraceous to pale ochraceous; tergum 2 with small, distinct punctures in lateral fourth or slightly more of interband zone . . . . *communis*

28(19). Posterior pronotal lobes with abundant dark brown hairs; facial hairs at least half dark brown; pale hairs of mesoscutum and scutellum orange-red; pale hairs of mesepisterna white at least above (West Indies) . . . . *rufodentata*

Posterior pronotal lobes with hairs all pale; facial hairs all pale; mesoscutal hairs ferruginous but not usually orange; mesepisternal hairs pale above but not usually white (United States, Mexico and Central America) . . . . *thelypodii*

Melissodes (Melissodes) communis Cresson.

The females of *communis* are recognized by their large size, the lack of punctures in the apical areas of metasomal terga 2 and 3, the rather sparse and large punctures separated usually by more than one puncture width in the posteromedian area of the mesoscutum, the dark brown hairs usually present on the mesoscutum and scutellum and the bright red hairs of the inner surfaces of the hind basitarsi. The males in general have these same characters, but the brown hairs of the mesoscutum are often absent and, in addition, the gonostylus has a tuft of long simple hairs near the base, the median plates of the seventh sternum are in the form of a long oblique scroll, the apex of the eighth sternum is usually deeply emarginate and bears long simple hairs, and the minimum length of the first flagellar segment equals one sixth of the maximum length of the second segment or more. This species is most easily confused with *M. comptoides* with which it is largely allopatric, but can be distinguished from the latter by the relatively longer first flagellar segment of the male, the impunctate apical areas of the terga in both sexes and by the more sparsely punctate mesoscutum in both sexes, but especially in the female. The western subspecies of *communis* is similar to *M. gilensis* from which it can be distinguished by characters summarized in the diagnosis of the latter.

Female. Measurements and ratios: N, 20; length, 12-16 mm.; width, 4-6 mm.; hooks in hamulus, $M = 16.95 \pm 0.285$; wing length, $M = 4.57 \pm 0.384$ mm.; flagellar segment 1/segment 2, $M = 2.01 \pm 0.019$.

Structure and color: integument generally black; distitarsi usually rufescent; basitarsi and apical areas of metasomal terga 2-4 often reddish-brown; antennal scapes and first two flagellar segments dark brown to black, remaining segments red to reddish-brown below and black above; eyes usually yellowish-green, occasionally gray to yellowish-brown. Clypeus coarsely punctate with punctures mostly round, deep, and separated by half of one puncture width or less, often with raised median carina or boss in apical half which is shiny and impunctate, ground smooth or delicately shagreened, shiny to moderately shiny; supraclypeal area with large round punctures at least laterally, usually dulled by delicate shagreening; flattened areas of vertex extending mesad and somewhat posterior from apices of compound eyes with distinct round punctures separated mostly by one to one half of one puncture width, ground shiny, delicately or not at all shagreened; eyes in facial view three times as long as wide or nearly so, converging slightly below; maxillary palpal segments in ratio of about 6:8:5:1, fourth segment variable and often twice as long; galeae with scattered punctures bearing short straight hairs dorsally, ground smooth and shiny except at tips. Punctures on mesoscutum large, deep, round, crowded anteriorly, laterally and in short posterior declivous area, but larger and separated mostly by more than one puncture width in flattened posteromedian area and often this area almost impunctate, ground shiny, delicately or not at all shagreened; scutellum with punctures of about same size as on adjacent area of mesoscutum except smaller punctures along midline and periphery, crowded, ground shiny; lateral surfaces of mesepisterna with round, deep punctures of about same size as on anterior half of mesoscutum, separated by less than one puncture width, ground usually delicately shagreened, shiny; metanotum usually as long as or somewhat longer than dorsal face of propodeum medially, with small crowded punctures, ground usually dulled by delicate shagreening, but often smooth and shiny on flat dorsal surface medially; basal face of propodeum reticulopunctate basally, punctures distinctly separated apically, declivous face and lateral faces with crowded large punctures except usually impunctate upper area of declivous face; ground usually dulled by coarse dense shagreening, occasionally shiny on impunctate upper area of declivous face and on basal face. First metasomal tergum with small shallow punctures separated mostly by one half to two puncture widths at least medially in basal half to three fifths, impunctate apically, ground dulled by dense, fine shagreening; tergum 2 with exceedingly small, round punctures beneath basal pubescent band, with small round punctures in interband zone separated mostly by more than one puncture width medially, but somewhat larger and more crowded laterally, without or with exceedingly minute punctures less than two times width of hairs arising from them in apical area, ground dulled by dense, fine shagreening; terga 3 and 4 with small round punctures separated by less than one puncture width medially and often confluent laterally in basal areas, apical area of tergum 3 as in tergum 2, ground dulled by very dense, fine shagreening.

Hair: On head ochraceous to white, often with abundant dark brown hairs on vertex between apices of compound eyes, but these may be sparse or absent. Mesoscutum usually with a large square patch of dark brown to black hairs in posteromedian area, reduced to a few hairs or absent in a few individuals, pale hairs of mesoscutum usually ochraceous, but often white in specimens from the eastern part of the range and pale rufescent in the west; scutellum with large median patch of dark hairs fringed with ochraceous to white hairs. First metasomal tergum with long pale hairs in basal two thirds or less and laterally to margin, apical area mostly bare, but with a few simple, appressed, dark brown hairs at extreme sides; tergum 2 with basal band of pale pubescence composed at least partially of basally plumose and apically narrowly spatulate hairs, joined at extreme sides with thin distal band of pale pubescence which equals about one third of apical area or more medially, interband zone and apical area with erect, suberect or appressed dark brown to black hairs; tergum 3 with broad median band of pale pubescence which is thick apically, thinner and more diffuse basally, basal area of tergum with abundant dark brown to black, erect or suberect hairs and pubescence, apical area as in tergum 2; tergum 4 with broad apical band of pale pubescence, often interrupted medially by a small triangle or rectangle of dark brown suberect hairs, basal areas as in tergum 3; terga 5 and 6 covered with dark brown to black appressed hairs, often with tufts of long pale hairs at extreme sides, especially on tergum 5. Inner surfaces of hind basitarsi and hind tibiae with bright red to yellow hairs; scopal hairs white to ochraceous.

Male. Measurements and ratios: N, 20; length, 10-15 mm.; width, 3.5-5.5 mm.; wing length, $M = 4.18 \pm 0.371$ mm.; hooks in hamulus, $M = 15.05 \pm 0.328$; flagellar segment 2/segment 1, $M = 4.80 \pm 0.115$.

Structure and color: Clypeus, bases of mandibles and entire labrum pale to bright yellow, yellow spot at base of mandible usually covers entire basal half or at least wider than depressed basal triangular area; scape dark reddish-brown to black, flagellum red to yellow above, dark brown to black below; eyes gray-brown to yellowish-green; integument otherwise generally black except legs often wholly red, at least distitarsi red, and apical areas of metasomal terga often hyaline or translucent. Minimum length of first flagellar segment usually equal to one sixth of maximum length of second segment, occasionally slightly less and often more, always distinctly longer than pedicle; maxillary palpal segments as in female, but rarely with a minute fifth segment; head sculptured as in female, but clypeus less coarsely punctate. Sculpturing of thorax as in female, but posteromedian area of mesoscutum sometimes with more crowded punctures. Sculpturing of metasoma as in female, but basal punctate area of tergum 1 equal to three fifths or more of median length of tergum, ground exceedingly densely shagreened and punctures small and shallow.

Gonostylus short, capitate, with basal outer tuft of long, simple hairs directed distally; inner surface of gonocoxite below gonostylus with abundant short simple hairs and with several short blunt hairs intermixed with pointed hairs, ventral surfaces of gonocoxite below gonostylus with several very short, simple, pointed hairs; spatha not emarginate medially, with a small notch on distal margin laterally to receive dorsal lamella of penis valve, lateral processes rectangular and directed anterolaterally. Sternum 7 with lateral plate less than twice as long as wide and usually shorter than half length of tergum from tip of plate to tip of apodeme; median carinae form a broadly V-shaped structure, not reaching apex of sternum medially; median plate large, forming and elongate, oblique, half to three quarter cylinder more than twice as long as wide; apodeme long, thin, pointed or rounded apically. Sternum 8 emarginate apically, with long simple hairs at apex laterally, with a high, longitudinal, ventral, median carina which just exceeds apex of sternum medially; lateral apodemes short, with slightly narrower neck region and a minute basally projecting process (Figs. 69-72).

Hair: Color and pattern much as in female, but with the following differences: rarely with dark hairs on head; often mesoscutum without dark hairs and scutellum occasionally without dark hairs; lower lateral, ventral and anterior surfaces of mesepisterna never with dark brown hairs; first metasomal tergum rarely bare apically, usually with dark brown appressed hairs across entire apical area and often these hairs yellowish at least medially; tergum 2 with distal pale band wider, usually equal to more than one third of apical area medially, hairs of apical and interband zone often pale, but usually dark brown to black; tergum 4 with a complete pale pubescent band separated from margin across most of tergum by an apical area similar to that on terga 2 and 3; tergum 5 often with a complete pale apical band; terga 6 and 7 with dark brown to black hairs, but usually with large pale tufts of hairs laterally.

Geographical variation. Two subspecies of *communis* are recognized here, the darker race, *communis s. str.*, occupying eastern United States and northern Mexico, and the paler race, *alopex*, occupying western United States and southwestern Canada. *M. communis* throughout its range is highly variable in regard to size. The largest specimens are those from Utah. The eastern race is more variable than the western in regard to color of vestiture and integument.

The specimens of *communis s. str.* from along the Atlantic Coast south into Florida and west through the Gulf States to Louisiana are on the average smaller in size and slightly darker in color than specimens from the plains area. The patch of brown hairs on the mesoscutum is always present in females from this eastern area, almost always present in the males, and is on the average larger than in specimens from farther west. The pale hairs of the body, how-

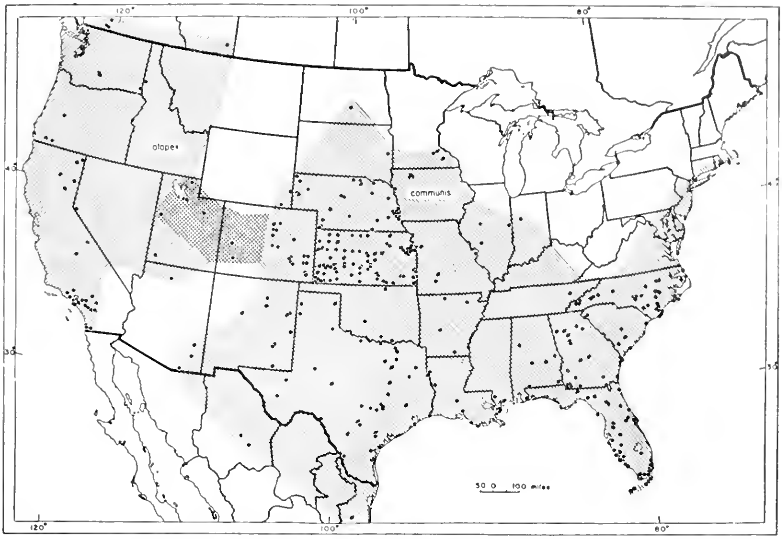

FIG. 11. Map showing the distribution of *M.* (*Melissodes*) *communis*. The overlapping type of shading indicates the zone of intergradation between the two subspecies.

ever, are white or extremely pale ochraceous in these eastern specimens, whereas farther west the pale hairs at least of the thorax and head are usually ochraceous and often become pale rufescent on the anterior part of the mesoscutum. This difference is less well expressed in the males than in the females. The eastern males only rarely have subhyaline apical margins on the metasomal terga and almost always have a large patch of reddish-brown hairs on the mesoscutum as well as the scutellum, unlike the western males. In spite of these differences indicating a third subspecies, no characters were found which would separate these specimens in a reasonable number of cases. A relatively smooth cline probably exists across the eastern United States in color characters and in size, but the paucity of material from the central states of Ohio, Indiana, Pennsylvania, Kentucky, Tennessee, Alabama, Mississippi, Louisiana and Arkansas prevents an adequate description of the changes occurring in this area.

A single female from Ness Co., Kansas, has the hairs of the head and thorax almost completely dark brown. A very few pale hairs remain near the antennal fossae and in a thin line between the mesoscutum and the scutellum. The abdominal banding is typical and this specimen is considered to be nothing more than a melanistic variant of *M. communis communis.* It is of interest because it parallels closely certain melanistic variants of *M. comptoides* which appear in the southern and eastern parts of the range of the latter. *M. rufodentata* of the West Indies also presents certain melanistic individuals similar to those of *communis* and *comptoides.*

Three females and two males from Mexico have much redder hairs on the thorax than normal. This is not unique within this species, but is mentioned because of the great similarity of these red individuals to another Mexican species (*M. elusa*). The sparsely punctate posteromedian area of the mesoscutum and the complete distal pale band of tergum 2 clearly identify these specimens as *communis.*

M. communis alopex is a rather distinct subspecies which does not display a great amount of variability, as does *communis s. str.*, except in size. A series of five females from Salt Lake City, Utah, shows a tendency towards the darker color of *communis* of the east. One of these has a small patch of dark brown hairs on the ventral surface of each mesepisternum and another has a small patch of dark hairs medially on the fourth tergum. All five have the distal pale band of tergum 2 broader than usual in *communis s. str.*, and narrower than usual in *alopex.* A single male from Saltair, west of Salt Lake City, Utah, is intermediate in that it has dark sternal hairs and one male from Troutcreek, southwest of Salt Lake City, is also intermediate in that the pale distal band of tergum 2 is narrow and the apices of the terga are slightly infumate. A single male from Logan, Utah, is quite intermediate. It bears all of the characteristics of *alopex* except that the distal band of tergum 2 is narrow and the pale band of tergum 5 is absent. A single female from Logan resembles the females from Salt Lake City. One male from the north rim of the Grand Canyon, Arizona, is typical of *alopex* and is the only specimen of this subspecies from Arizona. South of the Grand Canyon, three females from southeastern Arizona are typical specimens of *communis.*

The holotype of *alopex*, unfortunately, is from a locality (Duchesne, Utah) east of the above named Utah localities. It is probably from the zone of intergradation, but is typical of *alopex,* not differing from the Californian specimens. Such specimens would be expected to occur in the zone of intergradation, if one considers the situation in such zones within other species of *Melissodes.* Two males from Delta in western Colorado are intermediate in character, but are no paler than the palest of the Great Plains specimens. These males should not be considered as decisive, since, as in most *Melissodes*, the males are more variable than the females and the subspecies are based primarily on female characters. Another male from San Miguel, Colorado, is similar to those from Delta. Lack of material prevents adequate description of the zone of intergradation and, until additional material becomes available, the zone can be considered to occupy the largely hypothetical area outlined on the map (Fig. 11).

Melissodes (Melissodes) communis communis Cresson

Melissodes communis Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 204; Cockerell, 1898, Bull. Univ. New Mexico, vol. 1, p. 66; 1898, Bull. Sci. Labs. Denison Univ., vol. 11, p. 66; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 92; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 137; Smith, 1910, Ann. Rept. New Jersey State Museum, 1909, p. 693; Cockerell, 1914, Proc. Ent. Soc. Washington, vol. 16, p. 31.

Melissodes hortivagans Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 180 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 78, 83, 107; 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 360; 1936, Amer. Mus. Nov., no. 831, p. 5.

Melissodes martini Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 15, p. 526 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 86, 93; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 309; 1928, Univ. Colorado Studies, vol. 16, p. 114.

Melissodes variabilis Robertson, 1905, Trans. Amer. Ent. Soc., vol. 31, p. 368 (new synonymy); 1928, Flowers and Insects, p. 8.

Melissodes xanthopteralis Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 362 (new synonymy).

Melissodes manni Cockerell, 1924, Amer. Mus. Nov., no. 113, p. 1 (new synonymy).

Melissodes hortivagans melanotica Cockerell, 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 231 (new synonymy); 1928, Univ. Colorado Studies, vol. 16, p. 114.

This subspecies is distinguished from *alopex* by having a narrower distal band on tergum 2 and the pubescence of the metasoma being white at least in the female. In addition, the females have dark hairs on at least the ventral surfaces of the mesepisterna and the males usually have the apical areas of terga 1-5 dark, opaque to subhyaline, and the pale band of tergum 5 interrupted or absent.

Female. Structure and color: First tergum usually completely black or with an extremely narrow hyaline margin, occasionally more broadly hyaline apically; wing membranes infumate, yellow to dark brown, darkest in specimens from southeastern United States, veins dark red to black. Supraclypeal area with ground often dulled by fine shagreening; occasionally smooth and shiny; declivous face of propodeum usually with large upper impunctate triangle, occasionally reduced to small oval area; first tergum with small punctures in basal area usually separated by one or more puncture widths medially.

Hair: On labrum, mandibles and apical half of clypeus often brown; mesoscutellar patch of brown hairs occasionally reduced to several hairs or absent; pale hairs of dorsum of thorax often pale rufescent, usually ochraceous and occasionally white; ventral surfaces of mesepisterna, and usually anterior and lower lateral surfaces as well, with dark brown to black hairs; pubescent bands of metasoma usually white; tergum 2 with distal band usually equal to one third or less of apical area medially, occasionally slightly broader, but never as wide as half of apical area; tergum 4 usually with at least a small apical patch of dark brown hairs medially; terga 5 and 6 often without lateral tufts of long white or ochraceous hairs; sternal hairs dark brown to black, usually with small tufts of pale hairs laterally. Legs with variable hairs, generally white or pale ochraceous except as follows: fore tarsi dark reddish-brown, inner surfaces of fore and middle tibiae often brown at least apically, femora often dark brown, especially below and on posterior surfaces, scopal hairs usually ochraceous but sometimes paler, basitibial plates dark brown, inner surfaces of hind tibiae and basitarsi with red to yellow hairs.

Male. Structure and color: Apical areas of metasomal terga usually opaque, reddish-brown to black, occasionally hyaline but rarely completely colorless. Supraclypeal area with ground often dulled by fine shagreening; minimum length of first flagellar segment usually equal to about one sixth of maximum length of second segment, occasionally slightly shorter and rarely longer.

Hair: Pale hairs of head and thorax usually ochraceous, occasionally pale rufescent on anterior half of mesoscutum; pale pubescence of metasoma usually white, but often pale ochraceous; distal pale band of tergum 2 usually equal to about one half of apical area medially, often much less but rarely more; tergum 5 often with pale apical band interrupted medially or absent; tergum 5 usually and tergum 6 occasionally with a few long pale hairs laterally; sternal hairs usually mostly dark brown to black, often all red to ochraceous laterally and on basal few sterna, but usually brown medially on at least distal sterna. Legs with white to ochraceous hairs except rufescent hairs on distitarsi, inner surfaces of basitarsi and hind tibiae.

Bionomics. A group of twenty-two males of *M. communis communis* were collected by C. V. Riley at Centerville, Florida, on August 29 (year not given). These bees were apparently resting or sleeping clustered on a small twig. The bees and twig were collected together and the bees were loosely tied to the twig with black thread. This interesting display is in the collection of the U. S. National Museum.

This subspecies is highly polylectic. It seemingly collects little pollen from Compositae, although the species has been collected visiting a number of plants of this family. It appears to prefer Leguminosae and Labiatae and visits a large number of other non-Compositae. This bee is partial to *Melilotus* and *Medicago*, judging from the collection data, and could be of importance in pollination of the latter. Below are tabulated figures giving a general picture of the flower preferences of *communis* (Table IV). Note the difference in proportions of males to females collected on Compositae in contrast to the non-Compositae. This probably indicates that composites were visited primarily for nectar and not for pollen. Significant also is the fact that a relatively larger number of bees were collected per species of non-Compositae than per species of Compositae.

TABLE IV.—Summary of floral records for *Melissodes communis communis.*

Plant data				Records of *M. communis communis*			
Family	Number of Families	Number of Genera	Number of Species	Number of Collections	Number of Females	Number of Males	Total Number of Bees
Compositae	1	12	15	27	10	22	32
Labiatae	1	6	11	21	24	24	48
Leguminosae	1	8	11	42	56	48	104
Others	16	21	25	51	59	31	90
Totals	19	47	62	141	149	125	274

Type material. Lectotype female and lectoallotype male of *communis* from Georgia is in the Academy of Natural Sciences of Philadelphia. Holotype male of *hortivagans* from Garden City, Kansas, August, 1895, H. W. Mencke, is in the Snow Entomological Museum at the University of Kansas. Holotype male of *manni* from Garden Canyon, Huachuca Mts., Arizona, W. H. Mann, is in the American Museum of Natural History, New York City. Holotype female of *martini* from Gallinas River (La Cueva), New Mexico, August 6, Parks and Cockerell, is the property of the California Academy of Sciences, but on temporary deposit in the collection of the Citrus Experiment Station, Riverside. Holotype female of *melanotica* from La Junta, Colorado, August 12, 1920, is in the American Museum of Natural History, New York City. Lectotype female of *variabilis*, here designated, from Carlinville, Illinois, August 7, 1895, on *Monarda fistulosa*, Charles A. Robertson (collection no. 17545) and lectoallotype male of *variabilis*, here designated, from Carlinville, Illinois, July 6, 1897, on *Pycnanthemum linifolium*, Charles A. Robertson (collection no. 19780), are in the collection of the Illinois Natural History Survey, Urbana. Holotype male of *xanthopteralis* from Fedor, Texas, July 26, 1901, G. Birkmann, is the property of the California Academy of Sciences, but on temporary deposit in the collection of the Citrus Experiment Station, Riverside.

Distribution. Southeastern Arizona south to Chihuahua, Mexico, and north through eastern Colorado and Wyoming to North Dakota and eastward through Illinois and Indiana in the north and through Texas and the Gulf States in the south to the Atlantic (Fig. 11). These bees have been collected from March 16 to September 23 in various parts of the range as follows: Florida, March 16 to September 17; Texas, April 18 to September 23; Nebraska, June 22 to September 14. However, they are most abundant from the end of June through August in most areas. In addition to the type material, 595 females and 555 males have been examined. The localities of these, plus localities reported in the literature, are listed below.

ALABAMA: Auburn; Burkville; Cowarts; Flomaton; Moore's Bridge; Selma; Seminole. ARKANSAS: Lawrence Co.; Marion Co.; Hot Springs. ARIZONA: Garden Canyon, Huachuca Mts.; Thatcher; Wilcox, Cochise Co. COLORADO: Baca Co.; Boulder; Chivington; Colorado Springs; Crowley; Denver; Duck Creek; Eads; Fort Lupton; Golden; La Junta; Lamar; Limon; Midland; Mill Gulch; Prowers; Rocky Ford; Two Buttes; Walker Hill, Crowley Co. DELAWARE: Dover. FLORIDA: Alachua Co.; Bartow; Biscayne Bay; Boca Grande; Cedar Key; Centerville; Cocoa; Cocoanut Grove; Coral Gables; Crescent City; Dade City; Daytona; Englewood; Fort Lauderdale; Fort Myers; Gainesville; Goulds; Homestead; Indian River; Jacksonville; Key Largo; Key West; Lacoochee;

Larkins; Long Key; Marco; Miami; Miami Beach; Monroe Co.; Naples; Naranja; No Name Key; Paradise Key; Parish; Perry; Punta Gorda; Royal Palm Hammock; Royal Palm State Park; Sanford; Sannibel Island; South Bay, Lake Okeechobee; South Miami; Suwanee Springs; Tamiami Trail; Titusville; Torreya Ravine; Upper Metacumba Key; Winter Park. GEORGIA: Athens; Atlanta; Bainbridge; Billy's Island, Okefenokee Swamp; Brinson; Butler's Ferry, Decatur Co.; Chester; Deenwood; DeWitt; Griffin; Kenesaw Mt.; Pomona; Rockmart; Shellman; Spring Creek, Decatur Co.; St. Simons; Thomasville; Thomsons Mills; Tybee; Unadilla. ILLINOIS: Bishop; Carlinville; Oakwood. INDIANA: Lafayette; South McAllester. IOWA: Sioux City. KANSAS: Arma, Crawford Co.; Baldwin, Douglas Co.; Barber Co.; Bourbon Co.; Charleston, Gray Co.; Chautauqua Co.; Cherokee Co.; Cowley Co.; Crawford Co.; Decatur Co.; DeSoto, Johnson Co.; Dickinson Co.; Douglas Co.; Ellis Co.; Ellsworth Co.; Eudora, Douglas Co.; Finney Co.; Fort Scott, Bourbon Co.; Garden City, Finney Co.; Grant Co.; Gray Co.; Gove Co.; Hamilton Co.; Hays, Ellis Co.; Hodgeman Co.; Holcomb, Finney Co.; Hudson, Stafford Co.; Hugoton, Stevens Co.; Hutchinson, Reno Co.; Jetmore, Hodgeman Co.; Jewell Co.; Johnson Co.; Kearny Co.; Kiowa Co.; Lakin, Kearny Co.; Lawrence, Douglas Co.; Leavenworth Co.; Liberal, Seward Co.; Logan Co.; McPherson Co.; Manhattan, Riley Co.; Marshall Co.; Meade, Meade Co.; Medora, Reno Co.; Morton Co.; Neodesha, Wilson Co.; Ness Co.; Pawnee Co.; Phillips Co.; Pratt Co.; Rawlins Co.; Reno, Leavenworth Co.; Reno Co.; Rice Co.; Richfield, Morton Co.; Riley Co.; Russell Co.; Saline Co.; Scott City, Scott Co.; Sedgwick Co.; Seward Co.; Sharon Springs, Wallace Co.; Shawnee Co.; Sheridan Co.; Sherman Co.; Smith Co.; Stafford Co.; Stanton Co.; Stevens Co.; Sumner Co.; Sunflower, Douglas Co.; Syracuse, Hamilton Co.; Thomas Co.; Topeka, Shawnee Co.; Trego Co.; Wallace Co.; Wilson Co.; Winfield, Cowley Co.; Wichita, Sedgwick Co. LOUISIANA: Keatchie; Logansport; Negreet; Olivier; Opelousas. MASSACHUSETTS: Woods Hole. MINNESOTA: Faribault; Rochester; Stanton. MISSISSIPPI: Biloxi; Gulfport; McNeill. MISSOURI: Atherton; Buffalo; Springfield; St. Louis. NEBRASKA: Alliance; Ashland; Badger; Carns; Dundy Co.; Dunning; Fairmont; Glenn, Sioux Co.; Haigler; Halsey; Hardy; Holt Co.; Imperial; Lexington; Lincoln; Louisville; Meadow; Mitchell; Nebraska City; Neligh; Niobrara; Omaha; Scottsbluff; South Bend; Sutherland; Union; War Bonnet Canyon; Weeping Water; West Point. NEW MEXICO: Acme; Alberg; Eddy Co.;

Galinas River (La Cueva); Isleta; Las Vegas; Portales; Roswell (5 miles S.); Tucumcari. NORTH CAROLINA: Beaufort; Black Mts. (valley of); Burgaw; Cape Fear River (mouth of); Carolina Beach; Faison; Fort Fisher; Fort Macon; Goldsboro; Governors Island; Barkers Island; Holly Shelter; Judson; Kingsboro; La Grange; Lakeview; Long Beach; Lumberton; Marion; Montague; Point Harbor; Raleigh; Rocky Mt.; Smoky Mt.; Spout Springs; Southern Pines; Statesville; Swannanoa; Tarheel; West End; Willard; Wilmington; Wrightsville. NORTH DAKOTA: Steele. OKLAHOMA: Anadarko; Ardmore; Durant; Washunga. SOUTH CAROLINA: Clemson College; Edesto Beach; Hampton Park; Myrtle Beach; St. George; St. Mathews. SOUTH DAKOTA: Brookings. TENNESSEE: Knoxville. TEXAS: Adrian (10 miles W.), Oldham Co.; Austin; Barstow; Bastrop; Bexar Co.; Cypress Mills, Blanco Co.; Dallas; Davis Mts.; Devil's River (near Del Rio); Dilley; Fedor, Lee Co.; Galveston; Giddings; Goliad; Jacksonville; Laredo; Lee Co.; Longview (6 miles E.); Mexia; Nueces; Quinlan; Red River, 2 miles W of Estelline; Rockport (10 miles N.); Romero; Rosser; San Angelo, Tom Green Co.; Weser; Wichita Falls; Willis; Wolfe City. WYOMING: Cheyenne; Torrington. CHIHUAHUA: Chihuahua (10 miles S. E.); Delicias. TAMAULIPAS: Padilla.

Flower records. M. communis communis has been collected visiting the flowers listed below. Records from Robertson's (1928) list are included here, but do not figure in the tabulation (Table IV) above, since quantitative data was not available.

Abutilon theophrasti, Althaea rosea, Amorpha sp., *Asclepias syriaca, A. tuberosa, Baptisia* sp., *Befaria racemosa, Blephilia hirsuta, Brazoria truncata, Campanula* sp., *Cassia fasciculata, Chrysopsis angustifolia, Cirsium* sp., *C. discolor, C. lanceolatum, Cleome serrulata, Convolvulus* sp., *Croton* sp., *Cucurbita* sp., *Cyrilla parviflora, Dalea* sp., *D. multiflora, Dianthera americana, Echium vulgare, Gossypium herbaceum, Grindelia* sp., *Helenium tenuifolium, Helianthus* sp., *H. annuus, H. lenticularis, Heliotropum* sp., *Hyrtia* sp., *Ipomoea* sp., *Lactuca* sp., *Lythrum alatum, L. lineare, Malva sylvestris, Medicago sativa, Melilotus* sp., *M. alba, Mentha* sp., *Monarda* sp., *M. citriodora, M. fistulosa, M. pectinata, M. punctata, Nepeta cataria, Oenothera elliptica, O. laciniata, Opuntia* sp., *Passiflora* sp., *P. incarnata, Petalostemum* sp., *P. occidentale, P. purpureum, P. violaceum, Phaseolus* sp., *Platycodon grandiflorium, Prionopsis* sp., *Proboscidea louisianica, Pycnanthemum* sp., *P. flexuosum, Ratibida columnifera, Rudbeckia* sp., *Rhus* sp., *R. glabra, Salvia* sp., *Sidalcea* *reticulata, Solanum elaeagnifolium, Solidago* sp., *S. serotina, Teucrium* sp., *T. canadense, Thelesperma megapotamicum, Verbena* sp., *V. stricta, Vernonia* sp., *V. baldwini interior, V. glauca.*

Melissodes (Melissodes) communis alopex Cockerell.

Melissodes alopex Cockerell, 1928, Psyche, vol. 35, p. 333.

This subspecies can be recognized by the characters listed in the diagnosis of *communis s. str.* and described below.

Female. Structure and color: First tergum always with apical margin at least translucent reddish-brown, usually hyaline, colorless or yellow; wing membranes usually somewhat infumate, yellowish, veins dark reddish-brown. Supraclypeal area with ground shiny and smooth; declivous face of propodeum usually with impunctate upper area reduced to a small oval, occasionally almost completely punctate; first tergum with small punctures of basal area separated mostly by less than one puncture width.

Hair: Labrum, mandibles and clypeus with yellowish or ochraceous hairs, never brown; mesoscutellar patch of dark hairs always present, large, usually with a medially indented anterior margin so as to appear cordate in outline; pale hairs of head and dorsum of thorax ochraceous, never rufescent and never white; pale pubescence of metasoma ochraceous, scarcely, if at all, paler than pale thoracic hairs; sides of thorax with ochraceous hairs, occasionally somewhat paler than pale hairs of dorsum; mesepisterna without dark hairs ventrally, anteriorly or laterally; distal pale band of tergum 2 always wider than one third of apical area medially (unless worn) and usually as wide as one half of apical area or wider; pale band of terga 3 and 4 broader than in *communis s. str.;* tergum 4 with small median apical patch of ochraceous suberect hairs, never brown, often rubbed off; terga 5 and 6 always with lateral tufts of ochraceous hairs; sternal hairs usually dark reddish-brown to red, except dark brown on last sternum, yellow apically and ochraceous laterally on each sternum. Legs with ochraceous hairs except as follows: fore basitarsi and apices of outer surfaces of fore and middle tibiae often brown; inner surfaces of tarsi and tibiae red to yellow; basitibial plates brown.

Male. Structure and color: Apical areas of terga always broadly hyaline, yellow to colorless. Supraclypeal area as in female; minimum length of first flagellar segment usually equal to one fifth of maximum length of second segment, occasionally less and often more.

Hair: Pale hairs of head and thorax ochraceous, rarely white; distal pale band of tergum 2 usually equal to more than one half of apical area in width medially, never less (unless worn), often as wide as apical area; tergum 5 always with a complete apical band of ochraceous pubescence; terga 6 and 7 with lateral tufts of long pale hairs; sternal hairs red to yellow medially, white laterally, occasionally apical sternum with reddish-brown hairs. Legs with pale ochraceous hairs except reddish-orange to yellow on inner surfaces of tarsi.

Remarks. In the original description of the male holotype, Cockerell makes the following statements: ". . . pubescence in general much redder, fox-red on thorax and very bright on tibiae and tarsi . . .", ". . . wings strongly blackish . . ." and ". . . hind margins of abdominal segments not at all hyaline . . ." These all are errors. The holotype has rather dark ochraceous hairs on the thorax and yellowish-ochraceous hairs on the tibiae and tarsi. The wings of the holotype are not strongly blackish, although they are somewhat infumate, but are best described as yellowish-brown. The hind margins of the terga are broadly hyaline. Cockerell was led astray in regard to the hyaline nature of the terga because the abdomen of the holotype is stretched out and each tergum is closely applied to the surface of the preceding tergum. Also, each tergum was wetted or greased beneath at one time. This allows the dark color of the preceding tergum to show through the very hyaline apices of the terga, making them appear opaque.

Type material. The holotype male from Duchesne, Utah, July 1926, Vasco M. Tanner, is the property of the California Academy of Sciences, but temporarily deposited in the collection of the Citrus Experiment Station, Riverside.

Distribution. From southernmost California north to British Columbia and east to Alberta and Utah (Fig. 11). These bees have been collected from May 15 to September 12, but mainly during June and July. In addition to the holotype, 99 females and 72 males were examined from the localities listed below.

ARIZONA: Grand Canyon (north rim). CALIFORNIA: Altadena; Alturas, Modoc Co.; Bishop, Inyo Co.; Chula Vista; Corona; Dulzura; Etiwanda; Fillmore; Glendale; Glendora; Hemet (8 miles W.); Idyllwild; Kaweah; La Jolla; Lake City, Modoc Co.; Lassen Park, Shasta Co.; Litchfield, Lassen Co.; Long Beach; Los Angeles; Los

Angeles Co.; Pasadena; Quincy (4 miles W.); Riverside; Santa Monica Mts.; South Fork Camp, San Bernardino Mts.; Tanbark Flat, Los Angeles Co.; Upper Santa Ana River, San Bernardino Co.; Whittier; Whittier Lake. COLORADO: * Delta; * San Miguel. IDAHO: Moscow. NEVADA: Minden. OREGON: Gold Beach; Murphy, Josephine Co.; Oakridge, Lane Co.; Phoenix. UTAH: * Duchesne; * Logan; Pine Valley Mts.; * Saltair; * Salt Lake City; * Troutcreek, Joab Co. WASHINGTON: Asotin, Snake River; North Yakima; Yakima. ALBERTA: Medicine Hat. BRITISH COLUMBIA: Penticton; Summerland; Westbank.

Flower records. As in *communis s. str.*, the subspecies *alopex* has been taken more often on non-Compositae than on Compositae. This subspecies has been collected on the flowers listed below.

Brassica sp., *Cirsium* sp., *Clarkia elegans, Datura meteloides, Duranta plumieri, Eriodictyon trichocalyx, Gilia capitata, Godetia amoena, Hugelia virgata, Lotus* sp., *L. scoparius, Malvastrum fasciculatum, Medicago sativa, Melilotus* sp., *Monardella lanceolata, Opuntia littoralis, Phacelia ramisissima, Salvia apiana, S. carnosa, Scabiosa* sp., *Sphaeralcea* sp., *S. fasciculata, Stachys ajugoides, Stephanomeria exigua, Trifolium involucrata.*

Melissodes (Melissodes) clusa, sp. nov.

Melissodes clusa is very difficult to separate from the foregoing species. The first flagellar segment of the male, so useful in other species of this subgenus, is here highly variable and ranges in length from one seventh or less to about one fifth of the second segment. Both sexes of *clusa* are like *thelypodii* and *communis* in lacking coarse punctures in the apical areas of the metasomal terga. The metasomal punctation is otherwise more like that of *thelypodii* than like *communis.* The brown hairs on the ventral, lower anterior and lower lateral surfaces of the mesepisterna serve to distinguish females of *clusa* from those of *thelypodii s. str.*, and the larger size of *clusa* will serve to separate the females from those of *M. thelypodii stulta.* The presence of a complete pale band on the fifth tergum in the male will separate these from the males of *stulta.*

Female. Measurements and ratios: N, 4; length, about 14 mm.; width, about 5 mm.; wing length, $M = 4.73 \pm 0.475$ mm.; hooks in hamulus, $M = 15.50 \pm 0.647$; flagellar segment 1/segment 2, $M = 1.99 \pm 0.032$.

* Localities considered as in the zone of intergradation.

Structure and color: Integumental color as in *communis*, but flagella dark, with only a narrow dark reddish-brown zone ventrally; wings deeply infumate. With structural and sculptural characters of *communis* with the following differences: clypeus usually more coarsely punctate; mesoscutum as in the more coarsely punctate specimens of *communis*, punctures well separated but without a virtually impunctate posteromedian area; basal area of first tergum with distinct round punctures separated mostly by less than one half of one puncture width, ground shagreened but moderately shiny; interband zone of tergum 2 narrow, with coarser, deeper punctures separated mostly by less than half of one puncture width, especially in lateral raised areas; terga 1-3 with moderately shiny apical areas, although finely shagreened, not dulled as in *communis*.

Hair: With hair and pubescence as in *thelypodii s. str.* with the following differences: scutellum with a few to many dark brown hairs medially; mesoscutum with few to many dark brown hairs in posteromedian area; mesepisterna with dark brown hairs on ventral, lower anterior and often lower lateral surfaces; pubescent bands of metasoma white; tergum 3 with pale band narrower medially than apical apubescent area; inner surfaces of hind basitarsi with orange-red to dark reddish-brown hairs.

Male. Measurements and ratios: N, 20; length, 11-15 mm.; width, 3-5 mm.; wing length, $M = 4.53 \pm 0.428$ mm.; hooks in hamulus, $M = 14.40 \pm 0.303$; flagellar segment 2/segment 1, $M = 5.49 \pm 0.103$.

Structure and color: Integumental color as in *communis* with the following differences: mandibles with basal yellow spots usually restricted to the depressed triangular areas or slightly larger; labrum occasionally with a narrow brown margin laterally; apical areas of terga always black and opaque; legs except tarsi always black. Structural and sculptural characters as in *communis* with the following differences: first flagellar segment of variable length, minimum length equals one eighth to one fifth of maximum length of second segment; mesoscutum without a relatively impunctate posteromedian area, punctures as in more densely punctate specimens of *communis;* punctures in basal area of tergum 1 and in interband zone of tergum 2 as in female. Genitalia and hidden sterna as in *communis.*

Hair: With hair and pubescence characters of *thelypodii* with the following differences: scutellum usually and mesoscutum often with a few dark reddish-brown hairs medially; apical area of tergum 1 and interband zone of tergum 2 often with dark brown hairs; tergum 2 with distal pale band usually extremely narrowly interrupted medially; tergum 4 with pale band distinctly notched along posterior margin, almost interrupted medially by the notch; tergum 5 always with a complete pale band; pale metasomal bands always white.

Remarks. It is possible that *elusa* is a southern subspecies of *communis.* The evidence for such an hypothesis is weak. *M. communis* has been collected in Mexico only three times and these specimens (three females and two males) are typical specimens of *communis* except for the slightly more rufescent thoracic hairs. They do not show evidence of intergrading with *elusa* in structural characters, such as the punctation and shagreening of the terga. *M. elusa* could be considered as a southern subspecies of *thelypodii,* if *stulta* were not known. The males of *elusa* and *thelypodii s. str.* are remarkably similar and some specimens are indistinguishable (especially old and worn individuals). It is best, therefore, to consider *elusa* as a distinct species until additional material becomes available, especially from northern Mexican states of Chihuahua and Coahuila.

Type material. Holotype male and allotype female and three paratype males collected by H. E. Evans at Guadalajara, Jalisco, July 23, 1951. Paratypes are as follows: Fresnillo, Zacatecas, 14 males, August 15, 1947, C. D. Michener; Sain Alto, Zacatecas, 3 males, August 14, 1947, on *Gutierrezia* sp., M. A. Cazier; Villa Guadalupe, Jalisco, 1 female, July 25, 1951, on *Asclepias* sp., P. D. Hurd; Guadalajara, 2 males, July 24, 1951, P. D. Hurd; Guadalajara (vicinity), Jalisco, 1 male, 1901, M. Diguet; Encarnación, Jalisco, 1 male, July 28, 1951, P. D. Hurd; Tizapán, Jalisco, 1 female, July 18, 1953, Univ. of Kansas Mexican Expedition; Puebla (6 miles S. W.), Puebla, 3 males and 1 female, July 2, 1953, 6600 feet altitude, Univ. of Kansas Mexican Expedition. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collections of the Snow Entomological Museum, the U. S. National Museum, the American Museum of Natural History, the University of California, Berkeley, and in the author's collection.

Distribution. From southeastern Arizona south to Oaxaca, Mexico, and west to Michoacán, Mexico. In addition to the type material, this species has been collected from the localities listed below.

ARIZONA: Carr Canyon, Huachuca Mts. (a single worn male probably belongs here). CHIHUAHUA: Catarinas; Santa Barbara. DURANGO: Durango; Nombre de Dios. MICHOACAN: Quiroga. OAXACA: Oaxaca. PUEBLA: Puebla.

Melissodes (Melissodes) flexa, sp. nov.

M. flexa is a Mexican species having long flexible hairs on the head and thorax of the male. The first flagellar segment is long, the minimum length equaling one third to one fourth of the maximum length of the second segment. The labrum of the male has a distinct brown apical margin. The hairs on the lower half of the lateral surfaces of the mesepisterna are consistently longer than the third flagellar segment. These hairs are best measured viewing the specimen in cephalic aspect.

Male. Measurements and ratios: N, 5; length, 10-13 mm.; width, 3.5-4.0 mm.; wing length, $M = 4.32 \pm 0.888$ mm.; hooks in hamulus, $M = 14.20 \pm 0.374$; flagellar segment 2/segment 1, $M = 3.77 \pm 1.065$.

Structure and color: Color as in *communis* with the following differences: Labrum with narrow dark brown apical margin; first flagellar segment and at least half of second segment dark brown, reddened lower area of remaining segments equal to less than half of width; mandibles with basal yellow spots restricted to depressed punctate basal areas or slightly larger; legs at most with tarsi rufescent; apical areas of terga not translucent or only slightly so, dark brown to black. Antennae shorter than in *communis*, not reaching apical margin of first metasomal tergum in repose; minimum length of first flagellar segment equal to about one third of maximum length of second segment, never less than one fourth of second segment. Characters of structure and punctation as in *communis* with the following differences: parapsidal lines usually short, equal to distinctly less than distance between anterior tip of line and supra-alar carina (each equal to about five sevenths of this distance); metasomal tergum 1 and interband zone of tergum 2 with coarse punctures not obscured by dense shagreening; apical areas of terga 2-4 moderately shiny, shagreened but not densely so, often with distinct punctures. Genitalia and hidden sterna as in *communis*.

Hair: Generally as in *communis* with the following differences: hairs generally longer and more flexible, lower half of lateral surface of mesepisternum with hairs distinctly longer than third flagellar segment (view specimen in anterior aspect to measure hairs); long bristlelike hairs of terga longer; long dark hairs in apical area of tergum 2 distinctly longer than plumose hairs of distal pale pubescent band; interband zone of tergum 2 and apical area of tergum 1 with pale hairs; tergum 5 without a complete pale band.

Remarks. A single female collected near Tapanatepec, Oaxaca, on the same date as the holotype male is possibly the female of this species. This female has the punctation of the terga and the mesoscutum as in *comptoides* and the coloration of *thelypodii* or *elusa.* However, the clypeus is longer than usual and more coarsely punctate than either *thelypodii* or *comptoides.* Because of the difference in punctation of the mesoscutum, there is doubt that this is the female of *flexa.* Perhaps it is a new form, but it is best not to apply a new name until additional specimens are available.

The few males available for study are from rather widely separated localities and show considerable variation in the color of the vestiture and some variation in punctation and size. Perhaps more than one subspecies, or even species, is involved and the above mentioned female should be allied with one of these. However, until more specimens are available, one cannot assess the range of variation with any accuracy.

Type material. Holotype male and one paratype male from 4 miles E. of Tapanatepec, Oaxaca, Mexico, July 9, 1953, 700 feet altitude, Univ. of Kansas Mexican Expedition. Paratypes are as follows: 2 males from Las Puentes, Durango, July 24, 1947, C. D. Michener; 1 male from 6 miles S. W. of Puebla, Puebla, July 2, 1953, Univ. of Kansas Mexican Expedition. The female mentioned above was taken 7 miles N. E. of Tapanatepec, Oaxaca, July 9, 1953, by a Univ. of Kansas Mexican Expedition. The holotype is in the Snow Entomological Museum at the University of Kansas. Paratypes are in the Snow Entomological Museum, the American Museum of Natural History, New York City, and in the author's collection.

Melissodes (Melissodes) panamensis Cockerell.

Melissodes panamensis Cockerell, 1928, Psyche, vol. 35, p. 174 (*tepaneca* subsp.); Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 132 (*tepaneca* subsp.) (in part).

This species is a small Panamanian species closely resembling *tepaneca* which also occurs in Panamá. *M. panamensis* can be separated from *tepaneca* by the virtual lack of dark hairs in the apical area of the first metasomal tergum of both sexes, by the form of the eighth sternum of the male and by the punctation and hairs of the interband zone of the second tergum of both sexes as described below.

Female. Measurements and ratios: N, 3; length, 10-11 mm.; width, 4.5-5.0 mm.; wing length, M = 3.69 ±0.355 mm.; hooks in hamulus, M = 14.33 ± 0.882; flagellar segment 1/segment 2, M = 2.09 ± 0.035.

Structure and color: Integument black except as follows: flagella red beneath, except first segment; distitarsi rufescent and often basitarsi and hind tibiae rufescent. Structure and punctation as in *communis* with the following differences: supraclypeal area coarsely punctate, ground shagreened; vertex with flattened lateral areas with punctures separated mostly by less than one puncture width, ground delicately shagreened; mesoscutum coarsely punctate, small oval posteromedian area with smaller, more crowded punctures as in *comptoides;* metasomal tergum 1 with basal three to four fifths coarsely punctate, punctures separated by less than half of one puncture width; tergum 2 with interband zone with small, round, crowded, distinct punctures separated mostly by less than half of one puncture width, punctures as crowded medially as laterally, regularly spaced; apical areas of terga 2 and 3 with abundant small punctures each separated from the nearest puncture by one to three puncture widths, punctures equal in width to two to three times diameter of hairs arising from them, ground shiny to moderately shiny.

Hair: With characters of hair and pubescence of *communis* with the following differences: pale hairs of vertex and mesoscutum bright ferruginous; pale metasomal bands usually pale ferruginous; mesoscutum, scutellum, ventral and lower lateral surfaces of mesepisterna with dark reddish-brown hairs; tergum 1 usually with at least a few short appressed dark brown hairs apically; tergum 2 with interband zone equal to twice width of distal pale band across entire tergum, with erect, rather long, stiff hairs, long pubescence of basal pale band bent upwards at tips by adjacent erect hairs of interband zone; tergum 4 with small, rectangular or diamond-shaped, median, apical patch of black pubescence, in width equal to less than one fifth of width of tergum and in length equal to half or less of pale band. Legs with pale rufescent to yellow hairs except brown on fore tarsi, tips of fore tibiae and fore coxae, and orange-red on inner surfaces of basitarsi and hind tibiae.

Male. Measurements and ratios: N, 14; length, 9-12 mm.; width, 3.5-4.0 mm.; wing length, M = 2.11 ± 0.258 mm.; hooks in hamulus, M = 13.29 ± 0.194; flagellar segment 2/segment 1, M = 8.63 ± 0.125.

Structure and color: Integumental color as in *communis*, but terga 1-4 usually with apical areas opaque, dark brown to black. Structure and punctation as in *communis* with the following differences: minimum length of first flagellar segment equal to less than one seventh of maximum length of second segment and about equal to length of pedicle; vertex between apices of compound eyes and lateral ocelli with punctation as in female but ground shiny, unshagreened; sculpturing of mesoscutum and metasomal terga 2-4 as in female; tergum 1 with basal punctate area almost reaching apical margin medially. Genitalia and hidden sterna as in *communis*, but sternum 8 with apex of median ventral carina extending well beyond apical margin of emargination.

Hair: With pubescence and hair characters of *communis* with the following differences: pale hairs and pubescence of head, thorax and metasoma ferruginous to pale ferruginous; vertex of head, mesoscutum and scutellum without brown hairs; tergum 2 with hairs of interband zone as in female, but interband zone narrower, about equal in width to distal pale band across entire tergum, hairs of interband zone all pale; terga 2-4 with hairs of apical areas as in apical areas of terga 2 and 3 of female. Legs with pale ferruginous to yellow hairs except yellowish-orange hairs of inner surfaces of tarsi.

Type material. Holotype female and allotype male from Cristóbal, Canal Zone, August 10, 1924, N. Banks, is in the Museum of Comparative Zoology, Harvard University.

Distribution. This species is known to occur only in Panamá. It has been collected from June 23 to December 24. In addition to the type material, 3 females and 14 males have been examined from the localities listed below.

CANAL ZONE: Balboa; Bella Vista; Chiva Chiva; Cristóbal. PANAMA PROVINCE: Pacora; Panamá City.

Melissodes (Melissodes) thelypodii Cockerell

This is a beautiful bee from southwestern United States, Mexico and Central America. It is distinguished from *communis* by the following characters: mesoscutum with small, close-set punctures in the posteromedian area in both sexes; first flagellar segment of the male is relatively short; mesepisterna of the female lack brown hairs below in the northern subspecies; basal area of the first metasomal tergum with relatively coarse punctures; mesoscutum usually with bright orange-red hairs. This species can be separated from *comptoides* by the following characters: apical areas of terga 2 to 4 relatively impunctate in both sexes; flattened lateral areas of the vertex in the female with small, round, well-separated punctures, ground usually shiny and unshagreened; interband zone of tergum 2 and apical area of tergum 1 of the male narrow, usually with only pale hairs; inner surfaces of hind basitarsi and tibiae of the female with pale, golden-red hairs; mesepisterna of the female of the northern subspecies without dark hairs below; distal pale band of tergum 2 of the female usually broader, at least laterally.

Female. Structure and color: Integument usually black; legs often bright red, at least distitarsi red in dark specimens; each sternum hyaline apically, basal sterna often wholly red; flagellar segments 3 to 12 red below, dark brown to black above; eyes gray to grayish-blue, rarely greenish-blue; wing membranes clear, yellowish, darker apically, veins red to dark reddish-brown. Clypeus coarsely punctate, punctures mostly round but somewhat elongate laterally, separated by less than half of one puncture width, often smaller and more crowded basally, ground shiny, delicately shagreened at least basally, without median carina or carina short and indistinct apically; supraclypeal area often with coarse punctures, ground dulled by dense shagreening; flattened area extending mesad and somewhat posterior from apex of compound eye usually with small, round, well-separated punctures, ground usually shiny; galeae and maxillary palpi as in *communis.* Mesoscutum and scutellum with punctures as in *comptoides*, but densely punctate postero-median area usually somewhat smaller and often less distinct; sculpturing of metanotum, propodeum and lateral surfaces of thorax as in *communis.* Sculpturing of metasomal terga as in *communis*, but punctures in basal area of tergum 1 more crowded and more distinct, punctures in lateral raised areas of interband zone of tergum 2 smaller and separated mostly by less than half of one puncture width, apical areas of terga 2 and 3 impunctate or with small punctures less than twice the width of the suberect hairs arising from them and ground moderately shiny, finely shagreened; sterna densely and coarsely punctate.

Hair: Hair and color pattern are described below for each subspecies.

Male. Structure and color: Integument as in *communis,* but legs often wholly red and at least distitarsi red in darkest specimens; apical areas of terga 1 to 4 tend to be somewhat translucent, but never clear and often opaque, piceous; clypeus and bases of mandibles bright yellow; labrum wholly whitish or pale yellow; eyes gray to grayish-blue; wings as in female. First flagellar segment short, minimum length about equal to pedicle and always shorter than one seventh of maximum length of second segment; vertex between apices of compound eyes and lateral ocelli with small round punctures separated mostly by two or more puncture widths, ground usually shiny, not shagreened. Sculpturing of mesoscutum as in *comptoides*, but densely punctate posteromedian area smaller and occasionally mesoscutum evenly punctate; sculpturing of metanotum, propodeum and lateral surfaces of thorax as in *communis*, but lateral surfaces of mesepisterna often with ground dulled by fine dense shagreening. Sculpturing of metasomal terga and sterna as in *communis*, but punctures in basal area of tergum 1 usually more distinct and more crowded, punctures in interband zone of tergum 2 smaller and more crowded laterally and more distinct medially, and apical areas of terga 2 to 4 impunctate or with small punctures, ground moderately shiny.

Genitalia as in *communis*. Sternum 7 usually with long lateral plates and short apodemes as in *comptoides*. Sternum 8 strongly emarginate medially at apex as in *communis* and usually with short lateroapical hairs as in *comptoides* (Figs. 74-76).

Bionomics. *M. thelypodii* is a highly polylectic species, in spite of its name, as are most species of the subgenus *Melissodes*. The author, together with R. H. and L. D. Beamer and Cheng Liang, has taken females of *thelypodii* in large numbers collecting pollen from *Solanum eleagnifolium* and *Hoffmannseggia jamesii* in New Mexico in July. These two plants are quite unrelated and belong to different families (Solanaceae and Leguminosae, respectively). It appears that *thelypodii* is important in crosspollination of alfalfa in irrigated areas of New Mexico and Arizona. The females have been collected a number of times visiting and seemingly collecting pollen from cotton. These collections have been made in localities as far separated as Tucson, Arizona, Brownsville, Texas, and Tlahualilo, Mexico. In addition, females have been taken on two other malvaceous plants—*Thurberia* and *Sphaeralcea*. Out of about thirty five collections in which specimens bear flower labels, only six were of bees visiting composites and of these six only four included females. It is apparent that *thelypodii* is a polylectic species visiting mainly non-Compositae for pollen and shows some preference for plants of the families Leguminosae, Malvaceae and Solanaceae.

Geographical variation. This species is divided into two subspecies which are quite distinct at least in the females. The southern subspecies, occupying Central America and Mexico south of Durango, is smaller, darker in color and somewhat more coarsely punctate. Intergrades are known from southern Chihuahua. In addition to this, the females of *thelypodii s. str.* from Chihuahua and Coahuila in Mexico appear to be larger in average size than those from New Mexico and Arizona. The majority of specimens from Arizona tend to have black legs and lack reddish-brown hairs on the mesoscutum, whereas the majority of specimens from New Mexico and northern Mexico have red legs and many have at least a few brown mesoscutal hairs. These differences are not well enough established to permit recognition of additional subspecies, however. It is useful to bear in mind these geographical variations in identifying specimens from these localities.

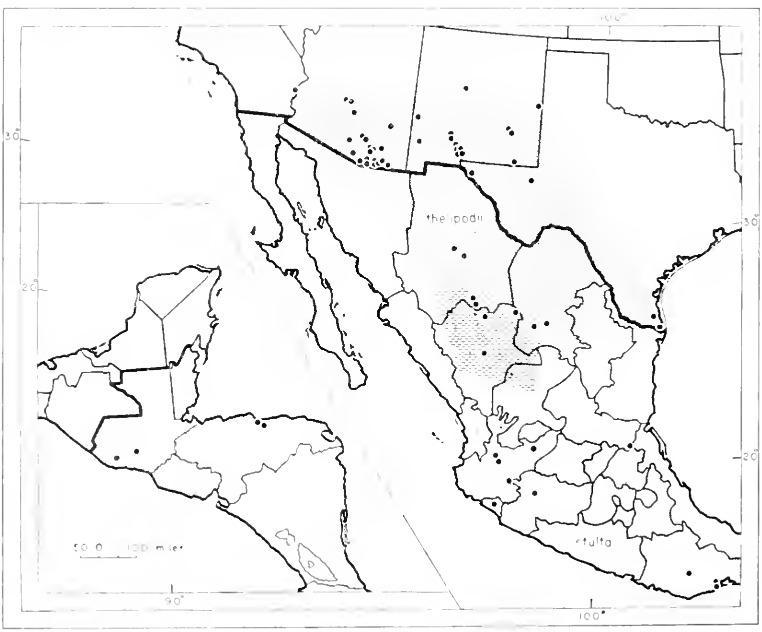

FIG. 12. Map showing the distribution of *M.* (*Melissodes*) *thelypodii.* The overlapping type of shading indicates the zone of intergradation between the two subspecies.

Melissodes (Melissodes) thelypodii thelypodii Cockerell.

Melissodes thelypodii Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 15, p. 527; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 84, 107; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 309.

Melissodes communis, Cockerell, 1898, Bull. Univ. New Mexico, vol. 1, p. 66 (misidentification); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 92 (misidentification); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310 (misidentification).

Melissodes kallstroemiae Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 216 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 81; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310.

Melissodes kallstroemiae var. *phenacoides* Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 217 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 81.

Melissodes thurberiae Cockerell, 1914, Proc. Ent. Soc. Washington, vol. 16, p. 31 (new synonymy).

The subspecies *thelypodii* can be separated from the following subspecies by the lack of brown hairs on the ventral and anterior surfaces of the mesepisterna in the female and by the larger average size of both sexes. The males cannot be satisfactorily separated from those of *stulta,* but the pale hairs of the head, thorax and metasoma of *thelypodii* are usually brighter red and the apical areas of terga 2 to 4 are usually less punctate.

Female. Measurements and ratios: N, 20; length, 11-16 mm.; width, 4-6 mm.; wing length, $M = 4.34 \pm 0.420$ mm.; hooks in hamulus, $M = 15.45 \pm 0.211$; flagellar segment 1/segment 2, $M = 2.02 \pm 0.022$.

Structure and color: Legs often entirely red; clypeus usually rather evenly and coarsely punctate, punctures usually not conspicuously smaller posteriorly; vertex with flattened lateral areas almost always with shiny, unshagreened or very delicately shagreened ground surface.

Hair: On head bright ferruginous at vertex, becoming ochraceous to white on face and genal areas; vertex often with a few to many long brown hairs. Thorax above with bright orange-red hairs, often with a few reddish-brown hairs in posteromedian area of mesoscutum and a few dark hairs medially on scutellum; lateral surfaces of thorax with pale ferruginous to white hairs, lateral, ventral and anterior surfaces of mesepisterna never with dark brown hairs, but ventrally may be golden to golden-brown. Metasomal banding as in *communis,* but often pale rufescent in color; distal pale band on tergum 2 usually wider than in *communis,* laterally as wide as or wider than apical apubescent area and somewhat narrowed medially; interband zone of tergum 2 narrow, usually with pale suberect hairs, dark hairs may be present in median third; tergum 1 usually without appressed dark brown hairs in apical area, except occasionally a few laterally; tergum 3 with pale band usually wider than apical area medially; tergum 4 with pale band usually without median brown interruption, or this area very small; tergum 5 always with tufts of long white hairs laterally; sternal hairs usually red medially and white laterally, except dark brown hairs of apical two sterna and occasionally all sterna with dark hairs medially. Legs with white hairs except ochraceous to brown hairs on fore tarsi and apically on outer surfaces of middle tibiae and bright yellowish-red hairs on inner surfaces of basitarsi and tibiae.

Male. Measurements and ratios: N, 20; length, 9-15 mm.; width, 3-5 mm.; wing length, $M = 4.11 \pm 0.516$ mm.; hooks in hamulus, $M = 14.15 \pm 0.284$; flagellar segment 2/segment 1, $M = 6.84 \pm 0.098$.

Structure and color: Vertex between apices of compound eyes and lateral ocelli with punctures separated by more than one puncture width, ground shiny, unshagreened; terga 2-4 with apical areas usually impunctate, or punctures no wider than hairs arising from them.

Hair: On head and thorax as in female, but never with dark hairs on vertex or on mesoscutum and very rarely with a few reddish-brown hairs medially on scutellum. Hairs of metasomal terga much as in female, but never with dark hairs in apical area of tergum 1 and pale hairs of tergum 1 usually reach apical margin; interband zone of tergum 2 narrow, with long suberect or erect pale hairs, basal band often fused with distal band medially, rarely interband zone with dark hairs in median third or less; pale pubescent bands of terga 2-5 usually pale rufescent in color, but often white; tergum 2 with pale distal band usually wider than in *communis*, equal to one half to two times width of apical area medially; tergum 3 with pale band wider than apical area and not strongly notched medially along posterior margin; tergum 4 with pale band wider than apical area medially, usually reaching apical margin in lateral third or more, often notched medially along posterior margin but not strongly so; tergum 5 usually without a complete pale band, with long pale hairs laterally and often with lateral fasciae of pale pubescence; sternal hairs as in female. Legs with white to yellow hairs except rufescent hairs of inner surfaces of tarsi.

Type material. Holotype female of *thelypodii* from La Cueva, Organ Mountains, New Mexico, September 4, C. H. T. Townsend, is in the U. S. National Museum. Holotype male of *kallstroemiae* from Mesilla Park, New Mexico, on *Kallstroemia* sp., T. D. A.

Cockerell, is in the collection of the University of Colorado Museum, Boulder. Holotype male of *phenacoides* from Las Cruces, New Mexico, T. D. A. Cockerell, is in the collection of the University of Colorado Museum, Boulder. Holotype female of *thurberiae* from Stone Cabin Canyon, Santa Rita Mountains, Arizona, August 26, 1913, on *Thurberia thespesioides*, W. D. Pierce, is in the U. S. National Museum.

Distribution. Southern California through Arizona and New Mexico to southeastern Texas and south to northern Durango (Fig. 12). This subspecies has been collected from the end of May to November 16, but mainly in July and August. In addition to the type material, 245 females and 139 males have been examined from the localities listed below. This list includes localities reported in the literature.

ARIZONA: Arivaca; Benson; Douglas; Hereford; Huachuca Mts.; Kits Peak, Baboquivari Mts.; Madera Canyon, Santa Rita Mts.; Marana; Mesa; Nogales; Pajarita Mts.; Palmerlea; Patagonia; Phoenix; Ramsey Canyon, Huachuca Mts.; Sacaton; Santa Rita Mts.; Stone Cabin Canyon, Santa Rita Mts.; Tucson; Thatcher. CALIFORNIA: Blythe. NEW MEXICO: Alma (5 miles N.); Dona Ana Co.; Garfield; Hatch; Isleta; Las Cruces; Lordsburg (25 miles E.); Mesilla; Mesilla Park; Portales; Radium (5 miles N.); Roswell (5 miles S. and 10 miles W.); San Ignacio; White's City, Eddy Co. TEXAS: Brownsville; Fabens; Pecos (10 miles N.); Raymondsville. CHIHUAHUA: * Catarinas; * Charcos (16 miles S. E.); Chihuahua; Meoqui (6 miles E.). COAHUILA: Cabos; Paila. DURANGO: * San Juan del Río; Tlahualilo.

Flower records. Asclepias sp., *Astragulus* sp., *A. cottonii, Baccharis glutinosa, Chamaesarcha coronopus, Cirsium* sp., *Convolvulus* sp., *Gaillardia* sp., *Gossypium herbaceum, Helianthus annuus, Hoffmannseggia jamesii, Ipomoea mexicana, Kallstroemia* sp., *K. grandiflora, Larrea* sp., *Lippia cuneifolia, Lygodesmia juncea, Medicago sativa, Melilotus* sp., *Solanum* sp., *S. eleagnifolium, Sphaeralcea* sp., *Thelypodium linearifolium, Thurberia thespesioides, Wedeliella incarnata.*

Melissodes (Melissodes) thelypodii stulta, subsp. nov.

This is a small subspecies from southern Mexico and Central America. Due to their small size and dark mesepisternal hairs, the females of this subspecies resemble those of *Melissodes tepa-*

* Localities considered as in the zone of intergradation.

neca to a remarkable degree. The females of *stulta* are distinguished from those of *tepaneca* by the distal pale band of tergum 2 which in *stulta* is relatively strongly arched and slightly wider laterally than medially and is as wide as or wider than the interband zone of tergum 2. Also, *stulta* does not have a large diamond-shaped medial patch of brown pubescence on tergum 4, the brown pubescence, if present, is usually restricted to a small apical oval or triangular spot. The subspecies *stulta* can be separated from *thelypodii s. str.* by the characters listed in the diagnosis of the latter.

Female. Measurements and ratios: N, 20; length, 9-13 mm.; width, 3-5 mm.; wing length, $M = 3.59 \pm 0.441$ mm.; hooks in hamulus, $M = 14.75 \pm 0.084$; flagellar segment 1/segment 2, $M = 1.97 \pm 0.020$.

Structure and color: Legs black except rufescent distitarsi and often rufescent basitari. Clypeus often with smaller and more crowded punctures posteriorly and laterally; vertex with flattened lateral areas with small punctures separated mostly by one puncture width, ground dulled by shagreening; mesoscutum with posteromedian area densely punctate as in *comptoides*; interband zone of metasomal tergum 2 with punctures slightly smaller and more crowded medially than in *thelypodii*; apical areas of terga 2-4 with abundant punctures mostly as wide as twice the basal diameter of hairs arising from them.

Hairs: On vertex always with at least a few dark hairs; mesoscutum usually with large patch of dark brown hairs and rarely without at least a few dark hairs in posteromedian area; scutellum usually with dark brown hairs medially; tegulae often with dark brown hairs; mesepisterna with dark brown hairs at least on ventral surfaces and usually on lower anterior and lower lateral surfaces as well; tergum 2 often with dark brown hairs in median half of interband zone; usually coxae and often hind femora and outer surfaces of middle tibiae with dark brown hairs.

Male. Measurements and ratios: N, 10; length, 11-12 mm.; width, 3-4 mm.; wing length, $M = 3.56 \pm 0.314$ mm.; hooks in hamulus, $M = 12.90 \pm 0.277$; flagellar segment 2/segment 1, $M = 7.59 \pm 0.242$.

Structure and color: Legs black except rufescent distitarsi and often rufescent basitarsi. Vertex laterally often with ground dulled by shagreening; mesoscutum more densely punctate than in most specimens of *thelypodii*; metasomal terga 2-4 with apical areas often with rather coarse punctures equal in width to about twice basal diameter of hairs arising from them.

Hair: Mesoscutum and scutellum often with a few reddish-brown hairs medially; tergum 5 rarely with pale pubescent band complete, usually broadly interrupted medially or absent; tergum 1 often with a few dark brown hairs in apical area; apical areas of terga 2-4 with dark brown to black hairs.

Remarks. Four males from the state of San Luis Potosí seemingly belong to this subspecies. However, since the males cannot be definitely identified, these specimens are only provisionally placed with this subspecies until females from that area can be studied. A single female from the state of Durango is typically *stulta* in size and color. It is probably from the zone of intergradation with *thelypodii*, wherein all variants from one extreme to the other may be expected to occur. Six females from the state of Oaxaca have much redder mesoscutal hairs than most females from Jalisco and Michoacán, but these appear to be younger individuals and the dullness of the northern females may be due to fading with age, a process known to occur in other species.

Five females and one male from Honduras are very small, ranging from nine to ten millimeters in length. The females of this series have more brown hairs in the interband zone of tergum 2 than usual and the mesoscutal hairs are red, as in the Oaxacan specimens. Two females from Guatemala are intermediate in size between the Oaxacan and Honduras specimens, being about as small as the smallest of the former (10 mm. in length). Perhaps a southern subspecies could be recognized with the Oaxacan and Guatemalan specimens being considered as from the zone of intergradation. However, the size difference is the only usable character and from the small amount of material available, there appears to be a rather smooth cline in size. Considering the great variability in size which occurs in other species of *Melissodes*, and which can be readily seen in a long series of *thelypodii s. str.* from New Mexico, one can expect this gradient in size to be disrupted by additional material from Central America.

Type material. Holotype female collected by H. E. Evans, 8 kilometers east of Tequila, Jalisco, Mexico, July 18, 1951, and the allotype male taken by H. E. Evans, at Villa Quadelupe, Jalisco, July 26, 1951. Paratypes from Mexico are as follows: Villa Guadelupe, Jalisco, 3 females and 2 males on *Asclepias* sp., July 25, 1951, 1 female and 1 male on *Asclepias* sp., 1 female without flower data, July 26, 1951, P. D. Hurd; San Juan de los Lagos, Jalisco, 1 female, July 27, 1951, P. D. Hurd; Tizapán, Jalisco, 2 females, July 18, 1953, Univ. of Kansas Mexican Expedition; Jacona, Michoacán, (3 miles W.), 1 female, July 18, 1953, Univ. of Kansas Mexican Expedition. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collections of the Snow Entomological Museum, the University of California, Berkeley, and in the author's collection.

Distribution. From the states of Durango and San Luis Potosí in Mexico south through Guatemala and into Honduras (Fig. 12). Localities from which specimens have been examined, aside of the type material, are listed below. Those localities which are probably in the zone of intergradation are marked with asterisks.

COLIMA: One male without more definite location on the label. DURANGO: * Encino. OAXACA: Salina Cruz; Tehuantepec (6 miles S.); Totolápam. SAN LUIS POTOSI: Tamazunchale. GUATEMALA: Variedades, Suchitepéquez. HONDURAS: La Ceiba, Colón.

Flower records. Both males and females have been collected on *Asclepias* sp., but no other flower records exist.

Melissodes (*Melissodes*) *cestus* Krombein.

Melissodes cestus Krombein, 1953, Amer. Mus. Nov., no. 1633, p. 26.

This species is closely related to *M. communis* and to *M. comptoides.* The females differ from those of *communis* by the sculpturing of the clypeus and the metasomal terga, as described below, and from the females of *comptoides* by the punctation of the mesoscutum. The males differ from those of *communis* by the shorter first flagellar segments and by the tergal punctation, and from the males of *comptoides* by the punctation of the mesoscutum. In addition, both sexes of *cestus* differ from *communis* and *comptoides* by having wider apical bands on tergum 2. *M. cestus* can be easily differentiated from other species of the subgenus *Melissodes* occurring in the West Indies by characters summarized in the key and discussed in the diagnosis of each of these species. It is more closely related to *M. cubensis* than to any other West Indian species.

Female. Measurements and ratios: N, 1; length, 11 mm.; width, 4.5 mm.; wing length, 3.85 mm.; hooks in hamulus, 17; flagellar segment 1/segment 2, 1.91.

Structure and color: Black, distitarsi dark reddish-brown; tegulae dark brown; antennae black, flagella slightly paler beneath than above, but not reddish as in most species of the subgenus; wing membranes slightly infumate, clear brown; veins dark reddish-brown to black; eyes grayish-black. Clypeus coarsely punctate, punctures separated mostly by half or less of one puncture width, ground areas and bottoms of punctures opaque, dulled by dense tessellations; supraclypeal area with abundant punctures laterally, dulled by dense shagreening; vertex with flattened lateral areas with distinct punctures separated mostly by less than one puncture width, ground shagreened, moderately shiny. Sculpturing of thorax as in *communis*, but impunctate area of declivous face of propodeum much larger and extending onto basal face medially where there are only one or two punctures present at extreme base. Sculpturing of metasoma as in *comptoides*, but punctures in apical areas of terga 2 and 3 slightly smaller, although abundant and separated mostly by one to three puncture widths.

Hair: On head white except abundant black hairs on vertex and upper third or half of face. Thorax with hair characters of *communis* except as follows: no dark hairs below on mesepisterna; tegulae with abundant dark hairs; mesoscutal patch of dark hairs within 3 to 4 hairs of tegulae and extending forward to a transverse line at anterior margins of tegulae; pale hairs of thorax white. Hair character of metasoma as in *communis* except as follows: tergum 1 with pale hairs white; tergum 2 with pale distal band broader, laterally as broad as apical area and medially as wide as half of apical area; terga 2 and 3 with more abundant dark brown or black appressed hairs in apical areas. Legs with white hairs except black or dark brown on fore and middle tibiae apically and on basitibial plates, and inner surfaces of hind basitarsi and tibiae with rufescent hairs; scopal hairs white.

Male. Measurements and ratios: N, 1; length, 9.5 mm.; width, 3.5 mm.; wing length, 3.57 mm.; hooks in hamulus, 15; flagellar segment 2/segment 1, 6.38.

Structure and color: Color as in female except as follows: labrum white; clypeus and large basal mandibular spots yellow; flagella below, except first segment, red, first segment and upper and lateral surfaces dark brown to black; basitarsi dark reddish-brown. Sculpturing as in female, but mesoscutal punctures somewhat more crowded. Minimum length of first flagellar segment equal to about one seventh of maximum length of second segment or slightly less.

Genitalia essentially as in *communis;* gonostyli with somewhat sparser hairs; spatha somewhat more angulate laterally. Sternum 7 as in *communis.* Sternum 8 not emarginate apically, or only slightly so, without apical hairs, shorter and broader than in *communis* (see Krombein, 1953, for illustrations of the male terminalia).

Hair: On head pale ochraceous to white except abundant dark brown hairs on vertex. Thorax above with ochraceous hairs, a large square mesoscutal patch of dark brown hairs, a large scutellar patch of dark hairs, and tegulae with brown hairs above; lateral surfaces of thorax with pale ochraceous to white hairs. Metasomal hairs as in *comptoides,* except distal pale band of tergum 2 as wide as or wider than apical area laterally and as wide as half of apical area medially; tergum 5 with tufts of white hairs laterally, without a pale pubescent band; sternal hairs dark brown except tufts of pale hairs laterally. Legs with white hairs except as follows: distitarsi and inner surfaces of basitarsi with rufescent hairs; basitibial plates with brown hairs; hind tibiae with brown hairs extending from basitibial plates along basal two thirds or more medially on outer surfaces.

Type material. Holotype male from South Bimini Island, Bahamas, May. 1951 (Cazier and Gertsch) and allotype female from same locality, June, 1951 (M. Cazier and C. and P. Vaurie), are in the American Museum of Natural History, New York City. One male paratype collected with the holotype and one female paratype collected with the allotype, both are in the U. S. National Museum.

Melissodes (Melissodes) cubensis, sp. nov.

This species, known only in the male sex, is closely related to *M. communis* from which it is distinguished by the mandibular yellow spots being small or absent, by the generally ferruginous vestiture and by the form of the median ventral carinae of the eighth sternum. Of the West Indian species of the subgenus *Melissodes, cubensis* is most closely related to *leprieuri* and *martinicensis* from which it can be distinguished by the color of the hairs of the head and thorax and by the punctation of the mesoscutum and metasomal terga. One dark specimen of *cubensis* superficially resembles the male of *foxi* due to the interrupted distal pale band of the second tergum. These can be distinguished by the more dense hairs of the outer surfaces of the hind tibiae and by the relatively long first flagellar segments of *cubensis.*

Male. Measurements and ratios: N, 4; length, 12-13 mm.; width, 3.5-4.0 mm.; wing length, $M = 3.69 \pm 0.045$ mm.; hooks in hamulus, $M = 12.50 \pm 0.647$; flagellar segment 2/segment 1, $M = 5.63 \pm 0.439$.

Structure and color: Integument black except as follows: labrum yellow; clypeus yellow; bases of mandibles at most with a small yellow triangular spot smaller than the depressed triangular area (absent in holotype); antennae dark reddish-brown, flagella somewhat pale below; eyes gray to black; legs and metasomal sterna usually dark red, distitarsi and tibiae often paler; wing membranes infumate, yellow, veins dark reddish-brown. Minimum length of first flagellar segment equals one seventh to one sixth (holotype) of maximum length of second segment; eyes in facial view somewhat longer than twice width, converging slightly below; clypeus with small round punctures separated by one to one half of one puncture width, ground coarsely shagreened; supraclypeal area with round distinct punctures at least laterally and usually medially as well, ground tessellate; vertex between lateral ocelli and apices of compound eyes with deep round punctures separated by one to two puncture widths, ground smooth and shiny. Mesoscutum with crowded punctures in anterior half, lateral third of posterior half and in short declivous posterior area, posteromedian area impunctate or virtually so, ground shiny, delicately or not at all shagreened; scutellum with smaller, more crowded punctures than in adjacent area of mesoscutum, punctures separated mostly by less than half of one puncture width, ground delicately shagreened; dorsal face of propodeum with large shiny-bottomed punctures, distinct apically and becoming reticulopunctate basally, declivous and lateral faces coarsely punctate except large inverted triangular area of upper half or more of declivous face, ground dulled by dense shagreening, but impunctate triangle of declivous face moderately shiny. Metasomal sculpturing as in *communis*, but punctures of basal area of tergum 1 and of interband zone of tergum 2 larger, separated mostly by one puncture width or slightly more, and apical areas of terga 2 to 4 with small piliferous punctures equal in diameter to two to three times basal width of hairs arising from them, ground finely shagreened, moderately shiny.

Genitalia and hidden sterna as in *communis* with the following differences: sternum 7 with ventral fold of median plates usually narrower, with ventral carinae below median apical emargination each bent at about half their length so that together they form a broadly Y-shaped structure, rather than V-shaped as in *communis*; sternum 8 with apical margin truncate or gently emarginate and usually with shorter hairs than in *communis* (Fig. 73).

Hair: On head and thorax rufescent; scutellum and usually mesoscutum with small patches of dark reddish-brown hairs. Metasoma with characters of vestiture of *communis* with the following differences: pubescent bands pale rufescent rather than white; bands on terga 2 and 4 may be interrupted medially by reddish-brown pubescence (not in holotype), but usually not; tergum 5 without a complete pale band. Legs with rufescent hairs, occasionally with brownish hairs medially on outer surfaces of tibiae below and on basitibial plates.

Type material. Holotype male from El Cano, Cuba, November 6, 1931, collected by L. C. Scaramuzza. Three male paratypes from Cuba as follows: Cabañas, Piñar del Río, September 5-8, 1913; 7 kilometers north of Viñales, P. del Río, September 16-22, 1913; Piñar del Río, P. del Río, September 9-24, 1913. The holotype is in the Snow Entomological Museum at the University of Kansas. Two paratypes are in the American Museum of Natural History, New York City, and one paratype is in the author's collection.

Melissodes (Melissodes) foxi Crawford

Melissodes foxi Crawford, 1915, Proc. U. S. Nat. Museum, vol. 48, p. 577.
Melissodes mimica, Fox, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 347 (misidentification).
Melissodes trifasciata, Fox, 1891, Trans. Amer. Ent. Soc., vol. 18, p. 347 (misidentification).

This is a very distinctive species which is not closely related to any other species of the subgenus, but belongs near *communis*, according to the characters of the male terminalia. The female is characterized by having distinctly punctate apical areas on terga 2 and 3, a sparsely punctate mesoscutum, abundant dark brown hairs on vertex, mesoscutum, scutellum and tegulae, and a broadly interrupted distal pale pubescent band on metasomal tergum 2. The males are similarly characterized, but have much less brown hair on the head and thorax and, in addition, have very sparse, relatively short hairs on the outer surfaces of the tibiae, a brown margin on the yellow labrum and very short first flagellar segments.

Female. Measurements and ratios: N, 4; length, 9-12 mm.; width, 3.5-4.0 mm.; wing length, $M = 3.69 \pm 0.596$ mm.; hooks in hamulus, $M = 14.00 \pm 0.435$; flagellar segment 1/segment 2 (N, 3) $M = 2.02 \pm 0.020$.

Structure and color: Integument black except as follows: distitarsi rufescent and often legs entirely red or dark reddish-brown; mandibles red medially; flagella red beneath; sterna red at least basally; apical areas of terga very dark reddish-brown; eyes green to yellowish-green; wing membranes slightly infumate, veins dark reddish-brown. Clypeus with small punctures separated mostly by about one half of one puncture width, somewhat elongate laterally and smaller and more crowded medioanteriorly, ground dulled by coarse shagreening; supraclypeal area with few or no punctures medially, ground dulled by coarse, reticular shagreening; flattened lateral areas of vertex with abundant small round punctures separated by one to two puncture widths, ground shagreened; eyes in facial view slightly broader than three times length. Thoracic sculpturing as in *communis* with the following differences: posteromedian area of mesoscutum virtually impunctate, sometimes a few punctures along midline, ground smooth and shiny; ground area of lateral surfaces of mesepisterna dulled by fine shagreening. Sculpturing of metasoma as in *comptoides* with the following differences: basal area of tergum 1 less coarsely punctate, ground dulled by dense fine shagreening; tergum 2 with punctures of interband zone smaller, round, separated by two to three puncture widths medially and by about one puncture width on lateral raised areas; apical areas of terga 2 and 3 and beneath apical brown hair patch in middle of tergum 4 with abundant small round punctures separated by one to three puncture widths, distinct but no larger than two to three times width of hairs arising from them.

Hair: Vestiture of head, thorax and metasoma, except for brown hairs where present, rufescent to dark ochraceous. Vertex of head, face laterad of antennal fossae, and usually clypeus with abundant dark brown hairs. Mesoscutum with large patch of dark brown hairs extending forward to a transverse line at anterior margins of tegulae and laterally to or beyond parapsidal lines; scutellum with large dark brown patch equaling about half of dark mesoscutal patch in size; tegulae with abundant dark brown hairs; mesepisterna usually with a few to several brown hairs ventrally. First metasomal tergum with abundant pale hairs in basal half; apical areas of terga 1-3 and median apical triangular patch on tergum 4 with abundant, short, appressed or subappressed, dark brown hairs; pale metasomal bands as in *communis*, but rufescent in color and distal pale band of tergum 2 broadly interrupted to form two thin lateral fasciae each equaling in length less than one third of width of tergum, these not connected to basal pale band at extreme sides; sternal hairs dark brown. Legs with dark brown hairs except as follows: dorsal surfaces of femora usually with ochraceous hairs; scopal hairs yellow to orange; inner surfaces of hind basitarsi and tibiae with yellow to red hairs; distitarsi with rufescent hairs.

Male. Measurements and ratios: N, 13; length, 8-10 mm.; width, 3-4 mm.; wing length, $M = 3.42 \pm 0.220$ mm.; hooks in hamulus, $M = 12.38 \pm 0.181$; flagellar segment 2/segment 1, $M = 7.57 \pm 0.120$.

Structure and color: Integument black except as follows: clypeus yellow; labrum pale yellow with distinct brown apical margin; bases of mandibles with large triangular yellow spots; antennal scapes dark red to brown, flagella dark red above, paler beneath; legs except coxae bright red; tegulae dark reddish-brown; apical areas of terga very dark reddish-brown to black; eyes gray to yellowish-green; wing membranes clear, yellowish, veins dark reddish-brown. Minimum length of first flagellar segment equals one eighth or less of maximum length of second segment, scarcely, if at all, longer than pedicle; eyes in facial view slightly more than one third as wide as long. Sculpturing as in female with the following differences: clypeus with less distinct punctures; vertex between lateral ocelli and compound eyes with punctures of same size as in female but separated by two to three puncture widths, ground smooth and shiny; mesoscutum usually with somewhat more abundant punctures, but posteromedian area virtually impunctate; terga 2 to 4 with punctures of apical areas less abundant to absent, most abundant and distinct on tergum 2.

Genitalia as in *communis;* gonostyli with hairs near base relatively short, not nearly reaching apices of gonostyli. Sternum 7 with rather straight lateral margins; apodemes narrow and not capitate or truncate apically; median ventral carinae broad, forming a V-shaped structure. Sternum 8 only slightly emarginate apically, with several short apical hairs; ventral longitudinal carina reaches apex of sternum; lateral apodemes narrow, bent anteriorly so that small anterior process is directed somewhat medially.

Hair: Generally rather sparse; on outer surfaces of tibiae hairs relatively short and not hiding surfaces, on hind tibiae not hiding surfaces below basitibial plates. Color of vestiture as in female with the following differences: head without dark hairs or these restricted to vertex; mesoscutal and scutellar patches of dark hairs smaller; tegulae without dark brown hairs; lateral fasciae of tergum 2 (remains of distal pale band) longer, often each more than one third of width of tergum, usually connected with basal pale band at extreme sides by long appressed pale hairs; sternal hairs pale laterally and apically on each sternum. Legs with ochraceous hairs except as follows: rufescent on inner surfaces of basitarsi and hind tibiae; often dark brown medially on outer surfaces of hind tibiae below basitibial plates.

Type material. Holotype female from Portland, Jamaica, W. J. Fox collection, is in the U. S. National Museum (U. S. N. M. Type No. 18179). Four paratype females from Portland, Jamaica, and three paratype males from Jamaica from the W. J. Fox collection also in the U. S. National Museum.

Distribution. Jamaica. In addition to the type material four females and thirteen males have been examined. The data on these specimens are listed below.

JAMAICA: George's Valley, Manchester, 1 female, January 8, 1920; Kingston, Fox collection, 1 female and 1 male; Portland, Fox collection, 2 females and 3 males; Rio Grande River, 9 males.

Melissodes (Melissodes) martinicensis Cockerell

Melissodes martinicensis Cockerell, 1917, Ann. Mag. Nat. Hist., ser. 8, vol. 20, p. 303.

This species, known only from the holotype male, can be distinguished from other members of the subgenus *Melissodes* occurring in the West Indies by the relative lengths of the first two flagellar segments, the punctation of the mesoscutum and metasomal terga and the distribution of dark hairs on the head and thorax as described below. Although its exact position is in doubt because the genitalia have not been studied, *martinicensis* is probably more closely related to *M. leprieuri* and *M. cubensis* than to the other West Indian species of *Melissodes*. The following description, taken from the holotype, will supplement the original description.

Male. Structure and color: Integument black; clypeus, labrum and spots at bases of mandibles yellow; legs dark red; wing membranes slightly infumate, yellowish, veins dark red; tegulae clear yellowish-red. Clypeus with coarse punctures, elongate medially, ground areas coarsely shagreened; vertex between lateral ocelli and apices of compound eyes with small punctures separated by 2 to 3 puncture widths; galeae smooth and shiny with scattered punctures; minimum length of first flagellar segment equals about one sixth of maximum length of second segment and about one fourth of third segment. Mesoscutum with round, deep, rather evenly spaced punctures separated by 1 to 2 puncture widths or less, ground areas smooth and shiny; scutellum with punctures separated by 1 puncture width or less, ground areas smooth and shiny; lateral surfaces of mesepisterna with punctures similar to those on mesoscutum, separated mostly by one puncture width; dorsal face of propodeum with large, round, mostly confluent punctures with shiny bottoms, ground areas, where they occur, dulled by coarse shagreening; hamuli each with 13 hooks. Metasomal tergum 2 with punctures of interband zone large, round, with indistinct posterior borders and separated by one puncture width or less; apical areas of terga 2-5 with small punctures scarcely larger than bases of hairs arising from them; sterna densely punctate, ground areas smooth and shiny.

Hair: On head pale ochraceous except abundant dark brown hairs on vertex. Thoracic hairs pale ferruginous above and ochraceous laterally except small patches of brown hairs on mesoscutum and scutellum; tegulae without dark hairs. Metasomal banding as in *communis* with the following differences: tergum 1 with basal four fifths medially and one half laterally with long ochraceous hairs, apical area with short, subappressed, simple, dark brown hairs; tergum 2 with distal pale band equal to less than one half of apical area medially, interband zone with dark brown hairs. Legs with white to pale ochraceous hairs except yellow hairs of inner surfaces of hind basitarsi and tibiae.

Type material. Holotype male from Martinique, French West Indies, July 15, A. Busck, is in the U. S. National Museum (U. S. N. M. Type No. 22898).

Melissodes (Melissodes) blanda, sp. nov.

This is a distinct species which is most closely related to *M. tepida* than to any other *Melissodes.* The males have relatively long first flagellar segments and distinct terminalia as described below. Both sexes can be distinguished by the generally pale color of the vestiture, the broad distal pale band of tergum 2, the relatively impunctate metasomal terga which are dulled by dense, fine shagreening, the coarsely punctate lateral areas of the vertex, the dark tegulae and the clear wing membranes.

Female. Measurements and ratios: N, 1; length, 11 mm.; width, 4 mm.; wing length, 3.64 mm.; hooks in hamulus, 17; flagellar segment 1/segment 2, 2.00.

Structure and color: Integument generally black, distitarsi, middle and hind basitarsi, mandibles medially, flagellar segments 2-10 beneath and basal sterna rufescent; eyes grayish-green; wing membranes clear, veins dark brown to black; tegulae piceous; tergum 1 with extremely narrow apical subhyaline margin, yellowish brown. Clypeus with fine regular punctures separated by half of one puncture width or less, except shiny impunctate median boss in apical third, moderately shiny, ground spaces with delicate shagreening; supraclypeal area with several distinct round punctures medially, ground areas dulled by fine shagreening; vertex with lateral flattened areas extending mesad and somewhat posteriorly from apices of compound eyes with round punctures separated mostly by half of one puncture width, obscured by coarse irregular shagreening dulling ground areas; maxillary palpal segments in ratio of about 3:2:2.5:1.3. Thoracic sculpturing as in *communis* with the following differences: mesoscutum with posteromedian area with punctures separated mostly by one to two puncture widths; lateral surfaces of mesepisterna with punctures separated by less than half of one puncture width, ground dulled by delicate sparse shagreening; dorsal face of propodeum with distinct crowded punctures apically, reticulopunctate basally, moderately shiny. Basal half or slightly more of metasomal tergum 1 with large, shallow punctures separated mostly by one puncture width or slightly less medially and obscured by dense shagreening; tergum 2 with interband zone virtually impunctate medially, lateral raised areas with shallow punctures separated mostly by one puncture width, ground dulled by dense shagreening; basal areas of terga 3 and 4 similar to lateral raised areas of tergum 2 but with smaller and more abundant punctures; apical areas of terga 2 and 3 impunctate, dulled by fine, dense shagreening.

Hair: Pale hairs of head and thorax grayish-white; vertex with abundant long black hairs; mesoscutum with black and white hairs mixed in posteromedian area, dark patch contained well within parapsidal lines laterally and extending forward to a transverse line at about middle of tegulae; scutellum with abundant brown to black hairs medially; mesepisternal hairs white, no dark hairs below. Metasomal terga as in *communis* with the following differences: tergum 2 with basal and distal pale bands connected at sides, distal band medially equal to about two thirds of apical areas and laterally to about apical area or more in width, interband zone with sparse subappressed black hairs; tergum 3 with apical area about equal to that on tergum 2 in width; apical areas of terga 2 and 3 with abundant suberect black hairs; tergum 4 with large triangular median patch of suberect black hairs at apex; tergum 5 with tufts of long white hairs at sides; sternal hairs dark reddish-brown, white laterally near apex of each sternum except the last. Legs with pale ochraceous to white hairs except as follows: outer surfaces of fore tarsi, apices of middle tibiae and basitibial plates brown; inner surfaces of tarsi and hind tibiae yellow to red.

Male. Measurements and ratios: N, 11; length, 9-11 mm.; width, 3-4 mm.; wing length, M = 3.45 ± 0.311 mm.; hooks in hamulus, M = 14.09 ± 0.415; flagellar segment 2/segment 1, M = 4.68 ± 0.152.

Structure and color: Integument black except as follows: clypeus and basal half of mandible yellow; labrum white; distitarsi and usually basitarsi rufescent; apical margins of sterna hyaline; tergum 1 with exceedingly narrow hyaline, yellowish-brown, apical margin; apices of terga 2-4 slightly paler than basally, dark brown; antennal flagella yellow to red below, dark reddish-brown to black above; supraclypeal area occasionally with a small apical transverse yellow macula; wing membranes clear, veins dark reddish-brown to black; tegulae piceous. Minimum length of first flagellar segment equal to about one fifth of maximum length of second segment; maxillary palpal segment as in female, fourth segment occasionally longer; sculpturing of head and thorax as in female with the following differences: clypeal sculpturing obscure, mesoscutal punctures more abundant, lateral surfaces of mesepisterna often more coarsely shagreened. Metasomal sculpturing as in female with the following differences: tergum 1 with basal four fifths punctate; tergum 2 with more distinct punctures in interband zone medially.

Terminalia as in *communis;* dorsal carina of gonocoxite angular apically, short, gonocoxite extends considerably beyond apex of carina; spatha broadly rounded laterally, gently emarginate medially. Sternum 7 with large flattened median plates which are rhomboidal in outline in ventral view and almost as wide as lateral plates at level of middle of median plates; ventral carinae very thick, together forming a broad V-shaped structure. Sternum 8 as in *gilensis* but with shorter apical hairs and with apodemes of *comptoides* (Figs. 96-97).

Hair: On head grayish-white, pale ochraceous on vertex; vertex without dark hairs. Pale hairs of thorax grayish-white laterally and below, grayish-white to pale ochraceous above; scutellum with abundant brown hairs medially; mesoscutum with few or no brown hairs in posteromedian area. Metasomal vestiture as in female with the following differences: tergum 4 with black suberect hairs in apical area as in tergum 3; tergum 5 with complete pale pubescent apical band, usually with suberect dark brown hairs apically in median third; tergum 6 with a few long pale hairs laterally; sternal hairs white apicolaterally, yellowish-brown medially. Legs with white to pale ochraceous hairs except yellow to red on inner surfaces of tarsi.

Type material. Holotype male, allotype female and four male paratypes from 5 miles east of Brownsville, Texas, April 13, 1950, on *Borrichia frutescens*, L. D. and R. H. Beamer, C. D. Michener, W. P. Stephen, B. L. and J. G. Rozen. Two additional male paratypes collected on *Opuntia* sp. at the same time and place as the above. Four additional male paratypes are as follows: Boca Chica, Cameron Co., Texas, 1 male, April 13, 1950, on *Gaillardia* sp., by the collectors listed above; 21 miles south of Sarita, Texas, 2 males, April 17, 1952, on *Sphaeralcea* sp., L. D. and R. H. Beamer, C. D. Michener, W. E. LaBerge and Alvaro Wille; Ardmore, Oklahoma, 1 male, June 25, 1908, F. C. Bishopp (Fig. 19). The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the Snow Entomological Museum, the U. S. National Museum and in the author's collection (Fig. 19).

Melissodes (*Melissodes*) *comptoides* Robertson.

Melissodes comptoides Robertson, 1898, Trans. Acad. Sci. St. Louis, vol. 8, p. 52; 1905, Trans. Amer. Ent. Soc., vol. 31, p. 369; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 80; Robertson, 1928, Flowers and Insects, p. 8; Brimley, 1938, Insects of North Carolina, p. 462; Michener, 1947, Amer. Mid. Nat., vol. 38, p. 453.

Melissodes martini hitei Cockerell, 1908, Ann. Mag. Nat. Hist., ser. 8, vol. 2, p. 33 (new synonymy); 1909, Can. Ent., vol. 41, p. 129; 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 233; 1927, Ann. Ent. Soc. Amer., vol. 20, p. 396; Rau, 1933, Trans. Acad. Sci. St. Louis, vol. 28, p. 221.

This species is closely allied to *M. communis* and *M. thelypodii*. The males of *comptoides* can be distinguished from those of *communis* by the shorter first flagellar segments and by the more coarsely punctate mesoscutum and apical areas of the metasomal terga. They can be separated from the males of *thelypodii* by the more coarsely punctate apical areas of the terga, by always lacking a white pubescent band on tergum 5, by almost always having dark brown to black hairs apically on the terga and in the interband zone of tergum 2 and by having the vertex between the lateral ocelli and the apices of the compound eyes punctate and usually shagreened. The females are distinguished from those of *communis* by the more coarsely punctate mesoscutum and apical areas of the terga. They can be distinguished from females of *thelypodii* by the more coarsely punctate apical areas of the terga and by the presence of dark brown to black hairs at least on the ventral surfaces of the mesepisterna and usually on the lower anterior and lower lateral surfaces as well. In addition, the females often have dark reddish-brown to black hairs on the inner surfaces of the hind basitarsi and the flattened areas of the vertex are coarsely punctate and dulled by dense shagreening.

Female. Measurements and ratios: N, 20; length, 12-15 mm.; width, 5.0-6.5 mm.; wing length, $M = 4.65 \pm 0.363$ mm.; hooks in hamulus, $M = 17.05 \pm 0.256$; flagellar segment 1/segment 2, $M = 2.03 \pm 0.021$.

Structure and color: Integument black; distitarsi and lower surfaces of flagella except first segments rufescent; often hind basitarsi and tibiae and fore, middle and hind femora rufescent, especially in specimens with more than usual dark hairs; eye color variable, from gray to blue or yellowish-green, occasionally brownish or somewhat violet; wings dark, membranes infumate, yellowish-brown to dark brown, veins dark brownish-red to black, darker apically. Punctation of face as in *communis,* but clypeus usually more evenly rounded, often without a median carina and usually more densely shagreened; flattened areas of vertex just mesad of apices of compound eyes with round, deep punctures separated by one and usually less puncture width, ground dulled by dense shagreening; supraclypeal area usually coarsely punctate and shagreened; eyes, galeae and maxillary palpi as in *communis.* Mesoscutal punctures small, crowded anteriorly and laterally, becoming larger and less crowded medially (separated by about one puncture width in posteromedial area) and then becoming quite suddenly smaller and much more crowded posteriorly (separated by half or less of one puncture width), this area of crowded punctures not confined to the short declivous posterior area of mesoscutum, but extending forward medially onto flattened dorsal surface; scutellum, metanotum, propodeum and lateral surfaces of thorax as in *communis,* but lateral surfaces of mesepisterna with ground usually dulled by delicate shagreening. First metasomal tergum with round, more distinct punctures than in *communis* and separated by about one puncture width medially; terga 2-4 punctate much as in *communis* basally, but tergum 2 with coarser and larger punctures especially medially in interband zone, and apical areas of terga 2 and 3 with abundant piliferous punctures usually as wide as 3 to 4 times basal width of hairs arising from them, ground with dense fine shagreening, but usually moderately shiny.

Hair: On head and thorax as in *communis* with the following differences: vertex of head always with brown hairs; dorsum of thorax with ochraceous to bright rufescent hairs, scutellum and mesoscutum usually without brown hairs, but often with very small patches of reddish-brown hairs on each; ventral surfaces and usually lower lateral and lower anterior surfaces of mesepisterna with dark brown hairs; rarely all or almost all thoracic hairs dark brown to black. Metasomal terga with vestiture as in *communis*, but usually with more dark hairs apically on tergum 1 and in the interband zone of tergum 2, tergum 2 with distal pale band rarely wider than one third of apical area medially, tergum 5 often without tufts of long white hairs laterally. Sternal hairs and legs as in *communis*, but often all hairs of fore and middle legs and hind femora and coxae dark brown; inner surfaces of middle and hind basitarsi and hind tibiae with bright red to dark reddish-brown hairs.

Male. Measurements and ratios: N, 20; length, 11-15 mm.; width, 3-5 mm.; wing length, $M = 4.33 \pm 0.250$ mm.; hooks in hamulus, $M = 14.90 \pm 0.181$; flagellar segment 2/segment 1, $M = 7.08 \pm 0.087$.

Structure and color: Color as in *communis*, but spots at bases of mandibles usually only slightly wider than basal depressed punctate triangles and apical margins of terga always piceous. Minimum length of first flagellar segment usually equal to one seventh of maximum length of second segment, often less, occasionally slightly more but never as much as one sixth of second segment; galeae, maxillary palpi and eyes as in *communis*. Punctures of head and thorax as in *communis* except for the following: supraclypeal area usually dulled by dense shagreening and densely punctate; vertex between apices of compound eyes and lateral ocelli with deep round punctures separated by no more and usually less than one puncture width, ground shiny, smooth or very delicately shagreened; mesoscutum with dense small punctures in posteromedian areas as in female; lateral surfaces of mesepisterna with ground usually dulled by fine shagreening. Metasomal terga as in *communis*, but more coarsely punctate in basal area of tergum 1 (punctures separated mostly by one puncture width or less) and in interband zone of tergum 2; apical areas of terga 2 and 3 usually with coarse piliferous punctures at least near the pale pubescent bands; apical areas of terga 1-3 finely shagreened, but moderately shiny, not dulled as in *communis*.

Terminalia as in *communis* with the following differences: gonostyli often slightly shorter and less capitate; spatha usually somewhat blunter laterally; sternum 7 with lateral plate usually equal to half or more of length of sternum from tip of lateral plate to tip of apodeme; sternum 8 usually shallowly emarginate or truncate apically and with short to moderately long hairs at apex (Figs. 79-81).

Hair: Color and pattern as in female with the following differences: head rarely with dark brown hairs; scutellar and mesoscutal patches of dark hairs usually absent; ventral, lower lateral and lower anterior surfaces of mesepisterna usually without dark hairs, but present in some specimens from southern and eastern parts of the range; apical area of metasomal tergum 1 usually with abundant dark brown hairs; tergum 2 with distal pale band often slightly wider than in female, but never as wide as half of apical area medially as in some specimens of *communis*; interband zone of tergum 2 always with dark hairs in at least lateral third; terga 3 and 4 as in *communis*; tergum 5 never with a complete pale band, usually with lateral tufts of long white hairs; terga 6 and 7 without tufts of white hairs laterally; sterna and legs as in *communis*, but hind coxae and femora and inner surfaces of hind tibiae often with dark reddish-brown hairs in specimens from the southern and eastern parts of the range, occasionally fore and middle femora and tibiae also with dark hairs; inner surfaces of basitarsi usually with yellow to bright red hairs, rarely darker.

Geographical variation. As in *communis*, a great deal of variation in color, as well as in size, occurs in *comptoides*, and there is a general darkening of the hair color towards the east and south. The males bearing dark hairs on the legs and mesepisterna as described above are all from the Gulf States or the Atlantic States south of North Carolina. These characters appear haphazardly and are exhibited by less than 60 percent of the males available for study from these areas. Other characters which also follow this pattern are the dark brown hairs on the scutellum, mesoscutum and vertex of the head and a general darkening of the metasomal vestiture. One small male from Lower Metacumbe Key, Florida, has the hairs of the head, thorax and legs almost all dark brown. The typical banding of the terga is retained in this specimen, although the basal area of tergum 1 has only dark hairs. Three males from Royal Palm State Park, Florida, are somewhat lighter than this, but are generally very dark. From other localities in Florida mixtures of normally pale, intermediate and dark individuals are available.

Females follow this same general distribution in regard to melanism. A series of eleven females from Royal Palm State Park, Florida, exhibit the greatest degree of melanism reached by this species. Of these eleven females, five have an almost totally dark head and thorax and retain the typical *comptoides* tergal banding, although with only dark hairs basally on tergum 1 and with the basal band of tergum 2 dark brown or mostly so. Two females have the typical coloration of *comptoides,* except for the presence of distinct patches of dark hairs on the mesoscutum and scutellum. The remaining four females exhibit an intergrading series between these. Specimens from other localities in Florida and from the other Atlantic and Gulf States are generally paler than these and most are as pale as the palest specimens from the northwestern part of the range of the species. Three specimens from Liberty, Harris County, and Trinity, Texas, respectively, are almost as dark as the darkest Florida specimen.

As great as the contrast is between the extremes in regard to color, no subspecies of *comptoides* are recognized at this time. A lack of material from the areas involved and, particularly, the almost total lack of series of specimens prohibits adequate description of the obviously highly complicated situation.

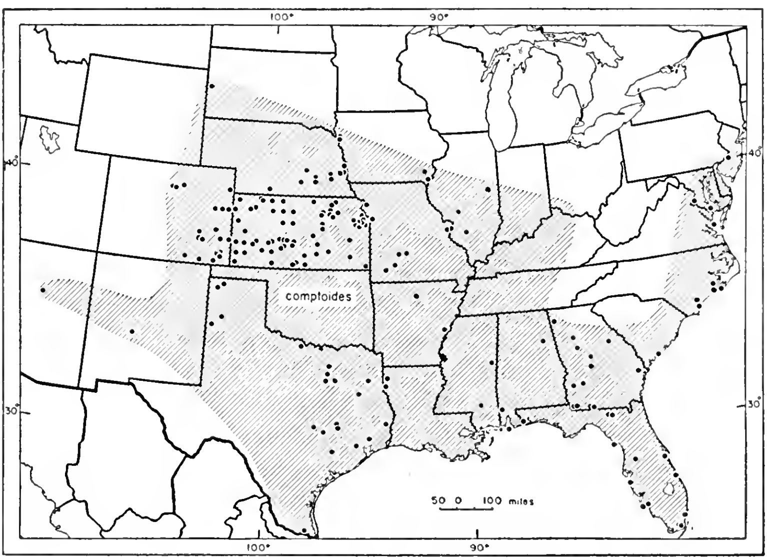

FIG. 13. Map showing the distribution of *M. (Melissodes) comptoides.*

Bionomics. M. comptoides, like *M. communis,* is a highly polylectic species. It has been collected visiting at least fourteen families and thirty-one genera of plants. There appears to be a rather strong preference for the pollen of *Euphorbia marginata,* at least in the great plains area. In the great plains area and elsewhere the females have often been collected on legumes, especially *Medicago sativa* and *Melilotus alba,* and these plants are probably important as pollen sources. The only composite from which they are known to collect pollen is *Vernonia.*

Type material. Lectotype female of *comptoides,* here designated, from Carlinville, Illinois, August 18, 1897, on *Lythrum alatum,* Charles A. Robertson (collection no. 20449), and male lectoallotype of *comptoides,* here designated, from Carlinville, Illinois, August 1, 1895, on *Lepachys pinnata,* Charles A. Robertson (collection no. 17480) are in the collection of the Illinois Natural History Survey, Urbana. Holotype female of *hitei* from Pueblo, Colorado, August 17, 1907, Hite, is the property of the California Academy of Sciences, but temporarily deposited in the collection of the Citrus Experiment Station, Riverside, California.

Distribution. From northcentral Arizona and eastern Colorado in the west through South Dakota and Illinois to New Jersey in the north and through Texas and the Gulf States to southern Florida in the south (Fig. 13). These bees have been collected from April 17 to October 10, but mainly in July and August over most parts of the range. In addition to the type material, 490 females and 445 males have been examined from the localities listed below. Localities of the type material and those reported in the literature are included in this list.

ALABAMA: Canebreak; Citronelle; Fort Morgan. ARIZONA: Flagstaff. ARKANSAS: Barshed; Spring, Stone Co. COLORADO: Baca Co.; Boulder; Brighton; Burlington; Eads; Flagler; Hoehne; Holly; Kirkwell, Baca Co.; Kit Carson Co.; La Junta; Lamar; Powars, Weld Co.; Rocky Ford; Springfield; Tobe; Two Buttes; Walker Hill, Crowley Co.; Wray. FLORIDA: Bradentown; Cedar Key; Cocoa; Estero; Lacoochee; Miami Beach; Pensacola; Punta Rassa; Royal Palm Hammock; Royal Palm State Park; Sanibel; Suwanee Springs; Swan; Vero Beach. GEORGIA: Atlanta; Bainbridge; Boston; Clyde; Griffin, Lee Co.; Macon; Perry; Rome; Shellman; Spring Creek, Decatur Co.; Thomasville; Warrenton. ILLINOIS: Carlinville; Covington; Urbana. IOWA: Fort Madison; Mount Pleasant; Sargent Bluffs; Sioux City. KANSAS: Baldwin; Barber Co.; Basehor; Blue Rapids; Burdett; Butler Co.; Cherokee Co.; Cheyenne Co.; Clark Co.; Clay Center; Clay Co.; Coffey Co.; Decatur Co.; De Soto; Dickinson Co.; Douglas Co.; Edwards Co.; Ellis Co.; Elmo; Finney

Co.; Ford Co.; Garden City; Graham Co.; Grant Co.; Gray Co.; Hamilton Co.; Harper Co.; Harvey Co.; Hodgeman Co.; Hudson; Jetmore; Johnson Co.; Kanorado; Kearny Co.; Kingman Co.; Lake View; Larned; Lawrence; Leavenworth Co.; Lewis; Manhattan; Marshall Co.; McPherson Co.; Medicine Lodge; Morton Co.; Norton Co.; Oberlin; Osborne Co.; Pawnee Co.; Phillips Co.; Pottawatomie Co.; Randolph; Republic Co.; Rexford; Riley Co.; Rooks Co.; Russell Co.; Stafford Co.; Stanton Co.; Sedgwick Co.; Thomas Co.; Wallace Co.; Wilson Co.; Wichita Co. LOUISIANA: Keatchie; Shreveport. MARYLAND: Indian Head; Scotland; Sea Shore. MISSOURI: Buffalo; Kansas City; Kirkwood; Lebanon (12 miles S. E.); Springfield; St. Joseph; St. Louis; Verona. MISSISSIPPI: Hattiesburg; Shuqualak. NEBRASKA: Cambridge; Chapman; Fairmont; Hastings; Lincoln; Louisville; Malcolm; McCool; Omaha; South Bend. NEW JERSEY: Riverton. NEW MEXICO: Magdalena Mts. NORTH CAROLINA: Beaufort; Bogue; Lake James; New Bern; Rocky Point; Wilmington. SOUTH CAROLINA: Edesto Beach. SOUTH DAKOTA: Black Hills. TEXAS: Brazos Co.; College Station; Conlen; Dalhart; Dallas; Dawn; Friona; Harris Co.; Jacksonville; Kirbyville; Lee Co.; Liberty; Longview (6 miles E.); Plano; Raymondsville; Riverside; Rock Island; Rosser; Sterrett; Taylor. VIRGINIA: Camp Peary.

Flower records. Amphiachyris sp., *A. dracunculoides, Asclepias incarnatus, Aster* sp., *Blephilia hirsuta, Campanula* sp., *C. americana, Cassia* sp., *C. fasciculata, Cleome serrulata, Cicuta maculata, Cirsium lanceolatum, Diodea teres, Euphorbia* sp., *E. marginata, Gossypium herbaceum, Helenium* sp., *H. tenuifolium, Helianthus* sp., *H. annuus, H. petiolaris, Lepachys pinnata, Lespedeza virginica, Ludwegia alternifolia, Lycopus americanus, Lythrum* sp., *L. alatum, L. lineare, L. salicaria, Medicago sativa, Melilotus alba, Monarda* sp., *M. citriodora, M. fistulosa, M. punctata, Petalostemum purpureum, Prunella vulgaris, Pycnanthemum* sp., *P. flexuosum, P. pilosum, P. virginianum, Ratibida* sp., *Solidago* sp., *S. serotina, Symphoricarpos* sp., *Taraxacum officinale, Teucrium* sp., *T. canadense, Verbena* sp., *V. hastata, V. stricta, Vernonia* sp., *V. fasciculata, V. noveboracensis, Veronica longifolia.*

Melissodes (Melissodes) negligenda Cockerell

Melissodes negligenda Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 466.

This species, known only in the female sex, is closely related to *M. comptoides.* Like *comptoides*, it can be distinguished from *communis* and several other members of the subgenus *Melissodes* by the large deep punctures in the apical areas of metasomal terga 2 and 3, by the densely punctate mesoscutum and by the bright ferruginous hairs of the thorax. These females can be separated from those of *comptoides* by the densely shagreened ground areas of the clypeus and thorax and by the brownish scopal hairs.

Female. Measurements and ratios: N, 1; length, 11-12 mm.; width, 5 mm.; wing length, 3.85 mm.; hooks in hamulus, 16; flagellar segment 1/segment 2, 2.12.

Structure and color: Integument black, distitarsi and flagella beneath rufescent; wings infumate, clear brown, veins dark brown to black; eyes dark grayish-blue. Eyes slightly less than 3 times as long as broad in facial view; maxillary palpal segments in ratio of about 2:2:1.5:1; clypeus with coarse crowded punctures, becoming smaller in apical third, separated by half or less of one puncture width posteriorly, ground opaque, dulled by extremely dense, coarse shagreening; flattened lateral areas of vertex with abundant small punctures separated mostly by one puncture width or slightly less, ground dulled by dense shagreening. Thoracic sculpturing as in *comptoides*, but punctures on mesoscutum and scutellum even more crowded and ground areas everywhere dulled by coarse shagreening. Metasomal sculpturing as in *comptoides*, but punctures in apical areas of terga 2 and 3 separated by 2 to 3 puncture widths and ground areas everywhere moderately shiny, somewhat dulled by moderately coarse, reticular shagreening.

Hair: Head with pale ochraceous to white hairs except abundant black hairs on vertex and on face just mesad of upper halves of compound eyes. Thorax above with bright ferruginous hairs, becoming pale ochraceous to white laterally and on propodeum; ventral, lower lateral and lower anterior surfaces of mesepisterna with dark brown to black hairs. Metasomal hairs and pubescence as in *comptoides*, but white pubescent bands of terga 2 and 3 thin, that on tergum 2 interrupted medially. Legs with dark brown hairs, except scopal hairs medially pale brown.

Type material. Holotype female from Agua Amarilla, Honduras, March 15, A. Carr, in the U. S. National Museum (U. S. N. M. Type No. 58550). Two paratype females from Agua Amarilla, Honduras, March 17, G. Vidales, are also in the U. S. National Museum.

Distribution. Known only from the type material and one additional female collected at Agua Amarilla, December 15, presumably by T. D. A. Cockerell.

Melissodes (Melissodes) maesta, sp. nov.

This species is the first of a series of melanistic species which belong to the *communis* complex in spite of the great color differences. *M. maesta* and *M. morrilli* are two intermediate species between *M. bimaculata* and *M. leprieuri*, the darkest species of North American *Melissodes*, and the other members of the *communis* complex. The males of *maesta*, and of the other melanistic species, have characters of the terminalia and, particularly, the eighth sternum in common with *communis*.

The females of *maesta* can be separated from the foregoing species by the following characters: mesoscutum relatively sparsely punctate; terga 2 and 3 with coarsely punctate apical areas; tergum 2 with the distal pale band broadly interrupted medially (pubescence absent medially, not merely brown). The females of *maesta* can be separated from the other melanistic species of the subgenus by the paler hairs of the thorax and head as described below. The males of *maesta* can be separated from the foregoing species on the same basis as the females, but the mesoscutal punctures are variable and not distinctive in this species. The males can be separated from the other melanistic members of the subgenus by being paler than most of the latter and by differences in tergal punctation as described below.

Female. Measurements and ratios: N, 5; length, 14-15 mm.; width, 5.0-6.5 mm.; wing length, $M = 5.19 \pm 0.495$ mm.; hooks in hamulus, $M = 17.20 \pm 0.374$; flagellar segment 1/segment 2, $M = 1.88 \pm 0.026$.

Structure and color: Integumental color as in *communis* with the following differences: legs dark reddish-brown to black; metasomal terga often very dark reddish-brown with slight violaceous reflections; flagella reddened only on outer half of lower surfaces, mostly dark brown to black; wing membranes dark brown, veins dark reddish-brown to black. With structural characters of *communis* with the following differences: supraclypeal area coarsely punctate; clypeus with rather regular coarse punctures, often without median carina, moderately shiny; metasomal tergum 1 with coarse distinct punctures separated by one puncture width or less in basal three fifths; tergum 2 with small round punctures separated by one puncture width or less in interband zone, these punctures distinct across entire tergum and not much smaller medially than laterally, apical area with abundant distinct punctures equal in diameter to two or three times basal diameter of hairs arising from them and separated from nearest punctures mostly by one to two puncture widths; tergum 3 with apical area punctate as in tergum 2.

Hair: With characters of vestiture of *communis* with the following differences: vertex of head with more abundant dark brown hairs mixed with pale often extending down along inner margins of compound eyes to clypeus and clypeal hairs all or almost all dark brown. Mesoscutum with large patch of dark brown hairs extending forward to or beyond a transverse line at anterior margins of tegulae and laterally beyond parapsidal lines; tegulae with abundant dark hairs; lateral surfaces of thorax with dark brown hairs, except pale hairs on extreme upper anterior areas of mesepisterna and on posterior halves of lateral surfaces of propodeum. First metasomal tergum with pale ochraceous hairs basally, often with a few dark hairs intermixed, especially on anterior face; tergum 2 with white basal pubescent band and thin, lateral fasciae of white pubescence medially, basal band and distal fasciae not connected laterally by pale hairs or pubescence on dorsum of tergum; tergum 3 with pale band as narrow as or narrower than apical area medially; tergum 4 usually with median diamond-shaped patch of dark brown hairs. Legs with hairs dark brown except reddish-brown to red hairs of inner surfaces of tarsi and hind tibiae, and pale ochraceous scopal hairs.

Male. Measurements and ratios: N, 4; length, 12-14 mm.; width, 4.0-4.5 mm.; wing length, $M = 4.47 \pm 1.610$ mm.; hooks in hamulus, $M = 16.75 \pm 1.493$; flagellar segment 2/segment 1, $M = 4.60 \pm 0.184$.

Structure and color: With integumental color as in *communis* with the following differences: mandibles with small triangular basal spots; clypeus yellow to yellowish-orange; apical areas of metasomal terga opaque, dark reddish-brown, often with slight violaceous reflections; legs reddish-brown to black; wing membranes infumate, brown, veins dark reddish-brown to black. With structural characters of *communis* with the following differences: vertex laterally with large round punctures separated mostly by one puncture width or less, ground smooth and shiny; mesoscutum with coarse punctures, posteromedian area with punctures separated by less than one puncture width to three puncture widths, but rather evenly spaced. Metasomal tergum 1 with basal three fifths with coarse round punctures separated mostly by one puncture width; basal area of tergum 2 with distinct punctures across entire tergum, punctures separated by one to two puncture widths; apical areas of terga 2-4 with small round punctures equal to two or three times basal width of hairs arising from them and separated from nearest punctures mostly by one puncture width or slightly more; metasomal terga with ground shiny to moderately shiny, finely shagreened.

Characters of genitalia and hidden sterna essentially as in *M. communis.*

Hair: Vestiture as in *communis* with the following differences: vertex of head with dark brown hairs; mesoscutum and scutellum with large patches of dark brown hairs; pale hairs of head, thorax and metasoma pale ochraceous to white; lateral surfaces of mesepisterna and metepisterna and anterolateral surfaces of propodeum often with brown hairs (as in holotype); metasomal tergum 1 with abundant dark brown appressed to suberect hairs apically; tergum 2 with distal pale band usually broadly interrupted medially, resulting in lateral fasciae which are exceedingly thin and connected with basal pale band by pale pubescence only at extreme sides of tergum; tergum 3 with pale pubescence diffuse, not completely hiding surface, pale band medially as wide as or narrower than apical area; tergum 4 with pale band often interrupted medially by brown pubescence, extremely narrow; tergum 5 with or without narrow, pale, medially interrupted band. Legs with pale ochraceous hairs except rufescent hairs of distitarsi and inner surfaces of basitarsi, and often with brown hairs on inner surfaces of femora and tibiae.

Type material. Holotype male and two paratype males from Kerrville, Texas, June 1, 1906, on *Helenium* sp., F. C. Pratt, and the allotype female from the Davis Mountains, Jeff Davis County, Texas, May 6, 1907, on *Monarda citriodora*, F. C. Bishopp. Three paratype females from the Davis Mts., July 10, 1907, H. A. Scullen; one paratype female from San Antonio, Texas, June, 1942, E. S. Ross. The holotype and allotype are in the collection of the U. S. National Museum. Paratypes are in the collections of the California Academy of Sciences, the Snow Entomological Museum at the University of Kansas, the Oregon State College of Agriculture and in the author's collection.

Melissodes (Melissodes) labiatarum Cockerell

Melissodes labiatarum Cockerell, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 291.

This species, known only in the male sex, is extremely close to *M. maesta.* It can be distinguished from the males of *maesta, bimaculata* and *leprieuri* by the less abundant punctures in the apical areas of terga 2-4 and by the impunctate triangular area on the upper part of the declivous face of the propodeum which in *labiatarum* is dulled by dense shagreening.

Male. Measurements and ratios: N, 4; length, 12-13 mm.; width, 4.0-4.5 mm.; wing length, M $= 4.31 \pm 0.342$ mm.; hooks in hamulus, M $= 15.00 \pm 0.435$; flagellar segment 2/segment 1, (N, 3) M $=$ 4.58 ± 0.247.

Structure and color: Black; clypeus, labrum (except extreme apical margin) and usually small triangular spots at bases of mandibles yellow; tarsi rufescent, tibiae and femora dark reddish-brown; metasomal terga black with slight violaceous reflections; sterna dark reddish-brown; flagellum dark brown below and dark red above, except first segment which is wholly brown; wings infumate, membranes yellowish-brown, veins dark reddish-brown to black. Clypeus coarsely punctate, ground dulled by shagreening; maxillary palpal segments in ratio of about 2:2:1.5:1; minimum length of first flagellar segment equal to one fourth of maximum length of second segment or slightly less. Mesoscutum with deep round punctures separated by half of one puncture width or less anteriorly and laterally and by one to three puncture widths in posteromedian area; scutellum with smaller more crowded punctures; ground areas of mesoscutum shiny, not or scarcely shagreened; metanotum with small crowded punctures, ground dulled by dense shagreening; lateral surfaces of mesepisterna with coarse punctures about equal in size to median mesoscutal punctures, ground areas dulled by delicate shagreening; propodeum coarsely punctate and dulled by dense shagreening, upper impunctate triangular area of declivous face opaque, densely shagreened. Sculpturing of metasoma as in *maesta* except punctures of apical areas of terga 2-4 larger and less abundant; apical area of tergum 2 with punctures separated mostly by two puncture widths basally, becoming more widely separated apically, with narrow impunctate apical margin equal to one third of apical area medially.

Genitalia much as in *communis.* Sternum 7 with truncate apodemes. Sternum 8 with short sparse hairs apically; median longitudinal carina not reaching apical margin of sternum which is deeply emarginate medially at apex (Figs. 82-84).

Hair: Vestiture as in *maesta* with the following differences: occipital and genal areas of head with dark brown hairs, but vertex and face without dark hairs; sides of thorax usually with abundant brown hairs; pronotum usually with hairs all or almost all dark brown; mesoscutum with large posteromedian patch of dark brown to black hairs, anteriorly and laterally with yellow or ochraceous hairs; propodeal hairs all dark; first metasomal tergum with dark hairs on anterior face, long mixed pale and dark hairs in basal half of dorsal face; terga 2-6 with very little pale pubescence laterally and no complete pale bands; sternal hairs mostly dark brown, pale laterally.

Remarks. The series of eight males from Paso de Telayo are remarkable in showing a great deal of variation in the color of the vestiture. These range from specimens as pale as *maesta* and hardly distinguishable from the latter on the basis of color to the dark color of the holotype as described above. The pale specimens are perhaps a new species, but are not described here, since the full range of color variation and punctation of *labiatarum* cannot be estimated from the few specimens available. If the pale specimens from Paso de Telayo are conspecific with *labiatarum*, it is likely that *maesta* is no more than a northern race of this species. Much more collecting needs to be done in the area along the eastern coast of Mexico to clarify this problem. Virtually no specimens of *Melissodes* are available from the coastal area between Veracruz and Brownsville, Texas. It is also probable that *M. morrilli*, known only in the female sex, from the southern plateau area of Mexico represents the female of *labiatarum*. However, the less distinct punctation of the apical areas of the terga of *morrilli* suggests that it is a distinct species. Until sexes can be allied by field observations, or at least by collecting them in the same region, it is best to consider these as being distinct species.

Type material. Holotype male from San Rafael, Veracruz, Mexico, March 11, 1895, C. H. T. Townsend, is in the U. S. National Museum (U. S. N. M. Type No. 3356). Five male paratypes from Paso de Telayo, Jicoltepec, Veracruz, April 7 and 8, C. H. T. Townsend, are also in the U. S. National Museum.

Distribution. Known only from the type material plus three additional males, provisionally placed here, which were collected by Townsend at Paso de Telayo, Veracruz, presumably at the same time as the paratypes.

Melissodes (Melissodes) morrilli Cockerell.

Melissodes morrilli Cockerell, 1918, Trans. Amer. Ent. Soc., vol. 44, p. 29 (*bimaculata* subsp.).

This species is closely allied to *M. communis* from which it differs chiefly by the dark hairs of the head and thorax. It superficially resembles *M. bimaculata* from which it can be distinguished by the more abundant punctures on the mesoscutum, by the less distinct punctures of the apical areas of the terga and by the red hairs of the inner surfaces of the hind basitarsi. It is superficially similar to *M. morosa* Cresson from which it is distinguished by the dark hairs of the face, the white metasomal pubescence and the shiny galeae.

Females. Measurements and ratios: N, 15; length, 13-15 mm.; width, 4.5-5.0 mm.; wing length, $M = 4.74 \pm 0.051$ mm.; hooks in hamulus, $M = 16.47 \pm 0.123$; flagellar segment 1/segment 2, $M = 2.02 \pm 0.103$.

Structure and color: Black; distitarsi and flagella on outer half of lower surfaces rufescent; mandibles dark red in apical halves except tips, often with golden maculae in apical median halves or less; eyes grayish-black to dark green; wing membranes infumate, dark brown, veins dark reddish-brown to black. With structural characters of *communis* with the following differences: punctures of mesoscutum usually more crowded, separated by one to two puncture widths in posteromedian area, becoming smaller and more crowded posteriorly; propodeum with ground areas opaque, dulled by dense shagreening; first metasomal tergum with punctures of basal three fifths more distinct, separated mostly by less than one puncture width, ground dulled by dense shagreening; tergum 2 with punctures of interband zone slightly more distinct, especially laterally; apical areas of terga 2 and 3 with small indistinct shallow punctures separated by 2 to 5 puncture widths, virtually impunctate, ground dulled by fine dense shagreening.

Hair: On head and thorax black or dark brown, occasionally genal areas immediately laterad of upper halves of eyes with a few white or ochraceous hairs. First metasomal tergum with black or dark brown hairs; tergum 2 with black or dark brown hairs and pubescence except often with short, thin, lateral fasciae of white pubescence medially (remnants of the distal pale band of other species of this subgenus); tergum 3 usually with a thin median band of white pubescence, often interrupted medially, occasionally entirely dark brown; tergum 4 usually with a broad apical band of white pubescence interrupted medially by a small rectangle of simple brown hairs, pale band narrower medially than apical area of tergum 3; terga 5 and 6 with dark brown to black hairs; sternal hairs dark brown to black. Fore and middle legs, hind coxae and femora and basitibial plates with dark brown to black hairs, except for rufescent hairs of inner surfaces of hind tarsi; scopal hairs pale ochraceous to yellow; hairs of inner surfaces of hind basitarsi usually yellowish-red, occasionally reddish-brown and hairs of inner surfaces of hind tibiae yellowish-red to red.

Remarks. As stated above, it is possible that these are the females of *labiatarum,* but males have not been collected with the females. Furthermore, *labiatarum* males appear to be closely related to those of *maesta,* so closely that these two may be geographical races of one species. The females of *morrilli* are quite distinct from those of *maesta* on the basis of sculptural characters, as well as color, and this provides indirect evidence that *morrilli* and *labiatarum* are distinct species.

Type material. Holotype female from Tlahualilo, Durango, Mexico, September 2, 1904, A. W. Morrill, on squash, is in the U. S. National Musuem (U. S. N. M. Type No. 22918). One paratype from the vicinity of México (city), Mexico, July, 1897, O. W. Barrett (C. F. Baker collection), is also in the U. S. National Museum.

Distribution. Lower plateau area of Mexico from Tlahualilo, Durango, in the north to Atlixco, Puebla, in the south. Since very little new material has become available in addition to the type material, data for these are given in full below. Fifteen additional females examined are as follows:

Durango: Durango, 1 female, August 14, 1947, W. Gertsch; Durango, 1 female, August 14, 1947, C. D. Michener; Nombre de Dios, 1 female, on *Eysenhardtia polystachya,* August 5, 1951, P. D. Hurd. Distrito Federal: 1 female, L. Conradt; Xochimilco, 1 female, September 1, 1947, H. E. Milliron; 8 females, vicinity of México (city), July, 1897, O. W. Barrett. Puebla: Atlixco (7 miles S.), 1 female, July 13, 1953, Univ. of Kansas Mexican Expedition.

Melissodes (Melissodes) bimaculata (Lepeletier).

This is a highly variable melanistic species divisible into two subspecies. The females are easily recognized by the dark hairs of the head, thorax and metasoma, except the two lateral maculae of white pubescence usually present on tergum 4 and the usually white scopal hairs, and by the black hairs of the inner surfaces of the hind tibiae and basitarsi. The females are easily separated from the other melanistic species of the subgenus *Melissodes* by the distinctly punctate apical areas of terga 2 and 3, the sparse pubescence on tergum 2 and the sparse punctures on the mesoscutum. The males are much more variable than the females in regard to the color of the vestiture. The punctate apical areas of terga 2 to 4, the length of the first flagellar segment, the punctation of the mesoscutum and the sparse metasomal pubescence will together separate the males of *bimaculata* from those of the other melanistic species of this subgenus.

Female. Measurements and ratios: N, 20; length, 12-15 mm.; width, 5-6 mm.; wing length, $M = 4.87 \pm 0.349$ mm.; hooks in hamulus, $M = 17.90 \pm 0.376$; flagellar segment 1/2, $M = 2.03 \pm 0.023$.

Structure and color: Black; distitarsi often and basitarsi occasionally dark brownish-red; eyes black, brownish when faded; flagella all black or somewhat reddish on lateroventral surfaces; wing membranes deeply infumate, brown, veins black to dark brown; tegulae black; tibial spurs dark brown to black. Clypeus coarsely punctate, punctures large, deep, irregular, elongate laterally and separated mostly by half of one puncture width or less, usually without median carina or boss, ground areas shiny to moderately shiny, with delicate striations; supraclypeal area coarsely punctate laterally, sparsely punctate medially, ground shiny to moderately shiny with delicate shagreening; flattened areas of vertex extending mesad and somewhat posterior from apices of compound eyes coarsely and densely punctate, punctures mostly separated by less than one puncture width, ground moderately shiny, delicately shagreened. Mesoscutum with punctures in large posteromedian area sparse, separated by one half to four puncture widths, round and deep, ground shiny, delicately or not at all shagreened; scutellum with crowded punctures separated mostly by one half to one puncture width, ground delicately shagreened, punctures of about same size as on adjacent area of mesoscutum; lateral faces of mesepisterna with abundant punctures separated mostly by half of one puncture width and rarely by more than one puncture width, distinctly smaller than those of posteromedian area of mesoscutum; propodeum as in *communis,* but upper impunctate triangle of declivous face moderately shiny, with delicate shagreening. Basal three fifths of first metasomal tergum with distinct round punctures separated mostly by one puncture width or less, ground shagreened, but moderately shiny; terga 2 and 3 punctate everywhere, punctures separated by one half to three puncture widths, but mostly by about one puncture width; tergum 4 similarly punctate medially and basally, but punctures more crowded beneath lateral pubescent fasciae.

Hair: Metasomal tergum 2 with sparse pubescence, with abundant appressed or suberect simple black hairs, plumose pubescent band at extreme base and often with very few black plumose hairs in a thin median strip on each side (remnants of distal pale band of other species); tergum 3 with sparse dark brown to black pubescence; tergum 4 with a distinct apical pubescent band, white laterally and brown medially, often interrupted medially by triangular area of simple black hairs. Characters involving color of vestiture are described more fully below for each subspecies.

Male. Measurements and ratios: N, 20; length, 10-15 mm.; width, 3.5-5.5 mm.; wing length, $M = 4.46 \pm 0.217$ mm.; hooks in hamulus, $M = 15.65 \pm 0.335$; flagellar segment 2/segment 1, $M = 4.69 \pm 0.108$.

Structure and color: Black; legs and sterna often dark reddish-brown; clypeus yellow; bases of mandibles usually with large yellow triangular spots, occasionally much reduced and rarely absent; labrum white, sometimes with narrow brown apical margin; flagella reddish to yellow below, first segment entirely and remaining segments above dark brown to black; wing membranes infumate, but less so than in females, veins dark reddish-brown to black; tegulae dark reddish-brown to black; tibial spurs yellow to black; eyes green to black. Eyes more than one third as wide as long in facial view, strongly converging below; minimum length of first flagellar segment equal to one fifth or more of maximum length of second segment; maxillary palpal segments as in female. Punctation as in female, but mesoscutal punctures often somewhat more crowded and basal four fifths of first metasomal tergum coarsely punctate.

Genitalia and hidden sterna much as in *communis*; sternum 7 with larger lateral plates and shorter apodemes than in *communis*; sternum 8 with larger lateral apodemes and more constricted medially than in *communis* (Figs. 85-87).

Hair: Hairs generally sparse as in female; metasomal terga 2 and 3 with very sparse pubescence as in female. Color characters involving vestiture are described below for each subspecies.

Bionomics. The only published record of the nesting habits of this species is a short note by W. A. Ashmead (1894). Ashmead found a female entering a burrow directly beneath a small flat stone in an open field. The burrow extended under the stone a short distance, then extended vertically into the soil and terminated in a cell constructed of clay at a depth of eight inches.

M. bimaculata is one of the most polylectic species of the genus *Melissodes.* It has been collected on flowers of about 65 families of plants and is known to collect pollen from about half of these. It follows that this species is not particularly dependent on composites as pollen sources. On the contrary, it seemingly prefers plants of the families Labiatae and Leguminosae, but is known to collect pollen from such unrelated families as Malvaceae, Convolvulaceae, Cucurbitaceae and Onagraceae. The list of plants given below on which this species has been collected is, accordingly, impressive for its length and for the variety of plants represented.

Geographical variation. *M. bimaculata* is divisible into two rather distinct subspecies on the basis of color. *M. bimaculata bimaculata* occupies most of the eastern United States, whereas the dark subspecies, *nulla,* occupies the tip of the Florida peninsula. The subspecies *bimaculata* is known from northern Florida, and darker specimens of this subspecies from Georgia and the Gulf States to Texas provide evidence of gene flow from the dark subspecies of southern Florida. Cockerell (1905) described a darker variety from Texas (*melanosoma*). These males are merely variants which appear haphazardly throughout the range of *bimaculata s. str.* and do not represent a distinct southwestern race. In the same paper Cockerell published a short key to three other varieties of *bimaculata* based on hair color and the size of the yellow mandibular spots of the males. As in the case of *melanosoma,* these are variants which appear throughout the range of *bimaculata* and Cockerell seemingly recognized this, since he did not honor these three with names.

The dark subspecies, *nulla,* superficially appears to represent intergrades between *bimaculata* and the generally darker species, *leprieuri,* from Cuba. However, the presence of a complete pubescent band on tergum 2 (albeit usually dark in color) in *leprieuri* and the difference in punctation of the terga between the two forms provide evidence for considering them as distinct species. Furthermore, *nulla* exhibits the maximum size for *bimaculata,* whereas *leprieuri* is on the average as small as the smaller specimens of *bimaculata.*

Melissodes (Melissodes) bimaculata bimaculata (Lepeletier).

Macrocera bimaculata Lepeletier, 1825, *in* Latreille, Encyclopédie méthodique. Histoire naturelle, vol. 10, p. 527.
Macrocera binotata Say, 1837, Boston Jour. Nat. Hist., vol. 1, p. 404.
Macrocera nigra Lepeletier, 1841, Histoire naturelle des Insectes, Hyménoptères, vol. 2, p. 112.

Melissodes nigra, Smith, 1854, Catalogue of Hymenopterous Insects in the Collection of the British Museum, part 2, p. 310.

Melissodes bimaculata, Cresson, 1879, Trans. Amer. Ent. Soc., vol. 7, p. 225; Ashmead, 1894, Psyche, vol. 7, p. 25; Smith, 1896, Rept. Ent. Dept. New Jersey Agric. Coll. Exp. Stat., fig. 21; Bridwell, 1899, Trans. Kansas Acad. Sci., vol. 16, p. 211; Cockerell, 1899, Ent. News, vol. 10, p. 3; Harris and Kuchs, 1902, Univ. Kansas Sci. Bull., vol. 1, p. 36; Banks, 1902, Jour. New York Ent. Soc., vol. 10, p. 209; Cockerell, 1903, Ann. Mag. Nat. Hist., ser. 7, vol. 12, p. 449; Robertson, 1905, Trans. Amer. Ent. Soc., vol. 31, p. 367; Cockerell, 1905, Can. Ent., vol. 37, p. 267; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 81; Tucker, 1909, Trans. Kansas Acad. Sci., vol. 22, p. 281; Smith, 1910, Ann. Rept. New Jersey State Museum, 1909, p. 693; Graenicher, 1911, Bull. Publ. Mus. Milwaukee, vol. 1, p. 247; Viereck, 1916, Bull. Connecticut Geol. Nat. Hist. Surv., vol. 5, no. 22, p. 733; Washburn, 1919, Seventeenth Report of the State Entomologist of Minnesota—1918, p. 230; Folsom, 1922, Ann. Ent. Soc. Amer., vol. 15, p. 183; Rau, 1922, Trans. Acad. Sci. St. Louis, vol. 24, p. 34; Leonard, 1926, Mem. Cornell Univ. Agric. Exp. Stat., no. 101, p. 1026; Robertson, 1928, Flowers and Insects, p. 8; Pearson, 1933, Ecol. Monogr., vol. 3, p. 380; Cockerell, 1935, Amer. Mus. Nov., no. 766, p. 3; Graenicher, 1935, Ann. Ent. Soc. Amer., vol. 28, p. 304; Brimley, 1938, Insects of North Carolina, p. 462; Fattig, 1945, Emory Univ. Mus. Bull., no. 3, p. 5; Michener, 1947, Amer. Mid. Nat., vol. 38, p. 453; Stevens, 1951, North Dakota Agric. Exp. Stat. Bull., vol. 14, p. 29.

Melissodes binotata, Tucker, 1909, Trans. Kansas Acad. Sci., vol. 22, p. 281.

Melissodes melanosoma Cockerell, 1905, Can. Ent., vol. 37, p. 266 (new synonymy).

FIG. 14. Map showing the distribution of *M. (Melissodes) bimaculata*. The overlapping type of shading indicates the zone of intergradation between the two subspecies.

This subspecies is on the average slightly smaller and paler than *nulla.* The females of *bimaculata* can be separated from those of *nulla* by almost always having the white lateral pubescent fasciae on tergum 4 and by the white scopal hairs. The males of *bimaculata* can be distinguished from those of *nulla* by the usual presence of white hairs laterally on the terga, the white hairs of the outer surfaces of the hind tibiae and basitarsi and by the usual presence of some white hairs on the mesoscutum and often on the sides of the thorax.

Female. Hairs and pubescence usually all black or dark brown except as follows: tergum 4 with distinct apical lateral fasciae of silvery-white pubescence; in palest specimens face with a few white hairs just above and laterad of antennal fossae; scopal hairs white, occasionally a few brown hairs at apices of hind basitarsi and around basitibial plates; inner surfaces of fore and middle tarsi and hind distitarsi often with very dark reddish-brown hairs; inner surfaces of hind basitarsi and tibiae usually with black or dark brown hairs, rarely these hairs rufescent and then probably due to fading with age.

Male. Very variable in color. Head with white hairs except black hairs on vertex and black hairs mixed with white on genal areas. Thoracic hairs usually all black, but often with sparse white hairs anteriorly and laterally on mesoscutum and on posterior margin of scutellum, and mixed black and white hairs on lateral surfaces of mesepisterna in pale specimens; tegulae with black hairs; propodeum always with black hairs except several long white hairs dorsally. Metasomal terga usually with black hairs and pubescence except short fasciae of white pubescence and a few long white hairs laterally on terga 2 to 5; occasionally dark specimens without metasomal white hairs, occasionally pale specimens with a complete white pubescent band on tergum 3 and rarely on tergum 4 as well; sternal hairs black to dark brown. Legs variable, usually outer surfaces of tibiae and basitarsi with white hairs and remaining surfaces with black or brown hairs; inner surfaces of fore, middle and hind basitarsi usually with dark reddish-brown hairs, occasionally red or yellow on these and on inner surfaces of hind tibiae.

Type material. Female holotype of *bimaculata* lost or destroyed. Male holotype of *nigra* is in the Saussure collection in the Museum of Natural History, Geneva, Switzerland. The type material of *binotata* from Indiana has been destroyed. The male holotype of *melanosoma* from Fedor, Texas, May 26, 1904, G. Birkmann, is the property of the California Academy of Sciences, but is temporarily deposited in the collection of the Citrus Experiment Station, Riverside, California.

Distribution. From North Dakota south through eastern Colorado to northeastern New Mexico, east to Maine in the north and to northern Florida in the south (Fig. 14). This subspecies has been collected from May 9 to October 27. Localities reported in the literature are listed below together with localities of 528 females and 838 males which have been examined.

ALABAMA: Coatopa; Cowarts; Decatur; Dothan; Florala; La Place; Mobile; Mt. Meigs; Tuskegee. ARKANSAS: Lawrence Co.; Polk Co.; Rich Mt.; White River. COLORADO: Boulder; Brighton. CONNECTICUT: Colebrook; East Haddum; New Haven; Storrs; Westville. FLORIDA: Indian River; Lacoochee; Orange City; Sanford; Suwanee Springs. GEORGIA: Armuchee; Atlanta; Billy's Island, Okefenokee Swamp; Dallas; DeWitt; Harlem; Macon; Mitchell Co.; Monticello; Rabun Co.; Rome Spring Creek, Decatur Co.; Stone Mt.; Summerville; Thomasville; Thomsons Mills; Unadilla; Valdosta. ILLINOIS: Bath; Bement; Bloomington; Carlinville; Champagne; Charleston; Chicago; Danville; Decatur; Downers Grove; Grand Tower; Harristown; Homer Park; Kankakee; McHenry; Manito; Matteson; Meredosia; Moline; Oak Park; Pekin; Peoria; Roseville; Tampico; Urbana; West Pullman; White Heath; Willow Springs. INDIANA: Lafayette; Vincennes; Wells Co. IOWA: Ames; Fort Madison; Griffin; Mt. Pleasant; Sioux City; Spencer. KANSAS: Allen Co.; Atchison Co.; Baldwin, Douglas Co.; Cherokee Co.; Clearwater, Riley Co.; Crawford Co.; Deep Creek, Riley Co.; DeSoto, Johnson Co.; Douglas Co.; Ellsworth Co.; Eudora, Douglas Co.; Franklin Co.; Garnett, Anderson Co.; Hamilton Co.; Jewell Co.; Labette Co.; Lake View, Douglas Co.; Lawrence, Douglas Co.; Louisburg, Miami Co.; Manhattan, Riley Co.; Marysville, Marshall Co.; Olathe, Johnson Co.; Onaga, Pottawatomie Co.; Ottawa, Franklin Co.; Parker, Linn Co.; Pottawatomie Co.; Republic Co.; Riley Co.; Saline Co.; Sunflower, Douglas Co.; Topeka, Shawnee Co.; Wabaunsee Co.; Wathena, Doniphan Co.; Wichita, Sedgwick Co. KENTUCKY: Cadiz. LOUISIANA: Covington; Creole; Forbing; Greenwell Springs; Keatchie; Leesville; Many; Mound; Natchitoches; New Orleans; Opelousas; Shreveport. MAINE: Winthrop. MARYLAND: Baltimore; Cabin John; Glen Echo; Montgomery Co. MASSACHUSETTS: Framingham; Holliston; Lexington; Marion; Woods Hole. MICHIGAN: East Lansing; Pontiac. MINNESOTA: Big Stone Co.;

Caledonia; Carver Co.; Chisago Co.; Excelsior; Faribault; Harmony; Hennepin Co.; Lake City; Lincoln Co.; Luverne; Lyon Co.; Mille Lacs; Minneapolis; North Branch; Otter Tail Co.; Powder Plant Woods, Ramsey Co.; Red Rock; Red Wing; Stanton; St. Anthony Park; St. Paul; St. Peter; Sucker Lake; Washington Co. MISSISSIPPI: DeSoto Co.; Hattiesburg; Iuka; McNeill; Meridian; Peetsville; Shuqualak; Toomsuba. MISSOURI: Atchison Co.; Atherton; Buffalo; Columbia; Hollister; Jackson Co.; Kansas City; Lebanon; Roaring River State Park; Rockport; Sedalia; Smithton; Pettis Co.; Springfield; St. Louis. NEBRASKA: Carns; Fairmont; Fontinelle Forest (near Omaha); Lincoln; Louisville; Malcolm; Meadow; Neligh; Omaha; South Bend; Union; Weeping Water; Westpoint. NEW JERSEY: Bergen Co.; College Farm; Eatontown; Englewood Cliffs; Haddon Heights; Jamesburg; Monmouth Co.; Manumuskin; Merchantville; Moorestown; New Brunswick; Passaic; Passaic Junction; Paterson; Princeton; Ramsey; Rancocas Park; Riverton; Salem Co.; Snake Hill; South Lakewood; South Orange; Springfield; Westville; Weymouth. NEW MEXICO: Magdalena Mts. NEW YORK: Copake Falls; Huntington; New Baltimore; New Windsor; New York City; Nyack; Pearl River; Pelham; Poughkeepsie; Scarsdale; Watchoque; Wyandauch. NORTH CAROLINA: Black Mts. (valley of); Bryson City; Burlington; Clinton; Faison; Hyde Co.; Judson; Lake James; Madison Co.; Marion; Mars Hill; Maxton; Murphy; Nanthala Gorge; New River; Raleigh; Rocky Mt. NORTH DAKOTA: Fargo; Lakota; Sheldon. OHIO: Athens; Butler Co.; Columbus; Elyria; Franklin Co.; Harrison; Lawrence Co.; Logan Co.; Shelby Co. PENNSYLVANIA: Annville; Belleville; Bloomsburg; Bird-in-hand; Bristol; Camphill; Chester; Delaware Watergap; Harrisburg; Highspire; Inglewood; Lemoyne; Philadelphia; Pittsburgh; Prospect; Torresdale; York. RHODE ISLAND: Providence. SOUTH CAROLINA: Batesburg; Clemson College; St. George. SOUTH DAKOTA: Brookings; Fairfax; Springfield. TENNESSEE: Gatlinburg; Nashville; "E. Tenn." TEXAS: Bexar Co.; Bonham; Brazos Co.; Brownwood; Calvert; McKinney; Palmetto State Park, Gonzales Co.; Paris; Victoria. VERMONT: Rutland. VIRGINIA: Alexandria Co.; Barcraft; Cape Charles; Charlottsville; Clifton; Falls Church; Glencarlyn; Great Falls; Nelson Co.; Pennington Gap; Princess Anne Co.; Scott's Run; Seven Pines; Shenandoah. WEST VIRGINIA: Baileysville. WISCONSIN: Maiden Rock; Milwaukee; Prescott; Shullsburg; Washington Co.

Flower records. Abutilon theophrasti, Agastache nepetoides, Althaea rosea, Arctium minus, Asclepias sp., *A. tuberosus, A. verticil-*

lata, Asparagus sp., *Aster* sp., *A. novae-angliae, A. paniculata, Astragulus canadensis, Baptisia tinctoria, Bidens aristosa, Blephilia hirsuta, Brauneria purpurea, Cacalia reniformis, Campanula* sp., *C. americana, C. rotundifolia, Cassia fasciculata, Cephalanthus occidentalis, Cicuta maculata, Cirsium* sp., *C. lanceolatum, Convolvulus* sp., *C. sepium, Cuphea petiolata, Cucurbita* sp., *C. pepo, Dalea onobrychis, Desmodium* sp., *D. bracteosum, D. canadense, D. dillenii, D. paniculatum, Dianthera americana, Dipsacus sylvestris, Echinocystis lobata, Eupatorium coelestinum, Gaura biennis, Gerardia grandiflora, Gladiolus* sp., *Gossypium herbaceum, Grindelia* sp., *Helenium* sp., *H. autumnale, Helianthus* sp., *H. annuus, H. divaricatus, H. grosse-serratus, H. tuberosus, Hibiscus* sp., *H. lasiocarpus, H. militaris, Impatiens biflora, Ipomoea* sp., *I. pandurata, I. purpurea, Jacquemontia temnifolia, Lepachys pinnata, Lespedeza procumbens, Lobelia* sp., *L. leptostachys, L. siphillitica, Lythrum* sp., *L. alatum, Malva rotundifolia, M. sylvestris, Medicago sativa, Melilotus alba, M. officinale, Mentha* sp., *Monarda fistulosa, M. mollis, M. punctata, Nepeta cataria, Oenothera biennis, Oxalis stricta, Petalostemum* sp., *P. purpureum, Petunia* sp., *Physostegia virginiana, Platycodon grandiflorum, Polygonum pennsylvanicum, Prunella vulgaris, Pycnanthemum* sp., *P. flexuosum, Ratibida* sp., *Rhus copallina, Rudbeckia triloba, Sagittaria* sp., *Scrophularia marilandica, Scutellaria lateriflora, Seymeria macrophylla, Sicyos angulatus, Silphium laciniatum, S. perfoliatum, Siscanna* sp., *Solidago* sp., *Stachys palustris, Strophostylis* sp., *Symphoricarpos* sp., *S. occidentalis, S. orbiculata, Teucrium canadense, Trifolium pratense, Verbena* sp., *V. hastata, V. stricta, V. urticaefolia, Vernonia* sp., *V. fasciculata, V. baldwini interior, V. spicata, Veronica virginica, Vitex agnus-castus.*

Melissodes (Melissodes) bimaculata nulla, subsp. nov.

This subspecies is on the average slightly larger and darker than *bimaculata s. str.,* and can be distinguished from the latter on the basis of the characters listed in the diagnosis of *bimaculata.* In both sexes of *nulla,* if the hairs of the outer surfaces of the hind basitarsi and tibiae are partially pale in color, they are usually ochraceous to bright orange, rather than white.

Female. In typical dark specimens vestiture, including scopal hairs, entirely dark brown or black; in somewhat paler specimens a few yellowish scopal hairs appear near apices of hind tibiae and these become more abundant in yet paler forms, yellowish scopal hairs of basitarsi first appear basally and spread towards apices, rarely with more than median two thirds of scopal hairs pale, pale scopal hairs, when present, ochraceous to bright orange; in palest specimens lateral fasciae of white pubescence appear on fourth tergum and become progressively larger until each equals one third of total width of tergum in palest specimens.

Male. In typical dark specimens vestiture, including hairs on outer surfaces of legs, black or dark brown, except white hairs on face above clypeus and below ocelli; in somewhat paler specimens several yellowish hairs appear on outer surfaces of hind tibiae near apices and progressively spread basad in still paler individuals, yellowish hairs appear first basally on outer surfaces of hind basitarsi and spread distally in still paler individuals, usually with two thirds or less of hairs of outer surfaces of hind basitarsi and tibiae pale and these usually ochraceous to orange, rarely white as in *bimaculata s. str.;* in palest individual small lateral tufts of white hairs appear on metasomal terga, especially on tergum 3, and a few white hairs anteriorly and laterally on mesoscutum.

Remarks. From the above description, one can perceive that a few specimens of both sexes are practically indistinguishable from the typical subspecies. This is especially true of the males. More than 90 percent of the females and more than 75 percent of the males are recognizable, however, on the basis of the characters listed in the diagnoses of these subspecies. The males, as in most species of *Melissodes,* are more variable than the females. Series of specimens from localities listed below as in the zone of intergradation show the entire range of color from one extreme to the other, and less than the above percentages are identifiable as either *bimaculata* or *nulla.* On the average these specimens are darker than *bimaculata s. str.,* and they probably mark only the southern edge of the zone of intergradation. More specimens are needed from the northern two thirds of the Florida peninsula in order that this zone be satisfactorily described.

Type material. Holotype male from Royal Palm Hammock, Florida, June 22, 1951, Roger Price, L. D. and R. H. Beamer and S. L. Wood. Allotype female with the same data, but collected from flowers of *Lythrum lineare.* Paratypes from Florida include 22 females and 16 males as follows: Homestead: 1 female, April 2, 1952, J. R. McGillis. Lower Metacumba Key: 1 female, September 4, 1931, Bradley and Knorr. Paradise Key, Dade Co.: 1 female, May 16, 1937, Richard Dow; 1 male, April 1, 1928, D. M.

Bates; 1 female, C. A. Mosier; 1 male, April 6, 2 males, April 12, 1951, H. and M. Townes; 1 female, March 29, 1952, G. S. Walley; 1 female and 2 males, March 22, 1 female and 5 males, March 23, 1954, K. V. Krombein. Royal Palm Hammock: 2 females, June 22, 1951, L. D. and R. H. Beamer, S. L. Wood and Roger Price. Royal Palm State Park: 2 females, March 8, 3 females, March 9-10, 1 male, March 12, 1 female, March 16, F. M. Jones; 3 females, April 12-18; 1 male March 17, 1925, W. S. Blatchley. Trail City: 1 male, April 7, 1952, J. R. Vockeroth. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collections of the U. S. National Museum, the American Museum of Natural History, the Snow Entomological Museum, the Museum of Comparative Zoology, Cornell University, the North Carolina State College of Agriculture and Engineering, the Canadian National Collection, and in the author's collection.

Distribution. Tip of the Florida peninsula north to Palm Beach and Lake Okeechobee, and the Islands off of southern Florida (Fig. 14). This subspecies has been collected from February 25 to the beginning of July. In addition to the type material listed above, 19 females and 38 males were examined from the localities listed below. This list includes localities of type specimens.

FLORIDA: Everglade, Dade Co.; Flamingo; Goulds; Homestead; * Lake Okeechobee; * Lake Worth; Lower Metacumba Key; * Mathewson Hammock; Miami; * Palm Beach; Paradise Key; Royal Palm Hammock; Royal Palm State Park; * South Bay, Lake Okeechobee; Trail City.

Melissodes (Melissodes) leprieuri Blanchard

Melissodes leprieuri Blanchard, 1849, *in* Cuvier, Le Règne Animal (ed. 3), insectes, vol. 2, p. 216, atlas pl. 128 *bis*, fig. 4.
Melissodes maura Cresson, 1865, Proc. Ent. Soc. Philadelphia, vol. 4, p. 188 (new synonymy); Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 81; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 123.

This is another melanistic species closely allied to *M. bimaculata*. The females of *leprieuri* can be distinguished from those of *morrilli* by the dark scopal hairs and by the completely dark vestiture of the metasoma. The females can be separated from those of *bimaculata* by the presence of a thin band of dark brown to dark ochraceous pubescence on the second metasomal tergum and by the finer punctation of the apical areas of terga 2 and 3. The males are easily separated from those of *maesta* and *labiatarum* by their darker

* Localities from the zone of intergradation.

color (legs and metasoma without white hairs or pubescence), and can be separated from the darkest males of *bimaculata* by the presence of a thin, median, narrowly interrupted band of dark brown pubescence on tergum 2.

Female. Measurements and ratios: N, 20; length, 10-13 mm.; width, 4-5 mm.; wing length, $M = 3.96 \pm 0.153$ mm.; hooks in hamulus, $M = 14.35 \pm 0.150$; flagellar segment 1/segment 2, $M = 2.03 \pm 0.021$.

Structure and color: Black; distitarsi dark red and often legs entirely dark red; antennae black, flagella usually slightly paler beneath; eyes black to gray-green; wing membranes deeply infumate, veins dark brown to black. With structural characters of *communis* with the following differences: maxillary palpal segments in ratio of about 3:3:2:1; eyes considerably less than three times as long as wide in facial view; clypeus with round deep punctures separated mostly by half of one puncture width, without a distinct median carina or boss, ground areas dulled by coarse shagreening; mesoscutum with deep round punctures separated by two or more puncture widths in posteromedian area, almost always with a small oval impunctate area about twice as wide as long posteromedially, often with a few scattered punctures in midline dividing this area into two rounded impunctate areas; propodeum dulled by coarse shagreening; first metasomal tergum with punctures of basal area small, round, distinct, separated mostly by one puncture width or less, ground shagreened but moderately shiny; tergum 2 with small distinct punctures in interband zone; apical areas of terga 2 and 3 with small distinct punctures separated by one to three puncture widths, ground finely shagreened, moderately shiny.

Hair: Head, thorax and metasoma with dark brown to black hairs, distal pubescent band of tergum 2 occasionally completely ochraceous, or ochraceous laterally, rarely distal pubescent band of tergum 3 ochraceous at extreme sides. Fore and middle legs, hind coxae, femora, basitibial plates and distitarsi with dark brown to black hairs, except rufescent hairs of inner surfaces of fore and middle basitarsi; scopal hairs usually entirely black, often those of at least distal halves of tibiae and basal halves of basitarsi bright yellowish-red; hairs of inner surfaces of hind basitarsi black to dark reddish-brown; inner surfaces of hind tibiae with long brown to black hairs laterally and short yellow to red hairs medially.

Male. Measurements and ratios: N, 2; length, 12 mm.; width, 3.5 mm.; wing length, 3.61-3.73 mm.; hooks in hamulus, 12-14; flagellar segment 2/segment 1, 5.71-5.96.

Structure and color: Color as in female except as follows: clypeus and labrum yellow; bases of mandibles with triangular yellow spots; flagellae, except first and last segments, red beneath; apical margins of terga 2-5 slightly translucent, dark brown. Structure as in female with the following differences: eyes strongly converging below, slightly more than twice as long as wide in facial view; minimum length of first flagellar segment equal to less than twice length of pedicle and about one sixth of maximum length of second segment. Genitalia and hidden sterna much as in *communis*; gonostyli capitate, truncate and curved slightly dorsally near apices.

Hair: Head, thorax and metasoma with black to dark brown hairs; tergum 2 with median lateral fasciae of dark brown pubescence equal in width to one third width of tergum and often more, these fasciae not pale in the two specimens available, as sometimes occurs in females; terga 3 and 4 with complete thin distal bands of dark brown pubescence. Hairs of legs dark brown to black except rufescent hairs of inner surfaces of tarsi and hind tibiae.

Type material. Type material of *leprieuri* lost and probably destroyed, according to the authorities of the Paris Museum. Blanchard did not give a type locality with his illustration of this species. Female holotype of *maura* from Cuba is in the Academy of Natural Sciences of Philadelphia.

Distribution. Known only from Cuba. This species has been taken from August 2 to September 30. In addition to the holotype of *maura*, 23 females and 2 males have been examined from the localities listed below.

Havana: Cotorro, Santiago de las Vegas. Oriente: Guana; Guantánamo (San Carlos Est.); Upper Yara Valley. Piñar del Rio: Piñar del Río; Viñales (north of). Santa Clara: Baños de Ciego, Montero; Buenas Aires, Trinidad Mts.; Castillo de Jagua; Guabairo; Zaza de Media.

Melissodes (Melissodes) tepida Cresson.

This is a distinctive species related to *communis*, but not closely so. *M. tepida* is distinguished in both sexes by its small size, by having a broad distal pale band on tergum 2 and by the moderately shiny, distinctly punctate, narrow apical areas of terga 2 and 3. The distal band of tergum 2 is usually wider than the apical area medially and often as much as twice as wide. The male usually has the first flagellar segment relatively long, as in *communis,* and the terminalia essentially as in *communis,* although the form of the seventh sternum is somewhat different as described below. The female has the lateral flattened areas of the vertex and the basal area of the first metasomal tergum much more coarsely punctate than in *communis* and often has the hairs of the inner surfaces of the hind basitarsi black or dark brown.

Female. Measurements and ratios: N, 20; length, 9.5-12.0 mm.; width, 3-4 mm.; wing length, $M = 3.55 \pm 0.200$ mm.; hooks in hamulus, $M = 13.90 \pm 0.214$; flagellar segment 1/segment 2, $M = 2.02 \pm 0.025$.

Structure and color: Black except as follows: distitarsi, often basitarsi and occasionally tibiae and hind femora dark red; sterna and lateral surfaces of terga often red; first tergum often with an extremely narrow hyaline apical margin; mandibles with apical halves red, often with large longitudinal golden maculae in apical halves; antennal scapes and first two flagellar segments black to dark brown, remaining segments yellow to red below, black above; eyes pale blue to greenish-blue; wing membranes slightly or not at all infumate, veins dark reddish-brown to black, darker anteriorly and apically. Clypeus with small, round, crowded punctures separated by less than one puncture width, rather evenly spaced in posterior half to two thirds, smaller and more crowded anteriorly, usually with an ill-defined median boss about one third of distance from apical margin, ground shiny, with delicate, sparse transverse shagreening; supraclypeal area usually with abundant coarse punctures, ground dulled by dense shagreening; vertex with flattened lateral areas with large round punctures separated mostly by about one puncture width, ground dulled by delicate irregular shagreening; maxillary palpal segments in ratio of about 3:3:2.5:1, fourth segment occasionally somewhat longer; galeae shiny dorsally, but often somewhat dulled by fine reticular shagreening, especially in apical half. Mesoscutum and scutellum with sculpturing as in *communis,* but posterior half or more of mesoscutum with punctures separated by two or more puncture widths and often with large posteromedian impunctate area; lateral faces of mesepisterna with punctures separated largely by less than half of one puncture width, about equal in diameter to those of anterior half of mesoscutum, ground areas often dulled by fine shagreening; dorsal face of propodeum with large crowded punctures in apical half; reticulorugose basally, declivous face and lateral faces as in *communis*. First metasomal tergum with large round punctures separated by one half to one puncture width in basal three fifths or less, ground moderately shiny, with fine transverse shagreening; tergum 2 with small punctures separated by one to two puncture widths medially and one or less laterally in interband zone; terga 3 and 4 with small round punctures separated by one puncture width or less in basal areas; terga 2 and 3 with narrow apical areas with exceedingly small, but distinct, punctures separated from their nearest neighbors by one puncture width or less, ground areas shiny to moderately so, with delicate transverse shagreening.

Hair: On head white, often pale ochraceous on vertex and vertex usually with a few to many black or dark brown hairs. Scutellum with large median patch of dark brown hairs fringed with pale ochraceous; mesoscutum with large square patch of dark brown hairs in posteromedian area, often extending forward to a transverse line at anterior margins of tegulae, occasionally larger and often smaller than this, anterior margin often irregular, pale hairs white to ochraceous and occasionally somewhat ferruginous; lateral surfaces of thorax with pale ochraceous to white hairs; vestiture of metasoma as in *communis* but bands on each tergum usually broader and often pubescence pale ochraceous or slightly ferruginous rather than white. Additional color characters are described below for each subspecies.

Male. Measurements and ratios: N, 20; length, 7.5-11.0 mm.; width, 2-4 mm.; wing length, $M = 3.20 \pm 0.250$ mm.; hooks in hamulus, $M = 12.55 \pm 0.135$; flagellar segment 2/segment 1, $M = 4.19 \pm 0.156$.

Structure and color: Color as in female except as follows: clypeus pale yellow to cream-colored; bases of mandibles with large pale yellow spots which cover entire basal width of each mandible and always larger than depressed triangular area; labrum white to cream-colored; antennal scape and pedicle dark brown to black; first flagellar segment dark reddish-brown, often with pale red ventral area, remaining segments yellow to red beneath and reddish-brown to black above; apical areas of terga 2-5 often hyaline apically but rarely completely colorless and then in worn faded specimens, usually piceous and opaque. Minimum length of first flagellar segment equal to slightly less than one sixth to slightly more than one third (usually about one fifth) of maximum length of second segment; maxillary palpi and galeae as in female; sculpturing as in female with the following differences: clypeus with punctures obscure, lateral areas of vertex with ground areas often completely dulled by fine shagreening and often completely smooth and shiny, first metasomal tergum with basal four fifths or more coarsely punctate, interband zone of tergum 2 with punctures separated mostly by one puncture width or slightly more, apical areas of terga 2 and 3 with small piliferous punctures usually restricted to narrow zone just apical to pubescent bands and with narrow apical impunctate areas broader than in female.

Terminalia much as in *communis*. Sternum 7 with median plates often slightly flattened and much less oblique than in *communis*, often with apical margin almost transverse; median carinae each narrow and together forming a V-shaped or sub-Y-shaped structure. Sternum 8 usually with slightly shorter hairs at apex than in *communis*, with shallow median emargination; ventral longitudinal carina short, not reaching apex of sternum (Figs. 77-78).

Hair: Generally as in female but pale hairs more often white and brown hairs often absent on vertex and mesoscutum and sparser on scutellum; metasomal tergum 5 with a complete pale pubescent band; additional characters of vestiture are described for each subspecies.

Bionomics. As in most species of *Melissodes,* little is known concerning the details of nesting habits and life history of *M. tepida.* Linsley (1946, p. 25) gives the following brief account of the nesting habits of *M. tepida timberlakei*: "The species nests in bare ground at a depth of from three to six inches, well within the depth of cultivation. The entrance tunnel is about 6 mm. in diameter and enters perpendicularly for about three inches, then turns abruptly at right angles. The nest series consists of cells placed vertically in short extensions from the main shaft. A brief account of the nesting habits has been given by Hicks (1926)." This account is rather surprising because of the shallowness of the nests reported therein. Also, the reference to Hicks' paper is in error. Hicks in his 1926 work described nests of bees occurring in Colorado and makes no mention of *M. tepida* or *timberlakei.* Mr. R. R. Snelling of Turlock, California, in a personal communication, informs me that *timberlakei,* "nests in large colonies . . . on very hard ground . . . is parasitized by *Triepeolus timberlakei* and *T. lineatulus.*"

A large amount of information is available concerning the flowers visited by *M. tepida,* due chiefly to the excellent collections made by Mr. P. H. Timberlake of the Citrus Experiment Station, River-

TABLE V.—Summary of floral records for *Melissodes tepida.*

Plant data				Records of *M. tepida*			
Family	Number of Families	Number of Genera	Number of Species	Number of Collections	Number of Females	Number of Males	Total Number of Bees
Compositae	1	14	20	73	48	50	98
Leguminosae	1	8	11	108	245	125	370
Labiatae	1	4	5	37	40	18	58
Euphorbiaceae	1	2	2	39	42	24	66
Boraginaceae	1	2	2	20	47	47	94
Others	14	24	33	64	65	52	117
Totals	19	54	73	241	487	316	803

side, California. *M. tepida* is a polylectic species, as are most members of the subgenus *Melissodes.* From the tabulation (Table V) it is apparent that legumes form an important food source for this species. The figures for legumes are considerably exaggerated, however, due to collections made by entomologists studying pollination of alfalfa by wild bees; over 50 of the collections from legumes are from alfalfa. The composites are not used to any great extent with the exception of *Gutierrezia sarothrae* and *G. californica* which account for 24 of the collections from composites. In addition, although *tepida* has often been collected on many species of composites, only a few specimens were collected at any one time, except in the case of *Gutierrezia.* The high ratio of males to females on the composites, if *Gutierrezia* is omitted (on which the ratio is 3:10), and on the Borraginaceae indicates that these families are relatively of little importance as pollen sources. The conclusions that may be drawn from these data are that *M. tepida* is a polylectic species, visiting many species of plants for pollen as well as nectar, but shows some preference for the families Leguminosae, Labiatae and Euphorbiaceae, and for the one composite genus, *Gutierrezia.*

Geographical variation. *M. tepida* is divisible into three geographical races, one southern, one northern east of the Sierra Nevada Mountains, and the third west of the Sierras in California and Oregon (Fig. 16). The southern subspecies (*yumensis*) is dis-

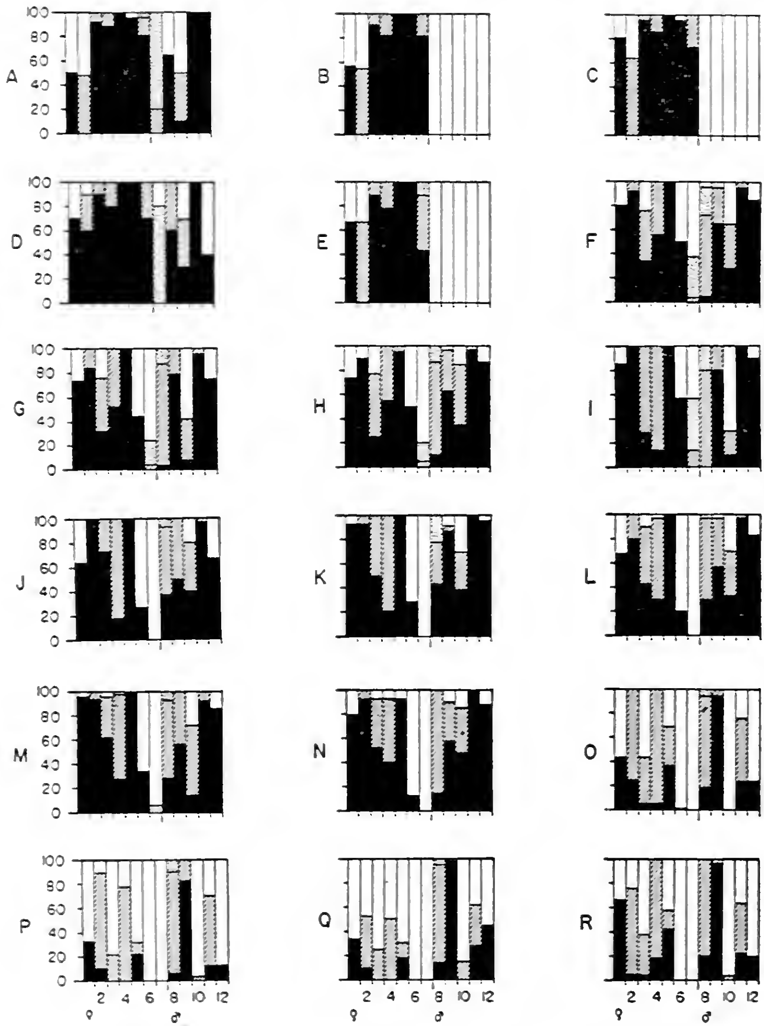

FIG. 15. Histograms showing percentages of individuals (ordinates) of *M. (Melissodes) tepida* bearing certain characters (abscissas) (see text for full explanation). Characters 1 through 7 refer to females and 8 through 12 to males. Each graph is lettered in accord with the areas outlined by broken lines on the map (Fig. 16). The number of individuals from each area studied is given in the explanation of figure 16.

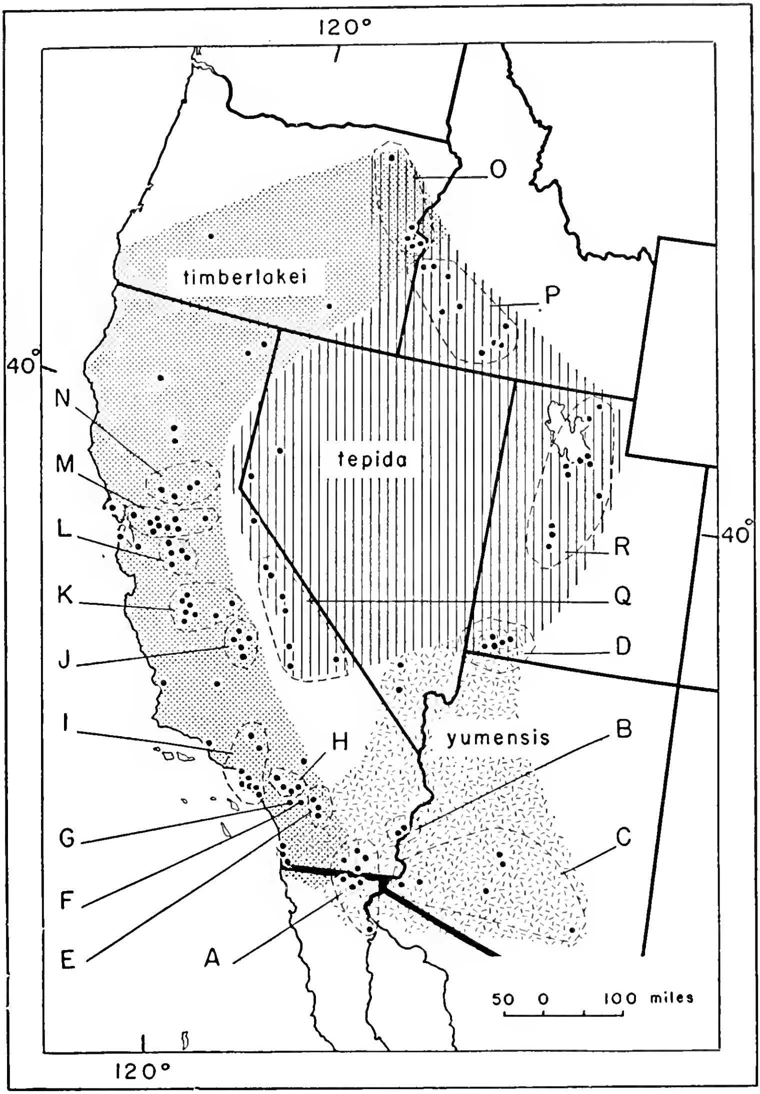

FIG. 16. Map showing the distribution of *M. (Melissodes) tepida*. Areas of overlapping types of shading indicate zones of intergradation between the subspecies. Numbers of specimens used from each area to produce the graphs of Figure 15 are listed below (female precedes male in each case): A 27, 20; B 11, 0; C 22, 5; D 10, 10; E 9, 0; F 50, 40; G 25, 24; H 40, 30; I 7, 10; J 11, 30; K 14, 23; L 30, 30; M 50, 14; N 15, 40; O 22, 21; P 13, 34; Q 91, 78; R 21, 30.

tinctive due to the dark hairs of the inner surfaces of the hind basitarsi of the female and the shorter first flagellar segment of the male. Intergrades between the southern subspecies and the northeastern subspecies (*tepida s. str.*) occur in southwestern Utah.

Intergrades between the southern subspecies and the northwestern subspecies (*timberlakei*) occur in the Palm Springs-Coachella Valley area and in the San Diego area of southern California. From Hemet on the west side of the San Jacinto Mountains, approximately twenty four miles from Palm Springs, California, in a straight line, a long series of males and females collected by J. W. MacSwain show that, although a few somewhat darker specimens are present, more than 90 per cent are typically *timberlakei* and none is so dark as the intermediates from Palm Springs and the Coachella Valley. Additional long series from Winchester and Riverside, California, resemble the Hemet series. The zone of intergradation seems to be narrow in this area, although how far it extends to the east is not known, since no specimens are available from California between Coachella Valley and Blythe. The San Jacinto Mountains seemingly form a rather effective barrier to gene flow in this area. Two specimens from Coronado, San Diego County, show that the zone of intergradation probably extends southwest from the Coachella Valley region, since one is typically *timberlakei* and the other is intermediate. Another intermediate female from Seeley, Imperial County, has been examined, and a few females with somewhat darker legs have been seen from Orange and Los Angeles counties.

To the north it seems likely that *tepida s. str.*, *timberlakei* and *yumensis* come together in the vicinity of the Mojave Desert or northern San Bernardino County, California. However, only four males from Hodge are available from that area and these can be readily assigned to the subspecies *timberlakei*. The subspecies *yumensis* probably also intergrades with *tepida s. str.* in southern Nevada, but there is no evidence of this at present.

Farther north *timberlakei* meets *tepida* in western Oregon where a series of intermediate specimens plus examples typical of each subspecies are known. Some gene flow perhaps occurs across the Sierras in the vicinity of Lake Tahoe, but again the few specimens available from that area do not permit definite conclusions. The long series of specimens from the Owens Lake Region in California are typical *tepida*, but, as elsewhere in the range of *tepida s. str.*, a small percentage of individuals are indistinguishable from the palest specimens of *timberlakei*.

In figure 15 are given histograms of certain characters of both sexes for various general localities in the range of each of the three subspecies. These graphs were produced in a fashion similar to that used for *M. obliqua.* For some characters three alternatives and for two characters (one male and one female) four alternatives were tabulated, rather than simply a pale and a dark alternative for each character as was done in *obliqua.* These alternatives are shown by various types of shading of the bars in the graphs. The graphs show that each locality has a rather distinctive set of characters differing from its neighbors in one particular or another. However, within each subspecies, certain similarities in pattern can be seen. It is evident that some individuals of *tepida s. str.* and *timberlakei* must be indistinguishable from one another. In the females these represent less than 10 per cent of the specimens available for study. However, about 25 per cent of the males are indistinguishable due to the greater variability of the males in all characters. The graph for the northern Utah region (R) is very similar to that for the zone of intergradation between *tepida* and *timberlakei* in eastern Oregon. In the case of the Utah specimens the general darkness is more likely due to gene flow from *yumensis* to the south rather than from *timberlakei* far to the west, although this series, if situated elsewhere, would be considered as a series of intergrades with the latter.

The ring of subspecies thus formed (Fig. 16) is a rather unequal circle in that the subspecies *yumensis* is much more distinct from either of the other two subspecies than the latter are from each other. It seems likely that, to produce a structural change such as the relative lengths of the first flagellar segments of the male in *yumensis,* the populations must have been isolated for a considerable period of time. The chief character distinguishing the females of *yumensis* (dark hairs on the inner surfaces of the hind basitarsi) is also a rather fundamental difference, since it is a departure from the usual color for the subgenus as a whole, and since it does not vary in or near the zones of intergradation. What the barrier was which presumably separated the populations which evolved into the subspecies *yumensis* is not clear.

On the other hand, the differences between *tepida s. str.* and *timberlakei* are of such an order that they could and probably did arise through shifts in gene frequencies in populations partially isolated for a considerable period of time. The incomplete barrier in this case has probably been the Sierra Nevada Mountains.

The characters used in preparing the bar graphs (Fig. 15) are listed below. Characters 1 through 7 refer to females, while characters 8 through 12 refer to males. The type of shading on the graphs is given in parentheses immediately after each alternative of a character.

Female:

1a. Mesoscutal patch of dark hairs reaches forward to or beyond a transverse line at the anterior margins of the tegulae (black).

1b. Mesoscutal dark patch not reaching a transverse line at anterior margins of tegulae (white).

2a. Black hairs on vertex abundant (black).

2b. Black hairs on vertex few (crosshatched).

2c. Black hairs on vertex absent (white).

3a. Tergum 2 with hairs of interband zone all or almost all dark brown to black (black).

3b. Tergum 2 with lateral third or less of interband zone with pale hairs (crosshatched).

3c. Tergum 2 with hairs of interband zone all pale (white).

4a. Apical area of tergum 3 with hairs all dark brown or dark brown in more than median third (black).

4b. Apical area of tergum 3 with hairs dark in median one third to one fourth (crosshatched).

4c. Apical area of tergum 3 with hairs mostly or all pale (white).

5a. Distal pale band of tergum 2 less than one and a half times as broad as apical area medially (black).

5b. Distal pale band of tergum 2 one and a half times as broad as apical area medially or broader, but less than twice as broad (crosshatched).

6a. Median apical patch of brown hairs present on tergum 4 (black).

6b. Median apical patch of brown hairs absent on tergum 4 (white).

7a. Hairs of inner surfaces of hind basitarsi black to dark brown (black).

7b. Hairs of inner surface of hind basitarsi reddish-brown (crosshatched).

7c. Hairs of inner surfaces of hind basitarsi orange-red to red (stippled).

7d. Hairs on inner surfaces of hind basitarsi orange to yellow (white).

Males:

8a. Ratio of second/first flagellar segments 4.0 or less (black).
8b. Ratio of second/first flagellar segments 5.0-4.1 (crosshatched).
8c. Ratio of second/first flagellar segments 6.0-5.1 (stippled).
8d. Ratio of second/first flagellar segments more than 6.0 (white).
9a. Mesoscutal patch of dark hairs as large as or larger than scutellum (black).
9b. Mesoscutal patch of dark hairs smaller than scutellum (crosshatched).
9c. Mesoscutal patch of dark hairs absent (white).
10a. Hairs of interband zone of tergum 2 all brown or brown in more than median third (black).
10b. Hairs of interband zone of tergum 2 brown in median third or less (crosshatched).
10c. Hairs of interband zone of tergum 2 all pale (white).
11a. Tergum 3 with hairs of apical area all brown or brown in more than median half (black).
11b. Tergum 3 with hairs of apical area brown in median half or less (crosshatched).
11c. Tergum 3 with hairs of apical area all pale (white).
12a. Tergum 4 with dark hairs in apical area at least medially (black).
12b. Tergum 4 without dark hairs in apical area (white).

A few of the areas outlined on the map (Fig. 16) and represented by histograms (Fig. 15) consist of single or of few localities. These are as follows: B—Blythe and Ripley, Riverside County; E—Coachella Valley area; F—Hemet, Riverside County; G—Winchester, Riverside County; H—Riverside area and southwestern San Bernardino County area. The remaining areas outlined on the map are easily recognized by reference to a standard map of the region.

Melissodes (Melissodes) tepida tepida Cresson.

Melissodes tepida Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 210; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 85; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 131.

This subspecies can be distinguished from the other two subspecies by the generally pale color of the vestiture. The females can be separated from those of *yumensis* by the yellow to red hairs of the inner surfaces of the hind basitarsi. The males can be separated from those of *yumensis* by the longer first flagellar segments and by the usually paler color of the hairs of the terga as described below. The females of *tepida* can be separated from those of *timberlakei* by the first of the four following characters plus any two of the remaining three: tergum 4 without dark brown hairs medially; vertex with few to about twenty long dark brown hairs, or these absent, and short hairs all or almost all pale; short suberect hairs of apical area of tergum 3 all pale or pale in lateral fourth or more; interband zone of tergum 2 with suberect hairs all pale or dark in medial third or less. The males of *tepida* can be separated from those of *timberlakei* by having two of the following three characters: mesoscutum without dark brown hairs; interband zone with hairs all or almost all pale (dark in median third or less, if at all); apical area of tergum 4 with suberect hairs all pale or pale in at least lateral fourth. Additional characters described below can be assessed by reference to the histograms (Fig. 15).

Female. Hairs of head and thorax white to pale ochraceous, rarely somewhat rufescent on mesoscutum anteriorly; vertex usually with a few to about twenty long dark brown hairs, often all pale, short hairs between lateral ocelli and apices of compound eyes usually white; dark hair patch of mesoscutum usually not extending forward to a transverse line at anterior margins of tegulae, rarely exceeding this line, anterior margins of dark patch often irregular and diffuse due to intermixture of pale hairs. Tergum 2 with distal pale band rarely narrower than one and one half of width of apical area medially and often twice as wide or more, interband zone narrower than distal band, usually with suberect hairs all white to yellow, often brown in median third or less; tergum 3 with pale band usually broader than three times width of narrow apical area medially, apical area with short suberect hairs usually white at least in lateral fourths and often entirely so (as in holotype); tergum 4 usually without dark brown hairs medially near apex, rarely a few dark hairs present; sterna usually with yellowish-brown hairs, with white hairs apically and laterally on each sternum except the last. Legs with white to pale ochraceous hairs except as follows: distitarsi ochraceous to rufescent; outer surfaces of fore basitarsi, tips of middle tibiae and basitibial plates brown; inner surfaces of basitarsi yellow to red.

Male. Minimum length of first flagellar segment usually equal to one fourth to one fifth of maximum length of second segment, occasionally as long as one third and rarely as short as one sixth of second segment. Pale hairs of head and thorax white to pale ochraceous; vertex without brown hairs; mesoscutum usually without brown hairs, occasionally with a few in posteromedian area. Pale pubescence of terga white to pale ochraceous; tergum 2 with interband zone narrow, with suberect to erect hairs white to yellow, occasionally brown in less than median third; tergum 3 with apical area usually with suberect hairs pale in outer fourth or more and dark brown in median half or less, often entirely pale; tergum 4 similar to tergum 3; tergum 5 usually without dark hairs medially at apex or with very few; terga 6 and 7 rarely with all hairs yellowish, usually brown at least medially; sternal hairs usually white to yellow, often yellowish-brown on last two sterna. Legs with white hairs except as follows: inner surfaces of tarsi and hind tibiae yellow to orange; basitibial plates often brown.

Type material. Holotype female from Nevada is in the Academy of Natural Sciences of Philadelphia.

Distribution. Northern half of Utah and Nevada west to the Sierra Nevada Mountains in California, north to northwestern Oregon and the southern half of Idaho (Fig. 16). This subspecies has been collected from May 26 to August 25, but mainly during July. In addition to the holotype, 152 females and 145 males have been examined from the localities listed below.

CALIFORNIA: Bishop, Inyo Co.; Big Pine, Inyo Co.; Convict Lake, Mono Co.; Furnace Creek, Inyo Co.; Lone Pine, Inyo Co.; Mammoth, Mono Co.; Olancha, Inyo Co.; Owens Lake, north end, Inyo Co.; Topaz Lake, Mono Co. IDAHO: Balanced Rock; Bliss; Boise; Fruitland; Grand View; Hazelton (3 miles N. E.); Hot Spring, Owyhee Co.; Kimberly; Mt. Home; Parma; Twin Falls. NEVADA: Nixon; Sparks. OREGON: * Huntington (10 miles N.); * Malheur Co.; * Meachem; * Ontario; * Vale. UTAH: Corinne; Delta; Erda; Garfield; Logan; North Delta; Pahvant; Provo; Saltair; Salt Lake City; Stockton.

Flower records. Asclepias sp., *Astragulus bolanderi, Glycyrrhiza lepidota, Helianthus* sp., *H. annuus, Medicago sativa, Melilotus* sp., *Mentha* sp., *Trifolium* sp., *T. pratense.*

Melissodes (Melissodes) tepida timberlakei Cockerell.

Melissodes timberlakei Cockerell, 1926, Ann. Mag. Nat. Hist., ser. 9, vol. 18, p. 624; Linsley, 1946, J. Econ. Ent., vol. 39, pp. 20-23, 25 (in part); Linsley and MacSwain, 1947, J. Econ. Ent., vol. 40, p. 352 (in part).
Melissodes tepida, Fowler, 1902, Report of the work of the Agric. Exp. Stat. of the Univ. of California, 1898-1901, pt. 2, pp. 322, 323 (misidentification); Cockerell, 1903, Psyche, vol. 10, p. 77 (misidentification).

* Localities from the zone of intergradation.

This subspecies can be distinguished from the subspecies *yumensis* by the same characters serving to separate *tepida s. str.* and from *tepida s. str.* by the characters listed in the diagnosis of the latter.

Female. Pale hairs of head usually ochraceous on vertex, becoming paler on face and genal areas, often faded to white in worn specimens; vertex usually with abundant long dark brown hairs, occasionally with few dark hairs but these never completely lacking, usually with abundant short brown hairs between lateral ocelli and apices of compound eyes and extending onto face medially. Mesoscutum with pale hairs usually ochraceous, occasionally rufescent, often white to pale ochraceous (especially in worn specimens), with posteromedian patch of dark hairs usually extending forward to or beyond a transverse line at anterior margins of tegulae, often somewhat broader near anterior margin than posteriorly; scutellum with dark brown hairs fringed posteriorly by pale ochraceous to white hairs; lateral and ventral surfaces of thorax and propodeum with white to pale ochraceous hairs, paler below. Tergum 2 with interband zone usually with suberect dark brown hairs except at extreme sides, often dark zone restricted to median third of tergum and occasionally less, rarely dark hairs absent, distal pale band of tergum 2 usually equal to about one and one half of width of apical area medially, occasionally less, but then usually due to wear, rarely as broad as two times apical area; tergum 3 with broad pale band usually equal to three times width of apical areas medially or less, apical area usually with suberect dark brown to black hairs except at extreme sides, rarely lateral fourth with pale hairs; tergum 4 often with at least a few dark brown hairs medially near apex; sternal hairs usually dark brown except pale ochraceous to white apically and laterally on each sternum but the last. Legs with color of hairs as in *tepida s. str.* but often dark brown areas on apices of middle tibiae and surrounding basitibial plates slightly larger and hairs of anterior tarsi darker brown.

Male. Minimum length of first flagellar segment usually equals one fourth to one fifth of maximum length of second segment, often as long as one third and rarely as short as one sixth of second segment. Characters of vestiture as in *tepida s. str.* with the following differences: pale hairs and pubescence usually ochraceous and often slightly ferruginous, white to pale ochraceous especially in worn specimens; vertex occasionally with a few brown hairs; mesoscutum usually with at least a few brown hairs in posteromedian area, often brown patch as large as or larger than that on scutellum; interband zone of tergum 2 usually with dark brown suberect hairs in at least median third but often entirely white to yellow; apical area of tergum 3 usually with dark brown suberect hairs except at extreme sides, occasionally with pale hairs in lateral fourth or slightly more, rarely dark hairs lacking; tergum 5 usually with at least a few dark brown to black hairs medially near apex; terga 6 and 7 never without brown hairs and these usually abundant.

Type material. Holotype female from Riverside, California, August, 1926, P. H. Timberlake and T. D. A. Cockerell, is in the collection of the University of Colorado Museum, Boulder, Colorado.

Distribution. San Diego in southern California northeast through the Mojave Desert to the Sierra Mountains, north through California west of the Sierras to the southern half of Oregon (Fig. 16). This subspecies has been collected from April (presumably the latter part of the month) to October 23, but mainly in June and July. In addition to the holotype, 612 females and 474 males have been examined from the localities listed below. This list includes localities reported in the literature.

CALIFORNIA: Alturas; Antioch, Contra Costa Co.; Arvin; Auburn; Byron; Chico; Chula Vista; Corona; Corral Hollow, San Joaquin Co.; Costa Mesa; Davis; Dos Palos, Madera Co.; Exeter; Fairmont Lake; Firebough, Fresno Co.; Fresno; Friant; Hemet; Hodge, San Bernardino Co.; Hospital Canyon; Lake City; Lindsay; Live Oak Canyon, Riverside Co.; Lodi; Long Beach; Loomis; Los Angeles Co.; Lower Panoche Creek, Fresno Co.; Mendota; Miles; Millbrae, San Mateo Co.; Modesto; Mokelumna Hill; Nelson; New Port, Los Angeles Co.; Newport Bay, Orange Co.; Oakley; Ontario; Oxalis; Patterson; Pt. Muga, Ventura Co.; Redding; Redlands; Rio Vista; Riverside; Romaland, Riverside Co.; Ryer Island; Sacramento; San Diego; San Pedro; Santa Monica; Seal Beach; Shafter, Kern Co.; Sherman Island; Stockton; Three Rivers; Tomales Bay; Tracy; Tranquility; Turlock; Visalia; Westley; Winchester; Wood Lake, Tulare Co. OREGON: Alford Hot Springs (N. of Andrews, Harney Co.); Diamond Lake, Douglas Co.

Flower records. Althaea rosea, Asclepias eriocarpa, Aster sp., *Bellis* sp., *Brassica* sp., *B. adpressa, B. incana, Centaurea cyanus, Centromadia pungens, Cleomella* sp., *Coreopsis* sp., *C. lanceolata, Croton californicus, Cryptantha intermedia, Cucurbita* sp., *Daucus carota, Duranta plumieri, Eremocarpus* sp., *E. setiger, Eriogonum* sp., *E. fasciculatum, E. gracile, E. involucratum, Eschscholtzia* *californica, Gilia capitata, Godetia amoena, Gutierrezia californica, G. sarothrae, Helianthus* sp., *H. annuus, H. bolanderi, H. petiolaris, Heliotropium* sp., *H. curassavicum, Hugelia virgata, Lippia filiformis, L. lanceolata, Lotus* sp., *L. americanus, L. scoparius, Madia* sp., *Marrubium vulgare, Medicago* sp., *M. sativa, Melilotus* sp., *M. alba, M. indica, Papaver heterophyllum, Phacelia ramosissima, Phaseolus* sp., *Pluchea borealis, P. camphorata, P. sericea, Rhaphanus* sp., *Salsola* sp., *S. kali, Scabiosa* sp., *Senecio douglasi, Stachys ajugoides, S. bullata, Stephanomeria exigua, S. virgata, Trichostema* sp., *T. lanceolatum, Trifolium* sp., *T. involucratum, T. repens, Wislizenia refracta.*

Melissodes (Melissodes) tepida yumensis, subsp. nov.

Melissodes timberlakei, Linsley, 1946, J. Econ. Ent., vol. 39, pp. 21, 25 (in part) (misidentification); Linsley and MacSwain, 1947, J. Econ. Ent., vol. 40, p. 351 (in part) (misidentification).

This subspecies can be separated from the other races of *M. tepida* by the dark hairs on the inner surfaces of the hind basitarsi of the female and by the relatively short first flagellar segments of the male.

Female. Vestiture as in *M. tepida timberlakei* with the following differences: pale hairs of head, thorax and terga paler, white to pale ochraceous; tergum 2 with dark suberect hairs of interband zone covering at least median third and usually more, distal pale band usually as broad as apical area medially or slightly narrower, occasionally as broad as one and one-half times apical area; tergum 3 with dark brown to black subappressed hairs in narrow apical area except at extreme sides; tergum 4 almost always with at least a few dark brown hairs medially at apex and often with patch of dark hairs equal to one sixth of width of tergum. Legs with hairs as in *timberlakei* except inner surfaces of hind basitarsi and often tibiae with dark brown to black hairs.

Male. Minimum length of first flagellar segment equals less than one fifth of maximum length of second segment and usually less than one sixth of second segment. Vestiture as in *timberlakei* with the following differences: pale hairs of head, thorax and terga paler, white to pale ochraceous; apical area of tergum 3 always with dark brown to black suberect hairs except at extreme sides; tergum 4 always with at least a few dark brown hairs medially at apex, unless worn, and usually with many dark hairs.

Type material. Holotype male from Yuma, Arizona, June 29, 1952, on alfalfa, S. Carl; allotype female and two paratype females from Yuma, Arizona, May 12, 1952, on Palo Verde, G. D. Butler. Eleven females and three male paratypes from Yuma, Arizona, are as follows: 2 females, June 7, 1951, G. D. Butler; 1 female, June 10, 1951, G. D. Butler; 1 female, June 18, 1951, F. E. Todd; 1 female, June 1909, A. McLachland; 1 female, June 11, 1951, G. D. Butler; 2 females, June 21, 1951, G. D. Butler; 1 female, June 30, 1951, F. E. Todd; 1 male, June 18, 1952, on *Medicago sativa*, G. D. Butler; 2 females, May 23, 1953, G. D. Butler. Ten female and one male paratypes from Arizona are as follows: Gila Bend, 4 females, July 23, 1946, H. A. Scullen; 2 females, July 22, 1948, C. and P. Vaurie. Marinette, 1 female, July 6, 1950, H. C. Wright. Roll, 1 female, May 23, 1952, on *Medicago sativa*, F. E. Todd. Sabino Canyon, Santa Catalina Mts., 1 male, August 23, 1933, G. E. Bohart. Tolleson, 1 female, May 29, 1933, on *Sphaeralcea* sp., P. H. Timberlake. Ten female and three male paratypes from southern California are as follows: Blythe, Riverside Co., 7 females and 1 male, July 15, 1938, on *Lippia nodoflora*, P. H. Timberlake; 2 females, July 24, 1945, on *Medicago sativa*, E. G. Linsley; 1 male, July 20, 1946, on *Medicago sativa*, J. W. MacSwain; 1 male, July 11, 1949, Ray F. Smith. Ripley, Riverside Co., 1 female, October 19, 1951, on *Aster* sp., P. D. Hurd; 1 female, June 20, 1946, on *Medicago sativa*, J. W. MacSwain. The holotype and allotype are the property of the University of Arizona, but are on loan for an indefinite period to the Snow Entomological Museum of the University of Kansas. Paratypes are in the collections of the University of Arizona, the Citrus Experiment Station, Riverside, California, the California Academy of Sciences, the Snow Entomological Museum, the U. S. National Museum and in the author's collection.

Distribution. Northern Baja California, southeastern California, southern Nevada, southwestern Utah and Arizona (Fig. 16). This subspecies has been collected from May 12 to October 19, but mainly in June and July. In addition to the type material listed above, 47 females and 29 males have been examined from the localities listed below.

ARIZONA: "Ariz." CALIFORNIA: Calexico, Imperial Co.; * Coachella Valley; * Coronado, San Diego Co.; Cronia; Imperial Co.; *Indio; * Palm Springs; * Seeley, Imperial Co.; Westmorland. NEVADA: Arden (3 miles E.); Indian Springs. UTAH: * Hurricane; * Leeds; * St. George; * Virgin; * Washington. BAJA CALIFORNIA: La Punta (6 kilometers E. and 7 kilometers N. E.); Mexicali (45 and 47 kilometers S. E., 35 kilometers S. W. and 42 kilometers S.).

* Localities considered as being in the zone of intergradation.

Flower records. *Aster* sp., *Cercidium torreyanum, Chilopsis linearis, Citrullus* sp., *Gossypium* sp., *Lippia nodoflora, Medicago sativa, Melilotus alba, Salix* sp., *Sida hederacea, Sphaeralcea* sp.

Melissodes (Melissodes) tepaneca Cresson.

Melissodes tepaneca Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 210.
Melissodes petalostemonis Robertson, 1900, Trans. Acad. Sci. St. Louis, vol. 10, p. 53 (new synonymy); 1905, Trans. Amer. Ent. Soc., vol. 31, p. 369; 1928, Flowers and Insects, p. 8.
Melissodes galvestonensis Cockerell, 1905, Proc. Biol. Soc. Washington, vol. 18, p. 181 (in part) (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 81, 84.
Melissodes bruesi Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 110 (new synonymy).
Melissodes loena Cockerell, 1909, Entomologist, vol. 42, p. 148 (new synonymy).
Melissodes masuca Cockerell, 1909, Entomologist, vol. 42, p. 148 (new synonymy); 1917, J. New York Ent. Soc., vol. 25, p. 191; 1923, Proc. U. S. Nat. Museum, vol. 63, p. 3.
Melissodes tepaneca ascheuborniana Cockerell, 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 10, p. 28 (new synonymy).
Melissodes aurescens Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 462.
Melissodes tepaneca panamensis, Michener, 1954, Bull. Amer. Mus. Nat. Hist., vol. 104, p. 132 (in part).

This species is quite distinct from the foregoing species and closely related to the West Indian species, *M. rufodentata.* The most distinctive characters involve the male terminalia and are as follows: the hairs on the bases of the gonostyli are short and sparse; the median plates of sternum 7 are greatly reduced and the ventral carinae enlarged as described below; sternum 8 has short, sparse hairs at the apex and a long ventral carina which is apically flattened into a peculiar diamond-shaped structure. Males of *rufodentata* share these peculiarities, but are separated from those of *tepaneca* on the basis of punctation as described in the diagnosis of the former.

Externally both sexes of *tepaneca* are practically indistinguishable from some specimens of both *comptoides* and *thelypodii.* The punctation of the thorax and metasoma is generally as in *comptoides*, although the punctures of the apical areas of the terga are generally smaller. The wing membranes of *tepaneca* are clear, unlike a large majority of individuals of *comptoides*, and the clypeus of the female has shallower punctures and more densely shagreened ground areas than in *comptoides.* The females of *tepaneca* can be separated from those of *M. thelypodii thelypodii* by the presence of dark hairs on the ventral surfaces of the mesepisterna and usually on the lower lateral and anterior surfaces as well. Males of *tepaneca* can be separated from those of *thelypodii s. str.* by the presence of abundant dark brown hairs in the interband zone of tergum 2. Both sexes are extremely difficult to separate from *M. thelypodii stulta,* the characters listed in the diagnosis of the latter will separate most of the females, while all of the males can be identified only on the basis of characters of the terminalia.

Female. Measurements and ratios: N, 20; length, 9-13 mm.; width, 3-5 mm.; wing length, M = 3.66 ± 0.319 mm.; hooks in hamulus, M = 13.65 ± 0.233; flagellar segment 1/segment 2, M = 1.85 ± 0.034.

Structure and color: Integument black except as follows: distitarsi and often hind basitarsi and tibiae rufescent; mandibles rufescent medially; flagella red below, dark brown to black above, except first two segments all dark; tegulae usually testaceous to reddish-brown, rarely darker; wing membranes clear, veins dark reddish-brown to black, darker apically; eyes grayish-black to yellowish-green. Sculpturing of head and thorax as in *comptoides* with the following differences: clypeus usually with somewhat larger, more crowded and shallower punctures, separated by half of one puncture width or less, ground areas and bottoms of punctures dulled by coarse shagreening; supraclypeal area coarsely punctate at least laterally, dulled by tessellation. Galeae shiny; maxillary palpi 4-segmented, in ratio of about 2:2:2:1, segments 3 and 4 often somewhat shorter; eyes in facial view distinctly narrower than three times as long as broad. Metasomal sculpturing as in *comptoides* with the following differences: tergum 2 with punctures of interband zone distinct and evenly distributed across tergum (not markedly smaller or sparser medially), separated by one to half of one puncture width (mostly by less than one); apical areas of terga 2 and 3 and tergum 4 medially with abundant piliferous punctures separated from their nearest neighbors by one to three puncture widths and equal in diameter to two or three times basal width of hairs arising from them, smaller, shallower and usually less distinct than in *comptoides,* but more abundant and distinct than in *communis;* apical areas of terga 1 to 3 with ground areas finely shagreened but moderately shiny.

Hair: On head white to pale ochraceous except abundant dark brown hairs on vertex. Mesoscutum and scutellum with abundant ferruginous hairs, becoming ochraceous in faded specimens, rarely with brown hairs in posteromedian area of mesoscutum or medially on scutellum; pale ochraceous on sides of thorax except ventral, anterior and often lower lateral surfaces of mesepisterna with dark brown hairs; tegulae with pale hairs. Metasomal vestiture of *comptoides* with the following differences: pale pubescent bands usually pale ochraceous to pale ferruginous rather than white; tergum 2 with distal pale band usually wider than in *comptoides,* usually equal to about half of apical area medially and occasionally equal to apical area in width, not strongly arched as in *comptoides* but almost straight across tergum in median half and slightly oblique in lateral fourths, or gently arched, so that apical area laterally equals half of apical area medially and usually considerably more; pale apical band of tergum 4 with large median triangular or diamond-shaped area of dark brown to black suberect hairs, usually as broad as on fourth width of tergum and often broader. Legs with brown hairs except as follows: coxae and femora usually white or pale ochraceous; outer surfaces of fore and middle tibiae mixed brown and white; inner surfaces of tarsi and tibiae yellow to dark red, occasionally brownish-red on hind basitarsi; scopal hairs ochraceous to white with a few brown hairs around basitibial plates.

Male. Measurements and ratios: N, 20; length, 8-13 mm.; width, 3-4 mm.; wing length, $M = 3.38 \pm 0.373$ mm.; hooks in hamulus, $M = 12.75 \pm 0.228$; flagellar segment 2/segment 1, $M = 8.09 \pm 0.198$.

Structure and color: Integument black except as follows: clypeus and bases of mandibles yellow; labrum entirely white or cream-colored; distitarsi and often basitarsi and tibiae brownish-red to bright red; apical areas of terga usually somewhat translucent, but never completely colorless, terga and sterna often wholly reddish-brown; antennal scapes dark brown to black, flagellum yellow to red beneath and dark brown to black above, at least ventral half of each segment pale and usually more; tegulae usually testaceous; eyes gray to green. Minimum length of first flagellar segment equals one eighth of maximum length of second segment or less and about equal to pedicle; maxillary palpi and galeae as in female; eyes in facial view much less than three times as long as broad, strongly converging below. Punctation as in female with the following differences: vertex between apices of compound eyes and lateral ocelli with abundant punctures separated mostly by one to one and a half puncture widths, ground shiny, unshagreened; mesoscutum with abundant punctures in posteromedian area, but these often not distinctly separated into areas of larger and sparser punctures anteriorly and crowded smaller punctures posteriorly as in female, punctures separated mostly by one puncture width or less; tergum 1 with distinct punctures almost to apical margin medially, but becoming progressively smaller from about half distance from base to apex; tergum 2 with punctures of interband zone often slightly sparser than in female; apical areas of terga 2 to 4 often with punctures somewhat sparser than in female.

Genitalia generally as in *communis;* gonostyli not distinctly capitate, with short, sparse hairs on outer surfaces in lower thirds. Sternum 7 with median plates reduced to small, ventrally curved structures about as wide as long and half as wide as lateral plates at that level or less, each separated from mid-point of median emargination of sternum by two to three times its own width; median ventral carina large, forming a broadly Y-shaped structure, each arm of which reaches and slightly surpasses apical margin of sternum immediately below median plates; apodemes long and thin. Sternum 8 usually with median apical emargination, or apical margin rounded, with sparse, minute hairs at apex; longitudinal ventral carina high and long, extending beyond apical margin of sternum by about one third of its own length, broadened and flattened at apex to form a flat diamond-shaped structure; lateral apodemes thin, sinuate along posterior margin and with a short, anteriorly directed process (Figs. 90-92).

Hair: Vestiture as in female except as follows: vertex of head usually without or with few dark brown hairs; mesoscutum and scutellum never with dark brown hairs; ventral, anterior and lower lateral surfaces of mesepisterna without dark hairs; metasomal tergum 2 more often with distal pale band as wide as apical area and rarely slightly wider, straight as in female; tergum 5 always with a complete apical pale pubescent band which has a small median apical patch of dark brown hairs; legs with pale ochraceous hairs except as follows: rufescent on inner surfaces of tarsi and usually hind tibiae; brown on basitibial plates and usually with a streak of brown hairs extending over basal half to three fourths of outer surfaces of hind tibiae.

Bionomics. *M. tepaneca* has been recorded visiting flowers belonging to at least fifteen families of plants. It is evident that a considerable degree of polylecty exists in this species. Seemingly, *tepaneca* does not use composites to any great degree as pollen sources. Out of 77 collections of bees from Texas bearing flower records (including 353 bees) only 21 are from composites, and in these 21 records only 33 bees are involved (22 females and 11 males). In contrast to this, 12 of the 77 collections are from *Opuntia* and these involve 146 bees (126 females and 20 males). There appears to be a decided preference for flowers of Cactaceae and Leguminosae, at least in Texas.

Robertson (1900) considered this bee as being restricted to *Petalostemon,* a legume, as indicated by the name he proposed for the species. This was an unfounded view, even considering the data concerning the flower activities of *tepaneca* in Illinois where, according to Robertson (1928), this species was collected from eight genera and seven families of plants. However, Robertson does not state what the bees were doing on various flowers, except in the case of *Petalostemon* on which he observed the females collecting pollen.

Geographic variation. This species is relatively uniform, considering the variation of other species belonging to this subgenus. The females vary considerably in the amount of dark hairs on the mesepisterna, but this does not follow any geographic pattern. Both sexes show variation in size throughout the range of the species and the specimens from Central America are, perhaps, slightly smaller on the average. The females from Panamá and Honduras often have wider distal pale bands on tergum 2 and often have slightly darker hairs on the inner surfaces of the hind basitarsi. These differences are slight, and in the relatively small series of specimens available they are not constant enough to permit the recognition of a Central American subspecies. If additional material reverses this position, the Central American race would be known as *M. tepaneca aschenborniana* Cockerell.

Remarks. Michener (1954) considered a series of specimens from Costa Rica determined by Friese as *Tetralonia costaricensis* Friese as probably being of this species (or *M. panamensis* Cockerell, since Michener had a series of the two species, *tepaneca* and *panamensis,* mixed) with the metasomal bands gone because of rubbing or greasing. However, it can be definitely stated that *costaricensis* is not a synonym of *tepaneca,* since the former does not belong to the subgenus *Melissodes* according to the original description of the male (black labrum). The types of *costaricensis* should be examined to see whether or not Friese erred in associating the sexes.

Type material. Lectotype female of *tepaneca* from Mexico is in the Academy of Natural Sciences of Philadelphia. Three female paratypes and two male paratypes of *tepaneca* from Mexico are also in the Academy of Natural Sciences of Philadelphia, but at least one female and both males are not conspecific with the lectotype, but are either *M. thelypodii thelypodii* or *M. thelypodii stulta.* Examination of the male genitalia will clarify this problem. The holotype male of *aschenborniana* from Gualán, Guatemala, on *Vernonia aschenborniana,* W. P. Cockerell, is in the American Museum of Natural History. The holotype female of *aurescens* from Zamorano, Honduras, November 27, 1946, W. P. Cockerell, is in the U. S. National Museum. The female holotype of *bruesi* from Fedor, Texas, May 5, 1902, is the property of the California Academy of Sciences, but on temporary deposit in the collection of the Citrus Experiment Station, Riverside. Lectotype female, here designated, of *galvestonensis* from Galveston, Texas, May, F. H. Snow, is in the Snow Entomological Museum at the University of Kansas. Holotype male of *loena* from Lee Co., Texas, September, 1908, is the property of the California Academy of Sciences, but temporarily deposited in the collection of the Citrus Experiment Station, Riverside. The holotype male of *masuca* from Fedor, Texas, April 17, 1901, is in the University of Colorado Museum. Lectotype female, here designated, of *petalostemonis* from Carlinville, Illinois, August 19, 1898, on *Abutilon avicennae,* Charles A. Robertson (Collection No. 21418) is in the collection of the Illinois Natural History Survey, Urbana.

Distribution. From southern Illinois south through northeastern and south central Kansas, Texas, Mexico and Honduras to Panamá, east in the United States from Texas through the Gulf States to northern Florida and north through the Atlantic States to North Carolina (Fig. 17). This species has been collected throughout the year in various parts of its range as follows: United States: March 23 (in the south) to November 11; Mexico: June 2 to July 26; Costa Rica: June 25; Honduras: November 22 to April 8; Panamá: November 29 to June 17. In addition to the type material, 744 females and 358 males have been examined from the localities listed below. This list includes type localities and localities reported in the literature.

ALABAMA: Decatur. ARKANSAS: Lawrence Co.; Marion Co. FLORIDA: Pensacola. GEORGIA: Adairsville; Brinson; Kennesaw Mountain. ILLINOIS: Carlinville; "Ill." KANSAS: Baldwin, Douglas Co.; Dickinson Co.; Meade Co. LOUISIANA: Dixie; East Point; Mandeville; Opelousas; Rayne; Tallulah. NORTH CAROLINA: Marion. TEXAS: Abilene; Austin; Bay City; Baytown; Bexar Co.;

FIG. 17. Map showing the distribution of *M. (Melissodes) tepaneca.*

Brownsville; Cameron Co.; Camp Bullis, Bexar Co.; Christoval; College Station; Concan (8 miles S.); Corpus Christi; Cotula; Cypress Mills, Blanco Co.; Del Rio; Dilley; Eastland Co.; Edna; Fedor, Lee Co.; Fort Sam Houston, Bexar Co.; Fredericksburg; Frio Co.; Galveston; Giddings; Goldthwaite; Goliad; Harper; Hidalgo; Hockley; Hungerford; Kerrville; Laredo; Lee Co.; Llano; Lopeno; Magnolia; Matagorda; Mission (15 miles N. W.); Nueces; Paris; Pecos River; Point Isabel; Progreso; Quemado; Refugio; Robstown; Rock Island; Rockport; Runge; Salado Creek, Bexar Co.; San Angelo; San Antonio; San Benito; San Gabriel River; Santa

Maria; San Ygnacio; Sargent; Sarita; Sonora; Southmost, Cameron Co.; Stonewall; Taylor; Tivoli; Uvalde; Victoria; Willis. Chihuahua: Madera. Distrito Federal: México (city). Guerrero: Mexcala. Hidalgo: Ixmiquilpan. Jalisco: Tequila (8 kilometers W.); Tizapán (10 miles W. and 2 miles E.); Villa Guadalupe. Michoacan: Ciudad Hidalgo (4 miles W.); Jacona (3 miles W.). Morelos: Alpuyeca. Nayarit: Ahuacatlán; San Blas; Tepic (32 miles N. W.). Nuevo Leon: El Cercado (4 miles W.); Vallecillo; Villa de Santiago. Oaxaca: El Camarón; Salina Cruz; Tehuantepec (6 miles S.); Totolápam. Puebla: Acatlán (9 miles N. W.); Atlixco (7 miles S.); Puebla (6 miles S. W.); Tehuacán. San Luis Potosi: El Salto; Pujal (15 miles S.). Tamaulipas: Ciudad Victoria; El Limón; El Limón (22 miles N.); Jiménez (22 miles S.); Llera; Padilla; Padilla (14 miles S.); Villagrán. Veracruz: Martínez de la Torre (9 miles S. W.); Tecolutla. Yucatan: Chichén Itzá. Costa Rica: San José. Guatemala: Gualán. Honduras: Zamorano. Canal Zone: Albrook Field; Ancón Hill; Chiva Chiva Trail; Corozal; Cristóbal; Culebra-Arraiján Trail; Juan Mina. Panama: Camarón; Chame; Chilibre; Chorrera; Matías Hernández; Old Panamá; Pacora; Panamá, city; Pueblo Neuvo.

Flower records. M. tepaneca has been collected on the flowers of the plants listed below. This list includes plants recorded in the literature. UNITED STATES: *Abutilon avicennes, A. theophrasti, Agastache braviflora, Asclepias syriaca, A. tuberosa, Aster* sp., *A. tenacetifolium, Baccharis* sp., *Borrichia frutescens, Brazoria truncata, Callirhoe involucrata, Cephalanthus occidentalis, Cercidium* sp., *C. texanum, Coreopsis palmata, Dalea grisea, Eryngium* sp., *E. leavenworthii, Gaillardia* sp., *G. suavis, Gossypium herbaceum, Grindelia* sp., *Helenium* sp., *H. microcephalum, Lactuca pulchella, Lindheimeria texana, Lythrum alatum, L. lanceolatum, Marrubium vulgare, Medicago* sp., *Monarda* sp., *M. punctata, Opuntia* sp., *O. lindheimeri, Parkinsonia* sp., *Petalostemum multiflorium, P. purpureum, P. violaceum, Phacelia* sp., *Phlox* sp., *Prosopis* sp., *Ratibida columnifera pulcherima, Rubus* sp., *Rudbeckia* sp., *Salvia* sp., *Sisyrinchium campestre, Teucrium canadense, Verbesina encelioides, Verbena officinalis, V. stricta.* MEXICO: *Asclepias* sp., *Donnellsmithia hintonii, Eysenhardtia polystachya, Ipomoea longifolia, Lippia* sp., *Sphaeralcea* sp. GUATEMALA: *Vernonia aschenborniana.* HONDURAS: *Ipomoea murucoides, Salvia* sp., *Sida acuta.* PANAMÁ: *Cornuta grandifloria, Cuphea balsamona, Davilla kunthii, Hibiscus tiliaceus, Ipomoea triloba.*

Melissodes (Melissodes) rufodentata Smith.

Melissodes rufodentata Smith, 1854, Catalogue of Hymenopterous Insects in the Collection of the British Museum, part 2, p. 314.

Melissodes trifasciatella Ashmead, 1900, Trans. Ent. Soc. London, p. 210 (new synonymy).

Melissodes rufodentata is a highly variable species from the Leeward Islands in the West Indies. The identity of this species has long been in doubt. Cockerell identified as *rufodentata* a series of males and females collected on St. Vincent, British West Indies, by Mr. J. Ogilvie. The males agree well with Smith's brief description and Dr. I. H. H. Yarrow of the British Museum has compared one of these with the type and considers them to be conspecific.

This species is closely allied to *M. tepaneca* of the mainland. The males have the same type of terminalia, but differ in the following respects: the apical margin of the eighth sternum is straight; the apodemes of the eighth sternum have smoothly rounded posterior margins, not sinuate as in *tepaneca*; the punctures on the vertex of the head, mesoscutum and terga are sparser and less distinct than in *tepaneca*. The paler females are easily separated from those of *tepaneca* by usually not having dark hairs ventrally, anteriorly or laterally on the mesepisterna, by being less conspicuously punctate and by the sharp contrast between the orange mesoscutal hairs and the white mesepisternal hairs. The dark females can be distinguished by the presence of brown hairs on the posterior pronotal lobes and face and by the sparser punctation.

Female. Measurements and ratios: N, 9; length, 10-11 mm.; width, 4 mm.; wing length, $M = 3.43 \pm 0.188$ mm.; hooks in hamulus, $M = 14.89 \pm 0.275$; flagellar segment 1/segment 2, $M = 1.85 \pm 0.044$.

Structure and color: Integument black except as follows: distitarsi and usually hind basitarsi and tibiae red, remainder of legs often dark brownish-red; apical half or more of mandibles with longitudinal median golden maculae; antennal scapes and first two flagellar segments black to dark brown, remaining segments dark red below, black above, occasionally all dark brown to black; apical area of tergum 1 often reddish-brown; eyes gray to grayish-green; wing membranes clear to slightly infumate, veins dark brown to black; tegulae testaceous. Structure and punctation as in *tepaneca* with the following differences: lateral flattened areas of vertex usually with smaller, sparser punctures, ground usually smooth and shiny; mesoscutum without posterior area of crowded punctures, or this area restricted to the short declivous area and punctures not noticeably smaller than in posteromedian area, punctures on mesoscutum more evenly distributed, separated by one half to two puncture widths, slightly sparser in posteromedian area; mesepisterna with ground areas often dulled by fine irregular shagreening; tergum 2 with punctures of interband zone sparser, separated by two to three puncture widths medially, small and round; apical areas of terga 2 and 3 with minute punctures, no wider than twice basal diameter of hairs arising from them, separated by one to four puncture widths.

Hair: pale specimens with characters of vestiture of *tepaneca* with the following differences: vertex of head with abundant dark brown hairs, often extending onto upper part of face and laterally to the level of antennal fossae or more; mesoscutum occasionally with a small posteromedian area of brown hairs; mesoscutal and scutellar hairs usually orange or orange-red; hairs of lateral surfaces of thorax white, except pale ferruginous in extreme upper portion near wing bases; posterior lobes of pronotum often with long brown hairs mixed with the pale; legs with less brown hairs, white except as follows: dark to pale brown on outer surfaces of fore and middle tarsi and tibiae, dark brown on and surrounding basitibial plates, yellow to orange on inner surfaces of hind basitarsi and tibiae, rufescent on inner surfaces of fore and middle basitarsi.

The darkest specimens with hairs of the head entirely dark brown except pale ochraceous to white hairs on lower two thirds of genal areas and often about one fifth of hairs of face (especially surrounding antennal fossae) white; hairs of thorax dark brown to black except as follows: posterior pronotal lobes with white tomentum along margins, lower posterior third or less of mesepisterna, at least lower third of metepisternum and propodeum with white to pale ochraceous hairs, propodeal hairs often brown on lower anterior part of lateral face; metasomal terga with hairs and pubescence all brown except usually long pale hairs on basal third of tergum 1, distal pale band of tergum 2 (although this often narrowly interrupted medially), terga 3 and 4 with pubescent bands pale to dark brown; hairs of hind legs as in typical pale specimens, hairs of fore and middle legs dark brown except rufescent hairs of inner surfaces of tarsi.

A single intermediate specimen has a large square mesoscutal dark brown hair patch, abundant scutellar and posterior pronotal dark hairs, dark hairs on lower lateral, ventral and anterior surfaces of mesepisterna, and the facial hairs approximately half dark and half white.

Male. Measurements and ratios: N, 13; length, 9-10 mm.; width, 2.0-3.5 mm.; wing length, M = 3.12 ± 0.378 mm.; hooks in hamulus, M = 13.15 ± 0.191; flagellar segment 2/segment 1, M = 8.47 ± 0.059.

Structure and color: Color as in *tepaneca* but legs with at least tarsi orange-red and often legs entirely red. Structure and sculpturing as in *tepaneca* except as follows: mesoscutum never with small posteromedian area of crowded punctures, punctures evenly distributed or with posteromedian flattened area sparsely punctate; interband zone of tergum 2 with smaller, more widely spaced punctures than in most individuals of *tepaneca;* apical areas of terga 2 to 5 impunctate or with punctures no wider than twice basal diameter of hairs arising from them.

Genitalia and hidden sterna as in *tepaneca* with the following differences: gonostyli with tufts of simple hairs on outer lower surfaces shorter and hairs more abundant; sternum 8 with straight apical margin, with very few, minute apical hairs, with longitudinal ventral carina extending beyond apex of sternum by about half of its own length, with lateral apodemes smoothly rounded posteriorly (Figs. 88-89).

Hair: With vestiture of *tepaneca,* but often with several to many long brown hairs on vertex of head and occasionally a few dark hairs on mesoscutum and scutellum.

Remarks. Ashmead named *trifasciatella* from melanistic females from St. Vincent, British West Indies. Among the females of *rufodentata* collected on St. Vincent by Mr. J. Ogilvie are two which are darker than the typical *rufodentata* and one of these is almost precisely half way between the palest and the darkest specimens studied. The paratype of *trifasciatella,* presumably collected with the holotype, is the darkest specimen examined and is considerably darker than the holotype. Another of the females collected by Mr. Ogilvie is almost identical with the holotype of *trifasciatella,* but is slightly paler. In view of these facts, and the additional fact that the punctational and structural characters of the holotype and paratype of *trifasciatella* are identical to those of the typical female of *rufodentata,* there is no reason to consider these as distinct species. That they might be subspecies seems contradicted by the fact that they are both found on the same, relatively small, island—St. Vincent. Additional material with more precise locality information might clarify the situation further.

C. D. Michener (1954) provisionally identified a single female from Cerro Cobre, Panamá, as *trifasciatella.* This female is badly worn and identification is uncertain. The coloration of the vestiture is similar to that of the dark *rufodentata* females. However, it is definitely not this species, as is shown by the very short clypeus, the dark hairs of the inner surfaces of the hind basitarsi and by the shiny, impunctate triangle of the declivous face of the propodeum. Perhaps it represents a new species, but is in such poor condition that a description does not appear justified until more material becomes available. One cannot be certain that it belongs to the subgenus *Melissodes*, because of destruction of characters of the vestiture.

Type material. Holotype male of *rufodentata* from St. Vincent, British West Indies, is in the British Museum (Natural History). Holotype female of *trifasciatella* from St. Vincent, B. W. I., collected by H. H. Smith, is in the U. S. National Museum (U. S. N. M. Type No. 6396).

Distribution. The Leeward Islands, West Indies, from Grenada in the south to Dominica in the north. The following specimens have been examined (including the type material of *trifasciatella*).

DOMINICA: Roseau, 2 males, June 9, 1911. GRENADA: 2 females, September 15, 1921, A. Busck; St. John's River, 1 male, H. H. Smith. ST. VINCENT: 2 males, 2 females (holotype, paratype of *trifasciatella*), H. H. Smith; 1 female, April 4, J. Ogilvie; 1 male, 1 female, April 5, J. Ogilvie; 2 females, 2 males, September 4, 1938, J. Ogilvie. One female and one male with no data.

Melissodes (Melissodes) gilensis Cockerell.

This species is closely related to *M. communis* and is difficult to distinguish from *M. communis alopex.* The males are easily recognized by the median plates of the eighth sternum which are similar to those of *communis* but flattened, enlarged and with the tips bent dorsally. The males can be recognized by the following external characters: the apical areas of the terga are hyaline and usually yellow; the punctation and flagellar segments are as in *communis;* the mesoscutum and scutellum always have patches of dark brown hairs and the tegulae usually have dark hairs; the distal pale band of tergum 2 is broad as in *alopex*; the apical areas of the terga are less densely shagreened than in *communis.* The females can be distinguished from those of *communis* as follows: the distal pale band of tergum 2 is broad as in *alopex;* the posterior pronotal lobes usually have at least one dark hair and often more mixed with the pale; the narrow anterior half of each tegula almost always has at least one and usually several moderately long, erect, black hairs mixed with the pale. Both sexes usually have the pale hairs of the head and thorax white or pale ochraceous and the pale metasomal pubescence yellow or ochraceous, especially on terga 3 and 4. This is best expressed in the female, but is obvious in fresh, unworn males.

Female. Measurements and ratios: N, 20; length, 11-14 mm.; width, 4.0-5.5 mm.; wing length, $M = 4.55 \pm 0.277$ mm.; hooks in hamulus, $M = 16.00 \pm 0.205$; flagellar segment 1/segment 2, $M = 1.88 \pm 0.017$.

Structure and color: Integument black except as follows: tarsi dark red; tibiae and femora often dark red; apical halves of mandibles dark red; flagella red beneath except first two segments, black above; tergum 1 with narrow hyaline yellow margin; terga 2 and 3 with apical areas dark reddish-brown; sterna dark red; eyes gray to yellowish-green; wing membranes slightly infumate, brownish, veins dark reddish-brown. Maxillary palpal segments in ratio of about 3:4:2:1.5, third segment often slightly longer; structural characters of head, thorax and metasoma of *communis* with the following differences: clypeus with punctures slightly sparser posteriorly, ground usually more densely tessellate, boss or median carina usually less well defined; mesoscutal punctures smaller; mesepisterna with ground areas usually delicately shagreened.

Hair: On head white or pale ochraceous except abundant black hairs on vertex between apices of compound eyes and extending onto face below median ocellus. Hairs of thorax white to pale ochraceous except as follows: mesoscutum with large patch of black hairs extending forward to a transverse line at anterior margins of tegulae or more; tegulae usually with brown appressed hairs on posterior halves (often rubbed off) and almost always with at least one or two and usually several long black hairs mixed with the white on narrow anterior halves; posterior pronotal lobes almost always with at least one and usually many long black hairs mixed with the pale. Metasomal vestiture as in *communis* with the following differences: pale hairs and pubescence ochraceous to yellow, band on terga 2-4 become progressively more yellow distally in unfaded specimens, concolorous and ochraceous in faded specimens; distal band of tergum 2 usually as wide as apical area medially or wider, occasionally slightly narrower but always wider than half of apical area and at least as wide as interband zone; pale pubescent bands of terga 3 and 4 broader than in *communis,* usually more than twice as broad as distal band of tergum 2 medially; apical areas of terga 2 and 3 with abundant suberect to erect hairs; tergum 5 with tufts of ochraceous hairs laterally but these absent on tergum 6; sternal hairs dark red to yellow medially, ochraceous laterally. Legs with pale ochraceous to white hairs except as follows: outer surfaces of fore tarsi, apically on outer surfaces of fore and middle tibiae and on basitibial plates brown; inner surfaces of tarsi and hind tibiae red to yellow.

Male. Measurements and ratios: N, 20; length, 10-13 mm.; width, 3.0-4.5 mm.; wing length, $M = 4.35 \pm 0.358$ mm.; hooks in hamulus, $M = 14.90 \pm 0.216$; flagellar segment 2/segment 1, $M = 5.03 \pm 0.116$.

Structure and color: Integument black except as follows: labrum white; clypeus and large triangular spots at bases of mandibles yellow; tarsi and hind tibiae red; fore and middle tibiae and femora often dark reddish-brown; apical areas of metasomal terga hyaline, yellow; flagella yellow to red beneath, except first segment and extreme base of second segment, dark brown to black above; eyes usually green, occasionally gray or brown; wing membranes slightly infumate, brown, veins dark reddish-brown to black. Maxillary palpi as in female; minimum length of first flagellar segment equals about one fifth of maximum length of second segment, occasionally more, rarely less and never less than one sixth of second; other structural characters as in *communis* with the following differences: mesoscutal punctures usually smaller; mesepisternal ground areas usually dulled by fine shagreening; metasomal terga 2-5 with apical areas dulled by fine shagreening, but usually less so than in *communis s. str.* and distinctly less than in *communis alopex.*

Genitalia and hidden sterna as in *communis* except as follows: spatha with apical margin sinuate; sternum 7 with median plates expanded and flattened, medially as wide as lateral plates at same level, apical oblique margin curved outwards, apical fifth or sixth bent sharply dorsally, with median carinae forming a broad V-shaped structure, with apodemes slender and truncate (Figs. 93-95).

Hair: Vestiture as in female with the following differences: pale hairs of head and thorax white to ochraceous, more often ochraceous than in female; vertex often with less black hairs than in female; tegulae often without dark hairs (about 50 per cent of specimens); posterior pronotal lobes often without dark hairs; mesoscutal patch of dark hairs often not extending forward to level of anterior margins of tegulae, but always present; pale hairs and pubescence of metasoma usually more yellow than in female, especially on terga 4 and 5, in fresh specimens; tergum 5 with a complete apical pale pubescent band as broad as that on tergum 4 or almost so; sternal hairs yellow medially, pale ochraceous laterally. Legs with white to pale ochraceous hairs except orange to yellow hairs on inner surfaces of tarsi and tibiae and brown hairs on basitibial plates.

Bionomics. M. gilensis is seemingly restricted to moderately high altitudes in arid or semiarid regions of the southwest. Most of the specimens examined are from localities which range in general altitude upwards from 4000 feet. A single specimen from Dublin, Texas, is the only exception to this. Those specimens bearing altitude data on the labels all show altitudes above 5000 feet. Furthermore, the only localities where this species has been taken in abundance are areas of rough terrain with many mountains and canyons. This has left notable gaps in the collection data. For instance, a large area between Nogal, New Mexico, and Jeff Davis County, Texas, where high plains dominate the physiography, has thus far yielded no specimens of *M. gilensis*. Perhaps, this species occurs in this region in such limited areas as the Guadelupe Mountains in New Mexico and Texas and the Delaware Mountains of Texas. The single male from Dublin, Texas, may perhaps be explained by the rough terrain of the escarpment of the Edwards Plateau in central Texas. This region should be collected more thoroughly in the future.

Little is known concerning the flower preferences of *gilensis*. According to the existing evidence, it is a polylectic species as are most members of this subgenus.

Geographical variation. This species is divisible into two subspecies, a paler race from Arizona, New Mexico and Colorado (*gilensis s. str.*) and a darker Mexican race (*crenata*). The specimens from southwestern Texas are intermediate between the two races in color. However, too few specimens are available to be able to describe the zone of intergradation in detail. Four males from the state of Chihuahua, Mexico, are also considered as from the zone of intergradation, although this is only tentative until series of females from this region can be studied. Two of these males from Santa Barbara in southern Chihuahua are much darker than the two from central Chihuahua and the former may be found to mark the northern limit of the subspecies *crenata*. A single male from

Fresnillo, Zacatecas, is as pale as the Santa Barbara males, but is within the range of *crenata*. Three females from the state of Durango and one from the state of Nuevo León are all typical specimens of *crenata*.

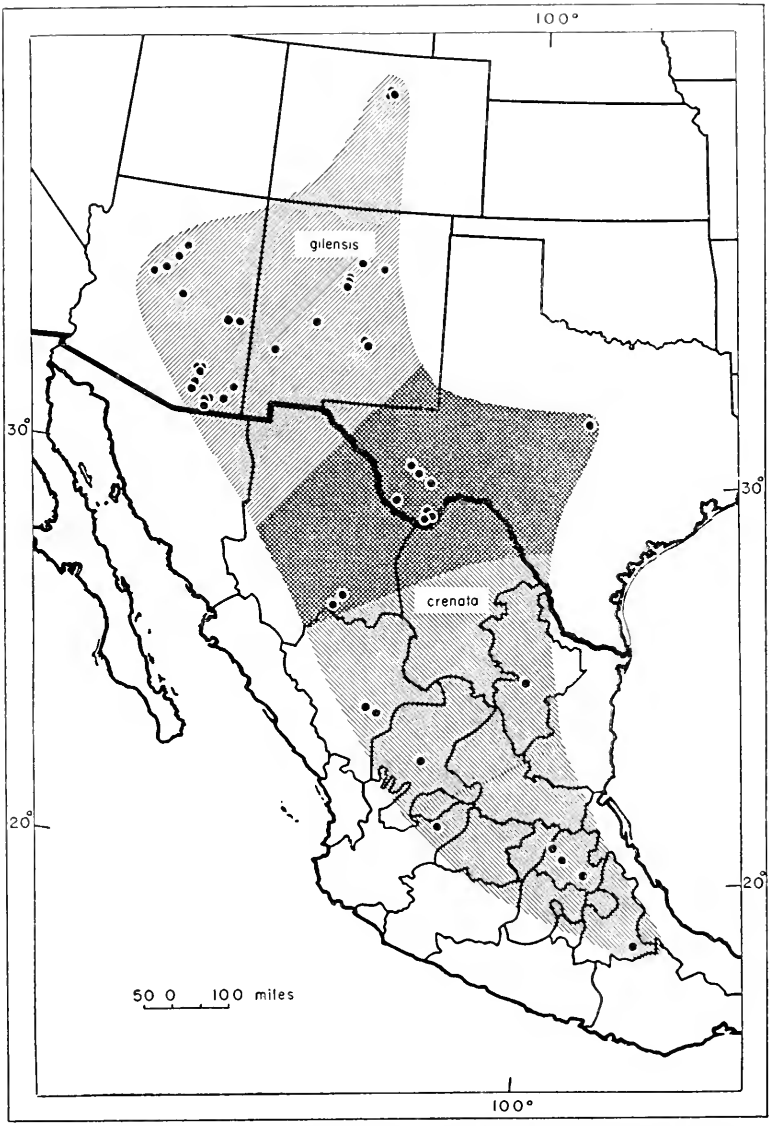

FIG. 18. Map showing the distribution of *M. (Melissodes) gilensis*. The overlapping type of shading indicates the zone of intergradation between the two subspecies.

TABLE VI.—Percentages of females of *Melissodes gilensis* exhibiting certain characters of vestiture.

Characters		Arizona (96)	New Mexico (23)	Texas (10)	Mexico (22)
Number of black hairs on the posterior lobes of the pronotum.	0	18.8	13.0	0	0
	1–10	47.9	47.8	0	0
	11–20	15.6	13.0	10.0	0
	21–30	8.3	21.7	40.0	4.5
	31–40	6.3	4.3	30.0	31.8
	41–50	1.0	0	10.0	14.4
	51–60	2.1	0	10.0	14.4
	61–70	0	0	0	22.7
	71–80	0	0	0	4.5
	81–90	0	0	0	4.5
With black hairs medially on tergum 4.		4.2	4.3	*100.0	†100.0
With black hairs on anterior part of tegulae.		95.8	91.7	100.0	100.0
Apical area of tergum 3 with hairs yellow or mostly so.		52.1	52.2	*0	0
Distal pale band of tergum 2 equal to apical area or wider.		69.8	69.6	*20.0	4.3

*Only 5 females in condition for use of metasomal characters.
† Only 16 females with distal band not badly worn.

Table VI illustrates the situation for some of the characters important in separating these two subspecies. The figures are percentages of females which bear the indicated character. The

Texas specimens are seen to be almost perfectly intermediate in regard to the number of dark hairs on the posterior pronotal lobes and the width of the distal pale band of tergum 2, but are more like the Mexican specimens in regard to the remaining characters. This last fact may be due to the small sample involved. The Texas females available are mostly in very poor condition and metasomal characters in five of the ten usable females (out of thirteen available) are not decipherable.

Melissodes (Melissodes) gilensis gilensis Cockerell.

Melissodes gilensis Cockerell, 1896, Entomologist, vol. 29, p. 306; 1898, Bull. Sci. Lab. Denison Univ., vol. 11, p. 67; 1898, Bull. Univ. New Mexico, vol. 1, p. 67; 1901, Ent. News, vol. 12, p. 40; 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 87, 92; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 137; Cockerell, 1926, Univ. Colorado Studies, vol. 16, p. 114.

Melissodes epicharina Cockerell, 1905, Psyche, vol. 12, p. 99 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, pp. 83, 87; Snow, 1906, Trans. Kansas Acad. Sci., vol. 20, p. 137.

This subspecies can be separated from *M. gilensis crenata* by the paler color as described below. The tabulation (Table VI) gives additional information regarding the value of the most diagnostic characters of the female in terms of percentages of females from each region bearing the particular characters. The males are more difficult to separate than the females because of their greater variability. However, a majority of males of *gilensis s. str.* can be distinguished by the use of two characters—the yellow hairs of the apical areas of the terga and the lack of brown hairs mixed with the pale on the posterior pronotal lobes.

Female. Structure and color; metasomal tergum 1 usually hyaline in apical sixth; apices of terga 2 and 3 usually reddish-brown; supraclypeal area with several large round punctures medially in about 40 per cent of the specimens.

Hair: Pale hairs of head and thorax usually white but often pale ochraceous; mesoscutal patch of dark hairs usually reaches transverse line at anterior margins of tegulae, rarely larger, occasionally extending laterally in front of tegulae near anterior margin; posterior pronotal lobes usually with 1 to 30 long black hairs mixed with the pale, occasionally with more than 30, rarely with none; anterior narrow halves of tegulae usually with at least one moderately long black hair mixed with the pale and often several; apical area of tergum 3 and often of tergum 2 usually with suberect yellow hairs, these becoming dark brown medially and often entirely dark brown; tergum 4 usually without dark brown or black hairs medially near apex, or with only 1 or 2 dark hairs, suberect, relatively simple hairs usually present in this area.

Male. Structure and color: Supraclypeal area with several large round punctures medially in half or less of the specimens.

Hair: Vertex between compound eyes usually without black hairs; mesoscutal patch of dark brown hairs usually not extending forward to a transverse line at anterior margins of tegulae, usually square or almost so; posterior lobes of pronotum without dark hairs mixed with the pale; tegulae often without dark hairs mixed with the pale anteriorly; metasomal tergum 2 with distal pale band usually as wide as or broader than apical area medially, with interband zone usually with long, erect or suberect, relatively simple, yellow to pale ochraceous hairs, occasionally these partly dark brown at least medially; apical areas of terga 2-4 with long, subappressed to suberect, relatively simple, yellow hairs, rarely brownish on tergum 2; tergum 5 without dark brown hairs medially at apex; terga 3-5 usually without dark brown hairs at extreme bases.

Remarks. Cockerell (1905) described a female from Oak Creek Canyon, Arizona, as *Melissodes epicharina.* This female has the basal pale band of tergum 2 worn away, but vestiges remain at the extreme sides of the tergum and the punctation across the tergum is evidence of the former presence of this band. As far as is known at present, no *Melissodes* lacks the pale pubescent band at the base of tergum 2 except certain melanistic species in which this band becomes dark brown—but the pubescence is still present. Also, the basal pale band may become fused with the distal band in some species, so that there appears to be only one broad band present, but even in these species, the basal band can be distinguished by the form of the hairs as contrasted with those of the distal band.

Type material. The type specimen of *gilensis* either was never designated or was lost. Cockerell did not designate a type specimen in the original description. Of the type series of eight females and one male, only six females and the one male have been located. These are as follows: two females from the West Fork of the Gila River, New Mexico, August 12 and 16, C. H. T. Townsend, are in the U. S. National Museum (U. S. N. M. cotype No. 3358); one female with the same data, collected on August 16, is in the Snow Entomological Museum at the University of Kansas and is labeled topotype; one female with the same data, collected on August 16, is in the collection of the California Academy of

Science, San Francisco; one female and one male with the same data, collected on August 16, and one female from La Tenaja, New Mexico, by M. Boyle are in the Colorado Museum of Natural History at Boulder. The male fits Cockerell's description perfectly, but, unfortunately, does not belong to the same species as the females from the same locality. It is probably *M. montana* Cresson. In view of the fact that Cockerell in his earlier descriptions of bees often did not select type specimens from a series, this is assumed to have occurred in the case of *M. gilensis* and the female collected by C. H. T. Townsend from the West Fork of the Gila River and deposited in the collection of the University of Colorado Museum is hereby designated as the lectotype. The holotype female of *epicharina* from Oak Creek Canyon, Arizona, July, 6000 feet altitude, F. H. Snow, is in the Snow Entomological Museum at the University of Kansas.

Distribution. Southeastern Arizona, New Mexico and eastern Colorado (Fig. 18). This subspecies has been collected from April 19 through September 27. From the localities listed below, 228 females and 113 males have been examined. This list includes localities reported in the literature.

ARIZONA: Apache Camp, Santa Catalina Mts.; Carr Canyon, Huachuca Mts.; Chiricahua Mts.; Cochise Co.; Flagstaff (Walnut Canyon); Fort Grant, Pinaleno Mts.; Graham Mts.; Jerome (4 miles S.); Madera Canyon, Santa Rita Mts.; Mud Springs, Santa Catalina Mts.; Oak Creek Canyon, near Flagstaff; Palmerlee; Prescott; Ramsey Canyon, Huachuca Mts.; Sabino Basin, Santa Catalina Mts.; Santa Rita Mts.; Sycamore Forest Camp (7 miles N. of Payson, Gila Co.); White Mts.; Whiteriver. COLORADO: Boulder; Jim Creek, near Boulder; Jim Creek (left hand junction), Boulder Co. NEW MEXICO: Cedro Canyon, Bernalillo Co.; Cienega Canyon, Sandia Mts.; Dripping Springs; La Tenaja; Las Vegas; Magdalena Mts.; Nogal; Rio Ruidoso, White Mts.; Sandia Mts.; Santa Fe; West Fork Gila River. TEXAS: * Alpine (20 miles S.); * Big Bend, Brewster Co.; * Big Bend National Park; * Chinati Mountain; * Chisos Mts.; * Davis Mts.; * Dublan; * Marathon. CHIHUAHUA: * Primavera; * Santa Barbara.

Flower records. Arabis sp., *Asclepias tuberosa, Cirsidium torreyana, Cirsium* sp., *Lippia lyciddea, Lotus* sp., *L. brightii, Lupinus* sp., *Malva* sp., *Melilotus alba, M. officinalis, Monarda* sp., *M. menthaefolia, M. stricta, Nolina* sp., *Robinia neomexicana.*

* Localities from the zone of intergradation.

Melissodes (Melissodes) gilensis crenata, subsp. nov.

This subspecies can be distinguished from *gilensis s. str.* by the characters listed in the diagnosis of the latter.

Female. Structure and color: First tergum usually extremely narrowly hyaline apically, less than apical sixth hyaline; apices of terga 2 and 3 usually dark brown to black; supraclypeal area usually with several coarse punctures medially.

Hair: Pale hairs of head and thorax usually white or almost so; mesoscutal patch of dark hairs usually extends forward beyond a transverse line at anterior margins of tegulae and usually extends laterally at anterior margin in front of tegulae, occasionally fusing with dark hairs of posterior pronotal lobes; posterior pronotal lobes usually with more than 30 long black or dark brown hairs mixed with the pale, occasionally less, but not with less than 21 dark hairs in the specimens examined; tegulae always with dark hairs mixed with the pale anteriorly; metasomal tergum 2 with distal pale band usually narrower than apical area medially, occasionally as wide as apical areas, but no wider in any specimens examined; apical areas of terga 2 and 3 with dark brown hairs; tergum 4 with at least a few black or dark brown suberect hairs medially near apex.

Male. Structure and color: Supraclypeal area usually with several coarse punctures medially.

Hair: Vertex between apices of compound eyes usually with at least a few dark brown hairs; mesoscutal patch of dark hairs usually extending forward to or beyond a transverse line at anterior margins of tegulae and often extending laterally at anterior margin so as to be inversely trapezoidal in outline; posterior lobes of pronotum usually with at least one or two long dark hairs mixed with the pale; tegulae always with at least a few dark hairs anteriorly; metasomal tergum 2 with distal pale band often slightly narrower than apical area medially, with interband zone always with dark hairs at least medially; apical areas of terga 3 and 4 always with dark brown hairs at least medially; tergum 5 often with an apical patch of suberect dark brown hairs medially near apex.

Type material. Holotype male, allotype female, four female and one male paratype from 3 miles west of Pachuca, Hidalgo, Mexico, June 24, 1953, on *Opuntia* sp., Univ. of Kansas Mexican Expedition. Fifteen female and ten male paratypes from Mexico as follows: DURANGO: Durango, 1 female, August 14, 1947, 6200 feet, W.

Gertsch; Nombre de Dios (10 kilometers N.), 1 female, August 5, 1951, H. E. Evans. Hidalgo: Ixmiquilpan, 4 males, June 23, 1953, 5300 feet, Univ. of Kansas Mexican Expedition; Pachuca (3 miles W.), 1 female, June 24, 1953, on *Argemone* sp., Univ. of Kansas Mexican Expedition; Zimapán, 7 females and 2 males, June 11-14, 1951, on *Eysenhardtia polystachya*, P. D. Hurd; 2 females, June 11, 1951, H. E. Evans. Jalisco: Encarnación de Diaz, 1 female and 1 male, July 28, 1951, P. D. Hurd. Nuevo León: El Cercado (4 miles W.), 1 female, June 6, 1951, P. D. Hurd. Puebla: Tehuacán, 1 female, June 23, 1951, H. E. Evans. Zacatecas: Fresnillo, 1 male, August 15, 1947, 7000 feet, C. D. Michener (Fig. 18). The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collections of the Snow Entomological Museum, the California Academy of Science, the University of California, the American Museum of Natural History and in the author's collection.

Melissodes (Melissodes) paroselae Cockerell.

Melissodes humilior, Cockerell, 1903, Ann. Mag. Nat. Hist., ser. 7, vol. 12, p. 447 (*humilior*, var. a).
Melissodes parosetae (*sic*) Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 15, p. 528; 1906, Trans. Amer. Ent. Soc., vol. 32, p. 78.
Melissodes paroselae Cockerell, 1905, Ann. Mag. Nat. Hist., ser. 7, vol. 16, p. 477 (emendation of *parosetae*); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310; 1925, Ann. Mag. Nat. Hist., ser. 9, vol. 16, p. 229.
Melissodes helenae Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 365 (new synonymy); 1906, Trans. Amer. Ent. Soc., vol. 32, p. 310
Melissodes communis gratior Cockerell, 1923, Proc. California Acad. Sci., vol. 12, p. 85 (new synonymy).

This is a distinctive small bee from the southwestern United States and northern Mexico. Both sexes can be distinguished as follows: the punctation of the mesoscutum and metasomal terga is much as in *communis*; the basal pale band of tergum 2 consists of plumose and spatuloplumose hairs mixed; the hairs of the mesoscutum are usually appressed. In addition, the male has short first flagellar segments and distinctive terminalia as described below, and the female has pale red to yellow hairs on the inner surfaces of the hind basitarsi.

Female. Measurements and ratios: N, 20; length, 9-12 mm.; width, 3.5-5.0 mm.; wing length, $M = 3.61 \pm 0.194$ mm.; hooks in hamulus, $M = 12.95 \pm 0.135$; flagellar segment 1/segment 2, $M = 1.77 \pm 0.030$.

Structure and color: Integument black except as follows: distitarsi rufescent and often legs entirely dark red; basal sterna and apical area of first tergum often reddish-brown; mandibles dark red with large median longitudinal maculae over distal halves; eyes usually gray, occasionally yellowish-green; antennal scapes and first flagellar segment black, second flagellar segment black but often red below in apical half, remaining segments red below and black above; wing membranes clear or slightly milky, not infumate, veins dark red to reddish-brown; tegulae testaceous to reddish-brown. Clypeus coarsely punctate, punctures round, separated by half of one puncture width or less, smaller and more crowded anteriorly, with an irregular median carina, ground areas shiny or moderately so, delicately shagreened; supraclypeal area with abundant punctures at least laterally, ground area medially dulled by fine dense tessellation; vertex of head with flattened lateral areas with minute punctures separated mostly by three or more puncture widths, virtually impunctate, ground areas smooth and shiny or with delicate shagreening; eyes in facial view much broader than one third of length and distinctly longer than facial width between upper apices of eyes; maxillary palpal segments in ratio of about 3:2:1:0.75, third segment often as long as second and fourth often as long as half of second. Mesoscutum with round punctures anteriorly and laterally separated by one half to one puncture width, in posteromedian area larger and separated by one to four puncture widths, often posteromedian area impunctate or with sparse punctures along midline forming two lateral oval impunctate areas, ground smooth and shiny or with delicate shagreening; scutellum with punctures about equal in size to those on anterior half of mesoscutum, separated mostly by less than one puncture width, ground areas smooth and shiny; mesepisterna sculptured much as anterior half of mesoscutum but punctures usually slightly larger; propodeum with distinct punctures on dorsal face apically, becoming reticulopunctate basally, with distinct punctures separated mostly by one puncture width or more on declivous and lateral faces, except impunctate inverted triangle on upper part of declivous face, ground areas opaque, dulled by dense tessellation, but occasionally shiny or moderately so on dorsal face. First metasomal tergum with small, shallow, round punctures in basal half to three fifths, punctures separated by two to three puncture widths, more crowded at extreme base and laterally but still separated by one puncture width, apical area impunctate, ground areas dulled by fine dense shagreening; tergum 2 with punctures of interband zone small, round, separated mostly by two to three puncture widths, slightly more crowded laterally, apical area impunctate, ground areas dulled by fine, dense shagreening; tergum 3 similar to tergum 2 but basal area (beneath diffuse part of broad pale pubescent band) with punctures more crowded.

Hair: On face, genal areas and occiput white, on vertex pale hairs often rufescent and black or dark brown hairs abundant. Hairs of mesoscutum relatively short and recumbent in at least anterior half; mesoscutum with large posteromedian, square patch of dark brown to black hairs extending forward to a transverse line at about middle of tegulae, often more restricted, pale hairs at least anteriorly usually ochraceous to red, fading through yellow to pale ochraceous; tegulae occasionally with brown hairs; scutellum with large median patch of dark brown hairs fringed with white or pale ochraceous hairs; propodeum and lateral surfaces of thorax with white hairs, occasionally ochraceous on dorsum of propodeum and somewhat rufescent or ochraceous on upper portion of mesepisterna near wing bases. Metasoma with banding as in *communis* but distal pale band of tergum 2 usually broader, often as wide as half of apical area medially and rarely as broad as apical area; basal pale band of tergum 2 consists of plumose and spatuloplumose hairs mixed in ratio of about 1:1; tergum 4 with median oval area of simple dark hairs interrupting broad apical white band; pale pubescence and hairs of metasoma pale ochraceous to white; sternal hairs dark brown to dark red medially, yellow apically and white laterally on each sternum except apical one or two sterna which have all brown hairs. Legs with white hairs except as follows: outer surfaces of fore tarsi, outer surfaces of middle tibiae near apices, and on and surrounding basitibial plates brown; inner surfaces of tarsi and hind tibiae yellow to orange-red; scopal hairs white.

Male. Measurements and ratios: N, 20; length, 8-11 mm.; width, 2-4 mm.; wing length, $M = 3.44 \pm 0.656$ mm.; hooks in hamulus, $M = 11.90 \pm 0.536$; flagellar segment 2/segment 1, $M = 9.19 \pm 0.090$.

Structure and color: Color as in female with the following differences: clypeus and bases of mandibles yellow; labrum completely white or cream-colored; apical areas of terga 2-5 usually dark reddish-brown to dark red, first tergum narrowly hyaline; flagella yellow to red below, black above. Maxillary palpi and sculpturing of head as in female but clypeal punctation obscure; minimum length of first flagellar segment scarcely longer than pedicle, if at all, equal to one eighth or less of maximum length of second segment. Sculpturing of thorax and metasoma as in female with the following differences: mesoscutum with punctures often more crowded and relatively impunctate posteromedian area often much reduced in size; dorsal face of propodeum often with ground areas smooth and shiny; tergum 2 with punctures of interband zone often somewhat more crowded.

Genitalia much as in *communis.* Sternum 8 with greatly expanded, flattened, median plates, each plate is longer than broad, more than twice as wide as apical third of lateral plate, superficially resembles large membranous plate of members of the subgenus *Eumelissodes,* but shape definitely derivable from the curved, scroll-like plate of *M. communis* and without hairs on ventral surface; lateral plates long, abruptly narrowed near middle and apical portion about half as wide as median plates or narrower; apodemes short, thin, not truncate or capitate; median ventral carinae form a broad, V-shaped structure, well separated from apical margin of sternum. Sternum 9 not emarginate medially at apex, but evenly rounded or slightly pointed; ventral longitudinal carina simple, reaches or slightly exceeds apical margin of sternum; apex with several short, simple hairs on each side of carina (Figs. 98-100).

Hair: As in female with the following differences: vertex of head often without dark hairs but usually with rufescent hairs; mesoscutal patch of dark hairs often restricted or absent; tegulae usually with abundant brown hairs; scutellar patch of brown hairs often restricted but never completely absent; apical areas of terga 1-4 often with some yellow simple hairs mixed with the black, especially along apical margin of tergum 1; tergum 2 with distal band usually broader than in female; tergum 5 with a complete apical pale band; legs with white hairs except yellow to red on inner surfaces of tarsi and hind tibiae, occasionally with a streak of brown on outer surfaces of upper halves of hind tibiae.

Bionomics. Like most members of the subgenus *Melissodes,* this species is highly polylectic. A peculiar feature of this species is the apparent preponderance of males over females. This is probably due to the fact that the females are rather swift fliers and are not easily captured. This unequal sex ratio, which is the reverse of the ratio in most other species, may be attributed also to the fact that the males will congregate in large numbers at the flowers of certain plants which seemingly are good honey sources (judging from the large number of other wasps and flies on these plants at the same time). The males are easily collected in large numbers while thus congregating, whereas the females do not behave in this manner. The author, together with R. H. and L. D. Beamer and Cheng Liang, observed males congregating on *Cleome luteum, Dasylirion wheeleri* and *Eriogonum trichopes* in Arizona in mid-July of 1952. In one locality 170 males were collected within a very few minutes on *Cleome*, while only a single female was taken. In another locality 30 males were taken on *Dasylirion* and only five females.

The rather small total number of collections with flower data, together with the unequal sex ratio, does not permit analysis of preferences such as has been performed for other species. The only conclusion that can be drawn at this time is that *paroselae* seems to be polylectic and visits many composites, as well as other families, for pollen and nectar.

Type material. Holotype male of *paroselae* from Mesilla, New Mexico, July 25, on *Parosela scoparia,* T. D. A. Cockerell, is the property of the California Academy of Sciences, but is temporarily deposited in the collection of the Citrus Experiment Station, Riverside. Female holotype of *gratior* from Guaymas, Sonora, Mexico, April 11, 1921, E. P. Van Duzee, is in the California Academy of Sciences, San Francisco. Holotype female of *helenae* from Las Cruces, New Mexico, August 19, C. H. T. Townsend, is in the collection of the University of Colorado Museum, Boulder.

Distribution. From Baja California to extreme southern California, east across Arizona and New Mexico to extreme southwestern Texas and south through Sonora and Chihuahua to Tepic, Nayarit, in Mexico (Fig. 19). This species has been taken from April 7 to October 20. In addition to the type material, 254 females and 952 males have been examined from the localities listed below (including localities reported in the literature).

Arizona: Apache Co.; Arivaca; Atascosa Mts.; Baboquivari Mts.; Benson; Bill William's Fork; Bisbee; Bowie; Carr Canyon, Huachuca Mts.; Casa Grande; Chandler; Chandler Heights; Chiricahua Mts.; Cochise; Cochise Co.; Congress; Congress Junction; Continental; Coolidge (17 miles N.); Cortaro; Cottonwood; Dos Cabezas (10 miles S. E.); Douglas; Duncan; Florence Juntion; Fort Huachuca; Fort Thomas; Globe; Hassayampa, Mariposa Co.; McNeill; Mule Mts. (near Bisbee); Nicks, Huachuca Mts.; Oak Creek Canyon, near Flagstaff; Olberg; Oracle; Palmerlee; Patagonia; Payson (10 miles S.); Peppersauce Canyon, Santa Catalina Mts.; Phoenix;

Picacho Pass; Pima Co.; Pinal Mts.; Prescott (32 miles S. and 21 miles S.W.); Ramsey Canyon, Huachuca Mts.; Redington; Red Rock; Rio Aravaipa; Roble's Pass, Tucson Mts.; Roosevelt Lake (E. end); Sabino Canyon, Santa Catalina Mts.; Sacaton; Sahuarita;

FIG. 19. Map showing the distribution of *M. (Melissodes) blanda, M. (M.) paroselae* and *M. (M.) tessellata.*

San Carlos; San Carlos Lake; San Simon; Santa Catalina Mts.; Santa Rita Mts.; Sedona; Seligman; Sentinel; Skull Valley, Yavapai Co.; Sonoita; Stone Cabin Canyon, Santa Rita Mts.; St. Xavier Mt., near Tucson; Sunnyside Canyon, Huachuca Mts.; Superior (E. Thompson Arbor); Tempe; Tombstone; Tucson; Walnut; Wickenburg; Wilcox; Williams; Winslow; Yarnell. CALIFORNIA: Calexico, Imperial Co. NEW MEXICO: Deming (23 miles E.); Gallinas Canyon; Hatch; Las Cruces; Lordsburg (10 miles N. E.); Mesilla; Mesilla Valley; Rodeo, Hidalgo Co.; Tularosa (25 miles W.); Tyrone; Willow Creek. TEXAS: Big Bend National Park, Brewster Co.; El Paso; El Paso Co. UTAH: Greenriver. CHIHUAHUA: Matachic (2 miles W.). NAYARIT: Tepic (32 miles N. W.). SONORA: Álamos; Bacachaka; Guaymas; Minas Nuevas; Naco; Navojoa; Río Mayo; San Bernardo; Tiburón Island, Gulf of California.

Flower records. *M. paroselae* has been collected on the following flowers: *Acacia* sp., *A. greggii*, *Argemone* sp., *Asclepias subulata*, *Aster* sp., *A. canescens*, *Cucurbita* sp., *Cleome* sp., *C. luteum*, *Dalea albifrons*, *Dasylirion wheeleri*, *Eriogonum* sp., *E. trichopes*, *Franceria eriocentra*, *Gaillardia* sp., *Gossypium herbaceum*, *Helianthus* sp., *H. annuus*, *Heterotheca subaxillaris*, *Isocoma* sp., *I. heterophylla*, *Kallstroemia grandiflora*, *Larrea* sp., *L. divaricata*, *Leucophyllum frutescens*, *Lippia* sp., *Lygodesmia juncea*, *Medicago sativa*, *Opuntia* sp., *Parosela scoparia*, *Pectis papposa*, *Petalostemum* sp., *Prosopis* sp., *P. glandulosa*, *Psilostrophe cooperi*, *Pyrrhopappus multicaulis*, *Rhus* sp., *Salix* sp., *Senecio longilobus*, *Thurberia* sp., *T. thespesioides*, *Verbesina* sp., *V. encelioides*, *V. exauriculata*, *Wedelia incarnata*, *Wislizenia palmeri*, *W. refracta*, *Zinnia grandiflora*.

Melissodes (Melissodes) tessellata, sp. nov.

Melissodes communis gratior, Cockerell, 1923, Proc. California Acad. Sci., vol. 12, p. 85 (in part) (misidentification).

This species is recognizable in both sexes by the dense, regular tessellation dulling the ground areas of the mesoscutum, scutellum and mesepisterna. Although *tessellata* is not closely related to any other *Melissodes*, its nearest relative is *M. paroselae* Cockerell, which it resembles in the form of the seventh and eighth sterna of the male.

Female. Measurements and ratios: N, 20; length, 10-13 mm.; width, 4-5 mm.; wing length, $M = 4.01 \pm 0.236$ mm.; hooks in hamulus, $M = 14.40 \pm 0.184$; flagellar segment 1/segment 2, $M = 1.95 \pm 0.035$.

Structure and color: Integument black; legs usually rufescent, at least distitarsi rufescent; flagella below dark reddish-brown; apical areas of terga 2-4 usually somewhat translucent, dark reddish-brown, apical area of tergum 1 similar but often colorless at extreme margin; wing membranes clear to milky, veins dark brown to black. Clypeus with coarse punctures separated mostly by less than one puncture width, round, much smaller and more crowded near apical margin, without a well-marked carina or boss, ground areas dulled by fine regular tessellation; supraclypeal area impunctate or with a few large punctures laterally and one or two medially, ground dulled by dense shagreening; eyes in facial view slightly less than three times as long as broad, converging below; maxillary palpal segments in ratio of about 2:2:2:1, fourth segment often minute; galeae shiny, with scattered punctures. Mesoscutum with minute punctures separated by 2 to 4 puncture widths, ground area opaque, dulled by dense, regular tessellation; scutellum similar, but punctures separated by 1 to 2 puncture widths; lateral surfaces of mesepisterna with round punctures distinctly larger than those of mesoscutum, separated by 1 to 2 puncture widths, occasionally less, ground dulled by dense tessellation; metanotum with sculpturing of scutellum; dorsal and lateral faces of propodeum coarsely punctate, declivous face coarsely punctate except large inverted triangular area in upper half or more, ground coarsely and densely tessellate. First metasomal tergum with small round shallow punctures separated by 1 to 3 puncture widths in basal three fifths, apical area impunctate, ground areas opaque, dulled by dense shagreening; tergum 2 with interband zone impunctate or with minute widely spaced punctures, ground dulled by dense shagreening; apical areas of terga 2 and 3 as in tergum 1; basal area of tergum 3 as in interband zone of tergum 2.

Hair: White on head and thorax except vertex with abundant dark brown hairs, mesoscutum with large patch of dark brown hairs extending forward beyond a transverse line at anterior margins of tegulae and laterally separated from tegulae by one or two rows of white hairs, and scutellum with large median patch of dark brown hairs; tegulae with brown hairs medially. Metasomal tergum 1 with white hairs basally, apical area with brown hairs at least laterally; tergum 2 with white hairs basally, distal pale band about half as wide as apical area medially; tergum 3 with broad white pubescent band which thins markedly medially in worn specimens giving the appearance of two thin bands connected laterally and separated by a zone of erect brown bristlelike hairs, basally with dark brown tomentum; terga 2 and 3 with erect or suberect dark brown simple hairs in apical areas, unless worn; tergum 4 with broad apical band of white pubescence interrupted medially by rectangular or triangular patch of sparse dark brown simple hairs, with dark brown tomentum basally; terga 5 and 6 with dark brown to black appressed hairs and lateral tufts of long white hairs at least on tergum 5; sternal hairs brown to red medially, becoming white at extreme sides and yellow apically on each sternum. Legs with white hairs except as follows: outer surfaces of fore and middle tibiae near apices brown; basitibial plates and apices of hind femora brown; inner surfaces of tarsi and tibiae golden-yellow to rufescent; scopal hairs white.

Male. Measurements and ratios: N, 20; length, 10-13 mm.; width, 3.0-4.5 mm.; wing length, $M = 3.74 \pm 0.236$ mm.; hooks in hamulus, $M = 12.60 \pm 0.169$; flagellar segment 2/segment 1, $M = 10.05 \pm 0.204$.

Structure and color: Color as in female with the following differences: clypeus and mandibular bases yellow; labrum white; lower surface of flagellum, except first segment, yellow to red. eyes in facial view little more than twice as long as broad, strongly converging below; minimum length of first flagellar segment equals less than one tenth of maximum length of second segment, no longer than pedicle; maxillary palpi and galeae as in female; sculpturing as in female but clypeus less coarsely punctate.

Genitalia much as in *communis;* gonostyli with long simple hairs on lower halves; spatha not emarginate medially. Sternum 7 with median plates flattened and greatly expanded transversely (not oblique as in *communis*), with two sharp apical processes; apodemes short, thin, widely diverging. Sternum 8 with apical margin pointed medially; ventral longitudinal carina reaches apex or slightly beyond (Figs. 101-103).

Hair: Color and pattern of vestiture as in female with the following differences: vertex with few or no brown hairs; mesoscutal patch of dark hairs usually smaller than in female; tergum 3 with broad pale pubescent band which is usually not divided by wear into two thin bands as in female; tergum 4 similar to tergum 3, but pale band thinner; tergum 5 with apical pale band; sternal hairs white to red; legs with white hairs except golden-yellow to rufescent on inner surfaces of tarsi and tibiae.

Type material. Holotype and two male paratypes collected by Jean Russell at Idyllwild, California, August 3, 1935; allotype female and one female paratype from the San Jacinto Mountains, California, August 5, 1935, E. I. Beamer. One hundred and sixteen male and fifty-six female paratypes from southern California are as follows: Altadena: 1 female, C. D. Michener, June 26, 1935. Banning: 1 male, July 22, 1930, T. F. Winburn and R. H. Painter. Beaumont: 1 female on *Helianthus annuus,* October 8, 1933, P. H. Timberlake. Cajon Pass, San Bernardino Co.: 1 female on *Helianthus* sp., March 19, 1936, G. E. Bohart. Campo: 1 female, Jean Russell, 2 males, E. I. Beamer, 1 male, R. H. Beamer, August 10, 1935. Chula Vista: 1 male, September 4, 1935, F. T. Thorne. Claremont: 1 female and 1 male, July, the O. S. Estcott collection. Corona: 1 female, July, 1910. Devore: 1 female on *Hugelia virgata,* June 23, 1935, P. H. Timberlake. Dos Carin, San Diego Co.: 1 male on *Gutierrezia californica,* August 16. Dulzura: 1 male, August 9, 1935, E. I. Beamer. Encinitas: 1 female, August 1, 1917. Garvalia: 2 females on *Lotus scoparius,* June 21, 1938, P. H. Timberlake. Hemet, Riverside Co.: 1 female, July 21, 1928, P. H. Timberlake; 1 female, July 17, 1945; 1 male on *Medicago sativa,* July 22, 1946, 3 males, August 14, 1946, 3 males on *M. sativa,* August 17, 1946, 1 male, August 24, 1946, 1 female on *Helianthus* sp., August 24, 1946, J. W. MacSwain. Idyllwild: 1 male, July 1936, E. S. Ross. Jacumba: 1 male, August 12, 1917, W. M. Wheeler; 1 male, August 12, 1935, Jean Russell; 4 males and 1 female, August 12, 1935, E. I. Beamer; 1 male, July 17, 1940, R. H. Beamer; 1 male on *Cucurbita faetidissima,* August 5, 1947, R. C. Dickson. Los Angeles: 2 males, Coquillett. Mill Creek, San Bernardino Co.: 2 males, August 31, 1930, C. D. Michener. Mountain Springs, Imperial Co.: 3 males, July 25, 1933, L. W. Hepner; 1 female, April 21, 1950, J. W. MacSwain. Pinon Flat, San Jacinto Mts.: 1 female, June 18, 1941, E. C. Van Dyke. Poway, San Diego Co.: 1 female, July 31, 1935, 2 females, May 30, 1935, F. E. Blaisdale. Ribbonwood, San Jacinto Mts.: 1 female on *Malvastrum fasciculatum,* July 2, 1936, P. H. Timberlake. Riverside: 2 males, July 7, 1935, C. M. Dammer; 1 male, July 21, 1935, A. E. Pritchard. The following were collected at Riverside, California, by P. H. Timberlake: 1 female on *Brassica juncea,* June 14, 1926: 2 males on *Trichostema lanceolata,* September 15, September 22, 1926; 1 female on *Encelia farinosa,* May 12, 1927; 1 female on *Lotus scoparius,* June 14, 1927; 1 female on *Helianthus annuus,* June 28, 1927; 1 male on *Marrubium vulgare,* July 6, 1927; 2 females on *Gutierrezia sarothrae,* July 8, 1927; 1 male on *Senecio douglasii,* July 25, 1927; 1 male on *Croton cali-*

fornica August 3, 1927; 2 males on *L. scoparius,* August 4, 1927; 2 males on *G. sarothrae,* August 8, 1927; 1 male on *S. douglasii,* 1 male on *C. californica,* 1 male on *Eriogonum fasciculatum,* 1 male on *G. sarothrae,* August 30, 1927; 1 male on *Stephanomeria* sp., September 7, 1927; 1 male on *T. lanceolata,* September 9, 1927; 2 males on *Isocoma vernonioides,* September 18, 1927; 1 male on *Stephanomeria virgata,* September 26, 1927; 1 female, 1 male on *G. sarothrae,* November 3, 1927; 1 male on *G. sarothrae,* November 15, 1927; 1 female on *G. sarothrae,* November 18, 1927; 1 male on *Chrysanthemum segetum,* July 2, 1928; 1 female on *G. sarothrae,* July 10, 1928; 1 male on *C. segetum,* July 9, 1928; 1 male on *L. scoparius,* 1 female on *G. sarothrae,* July 5, 1928; 1 male on *Centaurea* sp., July 6, 1928; 1 male on *G. sarothrae,* July 26, 1928; 2 males on *G. sarothrae,* September 3 and 4, 1929; 1 female on *Medicago sativa,* July 21, 1930; 1 male on *Hemizonia paniculata,* July 23, 1930; 2 males on *M. sativa,* August 6, 1930; 1 male on *T. lanceolata,* 1 male on *E. fasciculatum,* August 8, 1930; 2 males on *G. sarothrae,* 1 male *S. douglasii,* August 11, 1930; 1 male on *G. californica,* 1 male on *Corethrogyne* sp., August 12, 1930; 3 females on *Opuntia pareyi,* May 16, 18 and 26, 1932; 1 female on *L. scoparius,* May 31, 1932; 1 female on *Godetia amoena,* June 13, 1932; 3 females on *Clarkia elegans,* June 16, 1932; 1 female on *G. sarothrae,* July 17, 1932; 1 male on *Corethrogyne filaginifolia,* August 16, 1932; 1 male on *H. paniculata,* August 26, 1932; 1 male on *T. lanceolata,* September 15, 1932; 1 female on *G. sarothrae,* October 28, 1932; 1 male on *G. californica,* August 18, 1933; 1 male on *G. sarothrae,* August 31, 1933; 1 male on *H. annuus,* September 9, 1933; 1 female on *Corethrogyne* sp., 1 female on *G. sarothrae,* September 14 and 15, 1933; 2 females on *Pluchea camphorata,* May 15, 1935; 1 female, July 2, 1935; 1 male, August 2, 1935; 2 males, August 6, 1935; 2 males on *G. californica,* August 29, 1935; 2 females, 3 males, on *P. camphorata,* September 1, 1935; 1 male on *G. californica,* September 3, 1935; 2 females, 2 males on *P. camphorata,* and 1 male on *Polygonum lapathifolium,* September 8, 1935; 1 male on *Lippia filiformis,* September 5, 1935; 6 males on *T. lanceolata,* September 20, 1935; 2 males, July 28, 1936; 2 males on *Baccharis glutinosa,* July 29, 1936; 2 males on *Corethrogyne* sp., August 12, 1936; 1 male on *G. californica,* September 12, 1936; 3 males, July 29, August 4 and 5, 1938. San Diego: 1 female, August 7, 1935, Jean Russell. San Felipe Valley, San Diego Co.: 1 female on *Asclepias* sp., July 7, 1940, C. D. Michener; 1 male, September 11, 1938; 2 males, July 6, 1935; F. W. Thorne. San Jacinto Mts.: 2 females, August 7, 1935, E. I. Beamer.

Valley of the Falls, Riverside Co.: 1 male on *Monardella villosa,* September 7, 1935, P. H. Timberlake. Westwood Hills, Los Angeles Co.: 1 female on *Helianthus* sp., March 19, 1936, G. E. Bohart. Whitewater, Riverside Co.: 1 female, July 9, 1950, E. G. Linsley; 1 male on *Gebbia juncea,* September 11, 1935, P. H. Timberlake. Yorba Linda, Orange Co.: 1 male on Anise, August 5, 1920, P. H. Timberlake. The holotype and allotype are in the Snow Entomological Museum at the University of Kansas. Paratypes are in the collections of the Snow Entomological Museum, the American Museum of Natural History, the U. S. National Museum, the California Academy of Science, the Academy of Natural Sciences of Philadelphia, the Museum of Comparative Zoology, Harvard University, the Citrus Experiment Station, Riverside, California, the University of Minnesota and in the author's collection.

Distribution. Southern California as far north as Santa Clara County, Baja California and western Mexico as far south as Cocula, Jalisco (Fig. 19). In addition to the type material listed above, 16 females and 17 males were examined from the localities listed below.

CALIFORNIA: Santa Clara Co.; "southern California." BAJA CALIFORNIA: Ángel de la Guardia Island (Pond Island Bay and Puerto Refugio); Catavinia (10 miles S.); Ensenada (12 miles N.); La Paz; San Marcus Island, Gulf of California; San Francisquito; Todos Santos. JALISCO: Cocula.

Remarks. The specimens from Ángel de la Guardia Island (7 males) and San Marcus Island (1 male) are part of the cotype series of *M. communis gratior* Cockerell.

Flower records. This species visits a large number of species of plants for pollen and nectar. These plants are listed above with the other data for the type specimens. Females have been collected more often on composites than on plants of other families. Whether this indicates some degree of oligolecty cannot be decided on the basis of the number of records available.

Subgenus ECPLECTICA Holmberg.

Ecplectica Holmberg, 1884, Actas Acad. Nac. Cienc. Córdoba, vol. 5, p. 123.
Melissodes Brèthes, 1909, Anal. Mus. Nac. Buenos Aires, vol. 19 (ser. 3, vol. 12), p. 220.

Type Species. *Ecplectica tintinnans* Holmberg, 1884 (monobasic).

Female. With structural and color characters of the subgenus

Melissodes with the following differences: clypeus always relatively flat; metasomal *terga always black, never broadly hyaline apically, almost always with slight, but distinct, violaceous reflections,* usually with apical areas relatively coarsely punctate and shiny or moderately so.

Characters of vestiture as in the subgenus *Melissodes* with the following differences: usually somewhat melanistic with abundant black or dark brown hairs on head and thorax; *mesoscutum with large posteromedian patch of dark hairs which usually extends forward to or beyond a transverse line at anterior margins of tegulae and often with anterolateral extensions in front of tegulae and fusing with dark hair patches of posterior pronotal lobes; tergum 2* with basal pubescent band never consisting of spatuloplumose hairs, *with distal pubescent band absent or reduced to thin, short, lateral* faciae; tergum 3 usually with short simple golden-yellow hairs fringing apical margin at least laterally.

Male. With characters of color, sculpture and vestiture of the subgenus *Melissodes* with the following differences: labrum always entirely pale in color; *metasomal terga black, never hyaline apically, usually exhibiting metallic, violaceous reflections;* hairs often melanistic with thoracic and tergal characters of female, but mesoscutum often somewhat paler; *minimum length of first flagellar segment equals about one tenth of maximum length of second segment or less* (occasionally slightly more, but never as much as one ninth of second segment in the species involved in this revision), antennae very long, reaching beyond second metasomal tergum in repose.

Gonocoxite with dorsal carina not developed into a blunt, mesally directed process; *gonostylus very short, usually no longer than one third of length of gonocoxite, twice as broad basally as near apex, narrowing rather abruptly near middle, never capitate, with only short hairs on outer surfaces and near base. Sternum 7 with median plate enlarged, flattened, transparent, not curled or folded ventrally, with several short hairs ventrally, but never highly pilose; lateral plate narrow, long, testaceous, without a distinct, laterally directed, apical process, but with apex abutting dorsal surface of median plate;* apodemes simple, acuminate, not capitate, broad basally. Sternum 8 much as in the subgenus *Melissodes,* but median longitudinal ventral carina short, relatively low and broad.

Remarks. In a personal communication dated October 7, 1954, Padre J. S. Moure informs me that *E. tintinnans* Holmberg is a synonym of *Melissodes nigroaenea* Smith (1854). A series of specimens of *M. nigroaenea* from Perú deposited in the U. S. National Museum were identified by Miss Grace A. Sandhouse as *Melissodes nigroaenea* subspecies *tintinnans* Holmberg, and it is evident from this that Sandhouse considered *tintinnans* as no more than a subspecies of *nigroaenea.* From the foregoing information the type species of *Ecplectica* most likely is *M. nigroaenea* Smith; however, since the author has not had the opportunity to study critically the South American species, the formal synonymy of these forms will not be presented in this work.

Cockerell stated in a paper published posthumously (Cockerell, 1949, p. 467) that the species described in that paper (*Melissodes atripicta*), ". . . may eventually be taken as the type of a new genus or subgenus."

Melissodes (Ecplectica) trifasciata Cresson.

Melissodes trifasciata Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 208; Cockerell, 1906, Trans. Amer. Ent. Soc., vol. 32, p. 87; Cresson, 1916, Mem. Amer. Ent. Soc., vol. 1, p. 133.

Melissodes insularis Crawford, 1914, Proc. U. S. Nat. Museum, vol. 47, p. 132 (new synonymy).

This is a distinct West Indian species which can be readily separated from *M. raphaelis* in both sexes by the complete or almost complete lack of the distal pale band of tergum 2 and by the less punctate basal area of tergum 1. In addition, both sexes are paler in habitus, have red or orange legs and have generally finer punctation, although still dense, on the apical areas of terga 2 and 3.

Female. Measurements and ratios: N, 20; length, 8.5-11.0 mm.; width, 3.5-4.5 mm.; wing length, $M = 3.42 \pm 0.216$ mm.; hooks in hamulus, $M = 11.65 \pm 0.167$; flagellar segment 1/segment 2, $M = 1.87 \pm 0.024$.

Structure and color: Integument black; legs dark red; hind basitarsi basally, hind tibiae distally and hind femora below often orange; sterna dark reddish-brown; tegulae testaceous to piceous; mandibles red medially; flagella red below, except first two segments and black above; eyes greenish-gray; wing membranes clear, veins black. Sculpturing of head and thorax as in *raphaelis* with the following differences: lateral flattened areas of vertex with small round deep punctures separated by one puncture width or less, ground spaces shiny, usually without shagreening, occasionally delicately so; propodeum with punctures of dorsal face larger, three times as wide as punctures of metanotum or more, medially impunctate and irregularly tessellate; maxillary palpal segments in ratio of about 2.5:2:1.5:1.5, fourth segment occasionally shorter. With sculptural characters of metasoma as in *raphaelis* with the following differences: tergum 1 with basal three fourths coarsely punctate, punctures small, medially separated by one to two puncture widths; tergum 2 with punctures of interband zone small, separated by 2 puncture widths or more medially and by 1 or 2 puncture widths laterally; apical areas of terga 2 and 3 with minute punctures, but about as wide as three times basal width of the extremely fragile appressed hairs arising from them, separated by 1 to 3 puncture widths or more.

Hair: Vestiture as in *raphaelis* with the following differences: on head mostly white except abundant black hairs on vertex and often a few interspersed with the pale on face as far down as clypeus; mesoscutum often with grayish-white hairs posteromedially in middle of patch of black hairs, occasionally anterolateral arms of black patch obsolete; on mesepisterna white, except black hairs on ventral surfaces, a few to many on anterior surfaces and a few to several in upper anterior angles; propodeal and metepisternal hairs white; tergum 2 with pale distal band completely absent or represented by two or three minute silvery-white appressed hairs laterally; tergum 3 without golden-yellow hairs fringing apical margin; tergum 4 with median patch of suberect black hairs broadly triangular in outline with the base of triangle on apical margin; tergum 5 without pale hairs laterally; legs often with white hairs on femora and at least anterior surfaces of tibiae, with red to yellow on inner surfaces of tibiae and basitarsi; scopal hairs ochraceous to orange.

Male. Measurements and ratios: N, 20; length, 7.5-10.0 mm.; width, 2.5-3.5 mm.; wing length, $M = 3.38 \pm 0.260$ mm.; hooks in hamulus, $M = 11.20 \pm 0.186$; flagellar segment 2/segment 1, $M = 10.44 \pm 0.142$.

Structure and color: Integument black; clypeus yellow; labrum cream-colored to white; bases of mandibles often without yellow spots, often translucent orange basally; legs red, at least tibiae and tarsi usually orange-red or orange; sterna dark brownish red; terga dark brownish-red to black apically, flagella, except first segment, yellow to red below, reddish-brown to black above. Sculpturing as in female with the following differences: clypeal punctation obscure; mesoscutum more often impunctate posteromedially; mesepisterna often with ground areas more densely shagreened; tergum 1 with basal five sixths punctate; terga 2 to 4 with apical impunctate margins at least as wide as that on tergum 1 and often somewhat wider; maxillary palpi as in female.

Hair: On head ochraceous in palest specimens, vertex usually with abundant dark brown hairs, face often with a few to several dark brown hairs mixed with the pale, especially near and on clypeus and extending from vertex to clypeus just mesad of compound eyes. Mesoscutal hairs ochraceous in palest specimens, usually with a large posteromedian square patch of dark reddish-brown hairs, dark hairs never reaching forward and laterally in front of tegulae; scutellum with abundant dark hairs medially; tegulae often with dark hairs; lateral surfaces of thorax and propodeum with ochraceous hairs. Metasoma with vestiture as in female with the following differences: tergum 2 rarely with short, extremely thin, lateral fasciae of pale pubescence medially (present in type of *insularis*); tergum 4 with a pale pubescent band similar to that of tergum 3 but narrower. Legs with ochraceous to orange hairs except as follows: basitibial plates and usually outer surfaces of hind tibiae dark brown; occasionally outer surfaces of middle tibiae brown; inner surfaces of tarsi yellow to orange.

Gonostylus with basal half or somewhat less broad in lateral view. Sternum 7 with apical margin of median plate with a rather sharp median angle and well rounded laterally; membraneous area between median and lateral plates about as long as median plate. Sternum 8 with apical margin emarginate; lateral apodemes truncate, with anterior margin concave or sinuate (Figs. 104-106).

Type material. Holotype female of *trifasciata* from Porto Rico in the Academy of Natural Sciences of Philadelphia. Holotype male of *insularis* from Dominica, June-July, 1913, H. V. Foote, in the U. S. National Museum (U. S. N. M. Type No. 16732).

Distribution. The Lesser Antilles from Dominica in the south, north and west to Mona Island in the Greater Antilles. This species has been collected in all months of the year except September and November. In addition to the type material, 30 females and 172 males have been examined from the localities listed below (including localities reported in the literature).

DOMINICA: "Dominica." MONA ISLAND: "Mona Is." PUERTO RICO: Adjuntas; Aguirre; Aibonito; Añasco; Arecibo; Barceloneta; Barros; Bayamón; Caguas; Coamo Springs; Corozal; Crocouis; Fajardo; Isabela; Manatí; Naguabo; Parquera; Río Piedras; Utuado. VIRGIN ISLANDS: St. Croix; St. Thomas; "Virgin Is."

Flower records. M. trifasciata has been collected on flowers of the following plants: *Crotolaria* sp., Roble, Sweet Potato.

Melissodes (Ecplectica) raphaelis Cockerell

Melissodes raphaelis Cockerell, 1898, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 292; 1899, Catálogo de las Abejas de Mexico, p. 13; 1912, Ann. Mag. Nat. Hist., ser. 8, vol. 10, p. 28.
Melissodes atripicta Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 467 (new synonymy).

This species can be distinguished from *M. trifasciata* by having the distal pale band of tergum 2 present, although reduced to short, thin, lateral fasciae in both sexes. The males have the median plates of sternum 7 larger than in *trifasciata*. Both sexes have the apical areas of the terga more coarsely punctate than in *trifasciata* and the females of *raphaelis* have a diamond-shaped median patch of black hairs on tergum 4, and usually has tergum 3 fringed with golden-yellow hairs apically at least laterally.

Female. Measurements and ratios: N, 3; length, 11 mm.; width, 4.5 mm.; wing length, $M = 3.67 \pm 0.038$ mm.; hooks in hamulus, $M = 11.67 \pm 0.333$; flagellar segment 1/segment 2, $M = 1.81 \pm 0.467$.

Structure and color: Black, distitarsi dark reddish-brown; mandibles rufescent apically; flagella usually slightly paler below; tegulae dark brown to black; wing membranes somewhat infumate, brownish, veins dark brown to black; eyes dark greenish-brown to black. Clypeus with abundant, shallow punctures separated mostly by half of one puncture width, ground dulled by dense, fine tessellation; supraclypeal area with scattered round punctures, ground dulled by coarse tessellation; lateral flattened areas of vertex with abundant small round punctures separated by one puncture width or less, ground dulled by dense, irregular shagreening or tessellation; elsewhere face coarsely punctate and moderately shiny; maxillary palpal segments in ratio of about 2.5:2:1.5:1. Mesoscutum with abundant round punctures separated by half of one puncture width or less anteriorly and laterally, and by 1 to 3 puncture widths posteromedially, ground smooth and shiny; scutellar sculpturing similar to that of anterior part of mesoscutum, but punctures sparser medially and irregular in size; mesepisternal punctures about same size as those of mesoscutum, crowded, separated mostly by half of one puncture width or less, ground somewhat dulled by delicate, irregular shagreening; metanotum with punctures of same diameter as those of mesoscutum, separated mostly by half of one puncture width, ground dulled by coarse shagreening, except medially on dorsal surface; propodeum with dorsal face coarsely punctate, punctures twice as wide as those of metanotum, ground often dulled by fine tessellation, except medially; declivous face coarsely punctate and tessellate except impunctate, shiny, inverted triangle, lateral faces coarsely punctate and tessellate. Metasomal tergum 1 with coarse punctures separated mostly by less than one puncture width in basal half, ground areas and surface of apical area dulled by extremely fine, transverse shagreening, shiny to moderately so; tergum 2 with interband zone (or raised lateral areas if distal pubescent band is absent) with coarse punctures separated by 2 or more puncture widths medially and mostly by 1 puncture width or less laterally, apical area with coarse punctures separated by less than one to three puncture widths, about as wide as three times width of appressed dark brown hairs arising from them, ground area shiny or moderately so, with fine transverse shagreening; tergum 3 similar to tergum 2 but basal area somewhat more punctate; tergum 4 similar but surface beneath apical pubescent band more densely punctate than apical areas of terga 2 and 3; sterna coarsely punctate except narrow impunctate apical margins, ground dulled by fine tessellation.

Hair: On head white with abundant black hairs on vertex and extending somewhat onto face medially and laterally as far as the clypeus, mixed black and white on clypeus in ratio of about 1:8 and labrum with all black hairs. Mesoscutum with black posteromedian hair patch extending forward beyond a transverse line at anterior margins of tegulae and extending laterally near anterior end in front of tegulae to fuse with posterior pronotal patch of black hairs, this leaves a narrow semicircular strip of white hairs along anterior margins of and a narrow strip of white hairs mesad to tegulae and along mesoscuto-scutellar suture; scutellum with hairs mostly black, a few white hairs at extreme posterior margin; propodeum with white hairs dorsally and posteriorly, with black hairs laterally except a small tuft of white hairs anterior to propodeal spiracles; mesepisternal hairs black ventrally, anteriorly, on lateral surfaces above and below and mixed black and white or all white medially on lateral surfaces; metepisternal hairs white or white and black mixed. Metasomal tergum 1 with long white hairs in basal half or less, with short appressed black hairs apically; tergum 2 with complete basal band of grayish-white pubescence, with thin, short, lateral fasciae of white pubescence medially, lateral fasciae not fused with basal pale band laterally and in length each equals less than one third of width of tergum, interband zone and apical area with appressed or subappressed, simple, black hairs; tergum 3 with median band of grayish-white or yellowish-white pubescence which is about as broad as apical area medially, but sparse and diffuse anteriorly so that the narrow, distal, dense portion appears almost as a distinct band, apical margin fringed with at least several simple golden-yellow hairs laterally and these may extend almost across tergum, elsewhere as in tergum 2; tergum 4 with broad apical band of yellowish-white hairs interrupted medially by a broadly diamond-shaped patch of simple suberect black hairs; terga 5 and 6 with long black appressed hairs and a few ochraceous pale hairs laterally; sternal hairs dark brown, pale laterally near apex of each sternum. Legs with dark brown to black hairs except as follows: inner surfaces of tarsi dark red to reddish-brown, scopal hairs, except those immediately below basitibial plates, and hairs of upper surfaces of femora ochraceous.

Male. Measurements and ratios: N, 6; length, 8.5-10.0 mm.; width, 2.5-3.5 mm.; wing length, $M = 3.19 \pm 0.566$ mm.; hooks in hamulus, $M = 11.00 \pm 0.365$; flagellar segment 2/segment 1, $M = 11.44 \pm 0.465$.

Structure and color: Integument black; distitarsi and sterna often dark red; clypeus and triangular spots at bases of mandibles yellow; labrum white; flagella red below, dark reddish-brown above; wing membranes clear, veins dark brown to black; eyes grayish-green to dark gray. Sculpturing as in female with the following differences: clypeal punctation obscure; mesoscutum often with small posteromedian impunctate area, ground spaces shiny, but often with delicate, sparse shagreening; mesepisterna usually duller, ground spaces more distinctly shagreened and punctures slightly more widely spaced; tergum 1 coarsely punctate except apical fifth or less; terga 2-4 with narrow apical impunctate zones equal to that on tergum 1 or somewhat broader; maxillary palpi as in female. Minimum length of first flagellar segment equals less than one tenth of maximum length of second segment.

Gonostylus with basal three fifths broad in lateral view. Sternum 7 with apical margin of median plate with three blunt angles; membraneous area between median and lateral plates short, equal to less than length of median plate. Sternum 8 with apical margin sharply truncate, straight or evenly and gently concave, with long plumose hairs apically; lateral apodemes with anterior margins evenly rounded and each with a short posterior, pointed process (Figs. 108-110).

Hair: On head usually yellowish to grayish-white, often with abundant black hairs on vertex, face and clypeus. Mesoscutum with whitish hairs and a posteromedian patch of black hairs; scutellar hairs black except posterior fringe of white hairs; lateral surfaces of thorax and propodeum with grayish-white hairs, often with black hairs on upper part of mesepisternum; occasionally with thoracic hairs essentially as dark as in female and with the same pattern. Metasomal vestiture as in female with the following differences: tergum 5 with a complete apical pale pubescent band; tergum 4 with a pale band similar to that of tergum 3; terga 3 and 4 without golden-yellow hairs fringing apical margins; terga 6 and 7 with black hairs; sternal hairs mostly dark brown, whitish laterally. Legs with grayish-white hairs except as follows: inner surfaces of tarsi red, outer surfaces of hind tibiae at least posteriorly and usually outer surfaces of fore and middle tibiae dark brown.

Type material. Holotype male of *raphaelis* from San Raphael, Veracruz, Mexico, on *Ipomoea* sp., C. H. T. Townsend (U. S. N. M. Type No. 3355), and the holotype female of *atripicta* from Zamorano, Honduras, A. Pelén (U. S. N. M. Type No. 58553) are in the U. S. National Museum.

Distribution. Southeastern Mexico, Guatemala and Honduras. This species is known from so few examples that it seems more useful to indicate the full collecting data here. The data for the type material are not repeated, but information from the literature is included.

MEXICO: San Raphael, Veracruz, 2 females, March 22 and 23, 1 male, March 8, C. H. T. Townsend; Motzorongo, Veracruz, 1 male, February 11, 1892, H. Osborn; Lower part of the Río Nautla, Veracruz (Cockerell, 1899). GUATEMALA: Quirigua, 4 males, on *Ipomoea sidaefolia,* W. P. Cockerell.

Tachymelissodes, subgenus nov.

Type species. *Melissodes dagosa* Cockerell, 1909.

This subgenus consists of three species from southwestern United States and northern Mexico. The species are all small and are distinctive because of the apical pubescent bands of the terga and the short male antennae.

Female. Small to medium-sized bees; integument generally black, terga often transparent or translucent beneath apical pubescent bands, without violaceous reflections; wings clear, hyaline or milky, veins dark brown to black. Clypeus flat, not strongly protruding from face, not forming an abrupt step from supraclypeal plane to a flat clypeal plane, half as long as wide or slightly less; *eyes* less than half as wide as long and more than one third as wide as long in facial view, strongly converging towards mandibles, *as wide as genal areas in profile or slightly narrower;* minimum length of second flagellar segment distinctly shorter than width near apex and less than third segment; *galeae sparsely punctate above, without shagreening except at tips*; maxillary palpi 4-segmented, fourth segment always minute. Integument of head, thorax and metasomal terga generally punctate, ground areas smooth and shiny or moderately so, shagreening sparse and fine, except occasionally on terga; *terga not conspicuously punctate beneath apical pubescent bands; tegulae evenly rounded laterally in posterior two thirds, with lateral margin concave or straight in anterior third or slightly more* (Figs. 36, 37) *narrowed anteriorly;* metanotum about equal to dorsal face of propodeum in length medially; propodeum with dorsal face irregularly rugose and tessellate, not distinctly punctate apically.

Hairs generally silvery-white, often with brown to black hairs on mesoscutum, scutellum, mesepisterna and legs. Metasomal tergum 1 with long plumose hairs in basal half, with minute, scattered, brown hairs in basal half of apical area, apical fourth bare; *terga 2, 3 and 4 with apical bands of long silvery-white pubescence approximately equal in width to each other and of about equal width across each tergum, although often narrowed medially on tergum 2; tergum 2 with a short, indistinct, basal band of sparse, weakly plumose pubescence which is separated from apical pale band by at least the width of the latter*; terga 5 and 6 with long black appressed hairs, often with lateral tufts of white hairs on tergum 5. Scopal hairs white, weakly plumose, scarcely hiding outer surfaces of basitarsi and tibiae; inner surfaces of hind basitarsi with red to black hairs.

Male. Clypeus yellow; *labrum at least with apical margin dark brown to black, often entirely dark*; bases of mandibles with or without yellow spots; *metasomal terga with apical margins translucent yellow to transparent and colorless*, never piceous. Structural characters as in female with the following differences and additions: *minimum length of first flagellar segment equals at least half of maximum length of second segment and usually more; antennae extremely short, scarcely, if at all, reaching base of first metasomal tergum in repose; seventh tergum, as well as sixth, with lateral, apical spines*; pygidial plate notched on each side near apex.

Gonostylus simple, turned inwards near apex, with few short hairs on outer surface near base; penis valve short, lateral process short; *dorsal carina of gonocoxite not produced into a blunt process. Sternum 7 with median plate flat, expanded apically and laterally near apex, apical margin relatively straight, not rounded, somewhat oblique, ventral surface with abundant, extremely short, weak hairs,* apex well separated from apex of lateral plate; with *lateral plate piceous at least apically, with a short apicolateral process. Sternum 8 short, almost as broad as long, truncate, with apical margin simply transverse or with a small acuminate protuberance medially,* evenly rounded or slightly concave apicolaterally, with several weak hairs apically; lateral apodemes large, truncate; ventral longitudinal carina obsolete or weakly developed as a rather sharp, short, median protuberance well separated from apex of sternum (Figs. 118-121).

Vestiture as in female with the following additions: tergum 5 with an apical pubescent band similar to those on terga 2 to 4; terga 6 and 7 with long, appressed, white to golden-yellow hairs, never brown; hairs and pubesence generally golden-yellow rather than white in newly emerged specimens, becoming white with age.

Heliomelissodes, subgenus nov.

Type species. Melissodes desponsa Smith, 1854.

This subgenus consists of two, and possibly three, species, one of which is polytypic. The subgenus is widespread throughout the United States and southern Canada and includes two of the most common North American species of *Melissodes.*

Female. Integument generally black; terga piceous, not translucent or hyaline apically, without violaceous reflections; wing membranes often infumate, veins dark brown to black. *Clypeus in profile protruding beyond face by half of width of eye or more, with crowded, small, irregular punctures; eyes* in facial view almost three times as long as wide, converging slightly towards mandibles, *usually slightly narrower in profile than genal areas; galeae more than twice as long as clypeus, shiny or dulled by dense shagreening at least in apical third*; maxillary palpi 4-segmented, fourth segment minute; minimum length of second flagellar segment as long as width near apex and as long as or longer than third segment. Thorax coarsely punctate, ground areas often densely shagreened; metanotum usually slightly, but distinctly, shorter than dorsal face of propodeum medially; propodeum with dorsal face irregularly rugose and densely tessellate, not distinctly punctate apically; tegulae with lateral margins concave anteriorly (Fig. 33).

Vestiture various but thorax and tergum 2 never with spatulo-plumose hairs; terga never with apical pubescent bands (except tergum 4); scopal hairs with few branches and a strongly developed rachis, ochraceous to yellow; inner surfaces of hind basitarsi with dark reddish-brown to black hairs.

Male. Labrum black; mandibles without basal yellow spots; clypeus often partially black posteriorly; terga without violaceous reflections, never translucent or transparent apically; wing membranes often infumate, veins dark brown to black. With structural characters of female with the following additions: *minimum length of first flagellar segment equal to one third of maximum length of second segment or slightly more; antennae moderately long, reaching first metasomal tergum in repose but not to apical margin;* tergum 7, as well as 6, with lateral spines near apex.

Gonostylus simple, not turned in near apex, not capitate, not conspicuously broader near base than near middle, basal half to two thirds broader than distal portion, with abundant short hairs on outer and ventral surfaces; penis valve rather long and thin; dorsal carina of gonocoxite not produced into a blunt process. *Sternum 7 with lateral plate piceous, with a distinct, pointed, apical process directed somewhat laterally, long and narrow, twice as long as wide or longer; median plate large, three times area of lateral plate or more, with abundant short hairs covering ventral surface.* Sternum 8 much longer than wide, irregularly acuminate in apical fourth or third, emarginate apically, with abundant simple hairs apically; ventral carina short, near apex bidentate or bilobed and transverse; lateral apodemes short, bidentate apically (Figs. 114-117).

Vestiture as in female with the following addition: terga 6 and 7 often with black or dark brown hairs.

Psilomelissodes, subgenus nov.

Type species. Melissodes intorta Cresson, 1872.

This subgenus includes only one relatively rare species from the southern part of the Great Plains of the United States. Its distinctive features were recognized by C. D. Michener who drew up a brief manuscript description placing *M. intorta* in a new genus, but did not publish it because the female was then unknown to him.

Female. Integument black; terga with apical areas usually translucent or transparent; eyes grayish-blue to black; wing membranes not infumate, clear, yellowish, veins dark brown to black; tegulae piceous. Clypeus relatively flat, arising gradually from plane of supraclypeal area, slightly less than half as long as wide in facial view; *eyes* more than one third as long and less than one half as wide as long in facial view, strongly converging towards mandibles, *distinctly wider than genal areas in profile;* minimum length of second flagellar segment equal to width or longer, distinctly longer than third segment; galeae sparsely punctate above, smooth and shiny except tips, with short straight hairs; maxillary palpi 4-segmented, segment 4 minute, segment 2 longest. Integument of head and thorax coarsely punctate, shiny or moderately so, ground areas with no or delicate shagreening; *tegulae with lateral margins straight or concave in anterior half or third,* not evenly convex laterally but narrowing anteriorly. Metasomal terga extremely weakly and sparsely punctate, ground areas completely dulled by fine, dense, regular, transverse shagreening; metanotum slightly longer than dorsal face of propodeum medially; propodeum with dorsal face irregularly rugose, becoming densely tessellate apically.

Vestiture weak and sparse; pale hairs and pubescence white; thorax without spatuloplumose hairs; metasomal tergum 1 with moderately long hairs in basal third or more and along extreme sides of dorsal surface; *tergum 2 with basal pale band of plumose pubescence, with extremely narrow lateral fasciae of short white pubescence medially which almost, but not quite, meet medially, apical area bare or with extremely sparse, plumose, minute hairs laterally; tergum 3 similar to tergum 2,* but with more abundant hairs basally and with brown tomentum at extreme base; *tergum 4 with apical band of short, relatively sparse, white pubescence,* basally with more sparse white pubescence similar to that of apical band, with brown tomentum at extreme base and with erect brown bristlelike hairs in basal area; *terga 5 and 6 with dark brown hairs; scopal hairs weak, not at all hiding surfaces of basitarsi and tibiae, usually with two, occasionally three and often only one, long, weak branch on each side of the long weak rachis.*

Male. With characters of color and structure as in female with the following additions: *Clypeus, labrum and bases of mandibles black; antennae short, femalelike, not reaching beyond propodeum in repose; minimum length of first flagellar segment equals maximum length of second segment or slightly more;* seventh tergum with lateral spines similar to those of fifth and sixth sterna; pygidial plate with notches laterally near apex; sternum 6 deeply grooved medially, shiny.

Gonocoxite with dorsal carina not produced into a blunt process; *gonostylus large, thick, less than three times as long as greatest width in dorsal view,* narrowest near middle, with several minute hairs basally on ventral surface, and with several minute hairs along midline in basal half or two thirds of dorsal surface; penis valve large, lateral process long and hooked. *Sternum 7 with median plate flat, transparent, transversely oval in outline, with minute hairs ventrally, with broad, long neck about as large as the plate itself; lateral plate about as large as median plate, piceous apically, with minute hooked process at apex near median plate;* lateral apodemes broad, truncate. *Sternum 8 not emarginate apically, apex with short weak hairs;* lateral apodemes truncate or obscurely bidentate, curved anteriorly (Figs. 122-125).

Vestiture as in female with the following additions: terga 4 and 5 with pubescence as in tergum 3 of female; terga 6 and 7 with brown hairs.

Apomelissodes, subgenus nov.

Type species. Melissodes fimbriata Cresson, 1878.

This subgenus includes two species. The subgenus extends over the southeastern United States as far west as Texas and as far north as Kansas and Virginia.

Female. Integument black; terga piceous, not translucent or transparent apically; without violaceous reflections; wing membranes clear, yellowish, veins dark brown to black; eyes yellowish-gray to grayish-green; tegulae piceous. *Clypeus protuberant, extending beyond face by much more than half of width of eye in profile and often by as much as width of eye,* arising gradaully from plane of supraclypeal area, about half as long as wide; *eyes narrow,* about three times as long as wide in facial view, *distinctly wider than genal area in profile;* second flagellar segment usually shorter than or about as long as wide, occasionally longer; *galeae smooth and shiny or very weakly shagreened, with sparse punctures bearing weak straight hairs, or with more abundant punctures bearing hooked hairs at least laterally, more than twice and often almost three times as long as median length of clypeus; maxillary palpi 3-segmented with the third segment minute, or 4-segmented with fourth segment minute and second and third segments long. Head and thorax* coarsely punctate, ground areas generally smooth and shiny; *tegulae with lateral margins concave anteriorly;* metanotum as long as dorsal face of propodeum medially or longer; propodeum with dorsal face coarsely and irregularly rugose basally, often punctate apically but punctures obscured by coarse, irregular tessellation. Metasomal terga weakly punctate, ground areas dulled by dense, fine, regular, transverse shagreening.

Thorax and metasomal tergum 2 without spatuloplumose hairs; tergum 1 with long weak hairs in basal half or slightly more; *tergum 2 with narrow white basal pubescent band* which is often hidden completely beneath apical margin of tergum 1, *with narrow apical band of about same width across tergum or somewhat narrower medially; terga 3 and 4 with apical bands similar to that of tergum 2,* with dark brown tomentum at extreme bases; *scopal hairs simple, without branches, or weakly plumose, with only 2 to 4 weak branches on either side of a strong rachis, white to yellow.*

Male. With characters of color and structure of female with the following additions: *clypeus wholly yellow to wholly black; labrum and bases of mandibles black; antennae long, reaching apex of first metasomal tergum or beyond in repose; minimum length of first flagellar segment equals one fifth or less of maximum length of second segment;* terga 6 and 7 with lateral spines, but these weakly developed on tergum 5; pygidial plate with distinct lateral notches near apex, narrowing basally, longer than greatest width, often lateral notches extremely deep and pygidial plate thus divided into two portions which are on different levels, the longer basal portion being on a level above the short apical portion.

Gonocoxite with dorsal carina simple, not produced into a blunt process; *gonostylus long, half as long as gonocoxite or longer in dorsal view, thick, not capitate, narrowing slightly in apical third, with sparse, minute, weak hairs near base and on outer surface; penis valve notably narrow, ratio of greatest width of valve to greatest width of gonostylus about 4:3 or 5:4 never twice as wide as gonostylus, lateral process extremely short, blunt or obsolete. Sternum 7 with median plate greatly expanded, with or without a distinct neck region, with abundant weak hairs ventrally, median emargination of sternum usually reduced, lateral flange which joins median plate to the dorsum of lateral plate large, becoming practically dorsal in position due to the reduction of the lateral plate; lateral plate small, with a scarcely recognizable blunt apicolateral process or none, round to oval in outline, testaceous to piceous, equal to less than half of median plate in area; median membranous* *area between median and lateral plates extremely large, triangular in outline, much larger than lateral plate in size;* apodemes simple, broad basally. Sternum 8 acuminate or rounded apically, with a weak ventral longitudinal carina; apex bare or with short weak hairs; lateral apodemes truncate or bidentate apically, set near base of sternum (Figs. 111-113).

Eumelissodes, subgenus nov.

Type species. Melissodes agilis Cresson, 1878.

This is the largest of the North American subgenera. It comprises approximately eighty species, many of which are polytopic. It is distributed from southern Canada, throughout the United States, south into the West Indies and Panamá.

Female. Small to large bees; integument generally black, often with rufescent legs, sterna and/or tegulae; terga with apical areas often translucent or transparent, usually black. *Clypeus flat to gently protuberant, never protruding beyond face by as much as half width of eye in profile;* eyes various, usually strongly converging towards mandibles, usually as wide as or wider than genal areas in profile, but occasionally much narrower; minimum length of first flagellar segment variable; *galeae smooth and shiny or variously sculptured,* usually with short straight hairs but rarely with hooked hairs, *less than twice and usually less than one and one half times as long as median clypeal length;* maxillary palpi 4-segmented, fourth shortest, second and third usually longest. Integument of head, thorax and terga variously sculptured; *tegulae with outer margins gently concave anteriorly* (Fig. 38); *metanotum usually shorter than dorsal face of propodeum medially, rarely longer; propodeum with dorsal face irregularly rugose, densely tessellate, rarely punctate apically and then usually punctures small and obscured by tessellation.*

Vestiture highly variable; thorax and tergum 2 without spatuloplumose hairs; terga 2 to 4 never with apical pubescent bands which are subequal to each other in width and of about the same width across each tergum; scopal hairs usually highly plumose, occasionally weakly so, never simple and unbranched.

Male. With characters of color and structure of female with the following additions: clypeus usually all pale, yellow to white, occasionally partially or wholly black; labrum all black to all white; mandibles with or without yellow basal spots; terga with apical margins often hyaline and transparent or translucent; *minimum* *length of first flagellar segment always shorter than half of maximum length of second segment and usually less than one third of second segment;* tergum 7 always with short lateral spines similar to those of tergum 6, tergum 5 often with lateral spines; pygidial plate almost always notched laterally near apex, unless worn laterally.

Gonocoxite with dorsal carina not produced into a blunt process; *gonostylus various, usually somewhat capitate, half as long as gonocoxite or longer in dorsal view, slender, usually less than half as wide as greatest width of penis valve, usually with conspicuous short hairs near base and on outer surface;* penis valve large, lateral process usually well developed. *Sternum 7 with median plate large, flat, transparent, with abundant hairs ventrally; lateral plate usually piceous at least apically, with distinct apical or apicolateral process, usually much larger than one third and often more than one half of median plate in area;* apodemes variously shaped; membranous area between median and lateral plates not usually exceptionally large. Sternum 8 usually emarginate medially at apex, rounded laterally on either side of emargination, gently acuminate in apical half to one third, not sharply truncate, usually with abundant apical hairs; ventral carina usually weakly developed, short, usually apical, often bidentate or bilobed and transverse apically; lateral apodemes variously formed (Figs. 126-129).

Vestiture as in female with the following additions: tergum 5 with pubescent band usually similar to that of tergum 4; terga 6 and 7 usually with pale hairs, occasionally brown or black.

SPECIES ERRONEOUSLY REFERRED TO MELISSODES

In the course of preparing this paper, the author found 13 species described as belonging to the genus *Melissodes* (and considered as in that genus up to the present) but which obviously should be included in other genera. A list of these species, together with an indication of the correct taxonomic position of each, follows. A few species originally described as in the genus *Melissodes* were found to represent undescribed genera or to involve genera whose limits are undefined at present. These species will be dealt with in the future after additional study has clarified the status of the genera involved.

1. *Melissodes spissa* Cresson, 1872, Trans. Amer. Ent. Soc., vol. 4, p. 280, female [= *Xenoglossodes spissa* (Cresson), new combination].

2. *Melissodes suavis* Cresson, 1878, Proc. Acad. Nat. Sci. Philadelphia, vol. 30, p. 210, female [= *Tetralonia suavis* (Cresson), new combination].

3. *Melissodes pernigra* Cockerell, 1896, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 289, male [= *Peponapis pernigra* (Cockerell), new combination].

4. *Melissodes pimella* Cockerell, 1906, Ann. Mag. Nat. Hist., ser. 7, vol. 17, p. 363, male [= *Xenoglossodes pimella* (Cockerell), new combination].

5. *Melissodes bishoppi* Cockerell, 1914, Canad. Ent., vol. 46, p. 414, male [= *Xenoglossodes bishoppi* (Cockerell), new combination].

6. *Melissodes atramentata* Cockerell, 1918, Trans. Amer. Ent. Soc., vol. 44, p. 30, female [= *Thygater atramentata* (Cockerell), new combination].

7. *Melissodes agilis* var. *parksi* Cockerell, 1935, Amer. Mus. Novitates, No. 766, p. 5, male [= *Xenoglossodes parksi* (Cockerell), new combination].

8. *Melissodes albomarginalis* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 466, male [= *Xenoglossodes albomarginalis* (Cockerell), new combination].

9. *Melissodes crassidentata* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 466, male [= *Peponapis crassidentata* (Cockerell), new combination].

10. *Melissodes flavifasciatus* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 464, male [= *Xenoglossodes flavifasciatus* (Cockerell), new combination].

11. *Melissodes galerensis* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 465, male [= *Xenoglossodes galerensis* (Cockerell), new combination].

12. *Melissodes spilognathus* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 468, female [= *Diadasia spilognathus* (Cockerell), new combination].

13. *Melissodes tenuicincta* Cockerell, 1949, Proc. U. S. Nat. Museum, vol. 98, p. 464, female [= *Diadasia tenuicincta* (Cockerell), new combination].

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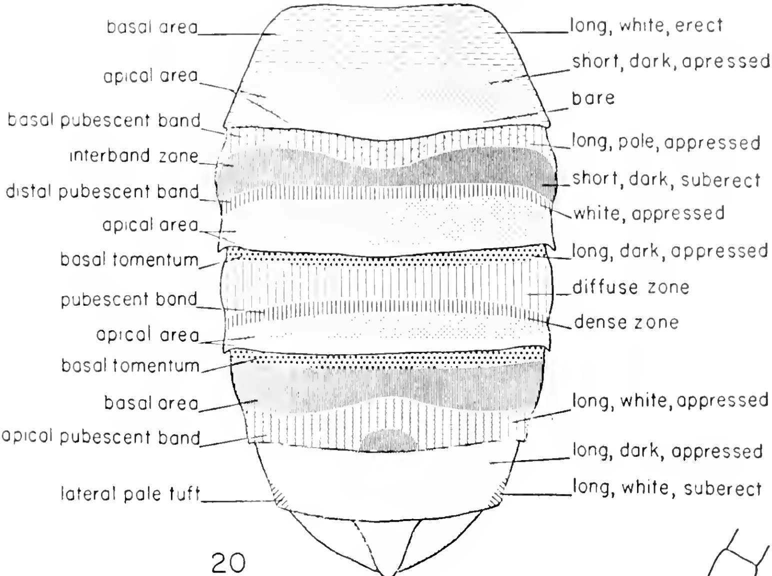

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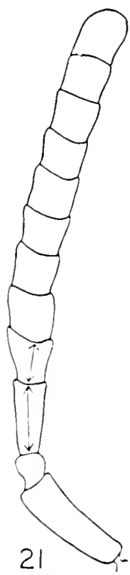

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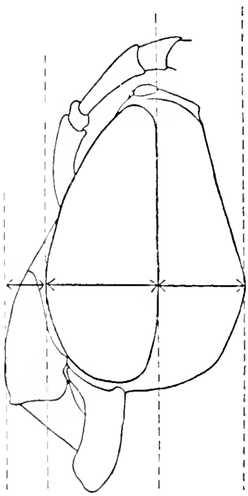

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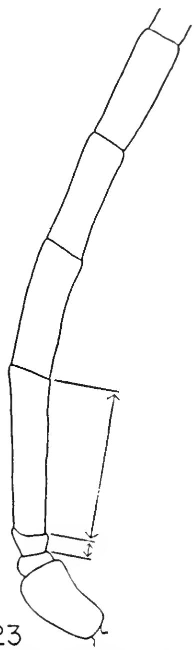

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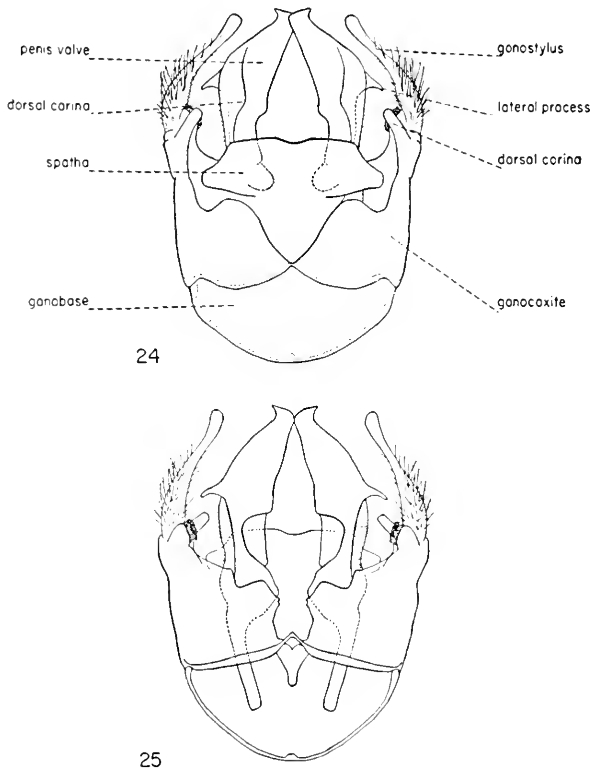

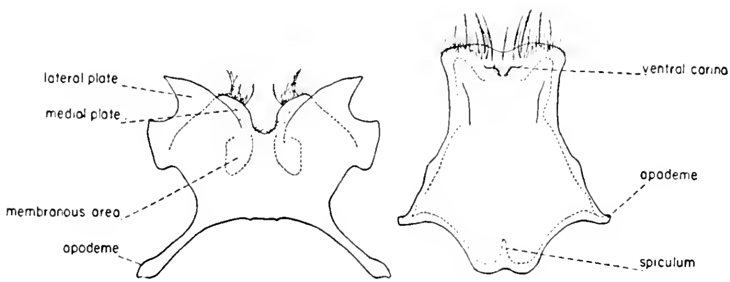

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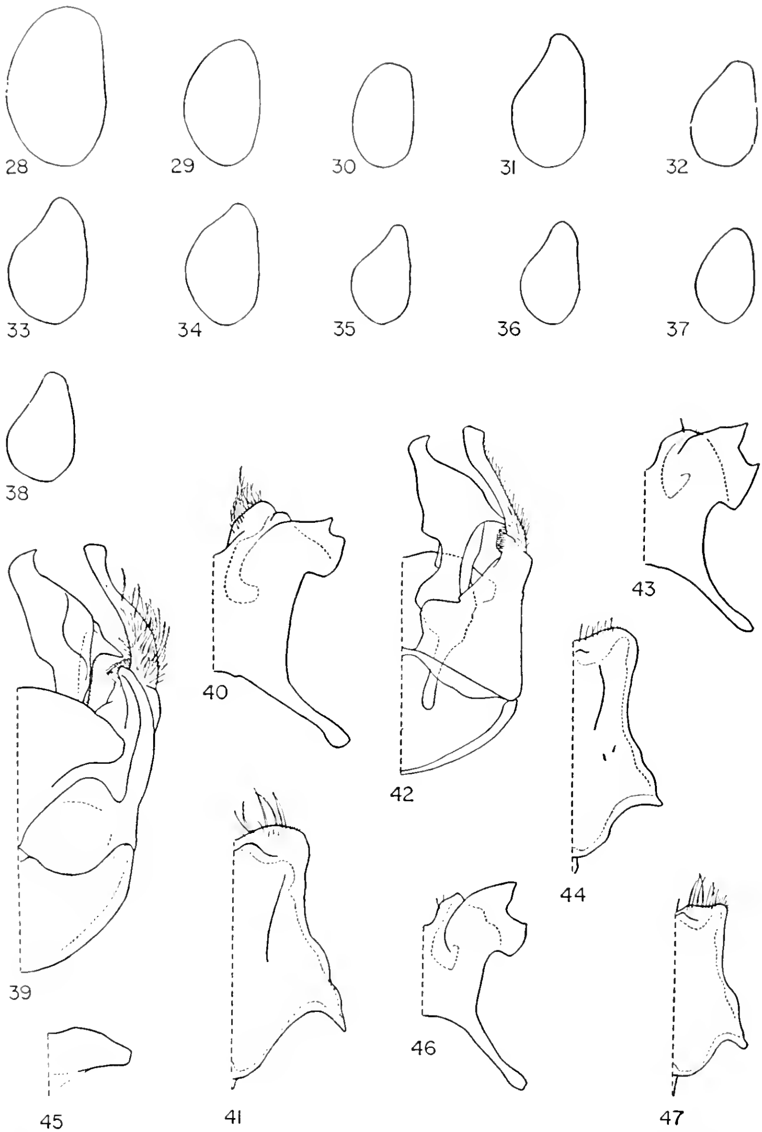

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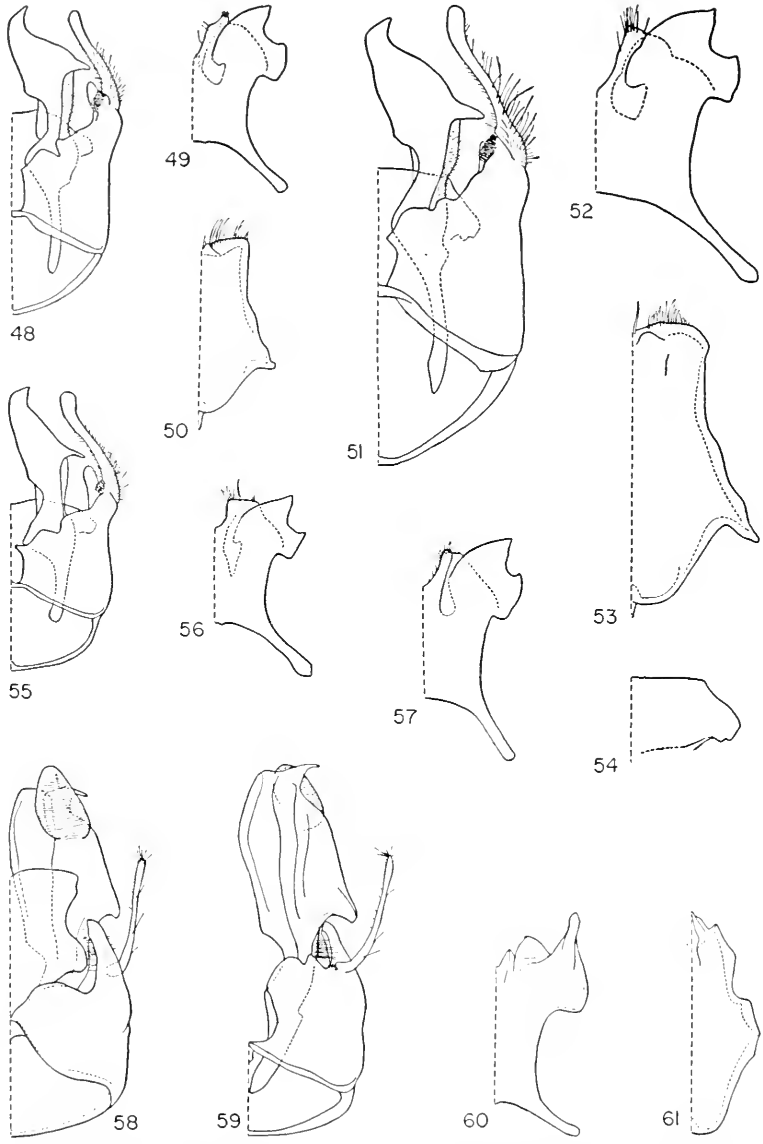

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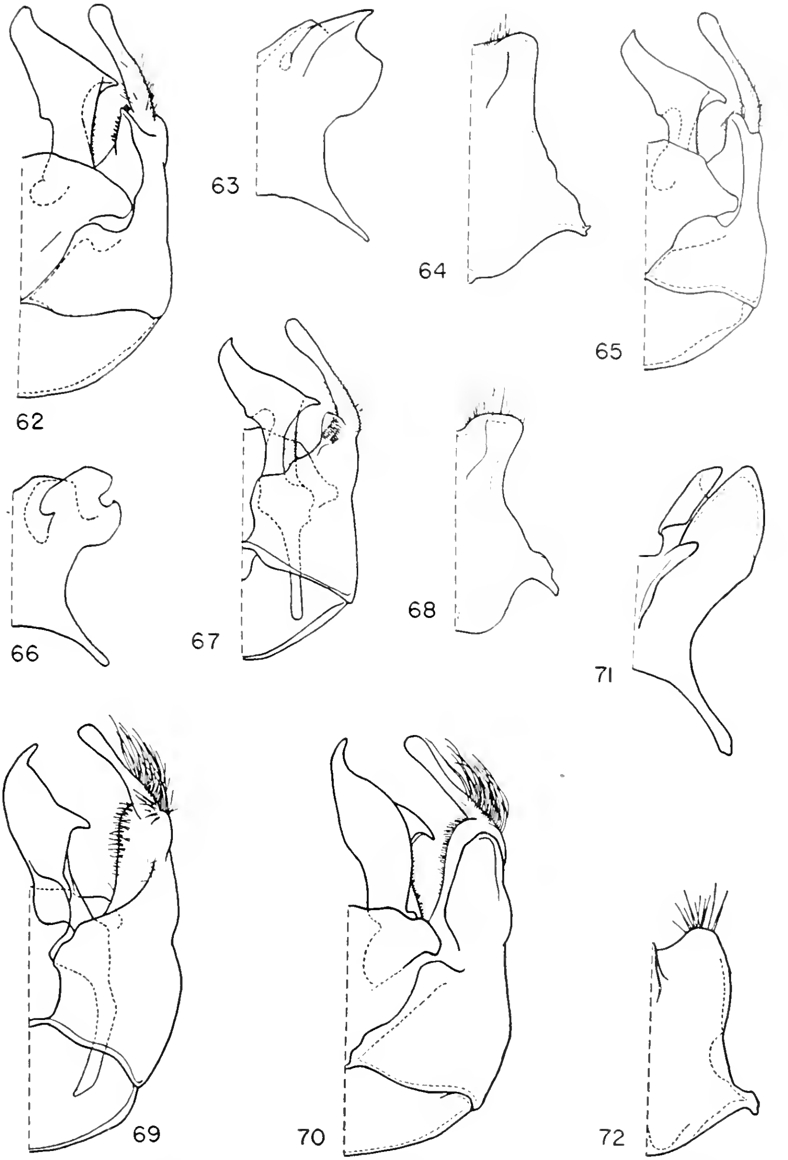

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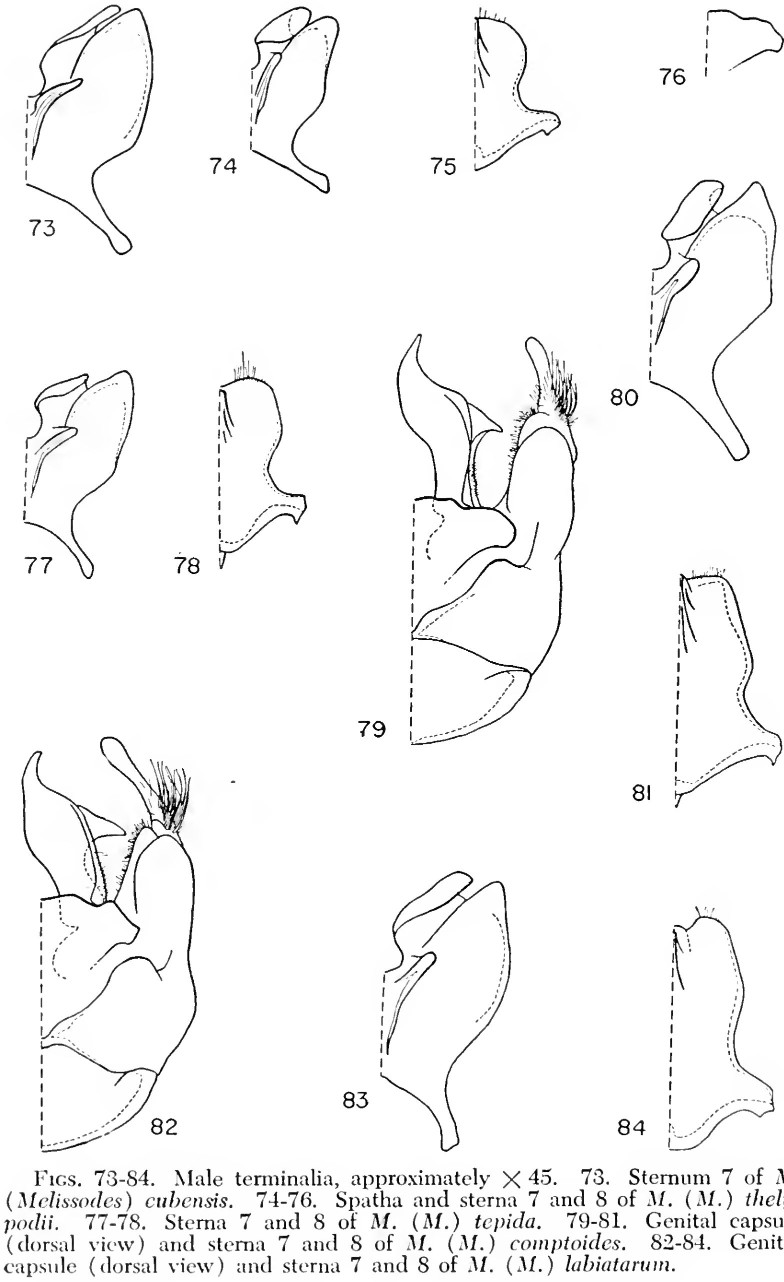

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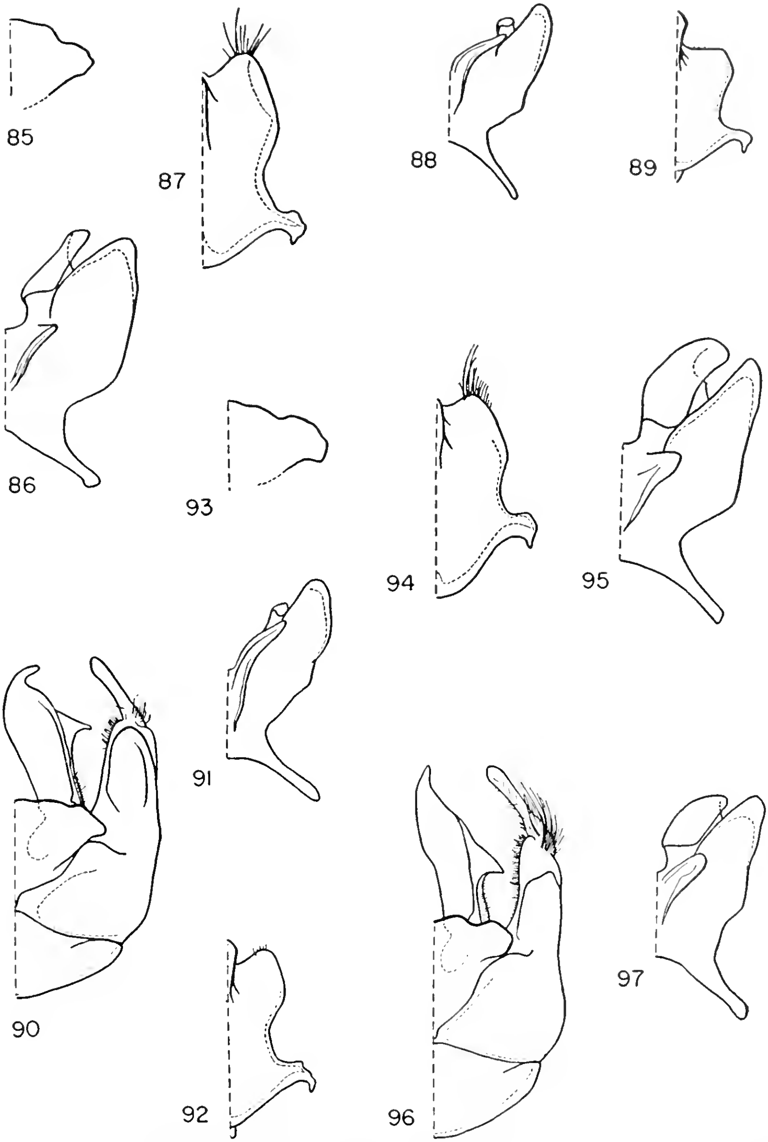

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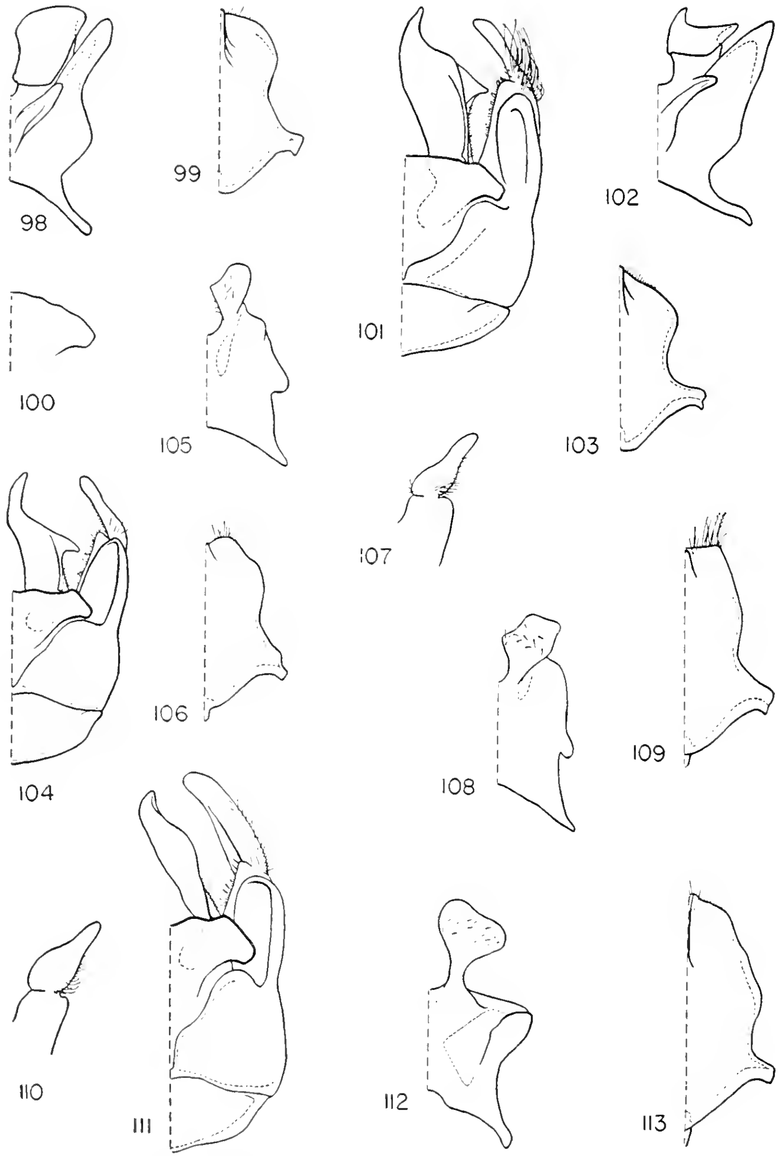

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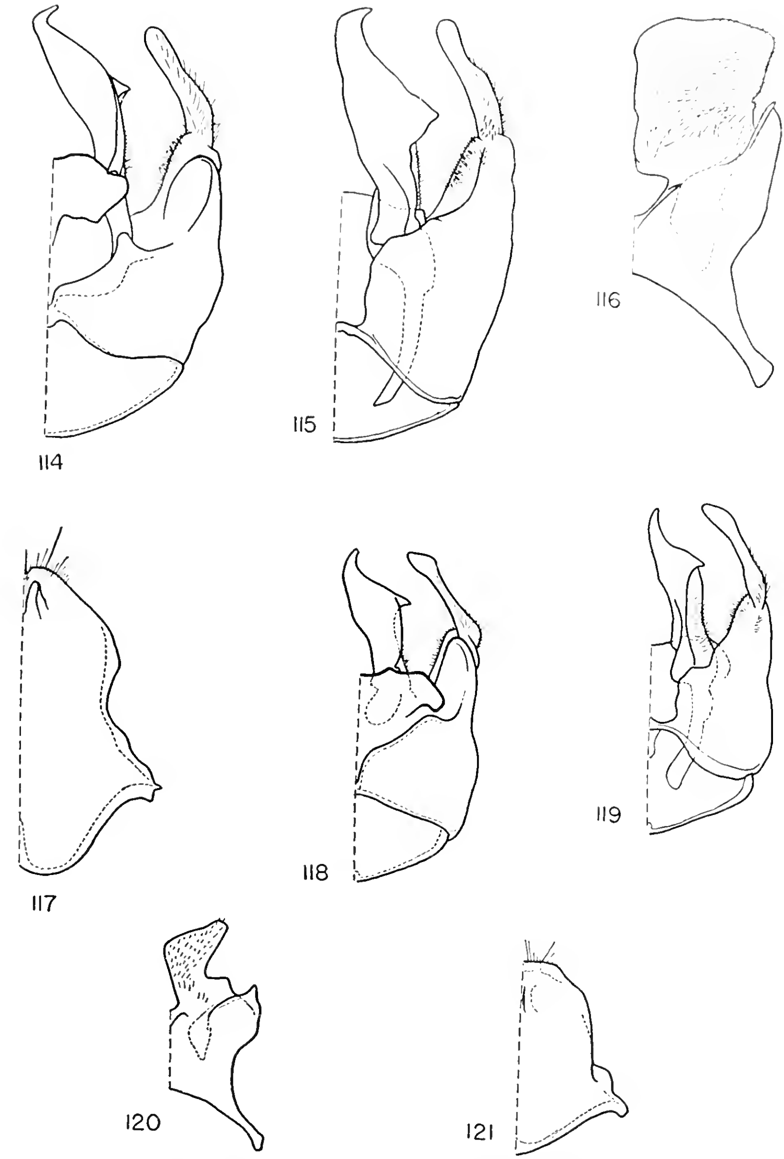

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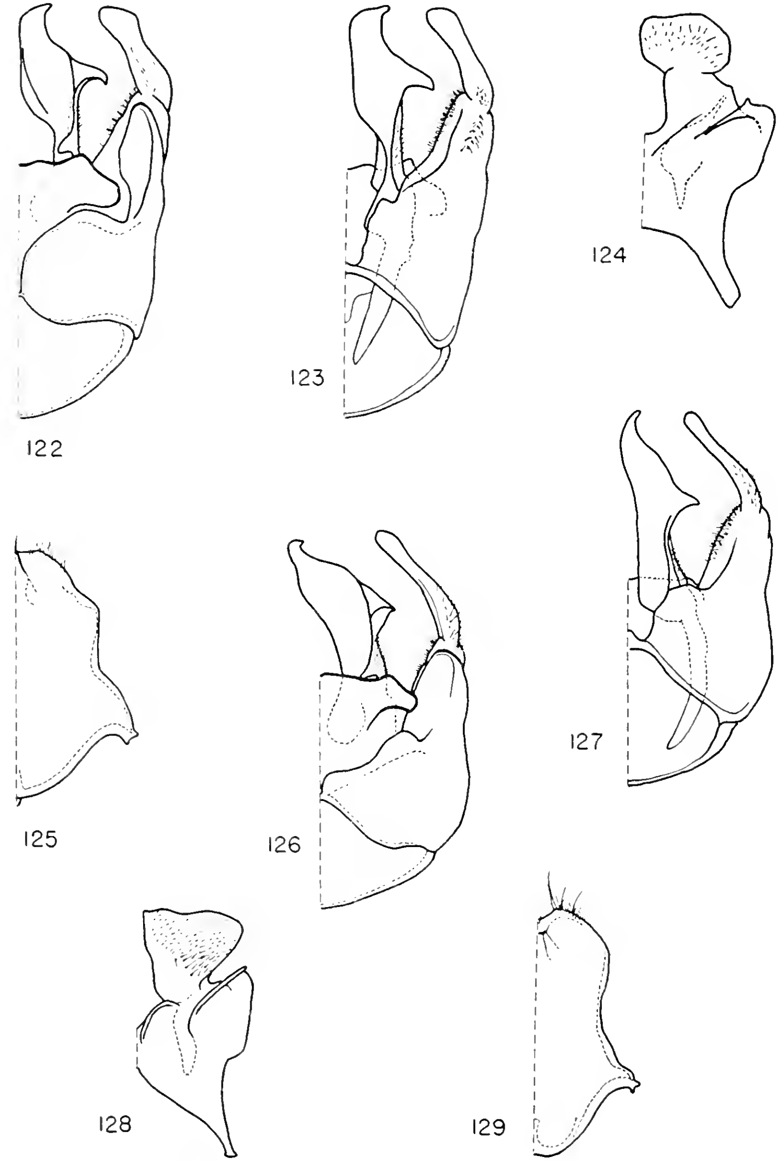

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The Chigger Mites of Kansas (Acarina, Trombiculidae)

BY

RICHARD B. LOOMIS

ABSTRACT: Studies of the chigger mites in Kansas revealed 47 forms, consisting of 46 species in the following genera: *Leeuwenhoekia* (1), *Acomatacarus* (3), *Whartonia* (1), *Hannemania* (3), *Trombicula* (21), *Speleocola* (1), *Euschöngastia* (10), *Pseudoschöngastia* (2), *Cheladonta* (1), *Neoschöngastia* (2), and *Walchia* (1). Data were gathered in the period from 1947 to 1954. More than 14,000 mounted larvae were critically examined. All but one of the 47 forms were obtained from a total of 6,534 vertebrates of 194 species. Larvae of eight species of chiggers also were recovered from black plastic sampler plates placed on the substrate.

Free-living nymphs and adults of all species seem to be active in warm weather. The time of oviposition differs in the different kinds, but there is little variation within a species. The exact time of emergence, abundance and disappearance of the larvae depends on the temperature of the environment. The species can be arranged according to their larval activity in two seasonal groups: the summer group (26 species) and the winter group (20 species). The seasonal overlap between these groups is slight. Rainfall and moisture content of the substrate affect the abundance of the larvae, but not the time of their emergence or disappearance. The summer species often have two generations of larvae annually, but in the winter species no more than one generation is known.

The larvae, normally parasitic on vertebrates, exhibit little host specificity. Exceptions are *Hannemania* restricted to amphibians, *Acomatacarus arizonensis* seemingly limited to lizards, possibly *Neoschöngastia brennani*, known only from birds, and several of the 20 species known only from mammals. Host specificity usually seems to result from limitation of certain chiggers to specific habitats. Ordinarily only one kind of host is available in such a restricted habitat. The numbers of species found on animals of each class of vertebrates are as follows: 5 on amphibians, 11 on reptiles, 14 on birds, and 40 on mammals. The larvae of a given kind of chigger seem to select the same general site or sites for attachment on different hosts. On mammals of different sizes, however, the larvae of a given kind of chigger select different sites. The wet mucous skins of amphibians and the tough dry skins of reptiles seem to repel larvae of many species. Also, the absence of suitable niches, such as those in the ears of mammals, seems to prevent certain species of chiggers from attaching.

Larvae with flagelliform sensillae (usually with few branches), eyes 2/2 and red, body red to orange, legs long, with mastisetae on leg III usually live in relatively open situations, move rapidly, have a wide range of hosts, including reptiles and birds for many species, and occur in large numbers. Larvae with expanded or plumose flagelliform sensillae, eyes normal to absent, body usually pale yellow or whitish, legs and leg segments usually short, without mastisetae on leg III seem to be restricted to specific habitats, such as decaying logs, tree-holes, and burrows and nests of mammals, and are almost always in close association with mammals, using one or several species as their regular hosts, frequently attaching in the ears. Expanded sensillae seem to be adaptations for detecting motion in the hosts, thus allowing the larvae to detach at the times most advantageous to them, normally when the host is inactive in its nest or shelter.

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INTRODUCTION

Chigger mites of the family Trombiculidae (Order Acarina) have a parasitic larval stage but are predaceous as free-living nymphs and adults. Larvae differ from eight-legged adults in having only six legs and normally attach to vertebrates and engorge on the tissue of the skin. Few species of chiggers are host specific, and those few seem to be restricted to a particular order or class of vertebrate. Numerous species have been found on a large variety of hosts; some of the species are known from all four classes of land vertebrates: amphibians, reptiles, birds and mammals.

When feeding has been completed after a period of from two days to several weeks, the engorged larva drops from the host and seeks a suitable habitat for the quiescent prenymphal stage. The nymph emerges, in from one to several weeks with eight legs and a setose, figure-eight-shaped body (diamond-shaped in some species of Leeuwenhoekiinae). The nymph feeds on eggs or early stages of small arthropods, increases in size and enters the quiescent pre-adult stage.

The adult closely resembles the nymph, but possesses fully developed reproductive organs, and is somewhat larger, reaching 1 mm. in length. The sexes are separate and presumably the eggs are fertilized internally. The sexes seem to occur approximately in the ratio of 1 to 1, according to Wharton and Fuller (1952:16).

PUBLIC HEALTH

Chigger mites are vectors of Tsutsugamushi Fever or Scrub Typhus in eastern Asia and the South Pacific and also may be vectors of other diseases of man including Murine or Endemic Typhus, Toxoplasmosis and Epidemic Hemorrhagic Fever.

Scrub Typhus, caused by a rickettsia, *R. tsutsugamushi*, has been demonstrated in lots of chiggers recovered from wild hosts and has been transmitted by larvae in the laboratory. The species of chiggers most frequently incriminated are *Trombicula deliensis* Walch and *T. akamushi* (Brumpt), which range over much of the Asiatic-Pacific region. Early work in Japan recently has been augmented by studies by members of research teams from the United States, Australia, Malaya, India, England and Japan (See Audy, 1954: 29-44).

In Africa, Giroud and LeGac (1952:1924) reported the isolation of two strains of *Toxoplasma gondii* from *Trombicula legaci* André, taken from wild mammals, and innoculated into mice.

Further studies are needed to verify the presence of toxoplasma in chiggers, and to determine their possible role as natural vectors.

Epidemic Hemorrhagic Fever, known from Korea, possibly is transmitted by larvae of chiggers.

Chigger mites may be vectors of other diseases, both in man and other mammals and in other vertebrates. The chigger mites should be investigated to determine if they are vectors of disease organisms between reservoir hosts, or between man and the reservoir host.

In the New World, chigger mites are not known as vectors of any diseases affecting humans; however, common pest chiggers, especially *T. alfreddugèsi* and *T. splendens,* produce intense irritation and swelling at the sites of attachment. Severe cases of chigger bites occur, especially in the southeastern part of the United States. Wharton and Fuller (1952:3-10) discuss this aspect of public health in detail.

In eastern Kansas, *T. alfreddugèsi,* the common pest chigger, is widespread and abounds in summer, causing considerable discomfort for individuals attacked by these larvae. The larvae attach most frequently at sites where clothing is pressed against the skin, such as the belt line, around the ankles, arm pits, and other moist protected areas, where there is a barrier to further movement and a sheltered site for attachment.

CHIGGER MITES IN KANSAS

Ewing (1921) reported a chigger mite, *Leptus irritans* (= *Trombicula alfreddugèsi*), in Kansas, although residents had long known of this and other pest chiggers prior to 1921. Jameson (1947) listed *Ascoschöngastia brevipes* (= *Euschöngastia peromysci*) from several species of small mammals in eastern Kansas. Brennan and Wharton (1950), in a study of the North American species of the subgenus *Neotrombicula* (genus *Trombicula*), reported *T. whartoni* and described *T. lipovskyi* and *T. sylvilagi* from Kansas.

In 1947 a contract was made between the University of Kansas and the Office of Naval Research, for the study of chigger mites in the Central United States. Specimens gathered from Kansas in this study have been described and reported in many publications including those by Brennan and Wharton (1950), Greenberg (1951 and 1952), Jones, *et al.* (1953), Wolfenbarger (1953), Kardos (1954), Crossley, Lipovsky and Loomis (1951 to 1955).

The chigger fauna of Kansas discussed below consists of 47 kinds (46 species) placed in 11 genera and 3 subfamilies. *Hannemania* *multifemorala* sp. nov. is described and the following 17 species are reported from Kansas for the first time: *Leeuwenhoekia americana, Acomatacarus arizonensis, A. galli, Hannemania eltoni, H. dunni, Trombicula splendens, T. myotis, T. montanensis, T. cynos, T. jonesae, Euschöngastia lacerta, E. trigenuala, E. setosa, E. diversa, E. criceticola, Speleocola tadaridae* and *Walchia americana*. Taxonomic changes of previously reported species include the transfer of *Acomatacarus senase* Greenberg to the genus *Whartonia* and the synonymy of *Acomatacarus angulatus* Greenberg with *A. galli* Ewing.

A total of nearly 300,000 larvae were found on 6,534 vertebrates of 194 species, on numerous chigger samplers and were reared in the laboratory and more than 14,000 of these chiggers were mounted and identified.

The following account lists the species of chiggers known from Kansas and includes information on the geographic distribution, the characteristics of the larval stages, the known hosts and habitats and other data when available.

ACKNOWLEDGMENTS

The studies of the larval chiggers of Kansas and the completion of the following account would have been most difficult without the generous aid of many individuals.

I thank my associates on the Chigger Project at the University of Kansas: D. A. Crossley, Jr., Robert B. Finley, Jr., Ervin H. Kardos, Leonard Koger, Louis J. Lipovsky and Keith A. Wolfenbarger for data from the field and laboratory, for recovering larvae from hosts, for mounting and directing the mounting by technicians of larvae on slides and for identifying vertebrates and chigger mites. I am especially grateful to D. A. Crossley for aid and suggestions in the study and preparation of the account that follows.

In addition to those listed above, I am grateful for aid in field work and for contributions of vertebrates and chigger mites from Kansas to many staff members and graduate students from the Departments of Entomology and Zoology of the University of Kansas, especially: Maurice F. Baker, Harold A. Dundee, Robert E. Elbel, James S. Findley, Cluff E. Hopla, J. Knox Jones, Jr., Edwin P. Martin, Robert L. Packard, Dennis G. Rainey, Thane S. Robinson, Wilmer W. Tanner, Harrison B. Tordoff and Olin L. Webb. David T. Clark, University of Illinois, also aided in field work, and John W. Twente, Jr. donated chiggers, for which I am grateful. The United States Public Health Service Plague Suppressive Units generously allowed me to work with them in northwestern Kansas for several days in July, 1948 and August, 1949.

For aid in identification of the species of chigger mites, I wish to thank Dr. James M. Brennan of the Rocky Mountain Laboratory, Hamilton, Montana, and Dr. George W. Wharton of the University of Maryland. For the loan of specimens I am grateful to Dr. Brennan, Dr. Wharton and Dr. Edward W. Baker, Division of Insects, U. S. National Museum, Washington, D. C.

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For typing this account as well as many other manuscripts on chiggers, I wish to express my indebtedness to my wife, Margaret Loomis. Thanks are also extended to Mrs. D. A. Crossley for aid in the preparation of the illustrations.

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TOPOGRAPHY

Kansas, nearly rectangular, with a surface area of 82,158 square miles, contains the geographic center of the United States.

The State is essentially a plain, although uplifts and erosion have formed hills and valleys. The surface gradually slopes toward the southeast and south. The highest elevation 4,135 feet above sea level is in western Kansas (Wallace County), and the lowest point, slightly less than 700 feet, is in the southeastern part of the State (Montgomery County).

Schoewe (1949:279) listed two major physiographic divisions, the Interior Highlands Division (the Ozark Plateaus Province) in the extreme southeastern corner, and the Interior Plains Division representing the rest of the State. The Interior Plains Division is subdivided into the Central Lowlands Province including the Flint Hills in the eastern half of the State and extending westward along the Arkansas River Valley, and the Great Plains Province of the west, including the Red Hills in the southeast part, dissected high plains in the northeast section and the high plains in the western half of the province. Frye and Schoewe (1953:246-252) give the physiographic subdivisions in greater detail. These subdivisions are based upon subtle changes in the topography since no sharp or abrupt contrasts exist in Kansas.

Cockrum (1952:6) found these divisions to coincide only in a general way with the distribution of mammals, and this seems to be true also of the distribution of chigger mites.

The soils of Kansas, so important to the free-living stages of chiggers, include a mantle of sand, silts, clays and gravel in addition to the organic material.

According to Fly (1946) the State can be subdivided into several sections on the basis of soils and bedrock. The western two thirds of the State, west of the Flint Hills consists of flat hardlands, sandhills, loess plains, breaks and canyons. The limestone Flint Hills in the eastern one third is a distinct area and east of this area are drift loess and loess hills in the northeast and prairie sections in the southeast. The Flint Hills separate the acid plano soil to the east from the slightly acid, neutral to limey soil to the west. The alluvial soils occur in valleys, being especially widespread in the larger valleys of the Kansas River, Arkansas River, Missouri River and others.

CLIMATE

Kansas has frequent and abrupt changes in climate. Summers are warm, but with low relative humidity, and usually with good wind movement. Summer nights usually are cool, especially in the west. Winters are cool and relatively dry.

Most of the precipitation occurs between April and September. The annual mean temperature is 55° F. and the warmest month is July with an average of 79° F. The first frost usually occurs in October and the last frost in early April to early May. The relative humidity is low in the daytime. Dew is rare in western Kansas where rapid evaporation occurs on dry surface soil.

The windiest months are March and April, and the least windy months are July and August. Most of the wind occurs in the daytime, tapering off after dark. Prevailing winds are from the south in April to November and from the west and northwest in December to March.

Three climatic areas and their climatic characteristics, according to Flora (1948) are as follows:

The eastern third has an average annual precipitation of more than 35 inches, a higher relative humidity, less sunshine and less range between day and night temperature than the rest of the State.

The middle third, ranging from 1,200 to 2,000 feet in altitude has an average annual precipitation of nearly 26.5 inches, moderate relative humidity, more sunshine, better wind movement and greater range in daily temperature than in the eastern third.

The western third of the State, 2,000 to 4,000 feet, has an average annual precipitation of 19 inches, dry air, the greatest amount of sunshine, strong wind movement and a large daily range in temperature.

Cockrum (1952:7) presents hydrothermographs of the three climatic areas of Kansas, giving the average monthly temperature and precipitation for each area. He shows also hydrothermographs for one town in each area (*op. cit.*, p. 8).

The extremes in the weather which may have affected the chigger studies in the period of 1947 to 1954 included severe sleet and snow storms, widespread devastating floods and excessive moisture followed by a prolonged drouth.

In the winter of 1948-1949, the ground was covered with several inches of sleet for nearly a month in northeastern Kansas, and the western part of the State had deep snow. The ice conditions in northeastern Kansas drastically reduced the populations of many small mammals, notably the cotton rat (Cockrum, 1952:185). Few small ground-living mammals were obtained in 1949 and early 1950 in northeastern Kansas due in part to their scarcity.

The year 1951 was one of the wettest recorded in Kansas. Rains fell in excess of normal in May, June and July, culminating in widespread floods, which were the most pronounced in the principal streams of the eastern third of the State, causing much damage to the lowland flora and fauna. The excessive rainfall probably also adversely affected the populations of certain small mammals in the higher areas.

The period from May, 1952 to October, 1953, was the driest on record in Kansas. The widespread drouth and unusually high summer temperatures, rapid and marked daily changes in temperature and the resulting changes in the flora markedly reduced many populations of mammals and probably the populations of chiggers as well.

The daily mean air-temperature and daily precipitation recorded in May through October of 1949 to 1952 at Lawrence are presented on the figures with the chigger samples of *T. alfreddugèsi.*

VEGETATION

Kansas is essentially a series of plains. The eastern hardwood deciduous woodlands are limited almost entirely to the stream valleys and hillsides although there are scattered trees in the upland of the eastern part of the state. The common trees include elm (*Ulmus*), oak (*Quercus*), hackberry (*Celtis occidentalis*), hickory (*Carya*), Osage orange (*Maclura*), honey-shuck (*Gleditsia*), black walnut (*Juglans nigra*), red bud (*Cercis canadensis*), ash (*Fraxinus*) on the slopes and valleys, and sycamore (*Platanus occidentalis*), cottonwood (*Populus deltoides*), and willows (*Salix*) along the streams and in the flood plains. Shrubs and shrublike trees of the eastern woodlands include coralberry (*Symphoricarpos orbiculatus*), dogwood (*Cornus*), sumac (*Rhus*), hazel (*Corylus americana*), blackberry (*Rubus*), and gooseberry (*Ribes*).

Interdigitation of the forests with grasslands creates the woodland edge situation consisting of scattered trees, many low shrubs, and grasses such as blue grass (*Poa*) and tall grasses of the prairie. Limestone outcrops and flat rocks frequently occur along the woodland edge usually at the crests of wooded hillsides or in uplands at the heads of ravines. The vegetation is that of both the woodlands and the tall grass prairie, usually with greater ground cover of tall grasses and shrubs than either the woods or prairies. The cutting of many trees in forested areas as well as planting of trees in grasslands have created greater areas of fringe habitats.

The tall grass prairie of the uplands formerly consisted of many native grasses including blue stem (*Andropogon*) and others, but most of these grasses have been greatly reduced. They have been replaced by cultivated crops or by grasses such as awnless brome (*Bromus inermis*), Japanese chess (*Bromus japonicus*) and many other weed species. Most grasslands of eastern Kansas are in the upland, although meadows also are present in the flood plains.

Central Kansas has tall prairie grasses; blue stem (*Andropogon*) and other native grasses still are especially prominent in the Flint Hills. Tall grasses are mixed with short grasses in the dissected high plains and red hills sections. The short grasses of the high plains are characterized by the dominant buffalo grass (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*), according to Gates (1937). However, large sections are now cultivated.

The sand hills, especially south of the Arkansas River in southwestern Kansas, formerly were covered with tall grasses, mainly little blue stem (*Andropogon scoparius*), but heavy grazing and drouths have largely eliminated them.

The sand hills and sandy soils now support sand sage (*Artemisia filifolia*), Russian thistle (*Salsola pestifer*), and soapweed (*Yucca glauca*).

FAUNAL DIVISIONS OF KANSAS

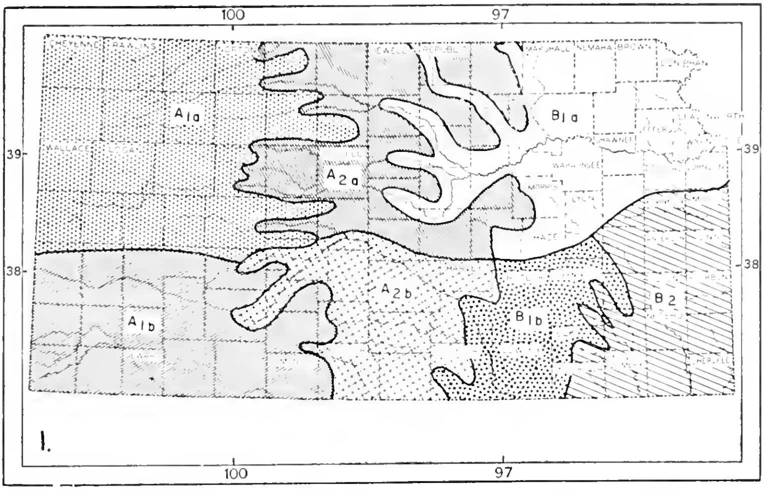
Cockrum (1952:13-15) reviewed the previous biotic divisions of Kansas, and established distributional areas based upon the presence or absence of certain kinds of mammals in given areas. This system as stated by him (*op. cit.*, p. 13) is not based on the total fauna and flora, although the areas (map on p. 15) correspond in part to the biotic districts of Brumwell (1951, map in Cockrum, 1952:12). The dependence of the mammals upon the environment also tends to make the mammalian distributions similar to those exhibited by other members of the flora and fauna. These mammalian distributional areas and their subdivisions are as follows.

- A. Great Plain Distributional Area
  - 1. Short Grass Plains Province
    - a. Central High Plains Subcenter
    - b. Southern High Plains Subcenter
  - 2. Mixed Grass Plains Province
    - a. Blue Hills Subcenter
    - b. Red Hills Subcenter
- B. Central Lowland Distributional Area
  - 1. Tall Grasses Province
    - a. Kansas River Valley Subcenter
    - b. Osage Plains Subcenter
  - 2. Cherokee Prairie Province

I have selected the mammalian distributional areas in Kansas to aid in the understanding of the distribution of chiggers and their affinities to other faunas. Although chigger mites do not seem dependent upon any particular host or hosts, 41 of the 46 species of chiggers have been found on mammals and are expected to occur regularly on mammals in the State. A total of 21 chigger species have been found only on mammals and an additional 13 species seem to be primarily parasitic on mammals.

The chigger mites seemingly restricted in Kansas to the Great Plains Distributional Area include the genera *Speleocola, Leeuwenhoekia, Acomatacarus* and *Whartonia;* the species *Trombicula batatas, T. twentei, T. hoplai, T. crossleyi, T. ornata, T. arenicola,* *Euschöngastia cricceticola, E. cynomyicola, E. lacerta, E. loomisi* and *Neoschöngastia brennani;* and the subspecies *T. gurneyi campestris.*

The Central Lowland Distributional Area is distinct in having the species *Trombicula lipovskyana, T. splendens, T. whartoni, T. sylvilagi, T. jonesae, T. kardosi, T. trisetica, Euschöngastia pipistrelli, E. peromysci* and *E. diversa,* and the subspecies *T. g. gurneyi* restricted to it.



MAP. 1. Mammalian distributional areas, from Cockrum (1952:15). The counties labeled are those from which one or more species of chigger mite has been recorded. A1a, A2a and other symbols of this general nature refer to distributional areas as defined.

The species which seem to be present in the eastern two thirds of the State, including the Central Lowland Distributional Area and the mixed grass province of the Great Plains Distributional Area, but seem to be absent from the Short Grass High Plains, include *Trombicula myotis, T. lipovskyi, T. cynos, T. fitchi, Euschöngastia setosa, E. jonesi, Walchia americana, Hannemania dunni* and *H. multifemorala.* All of these species have affinities with the eastern fauna.

Species of chigger mites which seem to be statewide in suitable habitats include *Trombicula alfreddugèsi, T. kansasensis, Euschöngastia trigenuala, Pseudoschöngastia hungerfordi, Hannemania eltoni,* and possibly *P. farneri* and *Cheladonta micheneri.*

EFFECT OF HUMAN DISTURBANCES ON CHIGGER MITES

Disturbances caused by man and his domestic animals include changes both beneficial and detrimental for chiggers in Kansas. The breaking of sod of the grasslands for cultivation destroys the free-living stages of chiggers and reduces the arthropod and vertebrate faunas. Heavy grazing by livestock reduces or eliminates the ground cover of low vegetation and permits erosion by wind and water and drying of the top soil. Postlarval chiggers which occur in the first few inches of the soil and on the surface cannot survive in such barren situations.

In forests and along streams of the State, the cutting of many trees has reduced the average and maximum size of the trees. Removal of dead trees and logs, clearing of the shrubs and understory, especially at the woodland edge, and burning grasslands and woods tend to reduce the free-living stages, especially of those chiggers that live in superficial habitats.

The killing of game mammals, such as rabbits and squirrels and reduction of other rodents, such as prairie dogs, is especially detrimental to those chiggers which depend largely on these mammals as hosts. The reduction of prairie dogs and their towns of large underground burrows and nests has destroyed one of the important habitats for several chiggers of the short-grass plains.

Disturbances and changes, brought about by man, that are beneficial to chiggers include the establishment of lawns which are watered in dry weather and which are visited regularly by chigger hosts such as dogs, cats and many birds, leading to the establishment and maintenance of chigger populations. In western Kansas, lawns are important for the pest chigger which is becoming more widespread than formerly. Irrigation also brings more moisture to the soil, and helps to maintain larger populations of chigger mites.

The farm ponds and other impounded waters create aquatic habitats for frogs, and water-edge habitats for their chiggers. The neighboring soil also is kept moist.

The creation of more grassland-woodland edge habitats, both by the cutting and thinning of the forests and the planting of trees in many areas of grasslands, affords more suitable niches for several chiggers and their hosts. The many brush piles erected from cut trees and limbs afford excellent winter shelters for cottontails and other mammals often infested by chiggers.

In eastern Kansas, many disturbed and cultivated areas allowed to return to a fallow condition become suitable habitats for chigger mites, especially *Trombicula alfreddugèsi* and *Neoschöngastia americana.*

DESCRIPTIONS OF STUDY AREAS

Specific areas from which a variety of vertebrates were obtained and numerous chiggers were recovered include the University of Kansas Natural History Reservation, Douglas County and other areas in northeastern Kansas (area B1a); the Pigeon Lake area, Miami County in eastern Kansas (B2); Russell County in north-central Kansas (A2a); Cheyenne and Rawlins counties in northwestern Kansas (A1a); Barber County in south-central Kansas (A1b and A2b); and Seward County in southwestern Kansas (A1b). These localities are distributed throughout the State and each of the areas differs in several respects from the others. The areas listed in parentheses are those of Cockrum, and are given on Map 1.

THE UNIVERSITY OF KANSAS NATURAL HISTORY RESERVATION

The Natural History Reservation (in area B1a) was sampled for chiggers throughout the study. The different ecological associations present in this area are typical of many other localities in northeastern Kansas. The Reservation, only recently protected, formerly was subjected to many disturbances typical of unprotected areas of the State. The cutting of timber and clearing of land for cultivation and pastures has reduced the native vegetation, particularly of the grasslands, and heavy grazing of pastures, especially in drouth years, has left many areas nearly barren and with marked erosion. The areas of cultivation are not suitable for chigger mites.

The Reservation consists of 590 acres of woods and grassland, situated in hilly land north of the Kansas River, in the northeasternmost section of Douglas County, four miles north and one mile east of Lawrence. A report on the Reservation is given by Fitch (1952) who states (*op. cit.:* 3) that "The . . . Reservation is situated within the broad belt of the ecotone or transition from the eastern hardwood forests to the grasslands of the Great Plains." The general topography consists of hills flanking the northern border of the Kansas River valley, with fingerlike projections of the valley dissecting the flat uplands. The uplands and the bottomlands are fields of grass and weeds with scattered trees near the edge of the woods, which cover most of the hillsides. Limestone outcroppings and exposed flat rocks occur on these hillsides including a prominent ledge extending along the crests of the hills and a second extensive outcrop approximately 20 feet below.

Shallow glacial till covers the hilltops and extends down the slopes into the valleys. The weathering limestone contributes to the soil over much of the area. The woods comprise 338 acres, the grasslands 136 acres, and the recently cultivated fields, 116 acres of the Reservation.

Prior to the establishment of the Reservation in 1948, the upland prairie and part of the woods were pastures; some bottomland was cultivated and some of the forest was left ungrazed. Operation of a former limestone quarry had cut a section from one hilltop and disturbed the surrounding area. Much of the woods on the hillsides consisted of second growth trees, since many of the larger trees of commercial value had been removed, leaving trees of less value such as elms, honey locust and Osage orange. The pastures were heavily overgrazed. A pond was formed by damming one of the small intermittent streams.

Protection since 1948 from major disturbances by humans and domestic animals has allowed the return and increase of many grasses, weeds, and trees. More luxuriant ground cover has provided better environments for the fauna, especially for small rodents which have increased in numbers. Game animals have also increased since discontinuance of hunting. However the greater ground cover and reforestation have reduced the numbers and distribution of certain open grassland species.

Chigger sampling was conducted along the limestone ledges, including the Quarry, the edge of the woods and in woodland clearings, and in the grasslands of the uplands and valleys. A series of study areas are listed below, designated as Stations A to G, for reference throughout the discussion of chiggers and their hosts.

The vegetation and the vertebrates of the Reservation are listed by Fitch (1952).

Larvae of 22 species of chiggers were found on the University of Kansas Natural History Reservation in Douglas County. All were taken from vertebrates and eight species marked with an asterisk (*) also were recovered on chigger samplers.

The most abundant and widespread species was *T. alfreddugèsi*, which occurred in summer. The most common early winter chigger was *T. lipovskyi* whereas *E. diversa* seemed to be the most abundant species on hosts in late winter and early spring.

LIST OF CHIGGERS COLLECTED ON THE RESERVATION

Summer	*Winter*
H. eltoni	*T. myotis*
H. multifemorala	* *T. lipovskyi*
* *T. alfreddugèsi*	*T. whartoni*
* *T. lipovskyana*	*T. fitchi*
* *T. sylvilagi*	*T. cynos*
* *T. g. gurneyi*	*E. setosa*
T. kansasensis	* *E. jonesi*
T. trisetica	* *E. diversa*
* *N. americana*	*E. peromysci*
P. hungerfordi	*E. trigenuala*
P. farneri	*W. americana*

Three additional winter species of chiggers, *T. jonesae*, *T. kardosi* and *C. micheneri*, have been taken in Douglas County, and presumably occur on the Reservation.

Station A.—This station is Plot A of Kardos (1954:104-105). The total area consisted of approximately 50 square feet on a southeast facing slope, adjacent to the limestone quarry and is at the edge of the woods, and is shaded most of the day by large elms and hickories. Small elms and dogwood trees are in the immediate vicinity. Forest litter of leaves covers the soil in fall and winter. The soil (pH 7.4), derived from glacial till, limestone substrate and forest litter, is well drained. A limestone outcropping two to four feet high containing the nest of a wood rat forms the northern edge of the station. There were no herbaceous plants growing on the ground where samples were taken. Larvae recovered from the soil on chigger samplers were the following: *T. alfreddugèsi*, *N. americana* and *T. sylvilagi* in summer and early fall; *T. lipovskyi*, *E. jonesi* and *E. diversa* in late fall and winter. The area was sampled in the spring, summer and fall of 1949 to 1952, and the winters of 1951 and 1952. Kardos (1954:105) gives the estimated number of *T. sylvilagi* per square foot at different times.

Station B.—This is plot B of Kardos (1952:104-105). It consists of approximately 30 square feet on a west-facing slope located in Skink Woods, near the woodland edge. The eastern edge of the station consists of a limestone ledge approximately three feet high. The soil was derived from glacial till, limestone substrate, leaves and forest debris. There were few patches of grasses and herbs, shrubs including gooseberry and fragrant sumac, trees were mostly elms, walnuts, hackberries. Leaves covered the ground in autumn. The soil was well drained and undisturbed. Extending from the limestone ledge across the station was an elm log (Rat Log) approximately 12 feet long and 1 foot wide in an advanced stage of decay. In the limestone ledge at the base of the log was the nest of a wood rat. Above the station, trees extended but a short distance into the flat upland prairie, being replaced by grasses and other prairie plants. Beneath the log, decomposed wood has accumulated forming a substrate several inches deep, surrounded by small patches of grass. At this station *T. alfreddugèsi* and *T. sylvilagi* were obtained in the areas of soil and decomposed wood and *T. g. gurneyi* on the log and directly beneath it. Samples were taken at this station in 1952. Kardos (1954:105) estimated the number of *T. sylvilagi* per square foot, based on chigger samples. The number of *T. g. gurneyi* from this station is listed on page 1316, (Table 2.)

Station C.—Several separate plots, all in Skink Woods, are included as follows: C-1 (Skink Elm), C-2 (Skink Log), and C-3 (Pit Elm). C-1 and C-2 are in a small clearing surrounded by woodlands, principally elms.

Skink Elm (C-1) is a living American elm. Part of its trunk, approximately one foot in diameter at the base, is decaying. The dead part extends upward nearly ten feet on the west side of the trunk and at the base is an accumulation of decaying wood upon which the chigger samplers were placed, and larvae of *T. g. gurneyi* were recovered.

Skink Log (C-2), in the small clearing, is part of a fallen log of American elm 14 feet long and 1½ feet in diameter. The bark had fallen to the ground along the log prior to sampling in 1952. Approximately 5 square feet of the surface was loose decomposing wood, whereas the remainder consisted of hard wood not yet weathered and decomposed. It was on the loose decomposed wood that most of the larvae of *T. g. gurneyi* were recovered. Most of the clearing is shaded except when the sun is overhead and supports dropseed, blue grass, gooseberry, virginia creeper, greenbrier, elm saplings, ragweed and nettles. Larval chiggers sampled on the decaying wood were mainly *T. g. gurneyi,* in addition to occasional larvae of *T. alfreddugèsi* and *T. sylvilagi.* The only extensive sampling was in 1952 (May to November). Five-lined skinks were common in the area.

Pit Elm (C-3) consists of a standing dead elm approximately one foot in diameter which has an accumulation of decayed wood at the base. Samples at the base produced *T. g. gurneyi* and *T. alfreddugèsi.*

Hole Oak consists of a large yellow oak, *Quercus Muehlenbergii*, which has a cavity at the base of the trunk among the roots. Sampling within the hole and in the immediate vicinity in autumn, 1952, revealed *T. sylvilagi* and a few *T. alfreddugèsi.*

Other samples from Skink Woods were taken in open sites shaded by large trees and where few or no grasses existed and only a few larvae of *T. alfreddugèsi* were recovered.

Most of the samples were in 1952, in addition to scattered samples in 1949-1951.

A summary of *T. g. gurneyi* taken in 1952 at Stations C-1 and C-2 are given in Table 2.

Station D.—This station consists of many plots situated at the quarry directly below the limestone ledge which varies from six to twelve feet in height. In general, these sites had shallow rocky soils on south facing talus slopes that did not extend more than ten feet from the ledge onto the exposed limestone of Quarry Flat with little soil and supporting only short sparse stands of common ragweed and Japanese clover. The temperature readings on these areas were relatively high, especially where little vegetation existed over shallow soil.

The dominant plant was Japanese chess which seeded and died in late June and early July, and was largely replaced by ragweed (*Ambrosia*), and clover (*Lespedeza*).

T. alfreddugèsi was sampled throughout. Larvae of *T. lipovskyana* and *T. sylvilagi* also were taken at plot D-1 and *N. americana* were taken at D-1 and D-3.

Important vertebrates which were frequently examined at the Quarry included collared lizards restricted to the limestone ledge and vicinity, six-lined racerunners common throughout the areas of sparse vegetation, gray skinks common along the limestone ledges, blue racers, common garter snakes, bull snakes, and copperheads. This area was sampled from May to November in 1949 to and including 1952.

Detailed descriptions of several plots are as follows: D-1, approximately 20 square feet, is at the west end of the Quarry Ledge adjacent to woodlands and is shaded in the afternoon by a large elm, and scattered elm saplings. Japanese chess was dominant and scattered grasses and weeds occurred in the area, none growing over two feet high.

D-2—This area (approximately 10 square feet) adjacent to the east resembles D-1, is shaded for a shorter period, and the soil has more limestone flakes, is drier and has less vegetation.

D-3—This plot is situated at the center of the Quarry where a gently sloping south-facing talus fill extends from the top of the limestone ledge to the Quarry Flat. A few elms approximately 5 feet high are located at the west edge. The total area sampled was approximately 30 square feet. Ground cover was principally Japanese chess in the spring and early summer, with patches of blue grass and awnless brome at the western edge. Later in summer, only dead Japanese chess covered patches of the soil. Ragweed afforded the only late summer shade for much of the barren soil which was extremely hot in summer. *T. alfreddugèsi* and *N. americana* were obtained here. Late in the hot dry summers, larvae of *T. alfreddugèsi* were restricted to areas of live blue grass and awnless brome. *N. americana*, however, was present in the open sites (See under *N. americana*).

A series of samples were taken in the early summer on the bare rocks of Quarry Ledge and barren soil which was composed of limestone flakes and clay. Larvae of *T. alfreddugèsi*, recovered in June, disappeared later in the summer.

The remaining parts of Station D mostly were dry rocky soil with little vegetation, and larvae of *T. alfreddugèsi* occurred there.

Station E.—This area situated at the southwestern corner of Quarry Field (Fitch, 1952:10) includes the flat upland field just north of the western half of Quarry Ledge. The soil, derived in part from limestone, was disturbed some years ago. Vegetation consists of Japanese chess, giant ragweed, sunflowers, and other grasses and weeds of lesser abundance. The dominant plant in early summer is Japanese chess. In some areas, not many other low plants follow, although giant and common ragweeds and sunflowers appear to afford some surface protection. One tree, an Osage orange of moderate size, shades part of the area. Adjacent to the north is awnless brome, coralberry and other low shrubs; to the west is a wooded rocky hillside, and to the northeast is Station F.

Several plots were sampled from May to November in 1949 through 1952. Larval chiggers recovered from the soil on chigger samplers were the following: *T. alfreddugèsi*, *N. americana* (E-2), and one *T. sylvilagi* (E-2).

E-1 was on disturbed soil supporting Japanese chess and hemp. E-2, less disturbed, had Japanese chess and ragweed. Open spots with barren soil produced *N. americana* whereas *T. alfreddugèsi* was common throughout the area.

Station F.—This consisted of several plots at the southeastern edge of the Quarry Field (Fitch, 1952:10) in the upland prairie mostly of awnless brome. This perennial grass has creeping rhizomes and forms sod; clusters are dense, remain green and seed late in summer. The height was approximately 1 foot in early June, 1952. Additional cover included a grove of smooth sumac in one area, coralberry along the northern edge, and scattered trees of small size. The soil of glacial till and cherty limestone had been disturbed in some areas.

Chiggers sampled included only *T. alfreddugèsi*. The areas were sampled from May to November in the years of 1949 through 1952.

Station G.—This station is in House and Vole Fields of Fitch (1952:10) in the bottomland meadows of an extension of the Kaw River Valley. The fields border small intermittent streams and a drainage ditch. The dominant plant, awnless brome, occurs along with other grasses, shrubs and few scattered trees. In general, this area was more moist and had more luxuriant plant growth than the upland prairies. Vertebrates of common occurrence include the prairie vole and other grassland species.

Chigger larvae on samplers included *T. alfreddugèsi* and *T. lipovskyana*.

This station was sampled in 1949 through 1952.

NORTHEASTERN KANSAS

Mice were taken in Chase, Lyon and Morris counties (Area B1a) on May 31, 1950, and are listed here separately since they were from typical Flint Hills habitats. They were all found under limestone slabs. *Perognathus hispidus* (1) had 10 *T. montanensis*, 75 *E. trigenuala*, 30 *P. farneri* and 5 *C. micheneri;* and *Peromyscus maniculatus* (3) had 42 *P. farneri* and 19 *C. micheneri* (on 1).

PIGEON LAKE AREA

The Pigeon Lake area, 3 miles east and 1 mile south of Fontana in Miami County, is in extreme eastern Kansas (Area B2), and has the only large stand of native first growth hardwood deciduous trees in Kansas. The flood plain of the Marais des Cygnes River and the bordering rocky hillsides are heavily timbered with oak, hickory, elm, cottonwood, sycamore, hackberry and many other deciduous trees. Many standing dead trees and decaying logs on the forest floor afford suitable habitats for many species of woodland chiggers. Gloyd (1932) described the area in greater detail and discussed the herpetological fauna.

Hosts and chiggers were obtained in April, May, September and October in the years 1948 to 1954. Ten species of chiggers were recovered from hosts and as adults. Additional information is given under *T. splendens* and *T. g. gurneyi.* The vertebrates and chiggers are included on the tables along with others from eastern Kansas.

North-Central Kansas

A group of reptiles were obtained in Jewell and Republic counties (Area A2a) in early July, 1951. They consisted of *Kinosternon flavescens* (1) without chiggers and the following with larvae (*T. alfreddugèsi* unless otherwise noted): *Terrapene ornata* (1) with 10; *Eumeces obsoletus* (8) with 1227, 1 *T. g. campestris* and 3 *T. montanensis; Thamnophis sirtalis* (1) with 106; *Heterodon nasicus* (1) with 197; *Diadophis punctatus* (2) with 8; *Elaphe guttata* (5) with 1195; *Pituophis catenifer* (1) with 343; *Lampropeltis getulus* (1 juvenal) with 109 and 1 *T. montanensis;* and *Lampropeltis triangulum* (5) with 92 and 3 *T. g. campestris.*

Russell County

In north-central Kansas (Area A2a), vertebrates and chigger mites were obtained in Russell County on April 26-27, 1952. The areas investigated consist of mixed grasses on slopes and short grass uplands, especially in grazed pastures. Numerous large flat slabs of limestone lie on the hillsides and shelter many deer mice and numerous kinds of reptiles. Adults of *T. alfreddugèsi* were also found under the rocks.

The vertebrates obtained and their chigger mites were as follows: Frogs, *Rana pipiens* (2) *H. eltoni* and *H. multifemorala;* reptiles (all without chiggers) *Crotaphytus collaris* (11), *Eumeces obsoletus* (8), *Eumeces septentrionalis* (2), *Cnemidophorus sexlineatus* (5), *Thamnophis radix* (1), *Tropidoclonion lineatum* (6), *Diadophis punctatus* (14), *Coluber constrictor* (3), *Elaphe guttata* (4), *Lampropeltis triangulum* (1), *Tantilla nigriceps* (3), and *Sistrurus catenatus* (1); birds (also without chiggers) *Sayornis saya* (1), *Sturnella neglecta* (2) and *Zonotrichia leucophrys* (1); mammals, *Neotoma floridana* (5) without chiggers, *Sylvilagus floridanus* (4), one with 4 *T. lipovskyi,* and *Peromyscus maniculatus* (14) with a total of 16 *A. plumosus,* 29 *T. lipovskyi,* 1 *T. montanensis,* 8 *E. criceticola,* 6 *E. setosa,* 5 *E. trigenuala* and 200 *P. farneri.*

The total kinds of chiggers were ten, most being winter species.

Barber County

One of the most intensive surveys of chigger mites was undertaken in Barber County, in south-central Kansas. Areas sampled included the mixed grass plains to the east and a wooded valley habitat to the south in Area A2b, and canyons and caves in the short-grass red hills upland to the south and west in Area A1b.

Mammals were trapped near Sharon, in the northeastern corner, in areas of mixed to short grasses with sandy to hard soils. *Speleocola tadaridae* was found on free-tailed bats obtained in a barn. A total of four species of chiggers was recovered in April and July, 1952.

In south-central Barber County, 10½ miles west of Hardtner, habitats in the valley of Salt Fork Creek were sampled in July (1952) and August (1949). The soil was extremely sandy, and the higher terraces supported either sagebrush, woodlands of elms and cottonwoods or short grass. Many standing and fallen dead trees probably afforded habitats for several species of chigger mites, including *T. gurneyi*, *T. crossleyi* and *N. brennani.* The vertebrates in the woodlands include several species of birds, one species of lizard, and cottontails.

The sagebrush area shelters cottontails and several were shot. Because of the wide range of these rabbits, they do not reveal any chiggers limited to the sage area.

Short-grass hardlands adjacent to the sagebrush and woods supported a colony of prairie dogs. The short grass extended into the woods and some burrows actually were among the trees. *T. montanensis* was the only chigger taken from these prairie dogs.

A low valley meadow of grasses and ledges of moderate height with scattered willows and cottonwoods yielded cottontails, cotton rats, and several kinds of birds. Only *T. alfreddugèsi* was recovered from these vertebrates.

Seven species of chigger mites were obtained from this entire valley area including the type series of *T. crossleyi, E. loomisi* and *N. brennani.*

Sandy areas directly east of the high plains area produced box turtles, rattlesnakes, kangaroo rats, pocket mice, and jackrabbits which bore *T. alfreddugèsi* (rare), *T. montanensis, T. g. campestris, E. loomisi, P. hungerfordi* and *P. farneri.*

The canyons and caves dissecting the short-grass uplands in extreme southwestern Barber County were most thoroughly investigated. Overgrazing and excessive erosion had created large gullies and barren soil in many areas. The canyon walls near the crests of the slopes consist of large outcrops of gypsum and sandstone, particularly at the heads of the canyons where large crevices and cracks occur in addition to small caves. The caves were formed by the erosion of the less resistant gypsum between formations of harder sandstone and shale. All of the caves visited in this area were small, not extending more than 200 feet into the hills. The caves afford shelter for several species of bats, as well as gray wood rats and white-footed mice which also are abundant throughout the rocky canyons. The floor of the canyons frequently are barren or support scattered cedars, elms, cottonwoods and other trees, vines, shrubs and tall grasses. Mammals of the grass areas include the deer mouse in addition to those of the canyon proper. Chiggers of 23 species were obtained from these habitats.

The short-grass uplands near the canyons support a few pocket gophers; and where rock outcrops occur collared lizards, prairie rattlesnakes and other reptiles were taken. In the short grass we took a silky pocket mouse, two cottontails (probably from the canyons) and one kangaroo rat, all at night, in addition to prairie dogs, ground squirrels, and several species of birds. No chiggers were found on these birds of the uplands. Ten species of chiggers were taken on the vertebrates from the short-grass uplands.

Larvae of 29 species are reported, and they are summarized in the tables of the hosts from Barber County.

NORTHWESTERN KANSAS

Vertebrates were taken in Cheyenne and Rawlins counties, in July, 1948, August, 1949, and early November, 1952.

The general area consists of a flat plain, dissected by stream valleys. The hardlands of the high plains are generally in cultivation, mostly wheat, whereas the rocky or eroded slopes, rolling hills, streamside meadows and sandy areas are used for pastures and hay fields. Mammals, reptiles and amphibians usually were obtained in the rougher land or along the edge of cultivation. Vertebrates taken from areas bordering the cultivated fields possessed fewer chiggers than those from uncultivated areas, such as prairie dog towns or sandy situations. Eight species of chigger mites were recovered from vertebrates in July and August.

In November, 1952, small mammals were trapped in a streamside meadow of the Arikaree River in Cheyenne County. The soil under the sod was extremely sandy. Two species of chigger mites were taken.

A total of 10 species of chiggers is recorded from the two counties.

Reptiles obtained in Cheyenne and Rawlins counties, in July and August included *Chrysemys picta* (1), without chiggers and the following with larvae (*T. alfreddugèsi*, unless otherwise noted): *Holbrookia maculata* (1) with 7; *Sceloporus undulatus* (1) with 10; *Cnemidophorus sexlineatus* (3) with 90; *Thamnophis radix* (3) with larvae present; *Tropidoclonion lineatum* (1) with 20; *Heterodon nasicus* (4), three with 40 and 5 *T. montanensis; Coluber constrictor* (3) with numerous larvae; *Masticophis flagellum* (3) with numerous larvae; 1 *T. g. campestris* and a moderate number of *T. montanensis*; *Pituophis catenifer* (7) with numerous *T. alfreddugèsi* and *T. montanensis*, and *Crotalus viridis* (5), two of which had 14, 11 *T. g. campestris* and 40 *T. montanensis*.

Birds from Rawlins and Wallace counties, in July and August consisted of *Charadrius vociferus* (3), *Zenaidura macroura* (1), *Empidonax* sp. (3) without chiggers; *Speotyto cunicularia* (5), with 5 *T. g. campestris* (on 3), 41 *T. montanensis* and 10 *N. americana* (on 3); *Eremophila alpestris* (10), three with 8 *T. alfreddugèsi*; *Sturnella neglecta* (8), five with 45 *T. alfreddugèsi*; and *Chondestes grammacus* (1) with 25 *T. alfreddugèsi*.

Mammals from Wallace County, obtained on July 3-4, 1949, consisted of *Perognathus* (*flavus* or *flavescens*) (1) with 10 *T. alfreddugèsi; Onychomys leucogaster* (1) with 1 *E. trigenuala* and 1 *P. hungerfordi*; *Peromyscus maniculatus* (3) with 30 *T. alfreddugèsi*, 9 *T. g. campestris*, 16 *T. kansasensis*, 1 *T. montanensis*, and 11 *P. hungerfordi* (on 2); and *Mus musculus* (1) with 7 *T. alfreddugèsi*.

Mammals from Norton County, obtained in October, 1946, include the following which were only superficially examined in the field; *Sylvilagus floridanus* (4) with 2 *A. galli* and 57 *T. lipovskyi*; *Reithrodontomys megalotis* (3) with 8 *T. lipovskyi*; and *Peromyscus maniculatus* (4) with 19 *A. galli*, 106 *T. lipovskyi*, 2 *T. montanensis*, and 2 *E. criceticola*.

See table 25 for a summary of the mammals taken in Cheyenne and Rawlins counties and their chiggers.

SEWARD COUNTY

In southwestern Kansas (Area A1b) vertebrates were obtained at two stations in Seward County in early September, 1948. One station (4 miles northeast of Liberal) was situated on the high plains, in a sandy area supporting short grass bordered by a low moist area with darker sod-covered soil supporting tall grasses and weeds such as sunflowers and ragweed. Mammals taken in the tall grasses included *Cryptotis parva* (1), *Onychomys leucogaster* (1), *Reithrodontomys megalotis* (1) without chiggers and *Sigmodon hispidus* (10), nine of which had more than 259 *T. alfreddugèsi.* A whip-snake, *Masticophis flagellum,* had many *T. alfreddugèsi* and *T. montanesis* were common. Birds in the area included *Charadrius vociferus* (5), *Bartramia longicauda* (3), *Xanthocephalus xanthocephalus* (3) and *Spizella pallida* (1) without chiggers; *Sturnella neglecta* (1) with 1 *T. alfreddugèsi,* and *Calamospiza melanocorys* (4), one with 1 *T. alfreddugèsi* and 3 *N. brennani.*

Mammals taken in the upland short grass habitats were *Lepus californicus* (2) and *Dipodomys ordii* (1) without chiggers.

The second station (12 miles northeast of Liberal) in the sandy valley of the Cimarron River had sagebrush, Russian thistle, yucca and short grasses in the higher sandy areas and meadows of medium to tall grasses, sedges, streamside willows, cottonwoods and elms along the stream and ox-bow lakes. Reptiles obtained were *Cnemidophorus sexlineatus* (2) and *Thamnophis radix* (1) without chiggers; *Sceloporus undulatus* (9), eight of which had larvae of *T. alfreddugèsi, Eumeces obsoletus* (1) with 25 *T. alfreddugèsi, Natrix erythrogaster* (2) and *Thamnophis sauritus* (3) all with numerous larvae of *T. alfreddugèsi.* Birds taken were *Zenaidura macroura* (1), *Empidonax trailli* (1), *Cyanocitta cristata* (1) without chiggers; *Colinus virginianus* (1) with 4 *T. alfreddugèsi, Muscivora forficata* (1) with 1 *T. arenicola* and 3 *T. brennani,* and *Sturnella neglecta* (1) with 2 *T. batatas* and 2 *T. alfreddugèsi.* Mammals included *Reithrodontomys megalotis* (1), *Reithrodontomys montanus* (2), *Peromyscus maniculatus* (3), *Peromyscus leucopus* (3) without chiggers; *Perognathus hispidus* (3) with 2 *T. batatas,* 10 *T. alfreddugèsi,* 4 *T. g. campestris,* and 8 *T. arenicola*; *Dipodomys ordii* with 47 *T. batatas,* 2 *T. alfreddugèsi,* and 55 *T. arenicola. Rana pipiens* also possessed *H. eltoni.* Only *T. alfreddugèsi* was taken from vertebrates of the meadow habitats.

MATERIALS AND METHODS

In the field, larvae were obtained almost entirely from vertebrates and from chigger samplers (black plastic plates), rarely from nests of mammals. Nymphs and adults were recovered from the soil or decaying wood.

HOSTS

More than 6,534 vertebrates of 194 species, obtained in Kansas from 1947 to 1954, were examined for chigger mites. They included 1,188 amphibians of 21 species with approximately 2,000 larvae of

5 species of chiggers; 2,628 reptiles of 48 species with nearly 126,000 larvae of 12 species of chiggers; 628 birds of 79 species with roughly 4,000 larvae of 14 species of chiggers; and 2,090 mammals of 46 species with more than 66,000 larvae of 40 species of chiggers. Of the total of more than 198,000 larvae, more than 13,000 were mounted and identified.

These vertebrates were shot or snap trapped, or were captured alive with a noose or by hand.

Fitch (1951) described the funnel trap used to catch reptiles at the University of Kansas Natural History Reservation. Many of the reptiles, amphibians and mammals, examined for chiggers were obtained in these traps. Pitfall traps, consisting of gallon tin cans buried in the ground at strategic places along natural barriers such as limestone ledges and logs, caught small mammals, amphibians and reptiles, especially five-lined skinks. These two methods of capture produced most of the reptiles obtained in the months from July through October in eastern Kansas. Most trapped vertebrates were recovered before more than a day had elapsed. Collared lizards usually were noosed with a thin flexible wire loop on the end of a limber stick. Mammals were taken with snap traps or with wire live-traps (Fitch, 1950:304). Birds were shot.

The vertebrate, when dead, was placed in a plastic bag of appropriate size (originally cellophane bags were used). The living vertebrate temporarily was placed in an appropriate field container.

Each specimen (or specimens) of each species from each locality was assigned a field number that was given to all related data.

On trips that took us from the laboratory, the bags with the dead specimens were sealed in water-tight containers such as gallon or smaller wide-mouth jars and were placed on ice in a portable ice box. Living amphibians and reptiles also were cooled in the ice box. Living mammals were placed in cages over detergent-water after capture, and were removed only for transporting to the laboratory.

In the laboratory, larger mammals, such as rabbits, were skinned leaving the skull attached to the skin and the skins were replaced in the plastic bag. All of the bags were placed in a refrigerator (40° F.) and kept there for one to several days. After at least one day in the refrigerator, birds and mammals were removed and examined for chiggers, especially in known sites of larval attachment and then placed in suitable jars for washing. Following warming for from one to two hours at room temperature, jars were thoroughly shaken and the contained animals were washed two or three times in a solution of synthetic detergent (Glim, Joy or Aerosol) and water. The solution then was decanted and the residue was examined under a dissecting microscope and larval chiggers if present were recovered and sorted. The animals always were examined after being washed, since chiggers frequently would remain attached. This was especially true of *T.* (*Eutrombicula*) and other summer chiggers, which did not wash off as readily as the winter larvae such as those of *T.* (*Neotrombicula*) and *Euschöngastia.* This method of washing mammals and birds (described in detail by Lipovsky, 1951) often revealed larvae that were not discovered in careful visual examinations of the host. Early in the study, some mammals and birds were not washed, but were subjected to complete and careful visual examination. The tables which summarize the chiggers recovered from hosts, include only the hosts which were carefully examined.

The dead amphibians and reptiles were carefully examined with a binocular dissecting microscope and the larvae were picked from the hosts with a needle and forceps.

The living amphibians and reptiles were examined under the dissecting microscope and the attached larvae on hosts were removed in part or entirely by hand. The reptiles, unless they were known to have no chiggers, were placed on screen platforms in jars containing detergent water, or in cages suspended over a solution of detergent-water (the same detergent used in washing). Lipovsky (1950:16) illustrates the cage. The solution was examined frequently to recover larvae while still alive and to record the time of larval detachment. Living mammals also were placed in the same type of wire cages suspended over detergent-water for recovery of larvae. A fine screen was placed under the mammals to catch feces and food, since this material as well as urine was harmful to the living larvae, and caused difficulty in recovering them. The living vertebrate was carefully examined for larvae when removed from over the detergent-water.

The numbers and kinds of chigger larvae recovered from each host were recorded, along with pertinent data, such as their sites of attachment, size, color, and degree of engorgement. The chigger mites recovered were usually preserved in 75 to 85% alcohol, some were reared, and occasionally some larvae of *T.* (*Eutrombicula*), were discarded after tentative identification.

Many times only a few larvae were recovered from a host; all of these usually were preserved and mounted for identification. However, when large numbers of larvae were obtained from a single host, it was impractical to mount all of them for identification.

In such cases the larvae were carefully sorted according to size, shape, color, and speed of movement, and a representative sample of each group (usually more than 20 larvae) was selected and mounted. When no sorting was done prior to preservation, the size, shape, number of body setae and other features were utilized to separate the preserved larvae. Many of these larvae preserved solely for identification were mounted in groups of two to ten on one slide whereas most of the other larvae were mounted individually. Lipovsky (1953) reported on the type of mounting media used, Polyvinyl alcohol and Lacto-phenol (PVA-LP). The unfed and partly engorged larvae usually were preserved, whereas many of the engorged larvae were cultured. Cultured larvae were identified by association with other larvae that were mounted from the same lot, by larval skins, by recovery of newly hatched larvae, and by comparison of reared nymphs and adults with those of species already correlated. A phase contrast microscope was used for the identification and study of larvae.

Methods used for collecting and for recovery of chiggers are stressed since care was taken to record the presence and abundance or absence of each species of chigger on each host. Although it was impossible always to recover all attached larvae or to identify correctly all individuals not on slides, our methods probably provided an accurate picture of the species and numbers of larvae taken from hosts and chigger samplers in Kansas.

CHIGGER SAMPLERS

The chigger sampler was one of the most successful devices for the recovery of active, unfed larvae. This device, a modification of the "cap sample" used at Duke University (Wharton and Fuller, 1952:107), consists of a thin black rectangular sheet of Plexiglas-Acrylic plastic (3 x 69 x 139 mm.), having a surface area of approximately one-tenth of a square foot. These samplers are small enough to be carried easily in the field, and to be placed in quart wide-mouth jars containing alcohol or detergent-water for the recovery of larvae. This size also facilitated the calculation of number of larvae per square foot. The weight (39 grams) was sufficient to hold the sampler when dropped or pressed down on the substrate of soil, loose leaves, and decaying debris. The black opaque sampler casts a distinct shadow and the active unfed larvae find and crawl onto the plate, where they are easily seen. The dark plastic which warmed in sunlight became too hot on sunny summer days, and was cooled in the shade or in water carried in wide-mouthed jars. When only a few larvae were present they were recovered with a camels-hair brush and were dropped into 80% alcohol in small vials. Many of the larvae were replaced in the area of recovery, especially where adequate numbers from that area had been mounted and identified. The larvae were recognized in life by the color, size and speed.

The success of the chigger sampler method depends on the time and place sampled. The length of time the sampler was allowed to remain on the substrate was approximately one minute in summer, three to five minutes in fall and winter when the temperature was low (especially below 70° F.). The number of larvae taken was recorded in the field, in addition to the time, weather conditions including air temperature, and in 1952 the substrate moisture and temperature. The temperature of the substrate was taken approximately two inches below the surface by a bulb thermometer. The areas were shaded when the temperatures were taken.

A total of eight species of larval chiggers was recovered on chigger samplers. *Trombicula alfreddugèsi, T. sylvilagi* and *T. g. gurneyi* were common, *T. lipovskyana*, *T. lipovskyi* and *Neoschöngastia americana* were obtained in small numbers on several occasions and *Euschöngastia diversa* and *E. jonesi* were taken once, the latter species represented by an engorged larva. Kardos (1954) reported on *T. lipovskyi* and *T. sylvilagi* recovered on chigger samplers from the Natural History Reservation, and additional information is given under each species listed above.

Habitats sampled included grasslands (Stations D-G), woodland edge (Station A), woodlands including the forest floor (Stations A and B) and on decaying logs and stumps (Station C) at the Natural History Reservation.

Recovery of Nymphs and Adults in the Field

Nymphs and adults of trombiculid mites were obtained by lifting up large flat limestone slabs and examining the soil. For collecting *T. alfreddugèsi,* this method was productive, especially in spring and early summer. Nymphs and adults of *T. splendens* were found on several occasions in decaying logs, just beneath the loose bark and in the decomposing wood.

Postlarval stages also were taken from the soil using the flotation method, which consists of breaking apart a sample of soil in a large container of water (Cockings, 1946:289). The arthropods including the trombiculid mites were recovered as they came to the surface. Adults are more easily recovered than other stages of Trombiculids since they are more buoyant due to air trapped by the long body hairs. Only *T. alfreddugèsi* and *T. lipovskyana* of the subgenus *Eutrombicula* were recovered by this method.

RECOVERY OF CHIGGER MITES USING BERLESE FUNNELS

Use of Berlese funnels has revealed remarkably few larvae, and no nymphal or adult chiggers. The nest material of mammals was placed in a large funnel over a screen with a jar of liquid beneath it and a warm, bright light above it. The light and heat drove many of the living arthropods downward and they fell into the jar of alcohol or detergent-water. The chigger mites, especially in the postlarval stages, seem delicate and susceptable to desiccation in comparison to many of the other mites commonly found in mammal nests. The larvae are less delicate although they may be attracted to the light and die before they can retreat down through the nest material into the jar. Some of the larvae recovered from nests of the eastern wood rat in Kansas include *Trombicula lipovskyi*, *Euschöngastia setosa* and *Cheladonta micheneri.* Larvae recovered from nests of the eastern wood rat in Oklahoma included *T. lipovskyi, T. myotis, T. cynos* and *Walchia americana.*

TREATMENT

The taxonomy of the trombiculid mites has been based almost exclusively on the characters of the larvae, these being more easily obtained than the adults or nymphs. In addition, the relatively simple morphology of sclerotized parts and few setae allow complete and detailed study and comparisons of homologous structures.

Most parts of the larva have been given names; the remaining unnamed features, such as branched setae, are identified by their position. The terminology used in this paper follows that of Wharton, *et al.* (1951) and Audy (1954). Figure 1 illustrates many of the important structures of the larva. The prominent features shared by the larvae, nymphs and adults include the color, the two sensillae, and the presence or absence of anteromedian scutal setae, which are termed tectal setae in the nymphs and adults. Many characteristics of the larvae are unique and seem to have arisen as adaptations to the parasitic mode of existence.

The arrangement and characterizations of the subfamilies, genera and subgenera generally follow the system used by Wharton and

Fuller (1952), although I have followed that of Audy (1954) in certain cases as noted in the text. The arrangement of species is similar to that of Wharton and Fuller (*op. cit.*) with the recently described kinds being inserted near related species.

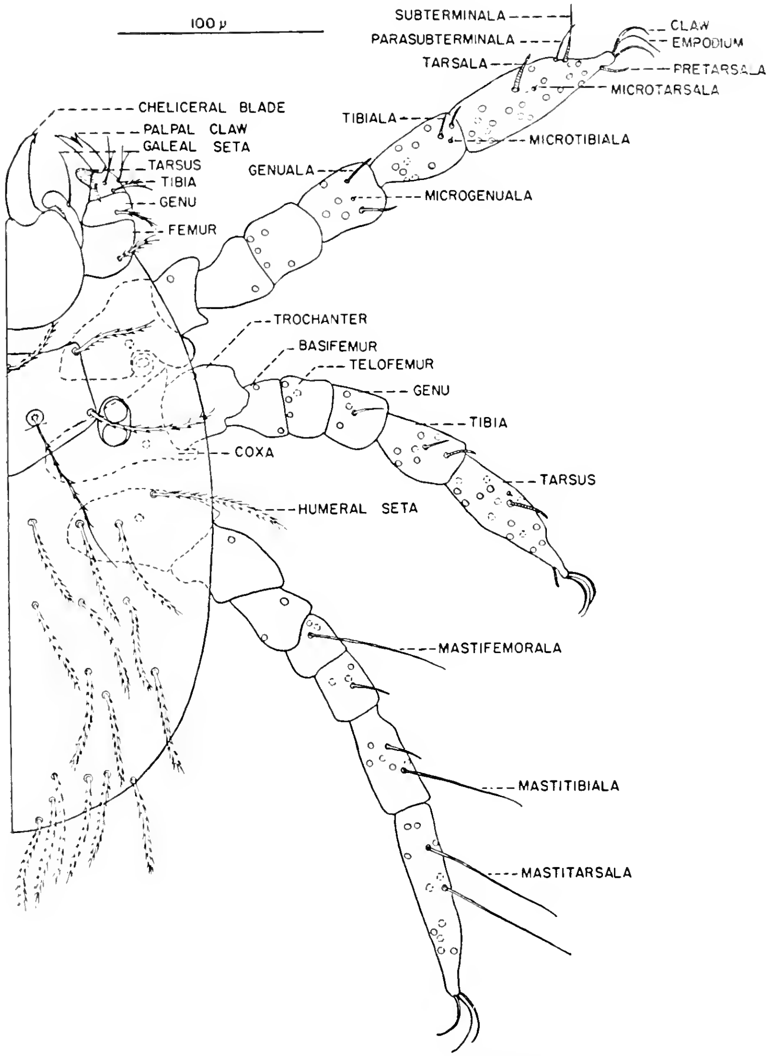


FIG. 1. Dorsal aspect of the larva of *Trombicula lipovskyi,* showing the nude setae and bases of the branched setae on the legs, the setae of the palpus, except for the palpal thumb (tarsus) where only the bases are shown.

The group name (which has no taxonomic status) seems best used to associate closely related species within recognized genera or subgenera. The name is derived from one specific name, usually that of the oldest best-known species of the group.

The synonymy of each species includes the original citation and the type data, different name combinations, important papers and references to specimens from Kansas. When the synonymy is

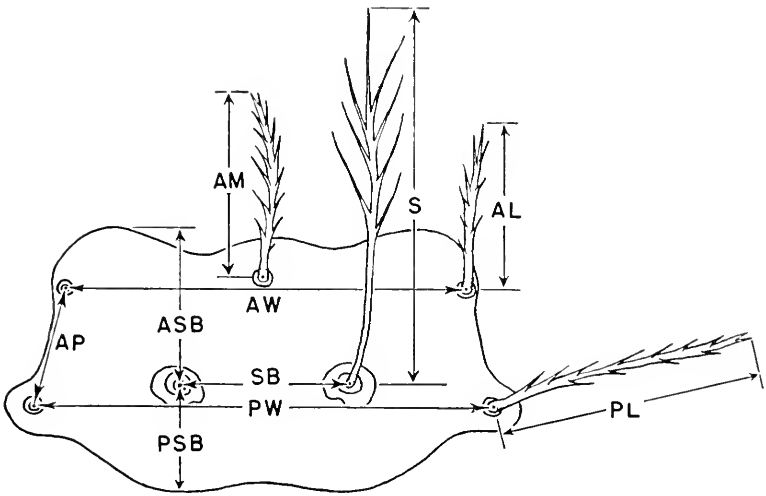


FIG. 2. Scutal plate, sensilla and scutal setae of *T. g. gurneyi*, illustrating the measurements taken and listed under the diagnosis of each species.

AW—Anterior width
PW—Posterior width
SB—Distance between bases of sensillae
ASB—Distance from sensillary base to anterior margin
PSB—Distance from sensillary base to posterior margin
AP—Distance between bases of anterior and posterior lateral setae
AM—Length of anteromedian seta
AL—Length of anterolateral seta
PL—Length of posterolateral seta
S—Length of sensilla

The center of the base of the sensilla or seta is the point to which all measurements are taken.

limited to pertinent references only, a citation is given to one or more sources of more complete listings (*e. g.*, Wharton and Fuller, 1952).

The diagnosis includes the characteristics of the species which will help to separate it from other related species and from other species in Kansas. The characters are not repeated from higher categories. The total of the characteristics listed under the diagnoses from family down through the species or subspecies should provide an accurate description of the larva.

Geographic distribution summarizes by state and county all reliable reports and specimens examined of the species. The sources of records outside of Kansas are included; with the initials KU signifying unpublished records of specimens examined by me in the collection at the University of Kansas. Specimens from Kansas are listed under specimens examined or additional records.

Seasonal occurrence of larvae includes the extreme dates of recovery from Kansas both for larvae from hosts and unfed larvae taken on chigger samplers. The times of greatest abundance and of regular occurrence are also given for the common species.

Specimens examined are those larvae examined by the author. The total number of larvae examined from Kansas is listed first, followed by the data on these larvae under COUNTY, exact locality (except when noted otherwise), host, date on which the host was obtained, and the number of larvae examined (in parentheses). Unless otherwise stated, the specimens are in the Snow Entomological Museum, University of Kansas. The counties, and the towns in each county are arranged alphabetically with the locality closest to the town listed first. The host names consist of the genus and species, following these and other general references; Mammals of Kansas (Cockrum, 1952), Fourth A. O. U. check list of North American birds, 1931, and supplements in the Auk (1944-1954), A check list of North American amphibians and reptiles (Schmidt, 1953), and the Handbook of amphibians and reptiles of Kansas (Smith, 1950). The reader is referred to these and other taxonomic papers to determine the recognized subspecies, using the locality as the basis of the subspecific determination for the mammals, reptiles and amphibians. The birds were not determined to subspecies, but other vertebrates were identified to subspecies for the majority of the specimens, and these determinations in general followed the published reports.

Additional records include those larvae not examined by the author, but which seem to be reliable reports from Kansas. The source is given in addition to all available data.

Maps illustrate the known localities for all of the species in Kansas. Solid circles, squares or triangles are placed at the exact localities based on larvae reported under specimens examined. Open symbols represent localities based on literature records cited under additional records. Type localities are indicated by a second outline around the symbol. See the legend of each map.

Tables of vertebrate hosts and their chiggers, are separated by area, and give the species of host, the month of host recovery and the species of larval chiggers obtained. The methods of recovery, unless otherwise noted, are those given under Methods. The period of capture was from 1947 to the spring of 1954. The exact dates of larval recovery can be found under specimens examined for all species except *T. alfreddugèsi* and *T. lipovskyi*. The total number of larvae listed in the tables usually differs from those listed under specimens examined since few of the large numbers of larvae of the common species were mounted for identification. Under each species of chigger is the total number of larvae taken from the host species for that month. The number of hosts for that particular species of chigger is given below in parentheses when it differs from the total number of hosts. The number of hosts listed with chiggers refers to the individuals possessing one or more larvae of one or more species.

CHECK LIST OF THE CHIGGER MITES OF KANSAS

PHYLUM ARTHROPODA

SUBPHYLUM CHELICERATA

CLASS ARACHNIDA

ORDER ACARINA

SUBORDER TROMBIDIFORMES

FAMILY TROMBICULIDAE EWING

SUBFAMILY LEEUWENHOEKIINAE Womersley
- GENUS LEEUWENHOEKIA Oudemans
  - Subgenus *Comatacarus* Ewing
    - *Leeuwenhoekia americana* (Ewing)
- GENUS ACOMATACARUS Ewing
  - Subgenus *Acomatacarus* Ewing
    - *Acomatacarus arizonensis* Ewing
    - *Acomatacarus galli* Ewing
  - Subgenus *Xenacarus* Greenberg
    - *Acomatacarus plumosus* Greenberg
- GENUS WHARTONIA Ewing
  - *Whartonia senase* (Greenberg)
- GENUS HANNEMANIA Oudemans
  - *Hannemania eltoni* Sambon
  - *Hannemania dunni* Sambon
  - *Hannemania multifemorala* sp. nov.

SUBFAMILY TROMBICULINAE Ewing
- GENUS TROMBICULA Berlese
  - Subgenus *Eutrombicula* Ewing
    - Batatas Group
      - *Trombicula batatas* (Linnaeus)
    - Wichmanni Group
      - *Trombicula alfreddugèsi* (Oudemans)
      - *Trombicula lipovskyana* Wolfenbarger
      - *Trombicula splendens* Ewing
  - Subgenus *Leptotrombidium* Nagayo *et al.*
    - *Trombicula myotis* Ewing
    - *Trombicula twentei* Loomis
  - Subgenus *Neotrombicula* Hirst
    - Microti Group
      - *Trombicula lipovskyi* Brennan and Wharton
      - *Trombicula whartoni* Ewing
    - Fitchi Group
      - *Trombicula fitchi* Loomis
      - *Trombicula kardosi* Loomis
    - Ungrouped species
      - *Trombicula sylvilagi* Brennan and Wharton
  - Subgenus *Miyatrombicula* Sasa *et al.*
    - *Trombicula cynos* Ewing
    - *Trombicula jonesae* Brennan
  - Subgenus *Euschöngastoides* Loomis
    - *Trombicula hoplai* Loomis
  - Subgenus *Trombicula, sensu lato*
    - Montanensis Group
      - *Trombicula montanensis* Brennan
      - *Trombicula arenicola* Loomis
    - Gurneyi Group
      - *Trombicula gurneyi gurneyi* Ewing
      - *Trombicula gurneyi campestris* Loomis
      - *Trombicula kansasensis* Loomis
    - Trisetica Group
      - *Trombicula trisetica* Loomis and Crossley
      - *Trombicula crossleyi* Loomis
    - Ornata Group
      - *Trombicula ornata* Loomis and Lipovsky
- GENUS SPELEOCOLA Lipovsky
  - *Speleocola tadaridae* Lipovsky

GENUS EUSCHÖNGASTIA Ewing
Subgenus *Euschöngastia* Ewing
Euschöngastia setosa (Ewing)
Euschöngastia pipistrelli Brennan
Euschöngastia jonesi Lipovsky and Loomis
Ungrouped *Euschöngastia*
Euschöngastia peromysci Ewing
Euschöngastia diversa Farrell
Euschöngastia criceticola Brennan
Euschöngastia cynomyicola Crossley and Lipovsky
Euschöngastia trigenuala Farrell
Euschöngastia lacerta Brennan
Euschöngastia loomisi Crossley and Lipovsky
GENUS PSEUDOSCHÖNGASTIA Lipovsky
Pseudoschöngastia hungerfordi Lipovsky
Pseudoschöngastia farneri Lipovsky
GENUS CHELADONTA Lipovsky *et al.*
Cheladonta micheneri Lipovsky, Crossley and Loomis
GENUS NEOSCHÖNGASTIA Ewing
Neoschöngastia americana (Hirst)
Neoschöngastia brennani Crossley and Loomis
SUBFAMILY WALCHIINAE Ewing
GENUS WALCHIA Ewing
Walchia americana Ewing

ACCOUNTS OF SPECIES AND SUBSPECIES

FAMILY TROMBICULIDAE Ewing

Ewing, Proc. Biol. Soc. Washington, vol. 57, Nov. 30, 1944, p. 101.

Diagnosis.—Larvae with dorsal plate or scutum at level of anterior two pairs of legs, bearing 3 to 6 marginal scutal setae (rarely more), and a pair of sensillae or pseudostigmatic organs arising from sensillary bases or pseudostigmata near center of plate; usually one pair of eyes on ocular plate on each side of scutum; body with several rows of dorsal setae and several rows of ventral setae; occasionally body with a pair of tracheal trunks opening through stigmata in region of gnathosoma; chelicera with two segments, basal segment stout and muscular, distal part a sclerotized curved blade with or without toothlike projections; palps with five segments, first segment of each palp fused at midline and projecting anteriorly over chelicera as a winglike galea with a galeal seta, basal segment bearing a pair of setae, palpal femur (second segment) and genu (third segment) each with 1 seta, tibia (fourth segment) with 3 setae (dorsal, lateral and ventral), and terminal palpal claw; tarsus (fifth segment) articulating ventrally with tibia, with several setae (usually 8) including basal striated tarsala (and occasionally nude subterminala); three pairs of legs, each with six segments (coxa, trochanter, femur, genu, tibia and tarsus) if femur undivided, or seven segments if femur divided into basifemur and telefemur; legs terminating with paired slender curved claws, usually with a claw-like empodium between them; tarsi I and II each with 1 stout striated seta or tarsala (rarely more than 1), and 1 short pointed seta or microtarsala, all leg segments with at least 1 branched seta, with stout nude setae usually present on genu and tibia of legs I and II, and with a sclerotized pit or urstigma at posterior edge of coxa I.

Remarks.—The family classification adopted here, based on characters exhibited by the larvae, follows Wharton and Fuller (1952:40-41). Chiggers of the subfamilies Leeuwenhoekiinae, Trombiculinae and Walchiinae occur in Kansas whereas those of a fourth, the Apoloniinae, have not been found in the state.

Womersley (1952:13-19) restricted the family name Trombiculidae to the Trombiculinae and Gahrliepiinae (= Walchiinae), and placed the Leeuwenhoekiinae and Apoloniinae in a separate family, Leeuwenhoekiidae.

I prefer to retain the older classification until a better understanding of phylogeny can be attained from the studies of the trombiculid nymphs and adults and from comparisons between the various stages of all subfamilies and families which are closely related. Some workers advocate reducing the family Trombiculidae to the rank of a subfamily, in the family Trombidiidae, while others advocate elevating many of its subfamilies to family rank. It seems both convenient and practical, however, to retain Trombiculidae as a family at this time.

Larvae of this family have been found attached to many land vertebrates, including amphibians, reptiles, birds, and mammals. Occasional occurrence on millipedes and scorpions, which do not seem to be the normal hosts, illustrates the wide host tolerance of at least some of the trombiculids.

The family is widespread throughout the world, commonly occurring in the regions which have temperate or tropical climates. Larvae have been taken as far north as southern Alaska and southward to southern South America in the Western Hemisphere. They occur in regions of varied habitat, from low hot dry deserts to high cool mountains.

KEY TO SUBFAMILIES OF TROMBICULIDAE IN KANSAS

1. Leg I with six segments, 2 setae on coxa I; scutum with paired anterior submedian setae .... Leeuwenhoekiinae p. 1231
1′ Leg I with seven segments, 1 seta on coxa I; scutum with 1 or no anteromedian seta 2
2. Scutum with 1 anteromedian seta; legs II and III with seven segments (six segments, with femora fused incompletely or completely, in *Pseudoschöngastia*) .... Trombiculinae p. 1250
2′ Scutum without anteromedian seta; legs II and III with six segments. Walchiinae p. 1362

SUBFAMILY LEEUWENHOEKIINAE Womersley

Womersley, Trans. Royal Soc. So. Australia, vol. 68, 1944, p. 102.

Diagnosis.—Larvae with all legs six-segmented; coxa I with 2 setae; sensillae flagelliform; scutum with 2 anteromedian setae (except *Odontacarus* *), and frequently with an anterior median projection or nase.

Species in Kansas have 6 marginal setae on scutum; palpal segments with setae branched or feathered (lateral tibial seta nude in *Hannemania*); palpal claw with 3 prongs (possibly 4 prongs in *A. galli*); leg I with trochanter having 1 branched seta, femur with 6 branched setae (and 1 femorala in *H. dunni* and *H. multifemorala*); genu with 4 or 5 branched setae, 1 to 11 genualae and 1 microgenuala, tibia with 8 or 9 branched setae, 2 tibialae and 1 microtibiala (absent in *W. senase*), tarsus with numerous branched setae, tarsala, microtarsala, pretarsala (subterminala and parasubterminala present or absent); leg II with coxa and trochanter each with 1 branched seta, femur with 5 branched setae, genu with 4 branched setae (5 in *A. galli*) and 1 to 5 genualae and/or 1 microgenuala, tibia with 6 branched setae and 2 tibialae, tarsus with numerous branched setae, tarsala, microtarsala, and pretarsala; leg III coxa and trochanter each with 1 branched seta; femur with 4 branched setae (and 2 to 5 femoralae in *H. multifemorala*), genu with 4 or 5 branched setae and without to 8 genualae, tibia with 6 branched setae and 1 tibiala, tarsus with numerous branched setae (1 mastitarsala in *A. arizonensis* and *A. galli*), all empodia clawlike.

Remarks.—Wharton and Fuller (1952) recognize six genera in this subfamily, and recently Jameson and Toshioka (1953:89) proposed an additional genus, *Shunsennia.* All seven genera are present in the United States. *Acomatacarus* Ewing, *Hannemania* Oudemans, *Leeuwenhoekia* Oudemans and *Whartonia* Ewing have

* Wharton and Fuller (1952:103) state that the genus *Odontacarus* is "probably a synonym of *Acomatacarus* (*Acomatacarus*). Specimens in existence are too badly damaged to study satisfactorily."

been found in Kansas but *Shunsennia, Chatia* Brennan, and *Odontacarus* Ewing have not. The subfamily is distributed throughout the warmer parts of the world, being known from every continent.

The Leeuwenhoekiinae seems to be an old group of generalized and specialized genera.

Larvae of this subfamily occur on amphibians, reptiles, birds and mammals, with one species, *Acomatacarus paradoxus* André, being recorded from a scorpion.

LEEUWENHOEKIINAE IN KANSAS

In Kansas, the genera of the subfamily Leeuwenhoekiinae can be separated into three groups on the basis of morphology, geographic distribution, ecological associations and the host preferences of the larvae.

The first group consists of the genus *Hannemania,* having three species in Kansas. The larvae of this genus have a greatly modified cheliceral blade, have salivary glands and lack tracheae and stigmata. Outside of Kansas the genus occurs principally to the south in regions which are generally warm and humid. The active unfed larvae appear only in warm weather and only parasitize amphibians. They penetrate and engorge within the layers of the skin, and may remain embedded for from several weeks to several months through the winter.

The second group consists of the genus *Leeuwenhoekia,* with one species known from northwestern Kansas. The larva has a simple cheliceral blade with only a tricuspid cap and lacks tracheae and stigmata. Its distribution (in North America) is principally northern, and the environment of the hosts seems to be moist. The known hosts are mammals. The cheliceral blade does not need teeth to penetrate the softer less resistant skin of the mammalian host whereas teeth appear to be advantageous for penetrating the more resistant reptilian epidermis or for burrowing into amphibian skin. The larvae were found in late fall in Kansas; earlier at higher altitudes in Colorado and to the north.

Other northern genera which lack pronounced teeth on the cheliceral blades and lack tracheae and stigmata are *Chatia* and *Shunsennia.* They lack the scutal nase and seem not to be closely related to *Leeuwenhoekia.*

The third group consists of *Whartonia* and *Acomatacarus,* the latter with two subgenera, *Acomatacarus* and *Xenacarus,* in Kansas. These genera have been found only in the western two thirds of the State. The species of these genera have serrate cheliceral blades, with at least one row of teeth, and have tracheae and stigmata. The distribution in North America is to the west and south where the climate is generally hot and dry. Hosts include reptiles, birds and mammals. The larvae appear in spring, summer and autumn.

The loss of the tracheae and stigmata in the larvae seems to be correlated with moist and cool habitats, the respiration being carried on through the cuticle. In the hot dry regions the larvae have retained functional tracheae and their cuticle seems thicker and would presumably reduce effective respiration through the body surface. This would help to avoid desiccation. It seems that the larvae with tracheae and stigmata are not able to persist in moist or wet situations. The species of Leeuwenhoekiinae without tracheae and stigmata do not seem to be successful in hot, dry areas, possibly due to rapid desiccation of the larvae.

KEY TO GENERA AND SPECIES OF LEEUWENHOEKIINAE IN KANSAS

1. Scutum without anterior median projection . . . *Whartonia senase* p. 1241
1′ Scutum with anterior median projection 2
2. Cheliceral blade with teeth restricted to terminal tricuspid cap. *Leeuwenhoekia (Comatacarus) americana* p. 1234
2′ Cheliceral blade with teeth not restricted to terminal tricuspid cap 3
3. Cheliceral blade not expanded distally, with various types of teeth. *Acomatacarus* 6
3′ Cheliceral blade expanded distally, with a series of teeth on expanded part (on Amphibia only) . . . . *Hannemania* 4
4. Femora I without nude seta (femorala) . . . . *H. eltoni* p. 1243
4′ Femora I with 1 nude seta (femorala) 5
5. Femora III with nude setae (2 to 5 femoralae) . *H. multifemorala* p. 1247
5′ Femora III without nude setae (femoralae) . . . . *H. dunni* p. 1246
6. Cheliceral blade with three rows of teeth (dorsal, lateral and ventral), teeth large and numerous . . . . *A. (Xenacarus) plumosus* p. 1240
6′ Cheliceral blade with two rows of teeth (dorsal and ventral), teeth small and few . . . . (*Acomatacarus*) 7
7. Sensilla branched on distal third, tarsus II with knobbed tarsala. *A. arizonensis* p. 1236
7′ Sensilla nude, tarsus II with normal tarsala . . . . *A. galli* p. 1238

GENUS LEEUWENHOEKIA Oudemans

Leeuwenhoekia Oudemans, Ent. Berichten, vol. 3, March 1, 1911, p. 138, type *Heterothrombidium verduni* Oudemans.

Diagnosis.—Larvae with cheliceral teeth restricted to tricuspid cap and scutum with anterior median projection.

Remarks.—The two subgenera currently recognized are found only in North and South America. The subgenus *Comatacarus*

Ewing is known from the United States and Canada. The genus seems to be most closely related to the genus *Acomatacarus.* Larvae have been found only on mammals.

Subgenus *Comatacarus* Ewing

Comatacarus Ewing, Jour. Parasit., vol. 28, Dec. 11, 1942, p. 489, type *Comatacarus americanus* Ewing.

Diagnosis.—Larva lacking both stigmata and tracheae.

Leeuwenhoekia americana (Ewing)

(Fig. 13, Map 2)

Comatacarus americanus Ewing, Jour. Parasit., vol. 28, Dec. 11, 1942, p. 490, fig. 7, type from Portland, Multnomah County, Oregon, host 'western mole' (= *Scapanus* sp.), May 20, 1936; Jameson, Jour. Mamm., vol. 31, May, 1950, p. 140.

Leeuwenhoekia (Comatacarus) americanus, Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 96; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, p. 163.

Diagnosis.—Larva with body moderate in size, yellow in life; eyes 2/2, red in life; sensilla nude; palpal tibia with all setae branched (lateral tibial seta nude in typical specimens, according to Brennan, *in litt.*); palpal claw trifurcate; palpal tarsus with 5 branched setae; leg I with 2 long genualae, 1 long microgenuala, 1 microtibiala, subterminala and parasubterminala; leg II with 2 genualae; leg III with 1 genuala (without long nude whiplike setae).

Scutal measurements, average and extremes, of 5 larvae from Cheyenne County: AW- 69 (68-71), PW- 81 (78-85), SB- 26 (24-27), ASB- 33 (31-36), PSB- 25 (23-27), AP- 36 (35-38), AM- 44 (43-45), AL- 53 (50-59), PL- 46 (45-47), S- 76 (71-81).

Taxonomic remarks.—Two differences were noted between the larvae from western Colorado (Archuleta and Mesa counties) and those from northwestern Kansas. The lateral tibial seta of the palpus is nude in the former and branched in the latter. There is also a difference in the lengths and ratios of tarsalae I and II. The specimens from western Colorado have a tarsala I of 17 microns and tarsala II of 21 microns, (ratio of 1.2), whereas the specimens from Kansas have a tarsala I of 17 microns and a tarsala II of 25 microns (ratio of 1.4). The specimens from eastern Colorado (Boulder County) which are intermediate geographically, have the palpal lateral tibial setae branched, but the ratio of tarsalae I and II is 1.3, indicating an intermediate condition morphologically. Dr. Brennan examined a specimen from Kansas and was the first to point out the above differences. He compared the Kansas specimen with notes on the type of *L. americana* and with other specimens in the collection of the Rocky Mountain Laboratory. From his information, the characters exhibited by the specimens from western Colorado are similar to the typical specimens of *L. americana.* The specimens from Kansas probably represent a subspecies.

Geographic distribution. — Known from northwestern Oregon (Multnomah County, Ewing, 1942), California (Monterey County, Brennan and Jones, 1954), eastward to southern Ontario, Canada (Welland County, Jameson, 1950), south to southeastern Alabama (Dale County, Ewing, 1942), Colorado (Archuleta, Boulder and Mesa counties, KU), and northwestern Kansas (Cheyenne County).

Seasonal occurrence.—Larvae were taken from hosts in Kansas on November 2, 1952. Specimens from Colorado were found in August and November.

Ecology.—The larvae taken in northwestern Kansas were found attached to the outer surfaces near the tips of the ears of *Peromyscus maniculatus* and *Reithrodontomys megalotis.* Several of these larvae were partially or fully engorged. The hosts were trapped in meadow situations along the Arikaree River which was dry at that time, due to a widespread drouth. The larvae probably appear regularly in late fall and winter in Kansas.

In addition to the 'western mole' (= *Scapanus* sp.), *Peromyscus maniculatus* and *Reithrodontomys megalotis* listed above, this species has been taken from a "cotton mouse" (Ewing, 1942:490) in Alabama, *Neotoma cinerea* and *Neotoma mexicana* in Colorado, *Blarina brevicauda* in Canada (Jameson 1950:140), and *Spermophilus beecheyi, Thomomys bottae* and *Microtus californicus* in California (Brennan and Jones, 1954:163).

Jameson (*loc. cit.*) stated that larvae of this species commonly infested *Blarina* and were found deeply embedded in the skin of the inguinal region.

Specimens examined.—Total, 10 larvae, as follows: CHEYENNE CO.: 15 mi. N, 11.5 mi. W St. Francis, Nov. 2, 1952, *Peromyscus maniculatus* (6) and *Reithrodontomys megalotis* (4).

GENUS ACOMATACARUS Ewing

Acomatacarus Ewing, Jour. Parasit., vol. 28, Dec. 11, 1942, p. 490, type, *Acomatacarus arizonensis* Ewing.

Diagnosis.—Larvae with scutum having anterior median projection (nase), cheliceral blade with from one to three rows (dorsal, ventral and lateral) of toothlike serrations on relatively unmodified blade.

Remarks.—This genus has a world wide distribution, being common in the warmer regions. There are five subgenera according to Wharton and Fuller (1952:96), and two of these, *Acomatacarus* Ewing and *Xenacarus* Greenberg, occur in Kansas; the other three have been found only in Africa.

Subgenus *Acomatacarus* Ewing

Diagnosis.—Larvae with tracheae and stigmata; cheliceral blade with few small teeth on dorsal and ventral edges, without median row of teeth; scutum relatively long; body setae not plumose.

Larvae from Kansas having eyes 2/2, red; palpal tibia with dorsal and ventral setae branched; leg I with 1 microgenuala and 1 microtibiala, leg II with 1 microgenuala, leg III with 1 mastitarsala (without genuala).

Remarks.—This subgenus has been found on every continent, with nine species known at present from North America. Two of these have been taken in the western half of Kansas.

Acomatacarus arizonensis Ewing

(Figs. 14-15, Map 2)

Acomatacarus arizonensis Ewing, Jour. Parasit., vol. 28, Dec. 11, 1942, pp. 490-91, figs. 8-9, type from near Wickenburg, Maricopa County, Arizona, host *Callisaurus draconoides*, May 11, 1937; Hoffmann, Rev. Soc. Mex. Hist. Nat., vol. 10, 1949, p. 190; Brennan, Jour. Parasit., vol. 35, Sept. 30, 1949, pp. 467-471; Greenberg, Ann. Ent. Soc. Amer., vol. 45, Oct. 25, 1952, pp. 479-80; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 97.

Diagnosis.—Larva with body moderate in size, red in life; ventral ganglion dark red and clearly visible in life; sensilla branched on distal half; cheliceral blade with 5-7 dorsal teeth and 1 ventrolateral tooth; palpal tibia with lateral seta branched; palpal claw trifurcate, palpal tarsus with 5 branched setae; leg I with 2 genualae, and tarsala long (33μ); leg II with tarsala (18μ) having distal knob.

Scutal measurements of 2 larvae from Barber and Comanche counties: AW- 48, 50; PW- 57, 64; SB- 20, 20; ASB- 25, 25; PSB- 14, 16; AP- 20, 21; AM- 27, 27; AL- 20, 20; PL- 25, 26; S- 53, 56.

Geographic distribution.—Known from Mexico * (Hoffmann, 1949) in Baja California (Cedros Island) and Guerrero, and from the United States in California (Riverside County, KU; Kern County, Brennan, 1949), southern Arizona (Maricopa County, Ewing, 1942; Cochise County, KU), southeastern Utah (Grand County, KU), southwestern Colorado (Mesa County, KU), south-

* These Mexican records actually may refer to one and possibly two other closely related species, according to Greenberg (1952:480).

central Texas (Bexar County, KU), north-central Oklahoma (Woods County, KU) and south-central Kansas (Barber and Comanche counties).

Seasonal occurrence.—Larvae have been taken from collared lizards in Kansas in September and early October. Collections in other states have been made in the summer.

Ecology.—This chigger inhabits hot dry regions of southwestern United States, and the larvae have been found only on lizards. Two of the genera most commonly parasitized are *Sceloporus* and *Crotaphytus;* larvae are known from *Callisaurus draconoides* and *Sceloporus jarrovii* (Arizona); *Dipsosaurus dorsalis, Phrynosoma coronatum* and *Sceloporus magister* (California); *Uta stansburiana* (Colorado); and *Crotaphytus collaris* (Kansas, Oklahoma, Texas and Utah).

A. arizonensis was sought but not found on many snakes, birds and mammals from Barber County, Kansas when, on the same dates, larvae were found there on lizards (see the Tables for exact numbers of vertebrates examined).

Twenty-five larvae were found attached in the axillary mite pockets directly above the front legs of a juvenal collared lizard, *Crotaphytus collaris,* obtained in Barber County on September 15, 1953. This lizard took shelter beneath a sandstone rock on a dry, nearly barren slope above a deeply eroded canyon. The entire area for a hundred feet in every direction was dry, rocky, and the vegetation consisted of only a few scattered patches of short-cropped grass. The paucity of vegetation is typical of the upland plains, but in the summer of 1953, grass was especially short and sparse since there had been less than one-half inch of rain since May of that year. In general the area would seem unfavorable for any species of chigger, although this lizard also had five larvae of *Trombicula alfreddugèsi* in the mite pockets. The small size of the host lizard indicated that it had hatched only a few weeks prior to its capture, and that it probably had not yet moved far.

The larvae, which have stigmata and tracheae, were easily and rapidly drowned in a solution of detergent and water in the laboratory, and were not successfully reared in moist culture tubes. This would seem to confirm the necessity of a dry habitat for the larvae as well as other free-living stages.

The larvae remained in the mite pockets of collared lizards for from one to three weeks in the laboratory. The mite pocket is an area of soft, nearly scaleless skin covered by a large overlapping fold. This pocket protects the chiggers from exposure to direct sunlight and from desiccation. The skin under this fold seems to be thinner and more suitable for chigger attachment and feeding than the general body surface.

Specimens examined.—Total, 3 larvae, as follows. BARBER CO.: 4 mi. S Aetna, *Crotaphytus collaris,* Sept. 15, 1953 (2). COMANCHE CO.: 4 mi. W Aetna, Schwartz Canyon, *Crotaphytus collaris,* Oct. 5, 1952 (1).

Acomatacarus galli Ewing

(Fig. 16, Map 2)

Acomatacarus galli Ewing, Proc. Biol. Soc. Washington, vol. 59, March 11, 1946, pp. 25-26, pl. 4, type from Uvalde, Uvalde County, Texas, host chicken, Jan. 13, 1943; Greenberg, Ann. Ent. Soc. Amer., vol. 45, Oct. 25, 1952, p. 485, figs. 17-18; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 98.

Acomatacarus angulatus Greenberg, Ann. Ent. Soc. Amer., vol. 45, Oct. 25, 1952, pp. 485-488, figs. 8-10, type from 4 miles west and 1 mile south of Logan, Norton County, Kansas, host *Peromyscus maniculatus,* Oct. 26, 1946. *New synonymy.*

Diagnosis.—Larva with body orange to yellow in life; dorsal setae total 90-100, body setae total approximately 150, scutum with anteromedian seta shorter than anterolateral or posterolateral setae; sensilla nude; cheliceral blade with 3-5 dorsal teeth and 3 ventral teeth; palpal tibia with lateral seta nude; palpal tarsus with 7 branched setae; palpal claw with 4 prongs; leg I with 1 genuala.

Scutal measurements (after Greenberg, 1952), average and extremes, of 8 topotypes of *A. angulatus*: AW- 58 (55-59), PW- 72 (69-77), SB- 26 (25-26), ASB- 30 (26-32), PSB- 25 (23-28), AP- 26 (24-28), AM- 25 (24-26), AL- 34 (31-37), PL- 48 (45-53), S- 69 (64-71).

Taxonomic remarks.—I have placed *Acomatacarus angulatus* Greenberg with *A. galli* since I can not find characters which will separate them. Eventually it may be possible to separate the northern and southern populations as distinct subspecies on the basis of measurements, but the material examined does not warrant this arrangement at the present time. Greenberg (1952) separated these two supposed species on the differences in the measurements of the scutum and certain setae. He found that the northern specimens had slightly smaller measurements and named them *A. angulatus.* He did not have the larvae from Oklahoma. These are geographically intermediate and their measurements overlap those of the specimens from Kansas and Texas. Additional material from Texas has shown a considerable amount of variation, demonstrating that supposed differences in measurements between these two populations are not alone sufficient justification for retention of *A. angulatus* as a separate species or even a subspecies.

Geographic distribution.—Known from the Great Plains in southern Texas (Uvalde County, Ewing, 1946; and Bexar County, KU), central Oklahoma (Cleveland County, KU) and northwestern Kansas (Norton County).

Seasonal occurrence.—Larvae have been taken in Kansas in late October. Records from the other states are as follows: November and December (Oklahoma), January, March and April (Texas).

Ecology.—Little is known concerning this species in Kansas. In Norton County, larvae were taken from several deer mice and a rabbit, presumably from the ears. The unengorged active larvae probably appear in the late autumn, attach to the hosts, engorge rapidly and drop from them soon after engorgement.

Larvae of this species were not taken from any of the many mammals examined from central and western Kansas in April, July, August or September.

Larvae of this species from central Oklahoma were taken from hosts, *Neotoma floridana* and *Sylvilagus floridanus,* in November and early December, but were absent from these same kinds of hosts examined from this same general area in late December, January and February. This tends to support the idea that the larvae appear in late fall and remain attached upon the hosts for only a short time.

The hosts of this species include the "chicken," *Peromyscus maniculatus* in Kansas, *Sylvilagus floridanus* in Oklahoma and Kansas, *Sylvilagus audubonii* and *Lepus californicus* in Texas, and *Neotoma floridana* in Oklahoma. It seems that rabbits are important hosts throughout the range.

Specimens examined.—Total, 20 larvae, as follows. NORTON CO.: 4 mi. W, 1 mi. S Logan, *Peromyscus maniculatus,* Oct. 26, 1946 (18); 5 mi. W, 1 mi. N Logan, *Sylvilagus floridanus,* Oct. 26, 1946 (2).

Subgenus *Xenacarus* Greenberg

Xenacarus Greenberg, Jour. Parasit., vol. 37, Dec. 31, 1951, p. 525, type *Acomatacarus (Xenacarus) plumosus* Greenberg.

Diagnosis.—Larvae with tracheae and stigmata; cheliceral blade with two rows (dorsal and ventral) of large prominent toothlike ridges and a third row (lateral) of small serrations (in *A. plu-*

mosus); scutum short, wide and with a short anterior median nase; and body with plumose setae having long branches.

Remarks.—The two species (*A. plumosus* and *A. brevicalcar* Brennan and Jones) have been taken from mammals in Kansas and California, respectively.

Acomatacarus plumosus Greenberg

(Figs. 20-21, Map 3)

Acomatacarus (Xenacarus) plumosus Greenberg, Jour. Parasit., vol. 37, Dec. 31, 1951, pp. 525-527, pl. 1, type from 4 miles south of Aetna, Barber County, Kansas, host *Peromyscus leucopus* (recorded as *P. maniculatus* by Greenberg), April 13, 1949; Greenberg, Ann. Ent. Soc. Amer., vol. 45, Oct. 25, 1952, p. 477; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 101.

Diagnosis.—Larva with body whitish in life, having shoulders; setae plumose, total approximately 180; eyes 2/2, red in life; sensilla flagelliform with basal barbs and approximately 14 long distal branches; cheliceral blade with third row of several small lateral teeth; palpal tibia with all three setae branched; palpal claw trifurcate; palpal tarsus with 5 branched setae; leg I with 2 genualae, 1 microgenuala, (subterminala and parasubterminala absent); leg II with 1 microgenuala and 2 tibialae; leg III without long nude whiplike setae.

Scutal measurements (modified and expanded from Greenberg, 1951), average and extremes, of 8 topotypes; AW- 78 (74-80), PW- 87 (83-98), SB- 37 (35-39), ASB- 17 (14-19), PSB- 16 (11-21), AP- 14 (11-15), AM- 27 (25-30), AL- 37 (26-44), PL- 41 (39-42), S- 58 (55-61).

Geographic distribution.—Known only from central Kansas (Barber and Russell counties).

Seasonal occurrence.—Larvae have been taken from hosts in early April to mid-September.

Ecology.—This species has been found only on mammals taken from rocky situations, with the exception of a single larva found on *Dipodomys ordii.* In Barber County, this chigger was commonly found on *Peromyscus leucopus*, *P. maniculatus* and *Neotoma micropus* trapped in the sandstone, gypsum canyons. For a summary of the chiggers taken from vertebrates in Barber County, see the tables under hosts.

A field trip to Russell County in April of 1952, resulted in recovery of this species from several *Peromyscus maniculatus*, which were found under large limestone slabs on slopes bordering upland prairie. However, larvae were not obtained from the four *Syl-*

vilagus floridanus and five *Neotoma floridana* that were taken in the same general area, at the same time.

The larvae were found principally in and on the ears of the hosts.

Specimens examined.—Total, 79 larvae, as follows. BARBER CO.: 4 mi. S Aetna, *Dipodomys ordii,* Sept. 14, 1953 (1) -*Sylvilagus floridanus,* Sept. 14, 1953 (1), -*Peromyscus leucopus,* April 13, 1949 (8), July 25-26, 1952 (2), Aug. 24, 1949 (2), Sept. 15-16, 1953 (12), and *Neotoma micropus,* April 11-14, 1949 (1), Aug. 22, 1949 (8), Sept. 15-16, 1953 (25); 5 mi. S Sun City, *Neotoma micropus,* April 12, 1949 (6), Sept. 14, 1948 (3) and *Peromyscus maniculatus,* April 12, 1949 ((1); 5 mi. S, 3 mi. E Aetna, *Neotoma micropus,* July 25, 1952 (1). RUSSELL CO.: *Peromyscus maniculatus,* April 26-27, 1952, 5 mi. N, 2 mi. E Gorham, (1); 7½ mi. S, 2 mi. E Russell, (3); 9 mi. S Russell, (4).

GENUS WHARTONIA Ewing

Whartonia Ewing, Proc. Biol. Soc. Washington, vol. 57, Nov. 30, 1944, p. 102, type *Hannemania nudosctosa* Wharton.

Diagnosis.—Larvae with tracheae and stigmata; scutum lacking anterior median nase; and cheliceral blade with a series of ventral (and occasionally dorsal) teeth.

Remarks.—Four species were placed in this genus by Wharton and Fuller (1952). A fifth species from Kansas, described as *Acomatacarus senase* Greenberg, is included in this genus on the basis of characters listed above. Four species occur in North America, while the fifth is known from the Solomon Islands.

The larvae of this genus have usually been found on bats, although one species (*W. whartoni* Hoffmann) occurs on small terrestrial rodents.

Whartonia senase (Greenberg) *new combination*

(Figs. 17-19, Map 4)

Acomatacarus senase Greenberg, Ann. Ent. Soc. Amer., vol. 45, Oct. 25, 1952, p. 484, figs. 5-7, type from 4 miles south of Aetna, Barber County, Kansas, host *Neotoma micropus,* April 11, 1949.

Diagnosis.—Larva with body large, dorsal setae 52, total setae about 108; eyes 2/2; sensilla flagelliform with several distal branches; cheliceral blade with 4 ventral teeth, dorsal teeth absent; galeal seta branched; palpal tibia with 3 branched setae; palpal tarsus with 4 branched setae; palpal claw trifurcate; leg I with 2 genualae, 1 microgenuala and 2 tibialae; leg II with 1 genuala; leg III with 1 genuala. Similar to *Whartonia perplexa* (Brennan) but differing from it in having only a ventral row of cheliceral teeth (several dorsal teeth in *W. perplexa*), without microtibiala I, subterminala and parasubterminala I (present in *W. perplexa*).

Scutal measurements (expanded from Greenberg, 1952), average and extremes, of 5 topotypes: AW- 70 (66-73), PW- 82 (78-89), SB- 31 (28-33), ASB- 27 (26-28), PSB- 19 (17-24), AP- 22 (20-23), AM- 36 (36-37), AL- 40 (38-42), PL- 58 (53-64), S- 67 (66-68 in 3).

Geographic distribution.—Known only from the type locality in south-central Kansas.

Seasonal occurrence.—The type series was obtained in early April.

Ecology.—The larvae of this species were taken from a gray wood rat, *Neotoma micropus,* and cave bats, *Myotis velifer,* caught in a canyon habitat. The bats were found in a small cave, and they may have been the principal hosts. The wood rat possibly acquired the larvae while moving about in the cave occupied by the bats. This possibility is supported in part by the presence on bats elsewhere of three other species of *Whartonia.* The free-living stages probably occur in bat caves, the larvae appearing in the early winter and/or early spring.

The bats from which the larvae were recovered were found semidormant in the cave, when the outside weather was cold and cloudy. The bats probably had not spent the entire winter in this small cave. According to John W. Twente, most of the cave bats in this area hibernate in the large McMoran Cave (Double Entrance S Cave), 2 miles to the west of the cave from which *W. senase* was taken. Cockrum (1952:58-60) reported banding 2000 of these bats in the McMoran Cave and these represented but a small fraction of the population seen by him on March 26 and 27, 1948. Three of these banded bats were found in the series from which the larvae of *W. senase* were recovered. This would seem to indicate that the group of several hundred cave bats examined for chiggers probably lived and hibernated in the large McMoran Cave.

Specimens examined.—Total, 7 larvae, as follows: BARBER CO.: 4 mi. S Aetna, April 10-11, 1949, *Neotoma micropus* (4) and *Myotis velifer* (3).

GENUS HANNEMANIA Oudemans

Hannemania Oudemans, Ent. Berichten, vol. 3, March 1, 1911, p. 137, type *Heterothrombidium hylodeus* Oudemans.

Diagnosis.—Larvae without tracheae and stigmata; with well-developed salivary ducts (resembling tracheae); cheliceral blades expanded distally, with a series of pronounced toothlike serrations on expanded part; scutum with anterior median projection or nase.

Species in Kansas with engorged body large, red to orange in life; eyes 2/2, red in life; sensillae flagelliform slender and nude; galeal seta with several slender branches; palpal femur, genu and tibia with seta having several slender branches; lateral tibial seta occasionally nude or with single branch; palpal tarsus with 6 branched setae; palpal claw trifurcate; leg I with 7 to 11 genualae, 1 microgenuala, 2 tibialae, 1 microtibiala, subterminala and parasubterminala; leg II with 3 to 5 genualae, and 2 tibialae, leg III with 5 to 8 genualae and 1 tibiala.

Remarks.—Fourteen species of this genus were listed by Wharton and Fuller (1952). The genus is widespread in the New World. One species has been described from New Caledonia, and a second possible Old World species was reported from Europe.

In Kansas, this genus is represented by three species; *H. eltoni* is statewide, *H. multifemorala* is known from the eastern two thirds of the State and *H. dunni* is known only from south-central Kansas. The larvae, which are parasitic only on amphibians, penetrate the skin of the host and remain embedded within it until engorged. This behavior differs from that of other chiggers which merely insert the chelicerae into the skin of the host.

Hannemania eltoni Sambon

(Map 5)

Hannemania eltoni Sambon, Ann. Trop. Med. and Parasitol., vol. 22, 1928, p. 129, type from San Antonio, Bexar Co., Texas, host *Rana sphenocephala* (= *Rana pipiens*).

Diagnosis (based on specimens from Kansas).—Larva with scutum having PL seta long (45-50μ); leg I with 10 genualae; leg II with 5 genualae; leg III with 5 genualae.

Scutal measurements, average and extremes, of 4 larvae from Douglas County: AW- 43 (41-46), PW- 59 (57-61), SB- 22 (21-23), ASB- 34 (32-35), PSB- 25 (24-27), AP- 20 (19-21), AM- 21 (20-21), AL- 31 (30-33), PL- 47 (45-49), S- 70 (68-71).

Taxonomic remarks.—The name *H. eltoni* has been used for this species as diagnosed above, on the basis of a series of specimens from 18 miles NNW of San Antonio, Bexar County, Texas, the same county as the type locality. Although two other species, *H. dunni* and *H. multifemorala,* occur in Texas, neither species has been taken near Bexar County. The original description of *H. eltoni* does not permit specific identification and the type specimens seem to be lost.

Several larvae possessed one femorala III on one of the legs. In each example it had replaced a branched seta, since only three other setae were present on the segment. The normal number of branched setae on femur III is four. *H. multifemorala* which has one to five femoralae III also normally possesses four branched setae.

Geographic distribution.—Known from southern Texas (Bexar County, Sambon, 1928, and KU), Oklahoma (LeFlore, Wagoner and Woods counties, KU), central Arkansas (Pope County, KU), southeastern Nebraska (Saunders County, KU) and statewide in Kansas (Cheyenne and Seward counties in the west to Leavenworth and Cherokee counties in the east).

Seasonal occurrence.—Larvae have been found on amphibians between February and October. The larvae frequently overwinter embedded within the skin of amphibians, and usually are engorged in early spring. The unengorged larvae seem to be active in the summer and early fall.

A large leopard frog, *Rana pipiens,* captured in Miami County, Kansas, on September 3, 1947, had more than one hundred larvae of *Hannemania* embedded in the skin, according to the field notes of the collector, R. B. Finley, Jr. Most of these larvae were unengorged while some were fully engorged. In addition, there were many scars where engorged larvae had recently emerged. The sites of the embedded larvae and the scars of those which had emerged were on the underside of the thighs. Sixty-eight larvae from this female frog were identified; 67 as *H. eltoni* and 1 as *H. multifemorala.*

Unengorged larvae of *H. eltoni* also were found embedded in leopard frogs taken in early September, 1948, in Seward County.

Hosts.—Larvae were recovered from *Ambystoma tigrinum, Bufo woodhousii, Acris gryllus* and *Rana pipiens.* Larvae were especially abundant on leopard frogs, *Rana pipiens,* both in numbers of individuals and in percentage of infestation, with 53 percent of the leopard frogs being positive. See Tables 3-5 for additional data on the presence and abundance of *Hannemania* on amphibians.

Habitats.—Neither free-living larvae nor postlarval stages were found in nature. The presence of larvae on the frogs, which inhabit the borders of permanent or semipermanent streams and ponds, seems to indicate that the free-living stages live in the moist soil near the water.

These chigger mites did well in moist culture tubes. A culture reared from engorged larvae obtained in Bexar County, Texas (near the type locality) reached the adult stage in approximately 66 days, and the first larvae followed in 16 days, a total of 82 days. The nymphs and adults readily fed on eggs of the collembolan, *Sinella curviseta.*

Specimens examined.—Total, 513 larvae, as follows: BARBER CO.: 5 mi. S Sun City, Sept. 14, 1948, *Acris gryllus* (5) and *Rana pipiens* (5). BOURBON CO.: 1 mi. W Ft. Scott, *Rana pipiens,* Sept. 3, 1947 (14). BUTLER CO.: 4 mi. E Augusta, Sept. 7, 1948, *Bufo woodhousii* (2) and *Rana pipiens* (1); 6 mi. S El Dorado, *Rana pipiens,* March 7, 1953 (5). CHAUTAUQUA CO.: 3 mi. NW Sedan, *Rana pipiens,* April 6, 1947 (4). CHEROKEE CO.: Galena, *Rana pipiens,* April 5, 1947 (12); 7 mi. E Baxter Springs, *Rana pipiens,* April 22, 1949 (2). CHEYENNE CO.: 4 mi. N St. Francis, *Rana pipiens,* July 22, 1948 (2). DOUGLAS CO.: Lawrence, *Acris gryllus,* Oct. 8, 1947 (6), 3 mi. S, 1 mi. E Lawrence, Haskell Bottoms, *Rana pipiens,* Feb. 22, 1950 (4), March 18, 1952 (2), March 27, 1947 (1), May 1, 1948 (1), March 18, 1952 (2), April 8, 1952 (3); 3 mi. N, 1 mi. E Lawrence, *Acris gryllus,* April 30, 1948 (10); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Acris gryllus,* March 19, 1948 (1), May 10, 1947 (5), May 18, 1947 (8), June 15, 1947 (8), July 7, 1947 (8), Aug. 18, 1947 (4), and *Rana pipiens,* May 4, 1947 (11), May 10, 1947 (3), June 7, 1948 (6), June 15, 1947 (12), June 21, 1947 (5), July 28, 1947 (15), Aug. 18, 1947 (3), Oct. 4, 1951 (4); 6 mi. NW Lawrence, *Acris gryllus,* May 3, 1947 (4). ELK CO.: 6 mi. N, 1 mi. E Howard, *Rana pipiens,* April 6, 1947 (3). GREENWOOD CO.: 1 mi. N, 1 mi. W Piedmont, *Rana pipiens,* April 7, 1947 (6). JEFFERSON CO.: 12 mi. N Lawrence,. *Rana pipiens,* Sept. 1, 1948 (15). JOHNSON CO.: Sunflower, *Acris gryllus,* March 29, 1949 (3). LEAVENWORTH CO.: 4 mi. S Lansing, April 22, 1947, *Acris gryllus,* (1) and *Rana pipiens* (3). MARSHALL CO.: 2 mi. N Marysville, *Bufo woodhousii,* May 13, 1950 (8). MIAMI CO.: 3 mi. E, 1 mi. S Fontana, Oct. 12, 1948, *Acris gryllus* (3) and *Rana pipiens* (1); 6 mi. S Louisburg, Sept. 3, 1947, *Acris gryllus* (33) and *Rana pipiens* (116). MONTGOMERY CO.: Feb. 8, 1948, *Rana pipiens* (2);

6 mi. W Coffeyville, *Acris gryllus,* April 6, 1947 (3). RAWLINS CO.: 5 mi. SW Atwood, *Ambystoma tigrinum,* April 30, 1947 (11); Atwood, *Bufo woodhousii,* Aug. 9, 1949 (6). RUSSELL CO.: 5 mi. N, 2 mi. E Gorham, *Rana pipiens,* April 27, 1952 (3). SEWARD CO.: 12 mi. NE Liberal, *Rana pipiens,* Sept. 9-10, 1948 (118).

Hannemania dunni Sambon

(Map 6)

Hannemania dunni Sambon, Ann. Trop. Med. and Parasit., vol. 22, 1928, p. 129, type from eastern United States, host *Desmognathus fuscus;* Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 102.

Hannemania penetrans Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, p. 18, type from Great Falls of Potomic, Virginia, host *Rana pipiens,* Sept. 26, 1926; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 103.

Diagnosis.—Larva similar to *H. eltoni,* but differs in having leg I with 1 femorala; leg II with 2-3 genualae (and 1 microgenuala); leg III with 2-3 genualae.

Scutal measurements, average and extremes, of 5 larvae from Barber County (2) and Woods County, Oklahoma (3): AW- 49 (44-57), PW- 74 (65-83), SB- 26 (25-30), ASB- 33 (30-35), PSB- 26 (23-29), AP- 22 (19-25), AM- 23 (22-23), AL- 30 (27-34), PL- 47 (45-49), S- 93 and 68.

Geographic distribution.—Known from Virginia (Ewing, 1931), North Carolina (Durham County, KU), northeastern Georgia (Rabun-Habershaw County line, KU), west to western Arkansas (Montgomery and Polk counties, KU), eastern Texas (Cass, Lee and McLennen counties, KU), eastern and northern Oklahoma (Le-Flore and Woods counties, KU) and south-central Kansas (Barber County).

Ecology.—This species was taken from cricket frogs obtained in September from a small stream in the Red Hills of Barber County. Larvae of *H. eltoni* also were found on these frogs.

Hosts of *H. dunni* from other states include five salamanders, *Aneides aeneus* (Georgia), *Desmognathus fuscus* (Type, Arkansas, Oklahoma and Texas), *Eurycea bislineata* (North Carolina), *Plethodon caddoensis* and *P. ouachitae* (Arkansas); one toad, *Bufo woodhousii* (Oklahoma); and five frogs, *Acris gryllus* (Oklahoma), *Rana clamitans* and *Rana palustris* (Virginia), *Rana pipiens* (Oklahoma) and *Gastrophryne olivacea* (Texas).

Specimens examined.—Total, 2 larvae, as follows. BARBER CO.: 5 mi. S Sun City, *Acris gryllus,* Sept. 14, 1948 (2).

Hannemania multifemorala sp. nov.

(Fig. 3, Map 6)

Types.—Larvae: Holotype and 26 paratypes from Douglas County, Kansas; holotype, KU slide no. 9901 and two paratypes, KU 9902-3, from *Rana pipiens*, (field no. L470818-7), obtained by L. J. Lipovsky on August 18, 1947, and 4 paratypes, KU 9904-6, from *Rana pipiens* and KU 9907 from *Acris gryllus*, all from the University of Kansas Natural History Reservation, 5 miles north and 1 mile east of Lawrence, three paratypes, KU 9908-10, host *Acris gryllus* from Lawrence, and 17 paratypes, KU 9911-9927, host *Rana pipiens* from Haskell bottoms, 3 miles south and 1 mile east of Lawrence.

Diagnosis.—Larvae similar to those of *H. eltoni*, but differs in having PL scutal setae short (36-41μ); leg I with 1 femorala and 9-14 genualae; leg II with 3-4 genualae; leg III with 2-5 femoralae and 8-13 genualae.

Description of larva.—Body: Holotype (slightly engorged) 290 by 187μ, orange in life. Eyes 2/2, subequal; on ocular plate, (length of plate 31, width 13).

Dorsal setal formula approximately 2-16-8-10-10-6-4, total 56; humeral seta measures 39, anterior dorsal seta 30, posterior dorsal seta 31. Ventral setal formula obscure, approximately 2-14-14-8-8-4-4, total 54, sternal seta measures 32, anterior ventral seta 21, ventral seta (near anus) 28. Total body setae approximately 110.

Scutum: (see Fig. 3B) Scutal measurements of holotype: AW- 43, PW- 59, SB- 23, ASB- 30, PSB- 23, AP- 16, AM- 21, AL- 27, PL- 38, S- 68. Scutal measurements, average and extremes, of 5 types: AW- 43 (39-48), PW- 56 (53-59), SB- 22 (19-23), ASB- 32 (30-35), PSB- 25 (23-26), AP- 17 (16-18), AM- 21 (19-24), AL- 26 (25-27), PL- 38 (36-39), S- 66 (64-68).

Gnathosoma: Cheliceral blade as in Figure 3A. Galeal seta with several branches, palpal segments with all setae having fine branches, lateral seta on tibia sometimes nude or with 1 branch; tarsus with 6 branched setae and tarsala (12μ), palpal claw trifurcate.

Legs: Leg I with 1 femorala, 10 (9-14) genualae, tarsala (25μ); leg II with 4 (3-4) genualae and tarsala (21μ); leg III with 3-4 (2-5) femoralae; 9-10 (8-13) genualae, without long nude whiplike setae. Leg segments with puncta.

Taxonomic remarks.—This species is extreme in numbers of nude setae on leg segments. The increased number of nude setae on any segment has not been due to the loss of branches of normal setae. All of these nude setae are on the dorsal surfaces of the segments, and in certain specimens are long, nearly as long as the branched setae or mastisetae of other species. Larvae from Erath County, Texas, had only 1 femorala III on ten specimens, although two of these had 2 femoralae on one leg. They seemed normal in other respects. The large amount of variation in numbers of these nude setae in this and other species of *Hannemania* seems unique among the Trombiculidae.

Geographic distribution.—Known from central and eastern Kansas (Russell and Butler counties east to Miami and Cherokee counties), southeastern Nebraska (Richardson County), central and western Arkansas (Little River, Logan and Pope counties); Oklahoma (Craig, Wagoner and Woods counties) and central Texas (Erath and McLennen counties).

Seasonal occurrence.—Larvae were found on frogs taken from February to October inclusive. They frequently overwinter on fiogs. Active unfed larvae probably emerge in the summer months. The larvae recovered from frogs in spring were engorged partially or fully, whereas a large number of those seen in summer and autumn were unfed or slightly engorged.

Hosts.—In Kansas, larvae were recovered from *Bufo woodhousii, Acris gryllus* and *Rana pipiens* and usually were taken in association with *H. eltoni.* See tables 4-5 and for a further summary of *Hannemania multifemorala* on amphibians.

Habitats.—This species was found only in the eastern and central parts of the State. This would seem to indicate that *H. multifemorala* is more dependent upon moisture and permanent water than is *H. eltoni.*

Larvae of these two species of *Hannemania* were taken frequently upon the same individual frog, and from series of frogs from the same locality. This seems to indicate a close proximity of the free-living stages of the two species in the soil. Permanent bodies of water exist at most of the known localities for *H. multifemorala.*

Specimens examined from Kansas.—Total, 230 larvae, as follows. BUTLER CO.: 4 mi. E Augusta, Sept. 7, 1948, *Bufo woodhousii* (6) and *Rana pipiens* (11). CHAUTAUQUA CO.: 3 mi. NW Sedan, *Rana pipiens,* April 6, 1947 (5). CHEROKEE CO.: 6 mi. E Baxter Springs, *Rana pipiens,* March 4, 1950 (4); Galena, *Rana pipiens,* April 5, 1947 (1); 2 mi. S Galena, *Rana pipiens,* Feb. 2, 1952 (16). COWLEY CO.: 2 mi. E Rock, *Rana pipiens,* March 7, 1953 (2). DOUGLAS

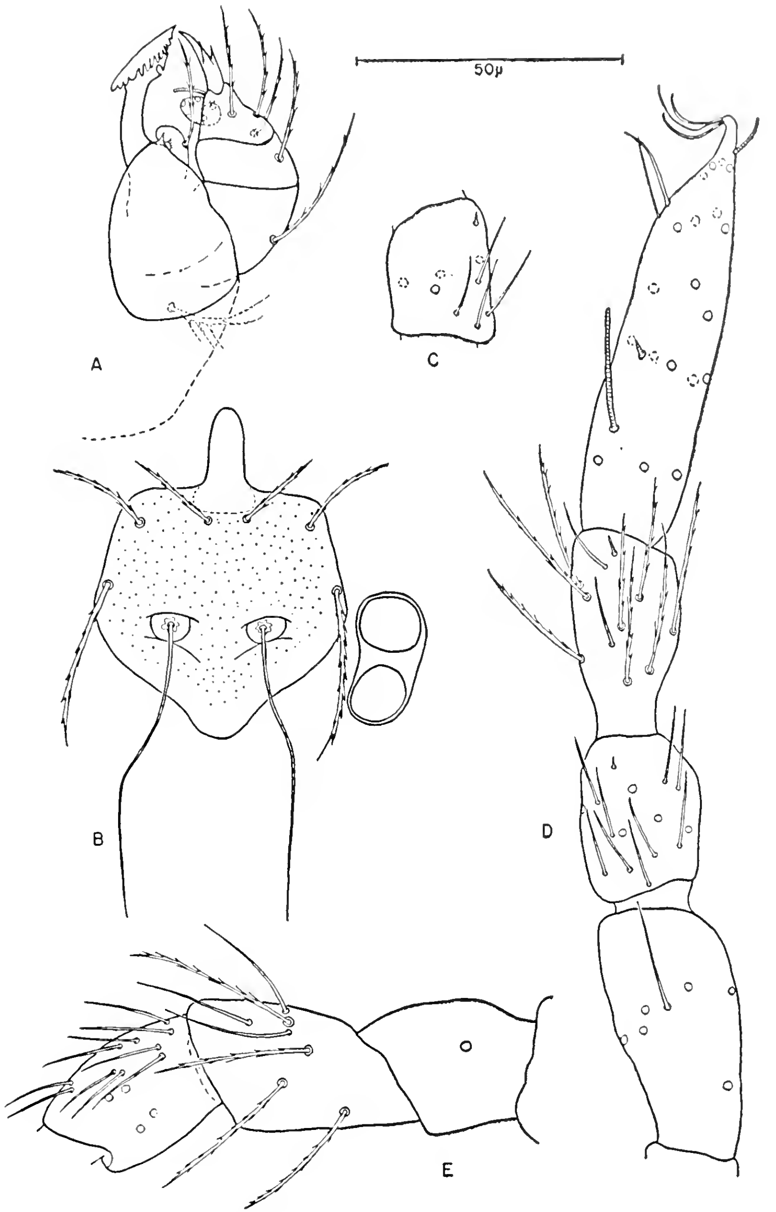


FIG. 3. *Hannemania multifemorala* sp. nov. A. Dorsal aspect of gnathosoma. B. Scutum and eyes. C. Genu of leg II. D. Leg I, excluding the coxa. E. Genu, femur and trochanter of leg III.

Co.: Lawrence, *Acris gryllus,* Oct. 8, 1947 (5), North Lawrence, *Rana pipiens,* Oct. 6, 1947 (13), 3 mi. S, 1 mi. E Lawrence, *Rana pipiens,* Feb. 22, 1950 (8), Feb. 27, 1948 (3), March 18, 1952 (1), March 27, 1947 (15), April 7, 1947 (13), May 1, 1948 (2); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Acris gryllus,* June 15, 1947 (1), July 7, 1947 (1) and *Rana pipiens,* May 10, 1947 (2), June 7, 1948 (6), June 15, 1947 (1), Aug. 18, 1947 (8), Oct. 4, 1951 (1). ELK CO.: 6 mi. N, 1 mi. E Howard, *Rana pipiens,* April 6, 1947 (20). GREENWOOD CO.: 1 mi. N, 1 mi. W Piedmont, *Rana pipiens,* April 7, 1947 (41). JEFFERSON CO.: 12 mi. N Lawrence, *Rana pipiens,* Sept. 1, 1948 (19). MIAMI CO.: 6 mi. S Louisburg, *Rana pipiens,* Sept. 3, 1947 (2). MONTGOMERY CO.: *Rana pipiens,* Feb. 8, 1948 (20). RUSSELL CO.: 5 mi. N, 2 mi. E Gorham, *Rana pipiens,* April 27, 1952 (3).

Additional specimens examined outside of Kansas.—Total, 100 larvae, as follows. ARKANSAS. *Little River Co.:* 2 mi. SE Ashdown, *Acris gryllus,* March 28, 1948 (1). *Logan Co.:* Clarksville, *Rana pipiens,* Sept. 9, 1947 (6). *Pope Co.:* Piney, *Bufo terrestris,* Sept. 9, 1947 (4); and *Rana pipiens* (12).

MISSOURI. *Jasper Co.:* 6 mi. N Carthage, *Rana pipiens,* Sept. 4, 1947 (11).

NEBRASKA. *Richardson Co.:* Verdon, *Rana pipiens,* Aug. 20, 1948 (3).

OKLAHOMA. *Craig Co.:* 9 mi. W, 2 mi. S Vinita, *Acris gryllus,* Sept. 11, 1947 (6). *Wagoner Co.:* 2 mi. S Okay, *Rana pipiens,* April 8, 1950 (7). *Woods Co.:* 6 mi. S, 2 mi. W Aetna, Kansas, Sept. 15, 1948, *Bufo woodhousii* (4) and *Rana pipiens* (27), (locality shown on Map 6).

TEXAS. *Erath Co.:* Stephenville State Park, *Gastrophryne olivacea,* April 18, 1952 (10). *McLennen Co.:* 7 mi. W Waco, *Rana pipiens,* April 9, 1950 (9).

SUBFAMILY TROMBICULINAE Ewing

Ewing, Manual of External Parasites, Thomas, Springfield, Ill., June, 1929, p. 22.

Diagnosis.—Larvae with scutum lacking anterior median nase, with one anteromedian seta; sensillae flagelliform or expanded; leg I with 7 segments, legs II and III usually with 7 segments, occasionally with 6 segments (femora fused), coxae I and II usually with 1 seta.

Species in Kansas with 3 or 5 marginal setae on scutum; body without posterior caudal plates; without tracheae and stigmata;

cheliceral blade with dorsal tricuspid cap usually prominent, without row of dorsal serrations; leg I with coxa, trochanter and basifemur each having 1 branched seta, telofemur with 5 branched setae, genu with 4 branched setae, 1 to 3 genualae and 1 microgenuala, tibia with 8 or 9 branched setae, 2 tibialae and 1 microtibiala, tarsus with 1 tarsala, 1 microtarsala and 1 pretarsala; leg II with coxa and trochanter each having 1 branched seta, basifemur with 2 branched setae and telofemur with 4 branched setae (fused femur with 6 branched setae), genu with 3 branched setae, tibia with 6 branched setae, 2 tibialae, tarsus with 1 tarsala and 1 microtarsala; leg III with coxa having 1 to 6 branched setae, trochanter with 1 branched seta, basifemur with 2 branched setae, telofemur with 2 to 4 (usually 3) branched setae, genu with 3 branched setae and usually with 1 genuala, tibia with a total of 6 branched and long nude setae and usually 1 tibiala; all empodia clawlike.

Remarks.—The majority of the chigger mites have been placed in the subfamily Trombiculinae. Audy (1954:134-135) lists 22 genera, ten of which are found in the Western Hemisphere. Six genera occur in Kansas: *Trombicula, Speleocola, Euschöngastia, Pseudoschöngastia, Neoschöngastia,* and *Cheladonta.*

Pseudoschöngastia, originally placed in the subfamily Walchiinae on the basis of leg segmentation (7-6-6), was transferred to Trombiculinae by Audy (1954:135). I concur with Audy in this placement and also in considering the fusion of the femora of legs II and III of little importance alone in the classification of major groups. Audy (*op. cit.*) includes *Walchiella* as a subgenus of *Euschöngastia,* although Fuller (1952) originally described it as a genus of Walchiinae. *Walchiella,* with leg segments 7-6-6 but with one anteromedian scutal seta, seems closely related to certain species of *Euschöngastia* with leg segments 7-7-7. *Cheladonta* with leg segments 7-7-7, has legs II and III short with the femora telescoped and seemingly fused, approaching the condition in which the suture is indistinct or absent. This fused condition of the femora may not even represent a character of generic value. Certain species now placed in *Ascoschöngastia* seem to resemble *Pseudoschöngastia* in all but the leg segmentation, and probably are representatives of the latter genus.

Trombiculinae in Kansas

In Kansas, the genera and subgenera of this subfamily can be arranged in several different groups on the basis of morphology, geographic distribution, seasonal occurrence, hosts and habitats of the larvae and the food of the nymphs and adults.

Audy (1954:134-135) separates the members of Trombiculinae into two groups, Group A with sensillae which are filiform and Group B which have them expanded. In Kansas, the genera of Group A with filiform sensillae are *Trombicula,* including several subgenera, and *Speleocola;* the latter with expanded setules on a slender stem.

Group B with expanded sensillae consists of *Euschöngastia, Pseudoschöngastia, Neoschöngastia* and *Cheladonta.*

In general the type of sensilla indicates relationship among these chigger mites. Expanded sensillae possibly arose from more than one group of chiggers which had flagelliform sensillae, since several distinct species of Group A differ from species in Group B principally in the type of sensillae (*e. g. T. hoplai* and *E. lacerta*). However, this resemblance may be from convergence in other characters due to similar habitats or to a re-occurrence of the ancestral type of sensilla.

The species of Group B with expanded sensillae are restricted almost entirely to birds and mammals, mostly the latter except for *Neoschöngastia. Speleocola,* of Group A, occurs solely on bats, whereas many of the members of *Trombicula* are found on reptiles as well as birds and mammals.

The absence from reptiles of larvae with expanded sensillae cannot be attributed entirely to limited seasonal activity, since eight of the fifteen species with expanded sensillae were taken in summer in places where reptiles were active and were sampled.

The geographic distribution, seasonal occurrence and the general type of habitat seem to be interrelated. Two major groups can be arranged according to the general distribution of the species and the group of related species (genus, subgenus or group).

Northern Group.—Larvae which appear in autumn and winter usually in woods or places having good ground cover are as follows:

Group A	*Group B*
T. (Leptotrombidium) (2)	*Euschöngastia* (8 species)
T. (Neotrombicula) (5)	*Cheladonta* (1)
T. (Miyatrombicula) (2)	

Representatives of all of these genera and subgenera occur in Japan, whereas only two of the groups have been found in Texas and one in Mexico.

Southern Group.—Larvae which appear in summer, frequently in open situations and grasslands are:

Group A	*Group B*
T. (*Eutrombicula*) (4)	*Euschöngastia* (2 only)
T. (*Euschöngastoides*) (1)	*Pseudoschöngastia* (2)
T. (*Trombicula*) *sensu lato* (7)	*Neoschöngastia* (2)
Speleocola (1)	

Representatives of three of the seven groups occur in Japan. All of the groups occur in Texas and probably in Mexico.

As can be seen from these groups, little correlation was made with the condition of the sensilla.

The food of the nymphs and adults consists of the eggs or the early instars of small arthropods. Lipovsky (1951, 1954) reported on the food preference of most of the genera. Those genera which feed on the eggs of Collembola in the laboratory include *Trombicula* (except possibly *Euschöngastoides*), *Speleocola* and *Euschöngastia* (except possibly *E. loomisi*).

Those which feed on early instars of Collembola are *Pseudoschöngastia, Neoschöngastia* and *Cheladonta.*

The different food preference by the nymphs and adults would help to account for the presence of several species of chigger mites in a single habitat.

KEY TO GENERA OF TROMBICULINAE IN KANSAS

1. Scutum with 3 setae, anteromedian and anterolateral setae, with posterolateral setae not on plate 2
1′ Scutum with 5 setae, with posterolateral setae on plate 3
2. Sensilla with leaflike setules expanded basally, on distal half of stout filiform stem, all legs with 7 segments (on bats only) . *Speleocola* p. 1326
2′ Sensilla expanded distally, legs II and III with 6 segments (not on bats) .... *Pseudoschöngastia* p. 1347
3. Sensilla expanded distally 4
3′ Sensilla flagelliform .... *Trombicula* p. 1253
4. Scutum partly submerged beneath striated cuticle . . *Neoschöngastia* p. 1354
4′ Scutum not beneath striated cuticle 5
5. Cheliceral blade with row of fine serrations on ventrolateral margin, legs II and III short, femora fused but with visible sutures. *Cheladonta* p. 1360
5′ Cheliceral blade without row of fine serrations on ventrolateral margin, legs II and III long, with femora not fused . . . . . *Euschöngastia* p. 1327

GENUS TROMBICULA Berlese

Trombicula Berlese, Redia, vol. 2, 1905, p. 155, type *Trombicula minor* Berlese, adults from bat guano from a cave in Java (types now destroyed).

Diagnosis.—Larvae having scutum with 5 setae; sensillae filiform, not expanded distally (shaft occasionally slightly thickened); cheliceral blades swordlike, usually with single tricuspid cap and small ventrolateral tooth; coxae I and II with single seta; legs with lateral claws normal and with slender median clawlike empodium.

Species in Kansas with palpal claws bifurcate or trifurcate; leg I with coxa having 1 to 6 branched setae; leg III with 1 tibiala.

Remarks.—The generic name *Trombicula* has been retained for the following species, based largely on the larval characteristics, although the type species, *T. minor* Berlese, is known only from the adult. The types have been destroyed and the original description and the redescription by Willmann (1941) do not allow specific identification with any known adults. Audy (1954:138-140) concludes that the type species (*T. minor*) is relatively small in all stages, the larva almost certainly is a bat parasite, and that the larva probably is similar to, if not the same as, *T. batui* Philip and Traub. Nymphs obtained in bat-guano (probably *T. batui*) and one nymph reared from larvae taken from bats were illustrated and compared with the drawing of the adult of *T. minor* in Willmann (1941). They were similar and seemed to fulfill the requirements of the type species. The correlated larva of one species which is also represented by a nymph fits the diagnosis of the genus as given above. The best procedure would seem to be to restrict the type species to one of these species, one represented by larva, nymph and adult if possible. This would eliminate doubt in the allocation and permit further subdivision of the genus. Audy seems to have the proper material for such a restriction.

Audy (1954:134) lists seven subgenera, *Trombicula (sensu stricto) Eutrombicula, Leptotrombidium, Trombiculindus, Crotiscella, Neotrombicula,* and *Blankaartia,* elevating *Fonsecia* from subgeneric (Wharton and Fuller, 1952:42) to generic rank. Audy expressed the opinion that *Eutrombicula* and perhaps *Blankaartia* may also justifiably be separated from *Trombicula.* Two additional subgenera, *Miyatrombicula* and *Euschöngastoides* have recently been described. Five of these, *Eutrombicula, Leptotrombidium, Neotrombicula, Miyatrombicula* and *Euschöngastoides,* and possibly a sixth, *Trombicula, s. s.* have been found in Kansas. *Trombiculindus* is closely related to *Leptotrombidium* and occurs only in Asia. *Crotiscella* is from South America and *Blankaartia* inhabits tropical and subtropical areas of the world.

The genus *Trombicula* is represented in Kansas by 21 species, included in the five (or six) subgenera listed above, in addition to several unassigned species. Larvae are found on mammals, birds, reptiles and amphibians.

Larvae of the genus occur throughout most of the year, being most common in summer and fall.

KEY TO SPECIES OF TROMBICULA IN KANSAS

1. Palpal claw bifurcate, with axial prong external to smaller internal accessory prong (*Eutrombicula*) 2
1′ Palpal claw bifurcate or trifurcate, with axial prong internal to accessory prong or prongs 5
2. Dorsal setae 36-38, leg III with 2 mastitibialae and 3 mastitarsalae. *T. batatas* p. 1257
2′ Dorsal setae 20-28, leg III with 1 mastitarsala (mastitibialae absent), 3
3. Dorsal setae 24-28, total body setae 40-48 . . . *T. splendens* p. 1284
3′ Dorsal setae 22, total body setae 36 4
4. Tarsala I short ($13\text{-}20\mu$); palpal genu with seta short ($18\text{-}21\mu$); palpal claw with shallow cleft . . . . . *T. alfreddugèsi* p. 1259
4′ Tarsala I long ($23\text{-}33\mu$); palpal genu with seta long ($24\text{-}33\mu$); palpal claw with deep cleft . . . . . *T. lipovskyana* p. 1280
5. Scutum roughly quadrangular 6
5′ Scutum roughly pentagonal 15
6. Coxa III with 3 to 6 setae, sternal setae 2-2-2 7
6′ Coxa III with 1 or 2 setae, sternal setae 2-2 8
7. Coxa III with 3, occasionally 4 setae, galeal seta nude, sensilla long (49μ) . . . . . *T. trisetica* p. 1321
7′ Coxa III with 5 to 6 setae, occasionally 4 setae on one side, galeal seta usually with 1 branch, sensilla short (33μ) . . . . . *T. crossleyi* p. 1323
8. Coxa III with 2 setae, leg III with 3 mastitarsalae . . . . *T. ornata* p. 1325
8′ Coxa III with 1 seta, leg III with 1 mastitarsala or without long, nude whiplike setae 9
9. Leg III with 1 mastitarsala, palpal claw bifurcate with deep cleft. [*T. merrihewi*] * p. 1367
9′ Leg III without long nude whiplike setae, palpal claw bifurcate with shallow cleft or trifurcate 10
10. Palpal claw bifurcate (short and stout) 13
10′ Palpal claw trifurcate (long and slender) 11
11. Subterminala and parasubterminala I present, sensilla branched on distal half, palpal femur and genu with setae nude, galeal seta branched . . . . . (*Leptotrombidium*) 12
11′ Subterminala and parasubterminala I absent, sensilla plumose along entire length, palpal femur and genu with setae branched, galeal seta nude . . . . . (*Euschöngastoides*) *T. hoplai* p. 1305
12. Scutum roughly rectangular with puncta small, sensilla short (64μ), body setae total 74 . . . . . *T. myotis* p. 1287
12′ Scutum roughly trapezoidal, with puncta large, sensilla long (79μ), body setae total 120 . . . . . *T. twentei* p. 1289
13. Scutum with anteromedian seta less than 40μ in length; tarsala I, 13μ, sensilla short ($45\text{-}55\mu$) 14
13′ Scutum with anteromedian seta more than 40μ in length; tarsala I, 16μ, sensilla long ($64\text{-}74\mu$) . . . . . *T. kansasensis* p. 1319

* Brackets denote species not yet reported from, but likely to occur in, Kansas.

14. Scutum with anteromedian seta short (26-30μ), *T. gurneyi gurneyi* p. 1312
14′ Scutum with anteromedian seta long (35-40μ) . . *T. g. campestris* p. 1317
15. Coxa III with 1 seta . . . . (*Neotrombicula*) 19
15′ Coxa III with 3 to 6 setae 16
16. Scutum with an acute angle on posterior margin, sensilla plumose or heavily branched . . . . (*Miyatrombicula*) 17
16′ Scutum with rounded posterior margin, sensilla with few distal branches 18
17. Genuala III present; dorsal setal formula begins 2-10, total body setae more than 46 setae . . . . *T. jonesae* p. 1303
17′ Genuala III absent; dorsal setal formula begins 2-6 or 2-8, body setae total less than 40 . . . . *T. cynos* p. 1302
18. Dorsal setal formula begins 2-8-8, total body setae 74-78. *T. arenicola* p. 1310
18′ Dorsal setal formula begins 2-6-6, total body setae 54-60. *T. montanensis* p. 1306
19. Leg III with no long, nude whiplike setae 20
19′ Leg III with 1 or more long, nude whiplike setae 21
20. Palpal femur with seta nude, genu and tibia with setae nude or with single branch . . . . *T. kardosi* p. 1299
20′ Palpal femur, genu and tibia with setae having many branches. *T. fitchi* p. 1297
21. Leg III with 1 mastitarsala (mastitibialae and mastifemorala absent) . . . . [*T. autumnalis*] p. 1366
21′ Leg III with 2 mastitarsalae, 1 or 2 mastitibialae 22
22. Leg III with 1 mastitibiala and 1 mastifemorala 23
22′ Leg III with 2 mastitibialae (mastifemorala absent) *T. sylvilagi* p. 1299
23. Galeal seta branched, sensilla with several pronounced apical branches . . . . [*T. loomisi*] p. 1367
23′ Galeal seta nude, sensilla without pronounced apical branches 24
24. Scutum with few, scattered puncta, posterior margin angular, sensilla usually with few minute basal barbs . . . . *T. whartoni* p. 1294
24′ Scutum with numerous, evenly distributed puncta, posterior margin broadly rounded, sensilla with pronounced barbs along most of the length . . . . *T. lipovskyi* p. 1291

Subgenus *Eutrombicula* Ewing

Eutrombicula Ewing, Jour. Washington Acad. Sci., vol. 28, June 15, 1938, p. 293, type *Microthrombidium alfreddugèsi* Oudemans.

Diagnosis.—Larvae with scutum roughly rectangular, posterior margin often convex, puncta usually large, with scutal setae branched; sensilla long, with several distinct distal branches usually appearing to be on single plane *; galeal seta nude; palpal femur and genu with branched setae; palpal tarsus with 7 branched setae

* The branches on the sensilla of most, if not all, species of this subgenus actually project from two planes, but the angle is less than 90° and when the larvae are mounted, the branches are pressed down on one side only.
In *T. alfreddugèsi*, the angle formed by these two rows of setules is less than 70°, and can be observed readily in specimens allowed to float in glycerine.

and tarsala; palpal claw bifurcate with lateral or dorsal prong longer than medial or ventral prong; leg I with 3 genualae, subterminala and parasubterminala; leg II with 1 genuala and pretarsala; leg III with coxa having 1 branched seta, 1 genuala, and 1 or more mastitarsala (*T. belkini* Gould with long branched seta in position of mastitarsala).

Batatas Group

Diagnosis.—Larvae with body having more than 58 setae, leg III with 2 mastitibialae and 3 mastitarsalae.

Remarks.—This group is proposed to include two species, *T. batatas* and *T. multisetosa* (Ewing). The former species is known from Kansas southward into South America; the latter has been found only in southern Florida.

Larvae have been found on birds and mammals, with a single record of *T. batatas* from a lizard in Dutch Guiana (Jenkins, 1949: 303). In Kansas, larvae were found in late summer.

Trombicula batatas (Linnaeus)

(Map 7)

Acarus batatas Linnaeus, Systema Naturae, 10th Ed., 1758, genus 235, species 22, p. 617, type from Surinam, South America, *Homo sapiens*.
Trombicula batatas, Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, p. 6.
Trombicula (*Eutrombicula*) *batatas*, Jenkins, Ann. Ent. Soc. Amer., vol. 42, Oct. 21, 1949, pp. 298-303; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 46 (includes a comprehensive synonymy); Wolfenbarger, Ann. Ent. Soc. Amer., vol. 45, Jan. 30, 1953, pp. 647-648.

Diagnosis.—Larva with dorsal body setae 34-36, total body setae 58-60; scutum not much wider than long, palpal claw with deep cleft between prongs; leg III with 2 mastitibialae and 3 mastitarsalae.

Scutal measurements (after Wolfenbarger, 1953), average and extremes, of 10 larvae from Seward County: AW- 63 (59-68), PW- 67 (63-75), SB- 27 (24-30), ASB- 22 (21-26), PSB- 22 (19-25), AP- 24 (19-27), AM- 31 (29-33), AL- 30 (28-31), PL- 40 (35-43), S- 56 (55-60).

Geographic distribution. — (Jenkins, 1949, unless otherwise noted): Known from Brazil, Dutch Guiana, French Guiana, Venezuela, Colombia, Panamá, Mexico, Puerto Rico, Jamaica, and the United States in Florida (Collier, Hernando and Orange counties), southern Georgia (Chatham and Thomas counties), southern Alabama (Baldwin County), southern Louisiana (Orleans Parish, KU), southwestern Kansas (Seward County) and California (Kern and Tulare counties).

Seasonal occurrence.—Larvae were taken from hosts in Kansas in early September.

Hosts.—Jenkins (1949:303) listed 12 species of mammals and 18 species of birds as hosts for this species. He also listed a doubtful record from a lizard in Dutch Guiana. Larvae have recently been taken in Louisiana from the red-winged blackbird, *Agelaius phoeniceus.*

Trombicula batatas found in Kansas were on two mammals, *Dipodomys ordii* and *Perognathus hispidus,* and a single meadow lark, *Sturnella neglecta.* The larvae were attached to the bodies, especially in the genital region.

Examination of other vertebrates, from the habitat of the hosts of *T. batatas* and from the immediate vicinity, failed to reveal other larvae of this species. Other vertebrates from the same habitat, which were negative, included lizards (*Sceloporus undulatus* and *Cnemidophorus sexlineatus*) and several species of birds. (See page 1218 for a list of vertebrates examined from 12 miles north of Liberal, Seward County, Kansas).

Habitat.—In Seward County, Kansas, the three species of hosts were obtained in the valley of the Cimarron River, where the soil was sandy and sagebrush was the principal plant. Near the stream were various grasses.

Specimens examined.—Total, 25 larvae, as follows. SEWARD CO.: 12 mi. NW Liberal, Sept. 8-10, 1948, *Sturnella neglecta* (2) -*Dipodomys ordii* (21) -*Perognathus hispidus* (2).

Wichmanni Group

Diagnosis.—Larvae with body setae few (36-44) and leg III with 1 mastitarsala.

Remarks.—This group includes the following closely related species: *T. alfreddugèsi, T. splendens* and *T. lipovskyana* known from Kansas and the United States, the former (including *T. tropica* Ewing) also occurring south into South America; *T. göldii* (Oudemans), *T. lahillei* Thor and Willmann and *T. tinami* (Oudemans) of Central and South America; *T. hirsti* Sambon, *T. samboni* Womersley, *T. sarcina* Womersley, *T. sobrina* Womersley, *T. wichmanni* Oudemans and probably others of the Old World (see Audy, 1954: 146).

Trombicula belkini Gould from the western United States is not included in the group since it does not possess a long nude whip-like seta on tarsus III.

Larvae of this group commonly parasitize reptiles, birds, and mammals and occasionally attach to amphibians. In Kansas, larvae are found in summer and early fall.

Trombicula alfreddugèsi (Oudemans)

(Figs. 4-12, Map 8)

Microthrombidium alfreddugèsi Oudemans, Ent. Berichten, vol. 3, no. 54, 1910, p. 84, type from Temascaltepec, 22 miles northeast of Tejupilco, México, Mexico, host man, *circa* 1892, according to Fuller (1952:107).
Eutrombicula alfreddugèsi, Ewing, Jour. Washington Acad. Sci., vol. 28, June 15, 1938, p. 294; Ewing, Jour. Parasit., vol. 30, Jan. 17, 1945, p. 348; Jenkins, Amer. Jour. Hygiene, vol. 48, July, 1948, p. 23; Fuller, Zool. Verhandel., no. 18, Dec. 16, 1952, pp. 101-113.
Trombicula (Eutrombicula) alfreddugèsi, Jenkins, Ann. Ent. Soc. Amer., vol. 42, Oct. 21, 1949, p. 289; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, pp. 44-46 (includes a comprehensive synonymy); Wolfenbarger, Ann. Ent. Soc. Amer., vol. 45, Jan. 30, 1953, pp. 652-658; Fitch, Ecol. Monographs, vol. 25, no. 3, Jan., 1955, pp. 79-80.
Trombicula alfreddugèsi, Fitch, Univ. Kansas Publ., Mus. Nat. Hist., vol. 8, Sept. 1, 1954, pp. 138-139, 148.
Leptus irritans, Ewing, U. S. Dept. Agr. Bull., no. 986, 1921, pp. 1-16.
Trombicula tlalzahuatl, Ewing, Jour. Agri. Res., vol. 26, 1923, p. 403.
Trombicula cinnabaris Ewing, Ann. Ent. Soc. Amer., vol. 13, Jan. 28, 1921, p. 387, type adult from East Falls Church, Virginia, Aug. 21, 1919.

Diagnosis.—Larva with dorsal setae 22, total body setae 36; scutum moderate in size; palpal claw slender with shallow cleft between prongs; tarsala I short (13-16μ); leg III with 1 mastitarsala.

Scutal measurements (modified from Wolfenbarger, 1953) average and extremes, of 14 larvae from Kansas: AW- 75 (68-82), PW-86 (79-94), SB- 42 (36-47), ASB- 23 (21-27), PSB- 26 (22-31), AP-26 (23-28), AM- 27 (23-31), AL- 28 (26-32), PL- 40 (38-44), S- 48 (44-53).

Taxonomic remarks.—Prior to the recognition of *T. lipovskyana* Wolfenbarger (1953:660), larvae of this species probably were identified as *T. alfreddugèsi* on the basis of the same number of body setae (36) and other characters shared in common. The related species *T. splendens* was separated from these species on the greater number of body setae (40 to 44). The recognition of *T. lipovskyana* will necessitate the re-examination of larvae formerly identified as *T. alfreddugèsi.*

The larvae from western Kansas identified as *T. alfreddugèsi* actually may include some of another species or subspecies. Series of larvae from Barber and Seward counties had some specimens with deep and others with shallow clefts in the palpal claw, although no other difference was observed. Further studies of the larvae, nymphs and adults may reveal additional differences necessitating a separation.

I have examined several larvae from Mexico that are referable to *T. alfreddugèsi* as now understood and find that they differ somewhat from the larvae from Kansas, being closest to those of the southwestern part of the State, which have a deep cleft in the palpal claw. The type locality of *T. alfreddugèsi* is in southern Mexico and the name actually may not apply to the species in Kansas. Further study based on new material is needed.

Geographic distribution.—(Jenkins, 1949, unless otherwise noted): Known from Argentina in South America, northward to several islands of the West Indies, Central America, Mexico, the United States and southern Canada. In the United States, this species has been reported from southern New York, south through Florida, west to southern South Dakota, western Colorado (Mesa County, KU), central Oklahoma (Comanche County, KU), eastern and southern Texas. Records from Arizona and California as mapped by Jenkins (1948:23) refer to *T.* (*E.*) *belkini* Gould.

Seasonal occurrence and abundance.—The larvae of *T. alfreddugèsi* were recovered from hosts in Kansas as early as May 20 (1950) and as late as November 5 (1947) in the years 1947 through 1953.

Larvae were recovered from chigger samplers in Douglas County from June 1 to Oct. 28 in the years 1949 through 1952: June 2 to Oct. 7, 1949; June 6 to Oct. 10, 1950; June 9 to Oct. 28, 1951; June 1 to Oct. 8, 1952. Figures 4 to 10 illustrate the abundance and occurrence of larvae taken on chigger samplers.

In northeastern Kansas, larvae became numerous in early June (shortly after they first appear), increase in numbers to greatest abundance throughout late June and July, decrease slightly in August, become markedly reduced in September, and only a few larvae (mostly on hosts) remain in October and early November.

This is the most abundant chigger mite throughout Kansas, being especially widespread and common in the eastern third of the State. *T. alfreddugèsi* represented nearly half of the chigger mites examined on slides and more than three fourths of all the larvae recovered from hosts. In addition, this species comprised nearly all of the larvae taken on chigger samplers.

Hosts.—A total of 83 species of vertebrates from Kansas are recorded as hosts for *T. alfreddugèsi* including 2 amphibians, 29 reptiles, 31 birds and 21 mammals.

Larvae of *T. alfreddugèsi* were the only chiggers recovered from 24 of these 83 host species. This included 13 (45%) of 29 reptiles, 8 (26%) of 31 birds and 3 (14%) of 21 mammals.

In addition, vertebrates, known from Kansas, that were hosts for *T. alfreddugèsi* in other states include 3 species of amphibians, 8 species of reptiles, approximately 25 species of birds and 9 species of mammals (Wharton and Fuller, 1952:45-46, and Wolfenbarger, 1953:656 *, 658).

In Kansas, the most important hosts for *T. alfreddugèsi* are those terrestrial vertebrates which are principally diurnal or crepuscular in the season of larval activity, and live on the surface of well-drained soils supporting heavy to sparse ground cover of moderate to tall grasses, weeds, shrubs and scattered trees, in grasslands and the grassland-woodland margin. Important hosts include lizards, snakes, turtles, birds, and mammals of moderate to large size that are common to abundant in the above habitats.

Hosts found to be of major importance for *T. alfreddugèsi* in Kansas are the following common species of vertebrates (including only the species that were examined frequently in the season of larval activity).

REPTILIA

Sauria	Serpentes
Crotaphytus collaris	*Thamnophis sirtalis*
Eumeces fasciatus	*Coluber constrictor*
Eumeces obsoletus	*Masticophis flagellum*
Cnemidophorus sexlineatus	*Pituophis catenifer*
	Ancistrodon contortrix

AVES

Tympanuchus cupido | *Colinus virginianus*

Most birds had only a moderate number of *T. alfreddugèsi* attached. (See below.)

MAMMALIA

Sylvilagus floridanus	*Neotoma floridana*
Sigmodon hispidus	*Neotoma micropus*
Microtus ochrogaster	

Figure 12 illustrates the number of *Trombicula*, principally *T. alfreddugèsi*, obtained in eastern Kansas on important hosts.

In Kansas, hosts which as individuals had only a moderate number of *T. alfreddugèsi*, but represented common to moderately common species of vertebrates, and thus seemingly were of importance as hosts for the larvae are as follows (including only those verte-

* Two birds, *Bartramia longicauda* and *Pipilo erythrophthalmus* are incorrectly listed under *T. alfreddugèsi*, Kansas—Eastern. *Pipilo* was taken in Lawrence County, Missouri (*op. cit.*, p. 658) and the 11 larvae listed with *Bartramia* (*op. cit.*, p. 665) are actually *T. lipovskyana*.

brates examined on several occasions in the season of larval activity):

REPTILIA

Terrapene ornata	*Heterodon platyrhinos*
Sceloporus undulatus	*Elaphe obsoleta*
Natrix erythrogaster	*Elaphe guttata*
Natrix sipedon	*Lampropeltis calligaster*
Heterodon nasicus	*Lampropeltis getulus*

AVES

Zenaidura macroura	*Quiscalus quiscula*
Toxostoma rufum	*Sturnella magna*
Turdus migratorius	*Sturnella neglecta*
Sturnus vulgaris	*Richmondena cardinalis*
Passer domesticus	*Spiza americana*

Vertebrates of little or no importance as hosts for *T. alfreddugèsi* include among others, the amphibians, small lizards and small snakes. Additional vertebrates seem to be poor hosts due to one or more of the following characteristics. They may be primarily fossorial, aquatic, arboreal or cave dwellers; nocturnal in surface activity; live either in barren eroded land, extremely sandy soils, upland short-grass plains, overgrazed pastures, cultivated fields, swamps, frequently inundated or heavily forested lands; or are absent from the State in the season when the larvae are active.

The following vertebrates (examined several times in the larval season) were either entirely negative or were poor hosts for *T. alfreddugèsi*, in Kansas. Amphibia: All species were negative or poor hosts (see Table 5).

Reptilia; *Ophisaurus attenuatus, Lygosoma laterale, Storeria dekayi, Diadophis punctatus, Carphophis amoenus, Sonora episcopa, Sistrurus catenatus, Crotalus horridus* and *Crotalus viridis.*

Aves; hawks (2 species), shore birds (4 species), *Coccyzus americanus, Chordeiles minor,* woodpeckers (5 species), *Petrochelidon pyrrhonota, Hirundo rustica, Cyanocitta cristata, Parus atricapillus, Parus bicolor, Sialia sialis,* warblers (4 species), *Agelaius phoeniceus, Columba livia* and *Molothrus ater.*

Mammalia; *Blarina brevicauda, Cryptotis parva, Scalopus aquaticus,* bats (5 species), *Sciurus carolinensis, S. niger, Lepus californicus, Cynomys ludovicianus, Spermophilus tridecemlineatus, Geomys bursarius, Reithrodontomys megalotis, Peromyscus leucopus, P. maniculatus, Rattus norvegicus, Mus musculus, Microtus pinetorum, Dipodomys ordii, Onychomys leucogaster* and *Taxidea taxus.*

See the tables listing the vertebrates for the exact number of hosts examined and the number of *T. alfreddugèsi* recovered.

The two lizards, *Ophisaurus attenuatus* and *Lygosoma laterale*, listed as negative or poor hosts seem to be successfully protected by scales against the attachment of *T. alfreddugèsi*, as well as larvae of other species of chiggers. *Ophisaurus attenuatus* is covered by large rectangular juxtaposed scales except for the ears, eyelids and the lateral body fold which have small granular scales. The close proximity of the scales to one another does not seem to afford access to soft areas suitable for attachment by chiggers. Even the area of small granular scales in the lateral fold is usually protected by the overlapping fold. One larva of *T. alfreddugèsi* was found, dead and dried, in the lateral fold of a glass snake. Fourteen other individuals were examined in the season of larval activity from areas of known chigger populations without recovery of larvae. On three occasions, an adult glass snake in a screen cage was placed in known sites of chigger concentrations, and numerous larvae were introduced into the cage. Larvae were observed to crawl over the body. Later the glass snake was examined and then was placed over a pan containing detergent and water. Not a single larva was seen attached nor did any engorged larvae drop from the lizard, although numerous unengorged larvae were found in the pan on the first day.

The brown skink, *Lygosoma laterale*, is the smallest lizard known in Kansas, the adults being 40-48 mm. snout to vent, up to 80 mm. in total length. In total size, the adult is not much larger than a recently hatched, five-lined skink, *Eumeces fasciatus*, which occurs with the brown skink in the woodlands of eastern Kansas. Nineteen *L. laterale* were examined from the field in the season of larval activity of *T. alfreddugèsi* and all were negative. In addition, adult brown skinks were kept on several occasions in terraria occupied by larvae of *T. alfreddugèsi*, *T. splendens* and *T. gurneyi*, and none of the larvae were found attached to these lizards, although at the same time, other lizards, *Sceloporus undulatus* and *Eumeces fasciatus*, were heavily parasitized.

The small scales of *L. laterale* and their close proximity to one another seems to be of greatest importance. In other skinks the size of the scales and the amount of space between their bases seems to regulate the amount of chigger attachment. The larger skinks, such as adults of *E. laticeps* and *E. obsoletus*, frequently had large concentrations of larvae under the large lateral scales of the neck, whereas small individuals of the same species and the subadults and young of *E. fasciatus* rarely possessed larvae under the scales of the neck and body, although larvae were attached in other areas such as the axilla and groin.

Mice, such as *Peromyscus* and *Mus,* were seen to scratch off both unattached and attached larvae of *T. alfreddugèsi* and other chigger mites. The active removal of chiggers by the more agile mammals must materially reduce the number of larvae that remain attached and complete their engorgment and may help to explain the low number of *T. alfreddugèsi* on many of the mammals.

Each species of host of *T. alfreddugèsi* usually had one or more sites where the majority of the larvae were found attached. In general, the area or areas of attachment were dependent on the size of the host, the parts of the host exposed and more frequently the types of areas on the host which were most suitable for larval attachment.

T. alfreddugèsi attached on the mammalian hosts in the ears, on the head, body, legs and feet. There were few larvae found (and presumably few attached) in areas which were covered by a thick coat of hair, such as usually occurs on the back and sides of the body. On larger mammals such as rabbits, large numbers of larvae were attached between the toes, along the feet and legs, and extending up to the abdomen, especially when larvae were abundant. Few larvae were found in the ears of rabbits. On small mammals such as prairie voles and cotton rats, the larvae were common on the abdomen and in the ears, few being attached on the legs and feet. This of course would be due in part to the limited space and absence of protected areas on the feet of these small rodents, as well as the relatively short distance from the soil to the body and ears, as compared to the rabbits.

Birds usually had larvae attached to the skin of the upper legs, body and wings, in addition to that of the tail, the ears and the head. Individual larvae frequently were attached along the feather tracts, whereas large patches of larvae were commonly situated in sites where two surfaces of skin come into contact, such as on the inner surface of the thigh and the opposed body area.

Reptiles usually were more heavily parasitized on the anterior part of the body. This was particularly true of the snakes, the larvae attaching singly or in groups between and under the scales of the head, neck and anterior part of the body, most commonly between the first few lateral rows of dorsal scales. Larvae also were found under the large ventral scales of the body, between the posterior dorsal body scales, around the anus and under the scales of the tail.

On lizards, the greatest concentrations of *T. alfreddugèsi* were found in the axilla and groin, the "mite pockets" above the forelimbs (*Sceloporus* and *Crotaphytus*), beneath the scales of the neck (*Eumeces*), between the scales of the belly and tail (*Cnemidophorus*) and at the site of any injury which exposed the soft skin. Larvae also attach to the eyelids, at the angle of the jaws, in the ears, between the toes, on the skin and under scales, on the legs, body and tail, and around the anus.

The sites of attachment on turtles included the skin of the neck and forelimbs, especially near the juncture of the skin to the shell, and to a lesser degree around the hind limbs and the tail.

The few larvae of *T. alfreddugèsi* found on frogs and toads were on the head and back.

Habitats.—Larvae of *T. alfreddugèsi* were found in Kansas on hosts and chigger samplers from many different habitats. This species seems to be most common in open fields supporting good stands of grasses, weeds and shrubs, and where moderate to large populations of vertebrates are present.

In eastern Kansas, larvae were common in grasslands, thickets of shrubs and weeds and in the grassland-woodland margin. Soils which seemed most suitable for larval and postlarval stages included loose well-drained prairie soils, disturbed loam and rocky soils left fallow for several years, limestone-derived soils in the vicinity of limestone outcroppings and flat rocks, all with a good ground cover of grasses and weeds. The larvae were absent or uncommon on tightly packed alluvial soils, extremely sandy soils, humus soils of the woodland, cultivated fields or dry barren rocky hillsides.

In western Kansas, the hosts of *T. alfreddugèsi* usually were obtained from low moist areas supporting good stands of tall and mixed grasses and weeds such as sunflowers and ragweeds. The soil usually was loose and porous, frequently bordering rock outcroppings and in disturbed soil left fallow for several years. Some suitable areas were at the edges of cultivated fields.

Larvae of *T. alfreddugèsi* were uncommon or rare on hosts recovered in western Kansas from upland shortgrass habitats, especially in prairie dog towns, overgrazed pastures, cultivated fields, areas of loose shifting sandy soil supporting sagebrush and other xeric plants, and from barren eroded slopes.

The habitats of *T. alfreddugèsi* are given in greater detail under Descriptions of Study Areas, and below under the section on chigger sampling.

Larvae recovered on chigger samplers.—The majority of larvae taken on chigger samplers were *T. alfreddugèsi.* Several different stations were sampled at the University of Kansas Natural History Reservation, 5 miles northeast of Lawrence, Douglas County. These stations were situated in the woods and along the woodland edge (Stations A, B and C) and in the open grasslands (Stations D, E, and F). They are listed below only briefly in relation to *T. alfreddugèsi,* the detailed descriptions being in the Descriptions of Study Areas. Figures 4 to 10 include the results of chigger sampling from several of the stations.

Station A, at the woodland edge, is largely characteristic of the deciduous forest, with a canopy of trees over nearly barren soil. This station was sampled extensively, and larvae of *T. alfreddugèsi* were rare or absent for the entire season. The late appearance of larvae in the station probably resulted both from the invasion of larvae from suitable habitats nearby and from a delay in egg laying and the emergence of larvae because this shaded site remained cooler than most of the other stations for the entire summer.

Stations B and C, also located in the woods, are similar to Station A. Larvae of *T. alfreddugèsi* were rare or absent for most of the summer.

Station D includes a series of plots directly below a limestone ledge, with the soil of limestone talus and glacial till covered with Japanese chess and other weeds. The chess dies in early summer and the soil is frequently without vegetation or is covered by ragweed and other weeds. Three areas, listed separately in Figures 6, 8 and 10, are D-1 and D-2 shaded part of the afternoon, and D-3 that is unshaded and with less ground cover.

Station E represents several plots in the uplands, the soil largely of glacial till being covered by Japanese chess, ragweed, hemp and other weeds. This station resembles Station D, although the vegetation of the former is usually denser and taller forming better cover.

Station F also is in the upland prairie, but differs in being largely covered by awnless brome. Several plots were sampled, all of which were in thick stands of awnless brome, which remains green throughout the summer and affords good ground cover.

Chigger sampling was begun in May of 1949 and continued to the end of 1952. The samples in 1952 are the most complete, being approximately one week apart. Each plot was sampled four or more times and each station includes one to several plots. Only the months of May to and including October are illustrated on the graphs. Additional samples in other months failed to reveal larvae of *T. alfreddugèsi.* Days more suitable for the activity of chiggers were selected whenever possible, avoiding extremely wet, hot or cold periods of the day. Usually more samples were taken when the larvae were scarce or absent, especially in the fall, in an attempt to find larvae of this and other species.

The samplers were left in each site for approximately one minute in the summer, up to five minutes when the temperature was low in the fall, winter, and spring. The period of one minute was selected so that few larvae would be attracted to the sampler from surrounding areas. Chigger samplers were not replaced in the same spots on the same date; however an attempt was made to sample the same approximate site on each visit. The size of the plots and stations are given in the Descriptions of Study Areas. Each plot usually consisted of nearly one square yard, and plots were usually more than ten feet apart.

The results of the chigger sampling are illustrated on figures 4 to 10, along with the mean air temperature and rainfall, for the years 1949 to 1952.

The numbers of larvae of *T. alfreddugèsi* per square foot were calculated by dividing the total number of larvae by the number of samples for each plot or station and then by multiplying that figure by ten (each chigger sampler is one tenth of a square foot). The calculated number of larvae is indicated for each of the days by a dot, and these dots are connected to illustrate the trend of the population of larvae. The reduction and absence of larvae in September and October creates a fusion of the lines and dots. Several samples were taken at each station in each of these months, thus confirming their absence or rarity.

The daily mean air temperature plotted is based on records from Lawrence, Kansas, approximately five miles from the stations sampled. These records were obtained from the Climatological Data for Kansas, published by the U. S. Weather Bureau. The mean was calculated by adding the daily maximum and minimum air temperatures and dividing by two. The mean seemed to best represent the general trend of the air temperature and, among the available records, probably comes nearest to indicating the general ground temperature and the variations throughout the period. The temperature of the soil was taken in each area only at the time of sampling in 1952, and was considered in the evaluation of data. Sampling records were not used when the temperature was extremely high as the larvae seemed to be greatly reduced or were inactive on the surface. The highest temperatures were found in the soil of open situations (Station D, especially D-3), lower in grasslands sheltered by thick grasses (Station F), and the lowest in the woods and woodland edge stations with a forest canopy.

The rainfall is indicated for each day, based on the readings in Lawrence. The amount of precipitation in the months excluded from the figures was moderate and did not seem to change the general conditions illustrated.

The following comments are given for each of the years, in relation to the figures:

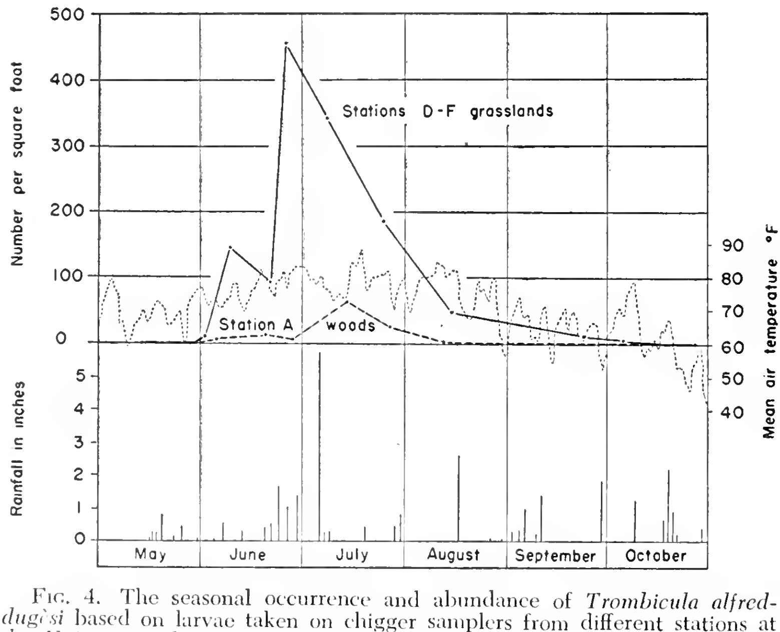


FIG. 4. The seasonal occurrence and abundance of *Trombicula alfreddugèsi* based on larvae taken on chigger samplers from different stations at the University of Kansas Natural History Reservation in 1949. The daily mean air temperature and rainfall are shown from May to November.

1949 (Figure 4): The apparent drop in the number of larvae on June 20, seemingly was the result of another person, other than the author, sampling the stations. In 1949, there were fewer samples taken on fewer days than in the other years.

1950 (Figures 5 and 6): The summer was cool and precipitation was above normal. The slight increase in larvae shown in August probably was due to their better survival in moist cool soil and the emergence of second generation larvae.

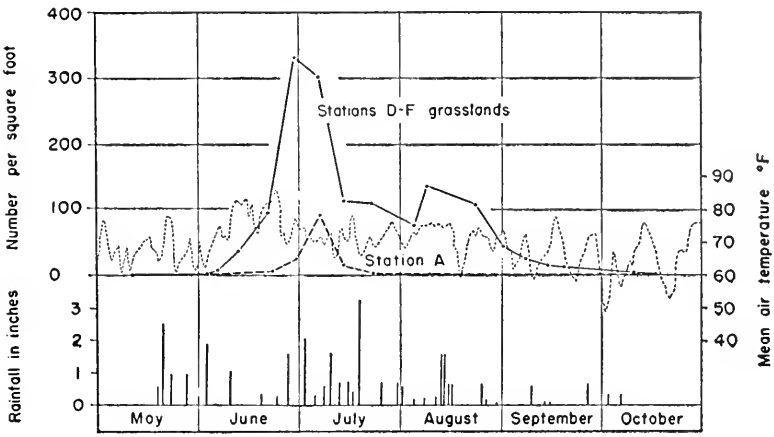


FIG. 5. The abundance of *T. alfreddugèsi* in 1950 at the same stations as listed above.

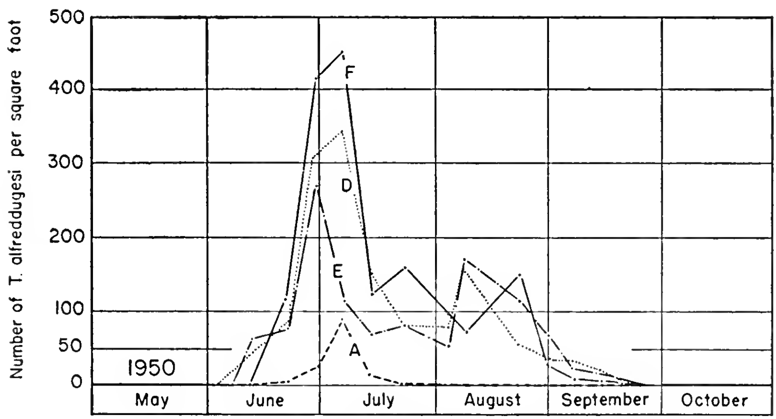


FIG. 6. The abundance of *T. alfreddugèsi* in 1950 from selected stations.

1951 (Figures 7 and 8): The summer was cool, precipitation was exceptionally high and widespread flooding occurred in early July. The Natural History Reservation was inaccessible for nearly three weeks in July, and therefore no sampling was conducted. Chigger samples in Lawrence at that time revealed large populations of chiggers in areas similar to those regularly sampled. The peak of larval abundance probably occurred in mid-July, delayed slightly by the cool weather and built up because of optimum conditions for the survival of larvae and eggs in the upland soil. The sharp decline in mid-August probably was due to the normal decline of egg laying and the absence or limited number of larvae from a second generation. The late emergence of larvae in June and the cool summer probably retarded the life cycle.

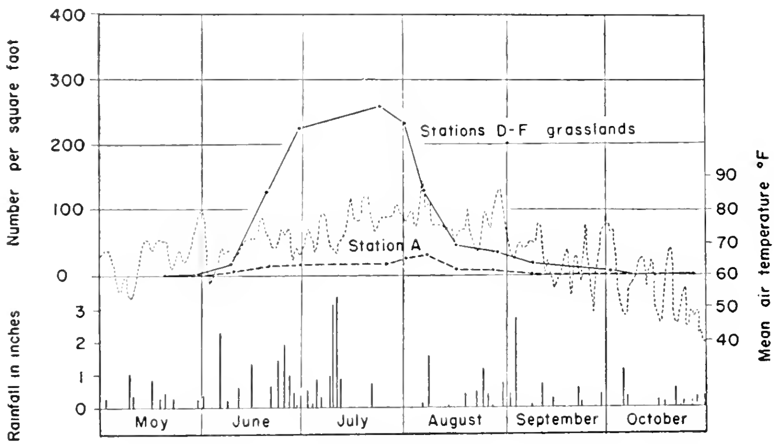


FIG. 7. The abundance of *T. alfreddugèsi* in 1951 based on larvae taken on chigger samplers.

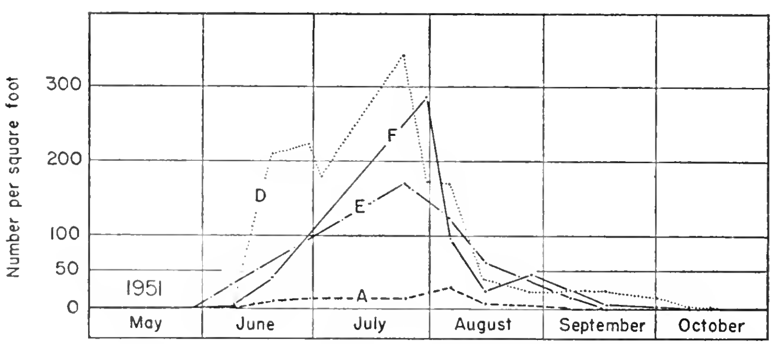


FIG. 8. The abundance of *T. alfreddugèsi* in 1951 based on larvae taken from several selected stations.

1952 (Figures 9 and 10): This summer had little precipitation, in sharp contrast to the record rainfall of 1951. The soil however did not become extremely dry until September and October, when only traces of rain fell for the entire two month period. The moist soil and high temperatures of early summer seemed highly favorable for chiggers and larvae were extremely abundant in good habitats. Station F (Figure 10) illustrates the large numbers of larvae, with a record of 600 larvae per square foot in late June. Some chigger samplers had up to 300 larvae present after only one minute on the soil.

A second increase of larvae in late August seems to be correlated with August rainfall and with the appearance of larvae of the second generation.

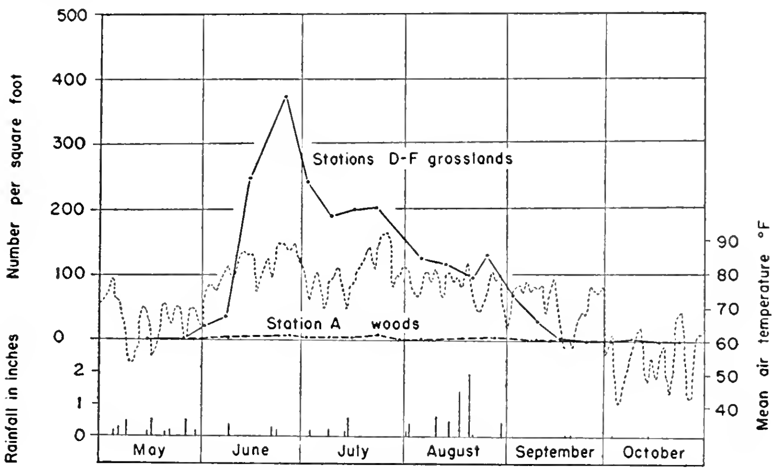


FIG. 9. The abundance of *T. alfreddugèsi* in 1952 based on larvae taken on chigger samplers.

COMPARISONS BETWEEN THE STATIONS

There was a marked difference in the number of larvae of *T. alfreddugèsi* taken from the grasslands (Stations D-F) and from the woodlands (Stations A, B and C). At Station A, the first appearance of larvae lagged behind the appearance at grassland stations, were relatively scarce, and also disappeared sooner in autumn. Differences from adjacent grasslands were the presence of a forest canopy, the lack of grasses and other ground cover and the presence of *T. sylvilagi*, larvae of which emerged in mid-August and continued until December. Adults of *T. sylvilagi* would seemingly compete with those of *T. alfreddugèsi* for available food, which in the laboratory cultures consisted of Collembola eggs.

Comparisons between stations D, E and F and their separate plots (Figures 4-10) show a slightly different pattern, because of differences in the amount of vegetation and the corresponding differences in temperature and moisture. The open, less-sheltered station (D, including all three plots) supporting mainly Japanese chess in early summer was warmer and larvae appeared earlier and reached a peak of abundance earlier than in more sheltered stations. This is especially noticeable for Station D, plot 3 on Figure 10 (lower). Of all of the plots, D-3 was the most exposed, had less ground cover and had the highest readings of soil temperature throughout the summer. The Station F possessed greater ground cover of awnless

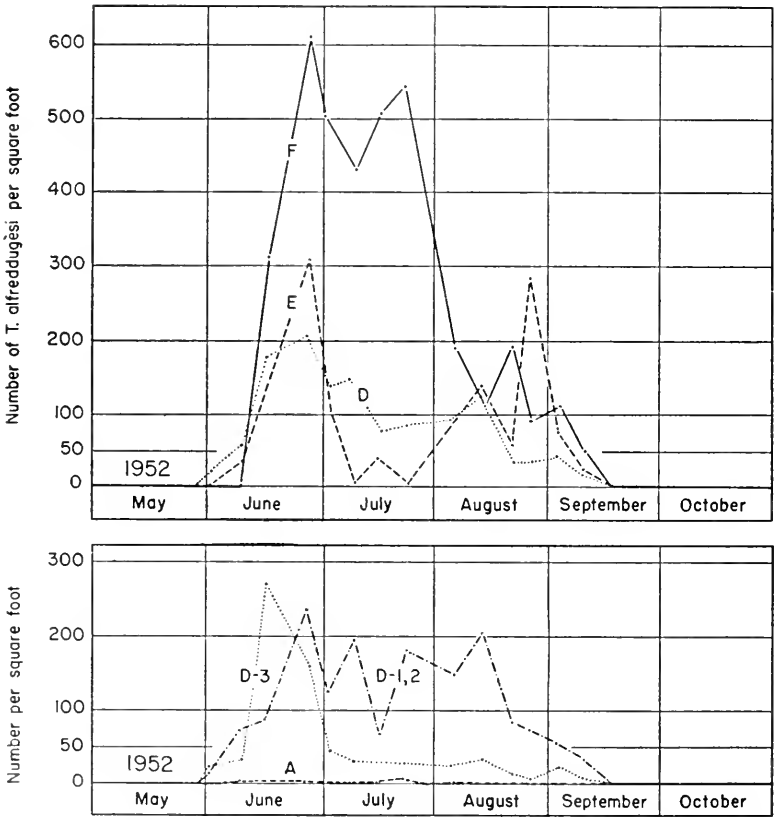


FIG. 10. The abundance of *T. alfreddugèsi* in 1952 based on larvae taken on chigger samplers from selected stations (D, E, and F in upper graph; A, D-1 and -2, and D-3 in lower graph). Station D of the upper graph is the total of all the D plots of the lower graph.

brome and the temperature readings of the soil were consistently moderate, lower than that of D-3 and of other stations in the grasslands. Although slightly later in first appearance here and in the peak of abundance, the larvae were more numerous and remained so over a longer period than in stations D and E.

Figures 4-10 show the sizes of samples from the various stations for the four years.

TEMPERATURE

The temperature can be seen to be positively correlated with seasonal occurrence and abundance of larvae of *T. alfreddugèsi*. By inference, and by results from the laboratory cultures, it also can be correlated with development and activity of the other stages. Temperature of the soil seems to control the oviposition and to regulate the development of eggs and deutova and activities of the larvae, nymphs and adults.

Under laboratory conditions (27 to 30° C) the eggs hatch approximately 14 days after laying. If we go back that length of time from the first emergence of the larvae as illustrated on Figures 7 and 9, the time of first oviposition would occur near the middle of May each year. It would also occur in a warm period immediately following a cool period. This warm period usually represented the second period in which the mean air temperature remained above 60° F. for several days.

A study of the daily mean air temperature for April of the four years shows the following information of possible importance in understanding nymphal and adult activity and oviposition.

Using 60° F. as an arbitrarily selected base line best correlated with abundance of larvae, most of the recordings for April are below the line. The temperatures are generally below the line for the first half of April for the four years. However the comparison of the last half reveals a slight rise above the line for the last ten days of 1949, a marked drop below the line for the same period in 1950, a rise for nearly the last week in 1951, and a rise, drop, and a second rise the last few days of April 1952. Included with the data from May, we can see that the earlier abundance of larvae in 1949 correlated with the warm period in April, plus the warm month of May. The more gradual increase in the other years seems correlated with shorter periods of warm weather in April and May, being especially marked in 1950 with a cool April and in 1951 with a marked cool period in early May. In 1952 the larvae emerged rather slowly at first, but rapidly became numerous in the warm weather of June.

The decline and disappearance of larvae in autumn also seems directly correlated with the cooler temperature. As the temperature becomes lower, the larvae become uncommon, and then after several days of cool weather become scarce and finally disappear.

Figures 4, 5, 7, 9 show the temperature and its presumed effect on the abundance of larvae.

Effect of Rainfall

The amount of rainfall does not seem to control the time of emergence, the general abundance through the season or the termination of activity for the larvae of *T. alfreddugèsi*. However, it was observed that the amount of rainfall and the moisture content of the soil did have the following influence on the activity and abundance of larvae. When the ground and vegetation was wet immediately following a shower the activity of the larvae was curtailed mostly by droplets of water. When the water obstacles disappeared the larvae became active again and frequently were more abundant than prior to the rain. The temperature usually dropped during and immediately following the rainfall and this also affected the larval activity. The paucity of rain and soil moisture for a prolonged period in the autumn of 1952 probably contributed to the factors which caused a decrease in larvae and shortened the period of activity. The dry soil and air also contributed to the extremes in temperature, and the early low temperatures would be significant. In the wettest summer (1951) the larvae remained more abundant later in the season and were active longer at the end of the season, despite early cool weather in September.

Life Cycle in Relation to the Chigger Samples

The life cycle of *T. alfreddugèsi* can be completed in a minimum of 55 days (Jenkins, 1947:67). On this basis, two, possibly three generations of larvae could emerge each season, which usually lasts for approximately 120 days. An examination of the figures of larval activity and abundance shows slight increases of larvae in August of 1950 and 1952, following the first and greatest abundance peaks in late June and early July. However, there is no evidence of a third generation of larvae for any of the years since a marked decline occurs each September. Therefore, in northeastern Kansas, it seems unlikely that three generations of larvae emerge, in any year, even as isolated individuals.

The continued egg-laying of females over a period of several months indicates that many of the larvae throughout one entire season belong to the first generation. Most or all oviposition probably terminates after several days of cool weather in autumn, and the larvae recovered thereafter probably are from earlier eggs.

Cool weather would tend to perpetuate the remaining larvae, unless the soil was extremely dry.

The first cool periods for the years studied were in early- and mid-September of 1949 and 1950, mid- and late-September and early October in 1951 and 1952. The larvae were observed to decline rapidly two to three weeks after these cool periods. In 1952, the mean air temperature is shown to stay above 60° F. until the last half of September. This is misleading, since September was unusually dry and the daily extremes of air temperature varied greatly. Both the aridity and extremes in temperature seem to have been important factors in the rapid decline of larvae in the latter half of September of 1952.

Thus, the continued or increased abundance of larvae in August, 60 to 80 days after the general emergence of larvae in June, indicates that there was a second generation of larvae. Their numbers decrease in September, and by October only a few larvae are still active. The drop in temperature (usually in September) seems to be directly responsible for the decrease and disappearance of larvae, due to the termination of egg-laying, which is not resumed until May of the next year.

Nymphs and adults were recovered from soil in winter, and these stages probably are those most frequently overwintering. Rarely, if ever, would eggs or larvae overwinter, but resting stages of prenymphs and preadults may survive. Chiggers would continue to develop whenever the temperature of the soil was high enough.

Populations of chigger mites are irregularly dispersed, even in favorable habitats. The larvae emerge from the immediate site of the eggs and tend to spread over a wider area. In the early part of the season, single samples of 100 or more larvae were not uncommon while a few feet away the larvae were scarce.

Nymphs and Adults.—Adults of *T. alfreddugèsi* were recovered in eastern and north-central Kansas in the months of February to July. The adults were in the soil of open grasslands, and under limestone slabs on slopes and ledges of the prairie and woodland edge.

In Russell County, on April 26 and 27, 1952, three adults were found under two limestone slabs, situated on grass-covered slopes, and another adult was recovered on May 6, 1951 from Wabaunsee County in the same type of habitat. Single adults were obtained in Anderson County from under limestone rocks situated among grasses on sparsely wooded slopes on July 7, 1950 and July 17, 1949.

In Douglas County, on April 16, 1952, adults were twice found under large flat limestone rocks along prairie ledges: two adult chiggers with an adult gray skink, *Eumeces obsoletus* and two adults with an adult glass snake, *Ophisaurus attenuatus.*

At the Natural History Reservation, on May 21, 1952, two adult *T. alfreddugèsi* were found moving about in the moist soil (temp. 78° F.) under a limestone rock at the crest of a wooded slope bordering grasslands. On June 14, 1951, three adults were found under limestone slabs in the same area as listed above, and also a single adult from soil adjacent to a mouse nest (probably of *Peromyscus leucopus*). An additional adult, probably of this species, was seen in the soil under a large limestone rock on July 9, 1949.

At the Reservation, the nest of a five-lined skink, *Eumeces fasciatus,* was found on July 9, 1949, under a limestone rock in a clearing adjacent to several trees. The nest, containing a female and nine eggs, consisted of a small cavity in the soil. The sides and bottom of the cavity seemed to have been packed and smoothed by the female. A close examination of the soil revealed a total of six adult *T. alfreddugèsi* moving about in the cracks and on the moist walls of the nest. Two larvae of *T. alfreddugèsi* were attached to the female skink.

The female skink presumably brought the engorged larvae to the nest cavity in which they detached and developed to adults. The moist condition of the area seemed advantageous for the chiggers, and the numerous cracks and crevices afforded protection from the movements of the skink and from other enemies. The interconnecting cracks and additional cavities and spaces in the immediate vicinity of the nest would afford the adult chiggers access to a large area to search for suitable food. The female and the newly hatched skinks also would provide hosts for larvae that might emerge.

Samples of the soil were examined at the Natural History Reservation for nymphs and adults from grassy areas where larvae of *T. alfreddugèsi* were known to be abundant. The flotation method cited by Cockings (1948:289) and Wolfenbarger (1953:658) was used to recover nymphs and adults. The few samples were primarily to determine if nymphs and adults were active in the early spring and just where they were living in the soil. A summary of the results of the samples are listed in Table 1.

TABLE 1.—Nymphs and adults of *T. alfreddugèsi* recovered from the soil.

Date	Size of sample	Soil type	*T. alfreddugèsi* nymphs	*T. alfreddugèsi* adults
February 27, 1951...	1'x1'x1' (1 cu. ft.)	rocky	1	2
March 28, 1952.....	6" deep x 1'x2'	rocky	0	2
July 7, 1950........	Top 4"x1'x1'	non-rocky	0	3
	next 4"x1'x1'	non-rocky	0	0
July 14, 1950.......	4 samples— approx. 4 cu. ft.	rocky and non-rocky soil	0	4

Adults were active in warm weather in February and March. Most of the adults were recovered from the top few inches of soil among roots of grasses. Other arthropods were recovered, including Symphila, Collembola, Acarina (especially Trombidiformes), Myriapoda, Crustacea, Hemiptera, and larvae of Coleoptera. The flotation method does not work equally well for all types of arthropods. Only those kinds that tend to trap air are bouyant enough to float to the surface readily.

Nymphs and adults were identified either by larvae from isolated individuals or from mounted postlarval stages, determined by D. A. Crossley.

Life history.—Wolfenbarger (1953:674) summarized the life cycle of *T. alfreddugèsi*, including data from Jenkins (1947 and 1948 *). According to these authors the egg and deutoval stages together are 13 to 20 days in duration. The larva attaches and engorges on a mammal in 2 to 5 days, longer up to 48 days on reptiles, then remains active for 1 to 8 days (average 2) after dropping from the host. The prenymphal stage lasts 6 to 10 days and the nymph emerges and remains active for from 7 to 32 days, usually longer than two weeks, depending on the amount of available food. The preadult stage lasts 5 to 10 days and the adult emerges to live up to 20 months, usually less. Eggs were laid after 14 days and females continue to lay up to ten months.

Jenkins (1947) gives the minimum time of 55 days for a complete cycle from unfed larva to unfed larva. The average time for the complete cycle would be somewhat longer, probably close to 68 days. Factors which would slow the development include low

* It seems that Jenkins cultured both *T. alfreddugèsi* and *T. lipovskyana*, since the latter was not recognized at that time.

temperatures, failure of the larva to find a host, a cold-blooded host and a low food supply for the nymphs and adults.

If the first large group of larvae emerge in early June, the second generation for that year would be expected to start emerging by mid-August. The numbers of the larvae taken on chigger samplers show increases in larvae in August in 1950 and 1952. A third generation seems unlikely.

Specimens examined.—Total 6,356 larvae, as follows, listed only by county (University of Kansas Natural History Reservation listed separately from the remainder of Douglas County) and host; larvae recovered between May 20 and November 5 (1947 to 1954).

ANDERSON CO.: *Crotaphytus collaris* (265), *Eumeces fasciatus* (10), *Eumeces obsoletus* (6), *Terrapene ornata* (1), *Diadophis punctatus* (1), *Lampropeltis getulus* (5), *Natrix rhombifera* (5), *Natrix erythrogaster* (17), *Sturnella magna* (1), *Tympanuchus cupido* (18). BARBER CO.: *Crotaphytus collaris* (1), *Eumeces obsoletus* (12), *Sceloporus undulatus* (3), *Terrapene ornata* (39), *Crotalus viridis* (7), *Heterodon platyrhinos* (5), *Masticophis flagellum* (12), *Pituophis catenifer* (2), *Buteo jamaicensis* (1), *Melanerpes erythrocephalus* (3), *Sturnella neglecta* (2), *Chondestes grammacus* (7), *Colinus virginianus* (9), *Eremophila alpestris* (1), *Cynomys ludovicianus* (1), *Lepus californicus* (6), *Neotoma micropus* (205), *Perognathus hispidus* (6), *Peromyscus leucopus* (1), *Sigmodon hispidus* (21), *Sylvilagus floridanus* (74). BOURBON CO.: *Richmondena cardinalis* (9). CHASE CO.: *Crotaphytus collaris* (9), *Eumeces obsoletus* (3). CHEROKEE CO.: *Sceloporus undulatus* (4). CHEYENNE CO.: *Cnemidophorus sexlineatus* (11), *Coluber constrictor* (4), *Masticophis flagellum* (12), *Pituophis catenifer* (34), *Thamnophis radix* (2), *Dipodomys ordii* (4), *Onychomys leucogaster* (2), *Perognathus hispidus* (18), *Rattus norvegicus* (6), *Reithrodontomys megalotis* (1). COWLEY CO.: *Lampropeltis calligaster* (2). DOUGLAS CO.: *Chigger samplers* (97), *Eumeces fasciatus* (3), *Eumeces obsoletus* (5), *Terrapene ornata* (1), *Elaphe obsoleta* (37), *Lampropeltis calligaster* (14), *Lampropeltis getulus* (146), *Pituophis catenifer* (10), *Thamnophis sirtalis* (83), *Agelaius phoeniceus* (1), *Colinus virginianus* (11), *Cyanocitta cristata* (2), *Molothrus ater* (2), *Passer domesticus* (39), *Quiscalus quiscula* (11), *Rallus elegans* (2), *Richmondena cardinalis* (15), *Spiza americana* (12), *Spizella passerina* (1), *Sturnella magna* (4), *Sturnus vulgaris* (2), *Troglodytes aedon* (4), *Turdus migratorius* (12), *Zenaidura macroura* (16), *Cryptotis parva* (1), *Canis familiaris* (1), *Microtus ochrogaster* (9), *Procyon lotor* (3), *Peromyscus maniculatus* (2), *Sciurus niger* (3), *Sigmodon hispidus* (80), *Sylvilagus floridanus* (119); Univ. Kansas Nat. Hist. Reservation, *Chigger samplers* (1841), *Acris gryllus* (2), *Cnemidophorus sexlineatus* (71), *Crotaphytus collaris* (30), *Eumeces fasciatus* (159), *Eumeces obsoletus* (74), *Ophisaurus attenuatus* (1), *Ancistrodon contortrix* (438), *Coluber constrictor* (280), *Crotalus horridus* (3), *Diadophis punctatus* (2), *Elaphe obsoleta* (84), *Lampropeltis triangulum* (5), *Pituophis catenifer* (27), *Thamnophis sirtalis* (283), *Natrix sipedon* (19), *Chondestes grammacus* (3), *Coccyzus americanus* (1), *Corvus brachyrhynchos* (8), *Icterus galbula* (1), *Molothrus ater* (2), *Sialia sialis* (2), *Cryptotis parva* (3), *Microtus ochrogaster* (245), *Neotoma floridana* (53), *Peromyscus leucopus* (1), *Sigmodon hispidus* (18). FRANKLIN CO.: *Elaphe obsoleta* (3), *Pituophis catenifer* (11). GREENWOOD CO.: *Neotoma floridana* (8). JEFFERSON CO.: *Eumeces fasciatus* (16), *Elaphe obsoleta* (2), *Lampropeltis calligaster* (8), *Piranga rubra* (2), *Sciurus niger* (25), *Sylvilagus floridanus* (3), *Peromyscus leucopus* (1) and *Peromyscus maniculatus* (5). JEWELL CO.: *Eumeces obsoletus* (22), *Diadophis punctatus* (8), *Elaphe guttata* (20), *Lampropeltis getulus* (4), *Lampropeltis triangulum* (11). LEAVENWORTH CO.: *Terrapene ornata* (8), *Pituophis catenifer* (253), *Neotoma floridana* (10). MIAMI CO.: *Eumeces fasciatus* (2), *Ancistrodon contortrix* (4), *Coluber constrictor* (5), *Elaphe obsoleta* (1), *Thamnophis sirtalis* (2), *Parus bicolor* (1), *Sciurus* sp. (2). MONTGOMERY CO.: *Passer domesticus* (1). RAWLINS CO.: *Cnemidophorus sexlineatus* (13), *Holbrookia maculata* (5), *Sceloporus undulatus* (9), *Crotalus viridis* (8), *Heterodon nasicus* (18), *Pituophis catenifer* (4), *Thamnophis radix* (3), *Tropidoclonion lineatum* (6), *Chondestes grammacus* (6), *Spermophilus tridecemlineatus* (1), *Perognathus hispidus* (21), *Perognathus flavescens* (15), *Peromyscus maniculatus* (1), *Reithrodontomys megalotis* (3). REPUBLIC CO.: *Terrapene ornata* (8), *Heterodon nasicus* (15), *Pituophis catenifer* (10), *Thamnophis sirtalis* (6). RUSSELL CO.: April 26-27, 1952; adults under rocks. SEWARD CO.: *Rana pipiens* (1), *Eumeces obsoletus* (16), *Sceloporus undulatus* (19), *Masticophis flagellum* (127), *Natrix erythrogaster* (5), *Thamnophis sauritus* (9), *Colinus virginianus* (4), *Sturnella neglecta* (3), *Calamospiza melanocorys* (1), *Dipodomys ordii* (1), *Perognathus hispidus* (10), *Reithrodontomys megalotis* (2), *Sigmodon hispidus* (100). SHAWNEE CO.: *Sylvilagus floridanus* (5). SUMNER CO.: *Sciurus niger* (1). WABAUNSEE CO.: *Pituophis* *catenifer* (2), adult, May 6, 1951 (5). WALLACE CO.: *Cnemidophorus sexlineatus* (19), *Terrapene ornata* (16), *Eremophila alpestris* (8), *Sturnella neglecta* (25), *Perognathus hispidus* (7), *Peromyscus maniculatus* (13). WYANDOTTE CO.: *Heterodon platyrhinos* (13), *Tamias striatus* (10), *Sylvilagus floridanus* (15), *Toxostoma rufum* (14), *Dumetella carolinensis* (8), *Zenaidura macroura* (2), *Colaptes auratus* (6), *Turdus migratorius* (3), *Richmondena cardinalis* (6), *Terrapene ornata* (3), *Quiscalus quiscula* (14).

Additional records.—COWLEY CO.: Winfield, *Crotaphytus collaris,* July 27, 1942 (Ewing, 1944:348 and Jenkins, 1948:23, Map). DONIPHAN CO.: Highland, *Homo sapiens,* July, 1905 (Ewing, 1923: 403). HARVEY, PHILLIPS, RILEY and SHAWNEE COUNTIES: (Jenkins, 1948:23, map).

Trombicula lipovskyana Wolfenbarger

(Fig. 12, Map 9)

Trombicula (Eutrombicula) lipovskyana Wolfenbarger, Ann. Ent. Soc. Amer., vol. 45, Jan. 30, 1953, pp. 660-666, figs. 3-4, 12-13, 18, 24, type from 4 miles south of Lawrence, Douglas County, Kansas, host *Colinus virginianus,* July 25, 1948; Penner, Francis and Brown, Jour. Kansas Ent. Soc., vol. 27, July 24, 1954, pp. 113-117; Fitch, Ecol. Monographs, vol. 25, no. 3, Jan., 1955, p. 79.

Diagnosis.—Larva with dorsal setae 22, total body setae 36; scutum large (see below); palpal claw stout with deep cleft and ends of prongs widely separated; tarsala I long (23-33μ); leg III with 1 mastitarsala. Similar to *T. alfreddugèsi* and *T. splendens.*

Scutal measurements (after Wolfenbarger, 1953), average and extremes, of 21 larvae from northeastern Kansas: AW- 86 (75-95), PW- 100 (87-121), SB- 44 (40-49), ASB- 26 (24-28), PSB- 27 (24-28), AP- 28 (23-31), AM- 36 (32-43), AL- 33 (28-36), PL- 50 (43-57), S- 50 (47-55).

Geographic distribution.—(Wolfenbarger, 1953, unless otherwise noted): Known from western Tennessee (Henderson County, Penner *et al.,* 1954), southern Mississippi (Hancock County, KU), southern Louisiana (Orleans and Jefferson parishes, KU), Arkansas (Prairie County, KU, Pope and Washington counties), eastern Oklahoma (Delaware County), eastern Kansas (Anderson, Miami, Bourbon, Montgomery, Douglas, Leavenworth, Jefferson, Riley, and Shawnee counties) and possibly western Kansas * (Logan County).

Seasonal occurrence and abundance.—Larvae were taken from

* The report of *T. lipovskyana* from Cheyenne County, in northwestern Kansas, by Wolfenbarger (1953:664, 675) is due to a cataloging error. These larvae (KU 307-312) were actually from Douglas County, Kansas.

hosts in Kansas between June 12 and November 5 and from chigger samplers between June 12 and Oct. 16. Larvae were common on hosts from late June to October.

Hosts.—In eastern Kansas, *T. lipovskyana* was recovered from 39 species: one frog, one toad, one turtle, two lizards, six snakes, 19 birds and nine mammals.

Eight larvae were recovered from 3 cricket frogs, taken in the Marais des Cygnes River Valley in wet woodland meadows.

Six larvae were taken from 3 toads, *Bufo woodhousii,* from low grasslands in Riley County. Relatively few amphibians were examined in the period of larval activity. This reduced the chance of finding larvae on species of this group.

Lizard hosts include a single gray skink, *Eumeces obsoletus,* with two larvae attached, and a series of six collared lizards, *Crotaphytus collaris* which had an estimated 32 larvae of *T. lipovskyana* attached along with a total of 513 larvae of *T. alfreddugèsi.* These collared lizards were taken at a limestone quarry partly filled with water. The snake hosts include one *Elaphe obsoleta* with one larva; *Lampropeltis getulus* with an estimated 50 larvae, along with 300 *T. alfreddugèsi;* and one timber rattlesnake, *Crotalus horridus* with 3 larvae. Two garter snakes, *Thamnophis sirtalis,* had 6 and 3 larvae respectively. Five copperheads, *Ancistrodon contortrix,* had a total of 10 larvae, and four blue racers, *Coluber constrictor,* had a total of 22 larvae. Individuals of the last four species of snakes also had larvae of *T. alfreddugèsi* attached along with *T. lipovskyana.*

Six of the nineteen host species of birds are characteristically ground dwellers, and 12 other species are frequent ground feeders. Most of the bird hosts were shot in or near stream valleys in meadows of the type known to support this chigger. In Haskell Bottoms and vicinity in the valley of the Wakarusa River south of Lawrence in Douglas County, 56 birds of 12 species were examined between June 23 and November 4. Of this total, 34 individuals (or 61%) of 10 species (83%) had chiggers attached. Larvae of *T. lipovskyana* were found on 31 of the 34 positive birds (91%).

Wolfenbarger (1953:666) recorded a single larva from a flycatcher, *Empidonax* sp. shot in Logan County in the valley of a small stream, approximately 255 miles west of the nearest locality (Riley County) in northeastern Kansas. It is possible that this record is based on "contamination" in the laboratory from a chigger collected elsewhere. Additional collecting in western Kansas is needed to verify the report.

Trombicula lipovskyana was taken only once on five of the nine known mammalian hosts. These five species are the eastern mole, *Scalopus aquaticus* (one larva), the least shrew, *Cryptotis parva;* fox squirrel, *Sciurus niger;* and deer mouse, *Peromyscus maniculatus* (each individual with two larvae); and a dog, *Canis familiaris,* with more than ten larvae.

The cottontail, *Sylvilagus floridanus,* prairie vole, *Microtus ochrogaster,* cotton rat, *Sigmodon hispidus,* and the Florida wood rat, *Neotoma floridana* all are important hosts for *T. lipovskyana.* Prairie voles and cotton rats are common inhabitants of tall grasses in low moist meadows where larvae of *T. lipovskyana* are known to be common.

Habitats.—Unfed larvae of *T. lipovskyana* were recovered from several localities in Douglas County, using chigger samplers. One station, in the low moist valley of the Wakarusa River, in Haskell Bottoms, supported larvae along with *T. alfreddugèsi* in areas where grasses and weeds afforded cover. Larvae also were taken on samplers at the University of Kansas Natural History Reservation in a small meadow extension of the Kansas River Valley. A single larva also was taken at the edge of the Quarry (E-1), in a patch of grass and weeds on October 16, 1951. No larvae of *T. lipovskyana* were found in many chigger samples of the upland prairie at the Reservation, although *T. alfreddugèsi* was abundant and *N. americana* was present. Larvae of *T. alfreddugèsi* were taken from all the known stations for *T. lipovskyana* in Kansas.

A single adult chigger of the subgenus *Eutrombicula,* identified as *T. lipovskyana* by Wolfenbarger (1953:666), was recovered from moist, tightly packed alluvial soil of a dyke in Haskell Bottoms, where the larvae of both *T. lipovskyana* and *T. alfreddugèsi* were taken at the surface on samplers. Weeds, such as ragweed and grasses afforded ground cover.

In general, the habitat for *T. lipovskyana* in Kansas seems to be in low moist meadows where sufficient grasses and weeds afford good ground cover and suitable microfaunas and where the areas are not greatly affected by flooding. All but the doubtful locality in Logan County are below 1100 feet. The stippled area on Map 9 is below 1000 feet in altitude.

Penner, Francis and Brown (1954:113-117) reported that large numbers of larvae * of this species were found in Henderson County,

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* It is not clear in what ecological situation the chigger larvae that were preserved and identified as *T. lipovskyana* were obtained. These larvae are correctly identified and are in the University of Kansas Snow Entomological Museum.

Tennessee, on August 16, 1945, after a heavy rain. These larvae, from a wooded area consisting of oak as well as other deciduous species, were found in greatest abundance in decaying logs and stumps, especially those logs which were covered with a common tree moss, identified as *Platygyrium repens.* They also reported that adult chiggers (not identified) were seen in the logs.

Specimens examined.—Total, 722 larvae, as follows: ANDERSON CO.: 2 mi. N Garnett, *Crotaphytus collaris,* July 17, 1949 (6); 1 mi. S Welda, *Tympanuchus cupido,* July 28, 1951 (2); 2 mi. S, 1 mi. W Welda, *Sturnella magna,* Aug. 4, 1951 (5) and *Tympanuchus cupido,* Aug. 10, 1951 (9). BOURBON CO.: 1 mi. W Ft. Scott, *Richmondena cardinalis,* Sept. 3, 1947 (10). DOUGLAS CO.: *Passer domesticus,* July 15, 1948 (2); 3 mi. S Baldwin, *Sylvilagus floridanus,* July 16, 1949 (6); 4 mi. W, 2 mi. S Baldwin, *Sylvilagus floridanus,* July 14, 1949 (4); 5 mi. S Clinton, *Sylvilagus floridanus,* July 10, 1949 (7); Lawrence, *Eumeces obsoletus,* July 29, 1947 (2), -*Elaphe obsoleta,* July 22, 1951 (1), -*Passer domesticus* (49), June 20 (1949) to Oct. 5 (1947) -*Richmondena cardinalis,* Oct. 17, 1947 (6), -*Troglodytes aedon,* Aug. 3, 1947 (1), -*Turdus migratorius,* Aug. 20, 1947 (19), Sept. 21, 1947 (6), -*Tyrannus tyrannus,* Aug. 3, 1947 (2), -*Canis familiaris,* Aug. 2, 1947 (10), -*Microtus ochrogaster,* Aug. 13, 1951 (2) -*Sigmodon hispidus* (48), Aug. 13 (1951) to Oct. 25 (1948), -*Sylvilagus floridanus,* June 21, 1949 (1), July 11, 1949 (8); 2 mi. W Lawrence, June 19, 1949, *Quiscalus quiscula* (4) and *Sylvilagus floridanus* (5); 2 mi. W, 2 mi. N Lawrence, *Scalopus aquaticus,* Sept. 23, 1948 (1); 3 mi. S, 1 mi. E Lawrence, Haskell Bottoms, *Chigger samplers,* June 12 to Aug. 21, 1950 (11), -*Agelaius phoeniceus,* Sept. 28, 1947 (1), Oct. 24, 1947 (10) -*Molothrus ater,* Aug. 10, 1951 (4), Oct. 24, 1947 (4) -*Rallus elegans,* June 23, 1949 (6) -*Spiza americana,* June 23, 1949 (1) -*Sturnella magna,* Oct. 24, 1947 (9) -*Sturnella neglecta,* Nov. 5, 1947 (3) -*Sturnus vulgaris,* Aug. 10, 1951 (7) *Zenaidura macroura,* June 23, 1949 (3), Sept. 28, 1947 (8) -*Cryptotis parva,* Oct. 25, 1947 (2) -*Microtus ochrogaster,* Sept. 25, 1948 (1), Oct. 24-25, 1947 (5) -*Sigmodon hispidus,* Oct. 25, 1947 (105) -*Sylvilagus floridanus,* July 14, 1949 (9) Sept. 25, 1948 (8); 4 mi. S Lawrence, *Colinus virginianus* (20) -*Zenaidura macroura* (8) -*Sylvilagus floridanus* (10), July 25, 1948; 7 mi. S Lawrence, *Sturnella magna* (4) and *Zenaidura macroura* (12); 8 mi. S Lawrence, *Quiscalus quiscula* (29) -*Sturnus vulgaris* (1) -*Sylvilagus floridanus* (1), June 14, 1949; 2-7 mi. SE Lawrence, Wakarusa River bottoms, *Agelaius phoeniceus* (15) -*Bartramia longicauda* (15) -*Molothrus* *ater* (7) -*Spiza americana* (16); 3 mi. N, 1 mi. E Lawrence, *Lampropeltis getulus,* Aug. 11, 1949 (30) -*Thamnophis sirtalis,* Aug. 16, 1947 (3) -*Richmondena cardinalis,* July 19, 1948 (1) -*Spiza americana,* July 7, 1947-July 29, 1947 (23) -*Zenaidura macroura,* Aug. 17, 1947 (1); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Chigger samplers,* Aug. 15, 1952 (4), Oct. 16, 1951 (1), -*Ancistrodon contortrix* (10), July 28-Sept. 19, 1949, -*Coluber constrictor* (22) July-Oct. 1949, -*Crotalus horridus,* Aug. 19, 1947 (3) -*Thamnophis sirtalis,* Sept. 23, 1949 (6) -*Chondestes grammacus,* Aug. 18, 1947 (1) -*Molothrus ater,* July 29, 1947 (5) -*Sialia sialis,* July 29, 1947 (2), Aug. 18, 1947 (1), -*Turdus migratorius,* Aug. 18, 1947 (2) -*Zenaidura macroura,* Aug. 17, 1947 (3) -*Neotoma floridana,* Aug. 16, 1952 (2), Aug. 20, 1952 (3); 20 mi. SW Lawrence, *Sciurus niger,* Sept. 20, 1953 (1); 2 mi. S, 2 mi. W Pleasant Grove, *Sylvilagus floridanus,* Aug. 4, 1951 (2). JEFFERSON CO.: 12 mi. N Lawrence, *Sciurus niger,* Sept. 1, 1948 (2). LEAVENWORTH CO.: 3½ mi. E, 3½ mi. N Lawrence, July 2, 1949, *Terrapene ornata* (2) and *Neotoma floridana* (34); 5½ mi. N, ½ mi. E Lawrence, *Peromyscus maniculatus,* July 7, 1953 (2). LOGAN CO.: 1½ mi. NE McAllaster, *Empidonax* species, July 3, 1949 (1). MIAMI CO.: 3 mi. E, 1 mi. S Fontana, *Acris gryllus,* Oct. 12, 1948 (8). MONTGOMERY CO.: Coffeyville, *Passer domesticus,* Sept. 11, 1947 (2). RILEY CO.: Manhattan, Wildcat Creek, *Bufo woodhousii,* Aug. 22, 1947 (6). SHAWNEE CO.: 3 mi. W Topeka, *Sylvilagus floridanus,* Aug. 26, 1948 (7).

Trombicula splendens Ewing

(Map 7)

Trombicula splendens Ewing, Bull. Amer. Mus. Nat. Hist. vol. 32, 1913, pp. 113-114, adult types from under stones in a tamarack bog, at Portage, Columbia County, Wisconsin, taken in 1909.

Acariscus masoni Ewing, Proc. Ent. Soc. Washington, vol. 45, March 31, 1943, pp. 60-61, type from Orlando, Orange County, Florida, host *Homo sapiens.*

Eutrombicula masoni, Jenkins, Amer. Jour. Hygiene, vol. 48, July, 1948, pp. 22-35.

Trombicula (*Eutrombicula*) *splendens,* Jenkins, Jour. Parasit., vol. 35, May 11, 1949, pp. 201-204; Jenkins, Ann. Ent. Soc. Amer., vol. 42, Oct. 21, 1949, pp. 303-305; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 50 (includes a comprehensive synonymy); Wolfenbarger, Ann. Ent. Soc. Amer., vol. 45, Jan. 30, 1953, p. 650.

Diagnosis.—Larvae with dorsal setae 24-28, total body setae 40-44; scutum large (see below); palpal claw stout with deep cleft between prongs; tarsala I short (13-16μ); leg III with 1 mastitarsala. Similar to *T. alfreddugèsi* and *T. lipovskyana.*

Scutal measurements, average and extremes, of 4 larvae from Miami County: AW- 84 (78-87), PW- 96 (93-100), SB- 48 (45-50),

ASB- 27 (24-28), PSB- 29 (28-30), AP- 28 (27-30), AM- 36 (33-38), AL- 32 (31-33), PL- 46 (44-48), S- 51 (49-53).

Geographic distribution.—(Jenkins, 1948, and 1949, unless otherwise noted): Known from Canada in Ontario (Welland County) and the United States along the Atlantic Coast from Massachusetts south to Florida, west to eastern Texas, southeastern Oklahoma (Choctaw County, KU), eastern Kansas (Miami County), southeastern Nebraska (Saunders County, KU), north to southern Minnesota, southern Wisconsin and southern Michigan.

Seasonal occurrence.—Adults have been taken in Kansas only in late May. Larvae were taken from hosts in August in Nebraska and in September in Missouri.

Hosts.—*Trombicula splendens* was not taken from hosts in Kansas. Wharton and Fuller (1952:50) listed the known species of hosts as 11 mammals, 6 birds, 16 reptiles, and 1 amphibian. We have recovered it from 2 additional mammals and 3 other reptiles in other states.

Jenkins (1948:28) stated that reptiles are important hosts of *T. masoni* [= *T. splendens*], and that birds and mammals also are good hosts.

In Kansas, larvae should be found on vertebrate hosts which occur around decaying logs. Several five-lined skinks were found under the loose bark of decaying logs, in close association with adults.

Habitat.—Adults of *T. splendens* were recovered from decaying logs and dead standing trees in deciduous woodlands along the Marais des Cygnes River in Miami County, Kansas on three different trips (May 26, 1951, May 30, 1952 and May 31, 1953).

On the first trip, 15 adults were found under a strip of bark on the trunk of a large dead standing chestnut oak, *Quercus Muehlenbergii,* located in thick deciduous woods on the valley floor. The trunk was hollow and had a small pool of water in a depression at the base, barely six inches above the ground. The adults were under a strip of loose bark adjacent to the cavity, near the water. Numerous collembolans of at least two species of the family Entomobryiidae, beetle larvae and other small insects were in the area of frass under the bark. The total area suitable for adults was not larger than 4 square feet. In the tree-hole pool, larvae and adults of *Aëdes triseriatus* (Say) were numerous. The Collembola, related to the laboratory species, *Sinella curviseta* Brook, whose eggs are regularily eaten by adult *T. splendens* in the laboratory, along with the tree-hole mosquitoes probably supplied eggs used as food. A young skink, probably *Eumeces laticeps,* escaped up the hollow trunk.

No adults of *T. splendens* were found in decaying logs or dead standing trees of the valley floor on the subsequent two trips. This absence of chiggers may have been due to a widespread flood in July of 1951, which inundated the entire valley destroying many suitable habitats. Adults, however, were found in decaying logs on the wooded hillsides adjacent to the valley. Logs of oak, elm and hackberry, in various stages of decay and usually in openings in the woods were found to harbor adults of *T. splendens.* The logs were usually more than 1 foot in diameter, and the bark either was absent or was loose over a layer of frass. This frass of partly decomposed wood is a product of insects and fungi. Adults were found in damp frass under the bark and within the log and in small cavities in the decaying wood beneath the frass. Adults frequently were found moving about the frass directly under the bark. No adults were found deep in the center of moist to wet logs. Several of the logs with *T. splendens* harbored five-lined skinks, *Eumeces fasciatus,* including females preparing nests. On May 30, 1952, we took 8, 4 and 22 adults in three logs. The log with 22 adults was a hackberry with loose bark over a thin layer of frass. The area from which the adults were recovered was approximately 3 square feet and was damp. The air temperature at the time was 80° F. and the log temperature on the surface of the frass was 74° F. On May 31, 1953, approximately 25 adults were found in damp logs, usually having loose bark and a layer of damp frass.

Trombicula splendens seems to be absent from Douglas County—more certainly from the University of Kansas Natural History Reservation; the samples of vertebrates taken there seemed sufficiently extensive to have included larvae if they were present in the sampling period (1947-1952). Forests in Douglas County are mostly second growth and are situated on rocky hillsides which become dry in summer, especially during the drier summers such as 1952 and 1953. Large trees and logs are scarce. In the summer of 1952, logs were sampled for chiggers on the Reservation. No larvae of *T. splendens* were recovered, although larvae of *T. g. gurneyi, T. alfreddugèsi* and *T. sylvilagi* were found. Only *T. gurneyi* was common and widespread in these logs. Most of the logs in Douglas County may dry out in the autumn and eliminate much of the microfauna reducing it to a state probably unsuitable for *T. splendens. Trombicula gurneyi* seems to live deeper in the logs and may escape desiccation. Also the soil around the logs becomes drier than in Miami County where the soil remains comparatively moist owing to better ground cover and poorly drained soil.

In Douglas County, *T. lipovskyana* seems to be successful in the more moist areas and is found in low grasslands. This species would compete with *T. splendens* where woods are sparse or lacking and where adults of *T. splendens* live away from logs.

Trombicula splendens has been successfully cultured in the laboratory and seems to thrive in damp cultures. It seems well suited for high humidities and damp substrata, and thrives in moist decomposed wood of rotting logs. *Trombicula alfreddugèsi,* however, does not seem to be especially successful under the same conditions, and the adults did not survive in decomposed wood.

Specimens examined.—Total, 71 larvae, as follows: MIAMI Co.: 3 mi. E, 1 mi. S Fontana, Pigeon Lake area, adults, May 26, 1951 (7), May 30, 1952 (58), May 31, 1953 (6).

Subgenus *Leptotrombidium* Nagayo, Miyagawa, Mitamura and Imamura

Leptotrombidium Nagayo *et al.,* Dobutsugaku Zasshi, vol. 28, 1916, p. 392, type *Trombidium akamushi* Brumpt.

Diagnosis.—Larva with scutum roughly rectangular, with scutal setae plumose; sensilla with barbs or branched; galeal seta branched; palpal femur and genu each with a nude seta (typically) and usually one or more nude setae on palpal tibia; legs without long whiplike nude or plumose setae. Species in Kansas with palpal claw trifurcate; leg I with 2 genualae, subterminala and parasubterminala; leg II with 1 genuala and pretarsala; leg III with 1 genuala and coxa with 1 branched seta.

Remarks.—Audy (1954) expanded this subgenus to include more than 66 species (including some not yet described) throughout the world. Most of these species are restricted to Asia, with only five species known from North America. Two of these species, *T. myotis* and *T. twentei,* are known from Kansas. Four of the five American species occur on bats.

Trombicula myotis Ewing

(Fig. 12, Map 7)

Trombicula myotis Ewing, Ent. News, vol. 40, Nov. 8, 1929, pp. 294-295, type from Mt. Katahdin, Piscataquis County, Maine, host *Myotis lucifugus,* Sept. 7, 1928; Wharton, Jour. Parasit., vol. 33, July 1, 1947, pp. 260-264; Brown and Brennan, Canadian Jour. Zool., vol. 30, Dec., 1952, p. 342.

Trombicula eptesici Brennan, Jour. Parasit., vol. 33, July 1, 1947, pp. 247-248, 1 fig., type from Hamilton, Ravalli County, Montana, host *Eptesicus fuscus,* Aug. 24, 1935.

Trombicula russicum myotis, Fuller, Zool. Verhandelingen, no. 18, Dec. 16, 1952, pp. 49-51.

Trombicula (*Leptotrombidium*) *myotis*, Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 54; Jameson and Toshioka, Pacific Sci., vol. 8, no. 1, Jan., 1954, pp. 19-20.

Diagnosis.—Larva with body white in life, moderate in size (engorged), dorsal setae 38, formula beginning 2-10, total setae 74; eyes 2/2 red in life; scutum having small numerous puncta; sensilla with branches on distal two thirds; palpal tibia with branched dorsal and ventral setae, lateral seta nude; palpal tarsus with 7 branched setae and tarsala.

Scutal measurements of two larvae from Douglas County and Barber County respectively: AW-71, 63; PW- 84, 73; SB- 27; ASB- 28, 22; PSB- 14, 14; AP- 28, 20; AM- 41, 50; AL- 42, 34; PL- 53, 56; S- 64, —.

Geographic distribution.—Known from Canada (Alberta, Brown and Brennan, 1952), Maine (Piscataquis County, Ewing, 1929), Pennsylvania (Monroe County, Wharton, 1947; and Beaver County, KU), Montana (Ravalli County, Brennan, 1947), Oklahoma (McClain County, KU), Arkansas (Polk County, KU), Missouri (Boone County, Fuller, 1952) eastern and south-central Kansas (Douglas and Barber counties), southeastern Nebraska (Otoe County, KU) and southwestern Iowa (Fremont County, KU).*

Seasonal occurrence.—Larvae have been taken from hosts in Kansas in August. Other collections have been made in January and February (Oklahoma), March (Missouri and Arkansas), May (Pennsylvania), July (Canada), August (Montana), September (Maine) and October (Nebraska and Iowa).

Hosts.—In Kansas, a single larva of *T. myotis* was found on a gray wood rat and another on a pilot black snake. Hosts from nearby states include *Neotoma floridana* and engorged larvae were found also in nests (Oklahoma); *Sylvilagus floridanus* (Arkansas); *Sciurus niger* (Nebraska); *Microtus pinetorum* (Iowa); and *Peromyscus leucopus* (Nebraska and Iowa).

Other known host records include *Peromyscus leucopus* (Canada), *Myotis lucifugus* (Maine) and *Eptesicus fuscus* (Montana, Missouri and Pennsylvania). It was formerly considered to be a bat chigger, but the accumulated evidence now seems to show that it occurs also normally on other mammals, especially those of the woodlands.

* Jameson and Toshioka (1954) reports T. *myotis* from *Myotis* sp. in Korea.

The larvae obtained from *Peromyscus leucopus* trapped in Iowa were found attached in clusters on the tragus and antitragus of the ears. Others possibly were attached on the body as well.

Habitats.—The majority of the hosts were obtained in deciduous forests. The presence on mammals which inhabit the forest floor as well as on those which are semi-arboreal or frequently climb seems to indicate that this chigger is not confined to trees or caves. The data from hosts do point to the presence of free-living stages in decaying wood and probably large nests of mammals as well. The presence on bats which frequently roost in cavities of standing dead trees and on squirrels and mice which commonly nest in such cavities, all indicate that decaying wood, whether in trees still standing or those that have fallen, is probably the usual habitat of the free-living stages.

Specimens examined.—Total, 2 larvae, as follows. BARBER CO.: 4 mi. S Aetna, *Neotoma micropus,* Aug. 22, 1949 (1). DOUGLAS CO.: 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserve, *Elaphe obsoleta,* Aug. 29, 1949 (1).

Trombicula twentei Loomis

(Fig. 22. Map 10)

Trombicula (Leptotrombidium) twentei Loomis, Univ. Kansas Sci. Bull., vol. 36, July 15, 1954, pp. 922-924, figs. 4-9, type from 4 miles south of Aetna, Barber County, Kansas, host *Antrozous bunkeri,* February 25, 1953.

Diagnosis.—Larva with body (engorged) large, total body setae about 106; tibia with 3 nude setae; scutum roughly trapezoidal, with few large puncta, posterior margin concave, sensilla long, flagelliform, with approximately 13 long branches on distal two thirds.

Scutal measurements (after Loomis, 1954), average and extremes, of 9 topotypes: AW- 62 (58-66), PW- 79 (75-83), SB- 27.5 (25-29), ASB- 33 (31-34), PSB- 12 (11-13), AP- 29 (28-31), AM- 49 (47-52), AL- 36 (35-38), PL- 48 (46-53), S- 79 (76-83).

Geographic distribution.—Known only from the type locality in south-central Kansas.

Seasonal occurrence.—Larvae were taken from bats on February 25, 1953.

Ecology.—The type series of nine fully engorged larvae were found on the wings and bodies of seven Bunker bats, *Antrozous bunkeri,* which were found on February 25, 1953, hibernating in a ceiling crevice of a small gypsum cave. This is the same cave from which *Myotis velifer* was obtained with larvae of several other chigger species attached. *Myotis velifer* was found hanging from the ceiling in clusters deeper in the cave. The engorged condition of the larvae of *T. twentei* indicates that the larvae had been attached for some time and may have attached to the bats prior to hibernation.

Specimens examined.—Total, 9 larvae, from type locality.

Subgenus *Neotrombicula* Hirst

Neotrombicula Hirst, Nature, vol. 116, 1925, p. 609, type *Acarus autumnalis* Shaw.

Diagnosis.—Larvae with sternal setae 2-2; scutum roughly pentagonal, with scutal setae branched; sensilla long, with barbs or branches usually present; palpal claw trifurcate with divergent prongs; leg III with coxa having 1 branched seta, 1 or more long nude whiplike setae (or long feathered setae) on tarsus, tibia and usually telofemur (only fitchi group lacking all long nude setae).

Species in Kansas having palpal tarsus with 7 branched setae, tarsala and subterminala; leg I with 2 or 3 genualae, subterminala and parasubterminala; leg II with 1 genuala and pretarsala, leg III with or without long nude whiplike setae, if no nude setae with long plumose setae in their places.

Remarks.—Brennan and Wharton (1950:156) subdivided the subgenus *Neotrombicula* as follows; the autumnalis group, microti group, bisignata group and the ungrouped species, based on the number and arrangement of the long nude whiplike setae on leg III. To these I am adding the fitchi group, containing two species. In Kansas the microti group is represented by *T. lipovskyi* and *T. whartoni,* the fitchi group by *T. fitchi* and *T. kardosi,* whereas *T. sylvilagi* is an ungrouped species. The thirty-four species of this subgenus listed by Wharton and Fuller (1952:45-61) are found in Europe, Asia, North America, South America and northern Africa. These species are found on mammals and birds, being more common on the former, especially the lagomorphs and rodents.

Microti Group

Diagnosis.—Larvae with leg III having 1 mastifemorala, 1 mastitibiala and 2 mastitarsalae.

Species in Kansas with dorsal setae beginning 2-6-6, total body setae 68-86, galeal seta nude; palpal femur, genu and tibia with all setae branched; leg I with 1 genuala.

Remarks.—Brennan and Wharton (1950:156) erected the microti group to include all species of the subgenus *Neotrombicula* with one long nude seta each on the femur and tibia and two long nude whip-like setae on the tarsus of leg III. Fifteen species are known from North America. Two of these species, *T. lipovskyi* and *T. whartoni*, occur in Kansas. A third species, *T. loomisi*, has been taken in Colorado and Nebraska only 7 miles from the northwestern corner of Kansas.

Larvae of this group are known from mammals and birds. In Kansas, the larvae first appear in the fall (October) and occur throughout the winter and early spring.

Trombicula lipovskyi Brennan and Wharton

(Figs. 1, 12, 23, Map 11)

Trombicula (Neotrombicula) lipovskyi Brennan and Wharton, Amer. Midl. Nat., vol. 44, July, 1950, p. 177, pl. 3, map 3, type from 4 miles west and 1 mile south of Logan, Norton County, Kansas, host *Peromyscus maniculatus*, Oct. 25, 1946; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 59; Kardos, Univ. Kansas Sci. Bull., vol. 36, pt. 1, no. 4, June 1, 1954, pp. 91-98, figs. 16-18, 23.

Diagnosis.—Larva similar to *T. whartoni*, but differs in having scutum broadly rounded posteriorly, with numerous small puncta; sensilla with pronounced barbs along entire length; legs with coxae having small puncta.

Scutal measurements (after Kardos, 1954), average and extremes, of 20 larvae from Norton and Douglas counties: AW- 68 (62-77), PW- 83 (77-94), SB- 26 (22-31), ASB- 37 (32-41), PSB- 25 (21-28), AP- 29 (26-33), AM- 48 (43-55), AL- 49 (45-54), PL- 72 (67-78), S- 87 (77-97).

Geographic distribution.—(Kardos, 1954, unless otherwise noted): Known from Missouri (Pike County, south to Stoddard and Jasper counties, west to Caldwell County), western Arkansas (Washington and Polk counties), eastern and central Oklahoma (Latimer, Cleveland and McClain counties), central and eastern Kansas (Norton, Russell and Barber counties, east to Riley, Nemaha, Brown, Jefferson, Douglas, Leavenworth, Anderson, Miami, Johnson, Linn and Wyandotte counties), and southeastern Nebraska (Otoe and Nemaha counties, KU; and Richardson County).

Seasonal occurrence and abundance.—Larvae were taken from hosts in Kansas from early October to late April. The number of larvae on hosts increased from a few in early October to a peak in the last half of November and the first half of December, decreased rapidly in late December through February, increased slightly in late February and March, and decreased to zero in late April (last records, April 27, 1952). Kardos, (1954:93) graphs the seasonal abundance of larvae on four hosts from northeastern Kansas. *T. lipovskyi* seems to be the most common chigger mite in northeastern Kansas on mammals in late fall and early winter.

Hosts.—In Kansas, *T. lipovskyi* is known from six species of birds and 17 species of mammals, as listed by Kardos (1954:111-112). Birds seem to be of little importance as hosts, whereas the principal hosts were found among the common small mammals. The most important host in northeastern Kansas is *Sylvilagus floridanus.* Other hosts of lesser importance include *Neotoma floridana, Sigmodon hispidus, Microtus ochrogaster, Sciurus niger* and *Reithrodontomys megalotis.*

The larvae of *T. lipovskyi* usually were found in the ears of the mammalian hosts, although some were attached on the head, body and legs. Fox squirrels, *S. niger,* had larvae attached on the head and body, one individual possessing a cluster of larvae immediately below each ear. The principal sites of attachment on cottontails were in the ears and on the feet.

Habitats.—In Kansas *T. lipovskyi* was taken from hosts which inhabit the woodland edge and prairies of tall and mixed grasses. It has not been taken in the short-grass high plains in western Kansas.

At the Natural History Reservation in northeastern Kansas, larvae were obtained on chigger samplers in late October, November, January and February 27, 1951, from the ground in a woodland edge habitat at Station A. This same station was inhabited by larvae of *T. sylvilagi* in autumn, and by *T. alfreddugèsi* and *N. americana* in summer and early autumn.

Larvae, both engorged and unengorged, were recovered from several nests of the wood rat, *Neotoma floridana,* from eastern Kansas and Oklahoma (McClain County), and from a small rodent nest (probably of *Peromyscus leucopus*) in Douglas County, Kansas, according to Kardos (1954:92). This seems to indicate that some of the larvae drop from the host into the nest when fully engorged and that unfed larvae emerge in nests of the previous hosts. Other larvae seem to emerge in burrows, runways and on the surface of the soil, especially where there are concentrations of mammalian hosts. The presence of larvae on a variety of hosts including squirrels and birds indicates that many unfed larvae occur in a surface habitat.

Many hosts of *T. lipovskyi* were taken from areas where grasses and weeds afforded good ground cover and where bushes, thickets and brush piles were present at the woodland edge. Brush piles must be important in maintaining *T. lipovskyi* in many areas, since the cottontails use the piles as shelters in the winter months. Presumably many of the engorged larvae drop from the host and enter the soil under these brush piles.

Specimens examined.—Total, 1021 larvae, as follows. Specimens listed by Kardos (1954:96-98) are summarized under the county, including the date, host and specimens examined: ANDERSON CO.: Nov. 29, 1947, *Sylvilagus floridanus* (14). BARBER CO.: April 11-12, 1949, *Neotoma micropus* (9) and *Peromyscus maniculatus* (3). BROWN CO.: Nov. 29-30, 1947, *Microtus ochrogaster* (17), *Mus musculus* (16), *Peromyscus maniculatus* (1), *Rattus norvegicus* (1), *Sigmodon hispidus* (1). DOUGLAS CO.: Oct. 15 (1947) to April 27 (1952); *Centurus carolinus* (1), *Melospiza melodia* (1), *Richmondena cardinalis* (2), *Sturnella neglecta* (1), *Canis latrans* (3), *Lepus californicus* (6), *Microtus ochrogaster* (14), *Microtus pinetorum* (4), *Neotoma floridana* (80), *N. floridana* nest (9), *Peromyscus leucopus* (3), *Peromyscus maniculatus* (1), *Reithrodontomys megalotis* (11), *Sciurus carolinensis* (11), *Sciurus niger* (46), *Sigmodon hispidus* (46), *Sylvilagus floridanus* (254), rodent nest (*Peromyscus* sp.) (4), chigger samplers (6) and Feb. 27, 1951 (1). JEFFERSON CO.: Nov. 21 (1951) to Feb. 19 (1952); *Asio otus* (2), *Parus atricapillus* (2), *Richmondena cardinalis* (1), *Didelphis marsupialis* (1), *Neotoma floridana* (2), *Peromyscus leucopus* (4), *Sciurus niger* (10); 5½ mi. N, ½ mi. E Lawrence, *Microtus ochrogaster*, Feb. 20, 1952 (3); 7 mi. N, 5 mi. W Midland, *Sciurus niger*, Nov. 26, 1953 (4); 10 mi. N Midland, *Sciurus niger*, Nov. 14, 1953 (4). JOHNSON CO.: 3 mi. W Aubury, *Sylvilagus floridanus*, Dec. 1, 1953 (3); 2 mi. W, 1½ mi. N Lenexa, *Sylvilagus floridanus*, Nov. 18, 1953 (82); 2 mi. N, 1 mi. W Lenexa, *Microtus ochrogaster* (2) and *Peromyscus leucopus* (1), April 2, 1954, -*Sciurus niger*, Nov. 18, 1953 (8), Jan. 4, 1954 (1), -*Sylvilagus floridanus*, Nov. 18, 1953 (60), Dec. 21, 1953 (19), Jan. 4, 1954 (1), March 16, 1954 (2), April 1, 1954 (1); Roeland Park, *Sylvilagus floridanus*, Nov. 10, 1953 (15); 4 mi. S, 3 mi. W Stanley, *Sciurus niger*, Jan. 6, 1954 (1). LINN CO.: 2 mi. S Trading Post, *Sylvilagus floridanus*, Dec. 10, 1953 (1). MIAMI CO.: 2 mi. W, 1 mi. S Louisburg, *Sylvilagus floridanus*, Nov. 24, 1953 (48); 4 mi. N, 1 mi. E Paola, *Sylvilagus floridanus*, Dec. 14, 1953 (17). NEMAHA CO.: Nov. 30, 1947, *Blarina brevicauda* (13), *Microtus ochrogaster* (7), *Reithrodontomys megalotis* (3). NORTON CO.: Oct. 23-30, 1946, *Peromyscus maniculatus* (30), *Reithrodontomys megalotis* (8), *Sylvilagus floridanus* (47). RILEY CO.: Manhattan, *Peromyscus maniculatus*, Nov. 1, 1953 (3). RUSSELL CO.: April 26, 1952, *Peromyscus maniculatus* (10) and *Sylvilagus floridanus* (1). WYANDOTTE CO.: Kansas City, *Sylvilagus floridanus*, Oct. 30, 1953 (27), Dec. 11, 1953 (1) and *Sciurus carolinensis*, Dec. 11, 1953 (1); 1 mi. N, 1 mi. E Piper, *Sylvilagus floridanus*, Oct. 29, 1953 (9).

Additional records.—(Brennan and Wharton 1950:177). DOUGLAS CO.: *Neotoma floridana*, Nov. 2, 1946 (20). LEAVENWORTH CO.: *Sylvilagus floridanus*, Oct. 7, 1946 (3). NORTON CO.: *Peromyscus* sp. [= *P. maniculatus*] Oct. 25, 1946 (type + 3) and *Reithrodontomys fulvescens* [= *R. megalotis*] Oct. 26, 1946 (2). For the exact locality of these, see the type locality in the synonymy.

Trombicula whartoni Ewing

(Fig. 12, Map 10)

Trombicula whartoni Ewing, Ent. News, vol. 40, Nov. 8, 1929, p. 296, type from Summerville, Dorchester County, South Carolina, host bird.
Trombicula (Neotrombicula) whartoni, Brennan and Wharton, Amer. Midl. Nat., vol. 44, July, 1950, pp. 175-176, pl. 4, map 3; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 60; Kardos, Univ. Kansas Sci. Bull. vol. 36, pt. 1, no. 4, June 1, 1954, pp. 98-102, figs. 19-22.

Diagnosis.—Larva similar to *T. lipovskyi*, but differs in having scutum angular posteriorly, with few large puncta; sensilla with small basal barbs, rarely nude; legs with coxae having large puncta.

Scutal measurements (after Kardos, 1954), averages and extremes, of 10 larvae from Douglas County: AW- 67 (60-74), PW- 83 (78-89), SB- 26 (24-28), ASB- 38 (36-41), PSB- 25 (23-28), AP- 28 (26-30), AM- 46 (40-51), AL- 52 (43-59), PL- 75 (68-80), S- 87 (80-100).

Geographic distribution. — (Brennan and Wharton, 1950, unless otherwise noted): Known from southeastern Pennsylvania (Dauphin County), south to central Florida (Orange County), Mississippi (Harrison and Franklin counties; and DeSoto County, KU), west to southern Arkansas (Miller and Polk counties, Kardos, 1954), eastern Oklahoma (McCurtain and Adair counties, *ibid*), north to eastern Kansas (Nemaha, Brown, Jefferson, Douglas, Johnson, Wyandotte and Miami counties), Nebraska in the southwest (Dundy County, Kardos, 1954) and southeast (Otoe and Nemaha counties, KU), northern Missouri (Linn County) and east-central Illinois (Champaign County).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from October 12 to March 10 (1954). They are common in November and early December. No larvae were recovered in January or February, while only two larvae were found in March.

Hosts.—This species is common on the cottontail, *Sylvilagus floridanus,* a mammal of the woodland margins, and the tree squirrels, *Sciurus carolinensis* and *S. niger,* common woodland dwellers. Birds were found to have larvae attached on several occasions, and several larvae were taken from each of four species of birds, which are characteristic of the thickets and tall weeds along the woodland edge. The closely related species, *T. lipovskyi,* was the common *Trombicula* found on small mammals, especially those of the grasslands, in late autumn and early winter.

Hosts of *T. whartoni,* in addition to those from Kansas, as listed by Kardos (1954:101-102) from the central states were as follows: *Microtus ochrogaster* and *Microtus pennsylvanicus* from Nebraska; *Sigmodon hispidus, Reithrodontomys fulvescens* and *Peromyscus maniculatus* from Oklahoma and Arkansas; *Neotoma floridana* from Oklahoma; *Peromyscus leucopus* from Arkansas; and *Troglodytes aedon* from Mississippi. Brennan and Wharton (1950:176) listed three additional hosts, *Thryothorus ludovicianus* from North Carolina, *Pipilo erythrophthalmus* from Florida and *Canis familiaris* from Maryland. Brennan and Wharton (*ibid*) listed as hosts, *Sylvilagus floridanus* (eight times), *Sciurus carolinensis* and *S. niger* (nine times), birds (5), and small mice (5) out of a total of 29 hosts.

Larvae mostly were found in the ears of the hosts but some were on the legs and body. The larvae on tree squirrels were taken from the legs and bodies, not in the ears.

Habitats.—In northeastern Kansas, this chigger seems to occur principally in the deciduous woods and at the woodland edge but seems to be absent in the open grasslands and on the forest floor where ground cover is lacking. It seems to require a habitat moister than that of *T. lipovskyi.* The unfed larvae probably are active on the surface of the ground, especially near runs and burrows of the mammalian hosts. This species was not taken west of the eastern woodlands in Kansas, but it was found in southwestern Nebraska on meadow and prairie voles in an isolated marshy meadow (see Kardos, 1954:100).

Two cottontails from Wyandotte County which had 200 larvae were found in a woodland edge habitat bordering oak-hickory woods. The habitat had ground cover of grasses, especially blue grass; coralberry was abundant and covered much of the area; blackberry was throughout the area, in addition to other low shrubs and saplings. The adjacent woods consisted of chestnut oak, hickory, walnut, elm, hackberry, osage orange, and honey-shuck trees. The ground cover in the sparse woods included many of the same plants as the woodland edge.

Specimens examined.—Total, 109 larvae, as follows: BROWN Co.: 5 mi. S Hiawatha, *Mus musculus*, Nov. 29, 1947 (2); 1 mi. N. Horton, *Richmondena cardinalis*, Nov. 29, 1947 (2). DOUGLAS Co.: 2 mi. W, 1 mi. N Baldwin, *Richmondena cardinalis*, Nov. 4, 1951 (2) and *Sylvilagus floridanus*, Nov. 30, 1951 (8); 4 mi. W, 3 mi. S Baldwin, *Sciurus niger*, Nov. 28, 1951 (4); Lawrence, *Sylvilagus floridanus*, Dec. 16, 1948 (3); 4 mi. S Lawrence, Nov. 4, 1947, *Parus bicolor* (3) and *Richmondena cardinalis* (1); 6 mi. W Lawrence, *Sciurus niger*, Nov. 29, 1947 (5); 7 mi. NW Lawrence, *Sciurus niger*, Nov. 11, 1949 (4); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Junco hyemalis*, Nov. 9, 1947 (4); 2 mi. S Worden, Nov. 26-28, 1949, *Sciurus carolinensis* (2) -*Sciurus niger* (18) -*Zonotrichia querula* (1). JEFFERSON Co.: 2 mi. NE Perry, *Junco hyemalis*, Oct. 26, 1948 (3); 10 mi. N Midland, *Sciurus niger*, Nov. 8, 1953 (4). JOHNSON Co.: 2 mi. N, 1 mi. W Lenexa, *Microtus ochrogaster*, April 2, 1954 (1); 6 mi. S, 1 mi. E Overland Park, *Sylvilagus floridanus*, March 10, 1954 (2); Roeland Park, *Sylvilagus floridanus*, Nov. 4, 1953 (26), Nov. 10, 1953 (3). MIAMI Co.: 3 mi. E, 1 mi. S Fontana, mixed skins of *Sciurus carolinensis* and *S. niger*, Oct. 12, 1948 (1); 2 mi. W, 1 mi. S Louisburg, *Sylvilagus floridanus*, Nov. 24, 1953 (6). NEMAHA Co.: 2 mi. S Sabetha, *Mus musculus*, Nov. 30, 1947 (1). WYANDOTTE Co.: 1 mi. N, 1 mi. E Piper, *Sylvilagus floridanus*, Oct. 29, 1953 (3).

Additional records.—(Brennan and Wharton, 1950:176). DOUGLAS Co.: Oct. 20, 1946, *Cyanocitta cristata* (1) and *Zonotrichia albicollis* (1).

Fitchi Group

Diagnosis.—Larvae with body yellow in life, dorsal setae beginning 2-6-6, total 28; total body setae 70; eyes 2/2, red in life; scutum with posterior margin rounded; sensilla flagelliform with few basal barbs and long branches on distal two thirds; galeal seta branched; leg I with 3 genualae; leg III with 1 genuala (no long, nude whiplike setae).

Remarks.—Two species, *T. fitchi* and *T. kardosi,* both of which occur in Kansas, are included in this group. The principal diagnostic character of this group seems to be the absence of long, nude whiplike setae on leg III. However, larvae of this group do have long plumose setae on leg III, two being present on the tibia, and two on the tarsus, one of the latter with its branches restricted to the basal part. These long plumose setae are situated in the same approximate position as the long nude whiplike setae of *T. sylvilagi* and seem to be homologous, suggesting close relationship.

Larvae occur in autumn, winter and early spring, and chiefly on mammals.

Trombicula fitchi Loomis

(Figs. 12, 24, 25, Map 13)

Trombicula fitchi Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, pp. 926-928, figs. 16-18, 20, type from 4 miles south of Aetna, Barber County, Kansas, host *Myotis velifer,* April 10, 1949.

Diagnosis.—Larva similar to *T. kardosi* Loomis but differs in having sensilla shorter, average 70µ, with more branches (12-14); galeal seta with more branches (5); palpal femur, genu and tibia with setae branched; tarsalae I (19µ) and II (14µ) shorter.

Scutal measurements (after Loomis, 1954), average and extremes, of 10 larvae from Barber and Douglas counties: AW- 65 (59-69), PW- 79 (71-82), SB- 26 (24-28), ASB- 28 (25-31), PSB- 31.5 (29-33), AP- 24.5 (22-28), AM- 43 (40-45), AL- 35 (32-37), PL- 55 (51-60), S- 70 (65-74).

Geographic distribution.—(Loomis, 1954): Known from central Illinois (Piatt County), southeastern Nebraska (Otoe County), eastern and south-central Kansas (Douglas, Jefferson, Miami, Wyandotte, Johnson and Barber counties).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from September 12 to April 14 and on October 10, 1953, were numerous on squirrels in southeastern Nebraska. Larvae were most abundant in eastern Kansas on squirrels in November. A possible second slight increase in abundance of larvae was seen in late March in eastern Kansas and early April in Barber County.

Hosts.—The principal hosts of this species in eastern Kansas are tree squirrels. Between October 15 and March 31, (1947 to 1954) the incidence of infestation amounted to 59 per cent in *Sciurus niger* and 50 per cent in *S. carolinensis.* A single engorged larva was on a pilot black snake taken on September 10, 1951. This is by far the earliest date of recovery. In south-central Kansas, larvae were taken from cave bats, *Myotis velifer,* and gray wood rats, *Neotoma micropus,* from a canyon area in which fox squirrels are absent or uncommon.

Larvae seem to prefer the bodies of the mammalian hosts, especially the abdominal regions. Only rarely have the larvae been taken from the ears of squirrels.

Habitats.—Hosts of this chigger mite were all taken in or near woods, especially in large stands of elm, oak and hickory in eastern Kansas. The larvae from Barber County were on two hosts that were not typical forest inhabitants although the hosts did occur in the vicinity of small stands of trees (elm, cedar, and cottonwood) in rocky canyons. The cave bats were taken in a small cave, although they probably had not been there throughout the entire winter (see *Whartonia senase*).

The available data concerning hosts and habitats seem to indicate that the free-living stages of this species in eastern Kansas inhabit cavities in dead trees, especially those which have nests of squirrels. Larvae were absent from other arboreal or ground dwelling woodland mammals and birds that were examined.

Specimens examined.—Total, 237 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Myotis velifer,* April 10, 1949 (68) and *Neotoma micropus,* April 11-14, 1949 (62). DOUGLAS CO.: *Sciurus niger,* Jan. 19, 1950 (1); Lawrence, *Sciurus niger,* March 27, 1948 (4), March 29, 1952 (7), Nov. 16, 1952 (1); 4 mi. S. 2 mi. W Lawrence, *Sciurus niger,* Nov. 18, 1950 (9); 2 mi. S Worden, *Sciurus carolinensis,* Nov. 26, 1949 (39), and *Sciurus niger,* Nov. 26, 1949 (6), Nov. 28, 1949 (7), and mixing of both species of *Sciurus,* Nov. 26, 1949 (8); 4½ mi. W, 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951 (4); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Elaphe obsoleta,* Sept. 10, 1952 (1). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Sciurus niger,* Nov. 21, 1951 (2); 7 mi. N Midland, *Sciurus carolinensis,* Oct. 30, 1953 (3); 10 mi. N Midland, *Sciurus niger,* Nov. 8, 1953 (3); 7 mi. N, 5 mi. W Midland, *Sciurus niger,* Nov. 26, 1953 (5). JOHNSON CO.: 2 mi. N, 1 mi. W Lenexa, *Sciurus niger,* Nov. 18, 1953 (2), Jan. 4, 1954 (1); Westwood, *Sciurus carolinensis,* Nov. 12, 1953 (3). MIAMI CO.: 3 mi. E, 1 mi. S Fontana, *Sciurus* (both *carolinensis* and *niger*), Oct. 12, 1948 (1). WYANDOTTE CO.: Kansas City, *Sciurus carolinensis,* Nov. 5, 1953 (1).

Trombicula kardosi Loomis

(Figs. 12, 26, Map 14)

Trombicula kardosi Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, pp. 929-930, figs. 19-21, type from 4½ miles west, 3 miles south of Baldwin, Douglas County, Kansas, host *Sciurus niger*, November 28, 1951.

Diagnosis. — Larva similar to *T. fitchi,* but differs in having sensilla longer (average 79μ) with fewer (7) branches; galeal seta with fewer (2-3) branches; palpal femur, genu and tibia with nude setae (genual seta occasionally with a single branch); tarsalae I (21μ) and II (15μ) longer.

Scutal measurements (after Loomis, 1954), average and extremes, of 5 topotypes: AW- 67 (65-69), PW- 82 (80-85), SB- 25 (23-28), ASB- 28 (26-29), PSB- 28 (28-30), AP- 25 (24-26), AM- 45 (43-48), AL- 35 (33-38), PL- 52 (51-54), S- 79 (78-81).

Geographic distribution.—(Loomis, 1954): Known from southwestern Utah (Garfield County) and eastern Kansas (Allen and Douglas counties).

Seasonal occurrence.—Larvae have been taken from hosts in eastern Kansas on November 28 (1951) and April 27 (1947).

Hosts.—Approximately 83 larvae were recovered from a fox squirrel, *Sciurus niger,* shot on November 28, and one larva was taken from a pilot black snake, *Elaphe obsoleta,* obtained on April 27. In addition, it was recovered from the chipmunk, *Eutamias umbrinus,* in Utah.

Habitat.—This chigger mite was taken in Kansas from typical woodland inhabitants. The fox squirrel was shot from a tall sycamore tree in a wooded stream valley adjoining wooded hillsides.

Specimens examined.—Total, 38 larvae, as follows: ALLEN Co.: 6½ mi. S Humboldt, *Elaphe obsoleta,* April 27, 1947 (1). DOUGLAS Co.: 4½ mi. W, 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951 (37).

Ungrouped Species

In Kansas, one species, *T. sylvilagi,* does not have the characters of any of the named groups of *Neotrombicula.* Since there are no closely related species known, no group is proposed here.

Trombicula sylvilagi Brennan and Wharton

(Fig. 12, Map 12)

Trombicula (*Neotrombicula*) *sylvilagi* Brennan and Wharton Amer. Midl. Nat., vol. 44, July, 1950, pp. 186-187, pl. 4, fig. 7, map 4, type from Leavenworth County, Kansas, host *Sylvilagus floridanus,* Oct. 7, 1946; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 60; Kardos, Univ. Kansas Sci. Bull., vol. 36, pt. 1, no. 4, June 1, 1954, pp. 103-111.

Diagnosis.—Larvae with dorsal setae beginning 2-6, total body setae 60; galeal seta nude; palpal femur and genu with setae nude; palpal tibia with dorsal and lateral setae nude; ventral seta branched; leg I with 3 genualae; leg III with 2 mastitibialae and 2 mastitarsalae.

Scutal measurements, average and extremes, of 6 larvae from Douglas and Miami counties: AW- 69 (64-71), PW- 81 (80-82), SB- 27.5 (26-29), ASB- 27 (25-28), PSB- 33 (32-37), AP- 26 (24-28), AM- 37 (36-39), AL- 37 (36-38), PL- 48 (46-50), S- 60 (57-62).

Geographic distribution. — Known from northeastern Kansas (Jefferson, Leavenworth, Douglas and Miami counties), southeastern Nebraska (Nemaha County, KU) and central Illinois (Piatt County, Brennan and Wharton, 1950).

Seasonal occurrence and abundance.—Larvae have been found on chigger samplers and hosts from mid-August to early December. Larvae were most abundant on chigger samplers in September and October (see Kardos, 1954:105).

Hosts.—The principal hosts for *T. sylvilagi* seem to be small mammals. The chiggers were found occasionally on birds although no more than one larva was recovered from each host. Several unengorged larvae were recovered from two different snakes: *Ancistrodon contortrix* with 1 larva and *Coluber constrictor* with 5 larvae, which were in cages over detergent water. The unfed condition suggests that *T. sylvilagi* could not successfully attach and feed on these snakes. *T. sylvilagi* were not found on any other reptiles examined in the season of larval occurrence.

The larvae were found attached on the legs and feet of the fox squirrels, and they regularly attached in the ears of the shrews and mice. Larvae placed on a week old house mouse were found attached on the head and body.

Habitats.—Descriptions of the stations from which larvae of *T. sylvilagi* were recovered on chigger samplers are given above (pp. 1209-11) (Stations A, B and C). Most of the areas were shaded for at least part of the day (before the leaves fell). Few larvae of other species were taken on chigger samplers in the *T. sylvilagi* stations. Larvae of *T. sylvilagi* and *T. gurneyi* were taken together on two decaying logs, although only a few *T. sylvilagi* were present for a short period at the height of their larval abundance.

Life history.—Kardos (1954:106, 110) found that unengorged larvae attached, fed, and dropped from a young mouse in 3 days under laboratory conditions. The prenymphal stage lasted approximately 15 days. The surviving nymph remained active for 18 days and then seemingly entered the preadult stage. It was then preserved.

Specimens examined.—Total, 267 larvae, as follows: DOUGLAS Co.: North Lawrence, *Turdus migratorius,* Oct. 5, 1947 (1); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *chigger samplers,* Sept. 24, 1949 (5), Oct. 10, 1950 (3), Aug. 16-Nov. 21, 1951 (76), Aug. 27-Dec. 11, 1952 (101) -*Ancistrodon contortrix,* Sept. 19, 1949 (1) -*Coluber constrictor,* Oct. 10, 1949 (5) -*Richmondena cardinalis* (1) and *Junco hyemalis* (1), Nov. 9, 1947, -*Cryptotis parva* (2) -*Microtus ochrogaster* (32) -*Mus musculus* (4) -*Peromyscus leucopus* (3) -*Peromyscus maniculatus* (6), -*Zapus hudsonius* (4), Oct. 16-20, 1951-1952; near Reservation, *Neotoma floridana,* Aug. 18, 1952 (1), Nov. 15, 1952 (9), Nov. 23, 1952 (1); 20 mi. SW Lawrence, *Sciurus niger,* Sept. 20, 1953 (5). JEFFERSON Co.: 5½ mi. N, ½ mi. E Lawrence, *Colinus virginianus,* Nov. 21, 1951 (1). MIAMI Co.: 3 mi. E, 1 mi. S Fontana, mixed skins of *Sciurus carolinensis* and *S. niger,* Oct. 12, 1948 (10).

Additional records.—(Brennan and Wharton, 1950:186). LEAVENWORTH Co.: *Sylvilagus floridanus,* Oct. 7, 1946 (3).

Subgenus *Miyatrombicula* Sasa, Kawashima and Egashira

Miyatrombicula Sasa, Kawashima and Egashira, Tokyo Iji Shinshi, vol. 69, June, 1952, pp. 337-338, type *Trombicula* (*Miyatrombicula*) *kochiensis* Sasa, Kawashima and Egashira.

Diagnosis.—Larvae with 2 pairs of sternal setae; eyes 2/2, ocular plate present; scutum pentangulate with a distinct posterior angle, puncta present; sensilla branched to plumose; palpal femur and genu with branched setae; palpal tarsus with 7 feathered setae, tarsala and subterminala; palpal claw trifurcate; leg III with coxa having 2 or more branched setae, 1 genuala (absent in *T. cynos*), 1 tibiala and a short mastitarsala (absent in *T. scottae* Brennan).

Species in North America (cynos group) with sensillae plumose, leg I with 3 genualae, subterminala and parasubterminala.

Remarks.—The American species of the cynos group, *Trombicula cynos* Ewing, *T. jonesae* Brennan, *T. sargenti* Brennan and *T. scottae* Brennan were placed in this subgenus by Sasa and Ogata (1953) who described an additional species *T. esoensis* from Japan. The similarities indicate a close relationship between these six species, and the use of this subgeneric name elevates this group to a rank equal to *Neotrombicula* and other subgenera which are no more distinct than *Miyatrombicula.*

In Kansas, this subgenus is represented by two species, *T. cynos* and *T. jonesae.*

Members of this subgenus have been found only on mammals. The larvae of the American species appear in fall and winter.

Trombicula cynos Ewing

(Figs. 12, 27, Map 15)

Trombicula cynos Ewing, Proc. Biol. Soc. Washington, vol. 50, Oct. 28, 1937, p. 171, type from Ithaca, Tompkins County, New York, host *Procyon lotor;* Brennan, Wasmann Jour. Biol., vol. 10, June 3, 1952, pp. 55-60, fig. 1; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 64; Sasa and Ogata, Jap. Jour. Exp. Med., vol. 23, 1953, pp. 336-338.

Diagnosis.—Larva similar to *T. jonesae* but differs in having body with dorsal setae beginning 2-6 or -8; dorsal setae 30-36; scutum with puncta more numerous and evenly distributed, posterior margin with slightly rounded angle; galeal seta usually with 1-2 branches, occasionally nude on one or both galea; leg III with coxa having 3 branched setae (occasionally 2, 4 and 5 setae), genu with 4 setae branched, genuala absent, and 1 mastitarsala. Body white with red eyes in life as in *T. jonesae.*

Scutal measurements, average and extremes, of 6 larvae from Barber, Douglas and Miami counties: AW- 56 (55-57), PW- 73 (71-77), SB- 21 (20-23), ASB- 23 (22-25), PSB- 32 (31-33), AP- 24 (23-25), AM- 33 (31-36), AL- 34 (31-36), PL- 49 (48-50), S- 56 (55-58).

Geographic distribution.—Known from western New York (Tompkins County, Ewing, 1937), southwestern Arkansas (Polk County, KU), southeastern, central and southwestern Oklahoma (McCurtain, McClain and Comanche counties, KU), eastern and south-central Kansas (Douglas, Jefferson, Miami and Barber counties), southeastern Nebraska (Otoe County, KU) and northeastern California (Plumas County, Brennan, 1952).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas between October 12 and April 13, in Comanche County, Oklahoma, on May 16, 1952, and in southeastern Nebraska in early October.

Hosts.—In eastern Kansas, this chigger mite has been found on woodland mammals, principally tree squirrels. It was never taken in large numbers from any individual host.

Hosts from Kansas include *Sciurus niger* and *S. carolinensis, Neotoma floridana* and *Myotis velifer.* Other known hosts include *Procyon lotor* (Ewing, 1937:172), *Sylvilagus floridanus* (Arkansas), and *Peromyscus maniculatus* (Oklahoma).

The larvae were found in the ears as well as on the body. Ewing (1937:172) stated that the type was taken from the ear of a raccoon. The larvae taken from tree squirrels were usually on the body and not in the ears. The ears of these squirrels are small and few chigger larvae of any species have been taken from within them.

Habitats.—The hosts of *T. cynos* from eastern Kansas were found in large stands of deciduous trees, usually in oak-hickory associations. In these wooded areas, it seems likely that the free-living stages of the chigger mite live in decaying wood, especially in standing dead trees and large dead limbs. Wharton and Fuller (1952:147) stated that "*Trombicula cynos* has also been found to be associated with decaying wood during its free-living stages."

Engorged larvae of *T. cynos* have been taken from the nest material of the wood rat, *Neotoma floridana,* from McClain County, Oklahoma. These nests were presumably found underground. The larvae were recovered by placing the nests in Berlese funnels.

The cave bats, from which larvae were recovered, were found in a small cave, formed in strata of gypsum and sandstone. The numerous fissures and crevices in this and other neighboring caves inhabited by these bats may afford suitable niches for the free-living stages. The canyon into which the cave opens has some trees, including cedar, elms and cottonwoods, although mammals obtained from this canyon in the same season were negative.

Specimens examined.—Total, 26 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Myotis velifer,* April 13, 1950 (5). DOUGLAS CO.: *Sciurus niger,* Jan. 1, 1950 (2); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Neotoma floridana,* Feb. 9, 1948 (3) and *Sciurus niger,* Jan. 19, 1950 (1); 4 mi. S, 2 mi. W Lawrence, *Sciurus niger,* Nov. 18, 1950 (1); 2 mi. S Worden, *Sciurus carolinensis,* Nov. 26, 1949 (2). JEFFERSON CO.: 7 mi. N Midland, *Sciurus carolinensis,* Oct. 30, 1953 (1). MIAMI CO.: 3 mi. E, 1 mi. S Fontana, *Sciurus carolinensis* and *S. niger,* Oct. 12, 1948 (12).

Trombicula jonesae Brennan

(Fig. 12, Map 16)

Trombicula jonesae Brennan, Wasmann Jour. Biol., vol. 10, June 3, 1952, pp. 59-61, fig. 2, type from Urbana, Champaign County, Illinois, host *Peromyscus* sp., Oct. 21, 1948; Sasa and Ogata, Jap. Jour. Exp. Med., vol. 23, 1953, p. 338.

Diagnosis.—Larva similar to *T. cynos,* but differs in having dorsal setae more than 40 (51 in the specimen from Kansas), formula beginning 2-10; scutum with acute posterior angle, puncta few and scattered; sensilla heavily branched or plumose along entire length; galeal seta with several branches; all palpal setae branched; leg III with coxa having 3 branched setae (3 and 4 setae in specimen from Kansas), genu with 3 branched setae and 1 genuala and 1 mastitarsala.

Scutal measurements of the larva from Douglas County: AW- 54, PW- 70, SB- 20, ASB- 23, PSB- 30, AP- 20, AM- 32, AL- 31, PL- 46, S- 53.

Geographic distribution.—Known from central Illinois (Champaign County, Brennan, 1952), southwestern Iowa (Fremont County, KU) and northeastern Kansas (Douglas County).

Seasonal occurrence.—Larvae have been taken from hosts in October.

Ecology.—The single larva from Kansas was recovered from a fox squirrel along with four larvae of *T. whartoni.* The larva from Iowa was recovered from a white-footed mouse, *Peromyscus leucopus,* and was picked from the ear. Both hosts were obtained in oak-hickory climax deciduous woodlands.

Specimen examined.—Total, 1 larva, as follows: DOUGLAS CO.: 7 mi. NW Lawrence, *Sciurus niger,* Oct. 26, 1949 (1).

Subgenus *Euschöngastoides* Loomis

Euschöngastoides Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, p. 924, type *Trombicula (Euschöngastoides) hoplai* Loomis.

Diagnosis.—Larva with scutum roughly rectangular, with few small puncta, with scutal setae branched; sensilla plumose along much of the length; palpal femur and genu with branched setae; palpal tarsus with 4 branched setae and tarsala; palpal claw trifurcate, long and slender; galeal seta nude; leg I with 2 genualae (subterminala and parasubterminala absent); leg II with pretarsala (genuala absent); leg III with coxa having 1 branched seta (genuala and long nude whiplike setae absent).

Remarks.—The single species is known from the southwestern United States. The similarity between the larvae of *T. hoplai* and *Euschöngastia lacerta* Brennan suggests a close relationship. Studies of nymphs and adults of both species certainly will aid in determining whether the similarities represent parallelism in the parasitic larvae which occur together on the same hosts, or close relationship. If these forms are really closely related, a re-examination of the use of flagelliform versus expanded sensillae as a character of major importance is needed. The possibility should not be overlooked that they may be present day representatives of the early transition from thick plumose flagelliform sensillae to those which are expanded. Also it is possible that the flagelliform sensilla represents a reappearance of the primitive condition.

Trombicula hoplai Loomis

(Figs. 28-29, Map 12)

Trombicula (*Euschöngastoides*) *hoplai* Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, pp. 924-926, figs. 10-15, type from 4½ miles south and 1 mile west of Aetna, Barber County, Kansas, host *Cynomys ludovicianus*, July 27, 1952.

Trombicula imperfecta Brennan and Jones, Wasmann Jour. Biol., vol. 12, no 2, Oct. 11, 1954, pp. 185-188, type from Santa Fe, Santa Fe County, New Mexico, host *Perognathus flavus*, July 9, 1952. *New synonymy.*

Diagnosis.—Larva with body white in life, dorsal setae total 56-58, formula beginning 4-10 to 12, sternal setae 2-2, ventral setae total 46, total body setae about 104; eyes 2/2, red in life; palpal tibia with dorsal and ventral setae branched and lateral seta nude; galeal seta nude; leg I with short tarsala (10µ); leg II with long tarsala (16µ); leg III with 1 tibiala. Similar to *Euschöngastia lacerta* Brennan, but differs in having the sensilla flagelliform as well as in other characters (see diagnosis of *E. lacerta*).

Scutal measurements (after Loomis, 1954), average and extremes of 5 topotypes: AW- 53 (51-56), PW- 65 (63-70), SB- 21 (21-22), ASB- 22 (21-23), PSB- 14 (13-16), AP- 19 (19-20), AM- 25 (24-25), AL- 26 (23-27), PL- 28 (26-33), S- 53 (50-56).

Geographic distribution. — (Loomis, 1954, unless otherwise noted): Known from south-central Kansas (Barber County), western Colorado (Mesa County), New Mexico (San Juan County; and Santa Fe County, Brennan and Jones, 1954), north-central Texas (Wichita County) and central California (Monterey County, Brennan and Jones, 1954).

Seasonal occurrence.—Larvae have been found to occur on mammalian hosts in Barber County, Kansas, from July 25 to October 7. They were common on several hosts in late July, August, and mid-September.

Hosts.—The mammals most commonly found to have larvae attached were the gray wood rat, the white-footed mouse and the prairie dog. Single larvae were found on a Bunker bat and two cottontails. In addition to the five hosts recorded from Kansas, Loomis (1954:926) records this chigger mite from *Neotoma lepida* in Colorado, *Neotoma mexicana* in New Mexico, and *Spermophilus tridecemlineatus* in Texas. Brennan and Jones (1954:197) reports this species (as *T. imperfecta*) from *Perognathus flavus* in New Mexico, *Perognathus californicus* and *Peromyscus maniculatus* from California.

Habitats.—In Kansas, the hosts of this chigger have been taken in only one general area, southwestern Barber County, characterized by the short grass on the high plains, dissected by deeply cut canyons through strata of sandstone and gypsum. The majority of hosts were trapped in or near the canyons. The Bunker bat is a frequent inhabitant of the rock crevices in the canyons. The three prairie dogs which were found to have larvae attached were shot in a dog "town" characterized by closely cut grass in the high plains area adjacent to the canyons.

Specimens examined.—Total, 65 larvae, as follows: BARBER CO.: Aetna, *Antrozous bunkeri,* Sept. 14, 1953 (1); 4 mi. S Aetna, *Neotoma micropus,* July 25, 1952 (8), Aug. 22, 1949 (9), Sept. 15-16, 1953 (15) -*Peromyscus leucopus,* July 25, 1952 (2), Sept. 15, 1953 (2), Oct. 7, 1951 (2) -*Sylvilagus floridanus,* Sept. 14, 1953 (2); 4½ mi. S, 1 mi. W Aetna, *Cynomys ludovicianus,* July 27, 1952 (24).

Montanensis Group

Diagnosis.—Larvae with body yellow in life; sternal setae 2-2; eyes 2/2, red in life; scutum subpentagonal with posterior margin broadly rounded, all scutal setae approximately the same length; sensilla with distinct branches on distal two thirds; palpal femur and genu with setae branched; palpal tibia with dorsal and lateral setae nude, ventral seta branched; palpal claw trifurcate; leg I with 2 genualae; leg II with 1 genuala and pretarsala; leg III with coxa having 3 or 4 branched setae, 1 genuala, and 1 short mastitarsala.

Remarks.—This group is proposed here to include two species, *T. montanensis* and *T. arenicola,* both of which occur in Kansas.

Larvae have been found on reptiles, birds and mammals, in the spring, summer and fall.

Trombicula montanensis Brennan

(Map 20)

Trombicula montanensis Brennan, Jour. Parasit., vol. 32, Oct. 20, 1946, pp. 441-2, fig. 1, type from Wheatland County, Montana, host *Cynomys ludovicianus,* Aug. 30, 1945; Eads, Menzies and Miles, Proc. Ent. Soc. Washington, vol. 54, Oct., 1952, p. 252; Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, p. 932; Lipovsky, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 14, July 15, 1954, p. 945; Fitch, Ecol. Monographs, vol. 25, no. 3, Jan. 1955, p. 79.

Diagnosis.—Larva similar to *T. arenicola,* but differs in having dorsal setae beginning 2-6-6, total 24-28; total body setae 54-58;

sensilla shorter; galeal seta nude, or with 1 branch; tarsalae I and II short (12-13μ); all leg segments with branched setae similar, having few, large branches.

Scutal measurements, average and extremes, of 6 larvae from Barber and Cheyenne counties: AW- 58 (53-61), PW- 79 (70-85), SB- 24 (23-26), ASB- 22 (21-25), PSB- 23 (21-24), AP- 21 (20-23), AM- 27 (26-28), AL- 26 (25-28), PL- 30 (29-32), S- 57 (53-63).

Geographic distribution.—Known from central Montana (Wheatland County, Brennan, 1946), southern Nebraska (Dundy, Hitchcock and Webster counties, KU), northeastern Colorado (Yuma County, KU), western and central Kansas (Cheyenne, Wallace and Seward counties, east to Jewell, Wabaunsee and Lyon counties), north-central Oklahoma (Harper and Woods counties, KU) and northwestern Texas (Terry County, Eads, Menzies and Miles, 1952).

Seasonal occurrence and abundance.—In Kansas, larvae have been taken from hosts examined between late April (April 26, 1952) and late October (October 26, 1946), being more abundant in July, August and September. Earlier collections were made in northern Oklahoma from hosts on April 13, 1950.

The long period of larval activity indicates that at least two generations of larvae emerge in a single season.

Hosts.—Trombicula montanensis is common during the summer in central and western Kansas on a number of the vertebrates inhabiting the grasslands. In Kansas it has been recovered from one species of lizard, one turtle, five snakes, two birds and ten species of mammals. Two additional hosts, *Heterodon platyrhinos* and *Tadarida mexicana,* are known from Oklahoma, just south of Kansas.

Three larvae were recovered from one of eight gray skinks, *Eumeces obsoletus.* Three larvae were obtained from two box turtles, *Terrapene ornata,* caught in the vicinity of a prairie dog town. The snake hosts include a young *Lampropeltis getulus,* one larva; one *Heterodon nasicus,* from a prairie dog town with four larvae; three *Pituophis catenifer,* each with numerous larvae present; three *Masticophis flagellum,* with many larvae on each individual; and six *Crotalus viridis,* which had an average of 58 larvae each. The greatest number of larvae on a single *Crotalus* was 137, and 118 larvae were found on a second.

A single larva was recovered from a blue jay, *Cyanocitta cristata,* which was shot near a prairie dog town and a total of 41 larvae were found on five burrowing owls, *Speotyto cunicularia,* shot near burrows of an old prairie dog town.

Trombicula montanensis was especially common on prairie dogs, *Cynomys ludovidianus,* and thirteen-lined ground squirrels, *Spermophilus tridecemlineatus.* All of the 34 *Cynomys* and 9 *Spermophilus* examined had larvae attached. Other mammalian hosts include *Dipodomys ordii,* on which larvae were found on six of ten individuals, averaging 4 larvae on the positive individuals and *Perognathus hispidus,* with eight of 17 mice having larvae present, averaging 18 larvae per positive mouse, and averaging 8 larvae for all of these mice examined. *Onychomys leucogaster,* had larvae on 3 of 10 individuals, averaging approximately 10 larvae per positive individual; 3 larvae each for all ten mice. Other grassland mammals that harbored *T. montanensis* includes *Perognathus flavus,* one larva; *Perognathus flavescens,* with 4 of 5 individuals each parasitized with a few larvae and *Peromyscus maniculatus,* with a single larva on each of five individuals, while more than twenty other mice of the same kind from the same places were negative.

Larvae were found on two mammals from Barber County which usually live in the breaks and rock outcrops, in the brush and scattered trees, adjacent to open grasslands. *Neotoma micropus* was examined on numerous occasions and in July a single young rat was found to have 45 larvae attached. This rat was found dead on the road in an eroded area of short grass. A series of 18 rats was obtained in August and was examined and washed together. A total of more than 400 larvae were recovered or approximately 23 *T. montanensis* per rat. Eighteen rats trapped in September in the same canyons as those listed above for August had approximately 1 larva per individual. Two *Sylvilagus floridanus,* from the canyon area of Barber County, had 4 larvae attached while 1 larva was taken from one of five other cottontails shot in Barber County.

The larvae of *T. montanensis* were usually found attached to the bodies of the hosts, and also on the inner surfaces of the thighs of birds and mammals. The larvae were observed on mammals to be in small depressions surrounded with circular swollen areas presumably caused by one or occasionally two or three, chigger mites. The mites attach in small clusters under the lateral scales of snakes, being especially common on the anterior part of the body.

Habitats.—This is a chigger of the grasslands, being especially abundant on hosts taken from the vicinity of prairie dog towns. The larvae were found also on mammals and reptiles of the grasslands which were not obtained in or near prairie dog towns, although the hosts characteristically live and forage in mammal burrows.

The prevalence of this species on prairie dogs seems to indicate that the free-living stages occur in the soil surrounding the burrows and nests of *Cynomys* and other mammals. It seems highly improbable that the larvae are active on the surface of the soil which is protected only by short-cropped grasses and which is usually excessively dry and hard during the season of larval activity.

In the regions where *T. montanensis* abounds, the only active, unattached larvae which seem to occur on the surface of the soil are those of *T. alfreddugèsi,* and these larvae occur only in the areas where the soil is sheltered by taller and thicker stands of grasses.

Life history.—Larvae of *T. montanensis* that have attached seem to be ready to drop from the mammalian host in from 3 to 6 days. Larvae took a longer time to engorge and detach from snakes brought into the laboratory. It took from 6 to 15 days for 26 larvae to drop from a *Crotalus viridis,* obtained on September 15, with the majority of the larvae detaching by the eleventh day. A young bull snake, *Pituophis catenifer,* taken on October 22, had 45 larvae drop off in from 2 to 25 days, most of them detaching before the seventeenth day. A large adult hog-nosed snake, *Heterodon platyrhinos,* from Woods County, Oklahoma, taken on October 7, 1951, had a total of 231 larvae detach, from the second to the fifty-sixth day, the majority dropping off in the first 18 days.

Life history studies in the laboratory seems to indicate a rapid development to the adult stage, comparable to that found in *T. splendens* and *T. alfreddugèsi.* This evidence supports the theory that at least two generations of larvae emerge each year.

Specimens examined.—Total, 491 larvae, as follows: BARBER CO.: 2 mi. E Aetna, *Dipodomys ordii,* Sept. 14, 1953 (1); 4 mi. S Aetna, *Crotalus viridis,* Aug. 21, 1949 (67), Sept. 15, 1953 (1), *-Dipodomys ordii,* Sept. 14, 1953 (3), *-Neotoma micropus,* Aug. 22-24, 1949 (53), Sept. 15-16, 1953 (15), *-Perognathus flavus,* July 26, 1952 (1), *-Sylvilagus floridanus,* Sept. 14, 1953 (4); 4½ mi. S, 1 mi. W Aetna, *Spermophilus tridecemlineatus,* July 27, 1952 (3) and Sept. 15, 1953 (18), and *Cynomys ludovicianus,* July 27, 1952 (5) and Sept. 16, 1953 (21); 4 mi. S, 2 mi. E Aetna, *Crotalus viridis,* Aug. 22, 1949 (13); 5 mi. S, 3 mi. E Aetna, *Neotoma micropus,* July 25, 1952 (11); 5 mi. S, 4 mi. E Aetna, *Dipodomys ordii,* Aug. 22-23, 1949 (2); 6 mi.

S, 3 mi. E Aetna, *Masticophis flagellum,* Sept. 14, 1948 (6); 5 mi. N Aetna, *Crotalus viridis,* Oct. 7, 1951 (8); 3½ mi. W Hardtner, *Cynomys ludovicianus,* Aug. 23, 1949 (8); 10½ mi. W Hardtner, *Cynomys ludovidianus,* Aug. 21, 1949 (19), July 26, 1952 (12), -*Sylvilagus floridanus,* July 26, 1952 (1), -*Terrapene ornata,* Aug. 21, 1949 (3), -*Cyanocitta cristata,* July 26, 1952 (1); 6 mi. W Medicine Lodge, *Crotalus viridis,* Aug. 23, 1949 (1); 3 mi. N, 1 mi. E Sharon, *Peromyscus maniculatus,* July 26, 1952 (1). CHEYENNE Co.: 3-5 mi. N St. Francis, July 23, 1948, *Masticophis flagellum* (16), -*Dipodomys ordii,* (3), -*Onychomys leucogaster* (9), -*Perognathus hispidus* (19). JEWELL Co.: 4 mi. W Lovewell, July 10, 1951, *Eumeces obsoletus* (3) and *Lampropeltis getulus* (1). LYON Co.: 2 mi. S Chalk, *Perognathus hispidus,* May 31, 1950 (7). NORTON Co.: 4 mi. W, 1 mi. S Logan, *Peromyscus maniculatus,* Oct. 26, 1946 (2). RAWLINS Co.: 3½ mi. S Atwood, *Perognathus hispidus,* Aug. 8, 1949 (8); 6 mi. S Atwood, July 30, 1948, *Dipodomys ordii* (3) and *Spermophilus tridecemlineatus* (20); 4½ mi. E Atwood, *Crotalus viridis,* Aug. 7, 1949 (26); 3 mi. S, 1 mi. E McDonald, *Cynomys ludovicianus,* Aug. 7, 1949 (4); 5 mi. E McDonald, *Pituophis catenifer,* Aug. 7, 1949 (1); 11 mi. S, 1 mi. E McDonald, *Cynomys ludovicianus,* July 27, 1948 (11); 13 mi. S, 6 mi. E McDonald, Aug. 8, 1949, *Cynomys ludovicianus* (9), -*Spermophilus tridecemlineatus* (12), -*Speotyto cunicularia* (22); 13 mi. N McDonald, *Perognathus hispidus,* July 28, 1948 (2); 9 mi. S Beardsley, Aug. 9, 1949, *Heterodon nasicus* (5), -*Crotalus viridis* (5), -*Peromyscus maniculatus* (1), -*Perognathus flavescens* (3). RUSSELL Co.: 9 mi. S Russell, *Peromyscus maniculatus,* April 26, 1952 (1). SEWARD Co.: 4 mi. NE Liberal, *Masticophis flagellum,* Sept. 12, 1948 (12). WABAUNSEE Co.: 3 mi. S, 1 mi. W Eskridge, *Pituophis catenifer,* Oct. 22, 1952 (9). WALLACE Co.: 3 mi. W Sharon Springs, *Peromyscus maniculatus,* July 4, 1949 (1).

Trombicula arenicola Loomis

(Figs. 30-31, Map 20)

Trombicula arenicola Loomis, Univ. Kansas Sci. Bull., vol. 36, pt. 2, no. 13, July 15, 1954, pp. 930-933, figs. 22-26, type from 12 miles northeast of Liberal, Seward County, Kansas, host *Dipodomys ordii,* Sept. 8, 1948.

Trombicula montanensis, Brown and Brennan, Canadian Jour. Zool., vol. 30, Dec., 1952, p. 342.

Diagnosis.—Larva similar to *T. montanensis,* but differs in having dorsal body setae total 36, formula beginning 2-8-8, total body setæ 74-80; sensilla longer (67-75μ); galeal seta with 2 or 3 branches;

tarsalae I and II longer (16μ) and most leg segments with two types of branched setæ (stout with few branches and long with many small branches).

Scutal measurements (after Loomis, 1954), average and extremes, of 7 topotypes: AW- 58 (53-64), PW- 81 (75-92), SB- 26 (24-28), ASB- 26 (25-28), PSB- 22 (20-25), AP- 24 (20-27), AM- 32 (30-34), AL- 31 (26-33), PL- 35 (31-37), S- 72 (67-75).

Geographic distribution.—(Loomis, 1954): Known from Canada (Alberta), western Utah (Tooele County), northern New Mexico (Santa Fe County), southeastern Colorado (Prowers County), southwestern Kansas (Seward County) and northern Mexico (Coahuila, KU).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas in early September, and in southeastern Colorado in early May. They were collected in August, September and October in Utah, October and December in New Mexico, and in June in Canada (Loomis, *op. cit.*).

Hosts.—This chigger mite has been found to occur most frequently on heteromyid rodents, especially the kangaroo rat, *Dipodomys ordii.* Larvae were recovered from this species in Kansas, Colorado, New Mexico and Utah. Other heteromyids from which larvae have been taken are *Dipodomys microps* (Utah), *Perognathus flavus* (New Mexico), *P. hispidus* (Kansas) and *P. parvus* (Utah). In addition to these hosts, larvae have been recovered from *Muscivora forficata* (Kansas), *Spermophilus richardsoni* and *Mus musculus* (Canada) and *Neotoma albigula* (Colorado). In the known collecting station in Kansas, a number of additional hosts were examined, without the recovery of this species.

The principal sites of attachments were on the belly and within the ears.

Habitats.—The hosts of *T. arenicola* from Kansas were obtained in the sandy, sage-covered valley of the Cimarron River. The kangaroo rat, *Dipodomys,* and the pocket mouse, *Perognathus,* are common inhabitants of the loose sandy soil of the valley floor, while the flycatcher, with a single larva, was shot in this valley. *Trombicula arenicola* was not recovered from *Dipodomys ordii* or any other mammals from the surrounding high plains, although the closely related species, *T. montanensis,* was found on a whip snake, *Masticophis flagellum,* in one of the high plains stations (4 mi. NE Liberal).

Specimens examined.—Total, 45 larvae, as follows: SEWARD Co.: 12 mi. NE Liberal, Sept. 8-10, 1948, *Muscivora forficata* (1), -*Dipodomys ordii* (38) and -*Perognathus hispidus* (6).

Gurneyi Group

Diagnosis.—Larvae with body (engorged) moderate in size, whitish to pale orange in life; dorsal setae beginning 2-6-6, sternal setae 2-2, total body setae 44; scutum roughly rectangular; sensilla with distal branches; galeal seta nude; palpal femur with seta branched, palpal genu with seta nude or with 1 branch; palpal tibia with all setae nude; palpal claw bifurcate, axial prong internal; leg I with 3 genualae; leg II with 1 genuala and pretarsala; leg III with coxa having 1 branched seta and 1 genuala (without long nude, whiplike setae).

Remarks.—The two species, *T. gurneyi* and *T. kansasensis,* included in this group, are known from Kansas.

Larvae have been found in spring and summer, on reptiles, birds and mammals.

Trombicula gurneyi Ewing

Trombicula gurneyi Ewing, Proc. Biol. Soc. Washington, vol. 50, Oct. 28, 1937, p. 169 (see synonymy under *Trombicula g. gurneyi* below).

Diagnosis.—Larvae with eyes 2/2, posterior eye smaller, on indistinct ocular plate, red in life; tarsalae I and II short (12-13μ). Similar to *T. kansasensis,* with differences noted under that species.

Remarks.—Two subspecies, both of which occur in Kansas, are recognized. They differ only slightly morphologically, but are found in different geographic regions, in different habitats, and on different hosts. A population located between the two subspecies is intermediate in characters and demonstrates geographical intergradation.

Trombicula gurneyi gurneyi Ewing

(Figs. 2, 12, Map 17)

Trombicula gurneyi Ewing, Proc. Biol. Soc. Washington, vol. 50, Oct. 28, 1937, p. 169, type from Priest Bridge, Patuxent River, Maryland, host *Eumeces fasciatus*, April 24, 1937; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, pp. 65-66; Fitch, Univ. Kansas Publ., Mus. Nat. Hist., vol. 8, Sept. 1, 1954, pp. 138-139, 148.

Trombicula hamertoni Radford, Parasitology, vol. 34, June, 1942, p. 62, fig. 28, type from unknown locality, host *Elaphe guttata*, from the London Zoo, March 8, 1939; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 66.

Trombicula gurneyi gurneyi, Loomis, Univ. Kansas Sci. Bull. Vol. 37, pt. 1, no. 9, Oct. 15, 1955, pp. 252-257, 5 figs.

Diagnosis.—Larva similar to *T. g. campestris,* but differs in having scutum smaller, with anteromedian seta short, average 27μ (25-30μ), and sensilla shorter with 8-10 long distal branches.

Scutal measurements (after Loomis, 1955), average and extremes, of 5 larvae from Miami County: AW- 61 (59-63), PW- 72 (71-75), SB- 28 (27-28), ASB- 22 (21-24), PSB- 16 (14-19), AP- 15 (14-17), AM- 28 (26-30), AL- 23 (21-24), PL- 41 (40-43), S- 48 (45-51).

Geographic distribution.—(Loomis, 1955): Known from Maryland (type locality), central Florida (Lake County), southern Louisiana (St. Tammany and St. Charles parishes), eastern Texas (Titus-Red River County line and Travis County), southwestern Arkansas (Little River County), eastern and central Oklahoma (Haskell and McClain counties, north to Creek County), eastern Kansas (Bourbon, Doniphan, Douglas, Jefferson, Johnson and Miami counties) and southeastern Nebraska (Nemaha County). Intergrades with *T. g. campestris* are known from south-central Kansas (Barber County).

Seasonal occurrence.—Larvae have been taken from hosts and chigger samplers in eastern Kansas from mid-April to mid-November. In eastern Oklahoma, larvae were taken from lizards on April 8, 1950, and in central Oklahoma (McClain County) from a wood rat nest on February 17, 1952, and from a wood rat (*Neotoma floridana*) on April 14, 1952.

Hosts.—In eastern Kansas, larvae of *T. g. gurneyi* were recovered from five-lined skinks, *Eumeces fasciatus,* greater five-lined skinks, *Eumeces laticeps,* pilot black snakes, *Elaphe obsoleta,* one timber rattlesnake, *Crotalus horridus*, one short-tailed shrew, *Blarina brevicauda,* one common mole, *Scalopus aquaticus,* white-footed mice, *Peromyscus leucopus,* gray squirrels, *Sciurus carolinensis,* and fox squirrels, *Sciurus niger.* In south-central Kansas, *T. gurneyi* (considered as intergrades between *T. g. gurneyi* and *T. g. campestris*) was found on red-headed woodpeckers, *Melanerpes erythrocephalus,* and on a cottontail, *Sylvilagus floridanus.*

Other animals recorded as hosts, elsewhere but not in Kansas, include the fence lizard, *Sceloporus undulatus* (Oklahoma), tree uta, *Uta ornata* (Texas), Floridan five-lined skink, *Eumeces inexpectatus* (Louisiana); common king snake, *Lampropeltis getulus* (Louisiana); and eastern wood rat, *Neotoma floridana* (Oklahoma).

The principal host in eastern Kansas seems to be the five-lined skink, *Eumeces fasciatus.* This small lizard is common in the woodlands of eastern Kansas and its diurnal activity coincides with that of the unfed larvae of *T. g. gurneyi.* The pilot black snake also was a common host. The tree squirrels, *Sciurus,* and the white-footed mouse, *Peromyscus leucopus,* are probably more important hosts than indicated by the few records. For a listing of abundance of *T. g. gurneyi* on the above hosts, see the tables under vertebrates.

The larvae usually attach on lizards in the axilla and groin, under the lateral scales of the neck, and at the site of any injury on skin. Larvae also occasionally attach between the toes and in the ear openings. On snakes, the larvae were found under the anterior lateral scales of the neck and body, with few larvae situated under the ventral scales or on the posterior half of the body and tail. On mammals the larvae usually were found attached on the inguinal region, frequently on the scrotum and around the genitalia. The mites were not recovered from the ears of any mammals examined.

Habitats.—All the hosts of *T. g. gurneyi* from eastern Kansas were taken in deciduous woodlands and are typical inhabitants of these forests and the woodland edge, as are other hosts from south-central Kansas (where intergrades between *gurneyi* and *campestris* were collected) and from other states. Many of these hosts were taken from inside decaying logs and stumps or in the vicinity of them. Most of these sites were at the edge of woodland or in open spots surrounded by trees. Six of the nine host species from eastern Kansas occur in or near decaying wood, usually nesting in cavities of logs, trunks or limbs, or under fallen logs. The five-lined skink frequently nests just under the bark of logs in the loose frass and wood, and the greater five-lined skink nests in large upright dead trunks. The timber rattlesnake, short-tailed shrew and mole do not regularly associate with decaying wood but do occur in or under logs.

The nymphs and adults of *T. g. gurneyi* were found in decaying logs in northeastern Texas (Loomis, 1955). In Kansas, larvae were taken on chigger samplers at the Natural History Reservation on decaying logs (Skink Log and Rat Log), on frass below a suspended rotting log (Rat Log), on frass adjacent to dead standing trees (Pit Elm and Skink Elm) and in Miami County on rotting wood in the cavity of a large stump. These larvae were taken from May to October, 1952. At the Reservation, *T. g. gurneyi* was especially common on a large decaying elm log (Skink Log). See description on page 1210. Approximately five square feet on the log was composed of soil, frass and loose decaying wood, and it was here that the larvae were recovered on chigger samplers. Fifty-two larvae taken on July 16, 1952 represented the greatest number on a single sampler. See Table 2 for a summary of the chigger sampling at the Reservation.

On May 30, 1952 in Miami County, larvae were recovered from the base of a well-decayed stump of approximately three feet in diameter on the flood plain of the Marais des Cygnes River. A few small seedlings were growing in the loose frass. On the east edge, a wide flat part of the trunk was still standing, affording some morning shade to the inside area. The air temperature was 80° F. at 1:30 P.M. the moist frass on the surface was 86° F., 3 inches below surface 66° F. The sampling results were as follows: 0, 6, 21, 20, 21, 20, 11, 42; total 141, 8 samples, average 17.6 per sampler, or 176 *T. g. gurneyi* per square foot. Three samples around the base of the tree (not over frass) were negative. Other samples on rotting logs on the hillsides were negative, although adults of *T. splendens* were common in several of the logs.

In Miami County both *T. splendens* and *T. g. gurneyi* seem to occur in decaying logs. The adults of *T. splendens* were found, but the adults of *T. g. gurneyi* were not recovered. They probably live deeper inside logs and stumps which are in an advanced stage of decay.

In Douglas County, and especially on the Reservation, *T. g. gurneyi* was the only species found regularly to inhabit the frass and decaying logs and stumps on the ground. Larvae of *T. alfreddugèsi* and *T. sylvilagi* were found on decaying logs and near them on decayed wood on the ground; but they seemed to have originated from the soil adjacent to the sites.

In general, the free-living stages of *T. g. gurneyi* seem to be closely associated with decaying wood. The nymphs and adults were found deep within decaying logs and stumps, especially those in advanced stages of decomposition. The unfed larvae emerge on the surface of the frass and rotting wood, but may occasionally wander beyond this habitat.

The moisture content of the decaying wood probably is a critical factor for this chigger mite. In addition, interspecific competition between nymphs and adults for food may be important. Both *T. splendens* and *T. g. gurneyi* seem to feed on the same type of food (Collembola eggs in the laboratory).

TABLE 2.—*Trombicula g. gurneyi* taken on chigger samplers at the Reservation in 1952.

Station in Skink Woods	May 25	May 31	June 20	June 30	July 16	Aug. 8	Aug. 20	Sept. 3	Sept. 17	Sept. 21–23	Oct. 2	Oct. 8–23
Rat Log (B-1)	0[1] 13[2]		0 6		0 1	3 3	18 5	7 3	25 4	34 9	1 6	0 19
Under Rat Log (B-2)	1 32			4 6	8 5	8 6	9 6	6 5	1 9	0 10	0 12	0 23
Skink Elm (C-1)	6 25	2 12	0 6	1 6	3 12	9 6	2 6	5 6	1 6		1 6	0 21
Skink Log (C-2)	0 10				167 6	70 4	91 6	57 6	15 6	18 22	2 6	0 24

1. Total number of *T. g. gurneyi* taken on chigger samplers.
2. Total number of samples.

Specimens examined.—Total, 279 larvae, as follows: BOURBON Co.: 1 mi. W Ft. Scott, *Peromyscus leucopus,* Sept. 4, 1947 (1); 2 mi. E Hiattville, *Elaphe obsoleta,* May 10, 1953 (1). DONIPHAN Co.: 2 mi. N White Cloud, *Peromyscus leucopus,* Aug. 21, 1948 (2). DOUGLAS Co.: 1 mi. W Clinton, *Eumeces fasciatus,* May 10, 1952 (2); 1½ mi. E Eudora, *Eumeces fasciatus,* April 20, 1950 (5), April 30, 1950 (8) and May 11, 1952 (2); Lawrence, *Elaphe obsoleta,* July 22, 1951 (6) and *Scalopus aquaticus,* Nov. 10, 1948 (1); 3½ mi. E, 4 mi. S Lawrence, May 15, 1948, *Eumeces fasciatus,* (1) and *Elaphe obsoleta* (1); 5 mi. N, 1 mi. S Lawrence, Univ. Kansas Nat. Hist. Reserv., *Chigger samplers* (40) May 25-Oct. 2, 1952, -*Eumeces fasciatus* (93) May 9-Aug. 16 (1950-1952), -*Crotalus horridus,* Sept. 2, 1953 (7), -*Elaphe obsoleta,* May 16, 1948 (6), Sept. 10, 1952 (1), -*Blarina brevicauda,* July 2, 1952 (1); 20 mi. SW Lawrence, *Sciurus niger,* Sept. 20, 1953 (1); Lone Star Lake, *Eumeces fasciatus,* April 24, 1948 (4); ½ mi. N Pleasant Grove, *Eumeces fasciatus,* May 20, 1949 (55); 1½ mi. S, 1½ mi. E Pleasant Grove, *Eumeces fasciatus,* April 30, 1950 (7). JEFFERSON Co.: 8 mi. N, 1 mi. E Lawrence, *Elaphe obsoleta,* June 27, 1952 (2); 2½ mi. E, 4 mi. N Williamstown, *Peromyscus leucopus,* April 29, 1952 (2). JOHNSON Co.: 1 mi. E Sunflower, *Eumeces fasciatus,* April 30, 1950 (8); 2 mi. N, 1½ mi. W Lenexa, *Peromyscus leucopus,* April 13, 1954 (2). MIAMI Co.: 3 mi. E, 1 mi. S Fontana, Pigeon Lake area, *Elaphe obsoleta,* Oct. 12, 1948 (1), -*Eumeces fasciatus* (12) May 13-31, 1950-1953 -*Eumeces laticeps,* May 13, 1950 (7), May 26, 1951 (2), -*Sciurus carolinensis,* May 31, 1953 (3), -*Chigger sampler,* May 30, 1952 (4).

Trombicula gurneyi campestris Loomis

(Map 17)

Trombicula gurneyi campestris Loomis, Univ. Kansas Sci. Bull., vol. 37, pt. 1, no. 9, 1955, pp. 258-260, type from 13 miles south and 6 miles east of McDonald, Rawlins County, Kansas, host *Spermophilus tridecemlineatus,* Aug. 7, 1949; Fitch, Ecol. Monographs, vol. 25, no. 3, Jan., 1955, p. 79.

Diagnosis.—Larva similar to *T. g. gurneyi,* but differs in having scutum larger with anteromedian seta longer, average 37μ (35-40μ); and sensilla longer with 10-12 branches.

Scutal measurements (after Loomis, 1955), average and extremes, of 6 topotypes: AW- 66 (63-70), PW- 76 (75-79), SB- 31 (30-33), ASB- 22 (20-23), PSB- 16 (15-18), AP- 20 (17-22), AM- 37 (35-38), AL- 26 (23-27), PL- 44 (42-45), S- 53 (51-55).

Geographic distribution.—(Loomis, 1955): Known from northeastern Colorado (Yuma County), southwestern and south-central

Nebraska (Hitchcock and Webster counties), western and central Kansas (Cheyenne, Rawlins, Wallace, Jewell, Seward and Barber counties) and western Oklahoma (Woods and Harmon counties). Intergrades with *T. g. gurneyi* are known from south-central Kansas (Barber County).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from early July to mid-September, and on October 7, 1951 in north-central Oklahoma, near the border of Kansas. The earliest record is April 12, 1950, when a single larva was recovered in southwestern Oklahoma.

Hosts.—This subspecies was found in the grasslands of the high plains, on reptiles and mammals typical of that habitat, including snakes, *Masticophis flagellum, Heterodon nasicus, Crotalus viridis,* small rodents, *Spermophilus tridecemlineatus, Dipodomys ordii, Perognathus, Onychomys leucogaster, Peromyscus maniculatus* and others. Larvae were found also on three burrowing owls, *Speotyto cunicularia.*

The usual site of larval attachment seems to be on the body of mammals, under the scales of snakes and lizards, and along the wings and legs of birds.

Habitats.—Larvae were especially common on mice and snakes indicating that the free-living stages probably live in the burrows and nests of the mammalian hosts. Only a single larva has been recovered from a prairie dog, *Cynomys ludovicianus,* although the chigger was common on certain mammals and burrowing owls that inhabited the burrows dug by *Cynomys.* It seems likely that the nymphs and adults of *T. g. campestris* and *T. montanensis,* if present together, would compete for food (nymphs of both species have been observed to eat collembolan eggs in the laboratory) and for suitable microhabitats, and that *T. montanensis* is probably better able to exist in the occupied burrows of *Cynomys* in the postlarval stages and on *Cynomys* in the larval stage.

The presence of *T. g. campestris* on hosts from mixed grass communities and from sandy areas supporting sage and yucca seems to indicate that more ground cover is necessary for it, while *T. montanensis* can survive in areas of short and closely cropped grasses.

Specimens examined.—Total, 210 larvae, as follows: BARBER CO.: 2 mi. E Aetna, *Dipodomys ordii,* Sept. 14, 1953 (6), 4 mi. S Aetna, *Neotoma micropus,* July 25, 1952 (1), Sept. 15, 1953 (2) -*Peromyscus leucopus,* July 26, 1952 (1) and *Sylvilagus floridanus* Sept. 14, 1953 (1); 4 mi. S, 2 mi. E Aetna, *Dipodomys ordii,* Aug. 22, 1949

(4); 5 mi. S, 3 mi. E Aetna, *Masticophis flagellum,* Sept. 14, 1948 (49); 10½ mi. W Hardtner, July 26, 1952, *Melanerpes erythrocephalus* (5), and *Sylvilagus floridanus* (1), considered intergrades with *Trombicula g. gurneyi;* 17 mi. W Medicine Lodge, *Arizona elegans,* Sept. 14, 1948 (1). CHEYENNE CO.: 3-5 mi. N St. Francis, *Onychomys leucogaster,* July 23, 1948 (4); 4 mi. E, 4 mi. N St. Francis, July 24, 1948, *Onychomys leucogaster* (30), and *Peromyscus maniculatus* (14); 6 mi. S, 2 mi. E Benkelman, Nebr., *Perognathus hispidus,* Aug. 7, 1949 (9). JEWELL CO.: 1 mi. E, ½ mi. N Lovewell, *Lampropeltis triangulum,* July 3, 1951 (3); 4 mi. W Lovewell, *Eumeces obsoletus,* July 10, 1951 (1). RAWLINS CO.: 3½ mi. S Atwood, *Perognathus hispidus,* Aug. 8, 1949 (1); 6 mi. S Atwood, *Perognathus hispidus,* July 30, 1948 (2); 4½ mi. E Atwood, *Crotalus viridis,* Aug. 7, 1949 (8); 9 mi. W, 1½ mi. S Atwood, *Peromyscus maniculatus,* Aug. 10, 1949 (1); near Beardsley, *Spermophilus tridecemlineatus,* July 26 and 28, 1948 (10); 9 mi. S Beardsley, Aug. 9, 1949, *Crotalus viridis* (2) and *Peromyscus maniculatus* (1); 13 mi. S, 6 mi. E McDonald, Aug. 7-8, 1949, *Spermophilus tridecemlineatus* (30) -*Cynomys ludovicianus* (1) and -*Speotyto cunicularia* (5). SEWARD CO: 12 mi. NE Liberal, *Perognathus hispidus,* Sept. 10, 1948 (4). WALLACE CO.: 3 mi. W Sharon Springs, *Peromyscus maniculatus,* July 4, 1949 (9).

Trombicula kansasensis Loomis

(Fig. 12, Map 18)

Trombicula kansasensis Loomis, Univ. Kansas Sci. Bull., vol. 37, pt. 1, no. 9, 1955, pp. 260-262, 1 fig., type from Univ. Kansas Nat. Hist. Reserv., 5 miles north and 1 mile east of Lawrence, Douglas County, Kansas, host *Pituophis catenifer,* Oct. 17, 1950.

Diagnosis.—Larva similar to *T. gurneyi,* but differs in having scutum larger, with anteromedian seta longer (44-50μ); sensilla longer (64-75μ); eyes 1/1, or with tiny posterior lens on faintly visible ocular plate; tarsalae I and II longer (16μ).

Scutal measurements (after Loomis, 1955), average and extremes, of 10 larvae from Barber and Douglas counties: AW- 71 (65-77), PW- 84 (75-92), SB- 37 (32-40), ASB- 25 (21-28), PSB- 19 (17-21), AP- 20 (17-22), AM- 47 (45-50), AL- 27 (25-30), PL- 50 (48-52), S- 69 (64-74).

Geographic distribution.—Known from Kansas in the western (Wallace County), south-central (Barber County) and northeastern (Douglas County) parts of the State and in Mexico (Coahuila and Durango, KU).

Seasonal occurrence.—Larvae have been taken from hosts from July to October. They were common in October in Douglas County.

Hosts.—*T. kansasensis* was found on deer mice, *Peromyscus maniculatus*, from all three known areas of occurrence. Larvae were also taken on four different species of snakes at the University of Kansas Natural History Reservation, although they were common only on two bull snakes, *Pituophis catenifer.* The hosts from Barber County included *Neotoma micropus* and *Peromyscus leucopus.*

The common site of attachment of the larva was under the anterolateral and ventral scales of snakes and on the body, especially the inguinal region, of mammals. Larvae were found on one *Peromyscus maniculatus* along the penis, near the anus and surrounding the base of the tail. Hosts from Mexico include the pocket gophers, *Cratogeomys castanops* and *Thomomys bottae.*

Habitats.—The hosts of *T. kansasensis* from Barber and Douglas counties were all taken in relatively open rocky situations. The hosts from the University of Kansas Natural History Reservation were taken along limestone outcroppings in or near the quarry, near the crest of the bluffs. The hosts from Barber County were trapped in canyons cut through strata of sandstone and gypsum. Presumably the larvae occur in the burrows of small mammals.

Specimens examined.—Total, 69 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Neotoma micropus*, Aug. 22, 1949 (1), Sept. 15-16, 1953 (5), Oct. 6-7, 1951 (2) -*Peromyscus leucopus,* Sept. 15, 1953 (3) and *Peromyscus maniculatus,* Oct. 7, 1951 (1). DOUGLAS CO.: University of Kansas Natural History Reservation, 5 mi. N, 1 mi. E Lawrence, *Coluber constrictor,* Oct. 5, 1949 (1) -*Crotalus horridus,* Sept. 5, 1949 (1) -*Pituophis catenifer,* Oct. 17, 1950 (26) -*Thamnophis sirtalis,* Aug. 25, 1949 (1) and *Peromyscus maniculatus,* Oct. 20, 1951 (12). WALLACE CO.: 3 mi. W Sharon Springs, *Peromyscus maniculatus,* July 4, 1949 (16).

Trisetica Group

Diagnosis.—Larvae with engorged body small, elongate, yellow in life; total body setae 36-38; sternal setae 2-2-2; eyes 2/2, red in life; scutum roughly rectangular, nearly square; palpal femur and genu each with seta branched; palpal claw bifurcate, axial prong internal, prongs short, nearly equal in length; leg I with 3 genualae; leg II with 1 genuala and pretarsala; leg III with coxa having 3 to 6 setae, 1 genuala and 1 mastitarsala.

Remarks.—Two species, *T. trisetica* and *T. crossleyi*, both of which occur in Kansas, are included in this group, which is closely related to the Ornata Group. Further studies may reveal that these two groups should be united and placed in the subgenus *Trombicula, sensu stricto*.

Larvae have been found on reptiles, birds and mammals, in spring, summer and fall.

Trombicula trisetica Loomis and Crossley

(Fig. 12, Map 19)

Trombicula trisetica Loomis and Crossley, Jour. Kansas Ent. Soc., vol. 26, March 1, 1953, p. 32, pl. 1, type from 3 miles east and 1 mile south of Fontana, Miami County, Kansas, host *Eumeces laticeps*, May 26, 1951; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, p. 188.

Diagnosis.—Larva similar to *T. crossleyi*, but differs in having sensilla longer (46-50μ) with fewer (8-10) long distal branches; galeal seta nude; leg III with coxa having 3, occasionally 4, setae.

Scutal measurements (after Loomis and Crossley, 1953), average and extremes, of 10 topotypes: AW- 49 (46-51), PW- 61 (59-63), SB- 18 (15-20), ASB- 25 (24-27), PSB- 23 (22-23), AP- 21 (19-23), AM- 25 (23-27), AL- 22 (20-26), PL- 30 (28-35), S- 49 (46-50).

Geographic distribution.—Known from eastern Kansas (Douglas and Miami counties), southwestern Arkansas (Little River County, KU) and central California (Monterey County, Brennan and Jones, 1954).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from May 26 to November 23. They were found on hosts in large numbers in late May and early September.

Hosts.—*Trombicula trisetica* has been found on both reptiles and mammals. Nearly 500 larvae were found under the scales of the neck on 3 of 4 adult female greater five-lined skinks, *Eumeces laticeps*. An adult male *Eumeces laticeps* from Arkansas had 125 larvae under the scales of the neck. A single larva was found also on one of two adult female five-lined skinks, *Eumeces fasciatus*, at the same locality in Arkansas. A single larva was taken from a copperhead, *Ancistrodon contortrix*, and approximately 700 larvae dropped from an adult pilot black snake, *Elaphe obsoleta*, that was kept over a pan from September 10 to 21.

Two species of mammals were found to possess larvae of this species. Six larvae were obtained from *Neotoma floridana*, and 52 larvae were washed from two young *Sciurus carolinensis*. The single record from California was from *Peromyscus truei*.

The known sites of attachment of this species are under large scales on the reptiles and on the bodies and occasionally in the ears of the mammalian hosts.

Habitat.—The hosts of *T. trisetica* have been taken in large stands of deciduous woodlands, usually in the oak-hickory climax, and where large standing dead trees are present. The hosts are semi-arboreal, with the exception of the copperhead which lives on the forest floor. The wood rat, although usually not living in trees, does frequently climb them and occasionally nests in them. The large number of larvae on the reptiles and mammals which usually nest and take shelter in large cavities of dead standing trees seems to indicate that the free-living stages occur in decaying wood, usually in cavities frequented by a vertebrate. The host data of the closely related species, *T. crossleyi,* also tends to substantiate this theory. In September, 1952, attempts to recover larvae of *T. trisetica* from cavities in dead standing strees in the vicinity of the site of capture of the pilot black snake host were unsuccessful. No larvae of *T. trisetica* were recovered on several decaying logs, which were frequently sampled from May to October in 1952 (see *T. g. gurneyi*).

Life history.—A total of 60 engorged larvae from *Elaphe obsoleta,* Douglas County, was placed in a 3 dram culture tube on September 21, 1952. On October 5 (14 days later) the majority of the individuals were active nymphs. They fed on Collembola eggs and appeared healthy and a total of 35 nymphs was counted on October 9, the first preadult was seen on November 11 (51 days), and by November 21 (61 days) nearly half were preadults. Examination of the tube on December 16 (87 days) revealed that approximately half were active nymphs and the other half active adults, total 25. They were kept until January 1 (103 days) and no chigger eggs were observed. Four adults and four smaller nymphs were preserved on January 1, 1953.

The majority of engorged larvae dropped off reptiles before the 9th day when kept over pans in the laboratory. The longest time was 15 days. The pilot black snake was ready to shed on the 12th day. This probably hastened the detachment of the last larvae.

Specimens examined.—Total, 46 larvae, as follows: DOUGLAS CO: 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Natural History Reservation, *Ancistrodon contortrix*, July, 1949 (1), -*Elaphe obsoleta*, Sept. 10, 1952 (5) -*Neotoma floridana*, Nov. 23, 1952 (6). MIAMI CO.:

3 mi. E, 1 mi. S Fontana, *Eumeces laticeps*, May 26, 1951 (28) and *Sciurus carolinensis*, May 31, 1953 (6).

Trombicula crossleyi Loomis

(Figs. 32-33, Map 19)

Trombicula crossleyi Loomis, Univ. Kansas Sci. Bull., vol. 36, July 15, 1954, pp. 920-922, figs. 1-3, type from 10½ miles west of Hardtner, Barber County, Kansas, host *Melanerpes erythrocephalus*, July 26, 1952.

Diagnosis.—Larvae similar to *T. trisetica*, but differs in having scutum smaller, slightly subpentagonal, sensilla shorter with more numerous branches; galeal seta usually with a single branch; and leg III with coxa having 5 setae (occasionally 4 setae on one coxa or 6 on one or both coxae).

Scutal measurements (after Loomis, 1954), average and extremes, of 8 topotypes: AW- 35 (32-38), PW- 45 (43-47), SB- 12 (12-13), ASB- 20 (20-22), PSB- 20 (20-22), AP- 21 (20-22), AM- 20.5 (20-21), AL- 18 (17-19), PL- 26.5 (25-28), S- 33 (30-35).

Taxonomic remarks.—This chigger mite may represent a subspecies of *T. trisetica*, but since the known populations are separated by nearly 250 miles, intergradation cannot be demonstrated at the present time.

Geographic distribution.—(Loomis, 1954): Known from south-central Kansas (Barber County) and south-central Oklahoma (Comanche County).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from July 26 to October 7, and in Oklahoma on May 16, 1952, being most common in late July.

Hosts.—This chigger mite was taken most frequently on *Melanerpes erythrocephalus*, with five of seven red-headed woodpeckers from Barber County being parasitized. Four of the five taken on July 26, 1952 averaged 11 larvae per individual, whereas the fifth shot in September had 2 larvae attached. The larvae were attached to the wings, upper legs, and breast.

On two occasions *Peromyscus leucopus* from Barber County was found to harbor *T. crossleyi*; four larvae were taken from two mice obtained on July 25, 1952 and 20 larvae were recovered from six mice obtained on October 7, 1951.

An additional host is *Peromyscus maniculatus* (2 larvae) from Oklahoma.

Habitats.—The three areas in Barber County from which hosts of this chigger were taken have small streams bordered by stands of deciduous trees such as cottonwood, elm, and others including dead standing trees and snags. The hosts are arboreal or semi-arboreal to a large extent. The woodpeckers invariably nest in cavities in dead trees or limbs and the mice, *Peromyscus leucopus*, frequently nest in cavities of standing trees or fallen logs and commonly climb trees. These data on hosts and habitats, along with the absence of larvae from a large number of local terrestrial vertebrates examined, indicate that the larvae of *T. crossleyi* were acquired from trees, probably the larger dead standing trees which have cavities accessible to the red-headed woodpeckers and white-footed mice. The nymphs and adults of *T. crossleyi* probably live in suitable niches within the cavities of these dead trees.

Life history.—This chigger possibly produces two generations of larvae annually. Laboratory evidence indicates that the time of 45 days from engorged larva to adult compares favorably with the time required by *Eutrombicula* for producing at least two generations per year in the same area.

Specimens examined.—Total, 38 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Peromyscus leucopus*, July 25, 1952 (1), Oct. 7, 1951 (16); 10½ mi. W Hardtner, *Melanerpes erythrocephalus*, July 26, 1952 (25); 5 mi. S Sun City, *Melanerpes erythrocephalus*, Sept. 13, 1948 (2).

Ornata Group

Diagnosis.—Larvae with body (engorged) frequently overlapping gnathosoma; dorsal setae 36-38; eyes 2-2, red in life; scutum roughly square, with numerous large pits; cheliceral blade short (14-22μ); galeal seta nude; palpal claw bifurcate, with large inner axial prong curving inward, short, slender accessory prong on outer side; leg I with 2 genualae; leg II with 1 genuala (pretarsala absent); leg III with 1 genuala and 1 or more mastitarsalae.

Remarks.—This group includes two species, *T. ornata* and *T. merrihewi*. The former species has been found in Kansas, while the latter is known from Oklahoma, just south of Kansas. *Trombicula cynictia* Radford from Africa and other related species probably belong in this group.

Larvae of this group have been found only on mammals in the spring, summer and early autumn.

Trombicula ornata Loomis and Lipovsky

(Figs. 34-35, Map 14)

Trombicula ornata Loomis and Lipovsky, Jour. Kansas Ent. Soc., vol. 27, May 15, 1954, p. 47, pls. 1-2, type from 4 miles south of Aetna, Barber County, Kansas, host *Neotoma micropus,* April 11, 1949.

Diagnosis.—Larva similar to *T. merrihewi* (p. 1367), but differs in having body orange in life; ventral body setae 44, total body setae 80; sensilla with 3-5 long slender branches on distal half; palpal tibia with ventral seta branched, lateral and dorsal setae nude; leg III with coxa having 2 branched setae and 3 mastitarsalae.

Scutal measurements (after Loomis and Lipovsky, 1954), average and extremes, of 4 topotypes: AW- 35 (34-36), PW- 48 (46-51), SB- 21 (19-22), ASB- 24 (22-24), PSB- 25 (24-27), AP- 31 (31-32), AM- 29 (28-30), AL- 23 (19-26), PL- 37 (34-45), S- 66 (64-67).

Geographic distribution.—(Loomis and Lipovsky, 1954): Known from south-central Kansas (Barber County) and north-central Colorado (Boulder County).

Seasonal occurrence.—Larvae have been taken from hosts between April 11 (1949) and October 7 (1951), and were more common in April.

Hosts.—The three known hosts, *Neotoma micropus, Peromyscus leucopus* and *Peromyscus maniculatus,* had larvae attached in the ears and probably on the body. They were common on the gray wood rats taken in April, 1949.

Habitat.—This chigger mite was attached only to mammals taken in rocky canyon habitats where sandstone and gypsum are present in large outcroppings. The seeming absence from mammals in other habitats may indicate that the free-living stages frequent crevices of the rock outcroppings, possibly associated with nests of mammals. This type of habitat approaches the probable cave habitat of the closely related bat species, *T. merrihewi.*

Specimens examined.—Total, 70 larvae, as follows. BARBER CO.: 4 mi. S Aetna, *Neotoma micropus,* April 11-14, 1949 (49), Aug. 22, 1949 (3) and *Peromyscus leucopus,* April 13, 1949 (5), July 25-26, 1952 (2), Sept. 15, 1953 (1); 5 mi. S Sun City, *Neotoma micropus,* April 12, 1949 (1), Sept. 14, 1948 (3) and *Peromyscus maniculatus,* April 12, 1949 (6).

GENUS SPELEOCOLA Lipovsky

Speleocola Lipovsky, Jour. Kansas Ent. Soc., vol. 25, Nov. 12, 1952, p. 134, type *Speleocola tadaridae* Lipovsky.

Diagnosis.—Larva with scutum elongate, longer than wide, with 3 scutal setae, posterolateral setae off scutum or on subdermal extension of plate; sensilla seemingly stout, flagelliform, but covered distally with numerous, basally expanded, leaflike setules, (giving appearance of an expanded sensilla); cheliceral blade with 2 or 3 terminal teeth; palpal claw trifurcate with large central prong, and 2 lateral needlelike prongs; leg II without pretarsala.

Remarks.—The single species, *S. tadaridae,* has been found on Mexican free-tailed bats, *Tadarida mexicana,* from Kansas, Oklahoma and Texas.

Speleocola tadaridae Lipovsky

(Figs. 36-37, Map 16)

Speleocola tadaridae Lipovsky, Jour. Kansas Ent. Soc., vol. 25, Nov. 12, 1952, pp. 134-137, pls. 1-2, type from the Merrihew Cave, 6 miles south and 2 miles west of Aetna, Kansas, in Woods County, Oklahoma, host *Tadarida mexicana,* August 24, 1949; Audy, Stud. Inst. Med. Res. Malaya, no. 26, April, 1954, p. 147.

Diagnosis.—Larva with body moderate in size, pale yellow to yellow-orange in life; eyes 1/1, red in life, posterior lens and ocular plate obscure; dorsal setae *circa* 60, including 2 pairs of humeral setae, total body setae *circa* 112, scutum longer than wide, 3 scutal setae (PL setae off scutum or on subdermal scutal plate) anterolateral setae short with several basal branches; AM and PL setae longer and branched along entire length; galeal seta nude; palpal femur and genu each with branched setae; tibia with 3 nude setae; tarsus with 1 stout plumose seta, 5 setae nude or with few branches, and tarsala; leg I with 3 genualae, parasubterminala and subterminala; leg II with 1 genuala (pretarsala absent or with several branches); leg III with 1 genuala and 1 tibiala; tarsi of legs I, II, and III each with several nude setae, not all strictly long whiplike setae.

Scutal measurements (modified from Lipovsky, 1953, and original data), average and extremes, of 10 topotypes: AW- 26 (23-28), PW- 50 (46-56), SB- 11 (11-12), ASB- 23 (21-24), PSB- 19 (17-21), AP- 26 (23-28), AM- 22 (21-23), AL- 19 (15-21), PL- 26 (25-28), S- 38 (34-40).

Geographic distribution.—Known from central Texas (Bexar County, KU), north-central Oklahoma (Woods County, Lipovsky, 1952) and south-central Kansas (Barber County).

Seasonal occurrence.—Larvae have been taken from free-tailed bats on July 26 in Kansas, August to October in Oklahoma and May in Texas and were common in late August and early September.

Ecology.—Ten larvae were found in the ears of one of five Mexican free-tailed bats, *Tadarida mexicana,* obtained from a barn in Barber County, Kansas. This site is approximately 40 miles northeast of the type locality in Woods County, Oklahoma. The Merrihew Cave is the well-known cave in that region which is regularly inhabited by large numbers of *Tadarida mexicana* each summer. It seems likely that the bats from Kansas originally were a part of this large colony, and obtained the larvae in that cave.

Specimens examined.—Total, 9 larvae, as follows: BARBER CO.: 3 mi. N, 2 mi. E Sharon, *Tadarida mexicana,* July 26, 1952 (9).

GENUS EUSCHÖNGASTIA Ewing

Euschöngastia Ewing, Jour. Washington Acad. Sci., vol. 28, June 15, 1938, p. 293, type *Euschöngastia americana* Ewing [= *Euschöngastia sciuricola* Ewing].

Diagnosis.—Larvae with scuta of various shapes not submerged under integument and not pentagonal with apex anterior, having 5 scutal setae, sensillae expanded (lanceolate to globose); cheliceral blade usually with a dorsal tricuspid cap and a ventrolateral tooth; legs usually with seven segments, occasionally legs II and III with 6 segments (*Walchiella* Fuller), coxae I and II each with 1 branched seta; all empodia clawlike; without caudal plate or plates.

Species in Kansas with eyes usually 2/2, red in life (eyes 1/1, colorless, in *E. pipistrelli*), palpal femur with branched seta, palpal genu with branched seta (nude on *E. trigenuala*), palpal tibia with dorsal and ventral setae branched; palpal claw with 3 to 5 prongs; leg I with subterminala and parasubterminala (absent in *E. lacerta*); leg II with 1 genuala (absent in *E. lacerta*), and pretarsala; leg III with 1 genuala (absent in *E. lacerta*), and no long nude whiplike setae.

Remarks.—In Kansas, the species of *Euschöngastia, sensu lato,* can be placed in two groups according to the seasonal occurrence of the larvae. The winter group includes *Euschöngastia trigenuala, E. setosa, E. pipistrelli, E. jonesi, E. peromysci, E. diversa, E. criceticola* and possibly *E. cynomyicola* (taken in July and August). The summer species are *E. lacerta* and *E. loomisi.* Although an occasional larva of the first group is found in the summer months, the great majority of the larvae were found from late October to late April. The summer species have been found only in July to early

October in Barber County. The cave species, *E. pipistrelli*, probably does not conform strictly to the seasons, but the lower temperature of the caves simulates a cool season, and probably slows down the rate of development of the postlarval stages.

The two summer species are small, and whitish in life. It is my opinion that each belongs to a separate genus, but studies of the nymphs and adults are needed. The winter species are whitish, pale yellow to orange.

Data from hosts indicate that the winter species normally attach to mammals and occasionally parasitize birds. The larvae have not been found on reptiles which would usually be dormant and inaccessible during the season of larval activity. The summer species have not been taken on reptiles or birds in Kansas, but *E. lacerta* has been found on a lizard in California. Larvae of the following two species have been taken from birds in Kansas: *Euschöngastia peromysci* from a crow and *E. diversa* from an English sparrow, cardinal and black-capped chickadee.

KEY TO SPECIES OF EUSCHÖNGASTIA IN KANSAS

1. Subterminala and parasubterminala I absent (sensilla clavate). *E. lacerta* p. 1345
1′ Subterminala and parasubterminala I present 2
2. Tibiala III absent 3
2′ Tibiala III present 4
3. Palpal claw with 5 prongs; scutum with no distinct ridge above each sensillary base .... *E. setosa* p. 1329
3′ Palpal claw with 3 prongs; scutum with a strong ridge above each deeply set sensillary base .... *E. criceticola* p. 1340
4. Three genualae I 5
4′ Two genualae I 6
5. Sensilla clavate; sensillary bases widely separated (28μ); palpal claw with 5 prongs .... *E. trigenuala* p. 1343
5′ Sensilla globose; sensillary bases close together (18μ); palpal claw with 3 prongs .... *E. loomisi* p. 1346
6. Palpal claw with 3 prongs; sensilla subclavate or globose 7
6′ Palpal claw with 5 prongs; sensilla clavate 9
7. Sternal setae 2-2 8
7′ Sternal setae 2-6 .... *E. cynomyicola* p. 1342
8. Scutum with 3 crescent ridges, 1 anterior to the anteromedian setal base, and 1 over each sensillary base; galeal seta nude or with 1 or 2 branches .... *E. diversa* p. 1337
8′ Scutum with 2 crescent ridges, over each sensillary base, no anterior median ridge; galeal seta with several branches .... *E. peromysci* p. 1334
9. Sensilla rounded or flat distally with many fine setules; eyes 1/1; galeal seta nude .... *E. pipistrelli* p. 1331
9′ Sensilla with pointed tip with a few large setules; eyes 2/2; galeal seta with several branches .... *E. jonesi* p. 1332

Subgenus *Euschöngastia* Ewing

Diagnosis.—Larvae with scutum wider than long with margins sinuous, posterior width greater than anterior width, posterolateral corners tend to be pointed, palpal claw with 5 or more prongs; leg III without long nude whiplike setae; leg I with subterminala and parasubterminala, all legs with 7 segments.

Species from Kansas with scutum twice as wide as long; palpal genual seta branched; palpal tarsus with 7 feathered setae; leg I with 2 genualae; leg II with 1 genuala; leg III with 1 genuala.

Remarks.—The species placed in this subgenus are those which seem most closely related to the type species, as judged by the nature of the palpal claw, number of setae on palpal tarsus, shape of scutum and sensilla and the presence or absence of certain nude setae on the legs.

The three species in Kansas included in this subgenus are *E. setosa*, *E. pipistrelli* and *E. jonesi*. *E. setosa* is closely related to the type species, while the other two, which frequently live in caves, are probably more specialized.

Euschöngastia setosa (Ewing)

(Fig. 12, Map 21)

Trombicula setosa Ewing, Proc. Biol. Soc. Washington, vol. 50, Oct. 28, 1937, pp. 170-171, type from Okefinokee Swamp, Georgia, host *Peromyscus gossypinus*, Dec. 2, 1934.

Euschöngastia setosa, Fuller, Bull. Brooklyn Ent. Soc., vol. 43, Oct., 1948, p. 103, Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 81.

Diagnosis.—Larva with engorged body large, yellow to orange in life; dorsal setae beginning 2-10, total about 46; total body setae about 106; scutum more than twice as wide as long, without puncta or ridges, sensillary bases near posterior margin; sensilla ovoid; cheliceral bases with puncta; galeal seta branched; palpal tibia with lateral seta nude; palpal tarsus with 7 feathered setae; palpal claw with 5 prongs; leg I with 2 genualae; leg III without tibiala. Similar to *E. sciuricola* Ewing, but differs in the shape of sensilla and in having puncta on cheliceral bases.

Scutal measurements, average and extremes, of 7 larvae from Barber, Douglas and Russell counties: AW- 68 (64-75), PW- 94 (84-102), SB- 29 (26-30), ASB- 21 (18-23), PSB- 10 (8-10), AP- 18 (17-20), AM- 38 (33-46), AL- 36 (33-44), PL- 64 (60-66), S- 27 (26-28).

Geographic distribution.—Known from southern Georgia (Okefenokee Swamp, Ewing, 1937), southwestern Tennessee (Shelby

County, KU), western Arkansas (Polk and Washington counties, KU), central Oklahoma (Cleveland County, KU), eastern and central Kansas (Douglas, Jefferson, Wyandotte, Johnson, Cowley, Barber and Russell counties), southwestern Iowa (Fremont County, KU), and southeastern Nebraska (Otoe and Nemaha counties, KU).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas between mid-August (August 16, 1952) and late April (April 26, 1952). They were usually not common on any individual host, although a total of 300 larvae were recovered from 5 cottontails in early November. Only two larvae were recovered in August, none in September, and a few in October. They were most common in November and December in eastern Kansas.

Hosts.—*Euschöngastia setosa* was found most frequently and in the greatest concentrations on cottontails, *Sylvilagus floridanus.* Other hosts of importance from eastern Kansas include *Sciurus carolinensis, S. niger* and *Peromyscus leucopus.* In central Kansas, six larvae were taken from 4 *Peromyscus maniculatus* in April and several *Neotoma micropus* had at least 6 larvae attached in April and early October.

The larvae attach singly to the body and legs of the hosts, and the skin around the site of attachment becomes swollen until the feeding larva rests in a cavity. These pits are visible on the skin after the larva has detached. Nothing had been learned concerning the time required for the larva to become fully engorged and detach. The absence on mammals late in winter, suggests that the larvae do not remain attached for a long period.

Habitats.—In eastern Kansas *E. setosa* was found on mammals obtained in deciduous woodlands and the woodland edge. Several hosts were taken from deciduous woods of oak and hickory with numerous limestone outcroppings in the immediate vicinity. In central Kansas (Russell County) the hosts, *Peromyscus maniculatus,* were found in nests under large flat limestone rocks on hillsides supporting closely-cropped mixed grasses. The presence of larvae on these mice and on cottontails indicates that the larvae are acquired from the ground, probably in the burrows and nests of the hosts, and possibly from inside decaying logs and trees where they are acquired by tree squirrels.

The free-living stages probably occur more frequently in the soil in the immediate vicinity of the burrows and nests.

Specimens examined.—Total, 47 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Neotoma micropus,* April 11-14, 1949 (4), Oct. 6, 1951 (2). COWLEY CO.: 2 mi. E Rock, *Peromyscus leucopus,* March 7, 1953 (2). DOUGLAS CO.: Nest of *Neotoma floridana,* Dec. 13, 1947 (1); Lawrence, *Sciurus niger,* Nov. 30, 1948 (1); 4 mi. S, 2 mi. W Lawrence, *Sciurus niger,* Nov. 18, 1950 (2); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Sciurus niger,* Jan. 19, 1950 (1), *-Neotoma floridana,* Aug. 16, 1952 (2), *-Peromyscus leucopus,* Feb. 8-9, 1948 (9), March 18, 1948 (2), *-Peromyscus maniculatus,* Oct. 16 and 20, 1951 (4); 2 mi. S, 2 mi. W Pleasant Grove, *Sylvilagus floridanus,* Dec. 4, 1948 (1). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Sciurus niger,* Nov. 21, 1951 (1), and *Sylvilagus floridanus,* Nov. 24, 1951 (1); 7 mi. N, 5 mi. W Midland, *Sciurus niger,* Nov. 26, 1953 (1); 10 mi. N Midland, *Sciurus niger,* Nov. 14, 1953 (5). JOHNSON CO.: 2 mi. N, 1 mi. W Lenexa, *Sciurus niger,* Nov. 18, 1953 (1) and *Sylvilagus floridanus,* Nov. 18, 1953 (1), Jan. 4, 1954 (1); 2 mi. W, 1 mi. N Lenexa, *Sylvilagus floridanus,* Nov. 18, 1953 (1); Roeland Park, *Sylvilagus floridanus,* Nov. 10, 1953 (6). RUSSELL CO.: 2 mi. N, 2 mi. E Gorham (1), 7½ mi. S, 2 mi. E Russell (2), and 9 mi. S Russell (1), all from *Peromyscus maniculatus,* April 26-27, 1952. WYANDOTTE CO.: Kansas City, *Sciurus carolinensis,* Nov. 5, 1953 (1), Dec. 11, 1953 (1), Dec. 17, 1953 (1) and *Sylvilagus floridanus,* Dec. 11, 1953 (1).

Euschöngastia pipistrelli Brennan

(Fig. 12, Map 22)

Euschöngastia pipistrelli Brennan, Jour. Parasit., vol. 33, July 1, 1947, p. 249, fig. 3, type from Mud Cave, Stone County, Missouri, host *Pipistrellus subflavus,* Sept. 11 and 23, 1946; Jones, Loomis, Krutzsch and Webb, Trans. Kansas Acad. Sci., vol. 55, Oct. 31, 1952, pp. 313-314; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec., 1952, p. 81.

Euschöngastia miricoxa Brennan, Jour. Parasit., vol. 34, Jan. 17, 1949, p. 465, figs. 3 and 10, type from Tompkins County, New York, host *Myotis lucifugus,* Aug. 5, 1947.

Diagnosis.—Larva similar to *E. jonesi,* but differing from it in having eyes 1 1, without color in life; body white in life; sensilla clavate, rounded distally, with numerous small setules; galeal seta nude.

Scutal measurements, average and extremes, of 7 larvae from Marshall County: AW- 67 (65-69), PW- 80 (77-83), SB- 30 (29-30), ASB- 32 (30-34), PSB- 10 (9-11), AP- 19 (17-21), AM- 42 (40-45), AL- 46 (43-51), PL- 112 (105-122), S- 36 (34-37).

Geographic distribution.—Known from New York (Tompkins County, Brennan, 1949) west to southern Missouri (Stone County, Brennan, 1947; Taney and McDonald counties, KU), northern Arkansas (Newton County, Jones, *et al.*, 1952), northeastern Oklahoma (Adair County, Jones, *et al.*, 1952) and northeastern Kansas (Marshall County).

Seasonal occurrence.—Larvae were taken from bats in Kansas in December. Larvae were recovered also from bats in the central states in February, March, September, October and December. It seems that the larvae remain attached to the bats in winter while they hibernate in suitable caves.

Ecology.—A series of these white larval chiggers were found on three species of bats, *Pipistrellus subflavus, Myotis keenii* and *M. lucifugus,* from an abandoned mine in Marshall County. These bats were obtained on December 29, 1951, while they hibernated in the mine. These mites were in and around the lower border of the bats' ears. One of four *Myotis keenii* had six engorged to partially engorged larvae attached, two of twenty *Myotis lucifugus* harbored one unengorged larva each, and three of fifty-two *Pipistrellus subflavus* were parasitized; two with one larva each and the third with fifteen engorged to partially engorged larvae. The small percentage of larval occurrence (8%) on these bats points to the possibility that the infested bats may have brought the larvae from other roosting places. The mine was not examined for a colony of these chiggers.

The larvae seem to attach most commonly upon the pipistrelle, *Pipistrellus subflavus*, which is a common cave bat throughout the central states. *Pipistrellus* from Kansas, Oklahoma, Arkansas and Missouri had larvae and larvae were found on *Myotis keenii* from Kansas and *Myotis lucifugus* from New York (Brennan, 1948:465), Kansas and Missouri.

Specimens examined.—Total, 7 larvae, as follows: MARSHALL CO.: 2 mi. W, ½ mi. N Blue Rapids, Dec. 29, 1951, *Myotis keenii* (2), *Myotis lucifugus* (1) and *Pipistrellus subflavus* (4).

Euschöngastia jonesi Lipovsky and Loomis

(Figs. 12, 38, Map 22)

Euschöngastia jonesi Lipovsky and Loomis, Jour. Parasit., vol. 40, Sept. 13, 1954, pp. 407-410, type from 2 miles east of Rock, Cowley County, Kansas, host *Peromyscus leucopus*, March 7, 1953.

Diagnosis.—Larva similar to *E. pipistrelli,* both having body white; scutum twice as wide as long, with posterolateral setae long;

palpal tibia with lateral seta nude or with 1 branch; palpal claw with 5 prongs; leg I with 2 genualae; leg III with 1 tibiala. Differs from *E. pipistrelli* in having eyes 2/2, pink to colorless in life; sensilla clavate, with tapering tip and a few large distal setules; galeal seta branched.

Scutal measurements (after Lipovsky and Loomis, 1954), average and extremes, of 11 larvae from Barber, Cowley and Douglas counties: AW- 67 (63-73), PW- 92 (83-106), SB- 33 (28-37), ASB- 30 (26-33), PSB- 12 (11-14), AP- 24 (21-28), AM- 45 (43-49), AL- 47.5 (43-53), PL- 90 (83-103), S- 43 (41-46).

Geographic distribution.—(Lipovsky and Loomis, 1954): Known from southwestern Missouri (Lawrence County) north-central Oklahoma (Woods County) and eastern and south-central Kansas (Wyandotte, Douglas, Cowley and Barber counties).

Seasonal occurrence.—Larvae have been found on hosts in Kansas from October to April, in Missouri on September 6, 1947. Larvae were present in moderate numbers on October 7 (Barber County) and October 16 (Douglas County). The larvae were more abundant in March and April.

Hosts.—*Euschöngastia jonesi* has been found on a variety of mammalian hosts. In Douglas County one *Cryptotis parva* had 12 larvae attached; four larvae were recovered from 46 *Sylvilagus floridanus* from the same locality collected from December 4, 1948 to January 29, 1949; and one *Peromyscus leucopus* possessed 4 larvae. In Barber County, one larva was recovered from seven *Neotoma micropus.* Ten larvae were found on one *Peromyscus maniculatus* taken on October 7, 1951, and 6 larvae were present on two deer mice taken on April 12, 1949. Also in Barber County, two larvae were recovered from approximately 50 *Myotis velifer,* and in Woods County, Oklahoma, one-half mile south of Kansas, a total of 18 larvae were taken from 24 cave bats. The type host, *Peromyscus leucopus,* from Cowley County, had approximately 75 larvae attached on the head and ears.

The larvae usually were found attached in and on the outer ear, but were found also on the face of *Peromyscus leucopus.*

Habitats.—The host of *E. jonesi* were all taken in the vicinity of rock outcroppings. In eastern Kansas hosts were obtained in association with limestone outcroppings and hillsides with large flat rocks on the ground. Deciduous trees usually were present over much of the areas. The least shrew was taken in a field at an abandoned limestone quarry, and one of the white-footed mice was caught after its rock shelter had been removed. The type host was caught at night in a limestone cave. In addition, one engorged larva was taken on a chigger sampler by Ervin Kardos near a limestone ledge at the Natural History Reservation.

In Barber County and in Woods County, Oklahoma, the hosts were obtained in canyons and caves of sandstone and gypsum.

The presence of this species on cave bats, *Myotis velifer,* seems to indicate a similarity of habitats for the free-living stages of *E. jonesi* and *E. pipistrelli.* These two species are closely related. Their known geographic ranges overlap only slightly and they probably developed in different regions. *Euschöngastia pipistrelli* seems to be restricted to caves and cave bats, and has only one lens on each side and the eyes are colorless. *Euschöngastia jonesi,* on the other hand, is not restricted to caves or cave bats, and has two lenses on each side of the body and the eyes are pink to colorless in life. The apparent lack of functional eyes in *E. pipistrelli* seems to point to an adaptation to cave life, while *E. jonesi* has retained eyes which probably are functional but poorly developed. The significance of the red coloration below the lenses is unknown.

Specimens examined.—Total, 81 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Neotoma micropus,* April 11, 1949 (1) -*Myotis velifer,* April 13, 1950 (2) and *Peromyscus maniculatus,* Oct. 7, 1951 (7); 5 mi. S Sun City, *Peromyscus maniculatus,* April 12, 1949 (6). COWLEY CO.: 2 mi. E Rock, *Peromyscus leucopus,* March 7, 1953 (44). DOUGLAS CO.: 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Chigger sampler,* Nov. 9, 1951 (1) and *Cryptotis parva,* Oct. 16, 1951 (12); 5 mi. S, 5 mi. W Lawrence, *Peromyscus leucopus,* April 28, 1952 (3); 2 mi. S, 2 mi. W Pleasant Grove, *Sylvilagus floridanus,* Dec. 4, 1948 (1), Dec. 29, 1948 (2), Jan. 29, 1949 (1). WYANDOTTE CO.: Kansas City, *Sciurus carolinensis,* Dec. 11, 1953 (1).

Euschöngastia

(Species which do not belong in the subgenus *Euschöngastia*)

Euschöngastia peromysci (Ewing)

(Figs. 12, 39, Map 23)

Schöngastia peromysci Ewing, Ent. News., vol. 40, Nov. 8, 1929, p. 296, type from Sturbridge, Worchester County, Massachusetts, host *Peromyscus leucopus,* May 27, 1928.

Euschöngastia peromysci, Fuller, Bull. Brooklyn Ent. Soc., vol. 43, p. 108, Oct., 1948; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 80; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, p. 171.

Neoschöngastia signator Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, pp. 14-15, pl. 2, fig. 1, type from Wilberton, Latimer County, Oklahoma, host "wood rat" [= *Neotoma floridana*], March 17, 1929.
Neoschöngastia brevipes Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, p. 16, pl. 2, fig. 4, type from College Park, Prince Georges County, Maryland, host *Peromyscus leucopus*, May 3, 1929.
Ascoschöngastia brevipes, Jameson, Univ. Kansas Publ., Mus. Nat. Hist., vol. 1, Oct. 6, 1947, pp. 143-144.

Diagnosis.—Larva with body (engorged) moderate in size, pale yellow to whitish in life; dorsal setae beginning 2-12, total about 64; sternal setae 2-2; total body setae about 164; scutum roughly rectangular with posterolateral setae anterior to sensillary bases, near anterolateral setae, with distinct circular ridges anterior to each sensillary base, usually meeting medially; sensilla capitate, galeal seta with 2-3 branches, palpal tibia with lateral seta branched; palpal tarsus with 7 feathered setae; palpal claw trifurcate; leg I with 2 genualae; leg III with 1 tibiala.

Scutal measurements, average and extremes, of 5 larvae from Douglas County: AW- 53 (49-57), PW- 61 (59-64), SB- 24 (21-25), ASB- 28 (25-32), PSB- 11 (9-12), AP- 15 (12-18), AM- 34 (31-36), AL- 47 (43-50), PL- 56 (53-62), S- 29 (28-30).

Geographic distribution.—Known from Massachusetts (Worchester County, Ewing, 1929), Maryland (Prince Georges County, Ewing, 1931), westward to northwestern Mississippi (DeSoto County, KU), southwestern Tennessee (Shelby County, KU), Arkansas (St. Francis, Polk and Washington counties, KU), Oklahoma (Adair, McCurtain, McClain, and Harper counties, KU), southeastern Nebraska (Richardson County, KU) eastern and central Kansas (Douglas, Jefferson, Johnson, Wyandotte, Cowley, Brown, Neosho, and Shawnee counties) and central California (Monterey County, Brennan and Jones, 1954).

Seasonal occurrence.—Larvae were taken from hosts in Kansas between mid-October and early June, three larvae in October, one larva in November, none in December (because few potential hosts were examined), many from January to April, none in May, and two from a crow on June 7, 1948. In general, the larvae seem to be more common in the winter and early spring, probably with a seasonal occurrence and abundance much as that of *E. diversa.*

Hosts.—In eastern Kansas, only one bird, *Corvus brachyrhynchos* was found to have larvae (two recovered). Seven species of mammals had larvae. Two *Microtus ochrogaster*, two *Sigmodon hispidus* and a *Reithrodontomys megalotis* each was found to have a single larva.

One individual of *Peromyscus maniculatus* had a single larva attached, and there were three larvae on a second individual. All four of these rodents are characteristic of the grasslands. One cottontail was found to have a single larva while another had five.

Jameson (1947:143-144) reported *Ascoschöngastia brevipes* (Ewing), now considered synonymous with *E. peromysci*, from *Peromyscus leucopus*, *Sigmodon hispidus* and *Microtus ochrogaster* at Lawrence, Douglas County, Kansas. I have examined four specimens obtained by Jameson from *Peromyscus leucopus* collected 2 miles WNW of Lawrence. These specimens are *E. peromysci*. The determination of the chiggers from the other two hosts is in doubt, since the *Euschöngastia* most commonly found on these mice is another species, *E. diversa*.

Larvae of *E. peromysci* were taken on the following additional hosts from other states: *Reithrodontomys fulvescens* from Arkansas and Oklahoma, *Peromyscus gossypinus* from Arkansas and *Peromyscus boylii* from Oklahoma. Larvae were common on *Peromyscus leucopus* and *Neotoma floridana* in Arkansas and Oklahoma.

The larvae usually were found in the ears of the mammalian hosts. They attached to the inner part of the ears, behind the tragus and antitragus, and were in clusters on several occasions. They were frequently trapped in the ear wax, although if engorged they usually were alive when recovered.

Habitats.—Larvae of *E. peromysci* were taken from hosts in the woodlands and woodland edges, usually in the vicinity of decaying stumps and logs. They are probably present in the burrows and nest sites of mice, especially *Peromyscus*, and are probably associated with the nests of wood rats. Nearly all of the hosts were from stands of hardwoods, including elms, oaks, hickories, and others. The chiggers frequently were taken from mice trapped on open ground shaded by trees.

Specimens examined.—Total, 278 larvae, as follows: BROWN CO.: 7 mi. N, ½ mi. E Hiawatha, *Microtus ochrogaster*, Nov. 29, 1947 (1). COWLEY CO.: 2 mi. E Rock, *Peromyscus leucopus*, March 7, 1953 (8). DOUGLAS CO.: 3 mi. W, 2 mi. S Clinton, *Sylvilagus floridanus*, March 10, 1949 (5); Lawrence, *Sigmodon hispidus*, Oct. 25, 1948 (1); 2 mi. WNW Lawrence, *Peromyscus leucopus*, Feb. 10, 1946 (4); 2 mi. W, 1 mi. S Lawrence, *Neotoma floridana*, March 5, 1949 (4); 3 mi. N, 2 mi. E Lawrence, *Peromyscus maniculatus*, Jan. 30, 1952 (1) and *Sigmodon hispidus*, Feb. 1, 1952 (1); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Corvus brachyrhynchos*, June 7, 1948 (2) -*Neotoma floridana* Feb. 8, 1953 (3), Feb. 9, 1948 (32), Feb. 18, 1950 (13), March 12, 1949 (1), April 2, 1950 (3), -*Peromyscus leucopus*, Feb. 8-9, 1948 (107), March 18, 1948 (19), March 28, 1952 (2), Oct. 16, 1952 (1) -*Peromyscus maniculatus*, Feb. 18, 1948 (3); Pleasant Grove, *Reithrodontomys megalotis*, March 31, 1952 (1). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Peromyscus leucopus*, Jan. 25-26, 1952 (20), Jan. 29, 1952 (3), Feb. 1, 1952 (10), Feb. 20, 1952 (3) and *Microtus ochrogaster*, Feb. 20, 1952 (1). JOHNSON CO.: 2 mi. N, 1 mi. W Lenexa, *Peromyscus leucopus*, April 2, 1954 (5), April 13, 1954 (3). NEOSHO CO.: 5 mi. W St. Paul, *Peromyscus leucopus*, April 27, 1947 (1). SHAWNEE CO.: 4 mi. W Richland, *Neotoma floridana*, Feb. 20, 1948 (19). WYANDOTTE CO.: 1 mi. N, 1 mi. E Piper, *Sylvilagus floridanus*, Oct. 29, 1953 (1).

Euschöngastia diversa Farrell

(Fig. 12, Map 24)

Euschöngastia diversa Farrell, Proc. U. S. Nat. Mus., in press.

Diagnosis.—Larva with body moderate, pale yellow in life; dorsal setae beginning 2-12 (14), total approximately 62; sternal setae 2-2, total body setae approximately 162; scutum roughly rectangular with posterolateral setae anterior to sensillary bases, near anterolateral setae, distinct circular ridge anterior to each sensillary base usually not meeting medially, with third circular ridge anterior to anteromedian seta, connecting other 2 circular ridges; sensilla capitate; galeal seta with 1-2 branches; palpal tibia with lateral seta nude or with 1 branch; palpal tarsus with 7 feathered setae; palpal claw trifurcate; leg I with 2 genualae; leg III with 1 tibiala.

Scutal measurements, average and extremes, of 5 larvae from Douglas County: AW- 55 (53-57), PW- 63 (61-65), SB- 18 (17-20), ASB- 35 (32-37), PSB- 10 (10), AP- 18 (17-19), AM- 36 (35-37), AL- 58 (56-60), PL- 55 (53-58), S- 23 (21-25).

Geographic distribution. — Known from southeastern Nebraska (Otoe, Nemaha and Richardson counties, KU), northeastern Kansas (Brown, Nemaha, Jefferson, Douglas, Johnson, Miami, Anderson and Linn counties) and north-central Missouri (Linn County, KU).

Seasonal occurrence and abundance.—Larvae have been taken from hosts in northeastern Kansas between mid-October and July. Only a single larva each was found in October (Oct. 16, 1952), May (May 21, 1952) and July (July 2, 1949) and none was found in June. Larvae were common from mid-November to late April. In general, *E. diversa* appeared slightly later in the fall than *T. lipov-*

skyi, and became more common than the latter on hosts from January to late April.

Hosts.—*Euschöngastia diversa* was taken from three birds, *Parus atricapillus, Passer domesticus* and *Richmondena cardinalis.* A single larva was recovered from each of the birds. Larvae were found on 14 species of mammals, with a single larva from *Sciurus niger* and two each from single *Geomys bursarius, Canis latrans,* and *Blarina brevicauda.* A single *Rattus norvegicus* had 22 larvae attached, two *Microtus pinetorum* had a total of 3 larvae in the ears, whereas the remaining hosts, *Sylvilagus floridanus, Microtus ochrogaster, Mus musculus, Neotoma floridana, Peromyscus maniculatus, P. leucopus, Reithrodontomys megalotis* and *Sigmodon hispidus* had larvae attached on at least four individual hosts.

Larvae were found in the ears of the mammalian hosts, usually attached singly or in clusters behind the tragus and antitragus, but may attach in other sites.

The chiggers were found in the ear wax, in which the engorged larvae seemed to survive.

Habitats.—Many of the hosts of *E. diversa* were taken from areas supporting thick ground cover, and the larvae were most abundant on cottontails and small rodents characteristic of tall grass and thicket habitats. Some of the hosts were taken at the edge of woods and in the woodlands although the hosts usually were in the vicinity of grasses and other ground cover such as brush piles and fallen logs. The single larva from a chigger sampler was recovered on nearly barren ground in a woodland edge habitat, under dogwood and hickory (Station A). A limestone ledge adjacent to the site harbored a wood rat nest.

The larvae probably are acquired by the small mice near their nests and as they move in their runs and burrows. Several larvae have been recovered from a wood rat nest. The larvae recovered from birds and from the sampler indicated that at least some of the unfed larvae are active on the surface of the ground. The free-living stages, by association, should be present in the soil in the immediate vicinity of the runs, burrows and nests of mammalian hosts.

Specimens examined.—Total, 1012 larvae, as follows: ANDERSON CO.: Welda, *Sylvilagus floridanus,* Nov. 29, 1947 (1). BROWN CO.: All taken Nov. 28-30, 1947; 5 mi. S Hiawatha, *Microtus ochrogaster* (28), *Mus musculus* (6), *Peromyscus maniculatus* (2), *Reithrodontomys megalotis* (32), *Sigmodon hispidus* (11); 3 mi. N Hiawatha, *Microtus ochrogaster* (94), *Mus musculus* (3), *Peromyscus* *leucopus* (10) and *Peromyscus maniculatus* (11); 7 mi. N, ½ mi. E Hiawatha, *Microtus ochrogaster* (61), *Peromyscus leucopus* (4), *Rattus norvegicus* (18) and *Reithrodontomys megalotis* (5); 1 mi. N Horton, *Passer domesticus* (1) and *Richmondena cardinalis* (1); 1 mi. E Reserve, *Blarina brevicauda* (2), *Microtus ochrogaster* (32), *Mus musculus* (6) and *Reithrodontomys megalotis* (6); 1 mi. N Reserve, *Mus musculus* (4). DOUGLAS CO.: *Neotoma floridana*, March 30, 1949 (22); 2 mi. W, 1 mi. N Baldwin, *Sylvilagus floridanus*, Dec. 4, 1951 (3); 3 mi. W, 2 mi. S Clinton, *Sylvilagus floridanus*, March 10, 1949 (1); 3 mi. S Eudora, *Sylvilagus floridanus*, Feb. 17, 1949 (2); Lawrence, nest of *Neotoma floridana*, Feb. 22, 1950 (1) -*Reithrodontomys megalotis*, Dec. 16, 1948 (1) and *Sylvilagus floridanus*, Dec. 16, 1948 (2), Dec. 31, 1948 (1); 2 mi. E Lawrence, *Sigmodon hispidus*, Nov. 18, 1948 (4); 3 mi. S, 1 mi. E Lawrence, *Microtus ochrogaster* (12) Feb. 18-April 27 (1947-1950), -*Peromyscus maniculatus* (17) April 6-April 27 (1947-1953) and *Sylvilagus floridanus*, May 7, 1948 (1); 4 mi. S Lawrence, *Sylvilagus floridanus*, Feb. 1, 1949 (3); 3 mi. W Lawrence, *Neotoma floridana*, Nov. 12, 1949 (2) -*Peromyscus maniculatus*, March 2, 1949 (7) -*Sylvilagus floridanus*, Nov. 12, 1949 (1) -*Parus atricapillus*, March 4, 1949 (1) -*Neotoma floridana*, March 5, 1949 (10) -*Microtus ochrogaster*, March 5, 1949 (3); 9 mi. W Lawrence, *Sylvilagus floridanus*, Jan. 2, 1949 (3), Feb. 7, 1949 (1); 11 mi. S, 1 mi. E Lawrence, *Geomys bursarius*, Nov. 4, 1947 (2); 3 mi. N, 2 mi. E Lawrence, *Reithrodontomys megalotis*, Jan. 30, 1952 (3), -*Sciurus niger*, April 15, 1952 (1), -*Sigmodon hispidus*, Jan. 31, 1952 (1), Feb. 1, 1952 (2), -*Sylvilagus floridanus*, April 15, 1952 (1); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Chigger sampler*, Nov. 21, 1951 (1), -*Microtus ochrogaster*, Jan. 9, 1952 (2), April 18, 1952 (10), May 21, 1952 (1), Oct. 16, 1952 (1), Nov. 23, 1951 (2), -*Microtus pinetorum*, Feb. 1, 1952 (3), -*Neotoma floridana*, Feb. 8, 1953 (6), Feb. 18, 1950 (1), March 12, 1949 (6), April 2, 1950 (3), Nov. 23, 1952 (10), Dec. 9, 1948 (1), -*Peromyscus leucopus*, Feb. 8-9, 1948 (8), Feb. 8, 1952 (1), March 28, 1952 (3), April 1, 1949 (14), Nov. 21, 1951 (1), -*Peromyscus maniculatus*, Nov. 23, 1951 (1), -*Reithrodontomys megalotis*, Feb. 1, 1952 (4), April 18, 1952 (2), Nov. 23, 1951 (4), -*Sigmodon hispidus*, Jan. 9, 1952 (3), Feb. 1, 1952 (11), Nov. 23, 1951 (3); 3 mi. S Lone Star Lake, *Sylvilagus floridanus*, April 23, 1949 (9); ½ mi. N Pleasant Grove, *Reithrodontomys megalotis*, March 31, 1952 (7); 2 mi. S, 2 mi. W Pleasant Grove, *Neotoma floridana*, March 4-5, 1949 (9)

-*Reithrodontomys megalotis,* Dec. 29, 1948 (1) -*Sylvilagus floridanus,* Jan. 29, 1949 (5), March 3, 1949 (10), March 19, 1949 (3), April 21, 1949 (3), April 26, 1949 (4), Dec. 29, 1948 (4); 2 mi. N Stull, *Sylvilagus floridanus,* March 13, 1949 (2); 4 mi. SW Stull, *Sylvilagus floridanus,* Jan. 9, 1949 (6); 2 mi. S Worden, *Sylvilagus floridanus,* Nov. 26, 1949 (1); DOUGLAS-SHAWNEE CO. line: *Canis latrans,* Jan. 11, 1948 (2). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Microtus ochrogaster,* Feb. 20, 1952 (8), -*Peromyscus leucopus,* Feb. 19-20, 1952 (5), -*Sylvilagus floridanus,* March 15, 1952 (1); Perry, *Sylvilagus floridanus,* March 22, 1949 (3); 7 mi. E, 3½ mi. N Valley Falls, *Sylvilagus floridanus,* Nov. 30, 1947 (1). JOHNSON CO.: *Sylvilagus floridanus,* Feb. 17, 1947 (2); 3 mi. W Aubury, *Sylvilagus floridanus,* Dec. 1, 1953 (2); 2 mi. N, 1 mi. W Lenexa, *Sylvilagus floridanus* (35), Nov. 18-April 13 (1953-1954) -*Microtus ochrogaster* (1) and *Peromyscus maniculatus* (10), April 2, 1954 and *Peromyscus leucopus,* April 2, 1954 (8), April 13, 1954 (10). LEAVENWORTH CO.: 8 mi. E Tonganoxie, *Sylvilagus floridanus,* Dec. 28, 1948 (1); 3½ mi. E, 3½ mi. N Lawrence, *Neotoma floridana,* July 2, 1949 (1). LINN CO.: 3 mi. E Pleasanton, *Sylvilagus floridanus,* Dec. 10, 1953 (1). MIAMI CO.: 2 mi. W, 1 mi. S Louisburg, *Sylvilagus floridanus,* Nov. 24, 1953 (5); 4 mi. N, 1 mi. E Paola, *Sylvilagus floridanus,* Dec. 14, 1953 (1). NEMAHA CO.: 2½ mi. S Sabetha, Nov. 30, 1947, *Microtus ochrogaster* (5), *Peromyscus maniculatus* (50), and *Reithrodontomys megalotis* (47). SHAWNEE CO.: 4 mi. W Richland, *Neotoma floridana,* Feb. 20, 1948 (53).

Euschöngastia criceticola Brennan

(Map 24)

Euschöngastia criceticola Brennan, Jour. Parasit., vol. 34, Jan. 17, 1949, p. 473, figs. 6 and 13, type from Ravalli County, Montana, host *Peromyscus maniculatus,* Febr. 6, 1946; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 75; Brown and Brennan, Canadian Jour. Zool., vol. 30, Dec., 1952, p. 341; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, p. 164.

Diagnosis.—Larva with body yellow in life; dorsal setae beginning 2-14, total approximately 76; sternal setae 2-2; total body setae approximately 160; scutum with strong ridges anterior to each deeply recessed sensillary base; sensilla clavate; galeal seta branched; palpal tibia with lateral seta nude or with 1 branch; palpal tarsus with 7 feathered setae; palpal claw trifurcate; leg I with 2 genualae; leg III without tibiala.

Scutal measurements, average and extremes, of 5 larvae from Barber County: AW- 65 (60-69), PW- 86 (80-92), SB- 30 (28-31), ASB- 19 (16-20), PSB- 13 (12-13), AP- 19 (18-20), AM- 37 (35-40), AL- 32 (30-35), PL- 49 (47-50), S- 31 (29-32).

Geographic distribution.—Known from Alberta, Canada (Brown and Brennan, 1952), central California (Monterey County, Brennan and Jones, 1954), eastern Idaho (Elmore County, Brennan, 1949), western Montana (Beaverhead and Ravalli counties, Brennan, 1949), southeast through Wyoming and Colorado to western and central Kansas (Cheyenne, Norton, Barber and Russell counties).

Seasonal occurrence.—Larvae have been found on hosts in Kansas in late July, September, October, November and April. One larva was recovered in July and another in September. They were common in late October, November and April.

Hosts.—The deer mouse, *Peromyscus maniculatus,* frequently had *E. cricetícola* attached to the ears. This mouse was the type host and in Kansas it was a host of *E. cricetícola* in all four counties listed above. Two of three *P. maniculatus* from Cheyenne County in November had 8 larvae and three deer mice from Russell County had 10 larvae.

In Barber County *E. cricetícola* was found on four hosts. One engorged larva, probably a straggler, was found on *Cynomys ludovicianus* in July. *Neotoma micropus,* all taken from the same canyons had the following numbers of larvae: one unengorged larva in September from 13 individuals; 10 larvae on 14 rats in early October and 500 larvae from 19 wood rats in April. *P. maniculatus,* examined in April, had approximately 13 larvae and *P. leucopus,* examined in April, also possessed *E. cricetícola.*

The majority of the larvae were found attached to the outer ear, especially on the antitragus and along the helix.

Habitats.—Larvae of *E. cricetícola* were found on mammals in grasslands or canyons dissecting the Great Plains. The probable habitat niche for the free-living stages is in the soil surrounding the burrows and nests of mammals. In Russell County deer mice possessing larvae were found nesting under large flat limestone rocks. The host deer mice from Cheyenne County were trapped in a meadow situated in the valley of the Arikaree River. In Barber County the mice and wood rats were from canyons cut through sandstone and gypsum.

Specimens examined.—Total, 330 larvae, as follows. BARBER Co.: 4 mi. S Aetna, *Neotoma micropus,* April 11-14, 1949 (267), Sept.

15, 1953 (1), Oct. 6-7, 1951 (4), and *Peromyscus leucopus,* April 13, 1949 (15); 4½ mi. S, 1 mi. W Aetna, *Cynomys ludovicianus,* July 27, 1952 (1); 5 mi. S Sun City, *Peromyscus maniculatus,* April 12, 1949 (14), and *Neotoma micropus,* April 12, 1949 (9). CHEYENNE CO.: 15 mi. N, 11½ mi. W St. Francis, *Peromyscus maniculatus,* Nov. 1, 1952 (8). NORTON CO.: 3 mi. W, 1 mi. S Logan, *Peromyscus maniculatus,* Oct. 26, 1946 (1). RUSSELL CO.: 2 mi. N, 2 mi. E Gorham, *Peromyscus maniculatus,* April 27, 1952 (10).

Euschöngastia cynomyicola Crossley and Lipovsky

(Map 21)

Euschöngastia cynomyicola Crossley and Lipovsky, Proc. Ent. Soc. Washington, vol. 56, Oct., 1954, pp. 240-243, figs. 1-5, type from 4 miles east of Stratton, Hitchcock County, Nebraska, host *Cynomys ludovicianus,* Aug. 8, 1949.

Diagnosis.—Larva with dorsal setae beginning 2-16, total 50; sternal setae 2-6; total body setae 100; scutum roughly rectangular, with ridges anterior to sensillary bases; sensilla obovoid; galeal seta with 4-5 branches; palpal tibia with lateral seta nude or with 1 branch; palpal tarsus with 7 feathered setae; palpal claw trifurcate; leg I with 2 genualae; leg III with 1 tibiala.

Scutal measurements (after Crossley and Lipovsky, 1954), average and extremes, of 10 larvae from Rawlins County and Hitchcock County, Nebraska: AW- 62 (56-69), PW- 81 (76-89), SB- 33 (30-35), ASB- 22 (19-25), PSB- 14 (13-15), AP- 19 (18-21), AM- 31 (29-32), AL- 29 (26-32), PL- 60 (55-67), S- 33 (28-35).

Geographic distribution.—(Crossley and Lipovsky, 1954): Known from southwestern Nebraska (Hitchcock County) and northwestern Kansas (Rawlins County).

Seasonal occurrence.—Larvae were taken from hosts in late July and early August.

Hosts.—The principal host seems to be the prairie dog, *Cynomys ludovicianus,* while other known hosts include *Spermophilus tridecemlineatus,* taken in a prairie dog town, and *Perognathus hispidus* (a single larva recovered), a typical plains inhabitant.

The known site of attachment is the abdominal region. The larvae probably utilize the inner thighs and genital region as well.

Habitat.—*Euschöngastia cynomyicola* was found on mammals obtained in short grass communities of the high plains. All of the known stations were situated in or near prairie dog towns. These towns are characterized by having the grasses and vegetation cropped close to the ground and by the numerous occupied and abandoned prairie dog burrows. It seems that the surface of the ground and the several inches of top soil are unsuitable for chigger mites in any stages, and that the free-living larvae and other stages, probably inhabit the burrows. The underground nests of the prairie dog probably harbor this and other chigger mite species.

Specimens examined.—Total, 10 larvae, as follows: RAWLINS CO.: 13 mi. N McDonald, *Perognathus hispidus,* July 28, 1948 (1); 13 mi. N, 6 mi. E McDonald, Aug. 7-8, 1949, *Spermophilus tridecemlineatus,* (1) and *Cynomys ludovicianus,* (7); 11 mi. S, 1 mi. E McDonald, *Cynomys ludovicianus,* July 27, 1948 (1).

Euschöngastia trigenuala Farrell

(Figs. 12, 40-41, Map 25)

Euschöngastia trigenuala Farrell, Proc. U. S. Nat. Mus., in press.

Diagnosis.—Larva with body moderate, whitish in life; dorsal setae beginning 2-10 to 14, total 60; total body setae 130; scutum roughly rectangular (trapezoidal) with circular ridges anterior to sensillary bases, without pronounced sinuous margins; sensilla elongate clavate, with few long slender setules; galeal seta nude; palpal genu with seta nude or with 1 branch; palpal tibia with lateral seta nude or with 1 branch; palpal tarsus with 7 feathered setae; palpal claw with 5 prongs; leg I with 3 genualae; leg III with 1 tibiala.

Scutal measurements, average and extremes, of 5 larvae from Jefferson County: AW- 56 (52-58), PW- 74 (72-79), SB- 27 (26-28), ASB- 26 (25-29), PSB- 17 (15-18), AP- 18 (17-20), AM- 32 (30-34), AL- 26 (23-27), PL- 37 (36-39), S- 43 (43).

Geographic distribution.—Known from Kansas (Wallace, Barber, Russell, Lyon, Douglas, Brown, Jefferson and Johnson counties), southeastern Nebraska (Nemaha County, KU) and central Oklahoma (Cleveland County, KU).

Seasonal occurrence and abundance.—Larvae were taken from hosts in Kansas throughout the year, although they were most common in November, April and May. A single larva was recovered in the months of June, July, August and September, whereas no larvae were recovered in October, December, January and March. Larvae were taken in October in Nebraska and in December in Oklahoma. In general, the larvae seem to be most common in early winter and spring.

Hosts.—Larvae of this species were taken four times on the mole, *Scalopus aquaticus.* In May, two had 16 and 20 larvae, whereas in November, two had 14 and more than 40 attached. Most of the moles that were negative were taken from yards in Lawrence. This species also was taken on another fossorial mammal, the pocket gopher, *Geomys bursarius.* Nine individuals of 4 lots of meadow mice, *Microtus ochrogaster,* were hosts with one individual having 29 larvae attached. Other hosts include *Blarina brevicauda,* one larva; *Peromyscus maniculatus,* with several having larvae attached; one *Perognathus hispidus,* with more than 45 larvae; and single records each from *Sigmodon hispidus* and *Onychomys leucogaster.* A single larva, listed below from a fox squirrel, is possibly in error (See tables on total mammals examined).

The usual site of attachment for *E. trigenuala* was the genitalia, base of the tail, and around the anus. They were not found attached in the ears or on the head.

Habitats.—This chigger mite was found on mammals taken in good stands of grasses and other ground cover, and several of the mammals are fossorial. The great majority of hosts dwell in runs and burrows, and frequently use the deserted tunnels of other fossorial animals. The deer mice from Russell County were found in nests under limestone slabs in upland mixed-grass situations. The prairie voles from Johnson County were trapped in patches of big blue stem surrounded by other shorter grasses.

The free-living stages probably live in the soil surrounding these subterranean runs, near the sites where the engorged larvae drop from the hosts.

Specimens examined.—Total, 103 larvae, as follows: BARBER CO.: 3 mi. N, 1 mi. E Sharon, April 21, 1952, *Peromyscus maniculatus* (1), and *Sigmodon hispidus* (1). BROWN CO.: 3 mi. N Hiawatha, *Microtus ochrogaster,* Nov. 28, 1947 (1). DOUGLAS CO.: Lawrence, *Scalopus aquaticus,* Nov. 11, 1947 (20), Nov. 22, 1947 (8) and *Blarina brevicauda,* June 8, 1947 (1); 1 mi. W Lawrence, *Peromyscus maniculatus,* Aug. 13, 1951 (1); 3 mi. S, 1 mi. E Lawrence, *Microtus ochrogaster,* April 27, 1950 (4); 3 mi. N Lawrence, *Geomys bursarius,* Sept. 1, 1948 (1); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Scalopus aquaticus,* May 7, 1947 (15); 5 mi. NW Lawrence, *Scalopus aquaticus,* May 10, 1947 (15). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Microtus ochrogaster,* Feb. 20, 1952 (7); 12 mi. N Lawrence, *Sciurus niger,* Sept. 1, 1948 (1) (doubtful record). JOHNSON CO.: 2 mi. N, 1 mi. W Lenexa, *Microtus ochrogaster,* April 2, 1952 (3). LYON CO.: 2 mi. S Chalk, *Perognathus hispidus,* May 31, 1950 (20). RUSSELL CO.: 9 mi. S

Russell, *Peromyscus maniculatus,* April 26, 1952 (3). WALLACE Co.: 3 mi. W Sharon Springs, *Onychomys leucogaster,* July 4, 1949 (1).

Euschöngastia lacerta Brennan

(Map 25)

Euschöngastia lacerta Brennan, Jour. Parasit., vol. 34, Jan. 17, 1949, p. 468, figs. 2, 9, type from Camp McQuaide, Santa Cruz County, California, host *Sceloporus occidentalis,* August 15, 1945; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952 p. 78; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, pp. 167-168.

Diagnosis.—Larva with body (engorged) moderate in size, white in life; dorsal setae beginning 2-6-6, total body setae 86; scutum roughly rectangular; without puncta and prominent ridges; sensilla clavate; galeal seta branched; palpal tibia with lateral seta nude or with single branch; palpal tarsus with 4 branched setae and tarsala; palpal claw trifurcate; leg I with 1 genuala (subterminala and parasubterminala absent); leg II without genuala; leg III with 1 tibiala (without genuala). Not closely related to *Euschöngastia, sensu stricto,* nor to other described species of this genus from America, but possibly most closely related to *Trombicula* (*Euschöngastoides*) *hoplai* Loomis differing from it principally in having the sensilla expanded (flagelliform, but plumose in *T. hoplai*).

Scutal measurements, average and extremes, of 5 larvae from Barber County: AW- 51 (47-54), PW- 69 (65-71), SB- 23 (20-25), ASB- 17 (16-20), PSB- 15 (14-16), AP- 23 (22-24), AM- 28 (27-29), AL- 20 (19-21), PL- 37 (35-38), S- 33 (29-35).

Geographic distribution.—Known from central California (Santa Cruz County, Brennan, 1948; and Monterey County, Brennan and Jones, 1954), western Colorado (Dolores, Gunnison, and LaPlata counties, KU) and south-central Kansas (Barber County).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas in the summer months of July, August and September. Larvae from California and Colorado were taken from hosts in July and August.

Ecology.—In Barber County, Kansas, larvae were found on *Neotoma micropus* in July and August, but were absent from these wood rats at the same locality in April, September and October. Larvae were taken in September from *Sylvilagus floridanus* from the same canyon area from which the other *E. lacerta* were obtained.

The larvae were taken only on mammals in Kansas, although numerous reptiles and birds were examined from Barber County in July, August and September (See Tables for a list of vertebrates examined for chiggers from Barber County). Larvae have been taken from *Sceloporus occidentalis, Perognathus californicus, Spermophilus beecheyi, Neotoma fuscipes, Peromyscus boylii* and *Sylvilagus audubonii* in California, *Cynomys ludovicianus, Neotoma micropus* and *Sylvilagus floridanus* in Kansas and *Neotoma albigula, N. cinerea* and *N. mexicana* in Colorado. The species was never found in abundance on any host. The usual site of attachment seems to be in the ears.

The presence of larvae on five species of wood rat suggests the possibility of a nest habitat for the active unfed larvae and the soil for the free-living stages.

Specimens examined.—Total, 21 larvae, as follows: BARBER CO.: 4 mi. S Aetna, *Neotoma micropus,* July 25, 1952 (3), Aug. 22, 1949 (6) and *Sylvilagus floridanus,* Sept. 14, 1953 (11); 3½ mi. W Hardtner, *Cynomys ludovicianus,* Aug. 23, 1949 (1).

Euschöngastia loomisi Crossley and Lipovsky

(Map 23)

Euschöngastia loomisi Crossley and Lipovsky, Proc. Ent. Soc. Washington, vol. 56, Oct. 1954, pp. 243-246, figs. 6-11, type from 10½ miles west of Hardtner, Barber County, Kansas, host *Sylvilagus floridanus,* July 26, 1952.

Diagnosis. — Larva with body (engorged) moderate in size, whitish to pale yellow in life; dorsal setae beginning 4-12, total 58; total body setae 110; scutum roughly rectangular, with small ridges anterior to the sensillary bases, sensillary bases close together (11-15μ); sensilla subcapitate; galeal seta nude; palpal tibia with lateral seta nude; palpal tarsus with 4 feathered setae; palpal claw trifurcate; leg I with 3 genualae; leg III with 1 tibiala.

Scutal measurements (after Crossley and Lipovsky, 1954), averages and extremes of 10 paratypes: AW- 44 (42-46), PW- 63 (59-65), SB- 13 (11-15), ASB- 22 (20-25), PSB- 11 (9-13), AP- 19 (16-20), AM- 27 (25-32), AL- 27 (25-32), PL- 35 (28-39), S- 24 (21-26).

Geographic distribution.—(Crossley and Lipovsky, 1954): Known from central and southern Texas (Archer and Zavala counties), north-central Oklahoma (Woods County) and south-central Kansas (Barber County) and northern Mexico (Coahuila, KU).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas between July 26 and October 7. Larvae were common in July, August and September in Barber County.

Hosts.—In Kansas this chigger mite has been taken in Barber County only in summer and autumn on mammalian hosts. Larvae were recovered from six of seven cottontails examined, with an average of 10 larvae per host. A single larva was present on one of three *Cynomys ludovicianus*, 14 larvae were obtained from 2 *Dipodomys ordii* and 178 larvae were taken from one *Perognathus flavus*. *Euschöngastia loomisi* was common on mammals trapped in the canyons. A single *Peromyscus maniculatus* had 12 larvae attached, and 77 larvae were recovered from 20 *Peromyscus leucopus*. *Neotoma micropus* was commonly parasitized and approximately 300 larvae were recovered from 64 rats.

Although birds and reptiles were examined from the known stations for *E. loomisi*, they were negative (See Tables under vertebrates).

The principal site of attachment was in the ears, although occasionally they were attached to the bodies and legs, the latter occurrences probably were due to the large size of the host or the poor shelter in the ears of *Cynomys*.

Habitats.—This chigger was common on mammals obtained from the grasslands and also from the canyons. The free-living stages probably occur in the soil of the burrows and surrounding the nests of mammals, with the larvae reaching the hosts as they move about in the nest and burrows. The severe heat and aridity on the surface of the soil in the area would probably eliminate the larvae from exposed areas.

Specimens examined.—Total, 121 larvae, as follows: BARBER CO.: 3 mi. S Aetna, *Neotoma micropus*, July 25, 1952 (1); 4 mi. S Aetna, *Neotoma micropus*, Aug. 22, 1949 (2), Sept. 15-16, 1953 (7), Oct. 6, 1951 (3) -*Peromyscus leucopus*, July 25-26, 1952 (13), Aug. 23, 1949 (5), Sept. 15, 1953 (7), -*Peromyscus maniculatus*, Oct. 7, 1951 (9) -*Perognathus flavus*, July 26, 1952 (9) -*Sylvilagus floridanus*, Sept. 14, 1953 (16); 5 mi. S, 3 mi. E Aetna, *Neotoma micropus*, July 25, 1952 (16); 5 mi. S, 4 mi. E Aetna, *Dipodomys ordii*, Aug. 22, 1949 (14); 4½ mi. S, 1 mi. W Aetna, *Cynomys ludovicianus*, July 27, 1952 (1); 5 mi. S Sun City, *Sylvilagus floridanus*, Sept. 12, 1948 (5); 10½ mi. W Hardtner, *Sylvilagus floridanus*, July 26, 1952 (13).

GENUS PSEUDOSCHÖNGASTIA Lipovsky

Pseudoschöngastia Lipovsky, Jour. Kansas Ent. Soc., vol. 24; July 23, 1951, p. 95, type *Pseudoschöngastia hungerfordi* Lipovsky.

Diagnosis.—Larvae with scutum small, broadly rounded on posterior margin, with 3 anterior setae, posterolateral setae off plate; sensillary bases close together; sensillae expanded, clavate to capitate; cheliceral blade with terminal tricuspid cap and ventrolateral tooth; palpal claw trifurcate, with large middle axial prong and 2 small lateral prongs; legs II and III with femora partially or completely fused, with sutures occasionally visible.

The species in Kansas with body (engorged) small, elongate, whitish in life; body setae numerous (130-140); sternal setae 2-2; sensillae capitate; galeal seta nude; palpal femur with seta feathered; palpal tibia with lateral seta nude; palpal tarsus with 5 feathered setae and tarsala; leg I with subterminala and parasubterminala; leg II with 6 branched setae on femur, 1 genuala, and pretarsala; leg III with coxa having 1 branched seta, 5 branched setae on femur, 1 genuala, and 1 tibiala (no long nude whiplike setae).

Remarks.—Two species are known from Kansas, while three additional species are known from North and Central America. Additional species, now considered *Ascoschöngastia,* from Mexico and the Old World almost certainly belong to this genus. The species in Kansas occur deep in mammalian ears, and their small, elongate, whitish bodies, the usual site of attachment and the occurrence in warm weather, make the generic determination of the living larvae relatively simple.

Audy (1954:135) transferred this genus to the subfamily Trombiculinae and his arrangement is adopted here. It is supported by the number of setae on the fused femoral segments. The number of branched setae on the segments of legs II and III are 6 and 5 respectively, which equals the total existing on the two comparable divided femoral segments in Trombiculinae. The Walchiinae have reduced numbers of setae on these leg segments.

KEY TO SPECIES OF PSEUDOSCHÖNGASTIA IN KANSAS

1. Scutum with anterolateral seta longer than anteromedian seta, 3 genualae I . . . . *P. hungerfordi* p. 1348

1′ Scutum with anterolateral seta shorter than or equal to anteromedian seta, 2 genualae I . . . . *P. farneri* p. 1351

Pseudoschöngastia hungerfordi Lipovsky

(Figs. 12 and 42, Map 26)

Pseudoschöngastia hungerfordi Lipovsky, Jour. Kansas Ent. Soc., vol. 24, July 23, 1951, pp. 95-99, pls. 1 and 2, type from 2 miles south and 4 miles west of Baldwin, Douglas County, Kansas, host *Sylvilagus floridanus,* July 14, 1949; Brennan, Proc. Ent. Soc. Washington, vol. 54, June 27, 1952, pp. 133, 137; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 95.

Diagnosis.—Larva similar to *P. farneri* but differs in having eyes 2/2, red in life; scutum with anterolateral setae long, much longer than anteromedian seta; palpal genu with seta branched; palpal tibia with dorsal seta nude and ventral seta branched; leg I with 3 genualae; legs short, but not as short as in *P. farneri.*

Scutal measurements (modified from Lipovsky, 1951), average and extremes, of 20 topotypes: AW- 41 (36-44), PW- 71 (61-82), SB- 16 (9-23), ASB- 21 (18-24), PSB- 13 (11-16), AP- 30 (23-40), AM- 21 (18-22), AL- 38 (34-44), PL- 25 (23-28), S- 23 (23).

Geographic distribution.—Known from eastern Texas (Archer, Bexar and Smith counties, KU; Williamson County, Lipovsky, 1951), northern Oklahoma (Delaware and Woods counties, KU), southwestern Missouri (Lawrence County, Lipovsky, 1951), and Kansas (Rawlins, Wallace, Barber, Greenwood, Shawnee, Jefferson, Johnson and Douglas counties).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from late June (June 21, 1949) to November (Nov. 18, 1953). Larvae were abundant in July, August and September, occasional in late October and a single larva was recovered in November.

Hosts.—The principal host for *P. hungerfordi* in Kansas seems to be the cottontail, *Sylvilagus floridanus.* In northeastern Kansas, 15 of 32 cottontails examined between June 21 and October 1 had larvae attached in the ears. A young cottontail had 300 larvae attached (July 14, 1949) and a second cottontail from the same date had 145 larvae, while a third, taken on August 31, 1952, possessed 160 *P. hungerfordi.* These 15 positive cottontails average 47 larvae. Of this group, 3 (listed above) had more than 144 larvae, average 202, while the remaining individuals had less than 31 larvae, average 9, and on two hosts only a single larva was recovered. In Barber County, 4 of 7 cottontails had a total of 68 larvae.

Two jackrabbits, *Lepus californicus,* from Barber County in mid-September had 175 and 25 larvae, respectively.

Eleven additional hosts have been recorded from Kansas. Six of these hosts have had larvae of both *P. hungerfordi* and *P. farneri* attached. The following four hosts had specimens possessing both species of larvae: *Neotoma micropus, N. floridana, Peromyscus maniculatus* and *P. leucopus.* Other hosts which had larvae present on several occasions are *Dipodomys ordii, Perognathus hispidus* and *Sigmodon hispidus,* while additional hosts include *Reithrodontomys megalotis, Perognathus flavus, Microtus ochrogaster, Mus musculus* and *Onychomys leucogaster.* Hosts from other states include *Reithrodontomys fulvescens* (Missouri) and *Sylvilagus audubonii* (Texas).

Neither *Pseudoschöngastia hungerfordi* nor *P. farneri* were recovered from squirrels or prairie dogs. Their seeming absence from sciurids may be due to the diurnal activity and habitats of the hosts, although the small ears of these squirrels may not provide a suitable habitat for the larvae.

Larvae frequently were found either singly or in compact clusters, attached to the skin of the external acoustic meatus. Larvae were found attached also in other areas within the external ear. Their selection of sites deep within the ears seems to indicate that the larvae require a moist sheltered habitat. Several detached larvae were found congregated around the moist eyes of a dead mouse showing their affinity for moisture. Observations on the mites in the laboratory indicates their susceptability to desiccation.

Habitats.—In northeastern Kansas, hosts of *P. hungerfordi* were taken along the edge of deciduous woodlands and from thickets and tall grasses and weeds. In western and central Kansas, larvae were taken from hosts found in canyons supporting tall grasses, thickets and some trees, as well as from mammals taken from upland prairies. The free-living stages probably occur in the immediate vicinity of burrows and nests of mammalian hosts. Several young cottontails had large numbers of larvae, indicating their close association with nests and burrows of cottontails.

Nymphs and adults of *P. hungerfordi* and *P. farneri* probably compete for food and living space where they occur together. Nymphs of both species fed on dead and maimed collembola, not eggs, in the laboratory, indicating a similarity of food habits. *P. hungerfordi* seems to be most common in more moist situations, in the presence of dense ground cover. It is much more common in the moist eastern third of the state than is *P. farneri* which usually occurs there in the drier uplands.

Specimens examined.—Total, 341 larvae, as follows: Barber Co.: 2 mi. E Aetna, *Lepus californicus* Sept. 14, 1953 (6); 4 mi. S Aetna, *Neotoma micropus,* July 25-26, 1952 (41), Aug. 22, 1949 (22), Sept. 15-16, 1953 (28), Oct. 6-7, 1951 (22) -*Peromyscus leucopus,* July 25-26, 1952 (9) -*Perognathus flavus,* July 26, 1952 (5), *Sylvilagus floridanus,* Sept. 14, 1953 (28); 5 mi. S, 3 mi. E Aetna, *Neotoma micropus,* July 25, 1952 (14); 5 mi. S, 4 mi. E Aetna, *Dipodomys ordii,* Aug. 22, 1949 (11); 5 mi. S Sun City, *Neotoma micropus,* Sept. 14, 1948 (6); 10½ mi. W Hardtner, *Sylvilagus floridanus,* July 26, 1952 (1); and *Lepus californicus,* Sept. 14, 1953 (7); 3 mi. N, 1 mi. E Sharon, July 26, 1952, *Dipodomys ordii* (2), -*Perognathus* *hispidus* (2), -*Peromyscus maniculatus* (8). DOUGLAS CO.: 2 mi. S, 4 mi. W Baldwin, *Sylvilagus floridanus*, July 14, 1949 (103); 3 mi. S Baldwin, *Sylvilagus floridanus*, July 16, 1949 (1); 5 mi. S Clinton, *Sylvilagus floridanus*, July 10, 1949 (1); 2 mi. S, 2 mi. W Pleasant Grove, *Sylvilagus floridanus*, Aug. 4, 1951 (5); Lawrence, *Sylvilagus floridanus*, June 21, 1949 (1), and *Sigmodon hispidus*, Aug. 27, 1947 (25); 2 mi. S, ½ mi. E Lawrence, *Sigmodon hispidus*, Oct. 25, 1947 (1); 2-7 mi. SE Lawrence, *Sylvilagus floridanus*, July 14, 1948 (1); 4 mi. S Lawrence, *Sylvilagus floridanus*, Aug. 6, 1951 (2); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Microtus ochrogaster*, Oct. 20, 1951 (2), -*Mus musculus*, Oct. 20, 1951 (1) -*Neotoma floridana*, Aug. 16-20, 1952 (18) -*Peromyscus leucopus*, July 26, 1951 (1), Aug. 19, 1947 (2), -*Reithrodontomys megalotis*, Aug. 6, 1951 (2) -*Sigmodon hispidus*, Aug. 17, 1947 (1). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Peromyscus leucopus*, July 7, 1953 (1). GREENWOOD CO.: 1½ mi. E Hamilton, *Neotoma floridana*, Aug. 14, 1949 (23). JOHNSON CO.: 2 mi. W, 1½ mi. N Lenexa, *Sylvilagus floridanus*, Nov. 18, 1953 (1). RAWLINS CO.: 9 mi. W, 1½ mi. S Atwood, Aug. 10, 1949, *Peromyscus maniculatus* (2) and *Reithrodontomys megalotis* (1); 9 mi. S, 1 mi. E Beardsley, *Peromyscus maniculatus*, Aug. 9, 1949 (1). SHAWNEE CO.: 3 mi. W Topeka, *Sylvilagus floridanus*, Aug. 26, 1948 (5). WALLACE CO.: 3 mi. S Wallace, *Peromyscus maniculatus*, July 4, 1949 (10); 3 mi. W Sharon Springs, *Onychomys leucogaster* July 4, 1949 (8).

Pseudoschöngastia farneri Lipovsky

(Figs. 12 and 43, Map 27)

Pseudoschöngastia farneri Lipovsky, Jour. Kansas Ent. Soc., vol. 24, July 23, 1951, pp. 101-102, pl. 3, type from 5 miles north and 1 mile east of Lawrence, Douglas County, Kansas, host *Cryptotis parva*, Aug. 19, 1947; Brennan, Proc. Ent. Soc. Washington, vol. 54, June 21, 1952, pp. 133, 137; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 95.

Diagnosis.—Larva similar to *P. hungerfordi*, but differs in having eyes 2/2, pink to colorless in life; scutum with anterolateral setae short, shorter than or equal to anteromedian seta; palpal genu with seta nude; palpal tibia with dorsal seta branched; leg I with 2 genualae; leg segments compressed and legs II and III especially short.

Scutal measurements (modified from Lipovsky, 1951), average and extremes, of 20 topotypes: AW- 41 (39-44), PW- 56 (44-73), SB- 14 (11-18), ASB- 20 (16-22), PSB- 16 (14-20), AP- 28 (24-35), AM- 19 (16-23), AL- 18 (16-20), PL- 26 (23-28), S- 28 (16-31, in 9 larvae).

Geographic distribution.—Known from north-central Colorado (Boulder County, Lipovsky, 1951), south-central Oklahoma (Comanche County, KU), central and eastern Kansas (Russell, Chase, Lyon, Morris, Barber and Douglas counties).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from early April to early October. Larvae were common in April and May in central Kansas and were nearly as abundant as *P. hungerfordi* between July and early October in Barber County.

Hosts.—*Pseudoschöngastia farneri* has been recovered from the ears of seven species of mammalian hosts. Six of these species have also harbored *P. hungerfordi* and several times both species of chigger have been found together on the same individual or series of individuals of four mammalian species. Larvae were more prevalent on *Peromyscus maniculatus* than on other hosts examined, and the larvae occurred in greatest numbers in April and May. A single *P. maniculatus* from Russell County taken on April 26, 1952, had 110 larvae in the ears, while a second deer mouse, from Chase County, obtained on May 31, 1950, possessed 38 larvae. Most of the other hosts had only a few larvae on each individual. The type host, *Cryptotis parva,* 2 of which possessed 7 and 16 larvae, is the only host of *P. farneri* from which *P. hungerfordi* has not been recovered. The other hosts with several larval recoveries are *Neotoma micropus* and *Peromyscus leucopus.* See the tables on mammals for the abundance of larvae on the hosts.

The larvae were found principally in the external acoustic meatus, attached singly or in clusters. They were not recovered from outside of the ears. The larvae seem to need this sheltered microhabitat.

It seems significant that *P. farneri* has not been taken from rabbits (*Sylvilagus floridanus* or *Lepus californicus*) taken along with mice having *P. farneri.* The sampling of *Lepus* was not adequate to demonstrate complete absence of *P. farneri,* but *P. hungerfordi* was present several times. Larvae of *P. farneri,* which have short legs II and III, may not be successful in reaching the ears of the larger rabbits. Also free-living stages may not be able to compete successfully with *P. hungerfordi* in microhabitats associated with rabbits and their shelters.

Habitat.—Hosts of *P. farneri* usually were found in grasslands, and in Douglas County the hosts were from upland prairies. The hosts from Chase, Lyon, Morris and Russell counties were taken from nests and burrows under large flat limestone slabs, situated on slopes, supporting grasses which were generally grazed close to the ground.

The free-living stages of *P. farneri* probably occur in the soil surrounding the burrows and nests of the small mammal hosts. The large limestone slabs would afford shelter for the chiggers, especially in the cooler periods, when the mice are also present. The nymphs and adults probably retreat deeper in the soil and surrounding sod. The larvae would not travel far from the site of hatching, since they move slowly with their short legs. The larvae have paired eyes with the posterior ones small and indistinct and the red pigment usually present beneath them is reduced or absent. This seemingly indicates poor light perception or none at all,* and suggests a subsurface habitat for the free-living unfed larvae.

In general the larvae were found principally in the grasslands, where the grass was moderately short. They seem to be absent from areas supporting thick cover, such as tall grasses and weeds, the woodland edge and the woodlands. The seeming absence from the areas supporting good ground cover may partly explain the absence of *P. farneri* from cottontails, common inhabitants of the thicker cover and woodland edge.

Specimens examined.—Total, 139 larvae, as follows: BARBER CO.: 2 mi. E Aetna, *Dipodomys ordii,* Sept. 14, 1953 (1); 4 mi. S Aetna, *Neotoma micropus,* April 11, 1949 (2), July 25-26, 1952 (16), Aug. 22, 1949 (21), Sept. 15-16, 1953 (18), Oct. 6-7, 1951 (9) -*Peromyscus maniculatus,* Oct. 7, 1951 (1), -*Peromyscus leucopus,* April 13, 1949 (2), July 25-26, 1952 (10), Sept. 15, 1953 (8), Oct. 7, 1951 (1); 5 mi. S, 3 mi. E Aetna, *Neotoma micropus,* July 25, 1952 (2); 5 mi. S Sun City, *Peromyscus maniculatus,* April 12, 1949 (2). CHASE CO.: 5 mi. NW Staffordville, *Peromyscus maniculatus,* May 31, 1950 (3); 6 mi. N Strong City, *Peromyscus maniculatus,* May 31, 1950 (2). DOUGLAS CO.: 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reserv., *Cryptotis parva,* Aug. 19, 1947 (24) -*Neotoma floridana,* Aug. 16, 1952 (2), -*Sigmodon hispidus,* June 19, 1951 (1). LYON CO.: 2 mi. S Chalk, *Perognathus hispidus,* May 31, 1950 (3). MORRIS CO.: 2 mi. S Council Grove, *Peromyscus maniculatus,* May 31, 1950 (2). RUSSELL CO.: April 26-27, 1952, *Peromyscus maniculatus,* 2 mi. N, 2 mi. E Gorham (2); 6 mi. S Gorham (3); 7½ mi. S, 2 mi. E Russell (3); and 9 mi. S Russell (4).

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* See discussion under eyes pp. 1416-1417.

GENUS NEOSCHÖNGASTIA Ewing

Neoschöngastia Ewing, Manual of External Parasites, Springfield, Ill., Thomas, June, 1929, p. 187, type *Schöngastia americana* Hirst.

Diagnosis.—Larvae with scutum partly submerged beneath cuticular striae, with five scutal setae; sensillae expanded; cheliceral blade with terminal tricuspid cap; empodium clawlike.

The two species in Kansas with body (engorged) large, with "shoulders," yellow to orange in life; body setae total 58; eyes 2/2, red in life; scutum roughly square; sensilla subcapitate; galeal seta with 1 to several branches; palpal femur, genu and tibia with feathered setae; palpal tarsus with 6 feathered setae, tarsala and subterminala; palpal claw trifurcate; leg I with 2 or 3 genualae, subterminala and parasubterminala; leg II with 1 genuala; leg III with coxa having 3 branched setae, 1 genuala and 1 tibiala (no long nude whiplike setae but branched setae long on tibia and tarsus III).

Remarks.—The presence of a submerged scutum seems to be the principal diagnostic character of this genus, and further studies probably will reveal the necessity for subdividing the genus. Both species in Kansas, however, belong to *Neoschöngastia, sensu stricto.*

Twenty-three species were listed in this genus by Wharton and Fuller (1952:84-87). More species seem to be present in the Pacific region, with species also being found in Asia, Africa and North America. Five species are known from North America.

This genus seems to occur principally on birds, although *Neoschöngastia americana* has been taken on lizards and is commonly found on rabbits, while *N. fullbergae* Brennan was recovered from a deer, *Odocoileus hemionus.*

KEY TO SPECIES OF NEOSCHÖNGASTIA IN KANSAS

1. Leg I with 3 genualae, (1 microgenuala) .... *N. americana* p. 1354
1′ Leg I with 2 genualae, (1 microgenuala) .... *N. brennani* p. 1359

Neoschöngastia americana (Hirst)

(Figs. 12 and 47, Map 29)

Schöngastia americana Hirst, Ann. and Mag. Nat. Hist., vol. 17, 1921, p. 37, type from Dallas, Dallas County, Texas, host "domestic fowl."

Neoschöngastia americana, Ewing, Manual External Parasites, 1929, p. 187; Hoffmann, Ciencia, vol. 10, Aug. 5, 1950, p. 153; Brennan, Jour. Parasit., vol. 37, Dec., 1951, pp. 577-579; Brennan, Jour. Parasit., vol. 39, May 19, 1953, p. 294; Brennan and Jones, Wasmann Jour. Biol., vol. 12, no. 2, Oct. 11, 1954, p. 183; Crossley and Loomis, Ent. News, vol. 66, May, 1955, p. 117.

Neoschöngastia americana americana, Wharton and Hardcastle, Jour. Parasit., vol. 32, June, 1946, p. 292; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 87.

Neoschöngastia scelopori Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, p. 15, pl. 2, figs. 2-3, type from Uvalde, Uvalde County, Texas, host *Sceloporus spinosus* (of Ewing), [= *Sceloporus olivaceus*], July 13, 1928.

Diagnosis.—Larva similar to *N. brennani,* but differs in having sensilla with coarse setules; cheliceral base with small scattered puncta; leg I with 3 genualae; all legs with small puncta, especially evident on distal 3 segments.

Scutal measurements, average and extremes, of 5 larvae from Douglas County: AW- 47 (44-50), PW- 61 (58-63), SB- 28 (27-29), ASB- 18 (18-19), PSB- 27 (25-28), AP- 28 (27-29), AM- 31 (29-34), AL- 54 (49-63), PL- 60 (56-62), S- 27 (27-28).

Geographic distribution.—(Crossley and Loomis, 1955, unless otherwise noted): Known from Guatemala (Dept. Chimaltenango, Brennan, 1951), Mexico (Morelos and Guerrero, Hoffmann, 1950), West Indies (Jamaica, Brennan, 1953), United States in Virginia (Wharton and Hardcastle, 1946), South Carolina (*ibid*), Louisiana (Caddo Parish), Texas (Bexar, Cameron, Dallas, Uvalde and Zavala counties), eastern Oklahoma (Delaware County), northwestern Arkansas (Washington County), southwestern Missouri (Jasper County), northern and eastern Kansas (Rawlins, Shawnee, Jefferson, Douglas, Anderson, Wyandotte, Bourbon and Montgomery counties) and central California (Monterey County, Brennan and Jones, 1954).

Seasonal occurrence.—Larvae have been taken from hosts in northeastern Kansas from late June to early November. In eastern Kansas, larvae were most abundant on birds and rabbits in July and August. Larvae also were found on chigger samplers in August, September and early October.

Hosts.—In eastern Kansas, *N. americana* was common on cottontails, *Sylvilagus floridanus.* Of 33 cottontails examined in July to October, 27 or 82 percent had *N. americana* attached. Nearly 1000 larvae were found on a single young cottontail shot on July 23, 1953. The larvae of *N. americana,* along with *T. alfreddugèsi,* were found attached in large clusters between the toes and on the feet and legs, a few also being found on the body and head although none were found in the ears. Most clusters were composed of one species. More than 100 larvae were found on several additional *S. floridanus.*

Birds comprise an important group of hosts for *N. americana.* In eastern Kansas, 13 species of birds had larvae attached, usually only a few per bird. A single prairie chicken, *Tympanuchus cupido,* taken in Anderson County on August 3, 1951, possessed more than 600 larvae. Most of the larvae were in large clusters at sites on the body and legs where two surfaces came into contact while the bird was in a resting position. These large clusters had the fully engorged larvae in the center, with the larvae less engorged towards the periphery. The larvae were in close contact with one another and presented a nearly solid mass in the area where they were engorged. At least one of three burrowing owls, *Speotyto cunicularia*, from northwestern Kansas (Rawlins County), had larvae of *N. americana* attached on the legs and body (10 larvae recovered from the three owls).

Birds which were found to have larvae attached on three or more occasions include *Tympanuchus cupido* (3), *Richmondena cardinalis* (4), *Passer domesticus* (5), *Molothrus ater* (3), *Colinus virginianus* (4) and *Turdus migratorius* (3). Other hosts were *Rallus elegans, Dumetella carolinensis, Sialia sialis, Sturnella magna, Spiza americana* and *Chondestes grammacus*. See the tables on birds for a summary of the larvae recovered.

Larvae have been recovered from two species of lizards; *Sceloporus olivaceus* (= *S. spinosus* of Ewing, 1931 and others) from Texas harboring the 4 cotypes of *N. scelopori* (= *N. americana*, according to Brennan, 1951:577) and *Sceloporus undulatus* from Arkansas, one of which had 3 unengorged larvae attached. The unengorged condition of the larvae suggests that *Sceloporus* is not a suitable host.

A single larva was recovered from an additional mammalian host, *Lepus californicus*, in Texas. In addition to the 14 species of birds from Kansas, *N. americana* has been recovered from *Vireo griseus* in Louisiana, and *Crotophaga sulcirostris, Geococcyx californicus, Pyrrhuloxia sinuata, Muscivora forficata* and *Myiarchus cinerascens* all from Texas.

Neoschöngastia americana was not recovered from mammals except rabbits. The absence from mammals examined and the probable absence from other mammals may be due to host specificity, or more probably is due to the habitat of the unfed larvae. All of the larvae recovered from chigger samplers were taken in open situations where no sign of small mammals was present, while it was still light. Birds and rabbits were seen several times in the daylight hours crossing these areas of known infestation. Possibly the larvae of *N. americana* are solely diurnal as well as occurring in open areas, not suitable for small mammals; if so little contact is made with other mammals.

Similar host relationships exist for the rabbit- and bird-infesting tick, *Haemaphysalis leporis-palustris* (Packard). This tick parasitizes both rabbits and birds and Bishopp and Trembley(1945:29) listed 84 hosts of which 64 were birds and rabbits, whereas only 10 other mammals were listed, and those had few ticks. Most of the rabbits examined, if not all of them, which had *N. americana*, also had *H. leporis-palustris*, and a number of the bird hosts also had larvae of this tick.

The usual sites of attachment on rabbits included the feet and legs, espescially between the toes and on the forefeet. The larvae were occasionally found on the body but the dense hair seemed to repel them. They were also taken in small numbers on the head and in the ears. Larvae were found attached on birds on the thighs, body, and fleshy parts of the wings.

Habitats.—In eastern Kansas, larvae of *N. americana* were recovered from cottontails and ground-dwelling birds, obtained from open fields and along the edge of woodlands. In northwestern Kansas the larvae were found on burrowing owls obtained in the short-grass, high plains. Larvae were taken on chigger samplers at the University of Kansas Natural History Reservation from barren soil surrounded by grasses, weeds and elm saplings and from the forest floor at the woodland edge. A single larva was found in the sweepings of tall grass and weeds from an insect net.

The larvae of *N. americana* were found on chigger samplers with *T. alfreddugèsi*, both species being similar in color, size and speed on the sampler. The unfed larvae of both species are red, although *N. americana* seems to have longer, paler legs and a paler body than *T. alfreddugèsi*. Both species move with great rapidity; the movements of the legs of *T. alfreddugèsi*, however, seem to be better coordinated than those of *N. americana*.

In summary, 14 larvae of *N. americana* were recovered on samplers from four barren areas (Stations D- 1, -3 and E) near sparse ground vegetation in or adjacent to the quarry. The larvae found in August to October were not common at any station. In general the soil was derived from glacial till and from surrounding limestone and most sites had been disturbed in the past. The stations were well drained, warm to hot and dry. All stations were inhabited by *T. alfreddugèsi* although larvae were uncommon when *N. americana* was first discovered, and at the edge of the woodland (Station A) where *T. alfreddugèsi* was never common. Larvae of *T. sylvilagi* also were obtained with *N. americana* along the woodland edge.

Hot dry situations seem preferable to the larvae of *N. americana* and to its free-living stages.

In the laboratory, this species was difficult to culture. The engorged larvae seem susceptible to molds and do poorly in moist tubes. The nymphs and adults thrived in tubes kept only slightly moist. The food of the nymphs and adults in the laboratory was dead or inactive early instars of collembolans, not the eggs eaten by many chiggers. This difference in food preference as well as in moisture requirements helps to account for the presence of both *N. americana* and *T. alfreddugèsi* at the same surface sites.

Specimens examined.—Total, 246 larvae, as follows: ANDERSON CO.: 1 mi. S Welda, *Tympanuchus cupido*, July 25, 1951 (13). BOURBON CO.: 1 mi. W Ft. Scott, *Richmondena cardinalis*, Sept. 3, 1947 (1). DOUGLAS CO.: *Passer domesticus*, July 15, 1948 (3); 4 mi. W, 2 mi. S Baldwin, *Sylvilagus floridanus*, July 14, 1949 (2); 5 mi. S Clinton, *Sylvilagus floridanus*, July 10, 1949 (33); Lawrence, *Passer domesticus*, Aug. 2, 1947 (4), Aug. 23, 1947 (4), -*Richmondena cardinalis*, Oct. 1, 1947 (1), Oct. 17, 1947 (3), -*Turdus migratorius*, Aug. 20, 1947 (1), Sept. 21, 1947 (4), -*Sylvilagus floridanus*, June 21, 1949 (2), July 11, 1949 (34); 2 mi. W Lawrence, *Sylvilagus floridanus*, June 19, 1949 (2); 2 mi. S Lawrence, *Molothrus ater*, Oct. 24, 1947 (3) and *Rallus elegans*, June 23, 1949 (20); 4 mi. S Lawrence, *Colinus virginanus*, July 25, 1948 (1), -*Richmondena cardinalis*, Nov. 4, 1947 (3), -*Sylvilagus floridanus*, July 25, 1948 (1), Aug. 6, 1951 (3); 2-7 mi. SE Lawrence, *Molothrus ater* (9) and *Sylvilagus floridanus* (16), July 14, 1948; 3 mi. N Lawrence, *Spiza americana*, July 7, 1947 (1) and July 19, 1948 (2); 5 mi. N, 1 mi. E Lawrence, Univ. Kansas Nat. Hist. Reservation, *Chigger samplers*, Aug. 14, 1952 (5), Aug. 22, 1952, (3), Aug 27, 1952 (3), Sept. 10, 1952 (1), Oct. 2, 1951 (1) and Oct. 10, 1951 (1), -*Sweepings*, July 7, 1947 (1), -*Chondestes grammacus*, July 29, 1947 (1), Aug. 18, 1947 (3), -*Molothrus ater*, July 29, 1947 (6), -*Sialia sialis*, July 29, 1947 (2), -*Sylvilagus floridanus*, Aug. 18, 1947 (16); 2 mi. S, 2 mi. W Pleasant Grove, *Sylvilagus floridanus*, Aug. 4, 1951 (6). JEFFERSON CO.: 6 mi. N, 1 mi. E Lawrence, *Sylvilagus floridanus*, Aug. 9, 1951 (5). MONTGOMERY CO.: Coffeyville, *Passer domesticus*, Sept. 11, 1947 (7). RAWLINS CO.: 13 mi. S, 6 mi. E McDonald, *Speotyto cunicularia*, Aug. 7, 1949 (5). SHAWNEE CO.: 3 mi. W Topeka, *Sylvilagus floridanus*, Aug. 26, 1948 (3). WYANDOTTE CO.: Kansas City, July 20-23, 1953, *Dumetella carolinensis* (1) -*Richmondena cardinalis* (3) -*Toxostoma rufum* (1), -*Turdus migratorius* (1) and *Sylvilagus floridanus* (5).

Neoschöngastia brennani Crossley and Loomis

(Fig. 48, Map 29)

Neoschöngastia brennani Crossley and Loomis, Ent. News, vol. 66, May, 1955, pp. 114-117, figs. 1-5, type from 10½ miles west of Hardtner, Barber County, Kansas, host *Melanerpes erythrocephalus*, July 26, 1952.

Diagnosis.—Larva similar to *N. americana* but differs in having scutal setae with more numerous branches; sensilla with more numerous and smaller setules; cheliceral base with fewer, larger puncta restricted to basal part; leg I with 2 genualae; all legs with few large puncta on leg segments, more pronounced distally.

Scutal measurements (after Crossley and Loomis, 1955), average and extremes of 10 topotypes: AW- 45 (42-50), PW- 65 (57-69), SB- 31 (28-34), ASB- 17 (14-20), PSB- 27 (25-28), AP- 29 (27-32), AM- 30 (28-32), AL- 41.5 (36-45), PL- 47 (43-50), S- 27 (23-31).

Geographic distribution.—(Crossley and Loomis, 1955): Known from eastern Colorado (Boulder and Lincoln counties) and southwestern Kansas (Seward and Barber counties).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas in July and September, and from Colorado in August. Larvae were abundant on woodpeckers taken on July 26, 1952.

Hosts.—This chigger mite has been taken only from birds. Approximately 250 larvae (including the type series) were obtained from 4 *Melanerpes erythrocephalus.* Other birds with a few larvae attached were *Chondestes grammacus, Tyrannus tyrannus* and *Muscivora forficata* from Kansas; *Chondestes grammacus* and *Calamospiza melanocorys* from Colorado.

The larvae were attached on the thighs, breasts and forewings of the woodpeckers.

Examination of four cottontails shot at the same locality on the same date as the type series failed to reveal a single larva. This apparent absence of *N. brennani* from rabbits seems to be due to a different habitat from *N. americana.*

Habitat.—The type series of *N. brennani* was found on birds from a wooded valley, where the trees were principally cottonwood and elm. Large numbers of standing dead trees and snags were distributed along the valley. The valley floor was sandy with sagebrush and short to tall grasses cover much of the area.

The arboreal habits of red-headed woodpeckers suggest that the larvae were obtained from the standing or fallen dead trees which provide food and shelter for these birds. A single larva was recovered from each of two other birds, but many other birds and mammals examined from the same area were negative (see the tables for the vertebrates from Barber County).

The Seward County station for *N. brennani* was in a sandy valley with widespread sagebrush along with areas of tall grass and scattered trees, such as cottonwoods, elms and willows. The single host was the scissor-tailed flycatcher, whereas *N. brennani* was not found on other birds examined at the same time.

Specimens examined.—Total, 33 larvae, as follows: BARBER CO.: 10½ mi. W Hardtner, *Chondestes grammacus* (1), *-Melanerpes erythrocephalus* (28), and *Tyrannus tyrannus* (1), all July 26-27, 1952. SEWARD CO.: 12 mi. NE Liberal, *Muscivora forficata*, Sept. 9, 1948 (3).

GENUS CHELADONTA Lipovsky, Crossley and Loomis

Cheladonta Lipovsky, Crossley and Loomis, Jour. Kansas Ent. Soc., vol. 28, Oct. 8, 1955, pp. 137-139, figs. 5-12, type *Cheladonta micheneri* Lipovsky, Crossley and Loomis.

Diagnosis.—Larvae with scutum roughly rectangular, having 5 scutal setae; sensilla expanded, clavate; cheliceral blade with dorsal terminal tricuspid cap and a series of serrations on ventral edge; body striae widely separated; body broad at shoulders usually extending over gnathosoma when engorged; without caudal plate or plates; eyes 1 1 or absent; palpal claw with 5 to 7 prongs; palpal tarsus with striated tarsala and 4 feathered setae; legs I and II with coxae having 1 branched seta; legs II and III with 6 functional segments, having femora fused with suture visible; leg III without long nude whiplike setae.

Remarks.—The genus *Cheladonta* is known from North America and Asia. The species are *C. ikaoensis* Sasa, *et al.*, from Japan and Korea, *C. micheneri, C. crossi* and *C. ouachitensis*, from the United States.

The members of this genus have been found only on mammals.

Cheladonta micheneri Lipovsky, Crossley and Loomis

(Figs. 12, 45-46, Map 28)

Cheladonta micheneri Lipovsky, Crossley and Loomis, Jour. Kansas Ent. Soc., vol. 28, Oct. 8, 1955, p. 137, type from 3 miles west of Lawrence, Douglas County, Kansas, host *Sylvilagus floridanus*, Nov. 12, 1949.

Diagnosis.—Larva with body (engorged) moderate to small, whitish to brownish in life; dorsal setae beginning 4-12, total 40; sternal setae 2-2; total body setae about 78; eyes indistinct or absent; scutum with few puncta; galeal seta nude; palpal femur with seta one-branched or nude; palpal genu with seta nude; palpal tibia with 3 setae branched; palpal claw with 5-7 prongs; leg I with 2 genualae, subterminala and parasubterminala; leg II with 1 genuala, and pretarsala; leg III with coxa having 1 branched seta, and 1 genuala (without tibiala).

Scutal measurements, average and extremes, of 5 larvae from Jefferson and Barber counties: AW- 58 (49-66), PW- 71 (64-85), SB- 26 (22-33), ASB- 20 (20-21), PSB- 15 (13-16), AP- 20 (20-21), AM- 26 (25-29), AL- 25 (21-28), PL- 36 (33-43), S- 33 (31-35).

Geographic distribution.—Known from southeastern Nebraska (Richardson County, Lipovsky, Crossley and Loomis, 1955) and Kansas in the northwest (Rawlins County), south-central (Barber County) and east (Lyon, Morris, Douglas, Jefferson, Johnson and Wyandotte counties).

Seasonal occurrence.—Larvae were taken in November, December, February and May from hosts in the east, in July and August in western Kansas.

Hosts.—In eastern Kansas, larvae (numbers in parentheses) were recovered from these five species of mammals; *Sciurus carolinensis* (1), *Sylvilagus floridanus* (1 and 13), *Perognathus hispidus* (2), *Peromyscus maniculatus* (19), *Peromyscus leucopus* (2) and *Neotoma floridana* (5). From western Kansas, eight larvae were found on *Cynomys ludovicianus.*

The larvae were found on the bodies and legs of the hosts, probably only infrequently attaching in the ears.

Habitats.—In eastern Kansas, hosts were found principally in the vicinity of limestone outcroppings and flat limestone slabs on the soil, both in woodlands and grasslands.

In western Kansas, the larvae must inhabit the deep burrows and runway systems of the prairie dog towns in the short-grass uplands. The small size and the short legs of the larvae indicate that they must live in close proximity to the hosts, possibly in the nests proper.

Specimens examined.—Total, 51 larvae, as follows: BARBER CO.: 4½ mi. S, 1 mi. W Aetna, *Cynomys ludovicianus,* July 27, 1952 (6). DOUGLAS CO.: Lawrence, *Neotoma floridana* (nest), Feb. 22, 1950 (1); 3 mi. W Lawrence, *Sylvilagus floridanus,* Nov. 12, 1949 (13). JEFFERSON CO.: 5½ mi. N, ½ mi. E Lawrence, *Peromyscus leucopus,* Feb. 1, 1952 (2). JOHNSON CO.: Roeland Park, *Sylvilagus floridanus,* Nov. 10, 1953 (1). LYON CO.: 2 mi. S Chalk, *Perognathus hispidus,* May 31, 1950 (2). MORRIS CO.: 2 mi. S Council Grove, *Peromyscus* *maniculatus,* May 31, 1950 (3). RAWLINS CO.: 13 mi. S, 6 mi. E McDonald, *Cynomys ludovicianus,* Aug. 9, 1949 (2). WYANDOTTE CO.: Kansas City, *Sciurus carolinensis,* Dec. 11, 1953 (1); 2 mi. W Kansas City, Dec. 13-14, 1953, *Peromyscus leucopus* (5) and *Peromyscus maniculatus* (15).

SUBFAMILY WALCHIINAE Ewing

Ewing, Jour. Parasit., vol. 32, Oct. 29, 1946, p. 436. [= Subfamily Gahrliepiinae Womersley, Records South Australian Mus., vol. 10, March 1, 1952, p. 278.]

Diagnosis.—Larvae with scutum usually enlarged posteriorly, frequently including dorsal body setae, always lacking anteromedian or submedian setae (tectum lacking setae in known nymphs and adults); sensillae expanded; leg I seven-segmented, legs II and III six-segmented with femora completely fused (without prominent sutures); coxa I with one seta, coxa III frequently with two or more setae; leg III without long nude whiplike setae (based on Audy, 1954:161).

Species in Kansas (*W. americana*) similar to members of Trombiculinae in the State except for characters listed above and in diagnosis of species.

Remarks.—Womersley (1952:278) restricted this subfamily (using the name Gahrliepiinae) to a single genus, *Gahrliepia* Oudemans, and included *Walchia* Ewing, *Gateria* Ewing and *Schöngastiella* Hirst as subgenera. *Giroudia* Vercammen-Grandjean also was included as a subgenus in the genus *Gahrliepia* by Audy (1954:135). I have followed this classification, except that *Walchia* has been retained as a genus.

In North America, this subfamily is represented by a single genus and species, *Walchia americana* Ewing, while the remaining ten species of *Walchia* and the other genera and subgenera have been found in Asia and Africa.

This subfamily is presently concentrated in southern Asia and seemingly was derived there from ancestors which possessed expanded sensilla and were related to certain members of *Euschöngastia, sensu lato,* of the subfamily Trombiculinae.

Larvae of this subfamily are known exclusively from mammals.

GENUS WALCHIA Ewing

Walchia Ewing, Proc. U. S. Nat. Mus., vol. 80, 1931, p. 10, type *Trombidium glabrum* Walch (not *Trombidium glabrum* Dugès) = *Walchia pingue* Gater.

Diagnosis.—Larvae with only four scutal setae, two anterolaterals and two posterolaterals. (Known nymphs and adults lack setae on tectum.)

Walchia americana Ewing

(Figs. 12 and 49, Map 4)

Walchia americana Ewing, Jour. Parasit., vol. 28, Dec. 11, 1942, p. 491, figs. 10-11, type from Tallahassee, Leon County, Florida, host "cotton mouse" [= ? *Peromyscus gossypinus*], Nov. 8, 1936; Farner, Proc. Ent. Soc. Washington, vol. 48, Oct. 11, 1946, p. 185, 1 fig.; Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, p. 92.

Diagnosis.—Larva with body small and nearly round, white in life; dorsal setae 2-6-6, total 26-28; eyes absent; scutum enlarged posteriorly; 4 scutal setae present; sensilla clavate; cheliceral blade with dorsal tooth and tricuspid cap; galeal seta nude; palpal femur, genu and tibia with setae nude; palpal claw trifurcate; leg I with 2 genualae, 1 microgenuala, 2 tibialae, 1 microtibiala, subterminala and parasubterminala; leg II with 5 branched setae on femur, 1 genuala and 2 tibialae (pretarsala absent); leg III with coxa having 2 branched setae, 4 branched setae on femur and with 1 genuala.

Scutal measurements, average and extremes, of 7 larvae from Barber and Douglas counties: AW- 45 (38-51), PW- 68 (56-82), SB- 38 (30-47), ASB- 20 (18-21), PSB- 44 (37-50), AP- 30 (24-33), AL- 25 (23-27), PL- 27 (25-28), S- 51 (46-56).

Geographic distribution.—Known from northwestern Florida (Leon County, Ewing, 1942), north to Wisconsin (Dunn County, Farner, 1946), Oklahoma (Adair, Comanche and McClain counties, KU), southeastern Nebraska (Nemaha and Otoe counties, KU), southwestern Iowa (Fremont County, KU), eastern and south-central Kansas (Douglas, Johnson, Jefferson, Wyandotte, Miami and Barber counties), westward to southwestern Utah (Garfield County, KU).

Seasonal occurrence.—Larvae have been taken from hosts in Kansas from mid-September to late May. Larvae from the other states mentioned above also were taken from September through May.

Hosts.—Larvae of *W. americana*, like all of the other members of the subfamily, seem to occur only upon mammals. Wharton and Fuller (1952:92) listed as hosts, the "cotton mouse" [= *Peromyscus gossypinus*], *Sciurus carolinensis*, and *Tamiasciurus hudsonicus*. Other known hosts include *Eutamias umbrinus* from Utah; *Peromyscus leucopus*, from Kansas, Iowa and Oklahoma; *Neotoma floridana* from Oklahoma; *Sciurus carolinensis* and *S. niger* from Nebraska and Kansas; *Sylvilagus floridanus* and *Neotoma micropus* from Kansas. Most of the host records are of squirrels.

The principal hosts of *W. americana* in Kansas seem to be the fox squirrel and gray squirrel which are common inhabitants of the deciduous forests and stream-side woods in eastern and central Kansas. A total of 300 and 135 larvae, taken from two fox squirrels in Douglas County, shot on November 28, 1951, and November 16, 1952, respectively, represented the largest concentrations on individual hosts. At least one larva of *W. americana* was found on approximately 67% of the gray squirrels and 50% of the fox squirrels that were examined during the known period of larval activity. The numbers of larvae on other hosts are listed in the tables of vertebrates.

The usual sites of larval attachment were on the belly, the inner surfaces of the legs, but some larvae were elsewhere on the body. They were only once found in the ears of a squirrel. Each larva occupies a central depression in a small swollen area of the skin. Usually only a single larva was in the depression but as many as three larvae were seen together.

Habitat.—In Kansas this chigger mite has been found only on mammals taken in the immediate vicinity of moderate to large stands of trees. The two principal hosts spend much of their time in trees, frequently in cavities in living trees, in dead snags and in large dead limbs where they build their nests. Free-living stages of *W. americana* probably live in these decaying parts of standing trees usually in close association with the nests of tree squirrels. Wharton and Fuller (1952:147) stated that free-living stages of *W. americana* have been found associated with decaying wood. Numerous larvae, but no nymphs or adults, were recovered from the nest material of wood rats, *Neotoma floridana*, from Oklahoma.

In Sumner County, five larvae were taken from a young fox squirrel, *Sciurus niger*, shot on September 14, 1953, from a large cottonwood (*Populus deltoides*). This cottonwood tree, more than fifty feet high and several feet in circumference at the base, was situated along a small intermittent stream, in association with other cottonwoods and elms. Several of its large limbs were dead and had cavities affording nesting sites for fox squirrels.

Gray wood rats, *Neotoma micropus*, from which the larvae were recovered, were trapped in a small canyon, in the vicinity of cottonwoods and elms, some of which were dead.

Life history.—This species has been reared in the laboratory from engorged larvae to newly-hatched larvae in 92 days. All stages were whitish. The eyeless larvae moved relatively slowly and deliberately, usually in a nearly straight line. They would crawl up an in-cline until they reached the top, explore it and then crawl down and off in another direction.

The nymphs and adults moved rapidly about the culture tube in search of food.

The food of the nymphs and adults consisted of the body fluids of young freshly dead (frozen) and maimed collembolans, *Sinella curviseta* Brook, and probably first instar collembolans as they hatched, as well as Collembola immobilized while molting. Lipovsky (1951:342-326) stated that tyroglyphid (= acarid) eggs may have been a source of food for *Walchia.* Lipovsky (1954:946) said that "*Walchia* in the laboratory would not feed on any eggs or any ovarian material offered them." In nature they probably feed on resting stages of various small insects.

Nymphs and adults of a successful culture of *W. americana* unsuccessfully attempted to feed on Collembola eggs. The resting stages of their own species probably are eaten when other food is not available.

The food in nature probably includes collembolans of the family Entomobryidae, since species belonging to this family frequently were abundant in decaying wood, tree holes (Park, *et al.*, 1950:30), and in nest material of small mammals.

Specimens examined.—Total, 55 larvae, as follows: BARBER CO.: 5 mi. S Sun City, *Neotoma micropus,* Sept. 14, 1948 (14). DOUGLAS CO.: *Sciurus niger,* Jan. 1, 1950 (1); Lawrence, *Sciurus niger,* Nov. 16, 1952 (1) and March 29, 1952 (3); 20 mi. SW Lawrence, *Sciurus niger,* Sept. 20, 1953 (1); 4½ mi. W, 3 mi. S Baldwin, *Sciurus niger,* Nov. 28, 1951 (6); 2 mi. S Worden, *Sciurus carolinensis* (2) and *Sciurus niger* (6), Nov. 26-28, 1949. JEFFERSON CO.: 10 mi. N Midland, *Sciurus niger,* Nov. 8, 1953 (1); 7 mi. N, 5 mi. W Midland, *Sciurus niger,* Nov. 26, 1953 (1). JOHNSON CO.: 2 mi. N, 1 mi. W Lenexa, *Sciurus niger,* Nov. 18, 1953 (1) and Jan. 4, 1954 (1) and *Peromyscus leucopus,* April 13, 1954 (1); Roeland Park, *Sylvilagus floridanus,* Nov. 10, 1953 (1); 4 mi. S, 3 mi. W Stanley, *Sciurus niger,* Jan. 6, 1954 (1); Westwood, *Sciurus carolinensis,* Nov. 12, 1953 (1). MIAMI CO.: 3 mi. E, 1 mi. S Fontana, *Sciurus carolinensis* and *S. niger* (skins mixed), Oct. 12, 1948 (5) and *Sciurus carolinensis,* May 31, 1953 (2). SUMNER CO.: 2 mi. E Milan, *Sciurus niger,* Sept. 14, 1953 (5). WYANDOTTE CO.: SW edge of Kansas City, *Sciurus carolinensis,* Dec. 11, 1953 (1) and Dec. 17, 1953 (1).

HYPOTHETICAL LIST

GENUS TROMBICULA

Subgenus *Neotrombicula*

Trombicula autumnalis (Shaw)

Acarus autumnalis Shaw, Nat. Misc., vol. 2, next to plate 42, 1790, type from Great Britain, man, autumn.
Trombicula autumnalis, Kneissl, Zool. Anz., Bd. 46, 1916, p. 253; Richards, Parasitology, vol. 40, 1950, pp. 105-117, lectotype [= neotype] designated from Birkshire, England, Fair Mile, Warren Farm, Streatley, Oct. 2, 1946.
Trombicula (Neotrombicula) autumnale, Hirst, Nature, vol. 116, 1925, p. 609.
Trombicula (Neotrombicula) autumnalis, Wharton and Fuller, Mem. Ent. Soc. Washington, no. 4, Dec. 10, 1952, pp. 56-58, (includes a comprehensive synonymy); Kardos, Univ. Kansas Sci. Bull., vol. 36, pt. 1, no. 4, June 1, 1954, pp. 74-77, figs. 3-6.

Diagnosis.—Larva with dorsal body setae beginning 2-6-6, total 74-84 body setae; sensilla with 6-9 long branches on distal half; galeal seta nude; palpal femur and genu with branched setae; palpal tibia with ventral seta branched, dorsal and lateral setae nude; leg I with 3 genualae; leg III with 1 mastitarsala and femur and tibia each with long plumose seta.

Scutal measurements (after Kardos, 1954), average and extremes, of 10 larvae from Dundy County, Nebraska: AW- 70 (65-76), PW- 91 (88-95), SB- 33 (31-36), ASB- 30 (28-33), PSB- 29 (26-31), AP- 30 (28-33), AM- 48 (41-51), AL- 46 (42-48), PL- 67 (61-71), S- 76 (70-81).

Geographic distribution.—Known from Europe (see Wharton and Fuller, 1952) and from the United States (Kardos, 1954) in southwestern Colorado (Dolores County) and southwestern Nebraska (Dundy County).

Seasonal occurrence.—Larvae were collected in southwestern Nebraska on November 1 and 2, 1952, and in Colorado on October 18, 1949.

Ecology.—The larvae from Nebraska were found principally in the ears of *Microtus ochrogaster*, *Microtus pennsylvanicus* and *Reithrodontomys megalotis*, trapped in or adjacent to a marshy habitat of tall grass and sedges, fed by continuously flowing springs, along Rock Creek. The locality, 5 miles north and 2 miles west of Parks, Dundy County, is approximately 7 miles from the northern border of Cheyenne County, Kansas. If *T. autumnalis* is restricted to spring-fed meadows, then its presence in northwestern Kansas would seem unlikely, since comparable habitats seem to be absent in adjacent parts of Kansas. Further fall and winter collecting in northern and western Kansas will be needed to determine whether this species is present in the state.

Microti Group

Trombicula loomisi Kardos

Trombicula (Neotrombicula) loomisi Kardos, Univ. Kansas Sci. Bull., vol. 36, pt. 1, no. 4, June 1, 1954, pp. 85-88, figs. 7-8, type from 1 mile east of Laird, Yuma County, Colorado, host *Reithrodontomys megalotis*, Nov. 2, 1952.

Diagnosis.—Larva with dorsal setae beginning 2-6, total body setae 64; scutum broadly rounded posteriorly; sensillary bases posterior to bases of posterolateral setae; sensilla with several pronounced apical branches; galeal seta branched; palpal femur, genu and tibia with setae branched.

Scutal measurements (after Kardos, 1954), average and extremes, of 7 larvae from Colorado and Nebraska: AW- 72 (69-76), PW- 93 (89-95), SB- 28 (27-30), ASB- 34 (32-35), PSB- 19 (17-21), AP- 29 (28-31), AM- 44 (40-47), AL- 47 (43-52), PL- 56 (51-60), S- 99 (94-103, from 3 larvae).

Geographic distribution.—(Kardos, 1954): Known from northeastern Colorado (Yuma County) and southwestern Nebraska (Dundy County) less than 10 miles from the northwestern corner of Kansas.

Seasonal occurrence.—Larvae were taken from hosts on November 1 and 2, 1952.

Ecology.—Larvae of *T. loomisi* were obtained from *Peromyscus maniculatus, Reithrodontomys megalotis* and *Mus musculus,* trapped in a streamside meadow habitat. The larvae were taken from the bodies of the mice.

This species should be found in northwestern Kansas.

Subgenus *Trombicula, sensu lato*

Trombicula merrihewi Loomis and Lipovsky

Trombicula merrihewi Loomis and Lipovsky, Jour. Kansas Ent. Soc., vol. 27, May 15, 1954, p. 51, pls. 1-2, type from 6 miles south and 2 miles west of Aetna, Kansas, in Woods County, Oklahoma, Merrihew Cave, host *Tadarida mexicana*, Aug. 24, 1949.

Diagnosis.—Larva similar to *T. ornata,* but differs in having body pale yellow; sensilla long and nude; palpal tibia with 1 nude and 2 branched setae, palpal thumb large, with nude and plumose setae; leg III with coxa having 1 branched seta and with 1 mastitarsala.

Scutal measurements (after Loomis and Lipovsky, 1954), average and extremes, of 5 topotypes: AW- 35 (33-40), PW- 43 (36-51), SB- 19 (16-24), ASB- 27 (26-28), PSB- 19 (17-21), AP- 24 (22-26), AM- 23 (22-24), AL- 16.5 (16-17), PL- 20 (18-22), S- 43 (40-46).

Geographic distribution.—Known only from the type locality in north-central Oklahoma, approximately one-half mile south of the Kansas border.

Seasonal occurrence.—Larvae have been taken only from Mexican free-tailed bats, in August, September and October in the Merrihew Cave.

Ecology.—The bats occur in this cave between May and October; where they live the rest of the year is unknown. Hundreds of thousands of these bats crowd the large chambers of the Merrihew Cave and they emerge and forage over a large area, including the adjacent part of Kansas, at night. Larvae of this chigger mite probably occur on many of the *Tadarida* flying over Kansas. Larvae were found in the ears of free-tailed bats from Oklahoma, in association with *Speleocola tadaridae* Lipovsky.

THE SPECIES OF HOSTS FROM KANSAS AND THEIR CHIGGERS

(Total number examined indicated in parentheses)

AMPHIBIA

Ambystoma tigrinum—tiger salamander (4)—*H. eltoni*

Bufo woodhousii—Woodhouse toad (67)—*H. eltoni, H. multifemorala, T. lipovskyana.*

Acris gryllus—cricket frog (70)—*H. eltoni, H. dunni, H. multifemorala, T. alfreddugèsi, T. lipovskyana.*

Rana pipiens—Leopard frog (166)—*H. eltoni, H. multifemorala, T. alfreddugèsi.*

REPTILIA

Terrapene ornata—ornate box turtle (24)—*T. alfreddugèsi, T. lipovskyana, T. montanensis.*

Crotaphytus collaris—collared lizard (322)—*A. arizonensis, T. alfreddugèsi, T. lipovskyana.*

Holbrookia maculata—earless lizard (3)—*T. alfreddugèsi.*

Sceloporus undulatus—fence lizard (17)—*T. alfreddugèsi.*

Ophisaurus attenuatus—slender glass snake (25)—*T. alfreddugèsi.*

Cnemidophorus sexlineatus—six-lined racerunner (108)—*T. alfreddugèsi.*

Eumeces fasciatus—five-lined skink (850)—*T. alfreddugèsi, T. g. gurneyi.*
Eumeces laticeps—greater five-lined skink (4)—*T. g. gurneyi, T. trisetica.*
Eumeces obsoletus—gray skink (355)—*T. alfreddugèsi, T. lipovskyana, T. g. campestris, T. montanensis.*
Natrix erythrogaster—plain-bellied water snake (3)—*T. alfreddugèsi.*
Natrix rhombifera—diamond-backed water snake (1)—*T. alfreddugèsi.*
Natrix sipedon—common water snake (9)—*T. alfreddugèsi.*
Thamnophis radix—plains garter snake (6)—*T. alfreddugèsi.*
Thamnophis sauritus—ribbon snake (7)—*T. alfreddugèsi.*
Thamnophis sirtalis—common garter snake (47)—*T. alfreddugèsi, T. lipovskyana, T. kansasensis.*
Tropidoclonion lineatum—lined snake (8)—*T. alfreddugèsi.*
Heterodon nasicus—western hog-nosed snake (6)—*T. alfreddugèsi, T. g. campestris, T. montanensis.*
Heterodon platyrhinos—common hog-nosed snake (2)—*T. alfreddugèsi.*
Diadophis punctatus—ring-necked snake (188)—*T. alfreddugèsi.*
Coluber constrictor—racer (130)—*T. alfreddugèsi, T. lipovskyana, T. kansasensis, T. sylvilagi.*
Masticophis flagellum—whip snake (5)—*T. alfreddugèsi, T. g. campestris, T. montanensis.*
Elaphe guttata—prairie rat snake (14)—*T. alfreddugèsi.*
Elaphe obsoleta—pilot black snake (70)—*T. alfreddugèsi, T. lipovskyana, T. myotis, T. g. gurneyi, T. trisetica, T. fitchi, T. kardosi.*
Arizona elegans—glossy snake (1)—*T. g. campestris.*
Pituophis catenifer—bull snake (30)—*T. alfreddugèsi, T. montanensis, T. kansasensis.*
Lampropeltis calligaster—blotched king snake (15)—*T. alfreddugèsi.*
Lampropeltis getulus—common king snake (5)—*T. alfreddugèsi, T. lipovskyana, T. montanensis.*
Lampropeltis triangulum—red king snake (17)—*T. alfreddugèsi, T. g. campestris.*
Ancistrodon contortrix—copperhead (159)—*T. alfreddugèsi, T. lipovskyana, T. trisetica, T. sylvilagi.*
Crotalus horridus—timber rattlesnake (31)—*T. alfreddugèsi, T. lipovskyana, T. g. gurneyi, T. kansasensis.*

Crotalus viridis—prairie rattlesnake (17)—*T. alfreddugèsi, T. g. campestris, T. montanensis.*

AVES

Buteo jamaicensis—red-tailed hawk (3)—*T. alfreddugèsi.*

Tympanuchus cupido—prairie chicken (4)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Colinus virginianus—bobwhite (25)—*T. alfreddugèsi, T. lipovskyana, T. sylvilagi, N. americana.*

Rallus elegans—king rail (1)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Bartramia longicauda—upland plover (4)—*T. lipovskyana.*

Zenaidura macroura—mourning dove (37)—*T. alfreddugèsi, T. lipovskyana.*

Coccyzus americanus—yellow-billed cuckoo (6)—*T. alfreddugèsi.*

Speotyto cunicularia—burrowing owl (5)—*T. g. campestris, T. montanensis, N. americana.*

Asio otus—long-eared owl (1)—*T. lipovskyi.*

Colaptes auratus—flicker (2)—*T. alfreddugèsi.*

Centurus carolinus—red-bellied woodpecker (10)—*T. lipovskyi.*

Melanerpes erythrocephalus—red-headed woodpecker (9)—*T. alfreddugèsi, T. gurneyi, T. crossleyi, N. brennani.*

Tyrannus tyrannus—Eastern kingbird (9)—*T. lipovskyana, N. brennani.*

Muscivora forficata—scissor-tailed flycatcher (8)—*T. arenicola, N. brennani.*

Empidonax sp.—flycatcher (1)—*T. lipovskyana.*

Eremophila alpestris—horned lark (17)—*T. alfreddugèsi.*

Cyanocitta cristata—blue jay (4)—*T. alfreddugèsi, T. whartoni, T. montanensis.*

Corvus brachyrhynchos—crow (4)—*T. alfreddugèsi, E. peromysci.*

Parus atricapillus—black-capped chickadee (26)—*T. lipovskyi, E. diversa.*

Parus bicolor—tufted titmouse (6)—*T. alfreddugèsi, T. whartoni, T. sylvilagi.*

Troglodytes aedon—house wren (2)—*T. alfreddugèsi, T. lipovskyana.*

Dumetella carolinensis—catbird (3)—*T. alfreddugèsi, N. americana.*

Toxostoma rufum—brown thrasher (3)—*T. alfreddugèsi, N. americana.*

Sialia sialis—bluebird (14)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Turdus migratorius—robin (18)—*T. alfreddugèsi, T. lipovskyana, T. sylvilagi, N. americana.*

Sturnus vulgaris—starling (11)—*T. alfreddugèsi, T. lipovskyana.*

Passer domesticus—English sparrow (37)—*T. alfreddugèsi, T. lipovskyana, N. americana, E. diversa.*

Agelaius phoeniceus—red-winged blackbird (37)—*T. alfreddugèsi, T. lipovskyana.*

Icterus galbula—Baltimore oriole (1)—*T. alfreddugèsi.*

Molothrus ater—cowbird (39)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Quiscalus quiscula—bronze grackle (8)—*T. alfreddugèsi, T. lipovskyana.*

Sturnella magna—eastern meadow lark (5)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Sturnella neglecta—western meadow lark (22)—*T. alfreddugèsi, T. lipovskyana, T. batatas, T. lipovskyi.*

Piranga rubra—summer tanager (1)—*T. alfreddugèsi.*

Richmondena cardinalis—cardinal (38)—*T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. whartoni, T. sylvilagi, N. americana, E. diversa.*

Spiza americana—dickcissel (15)—*T. alfreddugèsi, T. lipovskyana, N. americana.*

Calamospiza melanocorys—lark bunting (4)—*T. alfreddugèsi.*

Chondestes grammacus—lark sparrow (8)—*T. alfreddugèsi, T. lipovskyana, N. americana, N. brennani.*

Junco hyemalis—slate-colored junco (27)—*T. whartoni, T. sylvilagi.*

Spizella passerina—chipping sparrow (3)—*T. alfreddugèsi.*

Zonotrichia albicollis—white-throated sparrow (2)—*T. whartoni.*

Zonotrichia querula—Harris' sparrow (12)—*T. whartoni.*

Melospiza melodia—song sparrow (16)—*T. lipovskyi.*

MAMMALIA

Didelphia marsupialis—opossum (4)—*T. lipovskyi.*

Blarina brevicauda—short-tailed shrew (20)—*T. lipovskyi, T. g. gurneyi, E. diversa, E. trigenuala.*

Cryptotis parva—least shrew (12)—*T. alfreddugèsi, T. lipovskyana, T. sylvilagi, E. jonesi, P. farneri.*

Scalopus aquaticus—eastern mole (12)—*T. lipovskyana, T. g. gurneyi, E. trigenuala.*

Myotis lucifugus—little brown bat (20)—*E. pipistrelli.*
Myotis keenii—Keen myotis (4)—*E. pipistrelli.*
Myotis velifer—cave bat (413)—*W. senase, T. cynos, T. fitchi, E. jonesi.*
Pipistrellus subflavus—eastern pipistrelle (53)—*E. pipistrelli.*
Antrozous bunkeri—Bunker bat (17)—*T. twentei, T. hoplai.*
Tadarida mexicana—Mexican free-tailed bat (5)—*S. tadaridae.*
Lepus californicus—black-tailed jackrabbit (11)—*T. alfreddugèsi, T. lipovskyi, P. hungerfordi.*
Sylvilagus floridanus—eastern cottontail (233)—*A. galli, A. plumosus, T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. whartoni, T. sylvilagi, T. hoplai, T. gurneyi, T. g. campestris, T. montanensis, E. setosa, E. jonesi, E. peromysci, E. diversa, E. lacerta, E. loomisi, P. hungerfordi, N. americana, C. micheneri, W. americana.*
Sciurus carolinensis—gray squirrel (12)—*T. lipovskyi, T. whartoni, T. fitchi, T. sylvilagi, T. cynos, T. g. gurneyi, T. trisetica, E. setosa, E. jonesi, C. micheneri, W. americana.*
Sciurus niger—fox squirrel (58)—*T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. whartoni, T. fitchi, T. kardosi, T. sylvilagi, T. cynos, T. jonesae, T. g. gurneyi, E. setosa, E. diversa, E. trigenuala, W. americana.*
Cynomys ludovicianus—black-tailed prairie dog (33)—*T. alfreddugèsi, T. g. campestris, T. montanensis, T. hoplai, E. criceticola, E. cynomyicola, E. loomisi, E. lacerta, C. micheneri.*
Spermophilus tridecemlineatus—thirteen-lined ground squirrel (12)—*T. alfreddugèsi, T. g. campestris, T. montanensis, E. cynomyicola.*
Tamias striatus—eastern chipmunk (2)—*T. alfreddugèsi.*
Geomys bursarius—plains pocket gopher (4)—*E. diversa, E. trigenuala.*
Perognathus flavescens—plains pocket mouse (5)—*T. alfreddugèsi, T. montanensis.*
Perognathus flavus—silky pocket mouse (1)—*T. montanensis, E. loomisi, P. hungerfordi.*
Perognathus hispidus—hispid pocket mouse (33)—*T. alfreddugèsi, T. g. campestris, T. montanensis, T. arenicola, E. cynomyicola, E. loomisi, E. trigenuala, P. farneri, P. hungerfordi, C. micheneri.*
Dipodomys ordii—Ord kangaroo rat (46)—*A. plumosus, T. batatas, T. alfreddugèsi, T. g. campestris, T. montanensis, T. arenicola, E. loomisi, P. farneri, P. hungerfordi.*

Onychomys leucogaster—northern grasshopper mouse (13)—*T. alfreddugèsi, T. g. campestris, T. montanensis, E. trigenuala, P. hungerfordi.*

Reithrodontomys megalotis—western harvest mouse (90)—*L. americana, T. alfreddugèsi, T. lipovskyi, E. peromysci, E. diversa, P. hungerfordi.*

Peromyscus leucopus—white-footed mouse (155)—*A. plumosus, T. alfreddugèsi, T. lipovskyi, T. sylvilagi, T. hoplai, T. g. gurneyi, T. g. campestris, T. kansasensis, T. crossleyi, T. ornata, E. setosa, E. jonesi, E. peromysci, E. diversa, E. criceticola, E. loomisi, P. farneri, P. hungerfordi, C. micheneri, W. americana.*

Peromyscus maniculatus—deer mouse (172)—*L. americana, A. galli, A. plumosus, T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. sylvilagi, T. g. campestris, T. kansasensis, T. montanensis, T. ornata, E. setosa, E. jonesi, E. trigenuala, E. peromysci, E. diversa, E. loomisi, P. farneri, P. hungerfordi, C. micheneri.*

Sigmodon hispidus—hispid cotton rat (99)—*T. alfreddugèsi, T. lipovskyana, T. lipovskyi, E. peromysci, E. diversa, E. trigenuala, P. farneri, P. hungerfordi.*

Neotoma floridana—eastern wood rat (46)—*T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. sylvilagi, T. cynos, T. trisetica, E. setosa, E. peromysci, E. diversa, P. farneri, P. hungerfordi.*

Neotoma micropus—gray wood rat (92)—*A. plumosus, W. senase, T. alfreddugèsi, T. myotis, T. lipovskyi, T. fitchi, T. hoplai, T. g. campestris, T. kansasensis, T. crossleyi, T. ornata, T. montanensis, E. cricetícola, E. lacerta, E. loomisi, P. farneri, P. hungerfordi, W. americana.*

Microtus ochrogaster—prairie vole (224)—*T. alfreddugèsi, T. lipovskyana, T. lipovskyi, T. whartoni, T. sylvilagi, E. peromysci, E. diversa, E. trigenuala, P. hungerfordi.*

Microtus pinetorum—woodland pine vole (10)—*T. lipovskyi, E. diversa.*

Rattus norvegicus—Norway rat (7)—*T. alfreddugèsi, T. lipovskyi, E. diversa.*

Mus musculus—house mouse (93)—*T. alfreddugèsi, T. lipovskyi, T. whartoni, T. sylvilagi, E. diversa, P. hungerfordi.*

Zapus hudsonius—meadow jumping mouse (2)—*T. sylvilagi.*

Canis latrans—coyote (5)—*T. lipovskyi, E. diversa.*

Canis familiaris—dog (1)—*T. alfreddugèsi, T. lipovskyana.*

Procyon lotor—raccoon (1)—*T. alfreddugèsi.*

Homo sapiens—man (1)—*T. alfreddugèsi.*

THE SPECIES OF VERTEBRATES EXAMINED FROM KANSAS AND NOT FOUND TO HAVE CHIGGERS

(Total number examined shown in parentheses)

AMPHIBIA

Ambystoma texanum—narrow-mouthed salamander (46)
Notophthalmus viridescens—eastern newt (8)
Typhlotriton nereus—spring blind salamander (1)
Eurycea longicauda—long-tailed salamander (14)
Eurycea lucifuga—cave salamander (8)
Scaphiopus bombifrons—plains spadefoot (100)
Bufo cognatus—plains toad (50)
Hyla crucifer—spring peeper (2)
Hyla versicolor—common tree frog (119)
Pseudacris clarkii—spotted chorus frog (3)
Pseudacris nigrita—striped chorus frog (300)
Gastrophryne carolinensis—narrow-mouthed toad (1)
Gastrophryne olivacea—plains narrow-mouthed toad (100)
Rana areolata—crayfish frog (26)
Rana catesbeiana—bullfrog (35)
Rana clamitans—green frog (1)

REPTILIA

Kinosternon flavescens—yellow mud turtle (1)
Terrapene carolina—common box turtle (1)
Chrysemys picta—painted turtle (1)
Phrynosoma cornutum—Texas horned lizard (3)
Lygosoma laterale—brown skink (36)
Eumeces anthracinus—coal skink (2)
Eumeces septentrionalis—prairie skink (11)
Natrix grahamii—Graham's water snake (1)
Storeria dekayi—Dekay's snake (13)
Haldea valeriae—brown ground snake (3)
Carphophis amoenus—worm snake (60)
Opheodrys aestivus—rough green snake (2)
Tantilla gracilis—slender tantilla (14)
Tantilla nigriceps—black-headed tantilla (3)
Sonora episcopa—prairie ground snake (2)
Hypsiglena torquata—night snake (1)
Sistrurus catenatus—massasauga rattlesnake (4)

AVES

Ictinia misisippiensis—Mississippi kite (5)
Circus cyaneus—marsh hawk (1)
Falco sparverius—sparrow hawk (4)
Charadrius vociferus—killdeer (9)
Tringa solitaria—solitary sandpiper (1)
Columba livia—domestic pigeon (7)
Bubo virginianus—great horned owl (2)
Chordeiles minor—nighthawk (2)
Sphyrapicus varius—yellow-bellied sapsucker (1)
Dendrocopus pubescens—downy woodpecker (5)
Dendrocopus villosus—hairy woodpecker (3)
Myiarchus crinitus—crested flycatcher (2)
Sayornis saya—Say's phoebe (1)
Empidonax trailli—Alder flycatcher (1)
Empidonax virescens—Acadian flycatcher (1)
Hirundo rustica—barn swallow (2)
Petrochelidon pyrrhonota—cliff swallow (1)
Certhia familiaris—brown creeper (1)
Troglodytes troglodytes—winter wren (1)
Telmatodytes palustris—long-billed marsh wren (1)
Mimus polyglottis—mockingbird (2)
Lanius ludovicianus—loggerhead shrike (2)
Vireo olivaceus—red-eyed vireo (1)
Dendroica coronata—myrtle warbler (2)
Contopus virens—wood pewee (1)
Geothlypis trichas—yellow throat (2)
Xanthocephalus xanthocephalus—yellow-headed blackbird (3)
Guiraca caerulea—blue grosbeak (1)
Passerina cyanea—indigo bunting (1)
Spinus tristis—common goldfinch (3)
Pipilo maculatus—towhee (1)
Passerculus sandwichensis—savannah sparrow (3)
Pooecetes gramineus—vesper sparrow (1)
Spizella arborea—tree sparrow (24)
Spizella pallida—clay-colored sparrow (1)
Zonotrichia leucophrys—white-crowned sparrow (2)
Passerella iliaca—fox sparrow (2)
Melospiza lincolnii—Lincoln's sparrow (1)

MAMMALIA

Eptesicus fuscus—big brown bat (53)
Lasiurus borealis—red bat (2)
Corynorhinus rafinesquii—big-eared bat (5)
Marmota monax—woodchuck (1)
Spermophilus spilosoma—spotted ground squirrel (1)
Reithrodontomys montanus—plains harvest mouse (2)
Mustela frenata—long-tailed weasel (1)
Taxidea taxus—badger (2)
Spilogale putorius—spotted skunk (2)

VERTEBRATES AS HOSTS OF CHIGGERS IN KANSAS

To continue its development after hatching from the egg the larval chigger normally must attach to a single vertebrate host and feed. The type of vertebrate which is parasitized depends largely upon which individual is available to the active unfed larva. Little if any host specificity exists, except that *Hannemania* is found only on amphibians and that *Acomatacarus arizonensis* is found only on lizards. A number of additional species of chiggers have been found only on a single species of host or only on species of one group of vertebrates. For many of these species of chiggers, however, there has been inadequate sampling of the vertebrate fauna in the proper place at the proper time. Other examples of single host species seem to be due to the limited habitat of the active unfed larvae, such as those which presumably occur in caves and are found only on bats (*e. g. Speleocola tadaridae* on the Mexican free-tailed bat). Whether this represents host specificity or habitat specificity is unknown. The absence of some species from certain available vertebrates, such as snakes and lizards, may be the result of inability of the larvae either to attach and penetrate, or to survive on, the tough dry integument.

The success of the attached larva and of each species of chigger mite depends largely on the activities of the host. If the engorged larva can drop from its host in the same general area from which it was acquired, along with other larvae of the same species, then that larva and the species is likely to succeed. If, however, the host travels to an unfavorable area, then the chance for survival of the detached larva is poor. Each species would build up in the areas which supported enough hosts suitable for them and would be reduced or eliminated in areas without these suitable hosts.

In the following summaries of the vertebrates as chigger hosts, special emphasis is placed on the probable reason or reasons for the presence or absence of chigger mites on the available vertebrates. The repeated presence of the larvae on any vertebrate species would confirm its suitability as a host.

The tables under each class of vertebrate are arranged by the area of recovery. The species of vertebrate and numbers examined along with the number of larvae recovered are listed by the month. The number of individual hosts for most species of chiggers is listed (in parentheses) under the number of larvae, unless the hosts for that particular chigger correspond to the total number of hosts (given under the column, with chiggers). However, in some groups, *e. g. Neotoma micropus* and other mammals from Barber County, all individuals of each species from the same locality on the same date were washed together and the larvae were pooled. The vertebrates were taken from 1947 to 1954, and unless otherwise noted, were carefully and thoroughly examined for larvae. See Material and Methods for the procedure followed to recover and identify the chiggers.

AMPHIBIANS

In Kansas, 1188 individuals of 21 species of amphibians were examined for chiggers, the majority being secured in eastern Kansas. Tables 3 and 4 list the amphibians examined and the number and kinds of chiggers recovered. Table 5 gives a summary of the chiggers found on the three species most commonly parasitized.

In the brief discussion below the probable reasons for the presence or absence of chigger larvae on the amphibians examined in the present study are reviewed.

From a total of five different species of amphibians, five species of chigger mites were recovered: *T. alfreddugèsi*, *T. lipovskyana* and *H. dunni* occasionally; *H. eltoni* and *H. multifemorala,* both common in Kansas and, along with *H. dunni*, restricted solely to amphibians.

Salamanders.—Adults of three species, *Eurycea longicauda* (14), *E. lucifuga* (8) and *Typhlotriton nereus* (1) were taken in the Ozark Plateau of extreme southeastern Cherokee County, and seemed to be restricted to springs. These, as well as other adults of the first two species from northeastern Oklahoma, were devoid of chiggers.

Four aquatic adults and four terrestrial efts of *Notophthalmus viridescens* were negative. Newts from northeastern Oklahoma and other regions also were negative. Breeding occurs in small woodland pools in early spring, the adults returning soon after to decaying logs and subterranean habitats shared with the efts. The skin of these newts has poison glands, and their secretions may adversely affect the chigger mites. Louis Lipovsky placed unfed laboratory reared larvae of *H. eltoni* on an adult newt, and although one larva was seen to penetrate the skin, it continued to burrow until it died without noticeable engorgement.

All 46 individuals of *Ambystoma texanum* were negative. In eastern Kansas, breeding occurs in February and March, in shallow temporary pools and the salamanders then return to nearby burrows of crayfish and other animals, in the moist meadows and forested bottomlands. These salamanders frequently were taken in the same pools with leopard frogs which had numerous larvae of two species of *Hannemania.*

Ambystoma tigrinum was poorly sampled, being rare in extreme eastern Kansas where most of the study was done. Two of the four tiger salamanders examined had only recently transformed from aquatic larvae. The single adult that had 50 larvae of *H. eltoni* was taken in a temporary upland pool in early spring.

In summary, one (1.2%) of 81 salamanders had larvae of one species, *H. eltoni.* The absence of larvae from the other individuals and species seemed to be due to their restricted habitats, although secretions of the skin of the newt may repel or kill the burrowing chigger.

Frogs and toads.—Several species of frogs and toads examined in moderate to large numbers were negative. These species are listed below with comments on their habits and habitats, and the places in which they were obtained in the present study.

Rana catesbeiana even as an adult, usually stays near permanent bodies of water. Our specimens were taken in lakes and slowly flowing streams.

In western Kansas, the toads *Scaphiopus bombifrons* and *Bufo cognatus* occur in the upland prairie and frequently breed together. Those from northeastern Kansas breed in temporary pools in the Kansas River valley. These pools are formed by spring rains flooding cultivated fields. Chiggers are absent over much of this valley, especially in cultivated areas.

The following negative species usually breed in shallow, temporary pools: *Hyla versicolor,* which returns to the woods and arboreal habitats; *Pseudacris nigrita*, which leaves the water and lives in the soil; *Rana areolata*, which lives in burrows of crayfish and of certain other animals, in moist meadows; and *Gastrophryne olivacea*, which usually returns to the cover of limestone slabs on prairie or sparsely wooded slopes, or to other subterranean habitats.

The newly transformed frogs and toads are extremely small and thus may avoid discovery by larval chiggers. In addition, most of the above amphibians emerge from temporary pools around which *Hannemania* usually are absent, and the young frogs and toads usually move away from the pools soon after transformation.

Four species of frogs and toads examined were found to have larval chiggers attached on one or more individuals. The toads, *Bufo terrestris* and *Bufo woodhousii*, were parasitized on several occasions by a few larvae of *T.* (*Eutrombicula*), and *B. woodhousii* also occasionally had larvae of one or two species of *Hannemania*. *B. terrestris* usually occurs in moist meadows and woods in eastern

TABLE 3.—The amphibians examined from Kansas (1947-1954).

Species of amphibians	Eastern (Area B)					Western (Area A)	
	Total exam.	Feb.–May		June–Oct.		Total (April–Oct.)	
		exam.	hosts	exam.	hosts	exam.	hosts
Ambystoma texanum	46	45	0	1	0	0	0
Ambystoma tigrinum	3	1	0	2	0	1	1
Notophthalmus viridescens	8	8	0	0	0	0	0
*Eurycea longicauda**	14	14	0	0	0	0	0
*Eurycea lucifuga**	8	8	0	0	0	0	0
Scaphiopus bombifrons	97	97	0	0	0	3	0
Bufo cognatus	44	44	0	0	0	6	0
Bufo terrestris	68	61	0	7	1	0	0
Bufo woodhousii	56	48	3	8	6	9	2
Acris gryllus	67	24	10	43	23	3	3
Hyla versicolor	119	77	0	42	0	0	0
Pseudacris clarkii	0	0	0	0	0	3	0
Pseudacris nigrita	300	297	0	3	0	0	0
Gastrophryne olivacea	96	71	0	25	0	4	0
Rana areolata	26	26	0	0	0	0	0
Rana catesbeiana	34	18	0	16	0	1	0
Rana pipiens	147	106	52	41	27	19	19

* Taken in the Ozark area of Cherokee County, along with *Typhlotriton nereus* (1), *Hyla crucifer* (2), *Gastrophryne carolinensis* (1) and *Rana clamitans* (1), obtained February to May and all without chiggers.

Kansas, but *B. woodhousii* is widespread and common throughout the grasslands of the state. Both species breed in spring, usually in shallow temporary pools.

The cricket frog, *Acris gryllus,* and the leopard frog, *Rana pipiens,* were the amphibians most frequently found to be parasitized by chigger mites. A few larvae of *T.* (*Eutrombicula*) and *H. dunni* were recovered, whereas many individuals were parasitized by one or two species of *Hannemania.* Table 4 lists larvae recovered from the leopard frog.

In Kansas, the leopard frog is the most common and widespread amphibian and the most important host for *Hannemania.* The cricket frog, common in eastern Kansas, is also an important host for *Hannemania,* but the small size of this frog limits the number of larvae that can live on any individual.

These two frogs are semiaquatic, living in the vicinity of permanent water throughout the active season. The habitats of these two frogs and the species of *Hannemania* seem largely to coincide.

The most frequent site of attachment for *Hannemania* was on the undersides of the thighs, other larvae were found on the legs and belly whereas larvae of *Trombicula* were found on the dorsal surface.

TABLE 4.—*Rana pipiens* (Leopard frog), listed by area and month, with the total number of chiggers recovered.

Area	Months	Total examined	With chiggers	*H. eltoni*	*H. multifemorala*	*H. species**	*T. alfreddugèsi*	*T. lipovskyana*
B1a	Feb.–May	34	13	68(9)	52(7)	......	......	......
B1a	Feb.–May	46	22	......	......	357	......	......
B1a	June–Oct.	33	19	266(16)	178(11)	......	......	1?
B1a	July	4	4	......	......	39	......	......
B1b-B2	Feb.–May	26	17	57(14)	503(11)	......	......	......
B1b-B2	June–Oct.	4	4	15(3)	11(2)	......	......	......
A2a	April	1	1	23	23	......	......	......
A2b	September	1	1	5	......	......	......	......
A1b	September	16	16	101	......	......	1	......
A1a	July	1	1	2	......	......	......	......

* Refers to larvae of *Hannemania* counted (but not identified as *H. eltoni* or *H. multifemorala*) from Douglas County.

TABLE 5.—Summary of chiggers on amphibians from Kansas, excluding *H. dunni.*

	Bufo woodhousii	*Acris gryllus*	*Rana pipiens*
Total individuals examined	67	70	166
Total individuals with chiggers	11	32	98
Per cent with *Hannemania* species	12%	44%	58%
Total larvae of *Hannemania* species	23	106	1,700
Average number of *Hannemania* per host	3	3.3	18
Per cent with *H. eltoni*	10%	44%	53%
Total of *H. eltoni*	17	99	537
H. eltoni per host	2	3	9
Total with *Hannemania multifemorala*	3	4	32
Per cent with *H. multifemorala**	5%	6%	33%
Total of *H. multifemorala*	6	7	767
H. multifemorala per host*	2	2	24
Maximum *Hannemania* on one individual	5	10	150
Hosts with both species of *Hannemania*	2	4	22
Per cent of hosts with both *Hannemania**	3%	6%	23%
Total individuals with *T. (Eutrombicula)*	3	4	2

* Excluding the frogs and toads from western Kansas.

REPTILES

In Kansas, 2,628 reptiles of 48 species consisting of 27 turtles of 4 species, 1,736 lizards of 12 species and 892 snakes of 32 species were examined for chiggers.

The majority of the individuals and species were taken in eastern Kansas, from April to mid-October. The specimens from western and central Kansas, except for those from Russell County in late April, were taken in summer, (July to October).

Eleven species of chiggers were recovered from reptiles in Kansas; in addition, three chiggers known from Kansas, *T. splendens, N. americana* and *E. lacerta,* have been taken from reptiles in other states. The last two species have been taken only rarely from lizards.

A single species, *A. arizonensis,* seems to be restricted to lizards, and was found most frequently on collared lizards (*Crotaphytus*) and rough scaled lizards (*Sceloporus*).

In the State, reptiles were important hosts, perhaps the most important in many areas, for *T. alfreddugèsi, T. g. gurneyi* and *T. trisetica.* Chiggers common on both mammals and reptiles were *T. g. campestris, T. kansasensis,* and *T. montanensis,* with *T. lipovskyana* also common on birds. In areas where reptiles were the most common vertebrates, they usually would be the most important hosts for any of these seven species of *Trombicula.*

Uncommon or accidental parasites on reptiles include *T. myotis*, *T. fitchi* and *T. kardosi*, only a single larva of each being recovered from snakes, and *T. sylvilagi*, with several unengorged larvae from two snakes.

Three species of chiggers were taken from box turtles, lizards had seven species and snakes had ten species.

Seven different kinds of chiggers were recovered from the pilot black snake, *Elaphe obsoleta*, (69 individuals examined), representing the greatest variety found on any one species of reptile. Other snakes commonly having large numbers of chigger larvae attached in the summer included the blue racer, common garter snake, copperhead and bull snake.

The 355 gray skinks, *Eumeces obsoletus*, examined had four species of larvae, and several other lizards had three species attached.

Chiggers of Kansas not recovered from reptiles, although these chiggers may parasitize the reptiles, include *T. crossleyi* and *T. arenicola*, both having larvae that are active in spring and summer. Both are closely related to species which commonly occur on reptiles.

Other larvae (especially certain species of *Trombicula*) which occur in spring and summer possibly attach to reptiles.

A number of chigger mites were not found on reptiles although the larvae occurred frequently on warm-blooded hosts in spring and summer. Many hosts were taken along with reptiles from well-sampled areas (*e. g.*, the Natural History Reservation and Barber County). Summer species found only on mammals were *A. plumosus*, *T. hoplai*, *T. ornata*, *S. tadaridae*, *E. loomisi*, *E. lacerta*, *P. farneri*, *P. hungerfordi*, *N. americana* and *N. brennani*. In reptiles, tough dry skin and absence of moist, sheltered sites for attachment may account for the absence of some of these species. The small size of the cheliceral blade in several species (*e. g.*, *T. ornata*) may help to explain their absence from reptiles. The restricted microhabitat of the active unfed larvae of several species (such as in caves or nests of mammals) would reduce the chances of attachment on reptiles. Lastly reptiles were poorly represented in samples from some habitats, either because of their rarity or our failure to find them.

Certain sites on lizards were highly favorable for the attachment of larvae, including the axilla and groin, the mite pocket (collared lizards), under large scales of the neck (skinks) and between the large scales of the belly (racerunner). The slender glass snake and the brown skink both seem to repel successfully the larval chiggers.

TABLE 6.—Reptiles from eastern Kansas (Area B) examined for chiggers.

Species of reptiles	Total	March	April	May	June	July	August	September	October
Terrapene ornata	14	...	...	2	4	4	1	1	2
Sceloporus undulatus	1	...	...	...	1	...	...	...	...
Crotaphytus collaris	306	...	18	73	76	77	26	34	2
Ophisaurus attenuatus	25	...	9	1	2	1	5	7	...
Cnemidophorus sexlineatus	98	...	2	14	21	42	14	3	2
Lygosoma laterale	36	...	12	5	1	2	...	4	12
Eumeces fasciatus	850	68	294	172	123	85	81	25	2
Eumeces laticeps	4	...	...	4	...	...	...	...	...
Eumeces obsoletus	335	1	48	46	32	86	94	25	3
Natrix erythrogaster	1	...	...	...	...	1	...	...	...
Natrix rhombifera	1	...	...	...	...	1	...	...	...
Natrix sipedon	9	...	...	1	1	2	2	2	1
Storeria dekayi	13	1	7	2	1	1	1	...	...
Thamnophis sauritus	5	...	3	...	...	2	...	...	...
Thamnophis sirtalis	46	2	4	3	3	4	8	11	10
Heterodon platyrhinos	1	...	...	...	...	...	...	1	...
Diadophis punctatus	172	...	75	76	2	3	1	11	4
Carphophis amoenus	60	4	7	35	7	4	...	1	2
Coluber constrictor	124	...	16	13	4	3	7	12	69
Elaphe guttata	5	...	3	2	...	...	...	...	...
Elaphe obsoleta	70	1	14	13	8	4	10	6	15
Pituophis catenifer	21	...	2	6	3	1	...	2	7
Lampropeltis calligaster	15	...	1	4	1	2	3	3	1
Lampropeltis getulus	4	...	1	1	...	1	1	...	...
Lampropeltis triangulum	11	...	4	5	...	1	1	...	...
Tantilla gracilis	14	...	6	7	...	1	...	...	...
Ancistrodon contortrix	159	...	38	12	2	16	13	46	32
Sistrurus catenatus	2	...	...	...	1	...	...	...	1
Crotalus horridus	31	...	8	10	...	2	3	2	6

The sites of larval attachment on snakes were under the scales of the neck, body, tail and head; usually larvae were most common on the anterior third of the host.

A more complete discussion of these sites is given under *T. alfreddugèsi.*

Reptiles in nature did not seem to be adversely affected by the attachment of chiggers. A single instance of damage to the facial pit and skin of a captive rattlesnake, *Crotalus viridis*, was reported by Loomis (1951:83-84). The rattlesnake was placed in a chigger culture producing active unfed larvae of *T. splendens* and *T. g. gurneyi.* Numerous chiggers were observed on the snake, particularly on the head and neck. The area around one facial pit became enlarged and a number of larvae were seen in the pit. An

TABLE 7.—Collared lizards from eastern Kansas and their chiggers.

Crotaphytus collaris	Month	Total examined	With chiggers	*T. alfreddugèsi*	Number per host	*T. lipovskyana*
Univ. Kansas Nat. Hist. Res.						
Adults	May	18	5	10	2	.....
	June	37	35	7,621	217	.....
	July	40	40	6,998	175	.....
	Aug.	21	21	1,396	66	.....
	Sept.	1	1	20	20	.....
Juveniles	June	1	1	125	125	.....
	July*	0	...	...		.....
	Aug.	5	5	106	21	.....
	Sept.	31	28	170	6	.....
	Oct.	2	1	5	5	.....
Chase County (May 31, 1950). Adults	May	10	2	80	40	.....
Anderson County. Adults	June	31	31	5,136	165	.....
	July	24	23	2,967	129	28(6)

* The young of the previous year reach the size of young adults by July and are included with the adults.

increased rate of ecdysis was observed, possibly resulting from the damage to the pit. The cause of the swelling was not definitely determined; however attached chiggers may have caused the condition or contributed to it. The entire side of the head became greatly enlarged and the enlargement finally prevented feeding. The snake died in late 1951 nearly three years after capture and two years after the facial swelling and chigger attachments occurred. The great increase in size of the swollen area following the initial report (*op. cit.*) suggested a tumor but the cause was not definitely determined.

Other reptiles from eastern Kansas, obtained in small numbers and without chiggers, include the following: *Terrapene carolina*, Sept. (1); *Eumeces anthracinus*, April (1) and June (1); *Eumeces septentrionalis*, May (8) and Sept. (1); *Natrix grahamii*, May (1); *Thamnophis radix*, Nov. (1); *Tropidoclonion lineatum*, May (1); *Haldea valeriae*, April (3); and *Opheodrys aestivus*, April (1) and July (1).

TABLE 8.—Five-lined skinks, *Eumeces fasciatus*, from eastern Kansas (Area B) examined for chiggers.

Month and days, 1947–1953	Total examined	With chiggers	*T. alfreddugèsi*	*T. g. gurneyi*	*Trombicula* sp. (total)	Number per host	Number per skink
March (16–31)	50	0	....	....	....	......	......
April (1–15)	29	0	....	....	....	......	......
April (16–30)	256	18	....	227	....	......	......
May (1–15)	65	11	....	217	....	......	......
May (16–31)	102	23	3(2)	227(23)	230	10	2
June (1–15)	61	32	126(9)	1	218	6	4
June (16–30)	62	56	518(14)	112(8)	1,278	23	21
July (1–15)	50	37	222(13)	6(1)	1,055	29	21
July (16–31)	47	46	....	....	1,164	25	25
Aug. (1–15)	51	47	....	12(1)	997	21	20
Aug. (16–31)	30	30	....	(641)	452	15	15
Sept. (1–30)	23	15	....	....	65	4	3
Oct. (1–15)	1	0	....	....	....	......	......

TABLE 9.—Lizards from eastern Kansas (Area B) examined for chiggers.

Species of lizards	Month	Total examined	With chiggers	*T. alfreddugèsi*	Number per host	Number per lizard	*T. liporskyana*
Cnemidophorus sexlineatus	May	14	1	10	10	.7	.....
	June	21	20	13,050	653	620	.....
	July	42	41	11,819	288	281	.....
	August	14	13	1,500	115	107	.....
	September	3	3	43	14	14	.....
	October	2	1	1	1	.5	.....
Eumeces obsoletus...	May	46	2	3	1.5	.07	.....
	June	32	29	4,263	147	133	......
	July	86	80	18,825	235	219	2
	August	94	91	12,063	133	128	......
	September	25	23	1,406	61	56	......
	October	3	2	2	1	.6	......

TABLE 10.—Reptiles from eastern Kansas (Area B) examined for chiggers.

Species of reptiles (totals examined in summer are in parentheses)	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. liporskyana*	*T. g. gurneyi*	*T. trisetica*
Terrapene ornata (12)......	June	4	3	11	......	......	......
	July	4	4	90	3	......	......
	Aug.	1	1	2	......	......	......
Sceloporus undulatus (1)....	June	1	1	8	......	......	......
Ophisaurus attenuatus (15)..	Aug.	5	1	1	......	......	......
Eumeces laticeps (4)........	May	4	4	....	......	10(1)	500(3)
Natrix erythrogaster (1).....	July	1	1	31	......	......	......
Natrix rhombifera (1 juv.)...	July	1	1	5	......	......	......
Natrix sipedon (8).........	June	1	1	5	......	......	......
	July	2	2	430	......	......	......
	Aug.	2	1	190	......	......	......
Heterodon platyrhinos (1)....	Sept.	1	1	13+	......	......	......
Diadophis punctatus (21)....	June	2	1	1	......	......	......
	July	3	1	1	......	......	......
	Sept.	11	3	3	......	......	......
Lampropeltis calligaster (10)	July	2	1	4	......	......	......
	Aug.	3	2	450	......	......	......
	Sept.	3	2	30	......	......	......

TABLE 11.—Snakes from eastern Kansas (Area B) examined for chiggers.

Species of snakes (total in parentheses)	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. sylvilagi*	*T. kansasensis*	*T. g. gurneyi*	*T. trisetica*	*T. montanensis*
Thamnophis sirtalis.... (36)	June	3	3	330						
	July	4	3	98						
	Aug.	8	8	850	20		4			
	Sept.	11	7	137	20					
	Oct.	10	6	181						
Coluber constrictor (95)	June	4	2	325						
	July	3	3	771	275					
	Aug.	7	7	3,023	10					
	Sept.	12	11	1,464						
	Oct.	69	40	923	35	5(1)	1			
Pituophis catenifer... (13)	June	3	2	1,521						
	July	1	1	2,200						
	Sept.	2	2	70						
	Oct.	7	6	95			210(2)			46(1)
Ancistrodon contortrix.. (107)	July	16	16	5,898	110				1	
	Aug.	13	11	1,340						
	Sept.	46	41	1,204	19	1				
	Oct.	32	18	137						
Lampropeltis getulus (2)	July	1	1	25						
	Aug.	1	1	310	50					
Lampropeltis triangulum (2)	July	1	1	90						
Elaphe obsoleta... (69)	April	14	1[1]							
	May	13	2					9		
	June	8	5	367				3(1)		
	July	4	4	313	17(1)			33(1)		
	Aug.	10	9[2]	392						
	Sept.	6	4[3]	316				1	700(1)	
	Oct.	14	6	23				1		
	Nov.	1	1	4						

1. One *T. kardosi* recovered.
2. Also one *T. myotis* recovered.
3. Also one *T. fitchi* obtained.

TABLE 12.—Reptiles from Barber County (Areas A1b and A2b) and adjacent Woods County, Oklahoma (asterisk) examined for chiggers.

Species of reptiles (total number) (* Woods Co., Okla.)	Month	Total examined	With chiggers	*A. arizonensis*	*T. alfreddugèsi*	*T. g. campestris*	*T. montanensis*
Terrapene ornata (9)	Aug.	2	2	...	31	...	3
	Sept.	7	7	...	60+	...	...
Crotaphytus collaris (5)	April	1	0	...	...	...	...
(2*)	Sept.	3	1	20	5	...	...
	*Oct.	2	2	80	25(1)	...	...
Holbrookia maculata (2)	Aug.	2	0	...	...	...	...
Sceloporus undulatus (6)	April	1	0	...	...	...	...
(1*)	July	1	0	...	...	...	...
	Sept.	4	1	...	2	...	...
	*Oct.	1	1	...	1	...	...
Phrynosoma cornutum (3)	Sept.	3	0	...	...	...	...
Eumeces obsoletus (3)	April	1	0	...	...	...	...
	July	1	1	...	5	...	...
	Sept.	1	1	...	7+	...	...
Heterodon nasicus (1)	Aug.	1	0	...	...	...	...
Heterodon platyrhinos (1)	Sept.	1	1	...	20	...	...
(1*)	*Oct.	1	1	...	6	4	227
Masticophis flagellum (1)	*Aug.	1	1	...	70	30	50
(1*)	Sept.	1	1	...	30	200	15
Arizona elegans (1 juv.)	Sept.	1	1	...	...	1+	...
Pituophis catenifer (1)	Aug.	1	1	...	2	...	...
Sonora episcopa (2)	Sept.	2	0	...	...	...	...
(8*)	*Sept.	8	1	...	1	...	...
Hypsiglena torquata (1)	Sept.	1	0	...	...	...	...
Sistrurus catenatus (1)	April	1	0	...	...	...	...
Crotalus viridis (12)	April	3	0	...	...	...	...
	Aug.	4	3	...	6(2)	...	137
	Sept.	4	1	...	...	...	26
	Oct.	1	1	...	2	...	137

* Woods County, Oklahoma.

BIRDS

In Kansas, 628 birds of 79 species were examined for chiggers, 407 of these being obtained in Douglas County. The birds were taken from 1947 to 1954. The months best represented were July (119 birds) and November (103 birds), the smallest sample (7 birds) was from January. December and February (each with 23 birds) also were low. Complete summaries of those from eastern Kansas will follow.

The birds from central and western Kansas (except from Russell

County) were taken in summer. See Table 16 to follow on the avian collections and their chiggers in Barber County.

A total of 14 species of chiggers were recovered from these birds. Six of these chigger mites were taken only in the western half of the State. The only chigger taken solely from birds was *N. brennani*, whereas the other five species, *T. batatas, T. crossleyi, T. arenicola, T. gurneyi* (including *T. g. campestris*) and *T. montanensis*, were taken also on other hosts. *T. crossleyi* was found principally on birds. In the west, two other chiggers, *T. alfreddugèsi* and *N. americana*, occasionally were found attached to birds.

In eastern Kansas, birds seem to be major hosts for *T. alfreddugèsi, T. lipovskyana* and *N. americana*, and minor hosts for *T. lipovskyi, T. whartoni*, and *T. sylvilagi*, whereas the occurrences of *E. peromysci* and *E. diversa* seem to have been accidental. These latter two species regularly attach to small mammals.

In addition, *T. splendens* and *A. galli* have been taken from birds in other states. *T. trisetica* also probably occurs normally on birds.

The three species, *T. alfreddugèsi, T. lipovskyana* and *N. americana*, commonly found attached to birds are the most common and widespread surface-dwelling larvae which are active in the warm summer months. The first two species also were abundant on both mammals and reptiles. *N. americana* also was found commonly on the cottontail, an important host in some areas. Birds, however, were important hosts throughout and probably the only hosts in many areas. The species of *Neoschöngastia* regularly parasitize birds throughout the world.

T. lipovskyana was found more commonly attached to birds than to mammals or reptiles, probably because the samples from its habitat included more birds than either mammals or reptiles. Reptiles were rarely taken at known stations of *T. lipovskyana.*

Euschöngastia peromysci and *E. diversa* regularly occur on mammals and seem to live in the immediate vicinity of mammalian burrows and nests.

Birds in general seem to be the hosts which transport chigger larvae long distances and help to populate or repopulate suitable areas. The birds probably are chiefly responsible for the wide ranges of several warm weather species of chiggers, particularly of the subgenus *Eutrombicula.*

Birds which nest in decaying wood or burrows also would be potential hosts for other species of chiggers. The chiggers which probably occur in the immediate vicinity of nesting sites of birds include *N. brennani* and *T. crossleyi* found commonly on woodpeckers which nest in tree-holes; *N. americana* which is common on ground nesting birds, and probably other species of chiggers which occur in the soil and would drop off in or near nests on the ground or in burrows. Burrowing owls had two species of chiggers which normally were found on burrowing mammals.

The six species of chiggers commonly found on birds in eastern Kansas all are known to occur regularly as unfed larvae on the surface of the soil. Several species, especially *N. americana,* are common in open situations which are commonly visited in daylight by birds but are rarely frequented at any time by mammals or reptiles. Cottontails and their sign were commonly observed in several areas in which unfed larvae of *N. americana* were taken on chigger samplers. The diurnal activity of cottontails and of birds would seem to correlate with the known activity of unfed *N. americana.*

The 10 species of *Trombicula* that were found on birds in Kansas, have at least one long nude whiplike seta on leg III (except for *T. gurneyi;* it was taken only twice in small numbers on woodpeckers which nest in decaying wood and on burrowing owls inhabiting mammalian burrows). Four of the ten species have several nude whiplike setae on leg III which may be tactile organs, probably more sensitive than the branched setae of the legs and body, to aid in finding suitable hosts.

The larvae of *Neoschöngastia* in Kansas do not possess long nude setae on Leg III; several setae on tarsus III, however, are elongate and nude along much of the distal end. They possess expanded sensillae, unique for larvae regularly found on birds. The function of the sensillae may be to determine the proper time for detachment from volant hosts. See pp. 1420-1423 for further discussion.

The sites of attachment on birds seemed to center around the thighs, wings, tail and adjacent parts of the body. Few were taken on the head, neck or back. Large patches of larvae of *N. americana, T. alfreddugèsi* and *T. lipovskyana* were found on the bodies and legs of several ground-dwelling birds. The skin was swollen around these masses of attached chiggers and probably caused severe irritation to the hosts. Young of chickens and of other ground-dwelling birds may acquire infestations large enough to weaken or kill them.

Species of birds from eastern Kansas examined in small numbers and found to lack chiggers are the following: *Buteo jamaicensis,* March (1); *Circus cyaneus,* Dec. (1); *Tringa solitaria,* August (1); *Chordeiles minor,* Sept. (2); *Sphyrapicus varius,* October (1);

Dendrocopus villosus, Feb. (1), Oct. (1) and Nov. (1); *Myiarchus crinitus,* May (1) and June (1); *Empidonax virescens,* May (2); *Petrochelidon pyrrhonota,* August (1); *Hirundo erythrogaster,* May (2) and July (2); *Certhia familiaris,* Jan. (1); *Troglodytes troglody-*

TABLE 13.—Birds from eastern Kansas (Area B) examined for chiggers.

Species of birds	Total examined	January–February	March–April	May	June	July	August	September	October	November	December
Falco sparverius	2	...	...	...	...	...	1	...	1	...	...
Tympanuchus cupido	4	...	...	...	...	...	3	...	1	...	...
Colinus virginianus	18	...	...	...	...	4	...	...	...	14	...
Rallus elegans	1	...	...	...	1	...	...	...	...	...	...
Bartramia longicauda	1	...	...	...	...	1	...	...	...	...	...
Zenaidura macroura	35	...	...	3	3	19	3	4	1	2	...
Coccyzus americanus	4	...	...	...	1	1	2	...	...	...	...
Columba livia	7	...	...	...	...	2	...	5	...	...	...
Bubo virginianus	2	...	...	...	...	...	...	...	...	...	2
Asio otus	1	...	...	...	...	...	...	...	...	1	...
Colaptes auratus	3	1	...	...	...	1	...	...	...	1	...
Centurus carolinus	10	...	4	3	...	...	...	...	1	2	...
Melanerpes erythrocephalus	7	...	...	1	...	...	...	4	2	...	...
Dendrocopus pubescens	5	...	2	2	...	...	...	...	...	...	1
Tyrannus tyrannus	3	...	...	...	1	...	2	...	...	...	...
Cyanocitta cristata	5	...	...	...	1	...	1	3	...	...	...
Corvus brachyrhynchos	4	...	...	1	2	...	...	...	...	1	...
Parus atricapillus	24	2	7	2	...	2	...	...	...	8	3
Parus bicolor	6	...	1	...	...	...	...	...	2	2	1
Troglodytes aedon	2	...	...	1	...	...	1	...	...	...	...
Dumetella carolinensis	3	...	...	1	...	2	...	...	...	...	...
Toxostoma rufum	3	...	...	...	...	2	1	...	...	...	...
Sialia sialis	14	1	...	2	...	3	2	1	...	4	1
Turdus migratorius	18	1	8	1	2	1	3	1	1	...	...
Sturnus vulgaris	11	...	...	1	3	...	3	...	3	1	...
Passer domesticus	37	...	3	...	4	5	8	3	11	3	...
Agelaius phoeniceus	37	1	12	7	4	5	...	2	4	2	...
Icterus galbula	1	...	...	...	...	...	1	...	...	...	...
Molothrus ater	39	...	1	1	...	4	17	12	4	...	...
Quiscalus quiscula	8	...	1	...	2	...	...	5	...	...	...
Sturnella magna	5	...	1	...	...	2	1	...	1	...	...
Sturnella neglecta	5	...	3	...	...	...	...	...	...	2	...
Piranga rubra	1	...	...	...	...	...	1	...	...	...	...
Richmondena cardinalis	38	5	8	5	...	2	...	2	4	7	5
Spiza americana	15	...	...	2	5	8	...	...	...	...	...
Chondestes grammacus	2	...	...	...	...	1	1	...	...	...	...
Junco hyemalis	27	6	1	...	...	...	...	...	4	12	4
Spizella arborea	24	1	2	...	...	...	...	...	...	20	1
Spizella passerina	3	...	...	1	...	...	2	...	...	...	...
Zonotrichia albicollis	2	1	...	1	...	...	...	...	...	...	...
Zonotrichia querula	12	...	1	1	...	...	...	...	...	8	2
Melospiza melodia	16	7	...	...	...	...	...	...	...	9	...

TABLE 14.—Birds from eastern Kansas (Area B) examined and found to have chiggers.

Species of birds	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. whartoni*	*T. sylvilagi*	*N. americana*
Tympanuchus cupido	Aug.	3	3	270	180(2)				610
Colinus virginianus	July	4	4	common	common				1
	Nov.	14	1					1	
Rallus elegans	June	1	1	4	12				20
Bartramia longicauda	July	1	1		70				
Zenaidura macroura	June	3	3	8(2)	10				
	July	5	4	50	110				
	July	14	14	few	few				
	Aug.	3	1		3				
	Sept.	4	1		8				
Colaptes auratus	July	1	1	38					
Parus atricapillus	Mar.	2	1						*
	Dec.	3	1			2			
Parus bicolor	Oct.	2	1	1				1	
	Nov.	2	2				7		
Dumetella carolinensis	July	2	2	14					1
Toxostoma rufum	July	2	2	135					13
Sialia sialis	July	3	2	1	2				2
	Aug.	2	1	2	2				
Turdus migratorius	June	2	2	4					
	July	1	1	19					
	Aug.	3	2	22	87				78
	Sept.	1	1	50	100				32
	Oct.	1	1	1				1	
Sturnus vulgaris	June	3	2	32	12				
	Aug.	3	1	1	7				
Passer domesticus	June	4	3	9	1				
	July	5	4	52	51				7(2)
	Aug.	8	4	21	22				14(2)
	Sept.	3	3	7(2)	12(2)				13(1)
	Oct.	11	1		4				
	Nov.	3	1						*
Agelaius phoeniceus	July	5	3		23				
	Sept.	2	1	5	5				
	Oct.	4	3		20				
Molothrus ater	July	4	4	20	25(2)				51(2)
	Aug.	17	3		4(2)				2(1)
	Sept.	12	4	(sp. ?	12)				
	Oct.	4	3		6(2)				5(1)
Quiscalus quiscula	June	2	2	37	53				
	Sept.	5	5	35					
Sturnella magna	July	2	2	17	19				1
	Aug.	1	1	1	5				
	Oct.	1	1	4	15				
Sturnella neglecta	Nov.	2	2		5	1			

TABLE 14.—Birds from eastern Kansas (Area B) examined and found to have chiggers.—*Concluded.*

Species of birds	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. whartoni*	*T. sylvilagi*	*N. americana*
Richmondena cardinalis	Jan.	2	1	.....	.....	1	.....	.....	.....
	July	2	2	71	1	.....	.....	.....	4
	Sept.	2	1	9	10	.....	.....	.....	1
	Oct.	4	2	5	6	.....	.....	.....	5
	Nov.	7	3	1	.....	.....	3(2)	2(1)	3(1)*
	Dec.	5	4	.....	.....	2(2)	2(2)	.....	.....
Spiza americana	June	5	1	.....	1	.....	.....	.....	.....
	July	8	7	27(6)	79	.....	.....	.....	12(3)
Chondestes grammacus	July	1	1	1	.....	.....	.....	.....	1
	Aug.	1	1	2	1	.....	.....	.....	3
Junco hyemalis	Oct.	4	2	.....	.....	.....	3	.....	.....
	Nov.	12	3	.....	.....	.....	4	1	.....

* 1 *E. diversa* recovered.

tes, May (1); *Telmatodytes palustris,* Oct. (1); *Mimus polyglottis,* Jan. (1) and June (1); *Lanius ludovicianus,* May (1) and Nov. (1); *Vireo olivacea,* Sept. (1); *Dendroica coronata,* Nov. (2); *Contopus virens,* Sept. (1); *Geothlypis trichas,* March (1) and June (1); *Guiraca caerulea,* June (1); *Passerina cyanea,* June (1); *Spinus tristis,* Sept. (2) and Dec. (1); *Pipilo maculatus,* Dec. (1); *Passerculus sandwichensis,* March (3); *Pooecetes gramineus,* Oct. (1); *Zonotrichia leucophrys,* Oct. (1); *Passerella iliaca,* Feb. (2) and March (1); and *Melospiza lincolnii,* Oct. (1).

Birds from eastern Kansas (B) examined and found to have chiggers in extremely small numbers, include the following, arranged by host, positive month (total positive) and the species of chigger, *T. alfreddugèsi* unless otherwise noted: *Coccyzus americanus,* August (1) with 1; *Asio otus,* Nov. (1) with 2 *T. lipovskyi; Centurus carolinus,* Nov. (1) with 2 *T. lipovskyi; Melanerpes erythrocephalus,* Sept. (1) with 2; *Tyrannus tyrannus,* August (1) with 2 *T. lipovskyana; Cyanocitta cristata,* June (1) with 2; *Corvus brachyrhynchos,* June (1) with 8 and 2 *E. peromysci; Troglodytes aedon,* August (1) with 4 and 1 *T. lipovskyana; Icterus galbula,* August (1) with 1; *Piranga rubra,* Sept. (1) with 5; *Spizella passerina,* August (1) with 1; *Zonotrichia querula,* Nov. (1) with 1 *T. whartoni; Melospiza melodia,* Nov. (1) with 1 *T. lipovskyi.*

TABLE 15.—Summary of the birds from eastern Kansas and their chiggers.

Month 1947–53	Total birds	Total hosts	Number of species of hosts	Species of chiggers
January	7	1	One species	*T. lipovskyi*
February	23	0		
March	35	1	One species	*E. diversa*
April	27	0		
May	43	0		
June 1–13	14	1	One species	*T. alfreddugèsi* *E. peromysci*
June 14–30	21	15	Eight species	*T. alfreddugèsi* *T. lipovskyana* *N. americana*
July	67	54	Fifteen species	
August	54	22	Fourteen species	
September	49	18	Nine species	
October	46	14	Eight species	*T. alfreddugèsi* *T. lipovskyana* *N. americana* *T. whartoni* *T. sylvilagi*
November	103	16	Ten species	The five in Oct. plus *T. lipovskyi* *E. diversa*
December	23	5	Two species	*T. lipovskyi* *T. whartoni*

TABLE 16.—Birds from Barber County (Areas A1b and A2b) examined for chiggers.

Species of birds	Months	Total examined	With chiggers	*T. alfreddugèsi*	*T. gurneyi*	*T. crossleyi*	*T. montanensis*	*N. brennani*
Ictinia misisippiensis	July–Sept.	5	0	....	....	....	....	....
Buteo jamaicensis	August	1	1	1	....	....	....	....
Falco sparverius	September	2	0	....	....	....	....	....
Colinus virginianus	July, Sept.	6	3	11	....	....	....	....
Charadrius vociferus	August	1	0	....	....	....	....	....
Melanerpes erythrocephalus	July	4	4	3	8	45	....	250
	Aug.–Sept.	3	1	....	....	2	....	....
Dendrocopus pubescens	September	1	0	....	....	....	....	....
Tyrannus tyrannus	July	1	1	....	....	....	....	1
	Aug.–Sept.	5	0	....	....	....	....	....
Muscivora forficata	July–Sept.	7	0	....	....	....	....	....
Eremophila alpestris	July–Sept.	8	1	1	....	....	....	....
Cyanocitta cristata	July	1	1	....	....	....	1	....
Parus atricapillus	September	2	0	....	....	....	....	....
Passer domesticus	July	2	0	....	....	....	....	....
Sturnella neglecta	July	5	1	2	....	....	....	....
Chondestes grammacus	July	5	3	7	....	....	....	1

MAMMALS

In Kansas, 2,090 mammals of 46 species were examined for chigger larvae. This included 1,175 mammals of 31 species from eastern Kansas (throughout the year); 669 of 18 species from Barber County (February to October); 191 of 16 species from northwestern Kansas (July to November); 30 of 10 species from Seward County (September); and 23 of 3 species from Russell County (April), from 1946 to 1954.

Of the 40 species of chiggers recovered from these mammals, 20 including *L. americana, A. plumosus, W. senase, T. twentei, T. cynos, T. jonesae, T. hoplai, T. ornata, S. tadaridae, E. setosa, E. pipistrelli, E. jonesi, E. criceticola, E. cynomyicola, E. trigenuala, E. loomisi, P. hungerfordi, P. farneri, C. micheneri* and *W. americana* were found only on mammals. Two additional species, *E. lacerta,* originally found on a lizard in California, and *A. galli,* from a chicken in Texas, were taken only on mammals in Kansas.

Six species, *T. myotis, T. fitchi, T. kardosi, T. arenicola, E. peromysci* and *E. diversa,* seem to be parasitic almost exclusively on mammals but were found singly or in small numbers also on other hosts.

T. lipovskyi, T. whartoni and *T. sylvilagi* are found on both birds and mammals in Kansas, but seem to occur more regularly on mammals.

N. americana, T. crossleyi and *T. batatas* were taken from birds as well as from mammals; *T. trisetica* and *T. kansasensis* were taken from both mammals and reptiles; and *A. alfreddugèsi, T. lipovskyana, T. gurneyi,* and *T. montanensis* from mammals, reptiles and birds. *T. montanensis* seems to occur primarily on prairie dogs and other small mammals.

T. splendens was not recovered in the larval stage in Kansas; however it occurs regularly on mammals in adjacent states. The three species on the hypothetical list also have been found on mammals.

The mammals represent the principal hosts for most of the species of chiggers in the State. Of the 40 species of chiggers which occur on mammals, 31 of these seem to be parasitic on mammals predominately and an additional eight species occur commonly on mammals as well as other vertebrates.

Factors favoring acquisition and maintenance of these many kinds of chiggers by mammals include the widespread occurrence and abundance of mammals and the activity of most species throughout the year, the large amount of daily movement by most individuals, their runs, burrows in the soil and nest cavities in decaying wood and trees, all of which provide favorable micro-habitats for chiggers. The mammalian body affords warm moist sites for larval attachment, frequently in protected areas such as the ears, and under a protective coat of hair.

Eight of the 46 species of mammals were found to have ten or more species of chigger mites attached over the year. The cottontail (233 individuals examined) had 21 species of chiggers; whereas the white-footed mouse (155) and the deer mouse (172) each had 20 different kinds. All three of these species were well sampled throughout the State in most of the seasons.

The gray wood rat (92) had 18 species of chiggers. All of these wood rats were taken in Barber County, and all but one of the species of chiggers were found on the rats trapped in a single canyon four miles south of Aetna. At least eight kinds of chiggers were found on a single wood rat. The eastern wood rat (46) had 11 kinds of chiggers attached.

The fox squirrel (58) and the gray squirrel (12) had 14 and 11 species of chiggers respectively. All of these squirrels were from eastern Kansas.

The hispid pocket mouse (33) had 10 kinds of chiggers. These mice were taken in several areas from over the State in the warm months of May to October. They usually hibernate in the winter.

Other mammals which were frequently sampled, but possessed fewer kinds of chiggers include the following: prairie dog (33), kangaroo rat (46), each with 9 kinds of chiggers; cotton rat (99) and prairie vole (224) each with 8 species of chiggers; house mouse (93) and western harvest mouse (90) with six species of chiggers; and the cave bat (413, from one area) with four species of chiggers.

Whether or not a large number of species of chigger mites will be found on a particular kind of mammal seems to depend on examination of a good sample of individuals from different areas, in different habitats and in different seasons.

The eight hosts which had more than ten species of chigger mites fit most of these categories. All but the gray squirrels were well sampled; however the samples of fox squirrels, and the gray and eastern wood rats were from limited areas and the hispid pocket mice were not sampled in the winter, as they hibernate.

The larvae of most species of chigger mites were attached in the same areas on different individuals and different kinds of mammals.

The most frequent sites of attachment were in the ears and on the belly, legs and feet. Some species occurred principally in or on the ears, whereas others were found mainly on the body and limbs, or over the entire host.

Most of the species which regularly inhabited the ears have been found solely on mammals. Those which seemed to be restricted to the ears, and usually attached deep in the external auditory meatus, were *P. hungerfordi* and *P. farneri;* whereas larvae of *T. ornata, S. tadaridae, E. pipistrelli, E. jonesi, E. peromysci, E. diversa, E. cricelicola, E. lacerta, E. loomisi* and probably others normally were attached on the tragus and antitragus, or in the shallow depressions behind them, or on the pinna. When abundant, chiggers of the latter group frequently were found also on the face.

The ear is perhaps the best site for the larvae to attach, since it provides a moist shelter where the skin is soft and is free of long thick hair which would repel most larvae. The mammals having ears best suited for larval attachment were bats, rabbits and cricetid mice and rats, all possessing relatively large ears. Many species of chiggers which frequently attached in the ears also were common in other sites. They seemed less specific in the selection of sites for attachment.

In some mammals, especially squirrels and prairie dogs, ears are relatively small and possess tough hairy skin. These sciurids rarely had larvae of any species attached in their ears. Most of the chiggers which regularly attached to ears were either rare or entirely absent (*e. g., Pseudoschöngastia*).

The region including the belly and the base of the tail is another site commonly used by chigger larvae. The sparse covering of hair of this region on most mammals, especially around the genitalia and the anal opening affords easy access to the soft moist skin. This region also is in close proximity to the feet and legs and the ground from which most of the larvae originate. Chigger species which seemed to prefer this region includes *T. cynos, T. fitchi, T. kardosi, T. gurneyi, T. kansasensis, T. trisetica, T. montanensis, E. cynomyicola, E. trigenuala* and *W. americana.* This region, along with the inner thighs, is the principal site of attachment for larvae on the sciurids. Other species found commonly on the belly and inner thighs included *E. setosa* and *C. micheneri.* In addition, *T. alfreddugèsi, T. lipovskyana,* and *N. americana* were regularly found on the feet of the cottontail as well as on the belly and thighs.

Species of chiggers commonly found in the ears as well as on the body and limbs, included *T. lipovskyi, T. whartoni* and *T. sylvilagi.*

Many of the winter species, excepting those occurring regularly on sciurids, were in the ears of the hosts. This was particularly true for the colder periods of the winter. Many of the summer species, except for *Pseudoschöngastia,* were found on the belly, legs and feet.

The neck, head, back, and sides of the body usually are covered

TABLE 17.—Mammals from eastern Kansas (Area B) examined for chiggers.

Species of mammals	Total	January	February	March	April	May	June	July	August	September	October	November	December
Didelphis marsupialis	4	1	...	2	...	...	...	...	...	...	...	1	...
Blarina brevicauda	18	...	...	...	...	...	1	2	...	1	5	9	...
Cryptotis parva	11	...	1	...	...	...	...	...	2	...	7	1	...
Scalopus aquaticus	12	...	...	...	...	2	1	...	...	1	1	7	...
Myotis lucifugus	20	...	...	...	...	...	...	...	...	...	...	...	20
Myotis keenii	4	...	...	...	...	...	...	...	...	...	...	...	4
Pipistrellus subflavus	53	...	...	1	...	...	...	...	...	...	...	...	52
Eptesicus fuscus	3	...	...	...	...	...	...	...	...	...	...	...	3
Lasiurus borealis	2	...	...	...	...	1	1	...	...	...	...	...	...
Lepus californicus	5	...	2	...	...	...	...	...	...	1	...	...	2
Sylvilagus floridanus	218	29	8	16	7	8	12	17	15	4	4	58	40
Sciurus carolinensis	12	...	...	...	...	3	...	...	1	...	2	3	3
Sciurus niger	58	4	...	2	2	1	...	1	2	10	4	31	1
Marmota monax	1	...	...	...	...	...	...	...	...	...	...	1	...
Tamias striatus	2	...	...	...	...	...	...	1	...	1	...	...	...
Geomys bursarius	2	...	...	...	...	...	...	...	...	1	...	1	...
Perognathus hispidus	1	...	...	...	...	1	...	...	...	...	...	...	...
Reithrodontomys megalotis	76	9	5	1	8	3	7	3	3	...	2	30	5
Peromyscus leucopus	126	10	15	13	25	8	13	8	17	3	3	11	...
Peromyscus maniculatus	94	3	4	1	31	9	3	5	11	2	4	21	...
Sigmodon hispidus	83	2	2	...	3	1	1	9	19	...	27	18	1
Neotoma floridana	41	...	11	10	2	...	...	1	6	...	...	8	3
Microtus ochrogaster	219	13	9	5	43	17	32	27	38	2	5	37	1
Microtus pinetorum	10	2	4	...	...	...	...	1	2	...	...	2	...
Rattus norvegicus	5	...	...	...	...	...	...	...	...	...	3	2	...
Mus musculus	84	1	1	...	3	1	2	2	22	2	17	33	...
Zapus hudsonius	2	...	...	...	...	...	...	...	...	1	1	...	...
Canis latrans	5	1	...	...	...	...	...	...	...	...	...	...	4
Canis familiaris	1	...	...	...	...	...	...	...	1	...	...	...	...
Procyon lotor	1	...	...	...	...	...	...	...	1	...	...	...	...
Spilogale putorius	2	...	...	...	...	...	...	...	...	...	...	2	...

with long closely set hair which does not afford access to the skin beneath it for the larvae. These areas are therefore of little importance as sites for attachment.

Larvae of several species cause an area of irritation and inflammation at the site of attachment on the mammalian skin. The common pest chiggers, of the subgenus *Eutrombicula,* and certain species of *Neotrombicula* are known to cause this dermatitis in man. Larvae of other species, such as *T. montanensis, T. gurneyi, E. setosa* and *W. americana,* have been found attached in the center of swollen areas on many different mammals.

Mammals from eastern Kansas (B) with few chiggers include the following, along with the month of collection, (total positive) and number of chiggers found: *Didelphis marsupialis,* Nov. (1) with 1 *T. lipovskyi; Myotis lucifugus* (2), *Myotis keenii* (1) and *Pipistrellus subflavus* (3) Dec. with 2, 6 and 17 *E. pipistrelli* respectively; *Tamias striatus,* July (1) with 32 *T. alfreddugèsi; Geomys bursarius,* Sept. (1) with 1 *E. trigenuala* and Nov. (1) with 2 *E. diversa; Lepus californicus,* Dec. (1) with 6 *T. lipovskyi; Mus musculus,* Oct. (2) with 4 *T. sylvilagi* and 1 *P. hungerfordi* and Nov. (12) with 3 *T. whartoni* and 25 *E. diversa; Rattus norvegicus,* Nov. (1) with 1 *T. lipovskyi; Zapus hudsonius,* Oct. (1) with 4 *T. sylvilagi; Procyon lotor,* August (1) with 3 *T. alfreddugèsi; Canis latrans,* Jan. (1) with 3 *E. diversa* and Dec. (2) with 4 *T. lipovskyi; Canis familiaris,* August (1) with 1 *T. alfreddugèsi* and 10 *T. lipovskyana.*

TABLE 18.—Shrews and moles from eastern Kansas (B) with chiggers.

Species of mammals	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. sylvilagi*	*T. g. gurneyi*	*E. jonesi*	*E. diversa*	*E. trigenuala*	*P. farneri*
Blarina brevicauda	June	1	1	......	......	......	......	......	......	......	1	......
	July	2	1	......	......	......	......	1	......	......	......	......
	November	9	4	......	......	20	......	......	......	2	......	......
Cryptotis parva	August	2	2	......	......	......	......	......	......	......	......	23
	October	7	3	4(2)	2(1)	......	2(1)	......	12(1)	......	......	......
Scalopus aquaticus	May	2	2	......	......	......	......	......	......	......	35	......
	September	1	1	......	1	......	......	......	......	......	......	......
	November	7	3	......	......	......	......	1	......	......	44	......

TABLE 19.—Cottontails, *Sylvilagus floridanus,* from eastern Kansas (Area B) and their chiggers

Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. whartoni*	*E. setosa*	*E. jonesi*	*E. peromysci*	*E. diversa*	*P. hungerfordi*	*C. micheneri*	*N. americana*	*W. americana*
January	29	8	...	...	62	...	...	2	...	23	...	...	...	...
February	8	5	...	...	4	...	...	...	...	17	...	...	...	...
March	16	15	...	...	247	...	...	...	8	161	...	...	...	...
April	7	7	...	...	4	...	...	1	...	24	...	...	...	...
May	8	1	...	...	...	...	...	...	...	1	...	...	...	...
June	12	8	2,443	534	...	...	...	...	...	...	1	...	4	...
July	17	16	12,000	6,465	...	...	...	...	...	...	510	...	1,645	...
August	15	13	320	42	...	...	...	...	...	...	196	...	1,575	...
September	4	4	65	20	...	...	...	...	...	...	5	...	108	...
October	4	3	...	...	252	15	...	...	1	...	...	...	...	...
November	58	41	1	...	7,231	385	312	...	...	122	1	18	1	1
December	40	40	...	...	3,979	10	7	5	...	137	...	...	...	...

TABLE 20.—Tree squirrels from eastern Kansas (Area B) and their chiggers.

Species	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. whartoni*	*T. sylvilagi*	*T. jonesae*	*T. cynos*	*T. fitchi*	*T. kardosi*	*T. g. gurneyi*	*T. trisetica*	*E. setosa*	*E. diversa*	*W. americana*
Sciurus carolinensis	May	3	2										22	52			7
	October	2	1					1		1	3						
	November	3	3			33(1)	6(1)			6(1)	139				4(1)		8(2)
	December	3	3			2(1)									5(2)		5(2)*
Sciurus niger	January	4	4			6(3)				4(2)	6(2)				1		8
	March	2	2								18						7(1)
	April	2	1													1	
	July	1	1	2													
	August	2	1	26													
	September	9	9	26(3)	3(2)			19(7)					1				7(2)**
	October	4	2			1	4		1						52		
	November	31	31			120(21)	52(12)			1	104(20)	88(1)			52(19)		777(19)

* One *E. jonesi* and one *C. micheneri* also obtained.
** One *E. trigenuala* also recorded, but doubtful.

TABLE 21.—Mice from eastern Kansas (Area B) and their chiggers.

Species	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. sylvilagi*	*T. kansasensis*	*E. setosa*	*E. diversa*	*E. peromysci*	*E. trigenuala*	*P. hungerfordi*
Reithrodontomys megalotis	January	9	3	...	...	1	...	...	...	7	...	...	...
	February	5	2	...	...	1	...	...	...	4	...	...	...
	March	1	1	...	...	...	...	...	...	6	1	...	...
	April	8	3	...	...	...	...	...	...	pres.	...	...	...
	July	3	1	2?	...	...	...	...	...	...	...	...	...
	August	3	1	...	...	...	...	...	...	...	...	...	27
	November	30	26	...	...	20(15)	...	...	...	185(24)	...	...	...
	December	5	3	...	...	3(2)	...	...	...	2(2)	...	...	...
Peromyscus maniculatus	January	3	1	...	...	...	...	...	...	...	1	...	...
	February	4	1	...	...	...	...	...	...	...	4	...	...
	March	1	1	...	...	...	...	...	...	8	...	...	...
	April	31	11	...	...	...	...	...	...	27	...	...	...
	July	5	4	5	2	...	...	...	...	...	...	...	...
	August	11	2	2	...	...	...	...	...	...	...	1	...
	October	4	2	...	...	...	6	45	6	...	...	...	...
	November	21	17	...	...	5(4)	...	...	...	123(17)	...	...	...

TABLE 22.—White-footed mouse from eastern Kansas (Area B) and their chiggers.

Species	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. liporskyi*	*T. sylvilagi*	*T. g. gurneyi*	*E. setosa*	*E. jonesi*	*E. peromysci*	*E. diversa*	*P. hungerfordi*	*C. micheneri*	*W. americana*
Peromyscus leucopus	January	10	4	....	2(2)	....	....	....	....	4(4)	....	....	1	....
	February	15	15	....	5(4)	....	....	9(2)	....	340(12)	40(8)	....	2(1)	....
	March	13	10	....	....	....	....	8(2)	80(1)	126(8)	6(4)	....	....	....
	April	25	21	....	1	....	4(3)	....	4(1)	35(9)	76(20)	....	....	14(3)
	July	8	2	1	....	....	....	....	....	....	....	2(1)	....	....
	August	17	2	2	....	....	2	....	....	....	....	1	....	....
	September	3	2	....	....	....	2	....	....	....	....	....	....	....
	October	3	1	....	....	3	....	....	....	....	....	....	....	....
	November	11	5	....	2	....	....	....	....	....	28(5)	....	....	....

TABLE 23.—Eastern wood rat and nests from eastern Kansas (Area B) and their chiggers.

Species	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. liporskyana*	*T. liporskyi*	*T. sylvilagi*	*T. cynos*	*T. trisetica*	*E. setosa*	*E. peromysci*	*E. diversa*	*P. farneri*	*P. hungerfordi*	*C. micheneri*
Neotoma floridana	February	11	11	...	...	71(6)	...	3(1)	...	...	239(10)	302(8)	...	...	...
	March	10	9	...	...	84(5)	...	...	...	...	80(3)	586(8)	...	...	...
	April	2	2	...	...	...	...	...	...	...	3	3	...	...	...
	July	1	1	11	35	...	...	...	...	...	...	1	...	...	...
	August	6	6	92	8(3)	...	1	...	...	2	...	...	3(1)	34(4)	...
	November	8	8	...	...	342	19(4)	...	10(1)	...	...	61(5)	...	...	...
	December	3	3	...	...	243	...	...	...	...	...	30(1)	...	...	...
Nests	February	1	1	...	...	...	...	...	...	...	...	1	...	...	5
	November	...	1	...	...	3	...	...	...	...	...	...	...	...	...
	December	...	3	...	...	4(2)	...	...	...	1	...	...	...	...	...

TABLE 24.—Prairie voles, cotton rats and woodland pine voles from eastern Kansas (Area B) and their chiggers.

Species of mammal	Month	Total examined	With chiggers	*T. alfreddugèsi*	*T. lipovskyana*	*T. lipovskyi*	*T. whartoni*	*T. sylvilagi*	*E. peromysci*	*E. diversa*	*E. trigenuala*	*P. hungerfordi*	*P. farneri*
Microtus ochrogaster	January	13	4							16			
	February	9	5			1				11(4)	29(1)		
	March	5	4			9(2)				16(3)			
	April	43	20			8(5)	1			200(11)	38(6)		
	May	17	1							1			
	June	32	24	721									
	July	27	26	290									
	August	38	37	3,070								5	
	September	2	2	12	1								
	October	5	5	5	6(2)	1		36(2)		1		2	
	November	37	36			425(24)			1	2,470(35)	1		
	December	1	1			10							
Sigmodon hispidus	January	2	2							50			
	February	2	2							16			
	April	3	1							1			
	June	1	1										1
	July	9	9	650									
	August	19	19	385	132(16)							122(3)	
	October	27	21	39(13)	152(19)	17(3)			1			2(2)	
	November	18	12	3(1)		510(12)				64(9)			
Microtus pinetorum	January	2	2			3							
	February	4	3			1				3			
	November	2	1			2							

TABLE 25.—Mammals from northwestern Kansas (Area A1a), Cheyenne and Rawlins counties, examined for chiggers.

Species of mammals	Months	Total examined	With chiggers	*L. americana*	*T. alfreddugèsi*	*T. g. campestris*	*T. montanensis*	*E. criceticola*	*E. cynomyicola*	*P. hungerfordi*	*C. micheneri*
Blarina brevicauda	November	2	0								
Lepus californicus	July	2	0								
Cynomys ludovicianus	July–August	8	8			1	210		9		2
Spermophilus tridecemlineatus	July–August	10	10		4	55	100		1		
Perognathus flavescens	August	5	5		120		20				
Perognathus hispidus	July–August	28	21		116(18)	47(9)	147(8)		3(2)		
Dipodomys ordii	July	35	9*		7		6				
Onychomys leucogaster	July–August	11	5		9	54	36				
Reithrodontomys megalotis	July	8	6		11					20	
Peromyscus maniculatus	November	1	1	4							
	July–August	44	6		1	17	1			3	
	November	3	2	9				8			
Microtus ochrogaster	November	5	0								
Rattus norvegicus	July	2	1		8						
Mus musculus	July–August	8	0								
Mustela frenata	July	1	0								
Taxidea taxus	July	1	0								

* 92 *Trombicula* sp.? from seven individuals.

TABLE 26.—Bats from Barber County, Kansas (Areas A1b and A2b) and adjacent Woods County, Oklahoma (*).

Species of bats	Month	Total examined	With chiggers	*W. senase*	*T. alfreddugèsi*	*T. twentei*	*T. cynos*	*T. hoplai*	*T. fitchi*	*S. tadaridae*	*E. jonesi*	*T. merrihewi*
Myotis velifer	April	350	25	3	...	...	5	...	35	...	2	...
(413)	July	60	2	...	2	...	...	...	...	...	...	...
(200*)	September	3	0	...	...	...	...	...	...	...	...	...
	*October	200	8	...	...	...	...	...	...	...	18	...
Antrozous bunkeri	February	7	?**	...	...	9	...	...	...	...	...	...
(17)	September	10	1	...	...	...	...	1	...	...	...	...
Tadarida mexicana	July	5	1	...	...	...	...	...	...	10	...	...
(5)	*July	50	1***	...	...	...	...	...	...	...	...	...
(504*)	*August	200	75	...	3	...	...	...	...	100	...	125
	*September	54	40	...	1	...	...	...	...	110	...	...
	*October	200	2	...	...	...	...	...	...	1	...	1

* Woods County, Oklahoma.
** Visual examination by J. W. Twente.
*** One *T. montanensis* recorded, probably from contamination.

TABLE 27.—Mammals from Barber County, Kansas (Areas A1b and A2b) and adjacent Woods County, Oklahoma (*).

Species of mammals	Month	Total examined	With chiggers	*A. plumosus*	*T. alfreddugèsi*	*T. hoplai*	*T. g. campestris*	*T. montanensis*	*E. trigemmula*	*E. crieticola*	*E. lacerta*	*E. loomisi*	*C. micheneri*	*P. hungerfordi*
Lepus californicus	September	2	2		35(1)									200
Sylvilagus floridanus	July	4	3		46		1	1				46		10
	September	3	3	1	71	2(1)	1	4(2)			11(2)	28		28
Cynomys ludovicianus	July	8	8			12(3)		1,060		1		1	6(3)	
	August	14	14		4			900	1?		1?			
	September	3	3					21						
Spermophilus tridecemlineatus	July	1	1					40						
	September	1	1					18						
Perognathus flavus	July	1	1					1				178		56
Perognathus hispidus	July	1	1		6									2
	*July	1	1					75				25		150
Sigmodon hispidus	April	1	1						1					
	July	5	4		123									

* Woods County, Oklahoma.

TABLE 28.—Additional mammals from Barber County and Woods County, Oklahoma.*

Species of mammals	Month	Total examined	With chiggers	*A. plumosus*	*T. alfreddugèsi*	*T. lipovskyi*	*T. hoplai*	*T. g. campestris*	*T. kansasensis*	*T. crossleyi*	*T. ornata*	*T. montanensis*	*E. trigennala*	*E. jonesi*	*E. cricticola*	*E. loomisi*	*P. farneri*	*P. hungerfordi*
Dipodomys ordii	July	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36
	*July	1	1	....	....	....	....	1	....	....	....	60	....	....	....	....	....	16
	August	2	2	....	2	....	....	4	....	....	....	2	....	....	....	14	....	13
	September	4	3	1	....	....	....	41	....	....	....	8	....	....	....	....	1	....
Peromyscus leucopus	April	2	1	18	....	....	....	....	....	....	10	....	....	....	30	....	3	....
	July	5	4	4	1	....	5	1	....	4	2	....	....	....	....	63	10	12
	August	3	2	2	....	....	....	....	....	....	....	....	....	....	....	14	....	....
	September	8	8	25	....	....	2	....	3	....	2	....	....	....	....	7	47	....
	October	8	7	....	....	....	1	....	....	16	....	....	....	....	....	1	2	....
Peromyscus maniculatus	*April	1	1	....	....	....	....	....	....	....	....	9	....	....	....	....	....	....
	April	4	3	1	....	3(2)	....	....	....	....	6(2)	....	1	6(2)	13(2)	....	2	....
	July	1	1	....	....	....	....	....	....	....	....	1	....	....	....	....	....	80
	October	1	1	....	....	....	....	2	....	....	....	....	....	10	....	12	3	....

* Woods County, Oklahoma.

TABLE 29.—Gray wood rats, *Neotoma micropus,* from Barber County (Area A1b) and their chiggers.

Month	Total examined	With chiggers	*A. plumosus*	*W. senase*	*T. alfreddugèsi*	*T. myotis*	*T. lipovskyi*	*T. hoplai*	*T. fitchi*	*T. g. campestris*	*T. kansasensis*	*T. ornata*	*T. montanensis*	*E. setosa*	*E. crieticola*	*E. lacerta*	*E. loomisi*	*P. farneri*	*P. hungerfordi*	*W. americana*
April	19	19	20	15	....	....	25	....	80	....	....	80	....	10	500	....	....	5	....	....
July	20	20	3	....	1,279	....	....	13	....	1	....	....	45	....	....	3	34	130	198	....
August	18	18	50	....	800	1	....	30	....	....	1	25	400	....	....	25	40	175	225	....
September*	3	3	....	....	7	....	....	....	....	....	....	3	....	....	....	....	....	....	6	15
September	18	18	34	....	576	....	....	15	....	2	5	....	16	....	1	....	209	61	161	....
October	14	14	2	....	107	....	....	....	....	1	1	....	....	....	7	....	3	39	76	....

* 5 miles south of Sun City only.

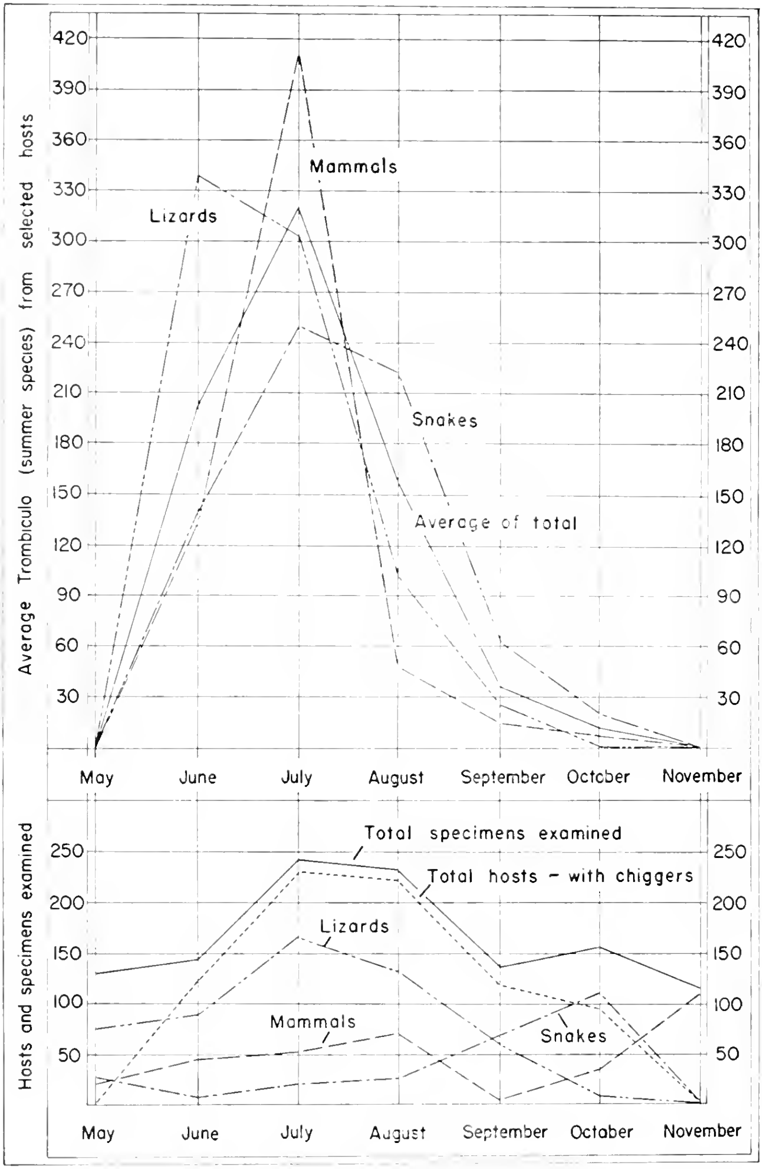


FIG. 11. (Upper graph) Average number of larvae of *Trombicula* (summer species) on three species each of lizards, snakes and mammals from eastern Kansas. Lizards included the collared lizard, racerunner and gray skink; snakes were the blue racer, common garter snake and copperhead; mammals were the cottontail, cotton rat and prairie vole. All were major host species for *T. alfreddugèsi*. See the tables for the numbers of specimens examined and the chiggers from each species of vertebrate.

(Lower graph) The total number of individuals in each group and the total specimens and total hosts.

Additional bats from Barber County which were found to lack chiggers are as follows: *Eptesicus fuscus,* Sept. (50) and *Corynorhinus rafinesquii,* April (3) and August (2). Bats from the Merrihew Cave in Woods County, Oklahoma, which were without chiggers were: *Eptesicus fuscus,* Oct. (2) and *Corynorhinus rafinesquii,* July (4) and October (5).

Mammals from Barber County which lacked chiggers were *Geomys bursarius,* July (2) and *Taxidea taxus,* Sept. (1).

CORRELATION OF THE CHARACTERISTICS OF THE LARVAE WITH THEIR ENVIRONMENT

There seems to be a definite correlation between the environment, including the hosts, of the larval chiggers and certain morphological characteristics, including the type of sensillae, the number and color of the eyes, the color of the body, the number of the leg segments and the type of setae on the legs.

Any one of the above features seems to be relatively uniform among the larvae of each species, with the exception of the number of nude setae on certain leg segments of *Hannemania.* Some individual variation also occurs among the branched setae, and other features, and anomalies occasionally are present, such as the duplication or the absence of setae or of other structures.

Audy (1954:125) in discussing larval characters known to be of polyphyletic origin, includes the shape of the scutum and its variation in the extension to include or exclude setae, its submergence beneath the cuticle; the condition of the femoral segments of legs II and III; and the modification of setae. When similar characteristics have appeared in different phylogenetic lines, he calls them recurrent polyphyletic characters. In addition to the above features, the condition of the sensillae probably should be added as another possible polyphyletic character.

The environment, as discussed below, consists of the general habitat, such as woods or grasslands; a more limited habitat if known, such as a decaying log or a burrow; the type of host and the sites of larval attachment.

Factors such as the mean and extreme daily and seasonal temperatures and the amount of moisture in the surrounding habitats are considered integral parts of the environment. The type of vegetation is mostly determined by these and edaphic factors, which certainly determine the presence or absence of many kinds of chiggers in each area.

Many morphological similarities among the chigger mites can be attributed to their close relationship. However the presence or absence of certain features seem to be due largely to adaptations of the larvae to the environment in which they live.

THE SENSILLA

The species of the subfamily Leeuwenhoekiinae possess only flagelliform sensillae, whereas all members of Walchiinae have expanded sensillae. Each of these subfamilies seemingly has been derived from an ancestor possessing only the type of sensilla now universally present. Two types of sensillae occur in the subfamily Apoloniinae, as presently understood, and in the subfamily Trombiculinae. Audy (1954:134-5) considers the condition of the sensilla important enough to divide the Trombiculinae into the Trombicula group (ten genera) with flagelliform and the Schöngastia group (twelve genera) with expanded sensillae. This arrangement implies that in each group all genera acquired the type of sensilla from a single common ancestor. This would not allow for more than a single appearance of expanded sensillae from the flagelliform type which seemingly was ancestral for all members of the family.

If it were not for the type of sensilla, a number of species of *Trombicula* probably would be placed in *Euschöngastia* and vice versa. *T. hoplai* and *E. lacerta* differ less from each other than they do from other species in their respective genera, and *T. jamesoni* Brennan more closely resembles certain *Euschöngastia* than it does species of *Trombicula*. This seems to indicate that more than one group of species with expanded sensillae have arisen from ancestors with unexpanded sensillae, or that the ancestral condition has reappeared.

The different kinds of sensillae include the long slender flagelliform type, either nude or with several to many branches or setules; the short stout stem with the setules greatly expanded on the distal half to give the appearance of being expanded and solid; and the expanded sensillae, either clavate with an enlarged midpart and gradually enlarged stem and tapered tip or capitate with a large nearly round head on a short thin stem.

All of these sensillae have a round base which fits in a socketlike cup or sensillary base located on the dorsal scutum. The base fits in this cup much as a ball does in a socket. An aggregation of nerve cells surrounds the cup and extends to the ventral concave wall, according to Jones (1950:487). Thus movement of the sensilla would cause a rotation of the base in the socket which presumably would stimulate the associated nerve cells. Jones (*loc. cit.*) also found that in *T. autumnalis* the flagelliform sensillae "in their natural position extend well above the other dorsal setae of the body." He concludes that "One would therefore expect them to have a sensory perception of touch and probably of vibrations in the air."

The short expanded sensilla extends only slightly if at all beyond the body setae. In addition it is not the usual shape for a tactile organ, thus casting considerable doubt on it being primarily a structure for the perception of touch.

However, it is suggested that these large, and relatively heavy organs detect the motion of the larva, through the stimulation of the nerve cells as the sensilla independently moves from acceleration and deceleration. This sensitivity to motion, especially the movement of the host, would be of major importance for the attached larva which after engorgement must detach and reach a favorable sheltered habitat. This ability to detect movement would aid the larva to remain on a moving host until it reached a roost or nest of the host, from which it was originally obtained. Obviously, larvae of the same species must reach and detach in the same suitable site to insure the success of the species.

In Kansas, the chigger mites which possess expanded sensillae are of the genera *Euschöngastia* (10 species), *Pseudoschöngastia* (2), *Neoschöngastia* (2), *Cheladonta* (1) and *Walchia* (1). In addition, *Speleocola* (1) has expanded setules on a slender stem giving it the appearance and probably the function of an expanded sensilla.

All of these species exhibit a close association with the hosts and probably occur together in places which afford resting and nesting sites for the hosts. With the exception of the two *Neoschöngastia*, found on birds, all of the species occur on mammals. Most of them seem to select specific sites for attachment on the host, especially in the ears. Larvae of ten species appear in autumn and winter, whereas those of seven species regularly occur in summer. Larvae which leave the host in the winter must escape the extreme cold, whereas summer species would need a sheltered situation to avoid heat and desiccation. This is especially true in arid situations of the south and west. In addition these chiggers, for the most part, seem to be restricted to one or several kinds of hosts which regularly return to dens or nests. Examples include *Speleocola* and *E. pipistrelli* found only on bats, *Walchia* found almost exclusively on squirrels, and other species of *Euschöngastia, Pseudoschöngastia* and *Cheladonta* restricted almost entirely to small groups of mammals found in specific habitats. *Neoschöngastia,* a genus associated mostly with birds, has two species in Kansas, both appearing as larvae in summer. Both species regularly occur on birds; in eastern Kansas, however, *N. americana* is perhaps more common on cottontails and has been taken on several occasions on chigger samplers from open situations. The larvae probably occur in more sheltered, protected niches in the areas of greater aridity, such as in dead standing trees or near nests of ground dwelling birds. If these chiggers should detach while their hosts were in flight over unsuitable areas the chiggers would certainly perish. This would be especially true in the Pacific region, where larvae of *Neoschöngastia* are common on the shore birds which live on small atolls, and regularly fly over water.

The species of *Trombicula* with filiform sensillae consist of the majority of chiggers which have a broad geographic distribution and which occur in less restricted habitats (*e. g., T. alfreddugèsi*). The larvae of numerous species occur on the surface of the soil in the woods and grasslands. The species of *Trombicula* which live in more restricted habitats frequently possess a thicker, more plumose sensillae than do the larvae of widespread species. This increase in the number of branches may represent a step toward enlargement as found in those species with expanded sensillae.

Possibly sensillae aid the unfed larva in some way, such as determining the movement of the air, or vibrations of the substrate. When the host is found, the unfed larva attempts to maintain a firm hold at all times as it moves about to find a suitable attachment site.

The Eyes

Larvae of the family Trombiculidae usually possess two eyes, each consisting of a pair of lenses or ocelli on an ocular plate lateral to the scutum. The anterior lens is larger and thicker than the posterior lens. Below each eye, a mass of red pigment surrounded by an almost black pigmented cup, is associated with nerve cells, according to Jones (1950:488). These nerve cells are presumably photosensitive to the light which enters the lens. The reduction or absence of this red pigment and the associated dark pigmented cup presumably indicate the reduction or elimination of the nerve cells and the perception of light.

In Kansas, most larvae possess prominent eyes with lenses 2/2 on a distinct or indistinct ocular plate above a red pigmented mass. The following condition, however, obtains for species without prominent eyes: Eyes 2/2, pigment pink to absent in *E. jonesi* and *P. farneri;* eyes 1/1, pigment pinkish to absent in *T. kansasensis, S. tadaridae*, and *E. pipistrelli;* eyes and pigment absent in *C. micheneri* and *W. americana.*

Among the above species, *S. tadaridae* has no known close relative; however, the others have closely related species which differ in the condition of the eyes. *P. farneri, T. kansasensis* and *W. americana* are related to species which have normal eyes. *Cheladonta micheneri* has a close relative (*C. ouachitensis*) with eyes 1/1 whereas *E. jonesi* and *E. pipistrelli* each with imperfect eyes are closely related.

The species in Kansas with the prominent eyes are those which usually occur on the surface of the soil or other substrate. The larvae which have imperfect eyes or lack them entirely seem to be limited, to judge by the hosts on which they occur, to microhabitats in which the active unfed larvae normally would be exposed only to dim light or to none at all. *S. tadaridae* and *E. pipistrelli* are known only from cave bats, and presumably are restricted to caves; *E. jonesi* also occurs on cave bats and on terrestrial mammals as well; *T. kansasensis, P. farneri* and *C. micheneri* occur on terrestrial vertebrates and probably are limited to the subterranean burrows and nests of mammals; and *W. americana* seems limited to arboreal mammals and their nests in tree-holes. All of these larvae, like many vertebrates and invertebrates which live in the darkness of subterranean caverns or burrows, seem to have lost most or all of their ability to perceive light.

Color

Color of the chigger mite, as expressed in the larva, normally persists throughout the entire life cycle. The body of the larva usually is somewhat paler when engorged, unless it has fed on dark pigmented tissue or on red blood corpuscles. The bodies are white with some pigment or are red, orange or yellow in various shades. In most species the legs and leg setae are pigmented to the same degree as is the body. In at least two species, *A. arizonensis* and *H. multifemorala*, the ventral ganglion is bright red.

In Kansas, larvae (unfed to engorged) which are normally red to orange include: *A. arizonensis, A. galli, H. eltoni, H. multifemorala, T. batatas, T. alfreddugèsi, T. lipovskyana, T. splendens, T. lipovskyi, T. whartoni, T. sylvilagi, T. ornata* and *E. setosa.*

Larvae which are usually pale orange to yellow are: *L. americana, T. fitchi, T. kardosi, T. g. gurneyi, T. trisetica, T. crossleyi, N. americana* and *N. brennani.*

Species usually pale yellow are: *T. montanensis, T. arenicola, T. g. campestris, T. kansasensis* (sometimes whitish), *S. tadaridae, E. peromysci, E. diversa, E. criceticola* and probably *E. cynomyicola.*

Species which usually lack most or all color and are whitish except for certain species with red or pink eyes are: *A. plumosus, T. myotis, T. twentei, T. cynos, T. jonesae, E. pipistrelli, E. jonesi, E. trigenuala, E. lacerta, E. loomisi, P. hungerfordi, P. farneri, C. micheneri, W. americana* and possibly *W. senase.*

The color of the unfed larva seems to be correlated to a large extent with its environment. The larvae with dark colors, such as reds and orange, usually emerge on the surface of the soil or other substrates and live in relatively open situations. The pale larvae seem to be free living in restricted habitats, such as in or on decaying logs, in tree-holes, burrows and nests in the soil or in caves. The darker species of this group are usually less secretive and are more closely related to species of the first group. The species which are whitish seem to live in darkness, in close association with mammals and rarely attach to other vertebrates.

LEG SEGMENTATION

The normal number of segments in the legs of the larva is 6-6-6 in members of the Leeuwenhoekiinae, 7-6-6 in the Walchiinae and 7-7-7 in most Trombiculinae. The difference in number of segments is due to the condition of the femur; undivided in those with six; divided into a basifemur and telofemur in those larvae with seven segments. The ancestral condition of the Trombiculidae may have been seven-segmented with femoral segments having fused on all legs in the Leeuwenhoekiinae and only on legs II and III in the Walchiinae and some species of the Trombiculinae. Certainly seven segments represented the ancestral condition in the Trombiculinae and the Walchiinae. The ancestral type of the subfamily Leeuwenhoekiinae probably had only six segments; whether earlier forms had seven segments is unknown. The subfamily Apoloniinae, which is probably closely related to, but more primitive than the Leeuwenhoekiinae, has larvae with seven-segmented legs.

Among the larvae of the Trombiculinae some genera and species, like members of the Walchiinae, have undivided or fused femora of legs II and III. This condition seems to be due to fusion rather than to a lack of division, since in some species (*e. g. P. hungerfordi*) a suture can be discerned, whereas in other closely related species (*P. farneri*) the suture seems to be entirely absent or indistinct. Further evidence can be seen in the total number of branched setae on the fused femur being the same as the sum of those on two segments and in the same approximate position as in other members of the Trombiculinae.

In Kansas, the species of the Trombiculinae which have fused femoral segments on legs II and III include *W. americana* of the subfamily Walchiinae and *P. hungerfordi, P. farneri* and *C. micheneri* of the subfamily Trombiculinae. All four species parasitize mammals regularly and probably exclusively. The sites of attachment include the ears for *Pseudoschöngastia,* and principally the body for the other two species. The larvae and other free-living stages all seem to be closely associated with the mammalian hosts especially with the nests and burrows. Larvae of *Pseudoschöngastia* appear in the warmer months; larvae of the other two species regularly appear in the cooler months. Nymphs and adults of all species seem to feed on early instars of insects and other arthropods, not on the eggs of these arthropods. All four species are small in all stages, and all of the stages are whitish.

Additional genera, not found in Kansas, which have the leg segments 7-6-6, include *Anomalaspis* Brennan; *Walchiella* Fuller, considered as a subgenus of *Euschöngastia* by Audy (1954); *Schoutedenichia* Vercamman-Grandjean (possibly *Doloisia* Oudemans or a subgenus of it); and all genera in the Walchiinae. These genera are parasitic only on mammals, *Schoutedenichia* being found in the nasal passages of large rodents in Africa.

A definite correlation exists between the condition of the femur, divided or undivided, and the type of host, habitat and habits of the larva. The species which possess long legs, have longer and more segments, are more active and attach to a greater variety of hosts usually in more habitats. The species which have fewer segments, or have the femur fused, usually have shorter legs, shorter segments, and the body is small. These larvae are slow in locomotion, are found on a limited number of hosts and occur in just one or only a few different habitats. The larvae seem to be closely associated with mammalian hosts, probably in or near the nest and adjoining burrows. These species have not been taken on other vertebrates. Probably reasons for their absence from reptiles are the following:

some of the larvae appear in the colder parts of the year, limited contact with the habitats of the larvae and the tough dry skin. Birds seem unsuited as hosts due to their lack of nesting and roosting sites in proper habitats, their greater mobility which would tend to disperse the species unfavorably, and their relatively uncommon occurrence in suitable habitats in the cooler months.

THE SETAE OF THE LEGS

Long nude setae of leg III.—The subfamilies Leeuwenhoekiinae and Trombiculinae each have some species which as larvae possess long nude whiplike setae or mastisetae on one or more segments of leg III, whereas they are absent from all larvae in the subfamily Walchiinae.

The long nude mastisetae which occur on the tarsus, tibia, telofemur and occasionally other segments of leg III, seem to be modified branched setae. They probably did not arise independently nor were they derived from any short stout nude setae, such as the genuala or tibiala, since both long and short kinds usually occur together on the same segments, and the short kind frequently occurs alone. The positions of the mastisetae correspond to branched setae in related species and genera. In addition, there are barbs on some mastisetae which usually are nude, and on nearly nude setae which usually are branched. This illustrates a transition from a branched to nude condition, and occasionally perhaps a reappearance of a few barbs. The total number of mastisetae and branched setae on each segment, except possibly the tarsus, is the same regardless of the number of mastisetae. This is demonstrated in the tibia of *T. batatas*, with 2 mastitibialae and 4 branched setae, whereas other members of *Eutrombicula* have 6 branched setae. Also, species of *Neotrombicula* with 1 mastitibiala have 5 branched setae, those without have 6 branched setae on the tibia.

Several genera and subgenera lack all long setae nude or plumose. These types of setae seemingly never developed or were lost in the early ancestral stock.

The genera and subgenera lacking all these setae include *Walchia* (and all of the Walchiinae), *Hannemania, Pseudoschöngastia, Cheladonta, Leptotrombidium* and *Euschöngastoides.* All species of *Euschöngastia* and *Neoschöngastia* in the New World also lack long nude setae.

Some Old World species of *Euschöngastia* possess one mastitarsala, but they are not closely related to the species in the New

World. The two species of *Neoschöngastia* have long setae on the tarsus which are branched only basally, approaching the mastisetae of *Trombicula.* Mastisetae do appear in the genus, since *Neoschöngastia asakawai* Fukuzumi and Obata has two to six and *N. posekanyi* Wharton and Hardcastle possesses one mastitarsala III. *N. asakawai* has as many as four tarsal setae which may have a few basal branches rather than being nude, and this branched condition obtains for some tarsal setae of *N. americana.*

Other genera represented by species in Kansas that do not have long nude setae include *Leeuwenhoekia* and *Whartonia* of the Leeuwenhoekiinae.

Most of the chiggers mentioned above seem to be restricted to mammals and the immediate territory surrounding the nest burrows and roosting sites. *Neoschöngastia,* which occasionally possesses mastitarsalae, is largely limited to birds.

In Kansas, the genera which have species possessing mastisetae include *Acomatacarus, Speleocola* and *Trombicula.* Two of the three species of *Acomatacarus, A. arizonensis* and *A. galli,* each possess a single mastitarsala. Several mastitarsalae III are present on *S. tadaridea,* along with other sparsely branched setae on several segments of leg III.

Among the 21 species of *Trombicula,* five species have more than one mastisetae, nine species have one mastitarsala, two species lack mastisetae, but possess long plumose setae in their place and five species lack all long setae on leg III.

The condition of the setae on leg III depends to some extent upon the relationship among the species. Most species of each subgenus are similar in the type of leg setae, and the placement in some of the subgenera is based largely upon the presence or absence of the nude setae. This arrangement seems to be correct if characters based on most of the other features indicate similar affinities, but those species which differ only in the branching of otherwise nude setae should not be eliminated. This is especially true of the *fitchi* group, now placed in *Neotrombicula,* which has two species possessing long plumose setae in place of mastisetae. Two other subgenera, *Eutrombicula* and *Miyatrombicula,* each include species which lack the mastitarsala III normally present on the remaining species. These mastisetae are not in themselves important enough to include or exclude species from any subgenus. In fact, their presence or absence in many cases may be due to adaptations to a particular type of habitat or host.

The species of *Trombicula* in Kansas are listed in Table 26 according to the presence or absence of mastisetae on Leg III, the general habitat and host preference and seasonal occurrence of the larvae. The single mastitarsala may be long or it may be short, approximately the length of the other setae. *Eutrombicula* has the longest mastiseta, and *Miyatrombicula,* the shortest. The other subgenera have mastitarsalae of moderate length. The length is not indicated in the table; in general the longest are at the top and the shortest are at the bottom. Only *T. merrihewi* with a long mastitarsala is out of place. When several mastisetae are present, they are all long. *T. fitchi* and *T. kardosi,* listed without mastisetae, have long plumose setae in their places.

Among the chiggers in Kansas, the condition of the setae on leg III can be correlated with the type of host and the habitat occupied by the active unfed larvae.

Of those species listed for the surface of the soil, all but *T. whartoni* have been recovered from the soil in the unfed larval stage. Some species also occur in other suitable sites, such as on decaying logs (*T. splendens*) and in mammal burrows. Presence on a wide variety of hosts indicates that the chigger occurs regularly in numerous situations.

The term "restricted" implies that the species, especially the active unfed larva, is more or less limited to a particular habitat. This seems to be true of all species including those found only on cave bats, most of those on decaying logs or in tree-holes and on vertebrates inhabiting them, and those chiggers which most likely occur in underground burrows and nests of mammals. Chiggers which occupy a restricted habitat usually occur most frequently on mammals.

In addition to the mastisetae of leg III, several other nude setae occur on the legs. In Kansas, members of the subfamilies Trombiculinae and Walchiinae possess one or more nude setae on the tarsus, tibia and genu of legs I and II and the tibia and genu of leg III. All but two species, *T. hoplai* and *E. lacerta,* possess the subterminala and parasubterminala on tarsus I; and these species also have fewer nude setae on other legs, lacking genualae II and III. Species which lack the pretarsala II are *T. ornata, T. merrihewi, S. tadaridae* and *W. americana.* Several species of *Euschöngastia* and *C. micheneri* lack tibiala III.

The chief function of most short stout blunt, striated, nude setae seems to be chemo-reception according to Jones (1950:486). Other

TABLE 30.—Condition of the setae on leg III of *Trombicula*.

HABITATS Hosts	No long nude setae	One nude seta (mastitarsala)	Two or more mastisetae
SOIL SURFACE, ETC. R, B, M—S**		*T. alfreddugèsi* *T. lipovskyana* *T. splendens*	
SOIL SURFACE, ETC. B and esp. M. S and W			*T. batatas* *T. lipovskyi* *T. whartoni* *T. sylvilagi*
RESTRICTED R, B, M—S	*T. gurneyi* *T. kansasensis*	*T. trisetica* *T. montanensis*	
RESTRICTED B, M, prob. R Summer		*T. crossleyi* *T. arenicola*	
RESTRICTED Mammals. Summer and Winter	*T. myotis* *T. twentei* *T. fitchi* *T. kardosi* *T. hoplai*	*T. merrihewi** *T. cynos* *T. jonesae*	*T. ornata*

* The only species above which is not from Kansas.
** R = reptiles, B = birds, M = mammals, S = summer, W = winter.

short solid nude setae with sharp tips probably serve as tactile organs.

All of the above species with less than the regular number of short nude setae are largely restricted to mammals, and probably occur in limited habitats near the suitable hosts.

SUMMARY

In summary, the type of sensillae, the condition of the eyes, the color of the body, the number of leg segments and the type of setae on the legs of the larva all can be correlated with their environment.

The larvae which have flagelliform sensillae with few branches, eyes 2/2 and red, body red to orange, leg segments long and usually 7-7-7 (except Leeuwenhoekiinae), and with mastisetae on leg III in addition to the normal complement of other nude setae, are those which usually emerge on the surface of the soil or other substrate, live in relatively open situations, move rapidly, have a wide range of hosts, including reptiles and birds for many species, and seem to occur in large numbers in any area in the proper season.

The species which have expanded or plumose flagelliform sensillae, eyes normal to absent, body usually pale, yellow to whitish, legs and leg segments short with the segmentation occasionally 7-6-6, without mastisetae on leg III and frequently with one or more of the other nude setae absent, seem to be restricted to specific habitats, such as those on or within decaying logs, in tree holes especially those containing nests of birds or mammals, in burrows and near nests in the soil and in caves or rock crevices, and almost always are in close association with mammals, using one or several species as the regular host.

CLIMATIC AND SEASONAL FACTORS IN THE DISTRIBUTION OF CHIGGER MITES IN KANSAS.

MOISTURE

Annual precipitation in the eastern half of the State is 25 to 42 inches, and the western half receives 15 to 25 inches. The precipitation and the evaporation determines the climax vegetation of each area; woodlands are in the extreme east and in other moist situations, and tall to short grasses are in the drier western two thirds. The amount of moisture in the environment seems to be critical for the continued presence of chigger mites. Several species are limited to the moist woodlands and meadows of the east; other species seem restricted to the dry areas of central and western Kansas.

Species more dependent upon moist habitats are *Trombicula lipovskyana*, especially common in valley meadows; *T. whartoni* in the woods and woodland edge; *T. g. gurneyi, T. trisetica,* and *T. splendens* in decaying wood; *Hannemania eltoni, H. dunni* and *H. multifemorala* along the edge of ponds and streams.

Species seemingly limited to drier situations include: *Acomatacarus arizonensis, A. galli, A. plumosus, T. hoplai, T. montanensis, Euschöngastia criceticola, E. lacerta, E. loomisi, Neoschöngastia americana* and *N. brennani.*

See the lists of species from each distributional area on pages 1204-1205, for a more complete summary of the different faunas of each area.

TEMPERATURE

Temperature seems to be the most important climatic factor in the time of appearance of the active unfed larvae.

Although the nymphal and adult stages of all species are active in the warmer months, two main groups of species, the summer chiggers and the winter chiggers, are arranged according to the season of larval activity. There is a slight difference in the time of first appearance of the larvae within each group, but in general they always emerge and become common in the same general season. Figure 12 illustrates the time of occurrence and abundance of the chigger mites of eastern Kansas.

The group of summer chiggers consists of those which appear, as larvae, in the warmer part of the year, usually from May to October, throughout Kansas. The period is somewhat shorter in the north and west and longer in the south and east. The appearance of these larvae in the warm months of the year depends upon the presence of adults, the oviposition by the adult females, the hatching of eggs and a temperature suitable for activity of the larvae.

Summer species seem to require a long warm period to complete the life cycle. Most of the species are not known north of latitude 47° N, and are most common below latitude 40° N. Some of the species produce at least two generations of larvae each summer in Kansas. These include *T. alfreddugèsi, T. lipovskyana, T. montanensis, T. arenicola, T. trisetica, T. crossleyi* and possibly *T. ornata* and *A. plumosus*. Many of the other species probably do not have more than one generation, except when the warm period is exceptionally long.

The females of the summer species seem to require a warm environment (60° F. soil temperature for *T. alfreddugèsi*, according to Wharton and Fuller, 1952:139-142) for oviposition, which commences in late spring. Jenkins (1948:33) found that *T. splendens* first lays eggs in large numbers, the numbers tapering off after the peak is reached.

Similarly high temperatures are required for the eggs to hatch. The larvae are most active between 80° and 100° F., but will die if exposed to temperature much above 110° F. Below 60° F. the larvae of most summer species become less active.

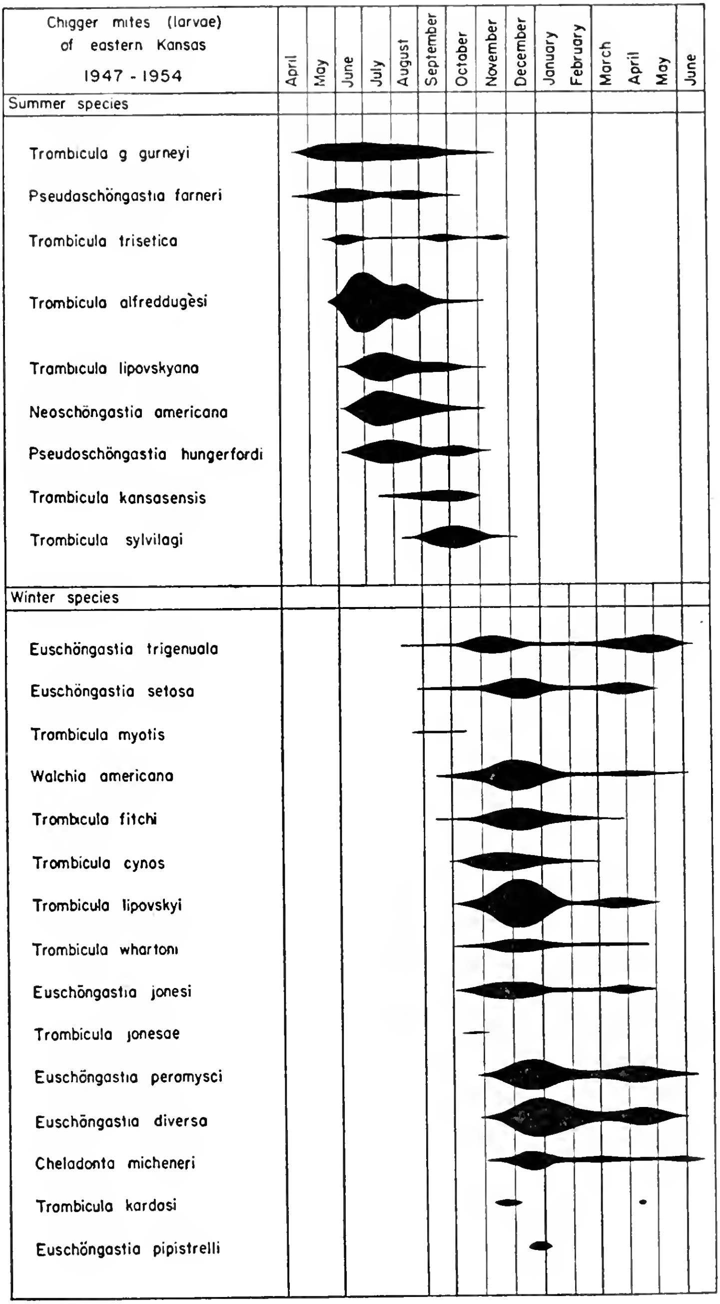
Active larvae of the summer species seem to be reduced and finally eliminated at temperatures of 32° F. and below. Exposures of several hours or even several days may be necessary for a complete kill. When air temperature falls below 32° F. larvae of *T. alfreddugèsi* seem to be eliminated from the soil. Some species of summer chiggers may not be affected until a hard freeze occurs.

The second group consists of species which have unfed larvae active in cool or cold weather from October to May. In general there is but slight seasonal overlap between the two groups in the occurrence of unfed active larvae. However the two types of larvae occur together attached on the hosts over a longer period, mainly in late September and October.

In northeastern Kansas, larvae of the winter species emerge in greatest numbers in October, November and December. Usually one or several periods of cold weather with air temperatures falling below zero F. occur in late December, January and early February of each year. During and immediately following these extremely cold periods few chigger mites can be found on mammals and birds. After a general warming in late February, March and April, a slight increase in the number of chigger mites usually occurs, especially in the species of *Euschöngastia* that occur on mammals. Larvae of the genus *Trombicula* are either uncommon or absent. See Figure 12 illustrating the larval abundance in eastern Kansas.

In the southern part of Kansas, and regions farther south, these same winter species have a slightly different pattern of abundance. To the south, the larvae appear later in the year and larvae of *Trombicula* as well as those of *Euschöngastia* are common in early spring This seems to be due to the later arrival of the cool weather and the fact that cold spells are fewer and less severe.

FIG. 12. The seasonal occurrence of the chigger larvae (except those of *Hannemania*) in eastern Kansas, based on the recovery of active unfed larvae and of larvae found on hosts in 1947 to 1954. The species are arranged according to the earliest known occurrence and are separated into two groups: the summer species and the winter species. The length of each symbol indicates the known period of activity of the larvae, the width represents the seasonal abundance and the relative number of larvae in relation to other species. Symbols for the commonest species (*e. g.*, *T. alfreddugèsi*) should be broader to show accurately the relative abundance.


Chigger mites (larvae) of eastern Kansas
1947 - 1954
April
May
June
July
August
September
October
November
December
January
February
March
April
May
June
Summer species
Trombicula g gurneyi
Pseudoschöngastia farneri
Trombicula trisetica
Trombicula alfreddugèsi
Trombicula lipovskyana
Neoschöngastia americana
Pseudoschöngastia hungerfordi
Trombicula kansasensis
Trombicula sylvilagi
Winter species
Euschöngastia trigenuala
Euschöngastia setosa
Trombicula myotis
Walchia americana
Trombicula fitchi
Trombicula cynos
Trombicula lipovskyi
Trombicula whartoni
Euschöngastia jonesi
Trombicula jonesae
Euschöngastia peromysci
Euschöngastia diversa
Cheladonta micheneri
Trombicula kardosi
Euschöngastia pipistrelli

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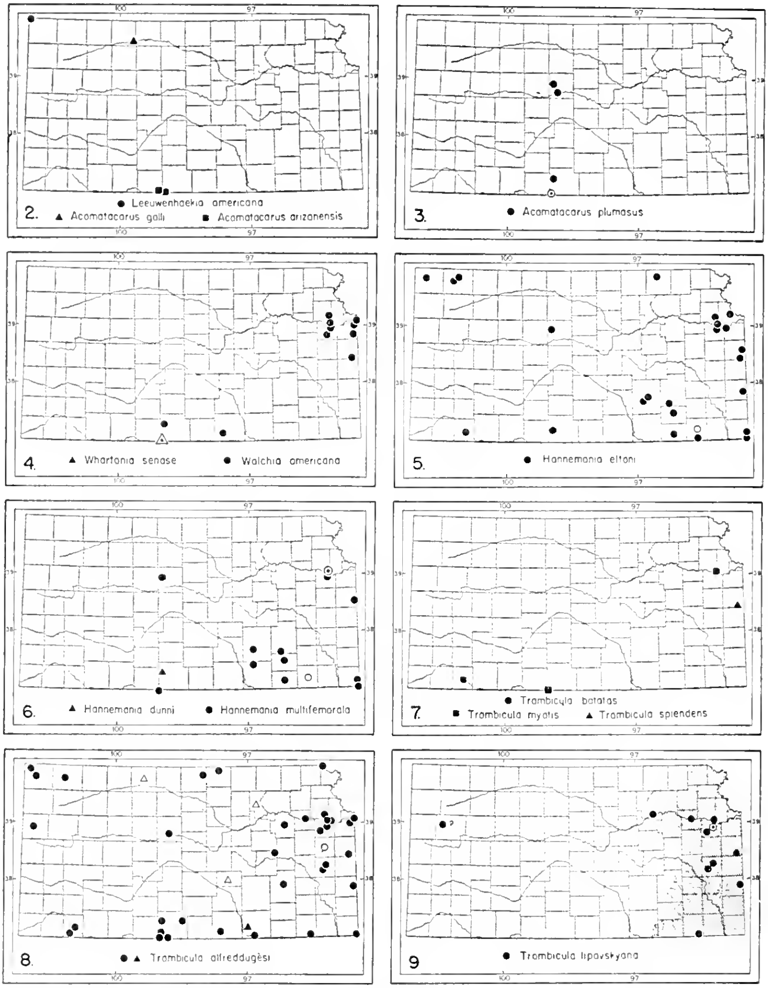
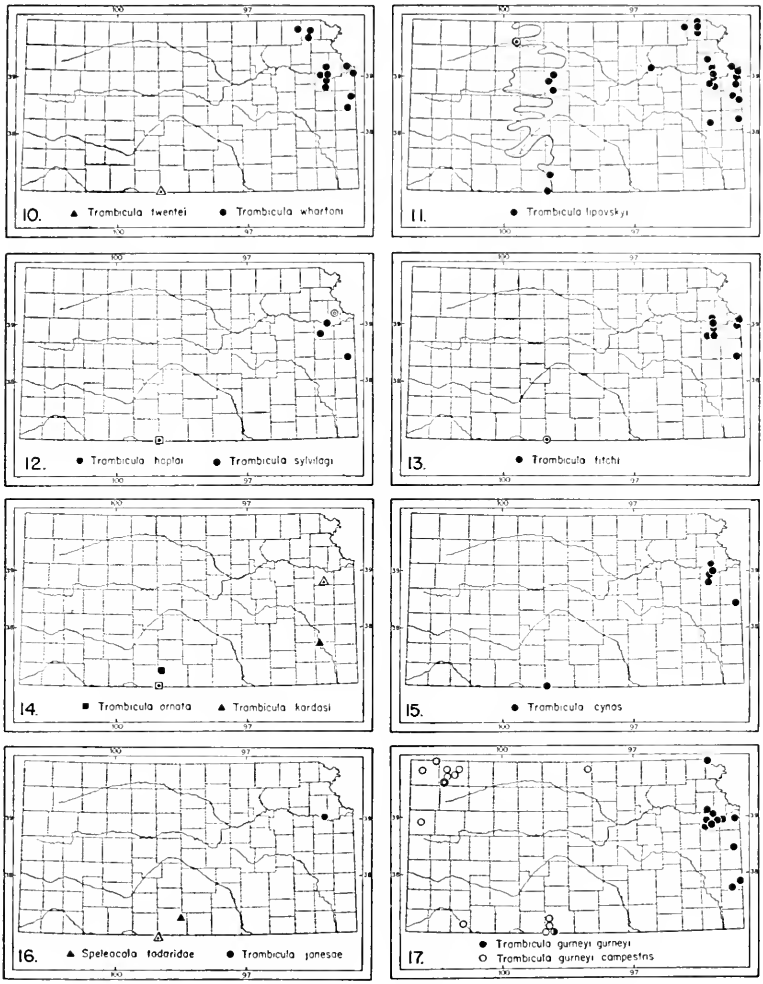
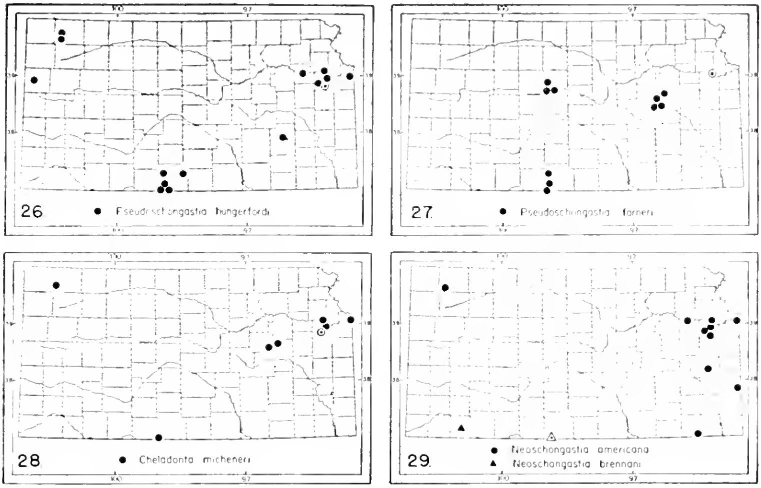


MAPS 2-9.—Distribution of chiggers in Kansas. Solid symbols represent exact localities, open symbols are county records and symbols within symbols are type localities. On Map 8 (*T. alfreddugèsi*) triangles show literature records and circles indicate specimens examined. The stippled area on Map 9 indicates an elevation below 1000 feet.



MAPS 10-17.—Distribution of chiggers in Kansas.

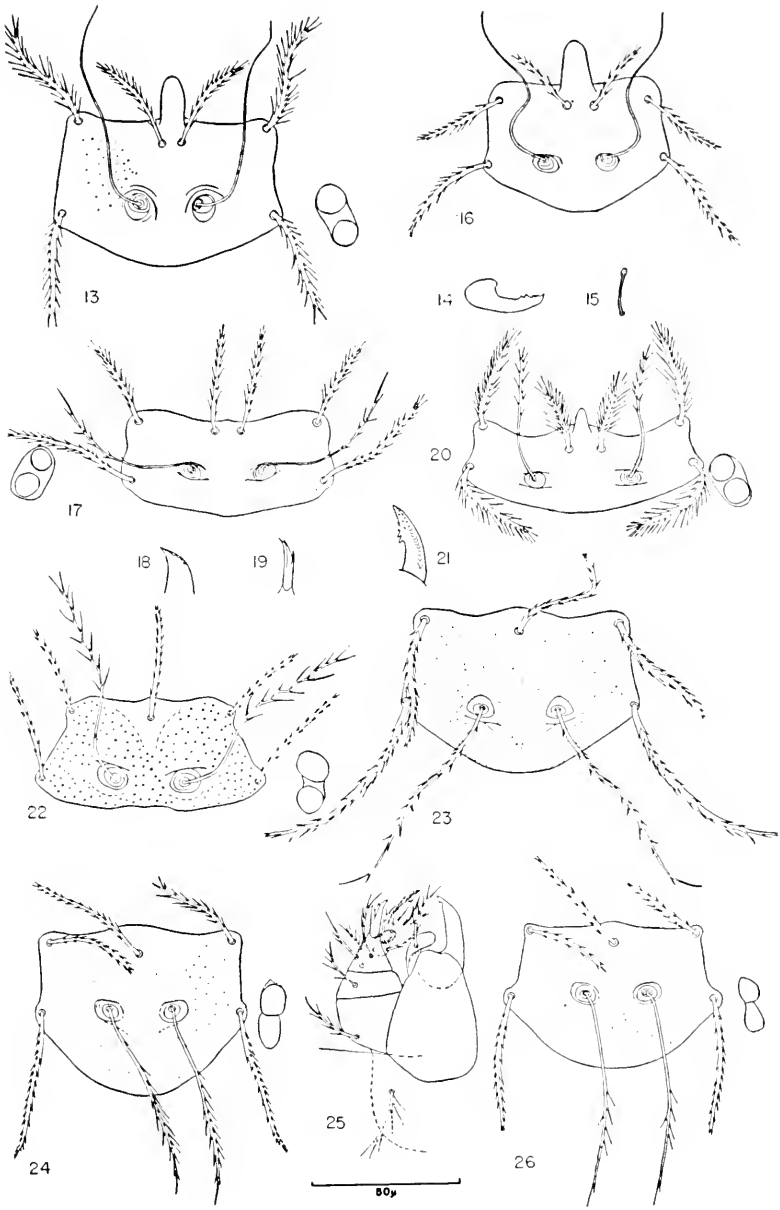
MAPS 18-25.—Distribution of chiggers in Kansas.



Maps 26-29.—Distribution of chiggers in Kansas.

EXPLANATION OF FIGURES 13-26.

Fig. 13. *Leeuwenhoekia americana,* scutum and eyes.
Fig. 14. *Acomatacarus arizonensis,* cheliceral blade.
Fig. 15. *Acomatacarus arizonensis,* tarsala II.
Fig. 16. *Acomatacarus galli,* scutum.
Fig. 17. *Whartonia senase,* scutum and eyes.
Fig. 18. *Whartonia senase,* tip of cheliceral blade.
Fig. 19. *Whartonia senase,* palpal claw.
Fig. 20. *Acomatacarus plumosus,* scutum and eyes.
Fig. 21. *Acomatacarus plumosus,* cheliceral blade.
Fig. 22. *Trombicula twentei,* scutum and eyes.
Fig. 23. *Trombicula lipovskyi,* scutum.
Fig. 24. *Trombicula fitchi,* scutum and eyes.
Fig. 25. *Trombicula fitchi,* gnathosoma.
Fig. 26. *Trombicula kardosi,* scutum and eyes.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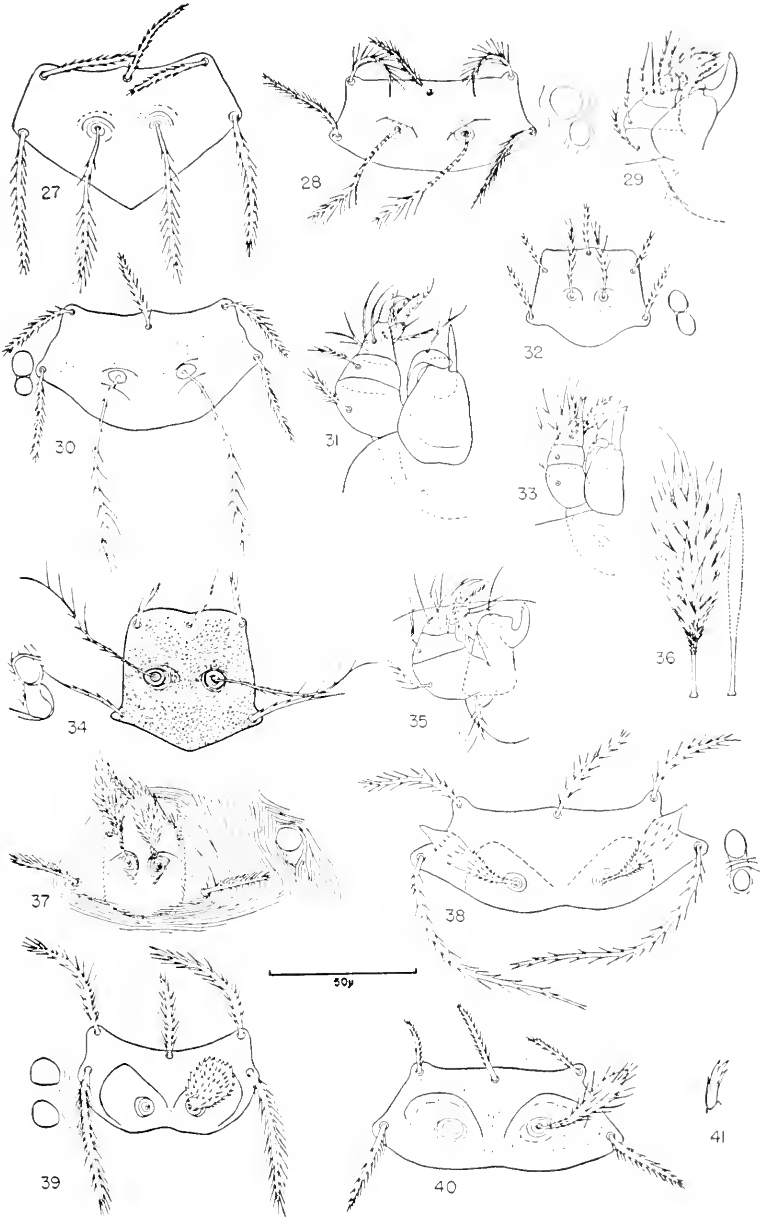
EXPLANATION OF FIGURES 27-41

Fig. 27. *Trombicula cynos*, scutum (puncta not shown).
Fig. 28. *Trombicula hoplai*, scutum and eyes.
Fig. 29. *Trombicula hoplai*, gnathosoma.
Fig. 30. *Trombicula arenicola*, scutum and eyes.
Fig. 31. *Trombicula arenicola*, gnathosoma.
Fig. 32. *Trombicula crossleyi*, scutum and eyes.
Fig. 33. *Trombicula crossleyi*, gnathosoma.
Fig. 34. *Trombicula ornata*, scutum and eyes.
Fig. 35. *Trombicula ornata*, gnathosoma.
Fig. 36. *Speleocola tadaridae*, sensilla (enlarged), showing stem.
Fig. 37. *Speleocola tadaridae*, scutum and eyes.
Fig. 38. *Euschöngastia jonesi*, scutum and eyes.
Fig. 39. *Euschöngastia peromysci*, scutum and eyes.
Fig. 40. *Euschöngastia trigenuala*, scutum.
Fig. 41. *Euschöngastia trigenuala*, palpal claw.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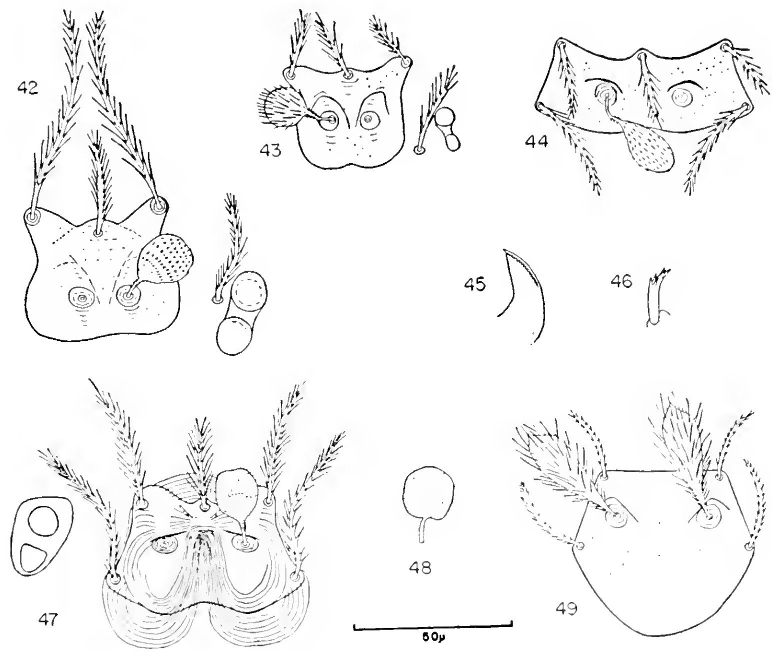
EXPLANATION OF FIGURES 42-49.

Fig. 42. *Pseudoschöngastia hungerfordi,* scutum and eyes.
Fig. 43. *Pseudoschöngastia farneri,* scutum and eyes.
Fig. 44. *Cheladonta micheneri,* scutum.
Fig. 45. *Cheladonta micheneri,* cheliceral blade.
Fig. 46. *Cheladonta micheneri,* palpal claw.
Fig. 47. *Neoschöngastia americana,* scutum and eyes.
Fig. 48. *Neoschöngastia brennani,* sensilla.
Fig. 49. *Walchia americana,* scutum.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Kansas University Quarterly

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