PARASITES IN LEAFHOPPERS FROM KANSAS GRASSLANDS (HOMOPTERA:CICADELLIDAE)

by

ROBERT SHOOT BALDRIDGE

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Approved by:

H D Blocker
Major Professor

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INTRODUCTION

The leafhopper family Cicadellidae is one of the largest in North America and the world (DeLong, 1948). They use varied groups of plants as food and oviposition hosts. Certain species are of major economic importance. Most work involving economic effects has dealt with species infesting high income crops such as sugar cane, rice, sugar beets, apples and grapes.

Oman (1949) listed four major types of leafhopper injury to plants: (1) damage caused by the transmission of virus diseases; (2) introducing foreign matter during feeding which mechanically interrupted the normal translocation in plants; (3) direct removal of liquid plant foods by feeding; and, (4) such injury as was caused by oviposition and defecation.

The injuries inflicted by leafhoppers are usually not as obvious as those of other herbivorous insects (Sanders and DeLong, 1920). Annual damage to grazing and hay production by high populations in grassland is probably of economic proportion (Osborn, 1915; Fattig, 1955; Young, 1959).

Leafhoppers can be partially controlled by man and insect agents. Agricultural practices can be applied to suppress large populations of leafhoppers (Osborn, 1915). These insects are also controlled to varying degrees by insect predators and parasites. Limited work has been done to determine predators and parasites operating in grassland biomes, particularly in Kansas.

This study was an attempt to determine parasites found infecting leafhoppers in native prairie grasslands in Kansas, using both field collecting and rearing data. The discussion was limited primarily to

three orders of leafhopper parasites: Hymenoptera, Strepsiptera and Diptera. These forms are those usually listed as parasitizing nymphal and adult leafhoppers (Lawson, 1920), and were the most frequently collected kinds of parasites.

LITERATURE REVIEW

The study of parasites of leafhoppers from the grasslands of Kansas has been neglected and only occasional references are noted in taxonomic treatments of leafhoppers occurring in the grassland biome. These usually concerned the three main groups of internal parasites (Lawson, 1920) or the presence of immature forms of one particular group (Blocker, 1967).

Dryinidae (Hymenoptera)

Members of the family Dryinidae are primarily internal parasites of auchenorhynchus Homoptera (Richards, 1939). The life histories of this group have been studied more than the other two parasitic groups to be mentioned.

Perkins (1905, 1906, 1912) and Fenton (1918) have done extensive work in many areas of dryinid biology and systematics. Perkins dealt with Hawaiian dryinids and species sent to him by his co-workers in the United States; Fenton primarily studied North American Dryinidae. Richards (1939) did a taxonomic study of the British Dryinidae. Douglas (1890), Ainslie (1920), Gentner (1926), Esaki and Hashimoto (1935), Steiner (1936), Knowlton (1937), Cook (1941) and Barrett et

al. (1965) have studied the biology of various dryinid parasites of leafhoppers, mostly of the genera Aphelopus Dalm., Gonatopus Ljungh and Pachygonatopus Fenton.

According to Fenton (1918) adult dryinids were found in grass, forbs and woody vegetation. Wingless females sought their prey on foot while winged forms flew actively in search of prey. The female upon nearing the prey stopped, made a sudden jump at the prey, and seized it with the chelate front tarsi. She then stung the host, causing a paralyzed condition. The female dryinid might: (1) consume the host; (2) oviposit in the host through either the cuticle or intersegmental membrane; or (3) release the host unharmed. The reason for the latter was unclear.

Richards (1939) indicated that five larval stages were probably involved in most of the life cycles. Barrett et al. (1965) recorded five larval instars in Pachygonatopus minimus Fenton. The first four molts, which were not typical larval molts, took place in the body of the host. Each preceding larval exuvium was split longitudinally down the back, yielding an exuvium which adhered to the body of the next larval instar. The succeeding larval stage darkened, giving the appearance of a tab or sac on the body of the host. The last larval stage liquified and consumed the body contents of the host, dropped from the host and pupated in a cocoon of silken material (Fenton, 1918; Barrett et al., 1965). The last larval molt was the only typical one (Barrett et al., 1965).

The larvae moved by means of peristalic body movements in search of suitable pupation habitats (Fenton, 1918). The cocoon might be formed on vegetation, at soil level, or in the soil. It might be formed

only of silken material or have soil particles or incorporated parts of the larval sac.

Only the female is known to actively prey on leafhoppers. Both sexes, however, feed on sugar solutions (Fenton, 1918). In nature, certain dryinids feed on honeydew secreted by their hosts (Perkins, 1905).

The females are longer-lived than the males. Barrett et al. (1965) recorded females of P. minimus Fenton as living from 5 to 46 days. The males lived from less than a day to four days, probably surviving only long enough to copulate (Perkins, 1905). Very little is known of male life history (Richards, 1953).

Parthogenetic reproduction occurred to a large extent in this group (Fenton, 1918); this was based on laboratory rearing data and the low number of males recorded from field collections. Polyembryony also has been recorded from one species.

The effect of this parasitic family as a controlling factor of leafhopper populations is uncertain. Field collections may indicate erroneously low or high populations of these parasites on leafhopper hosts (Lawson, 1920). The controlling effects of P. minimus Fenton on Macrosteles fascifrons (Stal), with 37% parasitism recorded, were considered unimportant (Barrett et al., 1965).

Halictophagidae (Strepsiptera)

Leafhopper parasites of the order Strepsiptera have been reported by Pierce (1909, 1918) and Bohart (1941, 1943). The latter presented the

most comprehensive treatment of North American Strepsiptera and includes a summary of leafhopper hosts, systematics and life history information.

The family Halictophagidae is the primary stylopid parasite (Bohart, 1943) and exhibits a high degree of sexual dimorphism. This information, as well as morphological differences between stages in the development of larval and pupal forms, was reviewed by Pierce (1909) and Bohart (1941, 1943).

The female of Halictophagidae lacks antennae, eyes, legs, wings, palpi and distinct body segments (Bohart, 1941). It is permanently sealed in its puparium within the host and appears externally as a flattened, semicircular to oblong tab (the cephalothorax) on the body of the host. The abdomen, within the host, is devoid of obvious characters except for one to three brood canals.

The males are free-living, and seldom live more than two days (Bohart, 1941). They have well-developed fan-shaped metathoracic wings. The mesothoracic wings are reduced to pseudohalteres.

A typical life cycle was described by Bohart (1941). The female was actively sought by the male. Copulation took place through an aperture in the cephalothorax of the female. The sperm fertilized a mass of eggs developing simultaneously within the abdomen of the female. Ultimately one to five thousand larvae developed and escaped through the cephalic aperture. These triungulin larvae got onto vegetation and awaited a host. They used their sharply-edged heads to penetrate the body of the host, where a series of hypermetamorphic molts took place prior to adult emergence. Those that became males formed an exarate pupa inside the last larval skin. The pupal case partially protruded from the body of the host as a rounded capsule. The end cap of this

puparium was pushed off by the mature male prior to its escape from the host.

The existence of parthogenesis was discussed by Pierce (1918) and Schrader (1924). It appears, however, that bisexual reproduction is more common.

Dorilaidae (Diptera)

Dorilaidae (Pipunculidae of authors) was the only family of Diptera recorded as internal parasites of leafhoppers. The larval stage occurs in the host.

Dorilaidae were recorded from the homopterous families Cicadellidae, Fulgoridae and Cercopidae (Hardy, 1943) in various parts of the world. Curran (1965) included the unconfirmed observation that the hemipterous family Miridae also served as a host.

Hardy (1943), in his Nearctic treatment of this family, indicated that these flies are common in grasslands. Almost any grassy area yielded one to many species of adults.

The biology of certain of these insects affecting leafhoppers has been dealt with by Douglas (1890), Keilin and Thompson (1915), Severin (1924) and Knowlton (1924). These works and that of Hardy (1943) should be consulted for life history information. Few American species have been reared and their life histories studied. Perkins (1905, 1906) associated 15 of 26 Dorilaidae species with their leafhopper hosts in Australia and Hawaii. Hardy (1943) listed several genera and species with which he associated proven or suspected leafhopper hosts.

The larvae are the life forms affecting the leafhopper directly. Hardy (1943) and others listed above describe such life forms. The larvae are oblong. The posterior end is rounded slightly whereas the anterior end is slightly pointed. Body segmentation is indistinct. No external mouthparts are present; each larva has a pair of heavily sclerotized mandibles or "mouth hooks". These appear in the first instar and are shed with the last larval molt. The larvae are amphineustic.

Larvae develop from eggs deposited in both nymphal and adult leafhoppers. Larvae develop within the abdomen of the host. They may completely fill the abdomen upon maturing, and extend into the posterior thoracic segments. The mature larva breaks out of the host's abdomen (Hardy, 1943), usually at its junction with the thorax (Oman, 1949), or at other points along the abdomen (Parker, 1967). This emergence kills the host.

Pupation may occur on the soil surface, in the soil, or on plant parts (Hardy, 1943). The puparium is formed from the last larval skin.

These parasitic forms are not as easily detected as Dryinidae or Halictophagidae. Distention of the infected host's abdomen and its sluggish behavior may be clues to parasitized conditions (Oman, 1949). However, a gravid female may have an appearance similar to that of a parasitized form (Hardy, 1943).

This family contains species which probably exert some control of leafhopper populations. Until more biological studies are carried out, however, their importance cannot be estimated adequately.

Henderson (1955) discussed possible methods for dissemination of these three internal parasites of leafhoppers based on collections of parasitized beet leafhoppers, Circulifer tenellus (Baker). He attempted to determine what effects parasitization had on distance traveled in their annual migrations. It appeared that, even though wind dispersion accounted for some adult movement of these parasites, dispersion was primarily dependent on the movements of the larvae within the host. This was particularly probable in the case of Dryinidae and Strepsiptera. Dorilaidae also depended on this method for dispersion, but adults, being good fliers, may have been carried by the wind.

MATERIALS AND METHODS

Grassland Collections

A survey of Kansas grasslands, involving 96 collections from 55 counties, was conducted between August 23, 1967, and September 24, 1967.

Grasslands were sampled for leafhoppers using a round sweep net. Each survey collection consisted of 120 sweeps. One sweep of the net was made approximately every three feet, or average walking stride. The sampling was made in a square quadrat of 30 sweeps per side. Each sample included as many of the existing grass types as noted in the collection area. No attempt was made to determine population densities of either leafhoppers or parasites.

Collected material from each site was placed in a small paper sack, labeled and stored until separated. Paradichlorobenzene (PDB) was added to each sack to insure kill of any arthropod material, especially

dermestid larvae and spiders. The sweep net bag was reversed after each collection to minimize contamination from the prior collection.

At each site the predominant grasses were recorded, particularly those which had well-developed seed heads at the time of the survey. No recording of specific forbs was made; such plants were recorded per collection as "forbs". Almost none of the collection sites was devoid of forbs.

Further collections were made involving four reseeded upland pastures at Fort Hays Branch Experiment Station, Hays, Kansas. Collections were made at irregular intervals from 1967 through 1968.

The pastures collected contained the following grass species:

1. A native mixture pasture of Andropogon gerardi (big bluestem), A. scoparius (little bluestem), Bouteloua curtipendula (sideoats grama), B. gracilis (blue grama), Buchloe dactyloides (buffalograss), and Panicum virgatum (switchgrass).
2. A pasture of Andropogon intermedius (caucasian bluestem).
3. A pasture of Agropyron smithii (western wheatgrass).
4. A pasture of primarily Panicum virgatum (switchgrass).

These pastures had been seeded initially in April, 1957. Grazing studies were in progress on these pastures and had been carried out in previous years. Each pasture had an area fenced off from the grazing area. Collections were made in these areas also. Due to the low incidence of leafhoppers in the caucasian bluestem pasture, this pasture was excluded during the 1968 collecting season.

Two types of collections were obtained from the Fort Hays area. One 100-sweep collection of dead leafhoppers which included the adult parasites was mailed to Manhattan, Kansas from Hays, Kansas in pint cardboard ice cream cartons from three of the pastures; one 50-sweep collection was taken from the caucasian bluestem pasture. One "live" collection per pasture was mailed at the same time in quart cardboard ice cream cartons lined with wet paper towels. A small amount of vegetation from each site was placed in each carton. This vegetation provided a surface for the leafhoppers to rest upon and tended to keep them off the wet paper towel. The number of sweeps per "live" collection varied during the study but was never less than 100.

Various collections were also made during this study in Donaldson Pasture, a research pasture near Manhattan (Riley county), Kansas. Areas of buffalograss, blue grama, bluestem and switchgrass were collected.

The grassland insect collections made by W. H. Arnett during his study of grasshoppers in Donaldson Pasture (1960) were made available for studying the contained leafhopper material. Material from the research collection of the Kansas State University Entomology Department was also used.

Procedure for Handling the Dead Parasitized Leafhoppers

The dead leafhopper material was removed and stored dry in empty plastic vials. They were viewed under a binocular microscope. The externally-parasitized leafhoppers were removed and mounted. External examination was sufficient to detect late larval Dryinidae and adult Halictophagidae.

It was necessary to clear a sample (approximately half) of each collection (minus the externally-parasitized materials) in order to find internal larval stages of parasitic Dorilaidae and early stages of Dryinidae and Halictophagidae.

Samples were cleared in a cold potassium hydroxide solution for one hour, then immersed in glycerine and viewed under a dissecting microscope. Any parasitized leafhoppers were removed and stored in glycerine in covered deep-well slides for future species determinations.

Since there are no keys to the larval stages of Dryinidae or Dorilaidae, only the host species (if discernible) and the stage of the parasite were recorded. The stage of the host, type of parasite, parasites per host, location in the host and the effects of parasitization, if any, on genitalic structures were noted. The stylopized leafhoppers were forwarded to R. M. Bohart for determination of the parasite species.

Rearing Cages

Cellulose nitrate cages were used for the rearing of larval Dryinidae to adults. Each cage (Fig. 1,a) was 45 mm long and 29 mm in diameter. Two of the cages were cut from each cellulose nitrate centrifuge tube (Lusteroid, Curtin Co., catalogue number 659) 29 mm in diameter and 105 mm long.

Each cage was fitted with a foam rubber plug (13 mm thick and 30 mm in diameter) at each end (Fig. 1, b_1 and b_2) to prevent the escape of the leafhopper. A slit was made in each plug from its center through the outer edge to facilitate insertion of a grass blade into the cage.

EXPLANATION OF FIG. 1

a = rearing cage

b_1, b_2 = foam rubber plug

d in c = cork in hole in cage

e = metal support rod

f = rubber band

g = six-inch clay pot containing grass

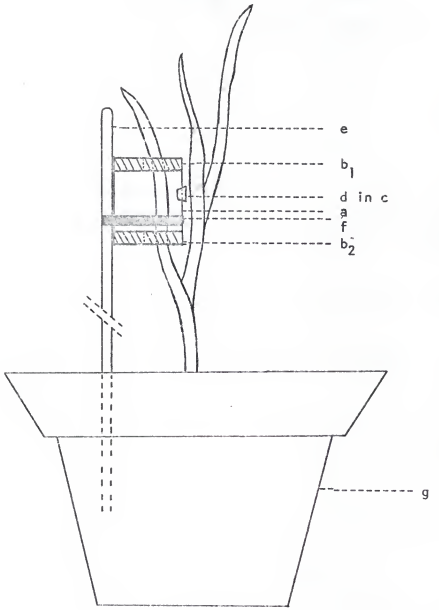

Fig. 1. Rearing cage.

A small hole (Fig. 1,c), made with a standard paper hole-punch, was positioned in the center of the cage side. Introduction and removal of the insect was accomplished by means of a six-inch straight tube glass aspirator inserted through this hole. The hole was plugged with a microvial cork (Fig. 1,d).

Each cage and its included plant and leafhopper were held in an upright position, attached by means of a rubber band (Fig. 1,f) to a metal rod (Fig. 1,e). The metal rod was then inserted into the soil to a depth of about three inches.

Procedure for Handling Live Leafhopper Material

In order to obtain identifiable adult material, attempts were made to rear dryinids from their leafhopper hosts. The parasitized leafhoppers were collected primarily from the buffalo and bluestem grasses in Donaldson Pasture and from the western wheatgrass pasture in Hays, Kansas.

Live material was aspirated from the sweep net and placed in cardboard ice cream cartons containing a small amount of vegetation and lined with wet towels. Care was taken to prevent direct sunlight from striking the containers, as this often resulted in death to the leafhoppers.

This live material was taken into the greenhouse and transferred to a large glass chimney cage atop a six-inch pot containing the following grasses: buffalograss, switchgrass, big bluestem, little bluestem and sideoats grama. These plants were grown from seeds in flats and when they attained healthy growth (about six inches tall) they were transplanted in the six-inch pots. The grass species were so planted in the pots as to be separated from each neighboring grass.

The top of the chimney cage was covered with a piece of cheesecloth to prevent escape of the leafhoppers. A small hole was cut in the cheesecloth to facilitate introduction of an aspirator tube for removal of individual parasitized leafhoppers. The hole was plugged with cotton.

Leafhoppers were maintained in this cage for 24 hours, at the end of which time observations were made to determine the presence of any externally-visible parasites. These leafhoppers were then aspirated from the grass species upon which they were feeding and placed individually into the cellulose nitrate cages attached to the same grass species. The cages were situated at the upper level of the plant growth and labeled with the collection locality (or the predominant grass type from which collected) and consecutively numbered.

They were observed daily, noting the development of the larvae, emergence of the mature larvae, and/or the death of the host.

The remaining leafhoppers in the chimney cage were allowed to remain undisturbed for one week. This allowed the previously undetected dryinid larva to become externally visible on the host. Such hosts were removed and treated as above. Few groups of leafhoppers lived more than a week. At the end of this period of time the remaining leafhopper material and the grass in the cage were destroyed. Fresh grass was used for each large collection of leafhoppers.

Individually parasitized leafhoppers from grasslands were treated as above when there was doubt as to the possible feeding host. However, those which were collected from relatively pure stands of grass, such as buffalograss, were placed on the corresponding grass in the individual rearing cages.

Rearing studies were carried out under both growth chamber and greenhouse conditions. However, no strict temperature, relative humidity or day length were enforced.

Observations were made at approximately 9:00 AM, 12:00 and 5:00 PM to insure removal of any mature larvae before they pupated. Upon emergence each last instar larva was removed from the cage using a small moistened camel's-hair brush. The dead host was removed from the cage, pinned and numbered for reference and specific identification.

Each emerged larva was placed individually in a "pupation" vial to observe pupation procedures. Those dryinid adults reared in 1967 were allowed to pupate in one-dram glass vials filled one-half full with white sand. A tight-fitting sponge rubber stopper was used to seal the mouth of the vials. Each vial was numbered corresponding to the host. The larvae were allowed to pupate and observations of this process were made using a binocular dissecting microscope.

This method proved satisfactory for pupation of numerous of the larvae. However, it did not allow for detection of pupal developments within the cocoon since the larvae incorporated sand particles into a compact, opaque cocoon. These cocoons were loose in the sand.

The larvae reared to adults in 1968 were allowed to pupate in one-dram vials containing no sand. The larvae were otherwise treated as in 1967. In the absence of sand the larvae constructed only silken cocoons which adhered to the sides and/or bottom of the vials. These cocoons allowed for observations of pre-pupal, pupal and pre-emerged adult activity.

The pupae were left undisturbed until the emergence of the adult dryinids. Upon emergence they were transferred from the pupation vials

into cellulose nitrate cages. Each cage was numbered corresponding to the host.

All the emerged adults were supplied with, and consumed, a sucrose-water solution. This solution was introduced twice daily into the cages using a hypodermic syringe. A medium-sized drop of this solution was placed directly on the sponge rubber floor of the cage and was usually consumed within one to two hours. That which was not consumed dried to hardness on the cage floor. Dryinid adults, especially females, were frequently observed to "lick" the hardened sugar spots. The sugar solution was placed in the same area of the cage to minimize danger of the parasite becoming immobilized in the sticky solution. This event did occur with two male dryinids which became stuck by their wings. The wingless females were not bothered.

After death, each adult was mounted and labeled with the host number. The cocoon was removed from the pupation vial, placed in a small gelatin capsule and pinned with the host. The sand-encrusted cocoons were easily removed from the vials. However, those cocoons which were formed against the empty vial surface were difficult to remove without damage. A mounted minuten-nadeln was used to tease the edges of the cocoons from the glass surface.

Occasionally a larva formed its cocoon on the cork stopper or on the foam rubber cage floor. In such cases the cage was left undisturbed until the adult dryinid emerged. The adult was removed and placed in a clean cage and the host was removed and pinned. The cocoon was then removed with that portion of the substrate upon which it was formed, placed in a gelatin capsule and pinned with the host.

Preparation of Adult Dryinids for Identification

The method of Richards (1939) for preparing dryinid adult heads and chelae for specific identification was used. The time necessary for adequate maceration of the structures depended on the size of the insect. Two hours was adequate for the largest specimens without causing deterioration of membranous areas.

Dissections of mouthparts were made under a binocular dissecting microscope at 60X. The heads, due to their small size and fragility, were difficult to secure on a glass slide surface. Therefore, a microscope dissection platform was made.

A deep-well ground glass slide was converted into a suitable dissecting platform. The small end of a microvial cork was glued with the flat side up in the center of the deep-well. The height of the cork was such that when the deep-well was filled with glycerine the head atop the cork was completely covered. The cork provided a suitable surface upon which to immobilize the head. One mounted minuten nadeln through the foramen secured the head to the cork surface while the mouthparts were teased from the head with another mounted minuten nadeln.

The labium and maxilla were dissected either separately or as one complete unit. The mouthparts and left prothoracic leg were placed in a separate drop of glycerine on a clean glass slide and covered with a glass coverslip. This temporary preparation was studied under a compound microscope at 100X and 400X. The mouthparts of all the identified specimens, unless obvious duplicates from the same collection, were dissected completely from the head.

After studying the dissected mouthparts and chelae, these structures were removed from the glass slide and stored in the manner described by Gurney et al. (1964) for insect genitalia storage.

RESULTS AND DISCUSSION

Kansas Collection Material

Table 1 summarizes the results of field collections made during 1967 and 1968, various collections from Hays, Kansas, miscellaneous materials from museum collections at Kansas State University and from Arnett's collection from Donaldson Pasture. These data are listed alphabetically by genera and species.

The data indicate each single date on which genera and species were collected and with what parasite they were infected. In addition, the collection locality and the predominant grass(es) present in the collection area are also listed.

Positive identification of the nymphal leafhoppers parasitized is difficult. Nymphs and females were tentatively identified by comparing the specimens with identified males.

Parasites of 27 leafhopper genera were collected. Of the 27 genera, 18 contained specimens of Strepsiptera, probably all belonging to the family Halictophagidae (Table 4). Dryinid larvae were the most frequent parasites occurring in all 27 genera. Only family identification is possible since no key to larval stages exists. Only the larvae of Dryinidae were found in five of the 27 genera. These are: Deltocephalus, Dicraneura, Empoasca, Norvellina and Scaphytopius. Dorilaidae larvae (Pipunculidae

of authors) were found in 11 genera. Larval stages cannot be identified to species because no keys are available.

Seven of the 27 leafhopper genera contained specimens parasitized by all three parasitic groups, possibly because more specimens of these genera were collected. These are: Athysanella, Flexamia, Graminella, Laevicephalus, Macrosteles, Mocuellus, and Parabolocratus.

Of the 27 genera, 11 contained parasites of both Dryinidae and Halictophagidae. These include: Aceratagallia, Balclutha, Dorycephalus, Draeculacephala, Driotura, Endria, Mesamia, Paraphlepsius, Polyamia, Stirellus, and Xerophlea.

Four of the 27 genera were parasitized by both Dryinidae and Dorilaidae larvae. These include: Chlorotettix, Exitianus, Gilletiella and Psammotettix.

Strepsiptera males were either emerged or unemerged. Unemerged specimens were pupae or pre-emerged adults, still contained within the unopened pupal cases. Pre-emerged adult forms could be easily dissected from the puparia after the leafhopper host had been slightly macerated in cold potassium hydroxide solution. Strepsiptera males noted as emerged indicated those which had emerged from the puparia prior to collection of the host. Empty puparia were considered evidence of parasitism.

Dryinid larvae were arbitrarily designated as in early or late stages of development. Early stages denoted those which were internal and undetectable in uncleared hosts. The larval sacs, noted externally on the host, which had only one exuvium in addition to the larva were designated as early.

Hardy (1943) indicated that the older larval stages of Dorilaidae are generally larger and darker than earlier stages in the host. Clearing,

however, removed much of the color and seemed to cause distortion of the larvae in this study. Therefore, these larvae were not recorded as early or late stages.

Also contained in Table 1 is a partial listing of the predominant grasses noted in each collection area. This study did not include determination of food or oviposition hosts of any leafhoppers, except for those from which adult dryinids were reared. Oman (1949), in his treatment of Nearctic leafhoppers, gave general categories of host plants utilized by some of the leafhoppers in this study. These were primarily herbaceous plant feeders. Added information on this subject was found in Metcalf (1964)

Nymphal and adult stages of several of the leafhopper genera were subject to parasitism (Table 1). Because nymphs cannot be identified with certainty, some records probably were missed and many included records were based on uncertain identification.

Dual parasitism, the existence of two different kinds of parasites within the same host, not different stages of the same parasite, was noted in two genera. A Laevicephalus female was collected which contained a strepsipteran female and a Dorilaidae larva. The strepsipteran female also contained several triungulin larvae. Also collected was a male Macrosteles fascifrons (Stal) which contained a late dryinid larva in addition to a Dorilaidae larva. This male did not have any apparent modification of the external genitalia.

The effects of parasitism on the host's external genitalia have been indicated by several investigators. Ross and Moore (1957) discussed the effects of dryinid parasitism on the genitalia of the Empoasca fabae

complex. In such specimens, the genitalic structures and the apodemes at the base of the abdomen failed to develop completely and were often entirely different from normal specimens. Raatikainen (1966) discussed the effects of the strepsipteran parasite Elenchus tenuicornis (Kirby) on the morphology of adult delphacids, Javesella pellucida (F.). Bohart (1943) mentioned several references to such effects of strepsipteran infections, primarily in hymenopteran hosts. Fenton (1918) mentioned modifications of genitalic structures caused by dryinid infections. Such modifications as a reduction in the size of the leafhopper ovipositor and the reduction in the number of the male aedeagal processes were noted. Oman (1949) stated that, in spite of their large size, the larval Dorilaidae did not seem to modify the host's genitalic structures. Douglas (1890) stated that the action of the larvae on the genitalia of the host did produce alteration and atrophy of these structures and abortion of function. Parker (1967) noted variations in the shape of the head and in the male genitalia of Opsius stactogalus Fieber due to parasitism by a Dorilaidae, Tomosvaryella frontata (Becker), in France. Blocker (1967) noted no apparent genitalic modifications in species of Athysanella which were parasitized by Dorilaidae larvae.

Males of several genera or species of leafhoppers collected in Kansas grasslands had modified genitalic structures. These modifications probably were due to the presence of the parasitic forms, although similar modifications may also occur in specimens containing no detectable parasite forms.

One male of Athysanella sp., Graminella mohri DeLong, and Laevicephalus sp., and two males of L. sp. (probably parvulus (Gillette)) were

noted to have aberrent genitalic structures. Each of these males contained one Dorilaidae larva. One male Flexamia reflexa (Osborn and Ball), containing both an unemerged male and a female Strepsiptera, also had altered external genitalia.

Location of Dryinid Larval Sacs in Leafhopper Hosts

Table 2 indicates the locations of dryinid larval sacs in the leafhopper hosts collected during the 55 county grassland survey. The number of included genera (16) is therefore less than that of Table 1.

Dryinid larvae were found in various locations in the host's thorax and abdomen. Specimens of Dorycephalus sp., Exitianus exitiosus (Uhler), Flexamia sp., and F. abbreviata (Osborn and Ball) had larval sacs between different thoracic segments, as well as between abdominal segments. The other genera in this study had larval sacs between abdominal segments.

The orientation of the larval body in the host did seem to be more consistent. Most of the larvae were situated with the head and posterior abdomen (due to the larva's U-shaped body) inserted into the venter of the host's thorax or abdomen. The larval body and any adhering exuviae adhered to the lateral surface of the abdomen. A few larvae were inserted dorsally rather than ventrally.

Dorycephalus sp. nymphs had the larval sacs located on the venter of the thorax. Exitianus exitiosus (Uhler) and Flexamia sp. had the larval sacs located on the ventrolateral surface of the thorax.

Although there was usually one dryinid larva per host, exceptions to this condition were frequent. Males and females of Athysanella argenteola (Uhler) contained one or two larval sacs per host. Usually there was a size difference between the two larvae. The earlier nymphal stages of this species contained only one larva. A similar condition existed in Mocuellus collinus (Boheman), which had females containing one or two larval sacs. Females of Parabolocratus sp. are larger and frequently contained up to three larval sacs. Difference in size was noted in externally visible sacs; internal early larval stages did not always show a marked size difference. It is possible that, due to its larger size, more than one larval parasite per host is normal. Fenton (1918) states that when there is more than one larva per host, the last one deposited would probably not reach maturity due to a competition for food. Multiple parasitism seemed to be a frequent condition in specimens of Macrosteles fascifrons (Stal) parasitized by the dryinid Pachygonatopus minimus Fenton. Only one parasite survived to maturity in these cases (Barrett et al., 1965). However, this may not be the case with dryinid parasites of Parabolocratus sp. The larval parasite stages in this host regularly occurred singly between consecutive abdominal tergites.

Most of the larval sacs were brownish-grey to black. No attempt was made to draw conclusions as to the possible number of parasite species per host based on color difference of the larval sacs. However, Empoasca sp. did have a very distinctive sac. They were long, often extending from the point of extrusion to the tip of the host abdomen.

The sacs were located under the wings on either side of the host. Their most striking feature was their light to deep green color, often the same shade of green as the host.

Frequently the adult host contained dryinid larvae positioned beneath the wings. This often caused a prominent displacement of the wing.

Position of Strepsiptera Parasites in their Hosts

Table 3 indicates the positions of Strepsiptera parasites in their hosts. These parasites seemed more restricted to the host's posterior abdominal segments than the dryinid larval sacs (Table 2).

A persistence in location of the sexes of these strepsipteran parasites was noted in the hosts. Females were found on the venter of the host abdomen. Male puparia were usually noted extruded between dorsal segments on the host's abdomen; only occasionally were they extruded ventrally.

Instances of more than one life form of strepsipteran parasite were noted. These were noted in both male and female hosts, whereas nymphs normally contained only one such life form. Several combinations of life forms were noted. Two female parasites, either on the same or opposite sides, were often noted in the same host. A female and male (emerged and/or unemerged) sometimes occurred within the same host. Also two male parasites (emerged and/or unemerged) occurred in the same host.

Summary of Identified Strepsiptera from Kansas Hosts

Table 4 lists the identified Halictophagus Curtis species which were collected from Kansas hosts. Halictophagus and its included species,

recorded from the homopterous families Cicadellidae, Membracidae, Fulgoridae and Cercopidae, have been discussed by Bohart (1941, 1943, 1962) in his studies of the North American fauna. A list of hosts for these parasites is included in these works. No records of Halictophagidae were recorded from Kansas in his earlier work (1941); however, he did record H. americanus Perkins from Aceratagallia helveola Oman in Garnett, Kansas (Bohart, 1943).

Six species of Halictophagus were represented in this collection. H. acutus Bohart was represented by a female parasite in Draeculacephala mollipes (Say). H. bidentatus Bohart was found parasitizing four leafhopper genera: Flexamia, Graminella, Athysanella and Parabolocratus.

Six leafhopper genera were parasitized by H. mackayi (Bohart). H. omani Bohart was identified from an unidentified species of Aceratagallia. A male specimen of Paraphlepsius irroratus (Say) was parasitized by a female of H. uhleri (Pierce). H. insularum (Pierce) was identified from a male Dorycephalus platyrhynchus Osborn.

A possible new species of Halictophagus was recorded from Stirellus bicolor (Van Duzee). More specimens of this form need to be collected in order to verify this.

The genus Flexamia contained species which were parasitized by either H. bidentatus Bohart or H. mackayi (Bohart). The majority of the collected Flexamia species contained the latter.

R. M. Bohart (personal communication) indicated that the host species and the locality records for these Halictophagus species are new Kansas records.

Notes on a Male Dryinid (Tribe:Gonatopodini) in its Late Larval to Adult Development

The stages in development of this specimen were similar to the stages in those specimens indicated by asterisks in Table 7(b). The length of time per stage varied among these specimens. The stages in development were observed in the cocoons formed in the empty pupation vials. This specimen pupated in the cellulose nitrate cage.

A male ("DP-103") was collected as a late larva in a male Balclutha neglecta (DeLong and Davidson) on 6 June 1968. The host was caged on buffalograss.

The larva emerged from the dead host on the morning of 8 June. It was orange-colored and had a light yellow area behind the head region. The larva was initially cream-colored and turned orange as it finished consuming the liquified body contents of the host. This process began toward the rear of the host and proceeded anteriorly. The larva worked its anterior body segments into the host's body cavity as the meal continued.

The mature larva crawled about on its dorsum on the cage floor. Microscopic observations revealed that the larva possessed what appeared to be several retractable protuberances on the lateral, dorsal and ventral body aspects. Each protuberance seemed to possess one short spine.

The larva moved about by use of peristalic body movements. The undulating movements proceeded primarily posterior to anterior, although the reverse was noted. The head was partially retractable into the anterior larval body segments. Light prodding with a mounted minuten nadeln resulted in such retraction.

The larva emerged about 8:30 AM and began spinning its initial cocoon on the side of the cage at 9:15 AM. The outer, loose cocoon was spun first. The larva stopped on the cage side and began depositing strands of a silken material. Deposition of this material from side to side and anterior to posterior provided a loose, imperfect covering over the larva. It appeared that each strand was laid down separately; each end was attached to the cage side.

The very active larva moved about within the confines of this imperfect cocoon and reinforced it with additional silken material. The deposition of material was done with the larva on its venter. The deposition of silk strands from anterior to posterior points along the length of the cocoon necessitated the larva's bending upon itself in a U-shape.

Very little silk was laid down on the cage side which formed the "floor" of the cocoon. It was through this "floor" that microscope observations were made.

Silk deposition continued for about three hours. At this time the outer cocoon was practically completed and had almost a papery-slick texture when viewed from above.

The larva then became still for about 45 minutes. Only occasionally did it move about in the cocoon as if to repair weak spots with added silk deposition.

The larva then began to deposit another layer of silk inside the outer cocoon. A similar manner of deposition was followed as before, except that the silken strands were attached to the cage side much closer to the larva. This resulted in the inner, tight-fitting cocoon in which pupation occurred. This inner cocoon more or less fit the contours of the extended larva.

An interesting point was observed in these procedures. The larva was observed to deposit increased amounts of silk at a point inside the inner cocoon. This material was so positioned as to occur at the junction of the thorax and abdomen of the later-developed pupa and pre-emerged adult. This same occurrence was noted in other observed larvae. This "safety belt" was possibly used later to aid the adult in emerging from the cocoon.

After the completion of the inner cocoon (in about four hours) the larva again became quite still, only occasionally moving in the inner cocoon. It contracted itself to about one-half of its original length at the end of the cocoon. All points of the body, except the head, were in close contact with the cocoon sides. This position was maintained for up to five minutes; then the larva extended itself to add silk to the cocoon. This done, it retreated as before often to the opposite end of the cocoon.

This procedure was repeated for about four hours, at the end of which time the larva moved to one end of the cocoon and again contracted to about one-half its original body length. During the stage of contraction only slight head movements were noted.

At this point the rough dimensions of the inner and outer cocoons were: 3 mm x 1 mm (inner cocoon) and 6 mm x 3 mm (outer cocoon).

Only slight larval activity was noted for the next 48 hours. On 10 June the larva was observed extended to about three-fourths the length of the inner cocoon. It did not move except when disturbed by a bright microscope light. The heat of the light could have caused the movement.

By 8:30 AM, 11 June, the prepupal stage was complete and the larva was extended the entire length of the inner cocoon. No body movement was noted. However, a constriction was observed to be forming at what would be the juncture of the thorax and abdomen of the pupal stage.

At 9:00 AM, 12 June, further changes were noted in the prepupal stage. A dark area appeared in the center of the abdomen and leg parts appeared to be forming. Also noted was a darkening in the "head" region posterior to the larval mouthparts. This darkened area later proved to be the ocular area of the adult.

Pupal formation was completed on 13 June after the last larval skin was shed and pushed to the posterior end of the inner cocoon. The larval mandibles were seen in the shed skin. At this time the pupal antennae appeared to be well formed, as were the legs and mouthpart palpi. These structures were cream-colored, not dark. Also noted was a much enlarged and darker ocular area than was observed on 12 June.

A gradual darkening of the pupa from a yellowish color to black and an enlarged and darkened ocular of the formed head were noted externally in the pupal stage between 13 and 17 June.

The first movements of pre-emerged adult appendages were noted on 17 June. The male emerged on the same date through a round opening cut at the anterior end of the cocoon, where the inner and outer cocoons were closely appressed. The male seemed to push with its body and legs against the "safety belt" during its emergence.

At this point the male was allowed to reach a stage of active flight. It was then transferred to a clean cellulose nitrate cage and fed sugar-water solution. It died on 22 June 1968.

Rearing of Dryinids from Exitianus exitiosus (Uhler) from Bermudagrass

Three nymphs and two females of Exitianus exitiosus (Uhler) were collected from bermudagrass in Manhattan, Kansas during July and August of 1968. These specimens contained visible larval dryinid parasites. These larvae were reared to adults: Neogonatopus (two specimens) and Gonatopus (three specimens). The larval sacs of Neogonatopus were located between abdominal segments 3-4; the Gonatopus sacs between segments 4-5. Table 5 indicates the lengths of larval, prepupal and pupal stages for each specimen reared. The length of adult life was also recorded.

Two of the larval dryinids formed their cocoons on the surface of a bermudagrass blade. The other three specimens pupated on the foam-rubber cage floor.

Parasitized nymphs did not molt from the initial caging until the death of the host resulting from the emergence of the mature larva. Caged leafhopper specimens fed readily on the bermudagrass supplied. Adult dryinids fed on the sugar-water solution supplied.

Dryinids from Collections and Rearing Studies

Table 6 lists the genera of dryinid females collected from grassland areas in Kansas. These genera were tentatively identified using keys to female forms (Perkins, 1905; Richards, 1939). No males were recorded from the field collections.

Specific identifications were not made for these specimens even though keys to certain species exist (Perkins, 1905; Kieffer, 1914; Fenton, 1918; Richards, 1939). Since many of the identified species listed in the literature are based on unique specimens, it is not certain just how many of

these species will be destined to synonymy if a detailed study of all available material is made. Changes in the color patterns of dryinids due to age would seem to compound the problem (Perkins, 1906).

Seven genera of dryinid females were identified (Table 6). The majority of the females belonged to Gonatopus and Pseudogonatopus. According to Barrett et al. (1965), Pachygonatopus is possibly congeneric with Epigonatopus. If this is the case, the number of genera recorded would be reduced to six.

The majority of females were collected during August and September 1967. This gives no real indication of their occurrence in the field because this heavy collecting resulted from taking the state survey. Each area would need to be collected through several seasons to get a valid idea of annual field populations.

Table 7 (a & b) summarizes the life history data on dryinid females and males reared from leafhopper hosts collected in Donaldson Pasture. Hosts were collected primarily from buffalograss but some collections from bluestem and switchgrass were also made.

Both female and male specimens reared from Donaldson Pasture material, as well as those reared from the Hays, Kansas site to be discussed later, belong to one tribe of dryinids, i.e., Gonatopodini. Richards (1939), Fenton (1918) and Perkins (1912) discuss the characteristics of this tribe and give keys to the other tribes in this family.

The 139 individual leafhopper hosts containing dryinid larval sacs in various stages of development were collected and caged. Two larvae ("DP-96", "DP-112") were recovered from the transport carton as mature, emerged larvae; no hosts were recorded for these specimens.

Due to the techniques used during 1967, the length of time (days) which the dryinid specimens spent in various stages within the cocoon could not be ascertained. Therefore, the table notation "cocooned specimen" refers to the length of time between the larva spinning the cocoon and its ultimate emergence as an adult. The refinement in method used in 1968 did allow for observations of the various intra-cocoon stages.

This group of leafhoppers yielded 37 adult dryinids: 33 females and 4 males. Seven of the hosts yielded mature larvae which, after forming normal-appearing cocoons, did not pupate. These larvae shriveled and occupied one end of the cocoons. Three hosts yielded larvae which died before forming cocoons; one larva attempted to form a cocoon but failed to complete it before dying.

Perkins (1905) discussed factors which might cause the shriveled condition in dryinid larvae and a method by which partial recovery of these larvae might be achieved. He suggested placing the cocoons in cooler and damper conditions, but this did not aid in the recovery of the seven larvae mentioned above.

The majority of the material from which parasites were reared were nymphs. Of 30 nymphs, possibly Athysanella, 25 were female Gonatopus, three female Epigonatopus and two male Gonatopodini.

One nymph of Parabolocratus yielded a female Chalcogonatopus. A female leafhopper, possibly Athysanella texana (Osborn), yielded a female of Epigonatopus. Another female of this same genus yielded a male of the tribe Gonatopodini.

A female Gonatopus was recovered from a male Flexamia prairiana DeLong. This host also contained a late larval dryinid which was completely internal and was not noted until the host was cleared. A male of Endria inimica (Say) yielded a female Gonatopus.

One male dryinid, tribe Gonatopodini, was reared from a male Balclutha neglecta (DeLong and Davidson). An Aceratagallia nymph yielded a female of Pachygonatopus.

The two emerged larvae found in the transport cartons were females of Gonatopus and Neogonatopus.

Life history data for dryinid adults reared from leafhopper hosts in a western wheatgrass pasture in Hays, Kansas are given in Table 8 (a & b). During the summer of 1967, 55 hosts were caged. From these, 12 larvae were recovered and reared to adults. Five other larvae emerged, formed normal-appearing coccons but did not pupate. Two genera were represented in this leafhopper material. Each host possessed one larval sac, with the exception of one Athysanella nymph which had two sacs. Only one larva emerged from this specimen. Ten Athysanella nymphs yielded ten specimens of female Gonatopus. An unidentified nymph yielded a male dryinid. One female Exitianus exitiosus (Uhler) was collected from which a female Gonatopus was reared.

Parasitic Worms Noted in Kansas Leafhoppers

Hair worms (Phylum Nematomorpha), or Gordiacea, are cited by Meglitsch (1967) as parasitizing certain arthropods. Immature forms of the order Gordioidea, in particular, parasitize insects. The adults are free-living and aquatic. Severin (1924) reported such a form from the body of a sugarcane leafhopper (Delphacidae), Perkinsiella saccharicida Kirkaldy

from the Hawaiian Islands. Apparently such findings of these worms in leafhoppers are uncommon.

Three leafhopper specimens were collected during this study, each containing one unidentified pale-yellow worm. No positive identification of the worm has been made. The probability exists that these worms belong to the above group.

Two nymphal stages of Mocuellus collinus (Boheman) were collected from western wheatgrass pasture at Hays, Kansas on 8 September 1967. In one nymph the worm's body was partially extruded between abdominal segments 3-4. The other worm was partially extruded between abdominal segments 7-8 in the host.

One female Balclutha neglecta (DeLong and Davidson) collected 3 July 1968 contained a similar worm form. This worm was partially extruded between abdominal segments 6-7.

SUMMARY AND CONCLUSIONS

Parasites of leafhoppers were studied from 96 sweep net collections from tall grass and mixed prairie grasslands, in 55 Kansas counties in late summer of 1967 and other collections in 1968. Material from 1957-1966 was also included. Adult parasites of Halictophagidae (Strepsiptera) and Dryinidae (Hymenoptera) were identified from both collected and reared material. Representative specimens of leafhoppers with their associated parasites are deposited in the insect collection of Kansas State University, Manhattan, Kansas.

Specimens from 27 leafhopper genera were collected with either larval or adult parasites of Diptera Dorilaidae (Diptera), Dryinidae (Hymenoptera)

and/or Halictophagidae (Strepsiptera). Specimens from 18 genera contained immature and/or adult Halictophagidae. All 27 genera contained dryinid larvae. Dorilaidae larvae were found in 11 leafhopper genera.

Seven of the genera were parasitized by species belonging to all three families. Parasites of both the families Dryinidae and Halictophagidae were found in 11 of the genera. Five genera contained only dryinid larvae. Four genera were parasitized by both Dryinidae and Dorilaidae.

Halictophagidae (Strepsiptera) were found in the hosts as triungulin larvae, males (emerged or unemerged) and/or females. Other strepsipteran larval stages were not observed. Dryinidae and Dorilaidae occurred as larvae within the hosts.

Leafhopper nymphs and adults were parasitized by the above forms. Dual parasitism was found in Laevicephalus sp. (with Halictophagidae and Dorilaidae) and Macrosteles fascifrons (Stal) (with Dryinidae and Dorilaidae).

Modifications of external genitalia of the hosts, possibly due to parasitism, were found. Aberrant genitalia were found in males of Athysanella, Graminella and Laevicephalus which contained Dorilaidae larvae, as well as in males of Flexamia reflexa (Osborn and Ball) containing Halictophagidae.

The dryinid larvae in 15 genera of leafhoppers were most often found in the abdomen. These did not occur with regularity between particular segments, except for Empoasca sp. in which the larvae occurred regularly between abdominal segments 3-4. Specimens of Dorycephalus sp. and Endria inimica (Say) had larvae between the mesothorax and metathorax. Larvae were found between the prothorax and mesothorax of Exitianus exitiosus (Uhler)

and Flexamia abbreviata (Osborn and Ball). Usually each host had one larval parasite, although more than one were noted in Athysanella argenteola (Uhler), Mocuellus collinus (Boheman) and Parabolocratus sp.

Strepsipteran parasites were localized posteriorly in the host's abdomen. The females appeared to locate more ventrad in the hosts; the males more dorsad. Both sexes were found in the same host.

Six species of Halictophagus Curtis (Strepsiptera) were found in a total of 14 genera of leafhoppers. One possible new species was found in Stirellus bicolor (Van Duzee). The host and locality records for these parasites are all new for Kansas.

Parasitic worms of the order Gordioidea were found in two nymphs of Mocuellus collinus (Boheman) and one female of Balclutha neglecta (DeLong and Davidson). These worms were partially extruded from the host's abdomen.

Developmental history of one male dryinid was recorded as observed through an exposed portion of the cocoon. The length of larval, prepupal, pupal and adult life stages was recorded. Larval behavior, cocoon formation and activities within the cocoon were recorded. Similar information was recorded for all the dryinids reared from leafhopper hosts.

Various dryinid genera were reared from larval stages, the hosts being kept alive on grass in cellulose nitrate cages until the larva emerged. Pupation occurred in one-dram glass vials. Adults reared and those collected from the grasslands provided the identifiable material in this study. Most of the hosts contained only one larva. If more were present only one emerged and developed.

Seven genera of dryinids were collected as females from grasslands with no host information. The majority of specimens belonged to the genera Gonatopus and Pseudogonatopus. Numerous hosts collected in Donaldson Pasture near Manhattan, Kansas, yielded 37 adult dryinids representing five genera. The majority of these were of the genus Gonatopus from Athysanella nymphs. Gonatopus was the only genus reared from a small number of Athysanella nymphs and one Exitianus exitiosus (Uhler) female from western wheatgrass from Hays, Kansas.

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APPENDIX

Table 1. Summary of leafhopper-parasites from Kansas grasslands.

Leafhopper host	Sex or life stage of host[a]	Kind of parasite[b]	Sex or life stage of parasite[a]	Date collected	County and grass type[c]
Aceratagallia sp.	F	H(S)	M (e)	5-June-67	Ellis (Pvi)
				23-Aug.-67	Smith (Bda)
				7-Sept.-67	Finney (Bda, Bgr, Asm)
			F	20-July-67	Riley (Bda)
				24-Aug.-67	Ottawa (Bda)
				7-Sept.-67	Finney (Bda, Bgr, Asm)
	F, N	D(H)	l.l.	30-June-67	Riley (Bda)
				21-Aug.-67	Riley (Bda)
				23-Aug.-67	Jewell (Bda)
					Phillips (Bda)
				24-Sept.-67	Miami (Pvi)
A. sanguinolenta* (Provancher)	M	H(S)	M (ue)	24-Aug.-67	Ottawa (Bda)
A. uhleri (Van Duzee)	M	H(S)	M (ue)	5-July-65	Wichita
				26-May-67	Riley (Bda, Bgr)
		D(H)	e.l.	23-Aug.-67	Smith (Bda)
			l.l.	8-Sept.-67	Kiowa (Bda, Bgr)
Athysanella sp.	N	H(S)	M (ue)	23-Aug.-68	Riley (Bda)
			M (e)	26-Aug.-68	Riley (Bda)
				18-Sept.--68	Riley (Bda)
		D(H)	e.l.	24-Aug.-67	Lincoln (Bda)
				7-Sept.-67	Hamilton (Bda)
					Kearny (Bda, Bgr)
				8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda, Bgr)
				23-Sept.--67	Marshall (Bda, Pvi)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Athysanella sp. (cont'd)			l.l	23-June-67	Riley (Bda)
				30-June-67	Riley (Bda)
				20, 30-July-67	Riley (Bda)
				17-Aug.-67	Riley (Bda)
				23-Aug.-67	Norton (Bda, Bgr)
				24-Aug.-67	Ottawa (Bda, Bcu)
					Osborne (Bda)
					Ellis (Pvi)
				8-Sept.-67	Kingman (Bda, Bgr, Bcu, Age)
					Kiowa (Bda, Bgr)
					Ford (Bda, Bgr, Asm)
				15-Sept.-67	Ellis (NN)
		D(H) w.	l.l	24-Sept.-67	Greenwood (Age, Pvi, Bcu)
		D(D)	l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
	F	H(S)	M (ue)	17, 23-July-68	Riley (Bda)
				25-Sept.-68	Riley (Bda)
			M (e)	24-Aug.-67	Dickinson (Bda)
				23-July-68	Riley (Bda)
				28-Aug.-68	Riley (Bda, Age, Pvi)
				29-Sept.-68	Riley (Bda)
			F	24-Aug.-67	Dickinson (Bda)
				7-Sept.-67	Finney (Bda, Bgr, Asm)
				23, 28-Aug.-68	Riley (Bda, Age, Pvi)
				4, 18-Sept.-68	Riley (Bda)
		D(H)	e.l.	7-Sept.-67	Hamilton (Bda)
					Hodgeman (Bda, Bcu)
				8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda, Bgr)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Athysanella sp. (cont'd)				24-Aug.-67	Russell (Bda, Bgr)
					Graham (Bda, Asm)
					Rooks (Bda, Pvi)
				24-Sept.-67	Franklin (Pvi)
			l.l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda, Bgr)
					Sedgwick (Bda, Bgr)
				23-Aug.-67	Phillips (Bda)
				24-Aug.-67	Russell (Bda, Bgr)
					Osborne (Bda)
	F	D(D)	l.	8-Sept.-67	Kiowa (Bda, Bgr)
					Morris (Bda, Age, Pvi, Bcu)
	M (aberrant)	D(D)	l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
A. (Gladionura) argenteola (Uhler)	F	D(H)	e.l.	8-Aug.-67	Ellis (NM)
	M	D(H)	e.l.	24-Aug.-67	Osborne (Bda)
				8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda, Bgr)
			l.l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
		D(D)	l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda)
A. (Amphipyga) attenuata Baker	M	D(H)	l.l.	2-Aug.-68	Ellis (Pvi)
		D(D)	l.	24-Aug.-65	Ellis (Asm)
				16-June-67	Ellis (Asm)
				15-Sept.-67	Ellis (Asm)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
A. (Gladionura) emarginata (Osborn)	M	H(S)	M (ue)	17, 28-July-68	Riley (Bda)
				23, 28-Aug.-68	Riley (Bda)
				25-Sept.-68	Riley (Bda)
			M (e)	12-July-68	Riley (Bda)
				26, 28-Aug.-68	Riley (Bda)
			F	12-Oct.-67	Riley (Bda)
				18, 23, 28-Aug.-68	Riley (Bda)
		D(H)	e.l.	7-Sept.-67	Hodgeman (Bda, Bcu)
					Pawnee (Bda, Asm)
				15-Sept.-67	Ellis (NM)
	M	D(H)	e.l.	24-Sept.-67	Osborne (Bda)
			l.l.	23-Aug.-67	Norton (Bda, Bgr)
		D(D)	l.	8-Sept.-67	Morris (Bda, Age, Pvi, Bcu)
	F	D(H)	e.l.	27-May-68	Ellis (NM)
A. (Amphipyga) redata Blocker	M	D(D)	l. (e)	16-June-67	Ellis (Asm)
				9-Aug.-67	Ellis (Asm)
				24-Aug.-67	Thomas (Bda, Asm)
				8-Sept.-67	Ellis (Asm)
A. (Amphipyga) texana (Osborn)	M	H(S)	M (ue)	26-Aug.-67	Riley (Bda)
			F	23-Aug.-67	Riley (Bda)
				24-Aug.-67	Dickinson (Bda)
		D(H)	l.l.	24-Aug.-67	Dickinson (Bda)
	F	H(S)	M (ue)	24-Aug.-67	Geary (Bda, Bgr)
Balclutha sp.	F	D(H)	e.l.	30-Aug.-65	Ellis (Pvi, Asm)
				7-Sept.-65	Ellis (NM)
				2-Aug.-68	Ellis (Pvi)
			l.l.	30-Aug.-65	Ellis (Pvi)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Balclutha sp. (cont'd)	F	D(H)	l.l.	7-Sept.-65	Ellis (NM)
				16-Sept.-66	Ellis (Pvi)
				21-June-67	Ellis (NM)
				8-Sept.-67	Ellis (NM)
					Grant (Pvi, Age)
				28-Aug.-68	Riley (Bda, Age, Pvi)
				25-Sept.-68	Riley (Bda, Age, Pvi)
B. neglecta (DeLong and Davidson)	M	S	F	17-July-68	Riley
		D(H)	e.l.	30-Aug.-65	Ellis (Asm)
				24-Sept.-67	Miami (Age, Pvi, Bcu)
			l.l.	30-Aug.-65	Ellis (Asm)
				7-Sept.-65	Ellis (NM)
				15,28-Sept.-66	Ellis (NM)
				13-Oct.-66	Ellis (NM)
				6-June-67	Riley
				8-Aug.-67	Ellis (NM)
				24-Aug.-67	Rooks (Bda, Pvi)
				8-Sept.-67	Grant (Age, Pvi)
Chlorotettix spatulatus* (Osborn & Ball)	N	D(H)	l.l.	23-Aug.-67	Norton (Bda, Bgr)
		D(D)	l.	24-Sept.-67	Wabaunsee (Age, Pvi)
	F	D(H).	l.l.	24-Sept.-67	Greenwood (Age, Pvi, Bcu)
Deltocephalus sonorus Ball*	N	D(H)	l.l.	7-Sept.-67	Ellsworth (Pvi, Age, Bda, Bgr)
Dicraneura ohioensis** (DeLong & Caldwell)	F	D(H)	l.l.	5-June-68	Riley (Bda)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Dorycephalus (Attenuipyga) sp.	N	H(S)	triung. larva	23-Aug.-67	Rawlins (Bda, Asm)
		D(H)	e.l.	23-Aug.-67	Decatur (Bda, Asm)
			l.l.	23-Aug.-67	Decatur (Bda, Asm)
					Cheyenne (Bda, Asm)
	F	H(S)	M (ue)	23-Aug.-67	Decatur (Bda, Asm)
D. (Dorycephalus) platyrhynchus Osborn	M	H(S)	F	23-Aug.-67	Cheyenne (Bda, Asm)
Draeculacephala mollipes Say	M	H(S)	M (ue)	24-Sept.-67	Linn (Pvi, Age)
			M (e)	10-Sept.-67	Cherokee (seeded pasture)
				24-Sept.-67	Franklin (Pvi)
			F	10-Sept.-67	Cherokee (seeded pasture)
				24-Sept.-67	Franklin (Pvi)
					Linn (Pvi, Age)
					Miami (Pvi)
		D(H)	e.l.	23-Sept.-67	Pottawatomie (Pvi, Age, Bcu, Bda, Bgr)
	F	H(S)	M (e)	10-Sept.-67	Cherokee (seeded pasture)
			F	10-Sept.-67	Cherokee (seeded pasture)
				23-Sept.-67	Nemaha (Pvi, Bda)
				24-Sept.-67	Miami (Pvi)
Driotura robusta* (Osborn & Ball	F	S	M (ue)	24-Sept.-67	Linn (Pvi, Age)
		D(H)	l.l.	20-July-67	Riley
Empoasca sp.	M	D(H)	e.l.	24-Aug.-67	Lincoln (Bda)
			l.l.	23-Aug.-67	Phillips (Bda)
					Decatur (Bda, Asm)
					Norton (Bda, Bgr)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Empoasca sp. (cont'd)	M	D(H)	1.1.	24-Aug.-67	Lincoln (Bda)
					Graham (Bda, Asm)
				8-Sept.-67	Pratt (Pvi, Bda, Bgr)
				24-Sept.-67	Woodson (Pvi, Age)
					Franklin (Pvi)
	F	D(H)	1.1	23-Aug.-67	Phillips (Bda)
				24-Aug.-67	Rooks (Bda, Pvi)
					Ottawa (Bda, Bcu)
				7-Sept.-67	Pawnee (Bda, Asm)
				8-Sept.-67	Seward (Bda, Bgr)
				24-Sept.-67	Miami (Pvi)
					Osage (Age, Pvi, Bda)
Endria inimica (Say)	M	H(S)	F	8-Sept.-67	Marion (Pvi, Age, Asm, Bcu)
				23-Sept.-67	Nemaha (Pvi, Bda)
					Marshall (Pvi, Bda)
				24-Sept.-67	Franklin (Pvi)
					Miami (Pvi)
					Lyon (Pvi, Age, Bcu)
					Riley
				12-Oct.-67	Ellis (Asm)
					Riley
			M (ue)	15-Sept.-67	Ellis (Pvi)
				23-Sept.-67	Nemaha (Pvi, Bda)
		D(H)	e.l.	23-Sept.-67	Jefferson (Pvi, Age)
			l.l.	23-Sept.-67	Pottawatomie (Pvi, Age, Bcu, Bda, Bgr)
					Brown (Pvi)
				24-Sept.-67	Miami (Pvi)
					Franklin (Pvi)
	F	H(S)	M (ue)	5-June-67	Ellis (Pvi)
				8-Sept.-67	Ellis (NM)
				23-Sept.-67	Doniphan (Pvi)
					Nemaha (Pvi, Bda)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
E. inimica (Say) (cont'd)	F	H(S)	M (e)	8-Sept.-67	Ellis (Pvi) Sedgwick (Pvi, Bda, Bgr) Morris (Age, Bda, Pvi, Bcu)
			F	23-Sept.-67 23-Sept.-67	Jefferson (Pvi, Age) Marshall (Pvi, Bda) Nemaha (Pvi, Bda)
		D(H)	e.l.	24-Sept.-67 3-Oct.-67 7-Sept.-65 6-Sept.-67 8-Sept.-67 23-Sept.-67 24-Sept.-67	Bourbon (Pvi, Age) Ellis (Asm) Reno Riley Ellis (Asm) Brown (Pvi) Miami (Pvi) Franklin (Pvi) Allen (Age, Pvi, Bcu)
	N	H(S)	1.l. M (ue) M (e)	15-Sept.-67 23-Sept.-67 7-Aug.-67	Ellis (Asm) Doniphan (Pvi) Ellis (NM)
		D(H)	1.l.	23-Sept.-67 24-Sept.-67	Brown (Pvi) Franklin (Pvi) Miami (Pvi)
Exitianus exitiosus (Uhler)	M	D(H)	e.l. 1.l.	23-Sept.-67 16-June-67 23-Sept.-67 24-Sept.-67	Jefferson (Pvi, Age) Ellis Jefferson (Pvi, Age) Greenwood (Pvi, Age, Bcu)
	F	D(D) D(H)	1. e.l.	24-July-67 8-Sept.-67	Ellis Sedgwick (Pvi, Bda, Bgr) Dickinson (Pvi, Age, Bda, Bgr, Bcu)
			1.l.	16-June-66 23-Aug.-67 7-Sept.-67 15-Sept.-67	Ellis (NM) Pottawatomie (Pvi, Age, Bcu, Bda, Bgr) Pawnee (Bda, Asm) Ellis (Asm)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Exitianus exitiosus (Uhler) (cont'd)	F	D(H)	1.1.	14-Nov.-67	Ellis
	N	D(H)	e.l.	8-Sept.-67	Dickinson (Pvi, Age, Bda, Bgr, Bcu)
				23-Sept.-67	Jefferson (Pvi, Age)
					Marshall (Pvi, Bda)
				24-Sept.-67	Miami (Pvi)
			1.1.	24-Aug.-67	Ottawa (Bda, Bcu)
					Rooks (Bda, Pvi)
				8-Sept.-67	Marion (Pvi, Age, Asm, Bcu)
					Ellis
				23-Sept.-67	Jefferson (Age, Pvi)
Flexamia sp.	F	H(S)	M (ue)	20-Aug.-59	Riley
				23-June-67	Riley
				24-Aug.-67	Ottawa (Bda, Bcu)
					Dickinson (Pvi, Age, Bda, Bgr, Bcu)
				8, 15-Sept.-67	Ellis (Pvi)
				24-Sept.-67	Osage (Age, Pvi, Bda)
					Bourbon (Pvi, Age, Bcu)
				20, 23-July-68	Riley (Bda)
				28-Aug.-68	Riley (Bda)
			M (e)	23-June-67	Riley
				8-Sept.-67	Sedgwick (Pvi, Bda, Bgr)
					Harvey (Pvi, Age, Bda, Asm)
					Dickinson (Pvi, Age, Bda, Bgr, Bcu)
				24-Sept.-67	Osage (Age, Pvi, Bda)
					Bourbon (Pvi, Age, Bcu)
					Allen (Pvi, Age, Bcu)
					Lyon (Pvi, Age, Bda)
				2, 20 23-July-68	Riley (Bda)
				28-Aug.-68	Riley (Bda)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Flexamia sp. (cont'd)	F	H(S)	F	20-Aug.-59	Riley
				23-June-67	Riley
				8-Sept.-67	Sedgwick (Pvi, Bda, Bgr)
					Harvey (Pvi, Age, Bda,, Asm)
				8-Sept.-67	Dickinson (Pvi, Age, Bda. Bgr, Bcu)
					Ellis
				15Sept.-67	Ellis (Pvi)
				23-Sept.-67	Marshall (Pvi, Bda)
				24-Sept.-67	Bourbon (Pvi, Age, Bcu)
					Allen (Pvi, Age, Bcu)
					Lyon (Pvi, Age, Bda)
				17, 20, 23-July-68	Riley (Bda)
				23-Aug.-68	Riley (Bda)
		D(H)	e.l.	23-Aug.-67	Phillips (Bda)
				24-Sept.-67	Bourbon (Pvi, Age, Bcu)
			l.l.	23-Aug.-67	Phillips (Bda)
				7-Sept.-67	Finney (Bda, Bgr, Asm)
				8-Sept.-67	Pratt (Pvi, Bda, Bgr)
				12-July-68	Riley (Bda)
		D(D)	l.	24-Aug.-67	Ellis (Pvi)
	N	H(S)	M (ue)	23-June-67	Riley
				24-July-67	Ellis (Pvi)
				15-Sept.-67	Ellis (Pvi)
				24-Sept.-67	Bourbon (Pvi, Age, Bcu)
				20, 23-July-68	Riley (Bda)
				23, 28-Aug.-68	Riley (Bda)
			M (e)	23-June-67	Riley
				8-Aug.-67	Ellis (Pvi)
				23-Sept.-67	Doniphan (Pvi)
				24-Sept.-67	Franklin (Age, Pvi, Bcu)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Flexamia sp. (cont'd)	N	H(S)	M (e)	24-Sept.-67	Greenwood (Pvi, Age, Bcu)
					Bourbon (Pvi, Age, Bcu)
					Lyon (Pvi, Age, Bda)
				3-Oct.-67	Ellis (Pvi)
				20, 23-July-68	Riley (Bda)
				2-Aug.-68	Ellis (Pvi)
				28-Aug.-68	Riley (Bda)
				29-Sept.-68	Riley (Bda)
			F	24-Sept.-67	Bourbon (Pvi, Age, Bcu)
					Lyon (Pvi, Age, Bcu)
				20, 23-July-68	Riley (Bda)
		D(H)	e.l.	21-July-67	Ellis (NM)
				23-Aug.-67	Decatur (Bda, Asm)
				24-Aug.-67	Osborne (Bda)
				8-Sept.-67	Kiowa (Bda, Bgr)
					Dickinson (Pvi, Age, Bda, Bgr, Bcu)
				23-Sept.-67	Pottawatomie (Pvi, Age, Bda, Bgr, Bcu)
				24-Sept.-67	Lyon (Pvi, Age, Bcu)
					Doniphan (Pvi)
					Marshall (Pvi, Bda)
					Miami (Pvi)
				9-July-68	Ellis (Pvi)
				17, 23-July-68	Riley (Bda)
			l.l.	23-Aug.-67	Pottawatomie (Pvi, Age, Bda, Bgr, Bcu)
				24-Aug.-67	Rooks (Pvi, Bda)
					Lincoln (Bda)
				8-Sept.-67	Harvey (Pvi, Age, Bda, Asm)
				15-Sept.-67	Ellis (Pvi)
				24-Sept.-67	Franklin (Pvi, Age, Bcu)
					Bourbon (Pvi, Age, Bcu)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Flexamia sp. (cont'd)	N	D(H)	1.1.	9-July-68	Ellis (NM)
				18-Sept.-68	Riley (Bda)
F. abbreviata (Osborn & Ball)	M	H(S)	M (e)	20-July-59	Riley
		D(H)	e.l.	24-Aug.-67	Rooks (Pvi, Bda)
					Russell (Bda, Bgr)
					Lincoln (Bda)
				24-Sept.-67	Woodson (Pvi, Age)
			1.1.	23-Aug.-67	Rawlins (Bda, Asm)
					Phillips (Bda)
					Decatur (Bda, Asm)
				24-Aug.-67	Russell (Bda, Bgr)
					Franklin (Pvi, Age, Bcu)
F. arizonensis Young	F	D(H)	1.1.	24-Aug.-67	Graham (Bda, Asm)
F. atlantica (DeLong)	M	H(S)	M (e)	8-Aug.-67	Ellis (Pvi)
			F	26-Oct.-65	Ellis (Pvi)
				15-Sept.-67	Ellis (Pvi)
		D(H)	1.	9-Aug.-65	Ellis (Pvi)
				16-June-67	Ellis (Pvi)
		D(D)	1.	9-Aug.-65	Ellis (Pvi)
	F	H(S)	F	18-Oct.-67	Ellis (Pvi)
F. curvata DeLong	M	H(S)	M (ue)	17, 20, 23-July-68	Riley (Bda)
			F	24-Aug.-67	Osborne (Bda)
				17, 20, 23-July-68	Riley (Bda)
				20-Aug.-68	Riley (Bda)
		D(H)	e.l.	2-June-59	Riley (Age)
				11-Aug.-67	Riley (Bda)
			1.1.	23-Aug.-67	Phillips (Bda)
				25-Sept.-68	Riley (Bda)

Table 1 (cont'd)

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
F. graminea DeLong	M	H(S)	M (e)	24-Sept.-67	Greenwood (Pvi, Age, Bcu)
F. inflata (Osborn & Ball)	M	D(H)	l.	7-Sept.-67	Riley (Age)
F. pectinata Osborn & Ball	M	H(S)	M (ue) w. triung. l.	20-July-59	Riley
		D(H)	e.l.	8-Sept.-67	Marion (Pvi, Age, Bcu, Asm)
			l.l.	24-Aug.-67	Dickinson (Pvi, Age, Bda, Bgr, Bcu)
					Ottawa (Bda, Bcu)
				24-Sept.-67	Greenwood (Pvi, Age, Bcu)
F. picta (Osborn)	M	H(S)	M (ue)	20-July-59	Riley
				24-Aug.-67	Ottawa (Bda, Bcu)
					Geary (Bda, Bgr)
			M (e)	8-Sept.-67	Sedgwick (Pvi, Bda, Bgr)
				8-Sept.-67	Sedgwick (Pvi, Bda, Bgr)
					Harvey (Pvi, Age, Bda, Asm)
			F	24-Aug.-67	Ottawa (Bda, Bcu)
					Geary (Bda, Bgr)
				8-Sept.-67	Harvey (Pvi, Age, Bda, Asm)
					Dickinson (Pvi, Age, Bda, Bgr, Bcu)
		D(H)	l.	1-Sept.-58	Sedgwick (Pvi, Age, Bgr, Bda)
				4-Oct.-66	Riley
		D(D)	l.	8-Sept.-67	Riley
					Sedgwick (Pvi, Bda, Bgr)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
F. prairiana DeLong	M	H(S)	M (ue)	20-Aug.-59	Riley
				24-Sept.-67	Lyon (Pvi, Age, Bda)
			M (e)	24-Sept.-67	Bourbon (Pvi, Age, Bcu)
					Allen (Pvi, Age, Bcu)
					Greenwood (Pvi, Age, Bcu)
			F	24-Sept.-67	Wabaunsee (Age, Pvi, Bda)
					Bourbon (Age, Pvi, Bcu)
					Lyon (Pvi, Age, Bda)
F. reflexa (Osborn & Ball)	M (aberrant)	H(S)	M (ue) w. F	20-July-59	Riley
	M (aberrant)	H(S)	M (ue)	20-July-59	Riley
	M (normal)	H(S)	M (ue)	2-June-59	Riley
		D(H)	1.	24-Sept.-58	Riley
				8-Oct.-58	Riley
Gilletiella sp.	N	D(H)	1.1.	8-Sept.-67	Kiowa (Bda, Bgr)
G. atropuncta* (Gillette)	M	D(D)	1.	8-Sept.-67	Kiowa (Bda, Bgr)
	F	D(H)	e.1.	7, 8-Sept.-67	Kearny (Bda, Bgr)
					Stevens (Bda, Bgr)
					Meade (Bda, Bgr)
					Hodgeman (Bda, Pvi, Bcu)
			1.1.	7, 8-Sept.-67	Hamilton (Bda, Bgr)
					Hodgeman (Bda, Pvi, Bcu)
					Ford (Bda, Bgr, Asm)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Graminella mohri DeLong	M (aberrant)	D(D)	1.	15-Sept.-67	Ellis (Pvi)
	M (normal)	H(S)	M (ue)	15-Sept.-67	Ellis (Pvi)
			M (e)	27-June-68	Ellis (Pvi)
			F	17-Aug.-59	Riley
				23-July-67	Ellis (Pvi)
				8-Aug.-67	Ellis (Pvi)
				24-Aug.-67	Ellis (Pvi)
				15-Sept.-67	Ellis (Pvi)
				3-Oct.-67	Ellis (Pvi)
				24-July-68	Riley (Bda)
		D(H)	e.1.	9-Aug.-65	Ellis (Pvi)
				7-Sept.-65	Ellis (NM)
				20-July-67	Riley (Bda)
				16-Aug.-67	Riley (Age)
	F	H(S)	M (ue)	21-Oct.-65	Ellis (NM)
				15-Sept.-67	Ellis (Pvi)
			M (e)	20-July-59	Riley
				15-Sept.-67	Ellis (Pvi)
			F	23-July-67	Ellis (Pvi)
				24-July-67	Ellis (Pvi)
				15-Sept.-67	Ellis (Pvi)
				24-July-68	Riley (Bda)
				6-Sept.-68	Ellis (Pvi)
		D(H)	e.1.	5-June-67	Ellis (Pvi)
	N	H(S)	M (ue)	15-Sept.-67	Ellis (Pvi)
			M (e)	15-Sept.-67	Ellis (Pvi)
				27-June-68	Ellis (Pvi)
		D(H)	1.1.	5-June-67	Ellis (Pvi)
				21-July-67	Ellis (Pvi)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Laevicephalus sp.	M (aberrant)	D(D)	1.	24-Sept.-67	Lyon (Pvi, Age, Bda)
	F	H(S)	M (ue)	17-July-68	Riley (Bda)
				28-Aug.-68	Riley (Bda)
			M (e)	5-Aug.-67	Leavenworth (grass)
				27-June-68	Ellis (NM)
				17, 20, 23-July-68	Riley (Bda)
			F	5-Aug.-67	Leavenworth
				24-Aug.-67	Dickinson (Pvi, Age, Bda, Bgr, Bcu)
				23-Sept.-67	Pottawatomie (Pvi, Age, Bda, Bgr, Bcu)
				24-Sept.-67	Osage (Pvi, Age, Bda)
					Lyon (Pvi, Age, Bda)
				18-June-68	Riley (Bda)
				17, 20, 23-July-68	Riley (Bda)
				28-Aug.-68	Riley (Bda, Age, Pvi)
				4, 25, 29-Sept.-68	Riley (Bda)
		H(S) w. D(D) D(H)	F 1. 1.1.	24-Sept.-67	Greenwood (Pvi, Age, Bcu)
				8-Aug.-67	Ellis (NM)
				23-Aug.-67	Smith (Bda)
					Norton (Bda, Bgr)
				24-Aug.-67	Ottawa (Bda, Bcu)
				7-Sept.-67	Hodgeman (Bda, Pvi, Bcu)
				15-Sept.-67	Ellis (NM)
				23-Aug.-68	Riley (Bda)
				25-Sept.-68	Riley (Bda)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
L. parvulus (Gillette)	M	H(S)	M (ue)	23-July-68	Riley (Bda)
			M (e)	17-Aug.-68	Riley (Bda)
			F	12-July-68	Riley (Bda)
				17, 28-Aug.-68	Riley (Bda)
				25-Sept.-68	Riley (Bda)
		D(H)	1.	24-Aug.-67	Lincoln (Bda)
				15-Sept.-67	Ellis (NM)
		D(D)	1.	15-Sept.-67	Ellis (NM)
	M (aberrant)	D(D)	1.	12-July-68	Riley (Bda)
				26-Aug.-68	Riley (Bda)
L. unicoloratus (Gillette & Baker)	M	H(S)	M (ue)	5-Aug.-67	Leavenworth (grass)
			M (e)	24-Sept.-67	Osage (Pvi, Age, Bda)
					Wabaunsee (Pvi, Age, Bda)
Macrosteles fescifrons (Stal)	M	H(S)	M	10-Sept.-67	Cherokee (seeded pasture)
				24-Sept.-67	Bourbon (Pvi, Age, Bcu)
		D(H)	1.1.	28-Sept.-66	Ellis (NM)
				7-Sept.-67	Ellsworth (Pvi, Age, Bda, Bgr)
				23-Sept.-67	Jefferson (Pvi, Age)
				24-Sept.-67	Wabaunsee (Pvi, Age, Bda)
		D(H) w.	1.1.	16-Sept.-67	Ellis
		D(D)	1.		
	F	H(S)	M	10-Sept.-67	Cherokee (seeded pasture)
			F	10-Sept.-67	Cherokee (seeded pasture)
		D(H)	1.1.	28-Sept.-66	Ellis (NM)
				7-Aug.-67	Hodgeman (Bda, Pvi, Bcu)
				24-Aug.-67	Geary (Bda, Bgr)
				23-Sept.-67	Jefferson (Pvi, Age)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
M. fascifrons (Stal) (cont'd)	F	D(H)	l.l.	24-Sept.-67	Miami (Pvi)
					Wabaunsee (Pvi, Age, Bda)
					Franklin (Pvi, Age, Bcu)
					Woodson (Pvi, Age)
					Osage (Pvi, Age, Bda)
					Greenwood (Pvi, Age, Bcu)
Mesamia coloradensis (Gillette & Baker)	M	D(H)	l.	12, 25-June-57	Riley
	F	H(S)	M	2-Aug.-59	Riley
			F	2-July-59	Riley
				2-Aug.-59	Riley
		D(H)	l.	8-Sept.-67	Harvey (Pvi, Age, Asm, Bda)
Mocuellus collinus (Boheman)	M	S	F	12-Oct.-67	Ellis (Asm)
		D(H)	e.l.	19-July-65	Ellis (Asm)
				29-May-67	Ellis (Asm)
				24-Aug.-67	Cheyenne (Bda, Bgr, Asm)
			l.l.	12-July-65	Ellis (Asm)
				19-July-65	Ellis (Asm)
				29-May-67	Ellis (Asm)
				23-Aug.-67	Decatur (Bda, Asm)
				24-Aug.-67	Sherman (Asm)
		D(D)	l.	20,30-June-65	Ellis (Asm)
				16-Aug.-65	Ellis (Asm)
				13-Oct.-66	Ellis (Asm)
				3, 12-Oct.-67	Ellis
		D(H)	e.l.	2-June-65	Ellis
				12,19-July-65	Ellis (Asm)
				29-May-67	Ellis (Asm)
				5-June-67	Ellis (Asm)
				16-June-67	Ellis (Asm)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
M. collinus (Boheman) (cont'd)	M	D(H)	e.l.	9-Aug.-67	Ellis (Asm)
				24-Aug.-67	Sheridan (Bda, Asm)
					Graham (Bda, Asm)
					Thomas (Bda, Asm, Bcu)
				2-Aug.-68	Ellis (Pvi)
	F	D(H)	l.l.	22-May-67	Ellis (Asm)
				23-Aug.-67	Cheyenne (Bda, Asm, Bgr)
				2-Aug.-68	Ellis (Pvi)
		D(D)	l.	29-May-67	Ellis (Asm)
				16-June-67	Ellis (Asm)
				9-Aug.-67	Ellis (Asm)
				24-Aug.-67	Sherman (Asm)
				15-Sept.-67	Ellis (Asm)
	N	D(H)	e.l.	3-Oct.-67	Ellis (Asm)
				19-July-65	Ellis (Asm)
				22-May-67	Ellis (Asm)
				29-May-67	Ellis (Asm)
				5-June-67	Ellis (Asm)
				15-Sept.-67	Ellis (Asm)
			l.l.	12-July-65	Ellis (Asm)
				19-July-65	Ellis (Asm)
				22-May-67	Ellis (Asm)
				29-May-67	Ellis (Asm)
				5-June-67	Ellis (Asm)
				24-Aug.-67	Sherman (Asm)
				9-July-68	Ellis (Asm)
Norvellina seminuda (Say)	F	D(H)	l.	20-June-58	Riley

Table 1 (cont'd)

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Parabolocratus sp.	M	H(S)	M (ue)	24-Sept.-67	Wabaunsee (Pvi, Age, Bda)
			F	23-Sept.-67	Marshall (Pvi, Bda)
	F	H(S)	M (ue)	23-Sept.-67	Pottawatomie (Pvi, Age, Bda, Asm, Bcu)
			F	4-Aug.-58	Riley
				23-Aug.-67	Cheyenne (Bda, Asm, Bgr)
		D(H)	e.l.	23-Aug.-67	Rawlins (Bda, Asm)
				24-Aug.-67	Osage (Pvi, Age, Bda)
					Sheridan (Bda, Asm)
				7-Sept.-67	Geary (Pvi, Age)
					Ellsworth (Pvi, Age, Bda, Bgr)
			l.l.	16-June-67	Ellis
				23-Aug.-67	Decatur (Bda, Asm)
					Cheyenne (Bda, Asm, Bgr)
				24-Aug.-67	Graham (Bda, Asm)
	N	H(S)	M (ue)	24-Aug.-67	Sheridan (Bda, Asm)
					Thomas (Bda, Asm, Bcu)
			M (e)	14-July-67	Marion
		D(H)	e.l.	20-July-67	Riley
				24-Aug.-67	Rooks (Bda, Pvi)
				7-Sept.-67	Hodgeman (Bda, Bgr, Asm, Bcu)
				8-Sept.-67	Dickinson (Pvi, Age, Bda, Bgr, Bcu)
					Meade (Bda, Bgr)
					Morris (Pvi, Age, Bda, Bcu)
				29-Apr.-68	Ellis (Asm)
		D(D)	l.	7-Sept.-67	Geary (Pvi, Age)

Table 1 (cont'd).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
P. viridis (Uhler)	M	H(S)	M	19-Aug.-66	Riley
			F	8-Sept.-67	Marion (Pvi, Age. Asm)
	N	D(H)	e.l.	29-Apr.-68	Ellis (Asm)
Paraphlepsius irroratus* (Say)	M	H(S)	F	15-Oct.-58	Riley
	F	H(S)	F	19-Oct.-58	Riley
		D(H)	l.l.	16-Sept.-66	Ellis (Pvi)
Polyamia sp.	M	H(S)	F	23-Sept.-67	Doniphan (Pvi)
		D(H)	e.l.	7-Sept.-67	Ellsworth (Pvi, Age, Bgr, Bcu)
				15-Sept.-67	Ellis (NM)
				28-Aug.-68	Riley (Age, Pvi, Bda)
	F	D(H)	e.l.	23-Aug.-67	Smith (Bda)
Psammotettix sp.	M	D(H)	e.l.	20-July-67	Riley
			l.l.	10-July-67	Riley (Age, Pvi)
				23-Sept.-67	Marshall (Pvi, Bda)
		D(D)	l.	20-July-67	Riley
Scaphytopius frontalis (Van Duzee)	M	D(H)	l.l.	31-Aug.-59	Riley

Table 1 (concluded).

Leafhopper host	Sex or life stage of host	Kind of parasite	Sex or life stage of parasite	Date collected	County and grass type
Stirellus bicolor (Van Duzee)	M	H(S)	F	10-Sept.-67	Cherokee (seeded pasture)
		D(H)	l.l.	20-July-59	Riley
	F	D(H)	l.l.	28-Aug.-68	Riley (Pvi, Age)
Xerophlea sp.	F	S	F	1-Sept.-67	Hodgeman (Bda, Asm, Bgr, Bcu)
	N	D(H)	e.l.	8-Sept.-67	Ford (Bda, Bgr, Asm)
					Kiowa (Bda, Bgr)

(a) M = male; F = female; N = nymph; l. = larva; e.l. = early larva; l.l. = late larva; triung.l. = triungulin larva.

(b) D(D) = Dorilaidae (Diptera); D(H) = Dryinidae (Hymenoptera); S = Strepsiptera; H(S) = Halictophagidae (Strepsiptera)

(c) Age = Andropogon gerardi (big bluestem)
Asm = Agropyron smithii (western wheatgrass)
Bcu = Bouteloua curtipendula (sideoats grama)
Bda = Buchloe dactyloides (buffalograss)
Bgr = bouteloua gracilis (blue grama)
Pvi = Panicum virgatum (switchgrass)
NM = native mixture pasture

* = probable identification

** = possible identification

Table 2. Position of Dryinidae larval sacs in leafhopper hosts from Kansas grasslands, August-September, 1967.

Leafhopper host	Number of specimens collected	Number and stage or sex of host[a]	No. of sacs per host	Location in thorax[b]	Location between abdominal segments
Aceratagallia sp.	8	4F	1		(4) 2-3
		4N	1		(1) 3-4
					(3) 6-7
Aceratagallia uhleri (Van Duzee)	1	M	1		(1) 6-7
Athysanella sp.	15	10F	1		(1) 3-4
		5N	1		(6) 4-5
					(7) 5-6
					(1) 6-7
					(1) 7-8
A. (Gladionura) argenteola* (Uhler)	37	23F	1-2		(6) 3-4
		3M	1-2		(17) 4-5
		11N	1		(7) 5-6
					(7) 6-7
					(2) 7-8
Balclutha neglecta (DeLong and Davidson)	5	M	1		(1) 2-3
					(3) 3-4
					(1) 4-5
Chlorotettix spatulatus Osborn and Ball	2	1F	1		(1) 3-4
		1N	1		(1) 4-5

Table 2 (cont'd).

Leafhopper host	Number of specimens collected	Number and stage or sex of host	No. of sacs per host	Location in thorax	Location between abdominal segments
Dorycephalus sp.	5	N	1	(5) meso-meta	
Draeculacephala mollipes (Say)	1	M	1		(1) 5-6
Empoasca sp.	37	23F 14M	1 1		(37) 3-4
Endria inimica (Say)	14	4F 5M 5N	1 1 1		(4) 3-4 (7) 4-5 (3) 5-6
Exitianus exitiosus (Uhler)	16	3F	1	(1) N-meso-meta	(4) 3-4 (3) 4-5 (4) 5-6 (2) 6-7 (2) 7-8
Flexamia sp.	16	6F 10N	1 1	(1) N-pro-meso	(1) 2-3 (6) 3-4 (2) 4-5 (5) 5-6 (1) 7-8
F. abbreviata (Osborn and Ball)	11	M	1	(4) pro-meso	(4) 3-4 (3) 5-6

Table 2 (cont'd).

Leafhopper host	Number of specimens collected	Number and stage of sex of host	No. of sacs per host	Location in thorax	Location between abdominal segments
F. curvata DeLong	1	M	1		(1) 4-5
F. pectinata (Osborn and Ball)	2	M	1		(2) 5-6
Gilletellia atropuncta (Gillette)	12	F	1		(2) 3-4 (3) 4-5 (6) 5-6 (1) 6-7
Laevicephalus sp.	3	F	1		(1) 4-5 (2) 6-7
Macrosteles fascifrons (Stal)	17	16F 1M	1 1		(1) 3-4 (1) 4-5 (4) 5-6 (11) 6-7
Mesamia coloradensis* (Gillette and Baker)	1	F	1		(1) 4-5
Mocuellus collinus (Boheman)	20	6F 14N	1-2		(7) 3-4 (9) 4-5 (5) 5-6 (3) 6-7
Parabolocratus sp.	13	7F 6N	1-3 1		(1) 2-3 (4) 3-4 (5) 4-5 (5) 5-6 (2) 6-7

Table 2 (concluded).

Footnotes:

(a) M = male; F = female; N = nymph.

(b) pro = prothorax; meso = mesothorax; meta = metathorax.

* probable identification.

Table 3. Parasitic Strepsiptera in leafhoppers from Kansas grasslands, August-September, 1967.

Leafhopper host	Number of specimens collected	Life stage or sex of host (a)	No. of parasites per host	Sex of parasite (a)	Number and location between abdominal segments
Aceratagallia sp.	2	F	1	F	(2) 6-7
A. sanguinolenta (Provancher)	1	M	1	M (ue)	(1) 7-8
A. uhleri (Van Duzee)	1	M	1	M (e)	(1) 6-7
Athysanella sp.	2	F	1	F	(1) 6-7
				M (e)	(1) 5-6
A. texana (Osborn)*	1	F	1	M (ue)	(1) 6-7
Dorycephalus (Dorycephalus) platyrhynchus (Osborn)*	2	F	1	M (ue)	(1) 5-6
					(1) 6-7
Draeculacephala mollipes (Say)	6	3F	1	5F	(1) 5-6
		3M	1	1M (e)	(4) 6-7
Endria inimica (Say)	20	7F	1-2	13F	(1) 6-7
					(11) 6-7
		10M	1-2	3M (ue)	(1) 7-8
					(1) 5-6
		3N	1	6M (e)	(2) 6-7
					(2) 5-6
					(4) 6-7
Flexamia graminea DeLong	1	M	1	M (e)	(1) 6-7

Table 3 (concluded).

Leafhopper host	Number of specimens collected	Life stage or sex of host	No. of parasites per host	Sex of parasite	Number and location between abdominal segments
F. picta (Osborn)	49	28F	1-2	32F	(2) 4-5 (4) 5-6 (21) 6-7 (5) 7-8
		18M	1-2	12M (ue)	(4) 5-6 (2) 6-7 (6) 7-8
		3N	1	18M (e)	(7) 5-6 (4) 7-8
F. prairiana DeLong	11	5F	1-2	8F	(2) 5-6 (6) 6-7
		4M	1-2	1M (ue)	(1) 5-6
		2N	1	5M (e)	(4) 5-6 (1) 7-8
Laevicephalus sp.	4	4F	1	F	(1) 6-7
L. unicoloratus (Gillette & Baker)	1	M	1	M (e)	(1) 6-7
Parabolocratus (inc. viridis Uhler)	17	4F	1	4F	(1) 6-7 (3) 7-8
		2M	1	2M (ue)	(1) 4-5 (1) 6-7
		11N	1	11M (e)	(4) 5-6 (7) 6-7

(a) M = male; F = female; N = nymph; (ue) = unemerged; (e) = emerged.

* Probable identification.

Table 4. Halictophagus Curtis species from leafhopper hosts from Kansas grasslands.

Leafhopper host	Sex of hosts(a)	Species of Halictophagus Curtis	Sex of H. sp.(a)	Date collected	County in which collected
Draeculacephala mollipes (Say)	M	H. acutus Bohart	F	10-Sept.-67	Cherokee
Athysanella sp.	F	H. bidentatus Bohart	F	24-Aug.-67	Dickinson
A. (Gladionura) sp.	F	" " "	F	20-July-67	Riley
A. texana (Osborn)	F	" " "	M	24-Aug.-67	Geary
Flexamia sp.	F	" " "	M, F	8-Sept.-67	Sedgwick
F. picta (Osborn)	M	" " "	F	8-Sept.-67	Dickinson
Graminella mohri DeLong	M	" " "	F	24-Aug.-67	Ellis
Paraboliocratus sp.	F	" " "	F	23-Aug.-67	Cheyenne
Dorycephalus platyrhynchus* Osborn	M	H. insularum (Pierce)	F	23-Aug.-67	Cheyenne
Endria inimica (Say)	M	H. mackayi (Bohart)	F	8-Sept.-67	Marion
" "	M	" " "	F	23-Sept.-67	Nemaha
Flexamia sp.	F	" " "	M, F	20-Aug.-59	Riley
F. pectinata (O. & B.)	M	" " "	M	20-July-59	Riley
F. picta (O.)	M	" " "	F	8-Sept.-67	Dickinson

Table 4 (concluded).

Leafhopper host	Sex of hosts	Species of Halictophagus Curtis	Sex of H. sp.	Date collected	County in which collected
F. prairiana DeLong	M	H. mackayi (Bohart)	M	20-Aug.-59	Riley
" " "	M	" " "	F	24-Sept.-67	Lyon
F. reflexa (Osborn and Ball)	M	" " "	F	20-July-59	Riley
G. mohri DeLong	M	" " "	F	17-Aug.-59	Riley
" " "	F	" " "	F	24-July-67	Ellis
Laevicephalus sp.	F	" " "	F	5-Aug.-67	Leavenworth
Macrosteles fascifrons (Stal)	M	" " "	F	24-Sept.-67	Bourbon
Mesamia coloradensis (Gillette and Baker)	F	" " "	F	2-Aug.-59	Riley
Aceratagallia sp.	F	H. omani Bohart	F	20-July-67	Riley
Paraphlepsius irroratus (Say)	M	H. uhleri (Pierce)	F	15-Oct.-58	Riley
Stirellus bicolor (Van Duzee)	M	H. "sp. n."	F	10-Sept.-67	Cherokee

(a) M = male; F = female.

* = probable identification.

Table 5. Life history data on Dryinidae reared from Exitianus exitiosus (Uhler).

Stage of host	Larva in host	Length of life stages (in days)				Dryinidae genera present
		Larva in cocoon	Prepupal	Pupal[a]	Adult[b]	
Nymph	2	5	3	12	3	Neogonatopus
Female	9	4	5	12	9	"
Nymph	6	4	4	12	5	Gonatopus
Nymph	6	4	4	13	8	"
Female	4	5	3	10	3	"

(a) Including days as pre-emerged adult.

(b) After emergence.

Table 6. Dryinidae females taken in sweep-net collections from Kansas grasslands.

Genus of Dryinidae	Number collected	Date collected	County collected	Grasses present (a)
Chalcogonatopus Perkins	1	4-July-38	Stafford	
	1	24-Sept.-67	Osage	Age, Pvi, Bda
Epigonatopus Perkins	1	19-Aug.-67	Riley	Bda
	1	23-Aug.-67	Decatur	Bda, WW
	1	24-Aug.-67	Rooks	Bda, Pvi
	1	24-Aug.-67	Lincoln	Bda
	2	8-Sept.-67	Ford	Bda, Bgr, Asm
	1	8-Sept.-67	Morris	Age, Pvi, Bda, Bcu
Gonatopus Ljungh	5	5,16-June-67	Ellis	Asm
	1	27-June-68	Ellis	Asm
	1	20-July-68	Riley	Bda
	1	17-Aug.-67	Riley	Bda
	1	23-Aug.-67	Cheyenne	Bda, Asm
	2	23-Aug.-67	Decatur	Bda, Asm
	2	23-Aug.-67	Phillips	Bda
	1	24-Aug.-67	Russell	Bda, Bgr

Table 6 (cont'd).

Genus of Dryinidae	Number collected	Date collected	County collected	Grasses present
Gonatopus Ljungh (cont'd)	1	24-Aug.-67	Thomas	Bda, Asm
	1	24-Aug.-67	Graham	Bda, Asm
	1	24-Aug.-67	Lyon	Age, Pvi, Bda
	1	24-Sept.-67	Bourbon	Age, Pvi
Neogonatopus Perkins	1	13-Oct.-66	Ellis	Ain
	1	23-Aug.-67	Phillips	Bda
	1	24-Aug.-67	Graham	Bda, Asm
	1	24-Sept.-67	Lyon	Age, Pvi, Bda
	1	24-Sept.-67	Allen	Age, Pvi, Bcu
Pachygonatopus Perkins	1	17-July-67	Riley	Bda
Platygonatopus Kieffer	2	24-Aug.-67	Rooks	Bda, Pvi
Pseudogonatopus Perkins	1	1-May-30	Riley	
	2	17-July-68	Riley	Bda
	1	18-Aug.-67	Riley	Bda
	1	23-Aug.-67	Phillips	Bda
	1	24-Aug.-67	Rooks	Bda, Pvi

Table 6 (concluded).

Genus of Dryinidae	Number collected	Date collected	County collected	Grasses present
Pseudogonatopus Perkins (cont'd)	1	24-Aug.-67	Russell	Bda, Bgr
	2	24-Aug.-67	Lincoln	Bda
	3	24-Aug.-67	Nemaha	Bda, Pvi
	1	24-Aug.-67	Ottawa	Bda, Bcu
	1	8-Sept.-67	Harvey	Age, Pvi, Asm, Bda
	1	24-Sept.-67	Franklin	Pvi, Age, Bcu

(a) Ain = Andropogon intermedius (caucasian bluestem).
Age = A. gerardi (big bluestem).
Asm = Agropyron smithii (western wheatgrass)
Bcu = Bouteloua curtipendula (sideoats grama)
Bda = Buchloe dactyloides (buffalograss)
Bgr = Bouteloua gracilis (blue grama)
Pvi = Panicum virgatum (switchgrass)

Table 7(a). Life history data for Dryinidae reared from leafhopper hosts from Donaldson Pasture, Manhattan, Kansas.

Host sex or life stage and "number" (a)	Leafhopper host	Genus or tribe of Dryinidae reared	Sex of Dryinidae (a)	Date collected as larva
N-"DP-1"	Athysanella	Gonatopus	F	23-June-67
N-"DP-3"	Aceratagallia	Pachygonatopus	F	23-June-67
N-"DP-9"	Athysanella	Gonatopus	F	23-June-67
M-"DP-13"	Flexamia prairiana LeLong	Gonatopus	F	23-June-67
N-"DP-18"	Athysanella	Gonatopus	F	23-June-67
N-"DP-19"	Athysanella	Gonatopus	F	23-June-67
N-"DP-22"	Athysanella	Gonatopus	F	23-June-67
N-"DP-24"	Athysanella	Gonatopus	F	23-June-67
N-"DP-31"	Athysanella	Gonatopus	F	23-June-67
N-"DP-35"	Athysanella	Gonatopus	F	30-June-67
N-"DP-47"	Athysanella	Gonatopus	F	30-June-67
N-"DP-53"	Parabolocratus	Chalcogonatopus	F	20-July-67
N-"DP-a"	Athysanella	Gonatopus	F	30-July-67
N-"DP-59"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-61"	Athysanella	Gonatopus	F	17-Aug.-67

Table 7(a) (cont'd).

Host sex or life stage and "number"	Leafhopper host	Genus or tribe of Dryinidae reared	Sex of Dryinidae	Date collected as larva
N-"DP-63"	Athysanella	Gonatopodini	M	17-Aug.-67
N-"DP-65"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-70"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-72"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-77"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-78"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-81"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-84"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-86"	Athysanella	Epigonatopus	F	17-Aug.-67
N-"DP-87"	Athysanella	Gonatopus	F	17-Aug.-67
N-"DP-93"	Athysanella	Gonatopus	F	19-Aug.-67
N-"DP-95"	Athysanella	Epigonatopus	F	19-Aug.-67
?-"DP-96"	Host unknown	Gonatopus	F	19-Aug.-67
M-"DP-99"	Endria inimica (Say)	Gonatopus	F	6-Sept.-67
N-"DP-100"	Athysanella	Epigonatopus	F	6-Sept.-67
M-"DP-103"	Balclutha neglecta (DeLong and Davidson)	Gonatopodini	M	6-June-68

Table 7(a) (concluded).

Host sex or life stage and "number"	Leafhopper host	Genus or tribe of Dryinidae reared	Sex of Dryinidae	Date collected as larva
F-"DP-111"	A. (Amph.) texana**	Epigonatopus	F	27-June-68
?-"DP-112"	Host unknown	Neogonatopus	F	27-June-68
N-"DP-113"	Athysanella	Gonatopodini	M	27-June-68
F-"DP-114"	Athysanella	Gonatopodini	M	27-June-68
N-"DP-150"	Athysanella	Gonatopus	F	17-July-68
N-"DP-153"	Athysanella	Gonatopus	F	23-July-68
N-"DP-154"	Athysanella	Gonatopus	F	20-July-68
N-"DP-157"	Athysanella	Gonatopus	F	23-July-68

(a) N = nymph; M = male; F = female..

Table 7(b). Life history data for Dryinidae reared from leafhopper hosts from Donaldson Pasture, Manhattan, Kansas.

Host "Number"	Plant species reared on(a)	Number of days as: larva in host	larva in cocoon	prepupa	pupa	pre-emerged adult	"cocoonad specimen"	emerged adult
"DP-1"	Bcu	5					29	6
"DP-3"	Bcu	5					29	5
"DP-9"	Age	3					31	8
"DP-13"	Age	5					34	6
"DP-18"	Age	5					29	5
"DP-19"	Bcu	8					29	5
"DP-22"	Pvi	3					34	6
"DP-24"	Bcu	8					40	11
"DP-31"	Age	11					28	9
"DP-35"	Age	3					33	2
"DP-47"	Bcu	3					304	3
"DP-53"	Age	4					33	7
"DP-a"	Pvi	3					33	2
"DP-59"	Bda	6					43	2

Table 7(b) (cont'd).

Host "Number"	Plant species reared on	Number of days as: larva in host	larva in cocoon	prepupa	pupa	pre-emerged adult	"cocooned specimen"	emerged adult
"DP-61"	Bda	5					57	2
"DP-63"	Bda	10					62	2
"DP-65"	Bda	9					34	2
"DP-70"	Bda	9					49	3
"DP-72"	Bda	10					42	3
"DP-77"	Bda	9					40	2
"DP-78"	Bda	6					44	3
"DP-81"	Bda	8					56	4
"DP-84"	Bda	2					46	7
"DP-86"	Bda	8					31	3
"DP-87"	Bda	8					54	3
"DP-93"	Bda	3					101	6
"DP-95"	Bda	2					34	6
"DP-96"		0					17	3
"DP-99"	Asc	4					26	4

Table 7(b) (concluded).

Host "Number"	Plant species reared on	Number of days as: larva in host	larva in cocoon	prepupa	pupa	pre-emerged adult	"cocooned specimen"	emerged adult
"DP-100"	Asc	5					27	2
*"DP-103"	Bda	3	3	3	5	3		4
*"DP-111"	Bda	5	4	4	7	5		9
*"DP-112"		0	5	3	8	4		3
*"DP-113"	Bda	9	4	6	8	6		3
"DP-114"	Bda	9					34	3
"DP-150"	Bda	8					26	10
*"DP-153"	Bda	4	9	6	14	5		13
*"DP-154"	Bda	7	8	6	11	5		7
*"DP-157"	Bda	6	6	5	10	6		6

(a) Age = Andropogon gerardi (big bluestem).
Asc = Andropogon scoparius (little bluestem).
Bcu = Bouteloua curtipendula (sideoats grama).
Bda = Buchloe dactyloides (buffalograss).
Pvi = Panicum virgatum (switchgrass).

* = Intra-cocoon development observed.

Table 8(a). Life history data for Dryinidae reared from leafhopper hosts from western wheatgrass pasture, Hays, Kansas.

Sex or host life stage and "number"(a)	Leafhopper host	Genus of Dryinidae reared	Sex of Dryinidae(a)	Date collected as larva
N-"WW-1"	Athysanella	Gonatopus	F	29-May-67
N-"WW-2"	Athysanella	Gonatopus	F	29-May-67
N-"WW-5"	Athysanella	Gonatopus	F	29-May-67
N-"WW-6"	Athysanella	Gonatopus	F	29-May-67
N-"WW-12"	Athysanella	Gonatopus	F	5-June-67
N-"WW-13"	Athysanella	Gonatopus	F	5-June-67
N-"WW-15"	Athysanella	Gonatopus	F	5-June-67
N-"WW-19"	Athysanella	Gonatopus	F	5-June-67
N-"WW-22"	?	Gonatopodini	M	5-June-67
F-"WW-27"	Exitianus exitiosus (Uhler)	Gonatopus	F	16-June-67
N-"WW-32"	Athysanella	Gonatopus	F	16-June-67
N-"WW-39"	Athysanella	Gonatopus	F	26-June-67

(a) N = nymph; M = male; F = female.

Table 8(b). Life history data for Dryinidae reared from leafhopper hosts from western wheatgrass pasture, Hays, Kansas.

Host "Number"	Plant species reared on (a)	Number of days as: larva in host	"cocooned specimen"	emerged adult
"WW-1"	Asm	3	35	2
"WW-2"	Asm	7	36	6
"WW-5"	Asm	12	32	3
"WW-6"	Asm	14	32	5
"WW-12"	Asm	8	36	2
"WW-13"	Asm	4	32	6
"WW-15"	Asm	5	32	5
"WW-19"	Asm	7	30	6
"WW-22"	Asm	7	31	4
"WW-27"	Asm	5	18	4
"WW-32"	Asm	6	34	8
"WW-35"	Asm	3	33	15

(a) Asm = Agropyron smithii (western wheatgrass).

PARASITES IN LEAFHOPPERS FROM KANSAS GRASSLANDS (HOMOPTERA:CICADELLIDAE)

by

ROBERT SMOOT BALDRIDGE

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Parasites of leafhoppers were studied from 96 sweep net collections from tall grass and mixed prairie grasslands in 55 Kansas counties in late summer of 1967 and in 1968, and from miscellaneous collections made from 1957-1966. Adult parasites of the families Halictophagidae (Strepsiptera) and Dryinidae (Hymenoptera) were identified from collected and reared material.

Immature forms of Dryinidae, Halictophagidae and Dorilaidae (Diptera) (Pipunculidae of authors) were collectively recorded from 27 leafhopper genera in six subfamilies: Deltocephalinae (20), Ledrinae (1), Agallinae (1), Hecalinae (1), Dorycephalinae (2) and Typhlocybinae (2). Specimens from 18 genera contained immature and/or adult Halictophagidae. All 27 genera contained dryinid larvae. Dorilaidae larvae were found in 11 leafhopper genera.

Seven leafhopper genera were parasitized by species belonging to all three families. Parasites of both Dryinidae and Halictophagidae were found in 11 of the host genera. Five leafhopper genera contained only dryinid larvae. Four genera were parasitized by both Dryinidae and Dorilaidae larvae.

Halictophagidae were found in the hosts as triungulin larvae, males (emerged or unemerged) and/or females. Other larval instars were not observed. Dryinidae and Dorilaidae occurred as larvae within the hosts.

Both leafhopper nymphs and adults were parasitized by the above forms. Dual parasitism was found in Laevicephalus sp. (with Halictophagidae and Dorilaidae) and Macrosteles fascifrons (Stal) (with Dryinidae and Dorilaidae).

Modifications of external genitalia of the hosts, possibly due to parasitism, were found infrequently. Aberrant genitalia were found in the males of Athysanella, Graminella and Laevicephalus, all containing Dorilaidae larvae, as well as in males of Flexamia reflexa (Osborn and Ball) containing Halictophagidae.

The dryinid larvae in 15 genera of leafhoppers were most often found in the abdomen. These did not occur with regularity between particular segments, except for Empoasca sp. in which the larvae occurred regularly between abdominal segments 3-4. Specimens of Dorycephalus sp. and Endria inimica (Say) had dryinid larvae between the mesothorax and metathorax, while dryinid larvae in Exitianus exitiosus (Uhler) and Flexamia abbreviata (Osborn and Ball) occurred between the prothorax and mesothorax. Usually each leafhopper host had one larval parasite, although more than one were noted in Athysanella argenteola (Uhler), Mocuellus collinus (Boheman) and Parabolocratus sp.

Halictophagidae parasites were localized posteriorly in the leafhopper's abdomen. The females appeared to locate more ventrad in the host; the males more dorsad. Frequently both sexes were found in the same host.

Six species of Halictophagus Curtis (Halictophagidae) were found in 14 genera of leafhoppers. One possible new species was found in Stirellus bicolor (Van Duzee). The host and locality records for these parasites are new for Kansas.

Developmental history of one male dryinid was recorded as observed through an exposed portion of its cocoon. The length of larval, prepupal, pupal and adult life forms was recorded. Larval behavior, cocoon

formation and activities within the cocoon were recorded. Similar information was recorded for all the dryinids reared from leafhopper hosts.

Various dryinid genera were reared from larval stages, the hosts being kept alive on grass in cellulose nitrate rearing cages until the larva emerged. Pupation occurred in one-dram glass vials. Most hosts contained only one larva. If more were present only one emerged and developed. The majority of dryinids reared were of the genus Gonatopus from Athysanella nymphs. Seven genera of dryinids were collected as females from grasslands with no host information. The majority of these specimens belonged to the genera Gonatopus and Pseudogonatopus.

Parasitic worms of the order Gordioidea were found in nymphs of Mocuellus collinus (Boheman) and one female of Balclutha neglecta (DeLong and Davidson). These worms were partially extruded from the host's abdomen.