The Chigger Mites of Kansas (Acarina, Trombiculidae)

by

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Abstract: Studies of the chigger mites in Kansas revealed 47 forms, consisting of 46 species in the following genera: Leuvenhoekia (1), Acomatacarus (3), Whartonia (1), Hannemania (8), Trombicula (21), Speleocola (1), Euschöngastia (10), Pseudoschöngastia (2), Cheladonta (1), Neoschöngastia (2), and Wauchia (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 *Trombicaula 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. alfreddugesi* 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. alfreddugesi*, 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 alfreddugesi*), in Kansas, although residents had long known of this and other pest chiggers prior to 1921. Jameson (1947) listed *Ascoschongastia brevipes* (*= Euschongastia 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*
multifemoralis 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. dumni, Trombicula splendens, T. myotis, T. montanensis, T. jonesae, Euschongastia lacerta, E. trigenual, 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.

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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. alfredrugesi.
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*,
Euschongastia criceticola, E. cynomyicola, E. lacerta, E. loomisi and Neuschongastia bremani; 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, Euschongastia 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, Euschongastia 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 alfredlugesi, T. kansasensis, Euschongastia trigenuala, Pseudoschongastia 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 alfredugesi* and *Neoschoengastia 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 northeastern-most 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 ex-
posed 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. lipowskyi* 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

<table>
<thead>
<tr>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. eltoni</td>
<td>T. myotis</td>
</tr>
<tr>
<td>II. multifemoralal</td>
<td>* T. lipovskyi</td>
</tr>
<tr>
<td>* T. alfredlugesi</td>
<td>T. whattoni</td>
</tr>
<tr>
<td>* T. lipovskyana</td>
<td>T. fitchi</td>
</tr>
<tr>
<td>* T. sylvilagi</td>
<td>T. cynos</td>
</tr>
<tr>
<td>* T. g. gurneyi</td>
<td>E. setosa</td>
</tr>
<tr>
<td>T. kansascensis</td>
<td>* E. jonesi</td>
</tr>
<tr>
<td>T. trisetica</td>
<td>* E. diversa</td>
</tr>
<tr>
<td>* N. americana</td>
<td>E. peromysci</td>
</tr>
<tr>
<td>P. hungerfordi</td>
<td>E. trigenuala</td>
</tr>
<tr>
<td>P. farneri</td>
<td>W. americana</td>
</tr>
</tbody>
</table>

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 south-east 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. alfredlugesi, 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. alfreddugesi* 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. alfreddugesi* 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
Hole Oak consists of a large yellow oak, *Quercus Muchlenbergi*, 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. alfreddugesi*.

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. alfreddugesi* 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. alfreddugesi* was sampled throughout. Larvae of *T. lipovskyanus* 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. alfredlugesi* and *N. americana* were obtained here. Late in the hot dry summers, larvae of *T. alfredlugesi* 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. alfredlugesi*, 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. alfredlugesi* 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. alfredlugesi*, *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. alfreddugesi* 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. alfreddugesi*. 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. alfreddugesi* 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. trigentala*, 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 wood-
land 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. alfreddugesi 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 juvenile) 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. alfreddugesi 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. trigennula 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 Alb.

Mammals were trapped near Sharon, in the northeastern corner, in areas of mixed to short grasses with sandy to hard soils. *Speleo-cola 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. alfredducis* 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. alfredducis* (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, par-
ticularly 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 
habitat 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 can-
yons) 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 

The general area consists of a flat plain, dissected by stream val-
leys. 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 re-
covered 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. alfreddugesi, unless otherwise noted): Holbrookia maculata (1) with 7; Scoloporus undulatus (1) with 10; Cnemidophorus scxlineatus (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. alfreddugesi 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. alfreddugesi; Sturnella neglecta (8), five with 45 T. alfreddugesi; and Chondestes grammacus (1) with 25 T. alfreddugesi.

Mammals from Wallace County, obtained on July 3-4, 1949, consisted of Perognathus (flavus or flavescens) (1) with 10 T. alfreddugesi; Onychomys lennocaster (1) with 1 E. trigenuala and 1 P. hungerfordi; Peromyscus maniculatus (3) with 30 T. alfreddugesi, 9 T. g. campestris, 16 T. kansascensis, 1 T. montanensis, and 11 P. hungerfordi (on 2); and Mus musculus (1) with 7 T. alfreddugesi.

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. cricetica.

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 in-
cluded *Cryptotis parva* (1), *Onychomys leucogaster* (1), *Reithrodontomys megalotis* (1) without chiggers and *Sigmodon hispidus* (10), nine of which had more than 259 *T. alfreddugesi*. A whip-snake, *Masticophis flagellum*, had many *T. alfreddugesi* and *T. montanus* 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. alfreddugesi*, and *Calamospiza melanocorys* (4), one with 1 *T. alfreddugesi* 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. alfreddugesi*, *Eumeces obsoletus* (1) with 25 *T. alfreddugesi*, *Natrix erythrogaster* (2) and *Thamnophis sauritus* (3) all with numerous larvae of *T. alfreddugesi*. Birds taken were *Zenaidura macroura* (1), *Empidonax trailli* (1), *Cyanocitta cristata* (1) without chiggers; *Colinus virginianus* (1) with 4 *T. alfreddugesi*, *Muscivora forficata* (1) with 1 *T. arenicola* and 3 *T. brennani*, and *Sturnella neglecta* (1) with 2 *T. batatas* and 2 *T. alfreddugesi*. 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. alfreddugesi*, 4 *T. g. campestris*, and 8 *T. arenicola*; *Dipodomys ordii* with 47 *T. batatas*, 2 *T. alfreddugesi*, and 55 *T. arenicola*. *Rana pipiens* also possessed *H. eltoni*. Only *T. alfreddugesi* 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 alfreddugesi*, *T. sylvilagi* and *T. gurneyi* were common, *T. lipovskyana*, *T. lipovskyi* and *Neoschön gastia 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. alfreddugesi*, 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. alfredlugesi 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 susceptible 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, Euschongastia 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

\[
\text{Fig. 2. Scutal plate, sensilla and scutal setae of } T. \ g. \text{ gurneyi, illustrating the measurements taken and listed under the diagnosis of each species.}
\]

- **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. alfreddugesi 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 durni Sambon

Hannemania multifemoralis sp. nov.
Subfamily Trombiculinae Ewing

Genus Trombicula Berlese

Subgenus Eutrombicula Ewing

Batatas Group
Trombicula batatas (Linnaeus)

Wichmanni Group
Trombicula alfreddugesi (Oudemans)
Trombicula lipovskyyana 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 Euschongastoides 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 Euschongastia Ewing
Subgenus Euschongastia Ewing
Euschongastia setosa (Ewing)
Euschongastia pipistrelli Brennan
Euschongastia jonesi Lipovsky and Loomis
Ungrouped Euschongastia
Euschongastia peromysci Ewing
Euschongastia diversa Farrell
Euschongastia criceticola Brennan
Euschongastia cynomyicola Crossley and Lipovsky
Euschongastia trigenuala Farrell
Euschongastia lacerta Brennan
Euschongastia loomisi Crossley and Lipovsky
Genus Pseudoschongastia Lipovsky
Pseudoschongastia hungerfordi Lipovsky
Pseudoschongastia farneri Lipovsky
Genus Cheladonta Lipovsky et al.
Cheladonta micheneri Lipovsky, Crossley and Loomis
Genus Neoschongastia Ewing
Neoschongastia americana (Hirst)
Neoschongastia brennani Crossley and Loomis
Subfamily Walchiinae Ewing
Genus Walchia Ewing
Walchia americana Ewing

Accounts of Species and Subspecies

Family Trombiculidae Ewing


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 sens-
sillary 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 seg-
ment of each palp fused at midline and projecting anteriorly over
chelicera as a winglike galea with a galeal seta, basal segment bear-
ing 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 Gahrlipeiinae (= 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 .................................................. Lecuwenhoekiiinae 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*) ................................................................. Troubiculiniae p. 1250

2' Scutum without anteromedian seta; legs II and III with six segments. Walmiinae p. 1362

SUBFAMILY LECUWENHOEKIIINAE WOMERSLEY


*Diagnosis.*—Larvae with all legs six-segmented; coxa I with 2 setae; sensillae flagelliform; scutum with 2 anteromedian setae (except *Odontacarus* *a*), 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 femorala 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.


*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 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. dunnii* p. 1246
6. Cheliceral blade with three rows of teeth (dorsal, lateral and ventral), teeth large and numerous .......... *A. (Xenacarns)* *plamosus* 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**


**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


Diagnosis.—Larva lacking both stigmata and tracheae.

Leeuwenhoekia americana (Ewing)

(Fig. 13, Map 2)


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).


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 speci-
mens 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**


**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)


**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 genuala, 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).
chigger mites of Kansas

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 jarrovi (Arizona); Dipsaurus 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 juvenile 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 alfредddugesi 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.


**Acomatacarus galli** Ewing

*(Fig. 16, Map 2)*


**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.


**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, demon-
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strating 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.


**Subgenus Xenacarus** 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)


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.


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.


Genus Whartonia Ewing


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)


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).


**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


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 para-subterminala; 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)


Diagnosis (based on specimens from Kansas).—Larva with scutum having PL seta long (45-50 µ); leg I with 10 genualae; leg II with 5 genualae; leg III with 5 genualae.


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 *Hanemania* embedded in the skin, according to the field notes of the collector, R. B. Finley, Jr. Most of these larvae were un-engorged 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 *Hanemania* 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*.


_Hannemania dunni_ Sambon

(Map 6)


**Diagnosis.**—Larva similar to _H. eltoni_, but differs in having leg I with 1 femorala; leg II with 2-3 genualae (and 1 microgenualae); 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 McLennan 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 picipiens (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. LA70818-7), 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.


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 whip-like 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 femorala 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 McLennan counties).

Seasonal occurrence.—Larvae were found on frogs taken from February to October inclusive. They frequently overwinter on frogs. 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.

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.


Subfamily Trombiculinae Ewing


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 genualæ and 1 microgenualæ, tibia with 8 or 9 branched setae, 2 tibialæ and 1 microtibialæ, 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 tibialæ, 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 Cheledonta.

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. Cheledonta 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**
  - T. (Leptotrombidium) (2)
  - T. (Neotrombicula) (5)
  - T. (Miyatrombicula) (2)

- **Group B**
  - Euschöngastia (8 species)
  - Cheladonta (1)

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:
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Group A
T. (Eutrombicula) (4)
T. (Euschongastoides) (1)
T. (Trombicula) sensu lato (7)
Speleocola (1)

Group B
Euschongastia (2 only)
Pseudoschongastia (2)
Neoschongastia (2)

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 Euschongastoides), Speleocola and Euschongastia (except possibly E. loomisi).

Those which feed on early instars of Collembola are Pseudoschongastia, Neoschongastia 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) ..........................................................Pseudoschongastia p. 1347
3. Sensilla expanded distally ............................................. 4
3' Sensilla flagelliform ..................................................Trombicula p. 1253
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 ..........Euschongastia 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*, *Neo-trombicula*, 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*, *Neo-trombicula*, *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 (18-20μ); palpal genu with seta short (18-21μ); palpal claw with shallow cleft ........................................ *T. alfredschuhi* p. 1259

4' Tarsala I long (23-33μ); palpal genu with seta long (24-33μ); palpal claw with deep cleft ..................................................... *T. lipovskyskyana* 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 2-2-2 ................................... 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. crosleyi* 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. twenties* p. 1289

13. Scutum with anteromedian seta less than 40μ in length; tarsala I, 13μ, sensilla short (45-55μ) ............................................. 14

13' Scutum with anteromedian seta more than 40μ in length; tarsala I, 16μ, sensilla long (64-74μ) .................................................. *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. camppestris* 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. Galeal III present; dorsal setal formula begins 2-10, total body setae more than 46 setae ........................................... *T. jonesae* p. 1303
17' Galeal 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 mastitibialae, 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. whartonii* 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


**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

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* 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. alfreddugesi*, 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. multiseta (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._


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.


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. alfreddugesi*, *T. splendens* and *T. lipovskyyana* known from Kansas and the United States, the former (including *T. tropica* Ewing) also occurring south into South America; *T. gólđii* (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 alfreddegæsi* (Oudemans)

(Figs. 4-12, Map 8)

Microthrombidium alfreddegæsi Oudemans, Ent. Berichten, vol. 3, no. 54, 1910, p. 84, type from Temascaltepec, 22 miles northeast of Tejupilco, Mexico, Mexico, host man, circa 1892, according to Fuller (1952:107).


**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.


**Taxonomic remarks.**—Prior to the recognition of *T. lipovskyyana* Wolfenbarger (1953:660), larvae of this species probably were identified as *T. alfreddegæsi* 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. lipovskyyana* will necessitate the re-examination of larvae formerly identified as *T. alfreddegæsi*.

The larvae from western Kansas identified as *T. alfreddegæsi* 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. alfreddugesi* 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. alfreddugesi* 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. alfreddugesi* 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. alfreddugesi* 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. alfreddugesi* including 2 amphibians, 29 reptiles, 31 birds and 21 mammals.

Larvae of *T. alfreddugesi* 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. alfredrugési* 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. alfredrugési* 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. alfredrugési* 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*

*Crotaphytus collaris*

*Eumeces fasciatus*

*Eumeces obsoletus*

*CNemidophorus sexlineatus*

*Serpentes*

*Thamnophis sirtalis*

*Coluber constrictor*

*Masticophis flagellum*

*Pituophis catenifer*

*Ancistrodon contortrix*

**Aves**

*Tympanuchus cupido*

*Colinus virginianus*

Most birds had only a moderate number of *T. alfredrugési* attached. (See below.)

**Mammalia**

*Sylvilagus floridanus*

*Sigmodon hispidus*

*Microtus ochrogaster*

*Neotoma floridana*

*Neotoma micropus*

Figure 12 illustrates the number of *Trombicula*, principally *T. alfredrugési*, obtained in eastern Kansas on important hosts.

In Kansas, hosts which as individuals had only a moderate number of *T. alfredrugési*, 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. alfredrugési*, 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
- Sceloporus undulatus
- Natrix erythrogaster
- Natrix sipedon
- Heterodon nasicus
- Heterodon platyrhinos
- Elaphe obsoleta
- Elaphe guttata
- Lampropeltis calligaster
- Lampropeltis getulus

**Aves**

- Zenaidura macroura
- Toxostoma rufum
- Turdus migratorius
- Sturnus vulgaris
- Passer domesticus
- Quiscalus quiscula
- Sturnella magna
- Sturnella neglecta
- Richmondena cardinalis
- Spiza americana

Vertebrates of little or no importance as hosts for *T. alfredrugesi* 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. alfredrugesi*, 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 epithoca
- Sistrurus catenatus
- Crotalus horridus
- Crotalus viridis

**Aves**

- Coccyzus americanus
- Chordeiles minor
- Petrochelidon pyrrhonota
- Hirundo rustica
- Cyanocitta cristata
- Parus atricapillus
- Parus bicolor
- Sialia sialis
- Age-laius phoeniceus
- Columba livia
- 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
- 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. alfredrugési* 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. alfredrugési* on many of the mammals.

Each species of host of *T. alfredrugési* 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. alfredrugési* 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. alfreddugési* 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. alfreddugési* found on frogs and toads were on the head and back.

**Habitats.—** Larvae of *T. alfreddugési* 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. alfreddugési* 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. alfreddugési* 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. alfredlugesi* 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. alfredlugesi*. 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. alfredlugesi*, 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. alfredlugesi* 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. alfredlugesi* 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. alfred dugesi*. 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. alfred dugesi* 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 alfred-dugesi 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.

![Graph showing rainfall and mean air temperature from May to October.](image)

**Fig. 5.** The abundance of *T. alfreddegesi* in 1950 at the same stations as listed above.

![Graph showing abundance of *T. alfreddegesi* from May to October.](image)

**Fig. 6.** The abundance of *T. alfreddegesi* 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. alfredudesi* in 1951 based on larvae taken on chigger samplers.

**Fig. 8.** The abundance of *T. alfredudesi* 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 favor-
Chigger Mites of Kansas

able 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.

![Graph](image)

**Fig. 9.** The abundance of *T. alfreddugesi* 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. alfreddugesi* 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. alfreddugesi* 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

![Graph](image)

**Fig. 10.** The abundance of *T. alfreduskeri* 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. alfreddugesi*. 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 nympha1 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. alfredlugesi*. 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. alfredlugesi* 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. alfredugesi* 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. alfredugesi* recovered from the soil.

<table>
<thead>
<tr>
<th>Date</th>
<th>Size of sample</th>
<th>Soil type</th>
<th><em>T. alfredugesi</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>nymphs</td>
</tr>
<tr>
<td>February 27, 1951</td>
<td>1'x1'x1' (1 cu. ft.)</td>
<td>rocky</td>
<td>1</td>
</tr>
<tr>
<td>March 28, 1952</td>
<td>6'' deep x 1'x2'</td>
<td>rocky</td>
<td>0</td>
</tr>
<tr>
<td>July 7, 1950</td>
<td>Top 4'x1'x1'</td>
<td>non-rocky</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>next 4'x1'x1'</td>
<td>non-rocky</td>
<td>0</td>
</tr>
<tr>
<td>July 14, 1950</td>
<td>4 samples—approx. 4 cu. ft.</td>
<td>rocky and non-rocky soil</td>
<td>0</td>
</tr>
</tbody>
</table>

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 buoyant 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. alfredugesi*, including data from Jenkins (1947 and 1948 *). According to these authors the egg and deuteroval 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. alfredugesi* and *T. liposcyana*, 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), Troglydytes aedon (4), Turdus migratorius (12), Zenaidura macroura (16), Cryptotis parva (1), Canis familiaris (1),
Chigger Mites of Kansas

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), Ophiurus 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), Corncrake brachyrhynchos (8), Melothrus 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. SEDGWICK 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), Stumella neglecta (25), Perognathus hispidus (7), Peromyscus maniculatus (13). WYANDOTTE Co.: Heterodon platyrhinos (13), Tamias striatus (10), Sylvilagus floridanus (15), Toxostoma rufum (14), Dunetella carolinensis (8), Zenaidura macroura (2), Colaptes auratus (6), Turdus migratorius (3), Richmondena cardinalis (6), Terrapene ornata (3), Quiscalus quiscula (14).


Trombicula lipovskyana Wolfenbarger
(Fig. 12, Map 9)


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. alfreddugesi and T. splendens.


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. lipovskynam* 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. lipovskynam* attached along with a total of 513 larvae of *T. alfreddugesi*. These collared lizards were taken at a limestone quarry partly filled with water. The snake hosts include one *Elaphie obsoleta* with one larva; *Lampropeltis getulus* with an estimated 50 larvae, along with 300 *T. alfreddugesi*; and one timber rattlesnake, *Crotalus horridus* with 3 larvae. Two garter snakes, *Thamnophis sirtalis*, had 6 and 3 larvae respectively. Five copperheads, *Anciastrodon 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. alfreddugesi* attached along with *T. lipovskynam*.

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. lipovskynam* were found on 31 of the 34 positive birds (91%).

Wolfenbarger (1953:666) recorded a single larva from a fly-catcher, *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. alfreddugesi* 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. alfreddugesi* was abundant and *N. americana* was present. Larvae of *T. alfreddugesi* 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. alfreddugesi* 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,

*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.


Trombicula splendens Ewing

(Map 7)


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 (13-16); leg III with 1 mastitarsala. Similar to T. alfredludgès 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),
Chigger Mites of Kansas


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 Aedes triseriatus (Say) were numerous. The Collembola, related to the laboratory species, Sinella curviseta Brook, whose eggs are regularly 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. alfredschlesi* 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. lipovskiyana* 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 alfreddugesi*, 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


**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)


Diagnosis.—Larva with body white in life, moderate in size (engorged), dorsal setae 3S, 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); Sylvislagus 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.


*Trombicula twentei* Loomis

*(Fig. 22, Map 10)*


*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.


*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


**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. whartonii*, 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)


Diagnosis.—Larva similar to *T. whartoni*, but differs in having scutum broadly rounded posteriorly, with numerous small puncta; sensilla with pronounced rounded barbs along entire length; legs with coxae having small puncta.


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, Scirrus 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. alfredrugèsi 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.

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 (5). 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).


Trombicula whartonii Ewing
(Fig. 12, Map 10)

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.


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, Thyothorus 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.


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)


Diagnosis.—Larva similar to *T. kardosi* Loomis but differs in having sensilla shorter, average 70\(\mu\), with more branches (12-14); galeal seta with more branches (5); palpal femur, genu and tibia with setae branched; tarsalae I (19\(\mu\)) and II (14\(\mu\)) shorter.


Geographic distribution.—(Loomis, 1954): Known from central Illinois (Piatt County), southeastern Nebraska (Otoe County), eastern and south-central Kansas (Douglas, Jefferson, Miami, Wyan- dotte, 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.

Trombicula kardosi Loomis

(Figs. 12, 26, Map 14)


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.


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)

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.


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 approxi-
mately 15 days. The surviving nymph remained active for 18 days and then seemingly entered the preadult stage. It was then preserved.


Subgenus Miyatrombicula 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 genuâ€‘æ, 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)


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*.


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.


_Trombicula Jonesae_ Brennan

_Fig. 12, Map 16_


_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 masti-tarsala.


**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. whartonii*. The larva from Iowa was recovered from a white-footed mouse, *Peromyscus leuco-pus*, 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**


**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)


**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 *Euschongastia lacerta* Brennan, but differs in having the sensilla flagelliform as well as in other characters (see diagnosis of *E. lacerta*).


**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.


**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 genua; 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.

**Trömbicula montanensis** Brennan

(Map 20)


**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 (12-13\(\mu\)); all leg segments with branched setae similar, having few, large branches.


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 ludovicianus*, 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 grass-
lands 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. alfred dugesi*, 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. alfred dugesi*. This evidence supports the theory that at least two generations of larvae emerge each year.


Trombicula arenicola Loomis
(Figs. 30-31, Map 20)


Diagnosis.—Larva similar to T. montanensis, but differs in having dorsal body setae total 36, formula beginning 2-8-8, total body setae 74-80; sensilla longer (67-75μ); galeal seta with 2 or 3 branches;
Chigger Mites of Kansas

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tarsalae I and II longer (16µ) and most leg segments with two
types of branched setae (stout with few branches and long with
many small branches).

Scutal measurements (after Loomis, 1954), average and ex-
tremes, 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 Can-
ad (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 Kan-
sas 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 fre-
cently on heteromyid rodents, especially the kangaroo rat, Dipod-
omys 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 Musci-
vora forficata (Kansas), Spermophilus richardsoni and Mus mus-
culus (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 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


Diagnosis.—Larvae with eyes 2/2, posterior eye smaller, on indistinct ocular plate, red in life; tarsalae I and II short (12-13 µ). 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)


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.


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.


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 *campesbris* 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. alfred-dugèsi and T. syleilagi 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 & gurneyi taken on chigger samplers at the Reservation in 1952.

<table>
<thead>
<tr>
<th>Station in Skink Woods</th>
<th>May 25</th>
<th>June 30</th>
<th>July 16</th>
<th>June 20</th>
<th>Aug. 8</th>
<th>Aug. 20</th>
<th>Sept. 3</th>
<th>Sept. 17</th>
<th>Sept. 21-23</th>
<th>Sept. 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rat Log (B-1)</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Under Rat Log (B-2)</td>
<td>13</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
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<td>Skink Elm (C-1)</td>
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<td>Skink Log (C-2)</td>
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1. Total number of T. & gurneyi taken on chigger samplers.
2. Total number of samples.

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The University Science Bulletin

_Trombicula gurneyi campestris_ Loomis

_(Map 17)_


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.


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.


*Trombicula kansasensis* Loomis

(Fig. 12, Map 18)


*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).


*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.


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)


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.


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 trees 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.

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)


**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).


**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.


**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 (14-22\(\mu\)); 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)


**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.


**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*.

Genus Speleocola 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)


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, parasternal 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.


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 north-east 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 Euschongastia 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 Euschongastia, sensu lato, can be placed in two groups according to the seasonal occurrence of the larvae. The winter group includes Euschongastia trigenuala, E. setosa, E. pipistrelli, E. jonesi, E. peromysci, E. diversa, E. criceti- cola 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: *Euschôngastia peromysci* from a crow and *E. diversa* from an English sparrow, cardinal and black-capped chickadee.

**Key to species of Euschôngastia in Kansas**

1. Subterminala and parasubterminala I absent (sensilla clavate).  
   *E. lacerta* p. 1345
   1' Subterminala and parasubterminala I present ........................................... 2
   3. Palpal claw with 5 prongs; scutum with no distinct ridge above each sensillary base  *E. setosa* p. 1329
   4. Three genualae I  .......................................................... 5
   5. Sensilla clavate; sensillary bases widely separated (28μ); palpal claw with 5 prongs  *E. trigenuala* p. 1343
   6. Palpal claw with 3 prongs; sensilla subclavate or globose ................................ 7
   7. Sternal setae 2-2  .......................................................... 8
   8. Sternal setae 2-6  .......................................................... 9
   8' Scutum with 3 crestent 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
   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 *Euschongastia* 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.

*Euschongastia setosa* (Ewing)

(Fig. 12, Map 21)


**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- 6S (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.

Euschöngastia pipistrelli Brennan

(Fig. 12, Map 22)


Diagnosis.—Larva similar to E. jonci, 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 Lipovský and Loomis
(Figs. 12, 38, Map 22)


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.


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.—Euschongastia 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
cought at night in a limestone cave. In addition, one engorged
larva was taken on a chigger sampler by Ervin Kardos near a lime-
stone 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 prob-
ably developed in different regions. *Euschongastia pipistrelli* seems
to be restricted to caves and cave bats, and has only one lens on
each side and the eyes are colorless. *Euschongastia 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).
11, 1953 (1).

*Euschongastia*

(Species which do not belong in the subgenus *Euschongastia*)

*Euschongastia peromysci* (Ewing)

(Figs. 12, 39, Map 23)

*Schongastia peromysci* Ewing, Ent. News., vol. 40, Nov. 8, 1929, p. 296, type
from Sturbridge, Worcester County, Massachusetts, host *Peromyscus leu-
copus*, May 27, 1928.

1948; Wharton and Fuller, Msm. Ent. Soc. Washington, no. 4, Dec. 10,
11, 1934, p. 171.


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.


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.


Euschöngastia diversa Farrell
(Fig. 12, Map 24)


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 antero-lateral 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 genua; leg III with 1 tibia.


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 Scirurus 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 Sigmoidon 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 (25), Mus musculus (6), Peromyscus maniculatus (2), Reithrodontomys megalotis (32), Sigmoidon hispidus (11); 3 mi. N Hiawatha, Microtus ochrogaster (94), Mus musculus (3), Peromyscus

Euschöngastia criceticola Brennan

(Map 24)


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 genualar; leg III without tibia.

Scutal measurements, average and extremes, of 5 larvae from Bar-
Chigger Mites of Kansas

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. criceticola attached to the ears. This mouse was the type host and in Kansas it was a host of E. criceticola 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. criceticola 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. criceticola.

The majority of the larvae were found attached to the outer ear, especially on the antitragus and along the helix.

Habitats.—Larvae of E. criceticola 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.
Euschongastia cynomyicola Crossley and Lipovsky


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 ovoid; 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 tibia.


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.—Euschongastia 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).

Euschongastia trigcnuala Farrell
(Figs. 12, 40-41, Map 25)


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 tibia.


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.

Chigger Mites of Kansas


**Euschöngastia lacerta** Brennan

*(Map 25)*


**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*).


**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).

Euschongastia loomisi Crossley and Lipovsky

(Map 23)


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 genuaæ; leg III with 1 tibiaæ.


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. Euschongastia 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.


Genus Pseudoschongastia 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 tibia (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 Ascoschongastia, 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 Pseudoschongastia in Kansas

1. Scutum with anterolateral seta longer than anteromedian seta, 3 genuala 1 .......................................................... P. hungerfordi p. 1348
1’ Scutum with anterolateral seta shorter than or equal to anteromedian seta, 2 genuala 1 .......................................................... P. farneri p. 1351

Pseudoschongastia hungerfordi Lipovsky
(Figs. 12 and 42, Map 26)


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*.


**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 susceptibility 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.


**Pseudoschöngastia farneri** Lipovsky
(Figs. 12 and 43, Map 27)


**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 1 with 2 genu-alae; leg segments compressed and legs II and III especially short.

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.


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* See discussion under eyes pp. 1416-1417.
**Genus Neoschöngastia Ewing**


**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 genua; leg III with coxa having 3 branched setae, 1 genua 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; 


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.


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 Harcastle, 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. alfred dugesi, 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. seelopori* (= *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.

*Neoschongastia 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, especially 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 shortgrass, 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. alfreddegesi*, 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. alfreddegesi*. Both species move with great rapidity; the movements of the legs of *T. alfreddegesi*, 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. alfreddegesi* although larvae were uncommon when *N. americana* was first discovered, and at the edge of the woodland (Station A) where *T. alfreddegesi* 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. alfredrugesi* at the same surface sites.

Neoschongastia brennani Crossley and Loomis

(Fig. 48, Map 29)


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.


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 *Muscicora 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 \textit{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 \textit{N. brennani} was not found on other birds examined at the same time.

\textit{Specimens examined}.—Total, 33 larvae, as follows: \textit{Barber Co.}: 10½ mi. W Hardtner, \textit{Chondestes grammacus} (1), \textit{-Melanerpes erythrocephalus} (28), and \textit{Tyrannus tyrannus} (1), all July 26-27, 1952. \textit{Seward Co.}: 12 mi. NE Liberal, \textit{Muscivora forficata}, Sept. 9, 1948 (3).

\textbf{Genus Cheladonta Lipovsky, Crossley and Loomis}

\textit{Cheladonta Lipovsky, Crossley and Loomis, Jour. Kansas Ent. Soc., vol. 28, Oct. 8, 1955, pp. 137-139, figs. 5-12, type \textit{Cheladonta micheneri} Lipovsky, Crossley and Loomis.}

\textit{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.

\textit{Remarks}.—The genus \textit{Cheladonta} is known from North America and Asia. The species are \textit{C. ikaoensis} Sasa, \textit{et al.}, from Japan and Korea, \textit{C. micheneri}, \textit{C. crossi} and \textit{C. ouachitensis}, from the United States.

The members of this genus have been found only on mammals.

\textit{Cheladonta micheneri Lipovsky, Crossley and Loomis}

(Figs. 12, 45-46, Map 28)


\textit{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
Chigger Mites of Kansas

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 genualae, and pretarsala; leg III with coxa having 1 branched seta, and 1 genualae (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 Pero-
myscus maniculatus (15).

Subfamily Walchiinae Ewing

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,

Species in Kansas (W. americana) similar to members of Trom-
biculinae 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 in-
cluded as a subgenus in the genus Gahrliepia by Audy (1954:135).
I have followed this classification, except that Walchia has been re-
tained 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 ex-
panded sensilla and were related to certain members of Euschö-
gastia, sensu lato, of the subfamily Trombiculinae.

Larvae of this subfamily are known exclusively from mammals.

Genus Walchia Ewing

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)


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 tricuspide 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.


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 Otoc 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* un-successfully 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.

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.


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


**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.


**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


**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 mastic-tarsala.

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. dunnii, H. multifemorala, T. alfreddugesi, T. lipovskyana.
Rana pipiens—Leopard frog (166)—H. eltoni, H. multifemorala, T. alfreddugesi.

REPTILIA

Terrapene ornata—ornate box turtle (24)—T. alfreddugesi, T. lipovskyana, T. montanensis.
Crotaphytus collaris—collared lizard (322)—A. arizonensis, T. alfreddugesi, T. lipovskyana.
Holbrookia maculata—earless lizard (3)—T. alfreddugesi.
Sceloporus undulatus—fence lizard (17)—T. alfreddugesi.
Ophisaurus attenuatus—slender glass snake (25)—T. alfreddugesi.
Cnemidophorus sexlineatus—six-lined racerunner (108)—T. alfreddugesi.
Eumeces fasciatus—five-lined skink (850)—T. alfreddegësi, T. g. gurneyi.
Eumeces laticeps—greater five-lined skink (4)—T. g. gurneyi, T. trisetica.
Eumeces obsoletus—gray skink (355)—T. alfreddegësi, T. lipovskyana, T. g. campestris, T. montanensis.
Natrix erythrogaster—plain-bellied water snake (3)—T. alfreddegësi.
Natrix rhombifera—diamond-backed water snake (1)—T. alfreddegësi.
Natrix sipedon—common water snake (9)—T. alfreddegësi.
Thamnophis radix—plains garter snake (6)—T. alfreddegësi.
Thamnophis sauritus—ribbon snake (7)—T. alfreddegësi.
Thamnophis sirtalis—common garter snake (47)—T. alfreddegësi, T. lipovskyana, T. kansasensis.
Tropidoclonion lineatum—lined snake (8)—T. alfreddegësi.
Heterodon nasicus—western hog-nosed snake (6)—T. alfreddegësi, T. g. campestris, T. montanensis.
Heterodon platyrhinos—common hog-nosed snake (2)—T. alfreddegësi.
Diadophis punctatus—ring-necked snake (188)—T. alfreddegësi.
Coluber constrictor—racer (130)—T. alfreddegësi, T. lipovskyana, T. kansasensis, T. sylvilagi.
Masticophis flagellum—whip snake (5)—T. alfreddegësi, T. g. campestris, T. montanensis.
Elaphe guttata—prairie rat snake (14)—T. alfreddegësi.
Pituophis catenifer—bull snake (30)—T. alfreddegësi, T. montanensis, T. kansasensis.
Lampropeltis calligaster—blotched king snake (15)—T. alfreddegësi.
Lampropeltis getulus—common king snake (5)—T. alfreddegësi, T. lipovskyana, T. montanensis.
Lampropeltis triangulum—red king snake (17)—T. alfreddegësi, T. g. campestris.
Ancistrodon contortrix—copperhead (159)—T. alfreddegësi, T. lipovskyana, T. trisetica, T. sylvilagi.
Crotalus horridus—timber rattlesnake (31)—T. alfreddegësi, T. lipovskyana, T. g. gurneyi, T. kansasensis.
Crotalus viridis—prairie rattlesnake (17)—T. alfredugesi, T. g. campestris, T. montanensis.

**Aves**

Buteo jamaicensis—red-tailed hawk (3)—T. alfredugesi.

Tympanuchus cupido—prairie chicken (4)—T. alfredugesi, T. lipovskyna, N. americana.


Rallus elegans—king rail (1)—T. alfredugesi, T. lipovskyna, N. americana.

Bartramia longicauda—upland plover (4)—T. lipovskyna.

Zenaidura macroura—mourning dove (37)—T. alfredugesi, T. lipovskyna.

Coccyzus americanus—yellow-billed cuckoo (6)—T. alfredugesi.

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. alfredugesi.

Centurus carolinus—red-bellied woodpecker (10)—T. lipovskyi.

Melanerpes erythrocephalus—red-headed woodpecker (9)—T. alfredugesi, T. gurneyi, T. crossleyi, N. brennani.

Tyrannus tyrannus—Eastern kingbird (9)—T. lipovskyna, N. brennani.

Muscicora forficata—scissor-tailed flycatcher (8)—T. arenicola, N. brennani.

Empidonax sp.—flycatcher (1)—T. lipovskyna.

Eremophila alpestris—horned lark (17)—T. alfredugesi.

Cyanocitta cristata—blue jay (4)—T. alfredugesi, T. whartoni, T. montanensis.

Corvus brachyrhynchos—crow (4)—T. alfredugesi, E. peromysci.

Parus atricapillus—black-capped chickadee (26)—T. lipovskyi, E. diversa.

Parus bicolor—tufted titmouse (6)—T. alfredugesi, T. whartoni, T. sylvilagi.

Troglodytes aedon—house wren (2)—T. alfredugesi, T. lipovskyna.

Dumetella carolinensis—catbird (3)—T. alfredugesi, N. americana.

Toxostoma rufum—brown thrasher (3)—T. alfredugesi, N. americana.
Sialia sialis—bluebird (14)—T. alfreddugesi, T. lipovskyana, N. americana.
Turdus migratorius—robin (18)—T. alfreddugesi, T. lipovskyana, T. sylvilagi, N. americana.
Sturnus vulgaris—starling (11)—T. alfreddugesi, T. lipovskyana.
Passer domesticus—English sparrow (37)—T. alfreddugesi, T. lipovskyana, N. americana, E. diversa.
Agelaius phoeniceus—red-winged blackbird (37)—T. alfreddugesi, T. lipovskyana.
Icterus galbula—Baltimore oriole (1)—T. alfreddugesi.
Molothrus ater—cowbird (39)—T. alfreddugesi, T. lipovskyana, N. americana.
Quiscalus quiscula—bronze grackle (8)—T. alfreddugesi, T. lipovskyana.
Sturnella magna—eastern meadow lark (5)—T. alfreddugesi, T. lipovskyana, N. americana.
Sturnella neglecta—western meadow lark (22)—T. alfreddugesi, T. lipovskyana, T. batatas, T. lipovskyi.
Piranga rubra—summer tanager (1)—T. alfreddugesi.
Spiza americana—dickcissel (15)—T. alfreddugesi, T. lipovskyana, N. americana.
Calamospiza melanocorys—lark bunting (4)—T. alfreddugesi.
Chondestes grammacus—lark sparrow (8)—T. alfreddugesi, T. lipovskyana, N. americana, N. bremani.
Junco hyemalis—slate-colored junco (27)—T. whartoni, T. sylvilagi.
Spizella passerina—chipping sparrow (3)—T. alfreddugesi.
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.
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.
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.
Onychomys leucogaster—northern grasshopper mouse (13)—T. alfreddugesi, T. g. campestris, T. montanensis, E. trigenuala, P. hungerfordi.

Reithrodontomys megalotis—western harvest mouse (90)—L. americana, T. alfreddugesi, T. lipovskyi, E. peromysci, E. diversa, P. hungerfordi.


Microtus pinetorum—woodland pine vole (10)—T. lipovskyi, E. diversa.

Rattus norvegicus—Norway rat (7)—T. alfreddugesi, T. lipovskyi, E. diversa.


Zapus hudsonius—meadow jumping mouse (2)—T. sylvilagi.

Canis latrans—coyote (5)—T. lipovskyi, E. diversa.

Canis familiaris—dog (1)—T. alfreddugesi, T. lipovskyan.

Procyon lotor—raccoon (1)—T. alfreddugesi.

Homo sapiens—man (1)—T. alfreddugesi.
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 mississippiensis—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)
Telingatoides 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)
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. Spelecocola 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 verte-
brates. 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. alfreddugi, T. lipovskyan 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>
<thead>
<tr>
<th>Species of amphibians</th>
<th>Eastern (Area B)</th>
<th>Western (Area A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>exam.</td>
<td>hosts</td>
</tr>
<tr>
<td><em>Ambystoma texanum</em></td>
<td>46</td>
<td>0</td>
</tr>
<tr>
<td><em>Ambystoma tigrinum</em></td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td><em>Notophthalmus viridescens</em></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><em>Eurycea longicauda</em></td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td><em>Eurycea lucifuga</em></td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td><em>Scaphiopus bombifrons</em></td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td><em>Bufo cognatus</em></td>
<td>44</td>
<td>44</td>
</tr>
<tr>
<td><em>Bufo terrestris</em></td>
<td>68</td>
<td>61</td>
</tr>
<tr>
<td><em>Bufo woodhousii</em></td>
<td>56</td>
<td>48</td>
</tr>
<tr>
<td><em>Acris grullus</em></td>
<td>67</td>
<td>24</td>
</tr>
<tr>
<td><em>Hyla versicolor</em></td>
<td>119</td>
<td>77</td>
</tr>
<tr>
<td><em>Pseudacris clarkii</em></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>Pseudacris ugrita</em></td>
<td>300</td>
<td>297</td>
</tr>
<tr>
<td><em>Gastrophryne olivacea</em></td>
<td>96</td>
<td>71</td>
</tr>
<tr>
<td><em>Rana areolata</em></td>
<td>26</td>
<td>26</td>
</tr>
<tr>
<td><em>Rana catesbeiana</em></td>
<td>34</td>
<td>18</td>
</tr>
<tr>
<td><em>Rana pipiens</em></td>
<td>147</td>
<td>106</td>
</tr>
</tbody>
</table>

*Taken in the Ozark area of Cherokee County, along with *Typhlotriton nercus* (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.

<table>
<thead>
<tr>
<th>Area</th>
<th>Months</th>
<th>Total examined</th>
<th>With chiggers</th>
<th><em>H. eltoni</em></th>
<th><em>H. multifemorada</em></th>
<th><em>H. species</em></th>
<th><em>T. affredopigasi</em></th>
<th><em>T. liposynaga</em></th>
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<tbody>
<tr>
<td>B1a</td>
<td>Feb.–May</td>
<td>34</td>
<td>13</td>
<td>68(9)</td>
<td>52(7)</td>
<td>357</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1b</td>
<td>Feb.–May</td>
<td>46</td>
<td>22</td>
<td>266(16)</td>
<td>178(11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3a</td>
<td>June–Oct.</td>
<td>33</td>
<td>19</td>
<td>15(3)</td>
<td>11(2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1b</td>
<td>June–Oct.</td>
<td>4</td>
<td>4</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2a</td>
<td>April</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2b</td>
<td>September</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A1b</td>
<td>September</td>
<td>16</td>
<td>16</td>
<td>101</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>A1a</td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Refers to larvae of *Hannemania* counted (but not identified as *H. eltoni* or *H. multifemorada*) from Douglas County.
Table 5.—Summary of chiggers on amphibians from Kansas, excluding *H. dunni.*

<table>
<thead>
<tr>
<th></th>
<th>Bufo woodhousii</th>
<th>Acris gryllus</th>
<th>Rana pipsiens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total individuals examined</td>
<td>67</td>
<td>70</td>
<td>166</td>
</tr>
<tr>
<td>Total individuals with chiggers</td>
<td>11</td>
<td>32</td>
<td>98</td>
</tr>
<tr>
<td>Per cent with <em>Hannemania</em> species</td>
<td>12%</td>
<td>44%</td>
<td>58%</td>
</tr>
<tr>
<td>Total larvae of <em>Hannemania</em> species</td>
<td>23</td>
<td>106</td>
<td>1,700</td>
</tr>
<tr>
<td>Average number of <em>Hannemania</em> per host</td>
<td>3</td>
<td>3.3</td>
<td>18</td>
</tr>
<tr>
<td>Per cent with <em>H. eltoni</em></td>
<td>10%</td>
<td>44%</td>
<td>53%</td>
</tr>
<tr>
<td>Total of <em>H. eltoni</em></td>
<td>17</td>
<td>99</td>
<td>537</td>
</tr>
<tr>
<td><em>H. eltoni</em> per host</td>
<td>6</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Total with <em>Hannemania</em> multifemorala</td>
<td>3</td>
<td>4</td>
<td>32</td>
</tr>
<tr>
<td>Per cent with <em>H. multifemorala</em></td>
<td>5%</td>
<td>6%</td>
<td>33%</td>
</tr>
<tr>
<td>Total of <em>H. multifemorala</em></td>
<td>6</td>
<td>7</td>
<td>767</td>
</tr>
<tr>
<td><em>H. multifemorala</em> per host</td>
<td>2</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>Maximum <em>Hannemania</em> on one individual</td>
<td>5</td>
<td>10</td>
<td>150</td>
</tr>
<tr>
<td>Hosts with both species of <em>Hannemania</em></td>
<td>2</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>Per cent of hosts with both <em>Hannemania</em></td>
<td>3%</td>
<td>6%</td>
<td>23%</td>
</tr>
<tr>
<td>Total individuals with <em>T. (Eutrombicula)</em></td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

* 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.

<table>
<thead>
<tr>
<th>Species of reptiles</th>
<th>Total</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrapene ornata</td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Sceloporus undulatus</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crotaphytus collaris</td>
<td>300</td>
<td>18</td>
<td>73</td>
<td>76</td>
<td>77</td>
<td>26</td>
<td>34</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Ophisaurus attenuatus</td>
<td>25</td>
<td></td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Cnemidophorus sclenicatus</td>
<td>98</td>
<td></td>
<td>2</td>
<td>14</td>
<td>21</td>
<td>42</td>
<td>14</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Lygosoma laterale</td>
<td>36</td>
<td></td>
<td>12</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Eumeces fasciatus</td>
<td>850</td>
<td>68</td>
<td>294</td>
<td>172</td>
<td>123</td>
<td>85</td>
<td>81</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>Eumeces laticeps</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eumeces obsoletus</td>
<td></td>
<td>335</td>
<td>1</td>
<td>48</td>
<td>46</td>
<td>32</td>
<td>86</td>
<td>94</td>
<td>25</td>
</tr>
<tr>
<td>Natrix erythrogaster</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natrix rhomboidera</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natrix sipedon</td>
<td>9</td>
<td></td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Storeria dekayi</td>
<td>13</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thamnophis sauritus</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thamnophis sirtalis</td>
<td>46</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Heterodon platyrhinos</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diadophis punctatus</td>
<td>172</td>
<td>75</td>
<td>76</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Carphophis amoenus</td>
<td>60</td>
<td>4</td>
<td>7</td>
<td>35</td>
<td>7</td>
<td>4</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Coluber constrictor</td>
<td>124</td>
<td>16</td>
<td>13</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>12</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Elaphe guttata</td>
<td>5</td>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elaphe obsoleta</td>
<td>70</td>
<td>1</td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>Pituophis catenifer</td>
<td>21</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td></td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Lampropeltis calligaster</td>
<td>15</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Lampropeltis getulus</td>
<td>4</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lampropeltis triangulum</td>
<td>11</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tantilla gracilis</td>
<td>14</td>
<td>6</td>
<td>7</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancistrodon contortrix</td>
<td>159</td>
<td>38</td>
<td>12</td>
<td>2</td>
<td>16</td>
<td>13</td>
<td>46</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Sistrurus catenatus</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Crotalus horridus</td>
<td>31</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. alfredugesi.
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 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

<table>
<thead>
<tr>
<th>Table 7.—Collared lizards from eastern Kansas and their chiggers.</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th><em>T. alfrediogesi</em></th>
<th>Number per host</th>
<th>T. <em>alleganiensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ. Kansas Nat. Hist. Res. Adults</td>
<td>May</td>
<td>18</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>37</td>
<td>35</td>
<td>7,621</td>
<td>217</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>40</td>
<td>40</td>
<td>6,998</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>21</td>
<td>21</td>
<td>1,396</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>1</td>
<td>1</td>
<td>125</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July*</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>5</td>
<td>5</td>
<td>106</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>31</td>
<td>28</td>
<td>170</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Chase County (May 31, 1950). Adults</td>
<td>May</td>
<td>10</td>
<td>2</td>
<td>80</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Anderson County. Adults</td>
<td>June</td>
<td>31</td>
<td>31</td>
<td>5,136</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>24</td>
<td>23</td>
<td>2,967</td>
<td>129</td>
<td>28(6)</td>
</tr>
</tbody>
</table>

* The young of the previous year reach the size of young adults by July and are included with the adults.
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 graminii*, May (1); *Thamnophis radix*, Nov. (1); *Tropidoclonion lineatum*, May (1); *Halicula 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.

<table>
<thead>
<tr>
<th>Month and days, 1947-1953</th>
<th>Total examined</th>
<th>With chiggers</th>
<th><em>T. affinis</em></th>
<th><em>T. g. gueneyi</em></th>
<th>Trombicula sp. (total)</th>
<th>Number per host</th>
<th>Number per shink</th>
</tr>
</thead>
<tbody>
<tr>
<td>March (16-31)</td>
<td>50</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April (1-15)</td>
<td>29</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April (16-30)</td>
<td>256</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May (1-15)</td>
<td>65</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May (16-31)</td>
<td>102</td>
<td>23</td>
<td>3(2)</td>
<td>227</td>
<td>230</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>June (1-15)</td>
<td>61</td>
<td>32</td>
<td>126(9)</td>
<td>1</td>
<td>218</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>June (16-30)</td>
<td>62</td>
<td>56</td>
<td>518(14)</td>
<td>112(8)</td>
<td>1,278</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>July (1-15)</td>
<td>50</td>
<td>37</td>
<td>222(13)</td>
<td>6(1)</td>
<td>1,055</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>July (16-31)</td>
<td>47</td>
<td>46</td>
<td></td>
<td></td>
<td>1,164</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Aug. (1-15)</td>
<td>51</td>
<td>47</td>
<td>12(1)</td>
<td></td>
<td>997</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Aug. (16-31)</td>
<td>30</td>
<td>30</td>
<td>(641)</td>
<td></td>
<td>452</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Sept. (1-30)</td>
<td>23</td>
<td>15</td>
<td></td>
<td></td>
<td>65</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Oct. (1-15)</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9.—Lizards from eastern Kansas (Area B) examined for chiggers.

<table>
<thead>
<tr>
<th>Species of lizards</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. alfredigesi</th>
<th>Number per host</th>
<th>Number per lizard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cnemidophorus sexlineatus</td>
<td>May</td>
<td>14</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>.7</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>21</td>
<td>20</td>
<td>13,050</td>
<td>653</td>
<td>620</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>42</td>
<td>41</td>
<td>11,819</td>
<td>288</td>
<td>281</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>14</td>
<td>13</td>
<td>1,500</td>
<td>115</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>September</td>
<td>3</td>
<td>3</td>
<td>43</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>.5</td>
</tr>
<tr>
<td>Eumeces obsoletus</td>
<td>May</td>
<td>46</td>
<td>2</td>
<td>3</td>
<td>1.5</td>
<td>.07</td>
</tr>
<tr>
<td></td>
<td>June</td>
<td>32</td>
<td>29</td>
<td>4,263</td>
<td>147</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>86</td>
<td>80</td>
<td>18,825</td>
<td>235</td>
<td>219</td>
</tr>
<tr>
<td></td>
<td>August</td>
<td>94</td>
<td>91</td>
<td>12,063</td>
<td>133</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>September</td>
<td>25</td>
<td>23</td>
<td>1,406</td>
<td>61</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>October</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>.6</td>
</tr>
</tbody>
</table>

Table 10.—Reptiles from eastern Kansas (Area B) examined for chiggers.

<table>
<thead>
<tr>
<th>Species of reptiles (totals examined in summer are in parentheses)</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. alfredigesi</th>
<th>T. liposkanzkyi</th>
<th>T. g. gurneyi</th>
<th>T. tridenta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrapene ornata (12)</td>
<td>June</td>
<td>4</td>
<td>3</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>4</td>
<td>4</td>
<td>90</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sceoporus undulatus (1)</td>
<td>June</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ophisaaurus attenuatus (15)</td>
<td>Aug.</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eumeces laticeps (4)</td>
<td>May</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natrix erythrogaster (1)</td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>2</td>
<td>2</td>
<td>430</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natrix rhombifera (1 juv.)</td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterodon platyrhinos (1)</td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diadophis punctatus (21)</td>
<td>June</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>11</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamproptelis calligaster (10)</td>
<td>July</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>3</td>
<td>2</td>
<td>450</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
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<td>30.</td>
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</table>
Table 11.—Snakes from eastern Kansas (Area B) examined for chiggers.

<table>
<thead>
<tr>
<th>Species of snakes (total in parentheses)</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. aferrobelli</th>
<th>T. liposzygma</th>
<th>T. kansasensis</th>
<th>T. g. gurneyi</th>
<th>T. tetrata</th>
<th>T. montanus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thamnophis sirtalis... (36)</td>
<td>June</td>
<td>3</td>
<td>3</td>
<td>330</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>4</td>
<td>3</td>
<td>98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>8</td>
<td>8</td>
<td>850</td>
<td>20</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>11</td>
<td>7</td>
<td>137</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>10</td>
<td>6</td>
<td>181</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coluber constrictor (95)</td>
<td>June</td>
<td>4</td>
<td>2</td>
<td>325</td>
<td></td>
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<td></td>
<td>July</td>
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<td>3</td>
<td>771</td>
<td>275</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>7</td>
<td>7</td>
<td>3,023</td>
<td>10</td>
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<tr>
<td></td>
<td>Sept.</td>
<td>12</td>
<td>11</td>
<td>1,464</td>
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<tr>
<td></td>
<td>Oct.</td>
<td>69</td>
<td>40</td>
<td>923</td>
<td>35</td>
<td>5(1)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pituophis catenifer... (13)</td>
<td>June</td>
<td>3</td>
<td>2</td>
<td>1,521</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>2,200</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>2</td>
<td>2</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>7</td>
<td>6</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ancistrodon contortrix... (107)</td>
<td>July</td>
<td>16</td>
<td>16</td>
<td>5,898</td>
<td>110</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>14</td>
<td>11</td>
<td>1,340</td>
<td>19</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>46</td>
<td>41</td>
<td>1,204</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Oct.</td>
<td>32</td>
<td>18</td>
<td>137</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lampropeltis getulus (2)</td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>1</td>
<td>1</td>
<td>310</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lampropeltis triangulum (2)</td>
<td>June</td>
<td>8</td>
<td>5</td>
<td>367</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>4</td>
<td>4</td>
<td>313</td>
<td>17(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>10</td>
<td>9</td>
<td>392</td>
<td>33(1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>6</td>
<td>4</td>
<td>316</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>14</td>
<td>6</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Species of reptiles (total number) (*Woods Co., Okla.)</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>A. arizonensis</th>
<th>T. aegyptiaca</th>
<th>T. o. cantans</th>
<th>T. monodonensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrapene ornata (9)</td>
<td>Aug.</td>
<td>2</td>
<td>2</td>
<td>31</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>7</td>
<td>7</td>
<td></td>
<td>60+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crotaphytus collaris (5)</td>
<td>April</td>
<td>1</td>
<td>0</td>
<td></td>
<td>20</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>25 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holbrookia maculata (2)</td>
<td>Aug.</td>
<td>2</td>
<td>2</td>
<td></td>
<td>25 (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sceloporus undulatus (6)</td>
<td>April</td>
<td>1</td>
<td>0</td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>4</td>
<td>1</td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phrynosoma cornutum (3)</td>
<td>Sept.</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eumeces obsoletus (3)</td>
<td>April</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterodon nasipus (1)</td>
<td>Aug.</td>
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<td>0</td>
<td></td>
<td>20</td>
<td>4</td>
<td>227</td>
</tr>
<tr>
<td>Heterodon platyrhinos (1)</td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>227</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Masticophis flagellum (1)</td>
<td>*Aug.</td>
<td>1</td>
<td>1</td>
<td>70</td>
<td>30</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Sept.</td>
<td>1</td>
<td>1</td>
<td></td>
<td>30</td>
<td>200</td>
<td>15</td>
</tr>
<tr>
<td>Arizona elegans (1 juv.)</td>
<td>Sept.</td>
<td>1</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td>1+</td>
</tr>
<tr>
<td>Pituophis catenifer (1)</td>
<td>Aug.</td>
<td>2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sonora episcopa (2)</td>
<td>*Sept.</td>
<td>8</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*Sept.</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypsiglena torquata (1)</td>
<td>Sept.</td>
<td>1</td>
<td>0</td>
<td></td>
<td>6 (2)</td>
<td>137</td>
<td></td>
</tr>
<tr>
<td>Sistrurus catenatus (1)</td>
<td>April</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Crotalus viridis (12)</td>
<td>Aug.</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td>137</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>4</td>
<td>1</td>
<td>6 (2)</td>
<td></td>
<td>137</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
<td>137</td>
<td></td>
</tr>
</tbody>
</table>

* 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. brenmani_, 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. alfreddugési_ and _N. americana_, occasionally were found attached to birds.

In eastern Kansas, birds seem to be major hosts for _T. alfreddugési_, _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. alfreddugési_, _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 *Neoschongastia* 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. alfredlugesi* and *T. lipovskyanus* 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);
Chigger Mites of Kansas

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); Troglydotes troglody-

Table 13.—Birds from eastern Kansas (Area B) examined for chiggers.

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<th>Species of birds</th>
<th>Total examined</th>
<th>January-February</th>
<th>March-April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
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Table 14.—Birds from eastern Kansas (Area B) examined and found to have chiggers.

<table>
<thead>
<tr>
<th>Species of birds</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. aferéndogí</th>
<th>T. lipóssykí</th>
<th>T. tóharí</th>
<th>T. sphylí</th>
<th>N. amériíána</th>
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<tr>
<td><em>Tympanuchus cupidó</em></td>
<td>Aug.</td>
<td>3</td>
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<td>270</td>
<td>180(2)</td>
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<td>4</td>
<td>12</td>
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Table 14.—Birds from eastern Kansas (Area B) examined and found to have chiggers.—Concluded.

<table>
<thead>
<tr>
<th>Species of birds</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. alfredlugesi</th>
<th>T. lipovskyi</th>
<th>T. whartonii</th>
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<td>Sept.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Oct.</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dec.</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spiza americana</td>
<td>June</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>July</td>
<td>2</td>
<td>7(6)</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td>12(3)</td>
</tr>
<tr>
<td>Chondestes grammacus</td>
<td>July</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Junco hyemalis</td>
<td>Oct.</td>
<td>2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nov.</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 1 E. diversa recovered.

tes, May (1); Telmatodytes palustris, Oct. (1); Minus polyglottis, Jan. (1) and June (1); Lanius ludovicianus, May (1) and Nov. (1); Virco 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); Poecetes 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. alfredlugesi 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. lipovskyi; Cyanocitta cristata, June (1) with 2; Corvus brachyrhynchos, June (1) with 8 and 2 E. peromysci; Troglohytes aedon, August (1) with 4 and 1 T. lipovskyi; 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. whartonii; Melospiza melodia, Nov. (1) with 1 T. lipovskyi.
Table 15.—Summary of the birds from eastern Kansas and their chiggers.

<table>
<thead>
<tr>
<th>Month 1947-53</th>
<th>Total birds</th>
<th>Total hosts</th>
<th>Number of species of hosts</th>
<th>Species of chiggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7</td>
<td>1</td>
<td>One species</td>
<td>T. lipovskyi</td>
</tr>
<tr>
<td>February</td>
<td>23</td>
<td>0</td>
<td>One species</td>
<td>E. diversa</td>
</tr>
<tr>
<td>March</td>
<td>35</td>
<td>1</td>
<td></td>
<td>T. alfredugési</td>
</tr>
<tr>
<td>April</td>
<td>27</td>
<td>0</td>
<td></td>
<td>E. peromysci</td>
</tr>
<tr>
<td>May</td>
<td>43</td>
<td>0</td>
<td></td>
<td>T. alfredugési</td>
</tr>
<tr>
<td>June 1-13</td>
<td>14</td>
<td>1</td>
<td>Eight species</td>
<td>T. lipovskya</td>
</tr>
<tr>
<td>June 14-30</td>
<td>21</td>
<td>15</td>
<td>Fifteen species</td>
<td>N. americana</td>
</tr>
<tr>
<td>July</td>
<td>67</td>
<td>54</td>
<td>Fourteen species</td>
<td>T. alfredugési</td>
</tr>
<tr>
<td>August</td>
<td>54</td>
<td>22</td>
<td>Nine species</td>
<td>T. whartonii</td>
</tr>
<tr>
<td>September</td>
<td>49</td>
<td>18</td>
<td>Eight species</td>
<td>T. syltegii</td>
</tr>
<tr>
<td>October</td>
<td>46</td>
<td>14</td>
<td></td>
<td>T. lipovskya</td>
</tr>
<tr>
<td>November</td>
<td>103</td>
<td>16</td>
<td>Ten species</td>
<td>The five in Oct. plus</td>
</tr>
<tr>
<td>December</td>
<td>23</td>
<td>5</td>
<td>Two species</td>
<td>T. lipovskyi</td>
</tr>
</tbody>
</table>

Table 16.—Birds from Barber County (Areas A1b and A2b) examined for chiggers.

<table>
<thead>
<tr>
<th>Species of birds</th>
<th>Months</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>T. alfredugési</th>
<th>T. gueneji</th>
<th>T. crossyi</th>
<th>T. montanensis</th>
<th>N. brunnii</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ictinia misissippiensis</td>
<td>July—Sept.</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Buteo jamaicensis</td>
<td>August</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Falco sparverius</td>
<td>September</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Colinus virginianus</td>
<td>July, Sept.</td>
<td>6</td>
<td>3</td>
<td>11</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Charadrius vociferus</td>
<td>August</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Melanerpes erythrocephalus</td>
<td>July</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>8</td>
<td>45</td>
<td>250</td>
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<tr>
<td>Dendroccopus pubescens</td>
<td>Aug.—Sept.</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tyrannus tyrannus</td>
<td>September</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Muscivora forficata</td>
<td>July—Sept.</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Eremophila alpestris</td>
<td>July—Sept.</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cyanocitta cristata</td>
<td>July</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Parus atricapillus</td>
<td>September</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Passer domesticus</td>
<td>July</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sturnella neglecta</td>
<td>July</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chondestes grammacus</td>
<td>July</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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</tr>
</tbody>
</table>
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. alfreddugesi, 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 cotton-tail (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. criceticola, 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. cynomyi-cola, 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. alfred-dugèsii, 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. whartonii* 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>
<thead>
<tr>
<th>Species of mammals</th>
<th>Total</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
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<td><em>Didelphis marsupialis</em></td>
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<tr>
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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. alfreddugesi*; *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. whartonii* 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. alfreddugesi*; *Canis latrans*, Jan. (1) with 3 *E. diversa* and Dec. (2) with 4 *T. lipovskyi*; *Canis familiaris*, August (1) with 1 *T. alfreddugesi* and 10 *T. lipovskyana*. 
Table 18.—Shrews and moles from eastern Kansas (B) with chiggers.

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<tr>
<th>Species of mammals</th>
<th>Month</th>
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<th>With chiggers</th>
<th>T. alfredengesi</th>
<th>T. liposcypha</th>
<th>T. liposkyi</th>
<th>T. sylviangi</th>
<th>T. g. grueyi</th>
<th>E. jonesi</th>
<th>E. diversa</th>
<th>E. trigemina</th>
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<td>T. liposkyra</td>
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<td>E. pecomysei</td>
<td>E. diversa</td>
<td>P. hopferfeldi</td>
<td>L. micheneri</td>
<td>N. americana</td>
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Table 20.—Tree squirrels from eastern Kansas (Area B) and their chiggers.

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<th>T. cynos</th>
<th>T. filei</th>
<th>T. kardosi</th>
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* One E. jonesi and one C. micheneri also obtained.
** One E. trigenua also recorded, but doubtful.
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Table 22.—White-footed mouse from eastern Kansas (Area B) and their chiggers.

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Table 24.—Prairie voles, cotton rats and woodland pine voles from eastern Kansas (Area B) and their chiggers.

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<th>T. whartonii</th>
<th>T. sylvestri</th>
<th>E. peromysci</th>
<th>E. diversa</th>
<th>E. tricraniata</th>
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| | February | 4 | 3 | 1 | | | | | | | | 3 |
| | November | 2 | 1 | 2 | | | | | | | | |
Table 25.—Mammals from northwestern Kansas (Area A1a), Cheyenne and Rawlins counties, examined for chiggers.

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<th>E. cynomica</th>
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</tbody>
</table>

* 92 *Trombicula* sp.? from seven individuals.
Table 26.—Bats from Barber County, Kansas (Areas A1b and A2b) and adjacent Woods County, Oklahoma (*).

<table>
<thead>
<tr>
<th>Species of bats</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>W. senex</th>
<th>T. alfrediænsi</th>
<th>T. texensis</th>
<th>T. eumops</th>
<th>T. hoplai</th>
<th>T. fitchi</th>
<th>S. tadaridae</th>
<th>E. Jonesi</th>
<th>T. mexicanus</th>
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<td>25</td>
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<td></td>
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</tr>
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<td>1</td>
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</table>

* Woods County, Oklahoma.
** Visual examination by J. W. Twente.
*** One *T. montanensis* recorded, probably from contamination.
<table>
<thead>
<tr>
<th>Species of mammals</th>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>A. plumosus</th>
<th>T. alfrediensi</th>
<th>T. hoploi</th>
<th>T. g. campesi</th>
<th>T. montanensis</th>
<th>E. trigona</th>
<th>E. cricticola</th>
<th>E. lacerta</th>
<th>E. lunata</th>
<th>C. micrornis</th>
<th>P. hungerfordi</th>
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<tr>
<td>Lepus californicus</td>
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<td>1</td>
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<td>1</td>
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<td>Sylvilagus floridanus</td>
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<td></td>
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<td>1</td>
<td>12</td>
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<td>Cynomys ludovicianus</td>
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<td>Spermophilus tridecemlineatus</td>
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<td>Perognathus flavus</td>
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<td>Sigmodon hispidus</td>
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* Woods County, Oklahoma.
<table>
<thead>
<tr>
<th>Species of Mammals</th>
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<th>August</th>
<th>September</th>
<th>April</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
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<td>Catophilus gundersonis</td>
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<td>22</td>
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<td>12</td>
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<td>Procyon lotor</td>
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<td>13</td>
<td>30</td>
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<td>13</td>
<td>30</td>
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<td>Vulpes fulva</td>
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<td>Urocyon cinereoargenteus</td>
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*Woods County, Oklahoma.*
Table 29.—Gray wood rats, *Neotoma micropus*, from Barber County (Area A1b) and their chiggers.

<table>
<thead>
<tr>
<th>Month</th>
<th>Total examined</th>
<th>With chiggers</th>
<th>A. plenusis</th>
<th>W. senosse</th>
<th>T. affodiensis</th>
<th>T. mydalis</th>
<th>T. liposkyi</th>
<th>T. fitchi</th>
<th>T. g. campesiris</th>
<th>T. kansasis</th>
<th>T. ornata</th>
<th>T. montana</th>
<th>E. setosa</th>
<th>E. creticola</th>
<th>E. laeucta</th>
<th>E. loomisi</th>
<th>P. farneri</th>
<th>P. hangerfordi</th>
<th>W. americana</th>
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<tr>
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<td>19</td>
<td>19</td>
<td>20</td>
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<td>130</td>
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<td>175</td>
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<tr>
<td>September*</td>
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<td>7</td>
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<td>October</td>
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<td>1</td>
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</tbody>
</table>

* 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. alfreddugesi. 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 re-appeared.

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. *Neuschöngastia*, 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. alfredlugèsi*). 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. alfreddugési, 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. tadaridaceae*, *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 *Pseudoschongastia*, 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 *Pseudoschongastia* 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 *Euschongastia* by Audy (1954); *Schoutedenichia* Vercammen-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*, *Pseudoschönöngastia*, *Cheladonta*, *Leptotrombidium* and *Euschönöngastoides*. All species of *Euschönöngastia* and *Neoschönöngastia* in the New World also lack long nude setae.

Some Old World species of *Euschönöngastia* possess one mastitar-sala, but they are not closely related to the species in the New
World. The two species of *Neoschönastia* have long setae on the tarsus which are branched only basally, approaching the mastitarseae of *Trombicula*. Mastitarseae do appear in the genus, since *Neoschönastia* *asakawai* Fukuzumi and Obata has two to six and *N. poseksi* Obata 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. *Neoschönastia*, which occasionally possesses mastitarsalae, is largely limited to birds.

In Kansas, the genera which have species possessing mastitarseae 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 mastitarseae, nine species have one mastitarsala, two species lack mastitarseae, 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 mastitarseae. Two other subgenera, *Eutrombicula* and *Miyatrombicula*, each include species which lack the mastitarsala III normally present on the remaining species. These mastitarseae 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. whartonii* 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. splendidens*) 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 sub-terminala 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 pretarsalae 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.

<table>
<thead>
<tr>
<th>HABITATS</th>
<th>No long nude setae</th>
<th>One nude seta (mastitarsala)</th>
<th>Two or more mastisetae</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOIL SURFACE, ETC., R, B, M—S**</td>
<td></td>
<td>T. alfreddugesi</td>
<td>T. batatas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T. lipovskyi</td>
<td>T. sylvilagi</td>
</tr>
<tr>
<td>SOIL SURFACE, ETC., B and esp. M, S and W</td>
<td></td>
<td>T. splendens</td>
<td></td>
</tr>
<tr>
<td>RESTRICTED</td>
<td>T. gurneyi</td>
<td>T. trisetica</td>
<td></td>
</tr>
<tr>
<td>R, B, M—S</td>
<td>T. kansasensis</td>
<td>T. montanensis</td>
<td></td>
</tr>
<tr>
<td>RESTRICTED</td>
<td>T. crossleyi</td>
<td>T. arenicola</td>
<td></td>
</tr>
<tr>
<td>B, M, prob. R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESTRICTED</td>
<td>T. myotis</td>
<td>T. merrihewi*</td>
<td>T. ornata</td>
</tr>
<tr>
<td>Mammals. Summer</td>
<td>T. twentei</td>
<td>T. cynos</td>
<td></td>
</tr>
<tr>
<td>and Winter</td>
<td>T. fiteki</td>
<td>T. jonesae</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T. kardosi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T. kopiat</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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 sensil-
lae, 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 precipi-
tation 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. gunneyi, 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: Acoma-
tacarus arizonensis, A. galli, A. plumosus, T. hoplai, T. montanensis,
Euschongastia criceticola, E. lacerta, E. loomisi, Neoschongastia
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. alfreddegis*, *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. alfreddegis*, 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. alfreddegis* 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.

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**Fig. 12.** The seasonal occurrence of the chigger larvae (except those of *Hannemannia*) 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 larva, 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. alfreddugési*) should be broader to show accurately the relative abundance.
### Chigger Mites of Kansas

#### Summer species

- *Trombicula gurneyi*
- *Pseudoschongastia farneri*
- *Trombicula trisetica*
- *Trombicula alfreddugesi*
- *Trombicula lipovskyana*
- *Neoschongastia americana*
- *Pseudoschongastia hungerfordi*
- *Trombicula kansasensis*
- *Trombicula sylvilagi*

#### Winter species

- *Euschongastia trigenuala*
- *Euschongastia setosa*
- *Trombicula myotis*
- *Walchia americana*
- *Trombicula fitchi*
- *Trombicula cynos*
- *Trombicula lipovskyi*
- *Trombicula whartonii*
- *Euschongastia jonesi*
- *Trombicula jonesae*
- *Euschongastia peromysci*
- *Euschongastia diversa*
- *Cheladonta micheneri*
- *Trombicula kardasi*
- *Euschongastia pipistrelli*
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Willmann, C.

Wolfenbarger, K. A.

Womersley, H.


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. alfred nugesi*) 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.
Chigger Mites of Kansas
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.
EXPLANATION OF FIGURES 42-49.

Fig. 42. *Pseudoschongastia hungerfordi*, scutum and eyes.
Fig. 43. *Pseudoschongastia farneri*, scutum and eyes.
Fig. 44. *Cheladonta micheneri*, scutum.
Fig. 45. *Cheladonta micheneri*, cheliceral blade.
Fig. 46. *Cheladonta micheneri*, palpal claw.
Fig. 47. *Neoschongastia americana*, scutum and eyes.
Fig. 48. *Neoschongastia brennani*, sensilla.
Fig. 49. *Walchia americana*, scutum.