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A NEW NET-WINGED MIDGE FROM IDAHO (BLEPHAROCERIDAE, DIPTERA)

Charles P. Alexander[1]

An interesting undescribed species of net-winged midge belonging to the genus *Bibiocephala* Osten Sacken was taken in Idaho by my friend Mr. James Baker, of Baker, Oregon. I am very deeply indebted to the collector for many new and rare crane-flies taken during the past twenty-five years in several of the western states and provinces. The unique type is preserved in my personal collection.

General Account of Bibiocephala

The genus *Bibiocephala* Osten Sacken (see Bibliography) now includes five nominal species, one occurring in Japan, the remaining four names pertaining to western Nearctic species. In attempting to clear the identities and synonymy of the American species I am reviewing briefly the series of circumstances under which the various names were proposed, the papers cited being included in the appended bibliography. Attention may be directed to two recent papers by the writer (1958, 1963) which include more detailed references to the family.

Osten Sacken (1874:564-566, figure, venation) proposed the genus *Bibiocephala*, based on the new species, *grandis*, taken at high altitudes in the mountains of Colorado, 8,000 to 10,000 feet, August 1873, represented by a single male specimen taken by Lieutenant W. L. Carpenter. Garrett (1922:91) described *Bibiocephala kelloggi* from a single female specimen taken in the city of Cranbrook, British Columbia, July 13, 1921, by Cecil B. D. Garrett. In defining the species Garrett recorded it as being a male but actually this type is a female. The specimen is in my personal collection having been acquired by purchase from Garrett. It still is uncertain whether this fly is distinct from *grandis*. Curran (1923) described *Bibiocephala grisea*, as type of a supposed new genus *Bibionus*, based on a single male taken at Nordegg, Alberta, June 26, 1921, by James Mc Dunnough. This evidently is identical with *kelloggi* which is the prior name.

1. Amherst, Massachusetts.

In 1890 von Röder proposed the genus *Agathon*, for *A. elegantula* von Röder, of Nevada, based on the short vein R_3 of the wings and the glabrous thoracic pleura. Kellogg (1903:192-195), in describing two new species from California with shortened vein R_3, referred these species to *Bibiocephala* as *B. comstocki* and *B. doanei*, not recognizing the distinctness of the two genera *Agathon* and *Bibiocephala*. This misinterpretation of the generic limits of *Bibiocephala* led to the further errors by Garrett and Curran, as mentioned. Walley (1927) recognized both genera and separated the various species correctly except for referring *Agathon comstocki* (Kellogg) to *Bibiocephala*.

The Japanese species was originally described by Matsumura (1916) as a species of *Liponeura*, under the name *Liponeura infuscata*. Kitakami (1950) again followed Kellogg's interpretation and considered that the Japanese species required a new generic name *Amika* (the Japanese name for these insects), thus creating a second synonym in *Bibiocephala*.

The presently known members of the genus are as follows:

Bibiocephala grandis Osten Sacken (1874); ♂.
Bibiocephala kelloggi Garrett (1922); ♀ (status in question).
synonym: *Bibiocephala grisea* (Curran, 1923); ♂.
Bibiocephala nigripes sp.n.; ♂.
Bibiocephala infuscata (Matsumura, 1916); ♂.
Generic synonymy:
Bibiocephala Osten Sacken (1874).
Bibionus Curran (1923).
Amika Kitakami (1950).

Bibiocephala nigripes sp.n.

Male.— Length, about 11 mm.; wing 9x4 mm.; antenna, about 1.2 mm.

Head very large, especially the eyes which are broadly contiguous above; eyes with reduced lower section only about one-third to one-fourth the upper division. Antennae 14-segmented, short, black throughout; scape short, pruinose, pedicel much longer, dilated at apex; proximal two flagellar segments united, nearly equal in length to the succeeding three combined; eighth and succeeding segments transverse, broader than long, the penultimate about one-half broader than its length, terminal segment short-oval. Head gray.

Mesonotal praescutum light gray with two brown stripes, their anterior ends much widened; posterior sclerites and pleura generally gray. Halteres with stem light yellow, knob dark brown. Legs with coxae infuscated; trochanters yellowed, darkened apically beneath; femora yellowed on about the basal two-thirds, the tips and remaining segments intensely black; tibial spur formula 1 - 2 - 2. Wings very broad, especially on proximal portion, the anal region produced backward; wings rather strongly infuscated, the whitened secondary wing folding more conspicuous than in *grandis* but narrower and less evident than in *infuscata*.

Basal abdominal tergites broadly light gray on sides, narrower on posterior borders, the midregion more blackened, the subterminal segments more uniformly darkened; hypopygium yellowish brown.

HOLOTYPE, ♂, near Featherville, Elmore County, Idaho, in Sawtooth State Forest, 4,900 feet, July 13, 1964 (*James Baker*).

Bibiocephala nigripes is most readily distinguished from the previously described American species by the intensely blackened tibiae and tarsi which have suggested the specific name.

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CURRAN, C. H. 1923. Studies in Canadian Diptera II. The genera of the family Blepharoceridae. Canad. Ent., 55:266-269 (*Bibionus; Bibionus griseus*).

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KITAKAMI, SIRO. 1950. The revision of the Blepharoceridae of Japan and adjacent territories. Jour. Kumamoto Women's Univ., 2:15-80, 5 pls., 3 figs. with subfigs.) (*Amika*).

MATSUMURA, S. 1916. Thousand Insects of Japan. Additamenta 2:185-474, pls. 16-25 (reference pp. 443-444, pl. 24, fig. 7 (*Bibiocephala infuscata*, as *Liponeura*).

OSTEN SACKEN, C. R. 1874. Report on the Diptera collected by Lieut. W. L. Carpenter in Colorado during the summer of 1873. *In* Hayden's U. S. Geol. & Geogr. survey of Colorado for 1873, pp. 561-566, 1 fig. (venation). (*Bibiocephala; Bibiocephala grandis*).

RODER, V. von. 1890. Zwei neue nordamerikanische Dipteren. Wien. Entomol. Zeitg, 9:230-232 (*Agathon*).

WALLEY, G. S. 1927. Review of the Canadian species of the dipterous family Blephariceridae. Canad. Ent., 59:112-116, 8 figs. (Key to genera and species).

A LIST OF SOME BEEFLIES OF THE NEVADA TEST SITE[1]

Dorald M. Allred[2], D. Elmer Johnson[3], and D Elden Beck[2]

During ecological investigations at the Nevada Test Site (refer to Brigham Young University Sci. Bull., II(2):1-52, 1963), several thousand beeflies were collected between March, 1961, and August, 1962. Specimens were taken by members of our field staff at the test site, and to a large extent by D. Elmer Johnson, who also identified the flies.

This reports 2,573 identifications representing 111 species of 24 genera. In addition several undescribed species were taken but are not listed here.

The species, numbers of individuals collected, months of occurrence, and ecological distribution are shown in Table I. The validity of some identifications made on the basis of descriptions and keys in the literature is open to question, and these names are followed by a question mark in the table.

Species which were taken in the most abundant numbers at the test site are *Lordotus albidus*, *L. nigriventris*, and *Poecilanthrax apache*. Those most widely distributed ecologically are *Paracosmus morrisoni*, *Poecilanthrax apache*, and *Villa aenea*. The greatest numbers of species and individuals were found in the Mixed and Larrea-Franseria communities (Fig. 1). Seasonally, the greatest

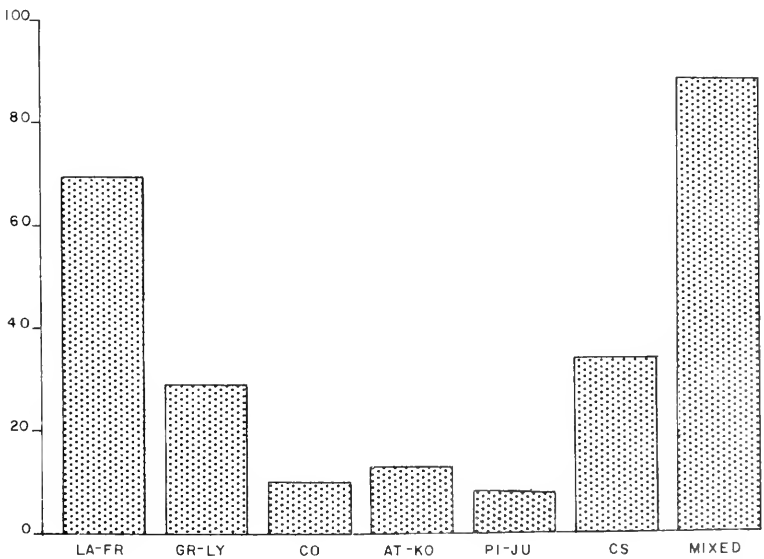

Fig. 1. Relative numbers of species of beeflies found in each of seven plant communities.

1. AEC-BYU Report No. COO-1355-7. Field work completed under Atomic Energy Commission Contract No. AT(11-1)786.

2. Department of Zoology and Entomology, Brigham Young University.
3. Ecology and Epizoology Research, University of Utah, Dugway, Utah.

numbers of species and individuals occurred in May, June, April, and September, respectively (Fig. 2).

Taxonomic Note

Material in the genus *Lordotus* collected for this study, plus that collected in other strategic localities, clarifies the relationships between some of the taxa in the genus and necessitates changes in the nomenclature of several of them.

Lordotus luteolus Hall, new combination
L. pulchrissimus luteolus Hall

Collection of a copulating pair of this species at Walker Pass, Kern County, California, on September 12, 1961, by D. E. Johnson

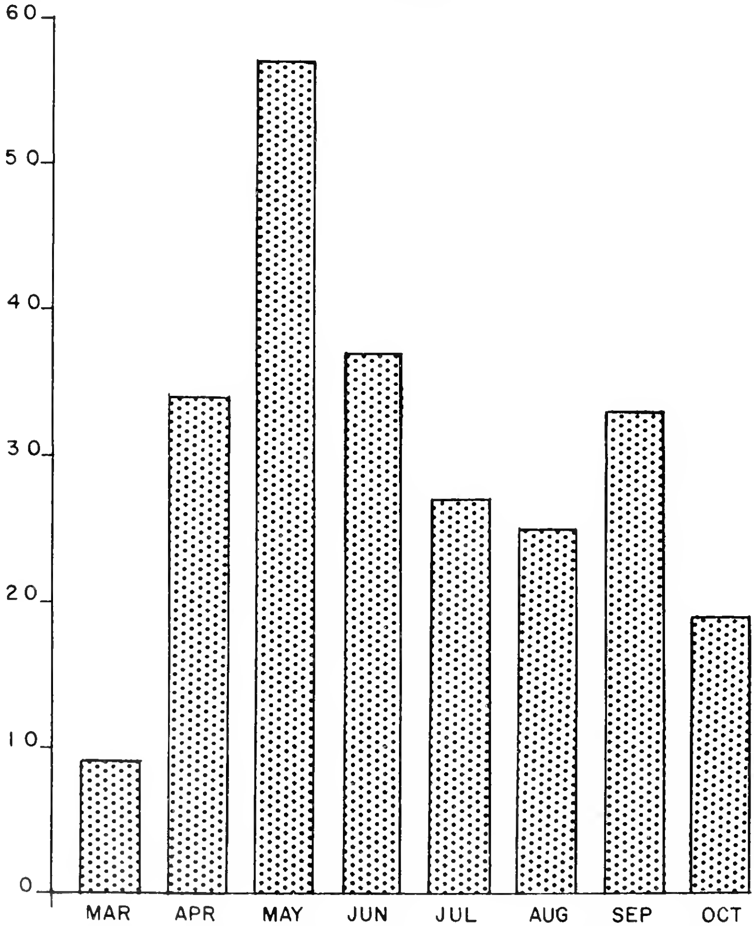

Fig. 2. Relative numbers of species of beeflies found during each of eight months of the year.

linked the two sexes of this species and made possible the certain separation of this species and *Lordotus pulchrissimus* Williston. In *L. pulchrissimus* the hypopleura are hairy while in *L. luteolus* they are bare. This holds true for both sexes.

Lordotus melanosus Johnson and Johnson, new combination
L. miscellus melanosus Johnson and Johnson

Examination of much material in this species and *L. miscellus* Coquillett has failed to reveal any intergrades between the two.

Lordotus nigriventris Johnson and Johnson, new combination
L. sororculus nigriventris Johnson and Johnson

As in the species above, examination of many specimens of this species and *L. sororculus* Williston and finding the two occurring at the same place, without intergrades being evident, are indicative that the two are best considered as distinct species. *Lordotus sororculus* is the more southerly and westerly in distribution, the two coming together in southern Nevada.

Lordotus striatus Painter, new combination
L. gibbus striatus Painter

This species and *L. gibbus* Loew have been found associated together in a number of places. They differ from each other as much as any of the related species in the group. Therefore, these are considered as distinct species.

Table 1. Occurrence of beeflies in plant communities at the Nevada Test Site

(* = Occurrence; P = Predominance; Month in boldface = Period of greatest abundance.)

Species	Plant Community or Locality[1]						
	La-Fr	Gr-Ly	Co	At-Ko	Pi-Ju	CS	Mixed
Anastoechus hessei Hall 41-Sept., **Oct.**	*					*	P
A. melanohalteralis Tucker 2-Sept.							*
Anthrax albofasciatus Macquart 11-April, **May**	P		*				P
A. limatulus Say 3-June, Sept.			*				
A. nidicola Cole ? 18-April, May	P	*					*
A. oedipus Fabricius 23-April through October	*				*	*	P
A. seriepunctatus (Osten Sacken) 9-May, **June, July**	P						*

Aphoebantus abnormis Coquillett 11-Aug., **Sept.**, Oct.	*					*	*
A. altercinctus Melander ? 37-June				*			
A. arenicola Melander 3-May	*						*
A. argentifrons Cole 6-Aug.							*
A. borealis Cole ? 2-May							*
A. brevistylus Coquillett ? 1-July							*
A. desertus Coquillett 28-**April**, May	*	*				*	P
A. eremicola Melander 17-**April**, May	P	*					
A. fumosus Coquillett 26-April	P	*				*	*
A. interruptus Coquillett 15-**April**, **May**, June	P	*				*	*
A. marcidus Coquillett 15-March, **May**, June	*	*					P
A. marginatus Cole ? 5-July	*						
A. marmon Melander 41-March, **Aug.**, **Sept.**, Oct.	*		P			*	P
A. mus Osten Sacken 7-April, **May**, July	*						P
A. pavidus Coquillett 8-Aug.						*	
A. parkeri Melander 8-July, **Aug.**, Oct.	P						*
A. peodes Osten Sacken 51-Mar., **April**, May	*					*	P
A. scalaris Melander 36-**May**, **June**, July	P				P		*
A. scriptus Coquillett 1-May	*						
A. tardus Coquillett 14-**May**, June	*						P
A. timberlakei Melander 1-July							*
A. transitus Coquillett 20-**April**, May	P	*				*	*
A. ursula Melander 15-April, May	P	*					*
A. varius Coquillett ? 9-June	*			P			
A. vasatus Melander ? 1-May							*
A. vittatus Coquillett 18-May, **June**, **Aug.**						*	P
A. vulpecula Coquillett 25-**May**, June	P						*
Astrophanes adonis Osten Sacken 1-May							*
Bombylius lancifer Osten Sacken 47-**May**, June							*
Conophorus fenestratus (Osten Sacken) 38-**April**, May, July	*					P	*

Desmatoneura argentifrons Williston 8-Aug.	*						
Dipalta serpentina Osten Sacken 7-Sept.							*
Empidideicus humeralis Melander 45-March, **May**	*	*					P
Epacmus connectens Melander 1-May	*						
E. labiosus Melander 11-July, **Aug.**, Sept.	*						P
E. litus Coquillett ? 34-Sept.							*
E. pulvereus Melander 11-March, April, **May**	*	P				*	*
Eucessia reubens Coquillett 1-July				*			
Exepacmus johnsoni Coquillett 20-March, April, **May**	*	*				*	P
Exoprosopa arenicola Johnson and Johnson 8-Aug.							*
E. caliptera Say 8-April, May, Aug., Sept.	*						P
E. divisa Coquillett 25-June, **July**, Aug.	P	*		*			P
E. dorcadion Osten Sacken 11-April, June, Aug., **Sept**.		*					P
E. doris Osten Sacken 68-**July**, Aug., Sept.	P	*		*			P
E. sharonae Johnson and Johnson 20-**Aug.**, Sept.							*
E. utahensis Johnson and Johnson 16-July, **Aug.**, Sept.			*			*	P
Geminaria canalis (Coquillett) 32-March, **May**, June	*	*				*	P
G. pellucida Coquillett 2-June, July							*
Geron argutus Painter 12-May, July, **Aug.**	*				*		P
Heterostylum robustum (Osten Sacken) 12-April, **May**, June	*	*				*	*
H. sackeni (Williston) 41-**April**, May	P	*				*	P
H. vierecki Cresson 8-April, May, June, Oct.	*		*			*	*
Lepidanthrax agrestis (Coquillett) 51-**May, June**, July, Aug.	P						*
L. angulus Osten Sacken 1-May		*					
L. hyalinipennis Cole 60-May, **June, July**	P					*	P
Lordotus abdominalis Johnson and Johnson 28-April, **May**, June, Sept.	P					*	*
L. albidus Hall 208-**April**, **May**, June	P	*					*
L. apicula Coquillett 63-May, **June**					*		*
L. singulatus Johnson and Johnson 85-**Sept.**, Oct.	P					*	P

L. gibbus Loew 10-Sept.							*
L. junceus Coquillett 7-**May**, June	*						
L. luteolus Hall 39-April, **May**, Sept., Oct.	P						*
L. melanosus Johnson and Johnson 42-Sept.							*
L. nigriventris Johnson and Johnson 116-March, **April, May**	P	*				*	*
L. perplexus Johnson and Johnson 22-**April**, May, Sept., Oct.	P						*
L. pulchrissimus Williston 9-Sept.							*
L. sororculus Williston 2-May	*						
L. striatus Painter 16-**Sept.**, Oct.						*	P
Oligodranes ater (Cresson) 5-April, **May**	*						*
O. cinctura (Coquillett) 1-April	*						
O. distinctus Melander 4-May	*						*
O. dolorosus Melander ? 4-May, June				*	*		*
O. fasciola (Coquillett) 14-**June, Sept.**, Oct.	*			*			P
O. mus (Bigot) 4-Sept.							*
O. pulcher Melander ? 4-June			*				
O. pullatus Melander ? 15-**May**, June					*		P
Pantarbes capita Osten Sacken 6-April, May	*	*					*
P. pusio Osten Sacken 7-April, **May**, June							*
P. willistoni Osten Sacken 5-April, May	*	*					
Paracosmus insolens Coquillett 3-May	*						
P. morrisoni Osten Sacken 61-March, April, **May, June**, July, Aug.	P	*			*	*	P
Poecilanthrax alpha (Osten Sacken) 11-Aug., **Sept.**, Oct.							*
P. apache Painter and Hall 127-**Sept.**, Oct.	*	*	*			*	P
P. californicus (Cole) 77-**Sept.**, Oct.	*		*			*	P
P. moffitti Painter and Hall 29-Aug., **Sept.**							*
P. poecilagaster (Osten Sacken) 1-Aug.							*
P. willistoni (Coquillett) 62-Aug., **Sept.**, Oct.			*			*	P
Toxophora pellucida Coquillett 5-April, May, June	*						

T. vasta Coquillett 12-June	*						P
T. virgata Osten Sacken 3-June, July, Oct.				*		*	
Villa aenea Coquillett 27-June, **July**, Aug., Sept., Oct.	*	*		*		*	P
V. arizonensis (Coquillett) 4-June				*			
V. atrata (Coquillett) 1-July							*
V. cautor (Coquillett) 26-Sept., Oct.	P	*				P	*
V. crocina (Coquillett) 72-June, **July, Aug.**, Sept.	P	*		*			*
V. cypris (Meigen) 5-May, June, July	*			*		*	
V. junctura (Coquillett) 20-April, **May**	*						*
V. lepidota (Osten Sacken) 37-July, **Aug., Sept.**, Oct.					*		P
V. mira (Coquillett) 1-July	*						
V. morio (Linnaeus) 37-April, May	P	*				*	*
V. scitula (Coquillett) 20-Sept.			*				P
V. sinuosa (Wiedemann) 2-July							*
V. supina (Coquillett) 38-**June**, July	*			P			
V. utahensis Maughan 49-April, **May**	*	*				*	P

[1]La-Fr = Larrea-Franseria; Gr-Ly = Grayia-Lycium; Co = Coleogyne; At-Ko = Atriplex-Kochia; Pi-Ju = Pinyon-Juniper; CS = Cane Springs; Mixed = areas not applicable to the designated communities.

TULAREMIA AND DEER FLIES IN THE ENVIRONS OF UTAH LAKE, UTAH[1]

Kaye B. Cox[2]

Introduction

Deer flies have been implicated as mechanical vectors of tularemia in Utah. Although infected flies heretofore have not been found in nature, there is little doubt of their importance in transmitting tularemia to man. Two species present in this area, *Chrysops discalis* Williston and *Chrysops noctifer* Osten Sacken, have been shown experimentally to transmit the disease. The presence of deer flies in the environs of Utah Lake where tularemia is endemic offers a potential health threat to man, and the expanding human population and development of recreational facilities adjacent to the lake increase this potential. Despite the fact that deer flies have been implicated with tularemia in Utah, little is known about their distribution or seasonal occurrence in the environs of Utah Lake.

The objectives of this study are: (1) to determine the distribution and seasonal occurrence of deer flies in the environs of Utah Lake; and (2) to determine the incidence of tularemia pathogens in the deer flies.

Grateful acknowledgment is made to Dr. Dorald M. Allred for the valuable suggestions and help given during this investigation, and to Dr. Don H. Larsen for his assistance and criticism of the manuscript. Special acknowledgment is made to Dr. Bert D. Thorpe, director of the Epizoology Research Laboratory, Institute of Environmental Biological Research, University of Utah, for the use of laboratory facilities in the bacteriological investigation, and for identification of the pathogen. Verification of deer fly identifications was made by Dr. Cornelius B. Philip, Principal Medical Entomologist, Rocky Mountain Laboratory, United States Public Health Service, Hamilton, Montana.

Review of Literature

Tularemia was first described by McCoy (1911) as a "plague-like disease" of rodents in Tulare County, California. McCoy and Chapin (1912) isolated the causative agent of the disease and named it *Bacterium tularense*. The taxonomic position of the pathogen is questionable. It is regarded by some as closely related to the pleuropneumonia group of organisms, and by others as more closely related to the genus *Brucella* than to its present position in the genus *Pasteurella* (Burrows, Porter, and Moulder, 1959). The name *Pasteurella tularensis* (McCoy and Chapin), as listed in Bergey's Manu-

1. This investigation was supported in part by a Pre-doctoral (Intermediate) Fellowship, 1-F1-GM-22, 918-01, from the National Institute of General Medical Sciences, National Institutes of Health, Bethesda, Maryland.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

al of Determinative Bacteriology, 7th ed. (Breed, Murray, and Smith, 1957), will be used in this paper.

The taxonomy, description, and characteristics of *Pasteurella tularensis* are found in publications of Breed, *et al.* (1957), and Burrows, *et al.* (1959). Hesselbrock and Foshay (1945) described the morphology of the organism. Diagnostic procedures were described by Burrows, *et al.* (1959), Davidsohn and Wells (1963), and Frankel, Reitman, and Sonnenwirth (1963). Lillie and Francis (1936) described the gross pathology of tularemia in laboratory animals. The virulence of tularemia isolates from nature has been measured in laboratory animals by Green (1931), Davis, Philip, and Parker (1934), and Philip and Davis (1935). Definitive virulence tests have been developed by Francis and Feltan (1942), Bell, Owen, and Larson (1955), and Owen, *et al.* (1955). Jellison, *et al.* (1961) separated North American isolates of *P. tularensis* from nature into two major groups on the basis of virulence, reservoir host, seasonal distribution, and geographical occurrence: (1) tick-borne tularemia of rabbits, and (2) water-borne tularemia of rodents. Both groups are known to occur in Utah (Woodbury, 1955; Jellison, Kohls, and Philip, 1951).

Tularemia in Utah was first recognized by Pearse (1911). Francis (1919, 1921, 1929, 1937) listed numerous cases of human infection, but it was not until 1937 that the disease was sufficiently recognized by Utah physicians to accurately report its occurrence to state health authorities (Woodbury, 1955). The Utah State Department of Health reported 839 human cases of tularemia from 1937 to 1964, of which 26 were fatal (Thompson and Wright, 1964; Wright, 1965). During this period, 136 cases were attributed directly or indirectly to deer flies (Jenkins, 1965); 14 occurred in Utah County. The seasonal incidence of tularemia in Utah for a 17-year period coincides with the seasonal distribution of deer flies (Woodbury, 1955).

Tularemia in Utah was initially referred to as "deer-fly fever" when Pearse (1911) associated the deer fly *Chrysops discalis* with its transmission. Francis (1919, 1921), while investigating a disease of unknown etiology in Utah, recognized "deer-fly fever," isolated the pathogen, and named the disease tularemia. Although deer flies have not heretofore been found infected with tularemia in nature (Jellison, 1950). Francis and Mayne (1921) demonstrated that female *C. discalis* could be experimentally infected and were capable of transmitting the disease to laboratory animals. *Chrysops noctifer* has also been implicated experimentally as a mechanical vector of tularemia (Parker, 1933). Although only two species in the United States have been shown to be experimental vectors of the disease, Philip (1931) stated that other deer flies probably were capable of mechanical transfer of tularemia.

Jellison and Parker (1944) concluded that the primary reservoir of tularemia was rabbits, and Burroughs, *et al.* (1945) listed animals of 28 species as natural hosts of tularemia in the United States. Tularemia has been found in 33 mammal and 34 bird species in the Great Salt Lake Desert region of Utah (Bodé, 1963), but Marchette, *et al.* (1961) concluded that tularemia in this region is primarily a disease of jack rabbits. Thirty-two of the mammal and 33 of the bird species listed by Bodé (1963) are known to occur in the Utah Lake area (Bee, 1947; Woodbury, Cottam, and Sugden, 1949; Durrant, 1962; Berrett, 1958; Hayward, 1965).

Correlation of the geographical distribution of human tularemia infections with the distribution of *Chrysops discalis* was shown by Jellison (1950). He concluded that although no infected deer flies had been found in nature and none had been found feeding on rabbits, circumstantial evidence indicated that *C. discalis* must be accepted as a vector of tularemia. Roth, Lindquist, and Mote (1952) subsequently observed deer flies biting the ears of wild rabbits.

Deer flies are placed taxonomically in the subfamily Pangoniinae of the family Tabanidae. The monograph of Brennan (1935) and catalog of Philip (1947) with its supplement (1950) summarize the present taxonomy of the Nearctic Pangoniinae and Tabanidae. The Pangoniinae of Utah were described by Rowe and Knowlton (1936). Lewis (1949) listed the taxonomy of the Tabanidae of Salt Lake County, Utah.

Distributional records of deer flies in Utah have been published by Knowlton and Thatcher (1934), Philip (1947, 1950), and Middlekauff (1950). *Chrysops fulvaster*, *C. aestuans*, and *C. discalis* were listed by Rowe and Knowlton (1936) as the common species of deer flies in salt-marsh areas of Utah.

The biology and ecology of deer flies in the western United States and Canada have been studied by Cameron (1926), Gjullin and Mote (1945), Roth and Lindquist (1948), Lewis (1949), and Roth, Lindquist, and Mote (1952).

Methods and Procedures

Eleven collecting sites in the environs of Utah Lake were chosen following an initial survey in April, 1964. Selection was made on the basis of plant association, larval habitat, and geographical location. Locations of the sites are shown in Figure 1, and a brief description of each follows:[3]

1. Orem Quadrangle, R. 2 E. x T. 6 S., Section 28, west center of section, elevation 4,500 feet. Station located 300 yards south-southwest of Orem City Sewage Disposal Plant and end of Powell Slough access road of the Utah Department of Fish and Game. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs and ponds.
2. Saratoga Springs Quadrangle, R. 1 W. x T. 5 S., Section 25, southeast corner of section, elevation 4,500 feet. Station located 50 yards south of Saratoga Springs resort swimming pools. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs and ponds.
3. Pelican Point Quadrangle, R. 1 E. x T .6 S., Section 32, west center of section, elevation 4,500 feet. Station located 0.9 mile south-southwest of Pelican Point pumping station. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs and drainage.

3. Topographical description of these sites was taken from United States Geological Survey Topographical Maps, 7.5 minute series, scale 1:24,000.

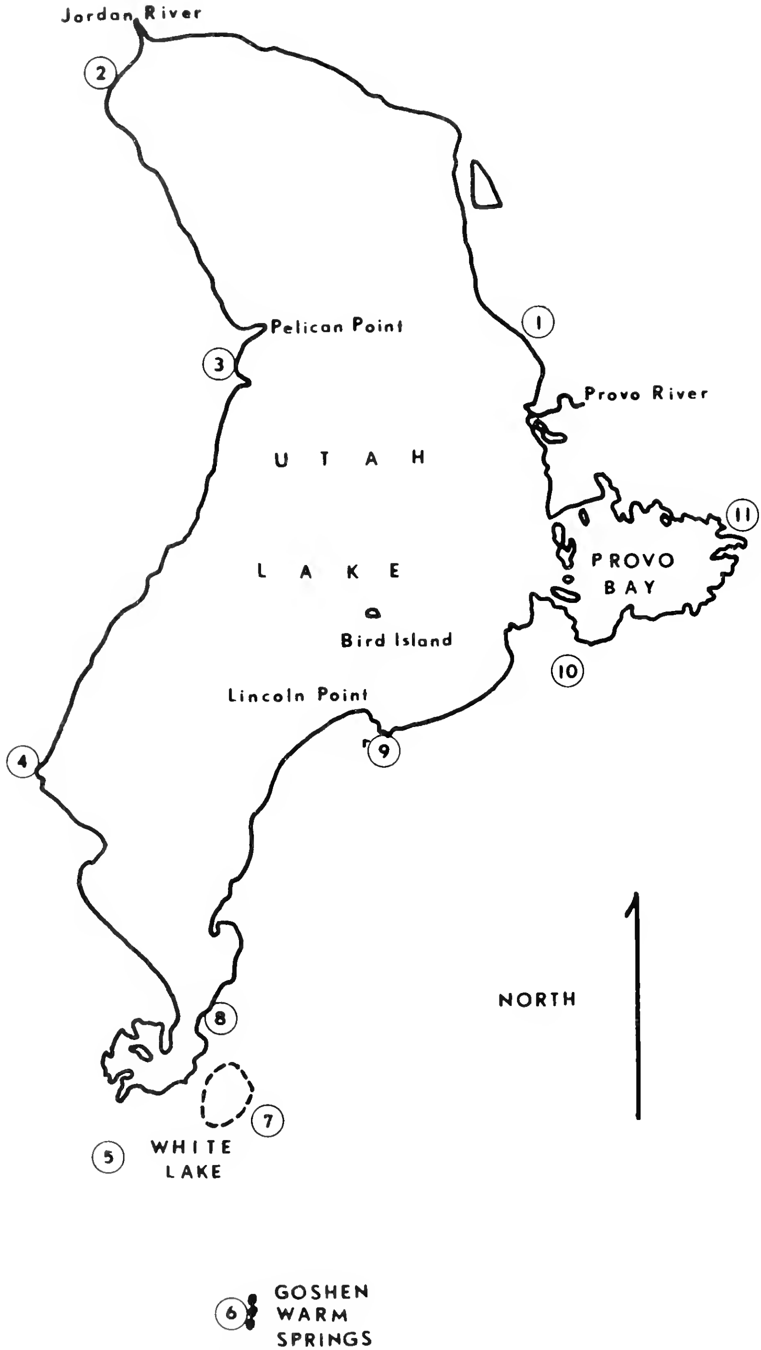

Fig. 1. Deer fly collection sites in the environs of Utah Lake, Utah.

4. Soldiers Pass Quadrangle, R. 1 W. x T. 8 S., Section 9, southeast corner of section, elevation 4,500 feet. Station located 1.1 miles southeast of Clyde Knoll. *Scirpus* spp. and *Distichlis* sp. present. Intermittant backwater of lake, no fresh-water springs.
5. Goshen Valley North Quadrangle, R. 1 W. x T. 9 S., Section 26, center of section, elevation 4,490 feet. Station located 3.5 miles north-northwest of Goshen school. *Scirpus* spp. and *Distichlis* sp. present. Intermittant fresh-water drainage stream.
6. Santaquin Quadrangle, R. 1 E. x T. 10 S., Section 8, west center of section, elevation 4,520 feet. Station located at Goshen Warm Springs. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs and ponds.
7. West Mountain Quadrangle, R. 1 E. x T. 9 S., Section 17, north center of section, elevation 4,500 feet. Station located 2.2 miles west of West Mountain peak, VABM 6904, and end of Lebaron Site access road of Utah Department of Fish and Game. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs and ponds.
8. West Mountain Quadrangle, R. 1 E. x T. 9 S., Section 20, east center of section, elevation 4,500 feet. Station located 2.1 miles west-northwest of Kiegley on east border of White Lake. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs, small ponds and drainage.
9. Lincoln Point Quadrangle, R. 1 E. x T. 8 S., Section 11, center of section, elevation 4,490 feet. Station located 0.7 mile south-southeast of Lincoln Point benchmark BM 4526, near mouth of Benjamin Slough. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water slough, springs, small ponds and drainage.
10. Provo Quadrangle, R. 2 E. x T. 8 S., Section 4, north center of section, elevation 4,500 feet. Station located 0.3 mile north of intersection of highway U 228 and Springville road. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs, drainage and standing roadside water.
11. Provo Quadrangle, R. 3 E. x T. 7 S., Section 17, west center of section, elevation 4,500 feet. Station located 100 yards west of General Offices, Pacific States Cast Iron Pipe Company. *Scirpus* spp. and *Distichlis* sp. present. Fresh-water springs, ponds, drainage and small stream.

Each site was visited for a one-hour period between 9 a.m. and 2 p.m. every two weeks from May through October. Collections were made on three consecutive days: Sites 1-4 were visited one day, Sites 5-8 the following day, and Sites 9-11 the succeeding day, alternating the hours of visitation of the areas collected on any given day. Adult female deer flies were attracted to me as I walked briskly through each area in a systematic pattern, stopping for several minutes every ten paces. As the attracted flies rose to attack or alighted on me, they were captured with an aerial insect net. Flies were frequently attracted to my automobile and were taken from its metal surfaces. Attempts at aerial capture of hovering flies or sweeping of vegetation proved futile. Captured flies were placed in an ethyl acetate killing jar.

After collections were completed at each site, the deer flies were removed from the killing jar and identified. The specimens were separated to species, thoroughly washed in sterile physiological saline solution, and put into four-dram screw-cap vials containing sterile. non-fat skim milk solution. Each vial was labelled externally with collection data, and frozen and stored at -30 C for subsequent bacteriological testing for the tularemia pathogen. Collection and other appropriate data were recorded for each site and collection. Temperature data were obtained from United States Department of Commerce Weather Bureau Climatological Data reports for Utah Lake, taken at Lehi, Utah.

Bacteriological investigations were conducted at the Epizoology Research Laboratory, Institute of Biological Environmental Research, University of Utah, Salt Lake City. Frozen deer flies were thawed and triturated in a mortar and pestal. Sterile, non-fat skim milk was added when required to insure sufficient innocula. Seventy-three pools were prepared, each containing not more than 15 flies of the same species, separated by area and date of collection. The supernatant from each pool was innoculated into one adult Hartley strain guinea pig and four adult Swiss-Webster strain white mice. Intraperitoneal injections of 1.0 cc per guinea pig and 0.5 cc per white mouse were given. Injected animals were caged and observed twice daily for a period of 28 days. Dead animals were removed on discovery, placed into separate containers, and stored at -30 C to await subsequent processing. Animals found dead within 24 hours after innoculation were discarded.

Aseptic necropsy procedures were used in the examination and processing of the dead animals. Each carcass was swabbed with 70 percent ethyl alcohol, the outer skin peeled back, and the thoracic and peritoneal cavities exposed. The gross pathology of the spleen and liver was noted, particularly for the swelling and mottling characteristic of tularemia infections. Sections of the spleen and liver were removed and plated on culture medium. After plating, the tissues were put into sterile vials and frozen for subsequent use. The culture medium used in testing for the tularemia pathogen was blood cystine heart agar (BCHA). It was prepared by dissolving 51 g of Difco Cystine Heart Agar (B47) in 950 ml of distilled water by heating in an 80 C water bath, adjusting to pH 7, autoclaving, and adding 50 cc of outdated, citrated human blood after cooling to 50 C in a water bath.

The plated BCHA media were incubated for 48 hours at 37 C and examined for characteristic colony growth. Typical colonies were subjected to Gram stain for determination of morphology and stain reaction. Slide agglutination tests were made on cultures demonstrating characteristic colony growth, morphology, and stain reaction. A slide agglutination titer of 1:80 or higher with complete agglutination was considered positive. Plates with positive slide agglutination test results, typical growth colonies, characteristic morphology, and Gram negative reaction were considered positive for *Pasteurella tularensis*.

Immediately after identification of the pathogen, the original tissue samples composing the positive isolation were examined and the pathogen reisolated from the infected tissues, confirming the initial isolation. Determination of the LD_{50} was made by testing various dilutions of the positive isolates in mice, rats, guinea pigs, and rabbits. Maximum virulence was established as an LD_{50} of nine organisms or less for the test animals used. Test animals surviving the 28-day observation period were bled and the sera collected. The sera were subjected to a standard tube agglutination test for tularemia, using a known positive of 1:640 titer as a control. Final identification of *Pasteurella tularensis* was made on the basis of typical colony characteristics, morphology, animal pathogenicity, pathology, and slide agglutination test reactions.

Results

A total of 823 deer flies representing three spices was collected during this study (Table 1). Of the total number taken, 97.8 percent were *Chrysops fulvaster* van der Wulp, 1.92 percent were *C. aestuans* Osten Sacken, and 0.24 percent were *C. discalis* Williston. *Chrysops fulvaster* was collected from ten, *C. aestuans* from seven, and *C. discalis* from two sites. The greatest population occurred during the

Table 1. Distribution of deer flies by species, site, and collection period.

		Collection Period								
Site	Species[1]	June 14-June 27	June 28-July 11	July 12-July 25	July 26-Aug. 8	Aug. 9-Aug. 22	Aug. 23-Sept. 5	Sept. 6-Sept. 19	Sept. 20-Oct. 3	Site Total
1	Cf	1	8	60	2					71
2	Cf	2	6	28	56	2				94
	Ca			1	3					4
3	Cf		1	6	30	1				38
	Ca				1					1
4				None observed						
5	Cf				4					4
6	Cf	1	4	27	21	1	3			57
	Ca			1	1					2
7	Cf	2	4	43	114	102	17	11	1	294
	Cd				1					1
8	Cf	3	29	15	35	15	1	1		99
9	Cf	2	5	11	1					19
	Ca				1					1
10	Cf	3	9	14	5					31
	Ca			5	1					6
	Cd				1					1
11	Cf	1	7	68	22					98
	Ca		2							2
Totals	Cf	15	73	272	290	121	21	12	1	805
	Ca		2	7	7					16
	Cd				2					2

[1]Cf = *Chrysops fulvaster*, Ca = *Chrysops aestuans*, Cd = *Chrysops discalis*.

July 26-August 8 period. Female deer flies first appeared during the June 14-June 27 period, approximately one month after the last freezing temperature in May. Greatest populations coincided with weekly average maximum temperatures of 75 F or higher (Fig. 2). Deer flies were not observed after the September 20-October 3 period when temperatures of 32 F or below occurred. Positive thermotaxic response was noted for *C. fulvaster*.

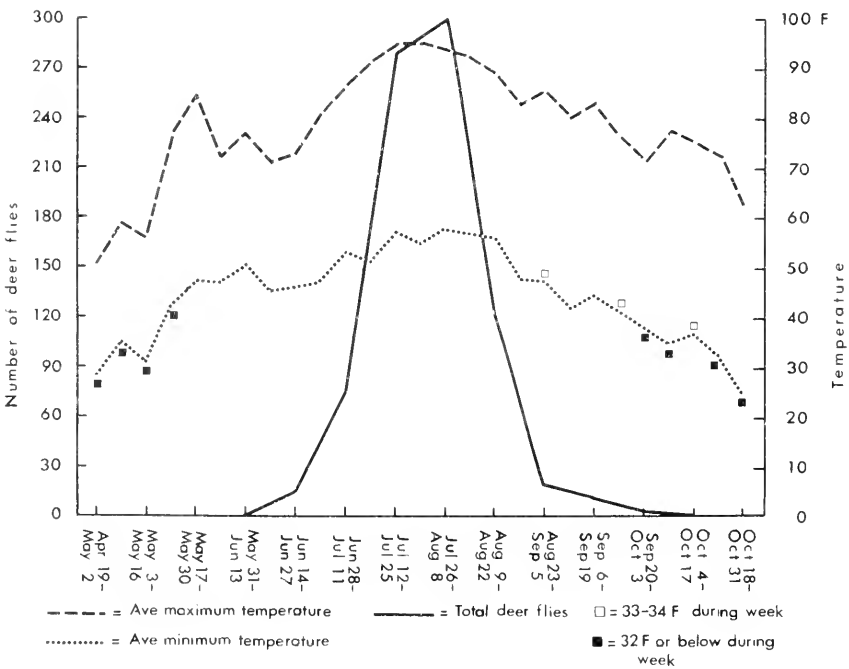

Fig. 2. Total numbers of deer flies captured each two-week period and weekly average maximum and minimum temperatures.

Sera tube agglutination tests of laboratory animals surviving the 28-day observation period were negative. Gross pathology was inconsistent. *Pasteurella tularensis* of maximum virulence was isolated from three of 73 pools tested. Isolations were made from one pool of five *Chrysops fulvaster* collected at Site 9, Lincoln Beach, on July 3, one pool of three *C. aestuans* collected at Site 2, Saratoga Springs, on July 27, and one pool of four *C. fulvaster* collected at Site 5, Goshen, on July 29 (Table 2). Slide agglutination tests of isolated and reisolated pathogen organisms demonstrated a titer of 1:80 or higher. Virulence tests of the isolates resulted in an LD_{50} of 10^0 (1 to 9 organisms).

Table 2. Isolation of *Pasteurella tularensis* from deer flies.

Pool no.	Deer fly species	Date collected	Site no.	No. flies in pool	Death day[1]	Virulence LD_{50}
2D2	*Chrysops aestuans*	July 27	2	3	6	10^0[2]
5D	*Chrysops fulvaster*	July 29	5	4	5	10^0
9B	*Chrysops fulvaster*	July 3	9	5	4	10^0

[1]Day of death of laboratory animal following injection for initial isolation.
[2]Nine or less organisms causing death.

Discussion

Occurrence and Distribution of Deer Flies

The three species of deer flies collected during this study, *Chrysops aestuans*, *C. discalis*, and *C. fulvaster*, were previously noted in the Utah Lake area by Knowlton and Thatcher (1934), and were listed by Rowe and Knowlton (1936) as those most common to salt-marsh areas in Utah. Other species have been listed for Utah from widely separated geographical areas and varied habitats, but the extent of their distribution in the state is largely unknown (Knowlton and Thatcher, 1934; Rowe and Knowlton, 1936; Philip, 1947, 1950; Middlekauff, 1950). One record of *Chrysops lupus* Whitney was listed for Provo by Knowlton and Thatcher (1934), but no subsequent collections of this species have been reported in this area.

The period of activity of the deer flies in this study corresponds with the observations of Gjullin and Mote (1945) at Summer Lake, Oregon, who noted that deer flies were active from the middle of June to the first part of September. Roth and Lindquist (1948) noted that the peak abundance of flies for a two-year period occurred during the last part of July and the first part of August. Cameron (1926) noted activity of *C. aestuans* from the first part of June into July.

The seasonal occurrence of the flies collected during this study showed variation with different species. The flies first observed were

C. fulvaster on June 24. These were subsequently taken at various sites until September 26, the peak abundance occurring during the July 26-August 8 period. The limited number of *C. aestuans* collected precludes conclusions as to their seasonal occurrence and distribution, but their activity during June and July corresponds with the observations of Cameron (1926). Comparative numbers of *C. aestuans* and *C. fulvaster* collected in this study support the contention of Rowe and Knowlton (1936) that *C. aestuans* is often taken with *C. fulvaster* but is less abundant. Insufficient collections of *C. discalis* preclude any conclusion on its activity other than that it was present in the study area. Its absence in habitats with which it is usually associated suggests that some factor or combination of factors resulted in the minimal number noted in this study.

The most abundant species, *C. fulvaster*, was collected at all sites at which activity was noted (Table 1), which suggests that the conditions at these sites were favorable for this species. *Chrysops aestuans* was taken at six sites. Its presence at some sites and absence from others of almost identical habitat is unexplained other than that the species is not abundant in the study area, as noted by Rowe and Knowlton (1936). *Chrysops discalis* was coptured at two sites. No explanation is offered as to the scarcity of this species in typical habitat sites in the study area other than that extrinsic factors may have reduced its numbers.

The daily activity of deer flies between 9 a.m. and 2 p.m. corresponds with that noted by Roth and Linquist (1948) and Roth *et al.* (1952). The period of activity may be attributed to warming of cool morning air to an optimum temperature. Few flies were active between 2 p.m. and 5 p.m., but a slight increase was noted at dusk. Little activity was observed during periods of strong wind, regardless of time of day.

The positive thermotaxic response to the metal surfaces of my automobile when stationary in open sunlight, particularly during early morning hours, as noted for *Chrysops fulvaster*, is similar to that observed for *C. aestuans* by Cameron (1926) and for *C. discalis* by Lewis (1949).

Factors Affecting Deer Fly Populations

Deer flies are associated by oviposition with particular plants. In studies at Summer Lake, Oregon, oviposition was noted on the sedges *Scirpus americanus* and *S. paludosus* (Gjullin and Mote, 1945; Roth and Lindquist, 1948). Lewis (1949) described oviposition by *C. discalis* on the salt-marsh grass *Distichlis stricta* in Salt Lake County. Cameron (1926) observed oviposition by *C. aestuans* on *Scirpus* sp. and other emergent aquatic plants. The major criterion for the selection of collection sites in this study was the presence of *Scirpus* sp. and *Distichlis* sp., although such factors as water source and area, larval habitat, and geographical location also were considered. No flies were observed at Site 4 even though it possessed the plant species usually associated with deer flies. Although Roth and Lindquist (1948) encountered flies up to two miles from breeding areas, the absence of flies from an area with typical associated plant species suggests that other factors may be essential for deer fly populations. All collecting sites except Site 4 were characterized by fresh-water springs, ponds, or drainage. The water at Site 4 was brackish, intermittent backwater of Utah Lake, with a sand and gravel bottom. The water sources at all other sites varied in size, but all drained alkaline soil, and the bottom of the water area was covered with thick, black muck, rich in organic debris typical of lentic habitats. The abundance of deer flies in these areas substantiates findings in their life history by Philip (1931) and Roth and Lindquist (1948) who discovered larvae and pupae in similar habitats. Philip (1931) described larval habitats of deer flies and associated *C. aestuans* with lentic conditions, and *C. fulvaster* with both lotic and lentic conditions. Lewis (1949) found *C. discalis* in brackish, alkaline ponds in lentic associations. The life cycle and abundance of deer flies appears to be dependent upon proper larval and pupal habitats as well as particular plant species for oviposition. The absence of flies at one site where appropriate plant species were present but where proper water habitat and larval and pupal environments were missing, supports this allegation.

The size of the breeding area may influence deer fly populations. Except for Site 4, all sites had alkaline drainage and bodies of water of various sizes. Sites 1, 6, 7, and 8 had very large water areas, and a comparison of the number and extent of deer fly collections at these sites (Table 1) reveals that all except Site 1 were characterized by large numbers of flies, an activity period of long duration, and a near normal curve of fly activity during the study period. Sites 3, 9, 10, and 11 had relatively small water areas, and were characterized by increasing numbers of flies until the July 26-August 8 period when the activity decreased abruptly, and then ceased entirely by the August 9-August 22 period. At Site 5, where a small intermittent stream drained an alkaline meadow, there was no activity during the study except for the July 26-August 8 period when large amounts of water were present and overflowed the stream into the adjacent meadow. The flies captured at this site may have been transients from nearby areas. Comparison of the number and activity of deer flies with the size of the water area and type of drainage indicates a correlation between the two factors.

Comparison of the number of deer flies collected each two-week period and the average weekly maximum and minimum temperatures (Fig. 2) suggests a relationship between temperature and deer fly activity. The weekly average maximum temperature rose to approximately 70° F before initial deer fly activity was observed, and maximum activity was noted when the weekly average maximum temperatures were 75° F or higher. This agrees with the findings of Roth *et al.* (1952) who observed greater activity of *C. discalis* when the temperature was above 75° F, and Davies (1959) who noted that peak abundance of *Chrysops* spp. occurred when the maximum temperature rose to 80° F, especially when this temperature was several degrees higher than the maximum of the preceding few days. The activity of the flies dropped sharply when the first near-freezing temperatures occurred during the week of August 23-29, and activity ceased with freezing temperatures during the last weeks of September. Freezing temperatures in the weeks of April 19 to May 9 may account for the minimal collections of *C. discalis* in this study. According to the observations of Lewis (1949), this species is normally active from April to September. If adult flies had emerged and were active as described, the freezing temperatures of April and May would have killed most of the emergent flies, and only those surviving or emerging after the freezing temperatures would have been present during this study. *Chrysops fulvaster* and *C. aestuans* apparently were not affected by the freezing spring temperatures, suggesting that these species emerge later than *C. discalis.* The sharp decline in activity at some sites when temperatures near 100° F occurred during the last three days of July agrees with the findings of Jamnback and Wall (1959) who observed that extended periods of high temperatures resulted in a sharp decrease in deer fly activity. The gradual decrease in activity at Sites 6, 7, and 8 may have resulted from an insulating effect of the large water areas at these sites and offered some protection from the effects of high temperature.

Deer fly activity at Site 1, where extensive water area, alkaline drainage, and associated plant species were present, declined abruptly after aerial spraying for mosquito control on July 27. A total of 68 *Chrysops fulvaster* had been collected at Powell Slough during the previous collecting period, but on the day of spraying only two specimens were taken, and none thereafter. The Utah County Health Department entomologist (Davis, 1965) revealed that the spray used was Parathion, applied at one pound per acre in an oil emulsion, and that spraying also had been done in the areas of Sites 1, 2, 9, and 11 during May and the first week in June. The effect of the May and June insecticide applications on *C. fulvaster* and *C. aestuans* is unknown, since no activity was noted for these species until later in June and July, several weeks after spraying. If the seasonal dynamics of *C. discalis* in the study area were similar to the activity noted by Lewis (1949), the May and June applications of insecticide may well account for the small numbers of this species collected during this study. The apparent complete absence of deer flies following the July 27 application of insecticide suggests that aerial spraying may effectively control adult female deer fly populations.

The species occurrence and geographical distribution of deer flies observed in this study may be related to several factors. Even though the 11 collecting sites in the environs of Utah Lake were selected on the basis of specific plant associations, larval habitat, and general environment similar to those noted by previous workers (Cameron, 1926; Gjullin and Mote, 1945; Roth and Lindquist, 1948; Lewis, 1949; Roth *et al.*, 1952), the sites may not have possessed habitats favorable to all species of deer flies. In order to insure as large a number of deer flies as possible for subsequent bacteriological examination, sites with apparent atypical habitats were not selected. An attempt was made to collect from a variety of habitats and to encompass the periphery of the lake and its environs. When possible, sites were selected on the basis of their proximity to areas of human habitation, agriculture and recreation. Collections from additional sites were limited by time, methods, and transportation requirements.

Isolation of Tularemia Pathogens

The isolation of *Pasteurella tularensis* from three pools of flies containing *Chrysops fulvaster* and *C. aestuans* substantiates the conclusion of Philip (1931) that deer flies other than *C. discalis* and *C. noctifer*, which had been implicated as mechanical vectors in laboratory experiments (Francis and Mayne, 1921; Parker, 1933), may be involved as vectors of tularemia. Pathogens were found in flies during the time of greatest fly populations and seasonal period when the greatest numbers of human tularemia cases were recorded over a 17-year period in Utah (Woodbury, 1955). Pathogens were also found in deer flies taken during an earlier period when fly populations were small, but well within the seasonal period of highest incidence in humans as noted by Woodbury (1955). The correlation of deer fly populations observed during this study with the seasonal incidence of human infections strongly implies that deer flies are a major source of human infections in Utah. Utah State Department of Health statistics list 136 of 839 cases of human infections as being directly or indirectly associated with deer flies, but 703 reports did not state the source of infection (Jenkins, 1965). It is possible that many of the unstated cases could be attributed to deer flies.

The geographical distribution of the infected flies does not show a significant pattern, although the distribution suggests that an endemic tularemia focus may be located at the southern end of Utah Lake.

The presence of a highly virulent strain of the pathogen indicates that a natural reservoir exists among the native fauna. Whether such reservoir animals are resistant to the strain is not known. No evidence of an epizootic was observed during the study in any of the areas, although many of the animal species known to be infected with tularemia in Utah (Bodé, 1963) are known to occur in the Utah Lake area (Bee, 1947; Woodbury *et al.*, 1949; Durrant, 1952; Berrett, 1958; Hayward, 1965). Rodents and lagomorphs were occasionally observed in collecting areas, particularly near Site 2, where large numbers of squirrels were present at a garbage dump adjacent to a resort.

Although it is possible that only three of 823 deer flies were infected, the isolation of the pathogen from deer flies is medically significant. Previous implications of deer flies as mechanical vectors of tularemia have been based on the results of experimental evidence for two species, *C. discalis* and *C. noctifer* (Francis and Mayne, 1921; Parker, 1933), and to this time no infected flies have been taken in nature (Francis and Mayne, 1921; Jellison, 1950). It has been assumed on the basis of circumstantial evidence (Jellison, 1950), that deer flies are responsible for the transmission of tularemia to humans. Tularemia has been found in rodents, lagomorphs, and other vertebrates (Burroughs *et al.*, 1945; Bodé, 1963); deer flies have been observed biting rabbits (Roth and Lindquist, 1948) and have been associated with human tularemia infections (Pearse, 1911; Francis, 1919, 1929; Jellison, 1950; Jenkins, 1965); and now to complete the chain of infection, *Pasteurella tularensis* has been found in deer flies in nature.

Recommendations for Further Study

The isolation of tularemia pathogens from deer flies in areas where human infection is probable is significant, and on this basis additional studies should be undertaken. Suggestions for further investigation arising from this study are:

(1) A comprehensive study should be made of a wide selection of habitats and geographical areas over several years to determine the occurrence, distribution, and seasonal dynamics of all the species of biting flies in the environs of Utah Lake.

(2) An extensive investigation of deer flies should be made to determine the time, place, and duration of infection by *Pasteurella tularensis.*

(3) An investigation of the pathogen isolates should be made to determine the strains present and their virulence.

(4) A comprehensive study of the potential reservoir animals in the environs of Utah Lake should be made to determine species, populations, distribution, and seasonal occurrence of the animals, and the incidence and virulence of tularemia in the native fauna.

(5) An investigation of the human population in the environs of Utah Lake should be made to determine the extent of clinical and subclinical infections.

Summary and Conclusions

On the basis of this study the following data are presented:

1. A total of 823 adult female deer flies representing three species was collected during the spring, summer, and autumn of 1964 from 11 collecting sites in the environs of Utah Lake, Utah. *Chrysops fulvaster* was the most abundant, *Chrysops aestuans* the next, and *Chrysops discalis* the least abundant.
2. Deer flies were found only in areas with fresh-water springs, ponds, or drainage.
3. Deer flies appeared approximately one month after the last freezing temperatures in May, and disappeared after the first freezing temperatures in September. Maximum activity of

the flies occurred between July 26 and August 8 when the weekly average maximum temperature was 75° F or higher.

4. The abundance of deer flies appeared to be dependent upon the size of breeding areas, typical larval habitats, and the presence of particular plant species.
5. Positive thermotaxic response was noted for *Chrysops fulvaster*.
6. The causative agent of tularemia, *Pasteurella tularensis*, was isolated from three of 73 pools of deer flies. Isolation was made from one pool of five *Chrysops fulvaster* collected at Lincoln Beach on July 3, one pool of three *C. aestuans* collected at Saratoga Springs on July 27, and one pool of four *C. fulvaster* collected at Goshen on July 29.
7. The presence of tularemia pathogens in deer flies near areas of human habitation, agriculture, and recreation in the environs of Utah Lake, Utah, represents a public health threat for which appropriate preventive measures should be taken.
8. Aerial spraying of appropriate insecticides may control adult female deer fly populations.

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THE GENUS *EUPAGIOCERUS* BLANDFORD[1] (SCOLYTIDAE: COLEOPTERA)

Stephen L. Wood[2]

A recent opportunity to study the habits of three species of *Eupagiocerus* Blandford in Central America makes possible the illucidation of the biology of this genus for the first time. Two previously undescribed species are also added to the two previously known in the genus. New synonymy for one species is included.

Eupagiocerus Blandford

Eupagiocerus Blandford, 1896, Biol. Centr.-Amer. 4(6):133.
Nemopagiocerus Schedl, 1962, Mitt. Münchner Ent. Gesellsch. 52:85 (new synonymy).

On the basis of the antennal characters, the entire eye, and the tuft of pleural hair on the prothorax, Schedl (1962:85) erected the genus *Nemopagiocerus* for his *Eupagiocerus nevermanni*. This species and the two described below as new were studied in the field. and all three species were compared to the type of *dentipes* Blandford All three species breed in the pith of woody vines where they have habits that fall well within the limits of the closely allied genus *Cnesinus*. Since those species of *Cnesinus* associated with ambrosial fungi may also have a pleural tuft of setae on the prothorax similar to that of Schedl's *nevermanni*, while those not associated with fungi lack this character, its presence or absence should have no generic significance. The strongly procurved sutures of the antennal club in *clarus*, while more nearly like Schedl's species, are intermediate between *nevermanni* and *dentipes* Blandford. The inner margin of the eye in Schedl's species varies from entire to sinuate, and in *clarus*, *dentipes* and *vastus* from rather strongly sinuate to shallowly emarginate. In view of the small number of species involved and the variability of characters it appears that *Nemopagiocerus* Schedl represents only an unusual form of *Eupagiocerus* Blandford and should be placed in synonymy under the latter name.

Key to the Species of *Eupagiocerus*

1. Sutures one and two of antennal club strongly procurved, with two extending at least to middle of club; second declivital interspace impressed or at least less strongly elevated than either one or three and, except at upper margin, devoid of tubercles 2

1. Field work for this research was made possible by a grant from the National Science Foundation, number GB-532.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Scolytoidea contribution number 27.

Sutures one and two antennal club moderately procurved, with two not extending beyond basal third of club; declivital interspaces equally convex and each bearing a single row of rounded tubercles 3

2. Smaller, 2.1-2.6 mm.; discal interspaces strongly convex posteriorly, almost as high as wide at upper margin of declivity, each elevation ending posteriorly as a small sharply pointed spine, a row of similar pointed tubercles continuing down each declivital interspaces (except two); Costa Rica to Venezuela and Peru .... *ater*

Larger 2.6-3.0 mm.; discal interspaces moderately convex, not ending abruptly posteriorly; second declivital interspace and perhaps lower part of third, somewhat impressed or flat and devoid of tubercles; declivital tubercles small, rounded; Panama .... *clarus*

3. Elytral striae narrowly impressed, the punctures obscure; interspaces smooth and shining; declivital granuals more sparsely placed, the vestiture fine, hairlike; pronotal punctures smaller and more closely placed; type 2.8 mm.; Guatemala .... *dentipes*

Elytral striae feebly impressed on disc, rather strongly at base of declivity, the punctures almost obliterated; interspaces finely reticulate, dull; declivital granules more numerous, the vestiture stout, almost scalelike; pronotal punctures larger, close, but less crowded; 3.0-3.8 mm.; Costa Rica .... *vastus*

Eupagiocerus ater Eggers

Eupagiocerus ater Eggers, 1931, Ent. Blätt. 27:14 (Venezuela).

Epagiocerus nevermanni Schedl, 1952, Dusenia 3:350 (Costa Rica) (new synonymy).

Eupagiocerus serratus Wood, 1961, Gt. Basin Nat. 21:104 (Panama) (new synonymy).

Nemopagiocerus nevermanni, Schedl, 1962, Mitt Münchner Ent. Gesellsch. 52:85.

The type of *ater* Eggers (in the Berlin Zoological Museum) was compared by Dr. K. E. Schedl to *nevermanni* Schedl (type?) and to one of my specimens collected Dec. 22, 1963 at Fort Clayton, Panama Canal Zone. According to Schedl (letter dated May 10, 1965) minor differences are apparent in the three specimens, but only one species is represented. The Panama specimen also agrees in all essential characters to the paratype of *serratus* Wood.

A series of this species was collected with the above mentioned Panama specimen from a common vine of the genus *Serjania*. From the entrance hole in a stem 2 cm. in diameter, the tunnels extended directly to the central axis of pith, then extended about one to three centimeters in either direction. The older mines contained larvae in the parental gallery. On the walls of the tunnel grew a thick mat of white cottony fungus mycelium upon which the larvae fed. This fungus could not be seen in galleries that contained only eggs. Additional larval excavations were not apparent.

Eupagiocerus clarus, n. sp.

This species is allied to *ater* Eggers, but is readily distinguished by the larger size, by the more slender body form, by characters of the elytral declivity indicated in the above key, and by other features of the frons and prothorax.

FEMALE.— Length 3.0 mm. (paratypes 2.6-3.0 mm.); 2.3 times as long as wide; body color black.

Frons broadly, evenly convex above and broadly, shallowly concave below level of eye emarginations, the abrupt line of separation extended forward slightly in median area; upper area reticulate, dull below, subshining above; lower areas shallowly, evenly concave between subacute lateral margins to epistomal margin; epistomal margin slightly raised, shining, with a small bilobed process; concave area rather densely, minutely pilose; other vestiture inconspicuous. Eye 2.6 times as long as wide, shallowly emarginate on upper half, depth of deepest point of emargination about equal to diameters of two facets. Antennal scape bearing several coarse setae, evidently shorter than the 7-segmented funicle; club 1.8 times as long as wide, the sutures strongly procurved, one extending to a point one-third length of club from base, two extending three-fifths of club length from base.

Pronotum 1.1 times as wide as long, sides almost straight and parallel on basal half then abruptly narrowed to the broadly rounded anterior margin; surface closely, finely, longitudinally strigose over entire dorsal surface; subshining; glabrous. Hairlike setae in anterior pleural area longer and conspicuous, but not forming a definite tuft as in *ater*.

Elytra 1.4 times as wide as long, sides feebly curved, somewhat narrowly rounded behind; basal margins slightly raised, neither crenulate nor acutely produced; striae narrowly, rather deeply impressed, the punctures very obscurely indicated; interstriae feebly convex anteriorly, moderately so at base of declivity, about three times as wide as striae, the surface reticulate, subshining and with numerous confused, small, shallow punctures. Declivity moderately steep, somewhat flattened between third interspaces; interspace one slightly elevated, uniseriately punctured, with a few punctures bearing small rounded granules, two flat, appearing impressed, with confused fine punctures, three and four convex on upper half and bearing regular rounded tubercles on the convex portion, becoming flattened on lower half and merging into impression of two, five to nine convex and each bearing a row of rounded tubercles. Vestiture scanty, restricted to a few hairlike setae in posterolateral area.

MALE.— Similar to female except frons with transition from convex to concave areas gradual, the concaveity slightly deeper, not pilose, but with a continuous tuftlike row of erect plumose setae on lateral and lower margins, the concave area with rather numerous small hairlike setae.

TYPE LOCALITY.— Rio Viejo, Volcan Chiriqui, Panama.

TYPE MATERIAL.— The female holotype, male allotype and 32 paratypes were collected at the type locality on January 11, 1964, at an elevation of 5500 ft., by S. L. Wood. They were taken from the central axis of a rough-barked vine in stems 2 cm. in diameter or less. The tunnels were similar to those of *vastus;* there was no evidence of an ambrosial fungus.

The holotype, allotype and some paratypes are in my collection; other paratypes are in the U. S. National Museum and in the British Museum (Natural History).

Eupagioceurs vastus, n. sp.

This species is closely allied to *dentipes* Blandford, but is readily separated by characters summarized in the above key.

FEMALE.— Length 3.7 mm. (paratypes 3.0-3.8); 2.1 times as long as wide; color rather dark brown.

Frons flatteened on lower half, feebly convex above, with median third remarkably sculptured; lower half with lateral margins acute and slightly elevated, a narrow marginal and epistomal area irregularly punctured, this area marked dorsally by a transversely elevated low median carina on median third; remaining area of lower half densely pilose; pilose area terminated above by a deep, narrow ventrally procurved groove on slightly more than median third, above the groove a median subhexagonal impunctate area densely very closely reticulate-granulate, a shallow transverse groove near lower margin of hexagonal area; lateral pubescence and median hexagonal area extended to upper level of eyes; dorsal areas head subreticulate and finely shallowly punctured. Eye elongate, shallowly sinuate on inner margin. Antennal scape elongate, about as long as 7-segmented funicle; club narrowly ovate, 1.4 times longer than funicle with two sutures, the first reaching one-fifth of length from base, broadly procurved, the second narrowly, subagnulately procurved reaching two-fifths of length of club from base.

Pronotum very slightly wider than long, base bisinuate, sides on basal half straight deverging anteriorly then narrowed abruptly to a constriction just in front of anterior margin, anterior margin very broadly rounded, submarginate at middle; surface dull, rather closely marked by moderately large elongate punctures, each about twice as long as wide, the punctures much smaller anteriorly and laterally; glabrous. Lateral margins acute on basal two-thirds, pleural areas rather coarsely punctured.

Elytra 1.3 times as long as wide, about 1.3 times as long as pronotum; sides almost straight and parallel on basal half, rather narrowly rounded behind; basal margins bisinuate, slightly elevated, not at all crenulate; scutellum small, round; striae very feebly impressed on disc, somewhat more strongly toward declivity, the punctures, indicated but very feebly impressed; interstriae more than twice as wide as striae, almost flat anteriorly, weakly convex at base of declivity, surface dull, densely, microscopically punctured (visible at a magnification of 80 diameters) and also finely closely, confusedly punctured, with about 4 to 6 punctures across the width of an interspace. Declivity moderately steep, convex, the surface (including strial area) closely reticulate-granulate, each interspace bearing a median row of small but high, rounded granules, each granule as high as wide and spaced by distances about equal to distance between rows of granules. Vestiture, consisting of rows of erect bristles, each arising from base of a granule, and forming a median row on each interspace, each bristle almost as long as distance between rows; and irregular rows of shorter bristles about half as long as median ones, located on each side of median row. Ninth interspace subacutely elevated.

MALE.— Frons subconcavely impressed on lower half and densely pilose in impressed area, the special sculpturing absent, otherwise similar to female.

TYPE LOCALITY.— Puerto Viejo, Heredia Province, Costa Rica.

TYPE MATERIAL.— The female holotype, male allotype and 51 paratypes were collected at the type locality on March 12, 1964, from an unknown woody vine 4 to 5 cm. in diameter, by S. L. Wood. From the entrance tunnel the adult beetles constructed linear galleries along the central axis of pith about 2 to 4 cm. The larvae and young adults then extended these somewhat. There was no evidence of fungal growth in the tunnels.

The holotype, allotype and some paratypes are in my collection; other paratypes are in the U. S. National Museum and in the British Museum (Natural History).

NOTE OF PHALANGIDS AT THE NEVADA TEST SITE[1]

Dorald M. Allred[2]

This is another of a series of faunal reports dealing with the ecology of the Nevada Test Site. A description of the biotic communities of the test site was given by Allred, Beck, and Jorgensen (1963), and subsequent publications have dealt with specific animal groups (refer to Beck, *et al.*, 1964, p. 209). The specimens for which the data are reported here were identified by Willis J. Gertsch, American Museum of Natural History, New York. Dr. Gertsch also supplied information on the general distribution of the species.

The Phalangida include the familiar long-legged, spider-like "daddy-long-legs" or "harvestmen" that occur in both temperate and tropical climates. Although a number of species are common in most parts of the United States. relatively little is known of their biology.

Two species are known from the Nevada Test Site. *Eurybunus*

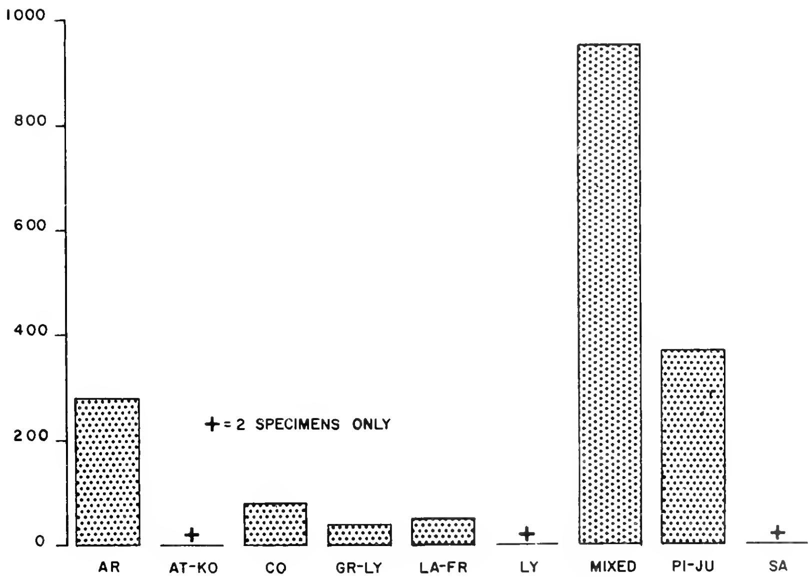

Fig. 1. Relative abundance of *Eurybunus riversi* in nine plant communities at the Nevada Test Site. (AR = *Artemisia tridentata*, AT-KO = *Atriplex confertifolia — Kochia americana*, CO = *Coleogyne ramosissima*, GR-LY = *Grayia spinosa — Lycium andersonii*, LA-FR = *Larrea divaricata — Franseria dumosa*, LY = *Lycium pallidum*, MIXED = other areas of a diversity which does not permit assignment to a specific community, PI-JU = *Pinus monophylla — Juniperus osteosperma*, SA = *Salsola kali*).

1. BYU-AEC Report No. COO-1355-9. Field work completed under AEC Contract No. AT(11-1) 786.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

riversi Goodnight and Goodnight was described from specimens taken near Reno, Nevada, and occurs in the Mojave Desert of California. At the test site, specimens of this species are widely distributed geographically, found in 10 of the 25 areas studied: 1, 4, 5, 6, 10, 12, C, E, J, and T. They are present in all of the plant communities, although they occur only rarely in the Atriplex-Kochia, Lycium. and Salsola communities (Fig. 1). Their seasonal activity is predominantly during the winter months, and only a few were taken during the summer (Fig. 2). At least half of the specimens collected were immature.

Leiobunum townsendi Weed is a common species in the western United States, but at the test site only four specimens were found. These were taken in a Pinyon-Juniper community during July and August. This species likely is more typical of the higher and more northern communities than of the Lower Sonoran and Mojave areas.

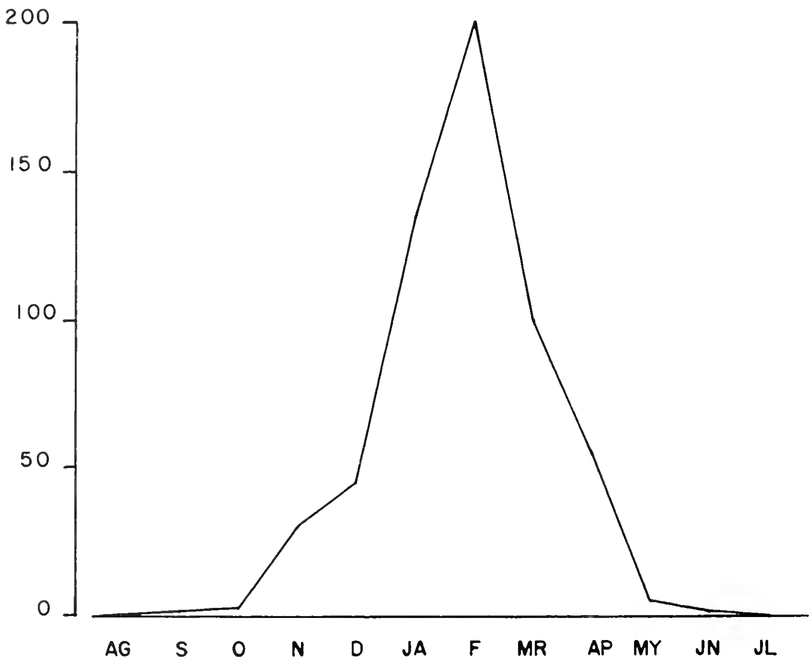

Fig. 2. Seasonal activity of *Eurybunus riversi* based on numbers of individuals taken at the Nevada Test Site.

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A NEW GENUS AND SPECIES IN THE CHILOPOD FAMILY TAMPIYIDAE[1]

Ralph V. Chamberlin[2]

The large family Sogonidae and the family Tampiyidae, both of which were first proposed in 1912, pertain to a larger and apparently homogeneous group of geophilid chilopods forming a characteristic element in the fauna of the northern tropical and subtropical areas of America, but so far unknown from the eastern hemisphere. Representatives of both of the two families mentioned occur in the southern and southwestern United States where their progenitors must have arrived by incursion from the south. As at present known the most readily recognizable characteristic of these chilopods is the possession of a labrum composed of a single piece which is always partially and sometimes completely fused with the clypeus with no indication of sutures setting off the divisions usual in most geophilids. In connection with the labrum there is often developed a more or less pronounced extension of the clypeus caudad in a lobe or process that involves the median section of the labrum which may show degeneration or be entirely replaced. Because of the very small size of most sogonids and the obscure habits of the members of the group as a whole, these animals have been generally overlooked or neglected by most collectors. As a result there undoubtedly remain many new forms to be discovered and new groupings to be defined.

The tampiyids in their superficial appearance contrast with the sogonids in their much larger size and more numerous segments. Of the four genera presently referred to the Tampiyidae two were brought to light in the study of a collection of chilopods from the Nevada Test Site kindly referred to me for identification by Drs. Dorald M. Allred and D Elden Beck, project directors of the Brigham Young University ecology project at the Site. One of these two genera is here first diagnosed; the other one, *Eremorus*, typified by *E. becki*, was previously described (Proc. Biol. Soc. Wash., 76:33-36). The following key will aid in distinguishing the four known genera.

Key to the Genera of Tampiyidae

1. Prosternum armed anteriorly with two stout teeth; last sternite narrow; pleurocoxal pores small, independent, and numerous .... *Tampiya* Chamb.

— Prosternum unarmed; last sternite very broad; pleurocoxal glands composite, opening through one or two large pores on each side 2

1. AEC-BYU Report COO-1355-10. Field work and research conducted under AEC Contracts AT(11-1)786 and AT(11-1)1355 with Brigham Young University, Provo, Utah.

2. Institute of Arachnology, University of Utah, Salt Lake City.

2. Two composite glands and two pores on each side .... *Abatorus* gen. n.
— One composite gland on each side, with a single pore 3
3. Median section of labrum presenting three separate dentate blocks .... *Eremorus* Chamb.
— Median section of labrum bearing teeth in a single unbroken series .... *Ketampa* Chamb.

Abatorus, new genus

Head small, but little longer than broad. Antennae long and filiform, only narrowly separated at base.

Labrum fused at middle with the clypeus, but free laterally; median section with posterior margin convex and bearing a series of teeth; the lateral pieces not dentate or fimbriate.

First maxillae with coxae forming a coxosternum; palpus typically thick, distally rounded and setose. Second maxillae with coxae united at middle by a membrane; palpus ending in a stout claw and bearing coarse setae.

Prehensors when closed not surpassing the anterior margin of head, all joints unarmed. Prosternum with pleurosternal suture long, extending to antero-ectal corner on each side; the sclerotic line or raphe strongly developed and complete; anterior margin smooth, unarmed.

Ventral pores present in a transverse band.

Last sternite very broad, trapeziform. The pleurocoxal glands composite, two glands and pores on each side, concealed beneath border of the sternite.

No terminal pores.

In the male the legs are long and crassate excepting the tarsal articles; tarsus biarticulate, bearing a stout unguiform pretarsus. Type species: *Abatorus allredi*, new species.

Abatorus allredi, new species

Head small, slightly longer than broad (cir. 10:9), of form shown in Fig. 1, with no frontal suture. Antennae long and slenderly narrowing distad; the terminal article with a subelliptic planate or slightly depressed area nearly as long as the article; this area clothed densely with short sensory hairs; similar but smaller areas on the two preceding articles which taken together somewhat exceed the ultimate in length.

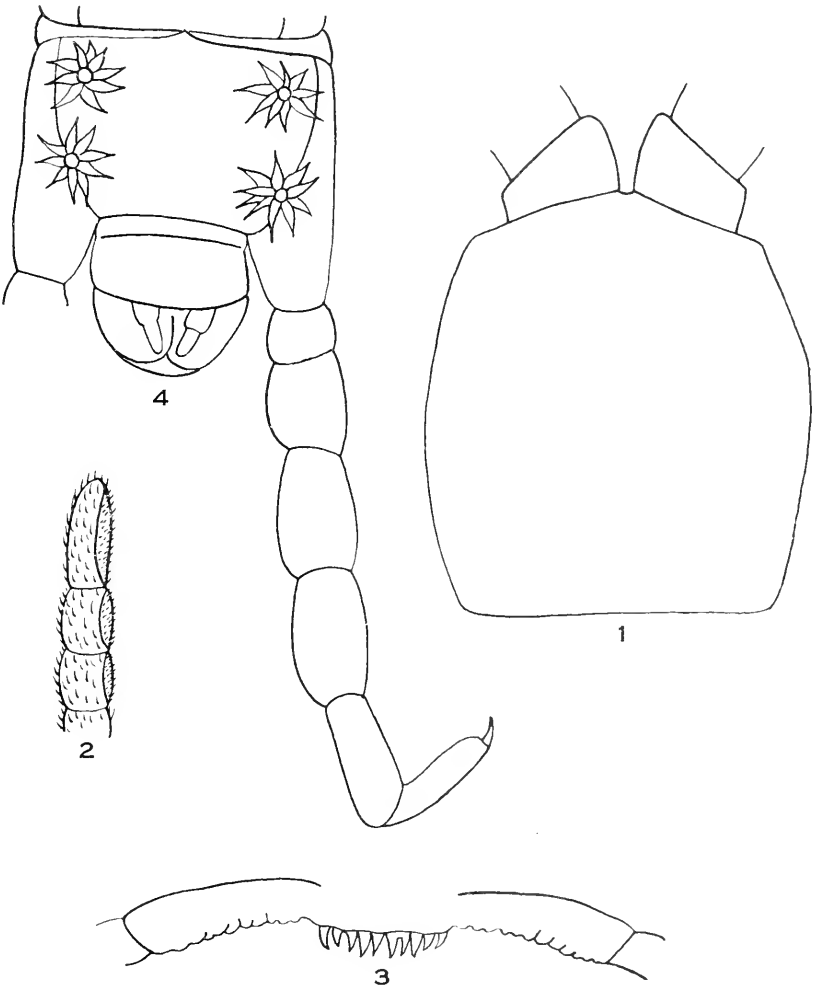
Labrum with median section moderately convex and bearing a comb of narrowly acute teeth as shown in Fig. 3; lateral divisions with caudal margin a little irregularly roughened or crenulate.

First maxillae with coxae fused into a coxosternum; inner processes conical; palpus with second or terminal article rounded, bearing numerous coarse setae. Second maxillae with coxae united at middle; palpus bearing at end a straight claw and many coarse setae.

Prehensors short, the claws when closed not surpassing the anterior margin of head; all joints unarmed. Prosternum unarmed; the pleurosternal suture long and extending forward to the antero-ectal corner; sclerotic line strongly developed and essentially complete, ending distally a litte ectad of the condyle.

Ventral pores in a transverse band in front of the caudal margin of the sternite.

Last sternite very broad, trapeziform. Pleurocoxal glands com-



Abatorus allredi, new species. Fig. 1, head in outline. Fig. 2, terminal articles of antennae. Fig. 3, labrum. Fig. 4, caudal end of body, ventral view.

posite, covered by border of sternite as shown in Fig. 4. No terminal pores. Gonopods of male biarticulate. Anal legs of male of form shown in Fig. 4. Pairs of legs 67 or more.

Length: 40-46 mm.

LOCALITIES: Nevada: Nye Co., Nevada Test Site. One male taken Dec. 24, 1961. California: Riverside, Box Springs. Several specimens taken by Dr. Joseph C. Chamberlin, Dec. 1, 1925.

TWO ISOPODS OF THE NEVADA TEST SITE[1]

Dorald M. Allred[2], and Stanley Mulaik[3]

During ecological studies over a four-year period at the Nevada Test Site (Allred, Beck, and Jorgensen, 1963a), 490 isopods of only two species were collected. These were determined by Dr. Stanley Mulaik as representing 381 specimens of *Armadillo arizonicus* (Mulaik) and 109 specimens of *Porcellio laevis* Latrielle. They were collected principally in sunken can traps (described by Allred, Beck and Jorgensen, 1963a) which were operated continuously for at least one year in nine areas representing seven major plant communities. In 19 other areas of the site, cans were operated only for a two-week period during a summer. This resulted in a total of 51,992 can trap-nights over the four-year period.

Armadillo arizonicus

(Tables 1 and 2, Fig. 1)

Isopods of this species were found in seven vegetation types as shown in Table 2. They were most commonly associated with *Lycium pallidum* and least with *Atriplex confertifolia-Kochia americana*. Within some plant communities the concentration of animals was somewhat localized. In the Mixed (Xeric) community the two collecting transects were only 825 feet apart, yet there were more than five times as many isopods taken from one transect than from the other. This same situation also occurred in the Larrea-Franseria, Lycium, and Grayia-Lycium communities. In the latter study area four collecting transects, each 1.5 miles long, ran NE, SE, SW and NW, respectively, from a central point (refer to Allred, *et al.*, 1963a, Fig. 12). Over 88 percent of the isopods taken were found on the NE transect, and 70 percent of the animals on this transect were taken at one collecting station. A similar situation was found in the Lycium study where more than 70 percent of the isopods from one transect were found at two adjacent stations. On the other transect over 40 percent of the animals were taken at one station.

In the total collection of adult isopods the sex ratio was 1:1, but this varied between different plant communities. In the Mixed (Xeric) community the ratio of males to females was 2:1, in the Lycium 3:4, in the Grayia-Lycium 1:2, with slight differences in the other communities.

Seasonally, *A. arizonicus* was active only from May through October (Fig. 1). Highest populations occurred during August for the adults and July through September for immatures. Seasonal appearance of males and females was similar in all communities except in

1. Atomic Energy Commission Report No. COO-1355-4. Field work completed under AEC Contract AT(11-1)786 with Brigham Young University.
2. Department of Zoology and Entomology, Brigham Young University.
3. Department of Zoology, University of Utah.

Table 1. Collection localities* of isopods at the Nevada Test Site, Nye County, Nevada.

Armadillo arizonicus

8 ♂ 15 ♀ 31 im., Study IB, Ground zero 1 to radius of 1.5 mi.
7 ♂ 11 ♀ 9 im., Study 5A, 0.2 mi. E. of Mercury Highway S of Well 5B road.
5 ♂ 9 ♀ 1 im., Study 5CQ, 0.3 mi. E. of Mercury Highway, N of Well 5B road.
34 ♂ 43 ♀ 90 im., Study 5E, 1.1 mi. E. of Mercury Highway, thence 1 mi. S of Well 5B road.
1 ♂, Study 6A, 0.5 mi. S of Well 3B, thence 0.6 mi. E.
2 ♂ 6 ♀ 1 im., Study 10D, 9.5 mi. N. of Well 3B along Groom Lake road, thence 0.5 mi. E.
16 ♂ 14 ♀ 1 im., Study CB, Environs of Cane Springs.
50 ♂ 25 ♀ 2 im., Study JA, 9.3 mi. W. of Mercury along Jackass Flats Highway, thence 1000 ft. SW.

Porcellio laevis

1 im., Study 10B, 9 mi. N. of Well 3B along Groom Lake road, thence 0.4 mi. W.
36 ♂ 58 ♀ 16 im., Study CB, Environs of Cane Springs.

*For specific location refer to Allred, Beck, and Jorgensen, 1963b.

Larrea-Franseria where the males did not appear in the collections until August.

Porcellio laevis
(Table 1, Fig. 2)

All but one of the 109 specimens were taken at Cane Springs in a Mixed (Mesic) plant community. The one exception was taken in a Coleogyne area. Over 90 percent of those at Cane Springs were found at the three adjacent stations closest to a pond.

The ratio of males to females was 1:1.6. Seasonally, highest populations of adult males appeared during August through December, and females during August through October (Fig. 2).

Discussion

It is unusual that so few species of isopods are represented at the test site. It is unlikely that other species, if present, are widely distributed. However, if the isopods tend toward localized and seasonal populations as demonstrated by the two species collected, then other species may exist at the test site in specific areas where we have not done extensive collecting on a year-round basis. Some isopods do not roam about as do *P. laevis* and *A. arizonicus*. Others climb onto plants and may be obtained by sweeping. However, our extensive sweeping of plants for other arthropods has still not yielded isopods other than the two species taken. Furthermore, we collected the entire plant and ground debris of eleven species monthly over a

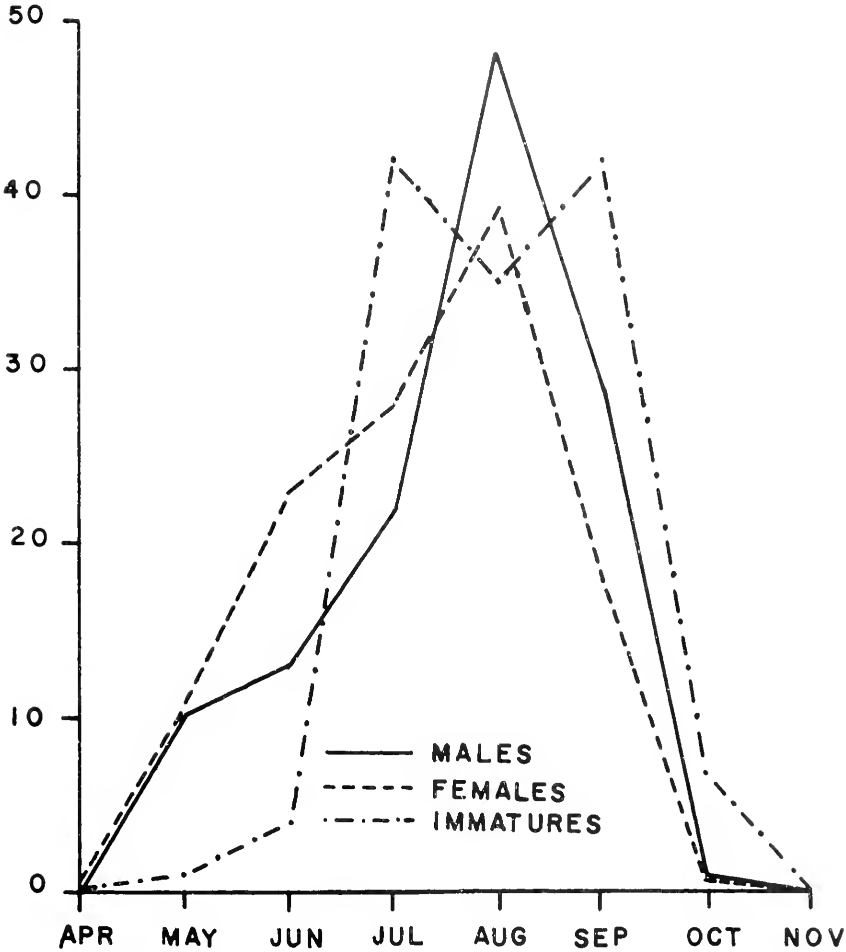


Fig. 1. Seasonal abundance of *Armadillo arizonicus*.

year's period (Allred and Beck, 1964), but not a single isopod was found. In addition to the buried can and other methods of collecting, considerable searching was made for isopods under rocks, fallen trees, and in plant humus. Nevertheless, our relatively limited collecting over the 1,000 square-mile area of the test site and our somewhat selective methods of sampling leave some question as to the complete isopod fauna of the site. It is evident that more specific investigations on the ecology of isopods in desert areas need to be made.

The occurrence of isopods around moist situations such as *P. laevis* at Cane Springs is not surprising. However, large populations of those such as *A. arizonicus* in such xeric habitats are not usually

Table 2. Relative abundance of *Armadillo arizonicus* in several plant communities at the Nevada Test Site.

	Atriplex-Kochia	Coleogyne	Grayia-Lycium	Larrea-Franseria	Lycium	Mixed (Mesic)	Mixed (Xeric)
Actual number collected	1	9	53	42	168	31	77
Relative abundance adjusted by no. of collecting attempts	2	20	53	78	381	53	169

expected. The differences in relative abundance of *A. arizonicus* in different plant communities are difficult to explain on the basis of either plant-food relationships or edaphic factors. Little is known of the feeding preferences of this species of isopod relative to organic debris. Rockiness of the soil and moisture conditions vary considerably between some plant communities at the test site. On the high mesas there are rocky situations and generally a greater degree of moisture which are more conducive to optimum conditions than in the drier valleys. Yet not a single isopod of either species was taken in our mesa studies. In the Lycium area where *A. arizonicus* occurred in greatest abundance there are essentially no surface rocks of a size that would provide suitable habitats for the isopods, and the soil is loose sandy-clay. This area is adjacent to the Frenchman Flat playa which is dry for most of the season. Other than this area *A. arizonicus* was found most abundantly in a Mixed community where the condition is also xeric but large rocks are abundant. In both plant communities the total plant cover is considerably less than in

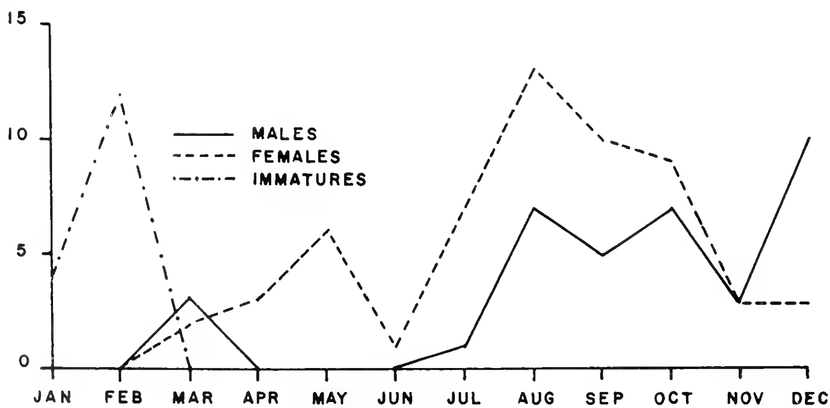


Fig. 2. Seasonal abundance of *Porcellio laevis.*

the Atriplex-Kochia and Coleogyne areas where populations of *A. arizonicus* were lowest. Except for the Grayia-Lycium site each of our study areas was established in areas where the vegetation was considered to be rather uniform. This was confirmed by vegetation analyses made by the line-intercept method.

Apparently there is no plant association which influences the occurrence and abundance of *A. arizonicus.* As far as is known, the edaphic factors within each of the study areas are generally uniform throughout. Further detailed studies are needed, however, to determine why populations of *A. arizonicus* are localized and more abundant around one small area than around another which is apparently similar.

The almost exclusive occurrence of *P. laevis* near a constant water source indicates that it requires a more mesic habitat than does *A. arizonicus.* It is likely that the Cane Springs habitat supplies more decaying, moldy food than is to be found in drier areas on the test site.

The seasonal activity of *A. arizonicus* occurred between May and October when temperatures are highest and rainfall lowest at the test site. On the other hand, *P. laevis* was active every month of the year in an area where moisture was available the year round, but where temperatures varied little from those of the more xeric conditions of the habitats of *A. arizonicus.*

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PRAIRIE FALCON IMITATES FLIGHT PATTERN OF THE LOGGERHEAD SHRIKE

White (Condor, 64, 1962:439-440) stated, "The normal mode of hunting for the prairie falcon is the expected falcon method of a swift direct flight about 30 to 200 feet in the air with a long, low angle stoop at the expected prey." On December 22, 1962, while attempting to trap prairie falcons at the Nevada Atomic Test Site (United States Atomic Energy Commission Contract AT(11-1)786), an unusual hunting method used by two prairie falcons was observed. Instead of hunting in the usual fashion, they left their perches in an undulating flight pattern similar to that of the loggerhead shrike. The hoax was executed so skillfully that the falcons were able to approach within 30 feet of their unsuspecting prey (White-tailed Antelope Squirrels). When the squirrels became alarmed and ran for cover, the falcons promptly returned to their usual onrushing attack to close the remaining distance. No squirrels were captured in this manner, even though six different flights were observed.

Another instance where a falconiform used the flight pattern of an unrelated species was reported by Mavrogordata (A Hawk for the Bush, 1960:4). He observed a European sparrow hawk using the characteristic wing beat of a lapwing to conceal its approach on some feeding starlings. In this instance the behavior was similar in that when the prey became alarmed the predator assumed its usual flight.—Gerald L. Richards, 1939 North 450 West, Provo, Utah.

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UNDESCRIBED SPECIES OF NEARCTIC TIPULIDAE (DIPTERA) VI.

Charles P. Alexander[1]

In the present paper I am describing three species of the genus *Tipula* Linnaeus and a single species of *Limonia* Meigen. All types of the novelties are preserved in my personal collection through the kindness of the individual collectors of the materials, Mr. James H. Baker of Baker, Oregon, Mr. W. E. Simonds of Sacramento, California, and the late Robert R. Dreisbach of Midland, Michigan.

Tipula (*Nippotipula*) *metacomet*, n.sp.

The present fly has been confused with *Tipula* (*Nippotipula*) *abdominalis* (Say) which it closely resembles but from hypopygial structure evidently is distinct. In size somewhat smaller than *abdominalis* (wing 23 mm.). Legs uniformly brownish black with no indication of pale rings on the femora or bases of tibiae. Male hypopygium with both dististyles black, outer style with the basal part before the oblique thickened ridge short, the outer half or more slightly angulated and produced into a rectangular blade, its apex truncate, with short spinoid setae; inner style much smaller, the base enlarged, outer end suddenly narrowed into a slender blackened club, the simple apex without major setae. In *abdominalis* the outer dististyle is roughly oval in outline, the oblique ridge beyond midlength, restricting the outer part to a smaller semioval lobe with abundant spinoid setae; inner style relatively large, the pale apex dilated, more or less bilobed, with several strong setae, at base of style with a pale blade or flange.

Habitat.— Massachusetts (Hampshire County).

Holotype, ♂, Amherst, August 15, 1945 (Charles P. Alexander); type mounted on two microscope slides.

Named for Metacomet, more commonly known as King Philip, second son of Massasoit of the Wamponoag tribe of New England Amerinds. King Philip's War (1675-1676) with the English colonists was waged in the vicinity of the type locality.

---

1. Amherst, Massachusetts

Tipula (Lunatipula) mercedensis, n.sp.

Allied to *degeneri;* male hypopygium with posterior border of tergite narrowly emarginate; inner dististyle with the beak bilobed, dorsal crest narrow, blackened, with long setae; outer basal lobe a powerful curved arm that narrows into a strong spine, the upper surface of arm with exceedingly long yellow setae.

Male.— Length about 18.5 mm.; wing 17 mm.; antenna about 6.5 mm.

Frontal prolongation of head long, nearly equal to remainder of head, yellow, narrowly dusted with light gray above, nasus long; palpi with proximal three segments yellowed, the fourth brownish black. Antennae elongate; scape, pedicel and most of first flagellar segment yellow, the remainder black; flagellar segments strongly incised, producing a conspicuous outer enlargement, subequal in size to the basal swelling; segments slightly exceeding their longest verticils. Head brownish gray, orbits paler gray; occipital region buffy.

Pronotal scutum gray, scutellum yellow. Mesonotal praescutum gray with four entire light brown stripes, the intermediate pair slightly more cinnamon brown than the laterals; posterior sclerites of notum gray, each scutal lobe with two brown areas, mediotergite with a capillary brown central vitta. Pleura gray, dorsopleural membrane yellowed. Halteres with stem whitened, the base more yellowed, knob brown. Legs with coxae light gray; trochanters yellow; remainder of legs yellow, the tarsi passing through brown to black; claws of male toothed. Wings brownish yellow, prearcular and costal fields clearer yellow, stigma a little darker, brownish yellow; obliterative areas poorly differentiated; veins brown. Venation: Tip of R_{1+2} atrophied; petiole of cell M_1 slightly longer than *m*.

Abdominal tergites yellow with a broad blackened central stripe, the posterior borders of the intermediate segments narrowly yellowed, sublateral areas very vaguely darkened; sternites yellow; hypopygium large, brownish yellow. Male hypopygium with posterior border of tergite narrowly and deeply emarginate, fringed with long setae, the border adjoining the emargination produced into a flattened blade. Appendage of ninth sternite dilated and weakly emarginate, the border with strong yellow setae, those of upper lobe stouter. Basistyle produced virtually as in *degeneri*. Inner dististyle with the beak bilobed, dorsal crest low, blackened, with long yellow setae; outer basal lobe produced into a powerful curved arm, its tip narrowed outwardly into a strong spine; upper or concave surface of the arm with exceedingly long yellow setae from base almost to the terminal spine; no basal dilation as in *degeneri*. Eighth sternite sheathing, posterior border broadly concave on either side with an apical lobe provided with abundant long yellow setae, the tips curved and twisted, the shorter mesal setae forming a dense tangle.

Habitat.— California (Mariposa County).

Holotype, ♂, Yosemite National Park, along Merced River, trail to Vernal Falls, altitude about 4,200 feet, June 12, 1963 (James Baker).

The only known relative of this fly is *Tipula* (*Lunatipula*) *degeneri* Alexander, still known only from Sequoia National Park, California. The present species differs conspicuously in the hypopygial characters, particularly the ninth tergite and the inner dististyle, as described. In *degeneri* the outer basal lobe of the inner style is expanded at base, the outer arm slender and without setae.

Tipula (? *Pterelachisus*) *simondsi*, n.sp.

Wings reduced in size, at least in the female; general coloration of head and thorax light gray, frontal prolongation of head elongate, with a nasus; mesonotum restrictedly patterned with brown; halteres chiefly pale yellow; wings about one-half the length of body, stenopterous, pale yellow, conspicuously patterned with dark and paler brown, veins behind *R* without macrotrichia; abdomen tricolored, segments dark brown basally, light gray on more than outer half, the posterior borders of outer segments narrowly light yellow; ovipositor with cerci smooth, hypovalvae elongate, with rounded apices.

FEMALE.— Length about 23 mm.; wing 11 x 2 mm.; abdomen about 18 mm.; antanna about 2.5 mm.

Frontal prolongation of head unusually long, only a little less than remainder of head, light gray, with indications of a narrow darker median line; nasus distinct, about twice as long as broad, with a few stout black setae; palpi black, sparsely pruinose. Antennae black, pruinose; 12-segmented, the proximal two flagellar segments partially fused, the combined length only a little less than the scape, terminal segment reduced to a tiny oval structure; verticils a little shorter than the segments. Head gray, the vertex with vague indications of a capillary darkened line, more diffuse behind; vestiture of head reduced to a few scattered microscopic black bristles.

Cervical region buffy. Pronotum gray, center of scutum elevated, slightly more infuscated. Mesonotum gray, praescutum with indications of two darkened lines on anterior half, converging behind and vaguely reaching the suture, evidently representing the usual interspaces, the four gray stripes including two narrow intermediate vittae and much broader lateral areas; pseudosutural foveae very small, blackened; scutum gray, more buffy medially, each lobe with narrow darkened lines; scutellum and postnotum light gray, vaguely patterned with darker; mesonotum glabrous. Pleura gray, dorsopleural membrane abruptly light yellow. Halteres pale yellow, base of knob weakly darkened. Legs with coxae light gray, with sparse long white setae ; trochanters brownish gray; femora and tibiae light yellowish brown, tips narrowly brownish black; basitarsi brown, outer tarsal segments blackened. Wings slightly reduced in size, stenopterous, to produce an evidently flightless condition; wings of nearly uniform width for most of the length; ground color pale yellow, restrictedly patterned with dark and paler brown; prearcular and costal fields, including both cells *C* and *Sc*, clear light yellow; the darker brown areas include marks at arculus, origin of *Rs* and the anterior cord; paler brown markings include a linear dash in cell

R adjoining the vein, and broad areas in cell *M* placed at midlength and near outer end; further linear pale brown lines at midlength and near outer ends of cells *Cu* and *1st A*, and almost the outer two-thirds of *2nd A;* beyond the cord, M_{1+2} is narrowly seamed with brown; veins light yellow in the ground areas, pale brown in the darker brown markings. Macrotrichia on veins *C*, *Sc* and *R*, lacking on all other veins; squama naked. Venation: *Rs* about one-half longer than *m-cu;* veins R_{1+2} and R_3 widely divergent, cell R_2 at margin about twice R_3; petiole of cell M_1 short, about one-third *m; m-cu* longer than distal section of Cu_1; prearcular field of wing elongate.

Abdomen long, the segments conspicuously patterned, the basal rings dark brown, the broader apical parts light gray; posterior borders of tergites five through eight and sternites six and seven narrowly light yellow; ovipositor with dorsal shield and the cerci brownish black, the ventral parts slightly paler. Ovipositor with cerci elongate, margins smooth, apices subacute; hypovalvae about four-fifths as long, compressed-flattened, tips obtuse.

Habitat.— California (Inyo County).

Holotype, ♀, on snow field along trail to Mount Whitney, Sierra Nevadas (Lone Pine to Whitney), altitude 12,500 feet, July 18, 1965 (W. E. Simonds).

I am pleased to name this interesting fly for the collector, Mr. William E. Simonds of Sacramento, California. In the absence of the male sex I hesitate to assign it definitely to any subgenus but am placing it with some question in *Pterelachisus* Rondani (*Oreomyza* Pokorny) where it appears to belong. It may possibly belong to *Serratipula* Alexander which includes various subapterous species. Other regional subgenera are excluded by different characters, as *Lindneria* Mannheims by the loss of the nasus, and *Lunatipula* Edwards and *Triplicitipula* Alexander by the presence of squamal setae. I cannot associate the present female with any of the numerous regional fully winged males. The striking tricolored pattern of the abdomen is somewhat suggestive of *Tipula* (*Pterelachisus*) *ternaria* Loew, which is fully winged in both sexes. This is a high northern Nearctic fly that ranges from Ontario to Quebec, westward to the Yukon, southwards into the more northern New England states. It is probable that the male sex of the present species likewise will be found to be fully winged.

Subapterous species of *Tipula* are well known in California, including several species in *Serratipula* and *Triplicitipula*, including the female sex and in a few cases also the male. As indicated above, the present fly has the reduced condition of the wings only moderate. By the scale of wing atrophy given by Bezzi in an important paper on the subject[1], the fly would fall between his categories 1 and 2 where the wing shape has been deformed but the venation clearly indicated. Attention may be called to a very recent paper by the

1. Bezzi, Mario. Riduzione e scomparse delle ali negli insetti Ditteri. *Rivista di Scienze Naturali, "Natura"*, 7.85-182, 10 figs., with numerous subfigures; 1916.

writer that concerns the Californian species of *Tipula* and bears on the present question; reference[2] below.

Limonia (*Dicranomyia*) *dreisbachi*, n.sp.

General coloration of head and thorax gray, the praescutum with a dark brown central stripe on anterior half; antennae black throughout; wings whitish hyaline, stigma pale yellow; *Sc* short, *Rs* less than the basal section of R_{4+5}, cell *1st* M_2 closed; male hypopygium with the rostral prolongation of the ventral dististyle long, spines subequal in length, placed close together at near two-thirds the length.

MALE.— Length about 6.5 mm.; wing 7 mm.

Rostrum yellow, sparsely pruinose above the base, palpi black. Antennae black throughout; flagellar segments oval, the outer ones slightly more elongate; verticels shorter than the segments. Head gray; anterior vertex broad, about three times the diameter of scape.

Pronotum buffy yellow. Mesonotal praescutum dark gray, clearer light gray on sides; a conspicuous dark brown central stripe on anterior half, lateral stripes not or scarcely indicated; scutum gray, lobes darker gray; scutellum dull yellow, sparsely pruinose at base; postnotum gray. Pleura gray, dorsal pteropleurite and meral region buffy; dorsopleural membrane brownish yellow. Halteres with stem whitened, knob brown. Legs with coxae and trochanters yellow; remainder of legs broken. Wings whitish hyaline, prearcular field light yellow; stigma vaguely indicated, pale yellow; veins delicate, brown, those of proximal third of wing more yellowed. Venation: *Sc* short, Sc_1 ending some distance before origin of *Rs*, the distance exceeding *Rs*, Sc_2 retracted, Sc_1 alone more than three-fourths *Rs*; *Rs* shorter than basal section of R_{4+5}; cell *1st* M_2 closed, nearly as long as distal section of M_{1+2}; *m-cu* longer than outer section of Cu_1, placed shortly beyond the fork of *M*.

Abdomen dark brown, hypopygium yellowed.Male hypopygium with the tergite transverse, posterior border shallowly emarginate to form low obtuse broadly thickened lobes, setae long, pale yellow, inconspicuous. Basistyle with ventromesal lobe oval, with long yellow setae. Dorsal dististyle a gently curved rod that narrows gradually to a slender point; ventral style subequal in area to the basistyle, body oval, with pale setae; rostral prolongation long, the apex narrowed, the two spines placed close together at near two-thirds the length, the spines subequal to the apex beyond their insertion. Gonapophysis with mesal-apical lobe slender, gently curved.

HABITAT.— Michigan (Midland County).

HOLOTYPE, ♂, Midland County, without more exact data, August 4, 1954 (R. R. Dreisbach).

The species is dedicated to the collector, the late Robert R Dreisbach, distinguished student of the Hymenoptera. Superficially it is much like *Limonia* (*Dicranomyia*) *brevivena* (Osten Sacken) in the venation, as the short *Sc* and *Rs* but actually is a very different fly.

2. Alexander, Charles P. New subgenera and species of crane-flies from California (Diptera Tipulidae). *Pacific Insects* 7, no. 2 333-386, 33 figs; June 1965.

TWO NEW MITES FROM THE UNITED STATES (ACARI: ORIBATEI, MICROZETIDAE AND ORIBATELLIDAE)[1]

Harold G. Higgins[2]

The family Microzetidae is composed of small, "winged" mites with large, often bizarre lamellae. Until the present time this family has been reported only once from the United States, but has been found in many collections from South America, Europe, Africa and Madagascar. In a collection of oribatid mites from North Carolina was an undescribed species of microzetid as well as a new species of *Ophidiotrichus*, a genus not previously recorded from North America. Figures and descriptions of these new species follow.

Allozetes n. gen.

Diagnosis: Lamellae long, extending over tip of rostrum, broad, incurved lateral margins; lamellar hairs heavy, incurved, strongly setose and extended beyond tip of lamellae by about one-half their lengths; sensillus with brush-like tip and long pedicle; fixed digit of chelicerae with a long, racemose, thorny spine as shown in figures 3 and 4.

Allozetes harpezus n. gen., n. sp.
(Figs. 1-4)

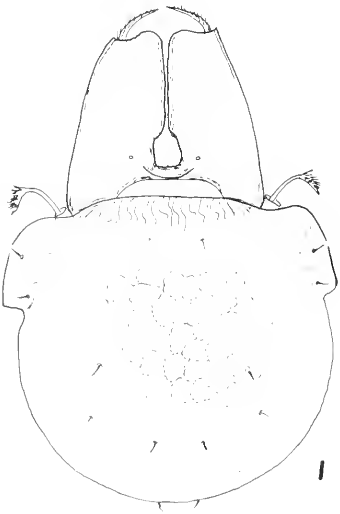
Diagnosis: Lamellar hairs heavy, incurved, strongly setose and extended beyond tip of lamellae by nearly one-half their lengths; sensillus brushlike, not proclinate.

Description: Propodosoma longer than wide; rostral hairs small, not visible from above; lamellae covering propodosoma, with smooth, incurved, lateral margins, anterior ends with rounded medial edges and a short, lateral point, medial edges nearly parallel, separated near base by a rectangular space; lamellar hairs heavy, setose, inserted under the lamellae and attached nearer the medial edge of lamellae, curving laterally and then medially, extending beyond tip of lamellae by about one-half their lengths; insertions of interlamellar hairs located on each side of the rectangular space between the lamellae, but interlamellar hairs missing in type specimen; pseudostigmata cup-like, located at junction of lamellae and pteromorphs; sensillus brush-like with a long pedicle.

Hysterosoma round in outline; sclerotized lines extending posteriorly from the straight dorsosejugal suture; pteromorphs not directed forword, each pteromorph with two setae on upper surface; dorsal setae as shown in figure 1; hysterosoma covered with an irregular, reticulate pattern.

Camerostome egg-shaped; chelicerae heavy, fixed digit with a long, racemose, thorny spine that is about as long as the movable

1. Salt Lake City, Utah.
2. Participant in National Science Foundation Research participation for High School Teachers



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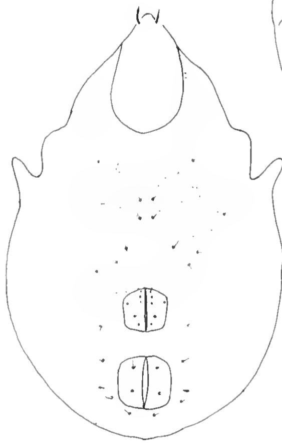

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Fig. 1. *Allozetes harpezus* n. gen., n. sp. dorsal view, legs omitted.
Fig. 2. *Allozetes harpezus* n gen., n. sp. ventral view, legs omitted.
Fig. 3. *Allozetes harpezus* n. gen., n. sp., chelicera.
Fig. 4. *Allozetes harpezus* n gen., n. sp., spine on fixed digit of chelicera.

digit, as shown in figures 3 and 4; genital plate about as long as wide with parallel sides, each plate with six setae (figure 2). g_3 even with g_4 but located near lateral edge of cover; anal opening about as long as wide, larger than genital aperture, each anal plate with two setae; aggenital setae located posterolaterad of genital plate; three pairs of adanal setae, ada_3 located at anterior level of anal plate; pore *iad* located between ada_2 and ada_3; ventral apodemata and setae as shown in figure 2.

Size: Length 276 μ; width 204 μ.

Type Locality: One specimen from four miles north of Cherokee, North Carolina, 28 May 1957 by W. Mason.

Discussion: Until now only one Microzetid has been reported from the United States. Jacot (1938) described *Microzetes auxiliaris appalachicola* from grass sod at Bent Creek Exp. Forest, North Carolina. However, because of the short description and lack of a figure, I must agree with Balogh (1962a) that it is impossible to put this form in its proper place in the genus *Microzetes*.

Allozetes harpezus n. gen., n. sp. is different from all known members of this family in the shape of the lamellae, the size and shape of the lamellar hairs, the brush-like sensillus, and the long, racemose, thorny spine on the fixed digit of the chelicerae. The name *harpezus* means "thicket" or "thorn hedge" and refers to the unusual spine on the fixed digit of the chelicerae.

Ophidiotrichus exastus n. sp.
(Figs. 5-6)

DIAGNOSIS: Anterior end of lamellae serrate, median dens longer than lateral dens; rostrum pointed, entire; interlamellar hairs more than two-thirds as long as lamellae; no distinct areae porosae.

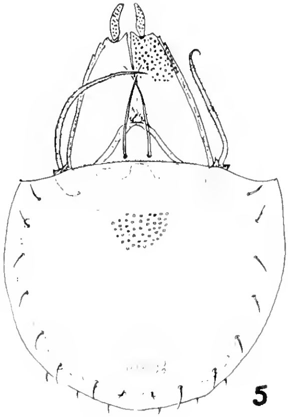
DESCRIPTION: Propodosoma longer than wide; rostrum pointed, entire, not visible from above; lamellae long, broad, finely pitted with a serrate tip, the median dens longer than lateral dens; lamellar hairs very heavy, broad, finely setose, located in anterior end of lamellae; interlamellar hairs located close together, medially on prodorsum near dorsosejugal suture, over two-thirds as long as lamellae, setose, with small insertions; pseudostigmata cup-like; sensillus weakly setose with nearly parallel sides and fine tip which extends nearly to ends of lamellae.

Hysterosoma quite round; dorsosejugal suture straight; entire dorsum finely pitted; setae simple and located as shown in figure 5; muscle scars around edge of hysterosoma; pseudoporosae anterior to setae r_1; no distinct areae porosae.

Camerostome egg-shaped; genital opening wider than long and separated from the larger anal plate by twice its length, each plate with six setae as shown in figure 6; anal opening larger than genital, nearly as wide as long, each plate with two setae, an_1 near medial edge of plate and an_2 nearer middle of plate; three pairs of adanal setae, ada_3 located at level near middle of anal plate; *iad* at antero-lateral margin of anal aperture anterior to ada_3; aggenital setae postero-laterad to genital plate; apodemata and setae as shown in figure 6.

SIZE: Length 247 μ; width 180 μ.

TYPE LOCALITY: A single specimen from four miles north of Cherokee, North Carolina, 29 May 1957 by W. Mason.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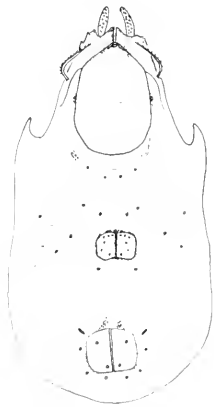
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Fig. 5. *Ophidiotrichus exastus* n. sp. dorsal view, legs omitted.
Fig. 6. *Ophidiotrichus exastus* n. sp. ventral view, dorsal plate removed.

Discussion: Although the genus *Ophidiotrichus* (family Oribatellidae) has been previously reported from Europe, this is the first record from North America. This species resembles somewhat *Ophidiotrichus connexus vindobondensis* Piffl in having a pitted body and notched lamellae, but differs from all known forms in having a serrate-tipped lamella with long median dens; longer, heavier, interlamellar hairs more medially located; rostrum entire, pointed; and in the lack of distinct areae porosae. In addition there is a difference in the location of the genital setae. The name *exastus* means "rough edge" and refers to the anterior edge of the lamellae.

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A NEW GENUS AND SPECIES OF ORIBATID MITE FROM COLORADO (ACARI: ORIBATEI, CERATOPPIIDAE)[1]

Tyler A. Woolley[2] and Harold G. Higgins[3]

Observations of collections of some montane oribatid mites disclosed what appeared to be a new genus and species related to *Ceratoppia bipilis* (Herm.) and *Pyroppia lanceolata* Hammer, yet different from either. Additional study and morphological comparisons of the new species with descriptions of *Pyroppia* and available specimens of *Ceratoppia* disclosed some marked differences in the lamellae, chelicerae and other structures. These differences indicated conclusively that the mite was distinct and new, so other diagnostic features were studied.

Although some similarities exist among these genera, several differences were observed, most striking of which was the discovery of pelopiform chelicerae, with a swollen base, narrow shaft, and small dentate shears. It was this discovery which prompted further investigation and comparison of the lamellae, infracapitulum and legs of the new species and those of established genera.

Because of these comparisons other details were disclosed that extend beyond the scope of this paper. It was apparent that further study would be necessary to determine final relationships and delimitations of these species. Research on this comparative morphology has begun to assess the generic and specific features of the ceratoppiids and liacarids. A few pertinent facts will be delineated below, but disclosure of many others will await completion of the study currently being conducted.

Paenoppia n. gen.

With sclerotized, tuberculated prodorsum and lamellae; lamellar cusps smooth, not tuberculated, finger-like, extended above prodorsum; chelicerae pelopiform; sensillus setiform, with small barbules along nearly parallel sides except for filiform tip, slightly swollen at beginning of terminal flagellum. Differs from *Pyroppia* in the wider, tuberculate lamellae; the setiform sensillus compared to the lanceolate sensillus of *Pyroppia;* the rounded body shape compared to the pear-shaped body of *Pyroppia.* The generic name is compounded to indicate a postulated relationship with other ceratoppiids.

Paenoppia forficula, n. sp.
(Figs. 1-7)

Diagnosis: Pelopiform chelicerae; lamellae broader than lamellar cusps, and each with a longitudinal dorsal ridge extending from base

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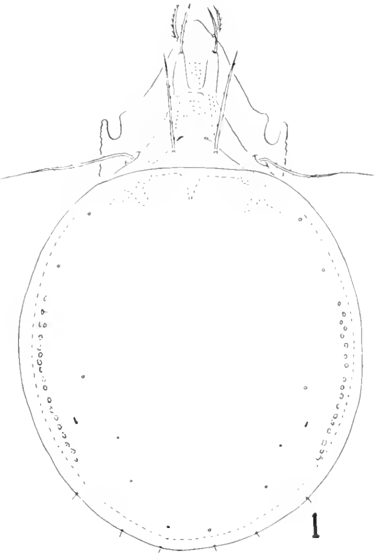
2. Department of Zoology, Colorado State University, Fort Collins.
3. Participant in NSF Research Participation for High School Teachers program, Colorado State University, summer 1965.

of cusp toward insertions of lamellar hairs, surface of lamellae and prodorsum tuberculate; lamellar cusps stout, finger-like, narrower than lamellae, cylindrical and smooth, projected above prodorsum; translammella incomplete, interrupted medially; sensillus bristle-like, with small barbules along proximal two-thirds, with a thin terminal filament. Differs from other species of Ceratoppiidae in the lamellae and lamellar cusps, but principally in the pelopiform chelicerae. The specific name is descriptive of the small shears of the distinctive chelicerae.

Description: Color yellowish-brown; prodorsum broadly triangular, surface finely tuberculate, tubercles more prominent between lamellae; rostrum rounded; rostral hairs plumose, curved, shorter than lamellar hairs, inserted in raised tubercles at lateral margins about half their lengths posterior to rostral tip (Figs. 1, 5); lamellae about as wide as width of pseudostigmata, with tuberculated surface, a dorsal longitudinal ridge extending from base of cusp to toward insertion of interlamellar hairs, lamellar cusps smooth, cylindrical, projected above surface of prodorsum, tapered anteriorly; lamellar hairs setose, longer and less plumose than rostral hairs, extending beyond tip of rostrum, inserted in tips of cusps; translamella incomplete medially; interlamellar hairs setose, projected slightly beyond tips of lamellar cusps, inserted posterior to longitudinal ridge of lamellar cusps, inserted posterior to longitudinal ridge of lamellae, insertions slightly raised; pseudostigmata cup-shaped, at posterior end of lamellae, slightly postero-mediad of pedotecta I; sensillus longer than length of lamella, proximal two-thirds setiform with fine barbules on shaft, slightly swollen near fine, terminal flagellum (Fig. 3); pedotecta I as seen in figures 1, 2.

Hysterosoma glabrous, nearly spherical, much more rounded than in *Pyroppia lanceolata;* nine pairs of dorsal setae; muscle scars and/or *pseudoporosae*, and fissures as seen in figure 1.

Camerostome elongated, with sclerotized rim; mentum, mental hairs, rutellum as in figures 2, 6; chelicerae pelopiform (Fig. 4), with swollen base, elongated shaft and tiny, serrate shears; postcamerostomal apodemata and ventral setae as seen in figure 2; pedotecta II smaller than pedotecta I, extended antero-laterally; apodemata II divided, a broad, decurved band between coxae, an incomplete incurved apodeme anterior to main band; a slightly sclerotized, vertical, medial apodematal bar extending from posterior margin of apodemata II to anterior margin of apodemata IV; apodemata IV an arched band investing anterior margin of genital aperture and confluent with perigenital ring; genital aperture about its length anterior to anal opening, trapezoidal; each cover angled antero-laterally, with a diagonal sclerotized bar near anterior margin and extending width of cover, each cover with six genital setae, g:1, g:2, g:3, g:4 about equidistant from each other, g:5 displaced laterally on cover, g:6 near postero-medial corner, but in line with first four setae; aggenital setae inserted about length of genital cover postero-lateral to genital opening; fissure *iad* postero-lateral to anterior margin of



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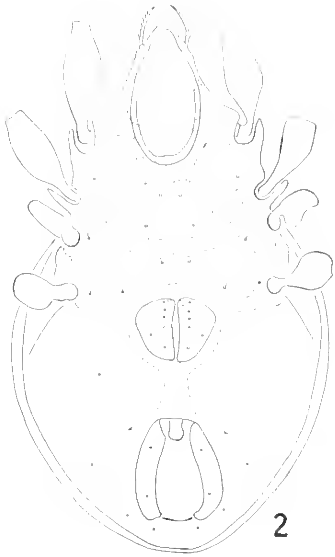

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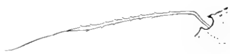

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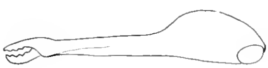

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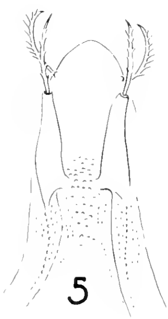

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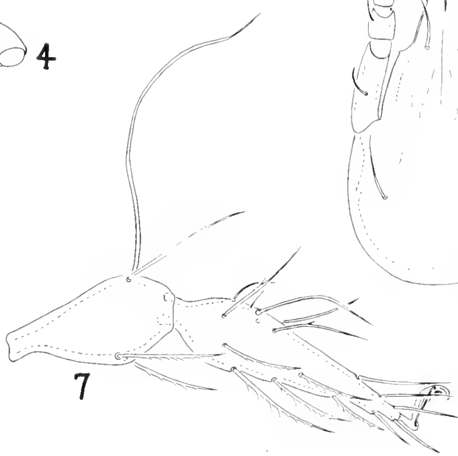

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Fig. 1: *Paenoppia forficula*, n. gen., n. sp., from the dorsal aspect. legs omitted.
Fig. 2: *P. forficula*, n. gen., n. sp., from the ventral aspect. legs partially omitted.
Fig. 3 Pseudostigmata and sensillus of *P. forficula* to show barbules and
Fig. 3: Pseudostigmata and sensillus of *P. forficula*, n. gen.. n. sp. to show barbules and terminal flagellum.
Fig. 4: Pelopiform chelicera of *P. forficula*, n. gen., n. sp.
Fig. 5: Enlarged detail of lamellae and rostrum of *P. forficula*, n. gen.. n. sp. from the dorsal aspect.
Fig. 6: Infracapitulum of *P. forficula*, n. gen., n. sp.
Fig. 7: Tibia and tarsus I of *P. forficula*, n. gen.. n. sp.

elongated anal opening; anal aperture with prominent preanal piece; each anal cover with two setae; three pairs of adanal setae, ada:1, ada:2 mainly posterior to anal opening, ada:3 lateral and farther from anal opening than *iad* fissure.

Legs heterotridactylous, median claw only slightly larger than laterals; tibia and tarsus I as in figure 7; trochanter III with thin, slightly plumose seta, similar to larger, more plumose seta of trochanter II in *Ceratoppia* and *Pyroppia*.

Length: 384 μ, prodorsum 102 μ, hysterosoma 282 μ; width 312 μ.

Nine specimens of this species were collected near the summit of Berthoud Pass, Colorado, 13 September 1958, by T. A. Woolley. The type and one paratype are deposited in the USNM.

Discussion: Aside from its smaller size, *Paenoppia forficula*, n. gen., n. sp., differs from known species of *Ceratoppia* and *Pyroppia* in the tuberculate prodorsum and lamellae. The most distinctive difference is the pelopiform chelicerae of *P. forficula* as contrasted to the more robust chelicerae of *Ceratoppia* and *Pyroppia*.

Hammer (1955, p. 15) states for *Pyroppia lanceolata* that "The long feathered hair on coxa III, which is characteristic of the genus *Ceratoppia*, is very short in *Pyroppia*." This seems to be a perpetuation of an error of Michael (1887, p. 357) concerning *Ceratoppia bipilis* that the prominent "spine on the coxa of each leg of the third pair near the proximal end, at the outer corner: . . . usually stands more or less parallel to the pseudostigmatic organ, and it is from these two spines on each side that the name is given." Willmann (1931) indicates that this bristle is located on trochanter III—not coxa III—and observations of representatives of *Ceratoppia* and *Paenoppia* confirm this location. We did not have access to specimens of *Pyroppia* for examination, but it appears conclusively from the literature and observations that these erect hairs are on trochanter III and are common to this complex of mites. Such hairs are found in *Paenoppia forficula*, n. gen., n. sp., but are less robust than those found in species of *Ceratoppia* and *Pyroppia*.

Although no specific relationships can be established, it appears that *Paenoppia forficula* is intermediate between *Ceratoppia* and *Pyroppia*, but probably related within the complex of *Astigestes*, *Cultroribula*, *Ceratoppia* and*Pyroppia*. Research currently underway should disclose information that will elucidate these relationships.

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STUDIES IN NEARCTIC DESERT SAND DUNE ORTHOPTERA

A new Genus and Species of Stenopelmatine Crickets from the Kelso Dunes with notes on its multi-annual life history and key. Part X

Ernest R. Tinkham[1]

During the past decade the author has made a score of trips to the great Kelso Dunes studying its fauna and flora: the summers of 1957-1960 assisted by National Science Foundation grants. As these dunes lie 155 miles north of Indio, California, by road, a total of 6200 miles has been travelled in these trips during the period 1954-1964. On the second trip in mid June, 1955, tracking a strange trail by day led to the discovery of a crippled Jerusalem sand cricket. Due to its great rarity, only a few specimens have been taken during the years. Often years go by without the finding of a specimen, especially true of the drouth years which most have been since 1960. The second specimen was a young nymph, captured the night of October 25, 1957, when a light drizzle of rain was falling on the dunes.

The discovery of specimens was somewhat expedited, when, in the spring of 1959, I started teaching Extension Courses for San Diego State College. One of the requirements for my course NATURE STUDY OF THE DESERT was an overnight field trip to the Kelso Dunes, usually held in late April and late October of every year. With 25 to 50 teachers, accompanied often by many children and quite a few Coleman lanterns, such a group of searchers covers an area far greater than any scientist can possibly do. Even with such groups, only a few specimens have been found through the years. The last finding was five young nymphs, the night of April 20, 1963, when the sands were icy cold (temperature of the sand next morning at 7:00 was 34° Fahrenheit). At the time of writing in August, 1965, almost two and one half years later, three are still alive and are about one-half to two-thirds grown, so that we may expect the multi-annual life cycle to run three or possibly four or more years in length.

In a paper soon to be published by the California Academy of Sciences, the author has laid the groundwork for future studies in the genus *Stenopelmatus* Burmeister. From this research it is obvious that the worker must rely on the chaetotaxy of the legs as the most significant taxonomic feature to distinguish the various species. In this article, I recognized and redescribed *S. intermedius* Davis and Smith along chaetotaxical lines. Such nebulous characters as punctation, length of antennal segments, nature of frontal sutures and the sternal plates have been discarded, along with the form of the ovipositor, which appears identical in all species. I have laid the stress on the spination of the legs.

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1 Indio, California

Hence, if a certain species shows a marked departure from the normal spination characteristic of the genus *Stenopelmatus*, then that creature must be accorded new generic rank. This I have done with the Kelso Jerusalem Sand Cricket and this consideration has been arrived at after years of thoughtful weighing of the problem. The Provisional Key presented below will amply illustrate the difference between the genus *Stenopelmatus* and the new genus based on chaetotaxical taxonomy.

Provisional Key to Californian Stenopelmatine Crickets

1. Tibial spines vestigial or missing on the apical dorsal margins of the caudal tibiae. Ringlet of 6 apical caudal calcars almost even and broadly spathulate for arenicolous habitus. Median or presubapical spur on the ventral surface of the foretibiae absent. Pronotum not expanding anteriorly. Size medium, coloration uniformly orangish .... *Ammopelmatus* new genus

   Tibial spines prominently developed on the apical dorsal margins of the caudal tibiae. Ringlet of 6 apical caudal calcars uneven in length, usually conical or subconical in form, the innermost calcar the longest. Median or presubapical spur on the ventral surface of the foretibiae always present. Pronotum expanding anterioradly to house the posterior portions of the very large head. Size medium to very large; coloration generally dark, especially on abdomen .... *Stenopelmatus* (2)

2. Size large; color of head and pronotum orange red 3

   Size medium to small; color of head and pronotum not orange red but piceus to shining black 4

3. Calcars of the caudal tibiae forming a semi-ringlet of 6 long spurs, the two innermost much the longest and cylindrical in form .... *longispina* Brunner

   Calcars of the caudal tibiae forming a semi-ringlet of 6 spurs, these spathulate or trowel-shaped on their inner faces, the three inner relatively equal and longer than the 3 outer spurs .... *fuscus* Haldeman

4. Entire body uniformly dark brown with black abdominal tergites. Caudal tibiae with 5 internal and 2 external apical dorsal teeth .... *intermedius* Davis & Smith

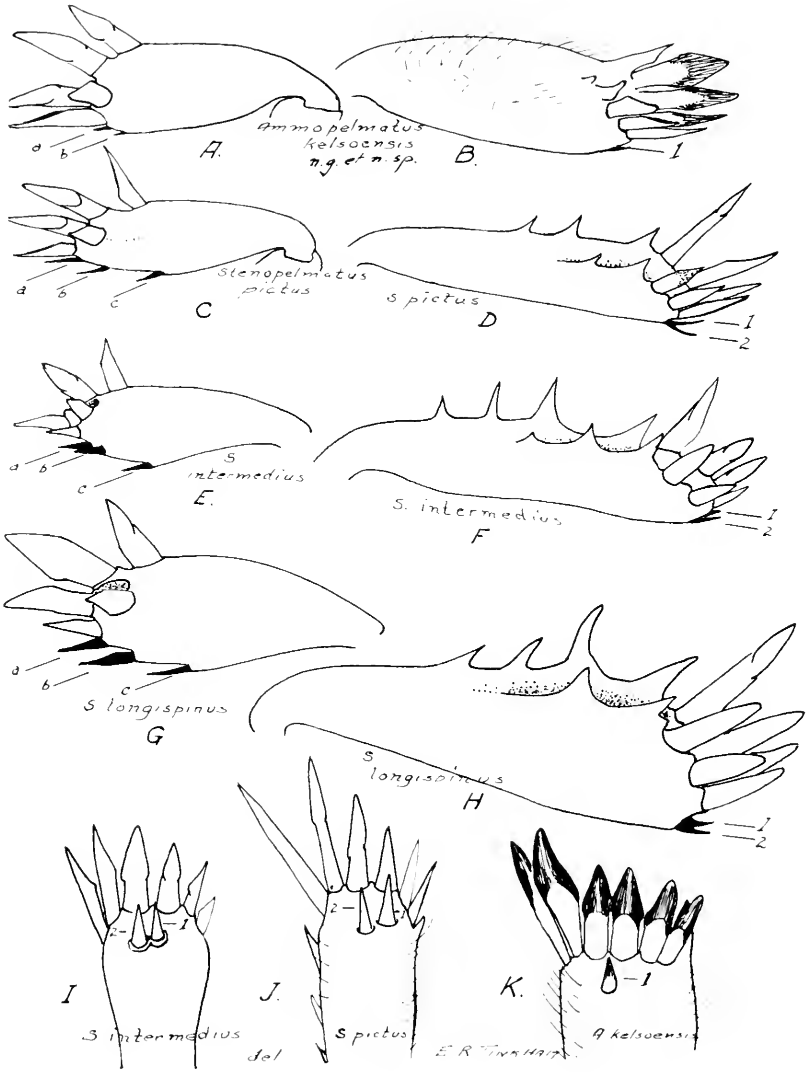
   Upper half of head shining black with tan sutural areas. Pronotum with dorsum bearing irregular areas of shining black. Femora marked with pale brown fasciations. Caudal tibiae with 3 to 4 internal and 2 external apical dorsal teeth .... *pictus* Scudder

Ammopelmatus Tinkham, new genus

Generic Diagnosis: Size medium, uniformly pale yellowish orange on head and pronotum; abdomen more whitish orange with the infuscated annular rings on the dorsum of the abdominal segments less conspicuous than observed in *Stenopelmatus*. The general features are those of a medium-sized *Stenopelmatus*, from which it is amply distinct in many features. Form more slender than in *Stenopelmatus*, the cephalic features generally similar but lacking the typical megacephalism portrayed by *Stenopelmatus*, nor does the anterior portions of the pronotum seem to house the posterior margin of the enlarged head as in *Stenopelmatus*. The pronotum is relatively narrower in *Ammopelmatus* and the posterior angles of the dorsum of the pronotum more evenly and broadly rounded than in *Stenopelmatus*, where this angle has a slight flattening on this latero-posterior face. Anterior lateral angle of the lateral lobes of the pronotum more evenly rounded in *Ammopelmatus* than in *Stenopelmatus*, where all species have a pronounced downward angulation. Sternal plates in the new genus are similar to those observed in *Stenopelmatus*.

Ammopelmatus shows several distinctive generic categories in the spination of chaetotaxy of the legs which quickly separates it from *Stenopelmatus*. These are chiefly found in the apical and subapical tooth-like spurs found on the ventral side of the tibiae. In *Ammopelmatus*, the ventral margin of the fore tibiae have only one or two very small spurs placed one behind the other (See A of plate), whereas the various species of *Stenopelmatus* have always three larger ones placed in linear alignment, the third or most posterior of which being almost median in placement. The mesotibiae are alike in both genera, there being only an evenly placed pair of apical conical spurs. Likewise, in the caudal tibiae in *Stenopelmatus*, there is always a pair of apical conical spurs on the ventral surface (see D, F, H, I and J of plate), whereas in *Ammopelmatus* there is only one centrally placed apical ventral spur (see B and K of plate); a feature of considerable generic worth. Thus the two features: single apical ventral spur of the caudal tibiae and the two apical small spurs placed in linear alignment on the ventral side of the fore tibiae, quickly identify *Ammopelmatus*, the new genus. In addition the six short spathulate calcars of the caudal tibiae and the lack of large teeth on the dorsal margins of the caudal tibiae, as well as the truncate or spathulate nature of the apical dorsal teeth of the caudal tibiae, further identifies *Ammopelmatus*. Other features, such as the ovipositor and supra-anal and subgenital plate, appear to be similar to that in *Stenopelmatus*.

The diagnostic characteristics peculiar to the new genus *Ammopelmatus* have apparently been developed through the ages by adaptation to an arenicolous or ammophilous environment. The loss of all tibial teeth on the dorsal margins of the caudal tibiae, except for the anal ones which have developed into a pair whose posterior surface has developed a truncate spathulate face, appears to be a direct response to a sand habitat. The broadening, shortening and evening of the calcars of the caudal tibiae is, likewise, a development for excavation of sand and a sort of pushing forward movement along



Explanation of Plate

All drawings of fore tibiae are of left fore tibiae, external face; drawings of caudal tibiae are left caudal tibiae external face. All drawings much enlarged and then reduced.

Ammopelmatus kelsoensis from Kelso Dunes. A. fore tibiae showing only 2 ventral apical teeth(a and b). B. Caudal tibiae showing 1 ventral apical tooth (1).

Stenopelmatus pictus from Antioch, California. C. fore tibiae showing 2 apical (a and b) and 1 subapical ventral teeth (c). D. Caudal tibiae showing dorsal tibial spines, calcars (1 to 6) and pair of ventral apical teeth (1 and 2).

Stenopelmatus intermedius from Lagunitas, California. E. fore tibiae showing calcars and 2 apical (a and b) and 1 subapical ventral tooth (c). F. Caudal tibiae showing dorsal tibial spines, calcars (1-6) and pair of ventral apical teeth (1 and 2).

Stenopelmatus longispina from Palo Alto, California. G. fore tibiae showing calcars, 2 apical and 1 subapical teeth. H. caudal tibiae showing dorsal teeth, calcars and two apical ventral teeth.

I. Ventral view of caudal tibiae of *S. intermedius* showing the pair of apical teeth and the six calcars.

J. Ventral view of *S. pictus* showing apical pair of teeth and the six calcars.

K. Ventral view of caudal tibiae of *Ammopelmatus kelsoensis* showing single apical tooth and the spathulate calcars.

the loose surface of the sand of the magnificent mountainous ridges of sand known as the Kelso dunes.

GENOTYPE: *Ammopelmatus kelsoensis,* new species

Having studied the life of the sand dunes of the three great North American Deserts since 1952, and four years, 1957-1960, under grant from the National Science Foundation, it would appear that *Ammopelmatus* is restricted to the Kelso Dunes.

Ammopelmatus kelsoensis Tinkham, new species

ALLOTYPE FEMALE: Kelso Dunes, San Bernardino County, California, April 27, 1963, Ernest R. Tinkham. Type deposited in the Tinkham Eremological Collection.

DESCRIPTION: Head typical of the Stenopelmatine crickets, the eyes more narrowly pyriform than in *Stenopelmatus,* otherwise closely similar in all general features of the head to that genus. Pronotum more evenly quadrate than in *Stenopelmatus*, the lateral margins parallel to the very broadly rounding posterior lateral angles; posterior margin squarely truncate, anterior margin evenly and conspicuously emarginate with that margin typically hirsute. Dorsum of the pronotum crossed by a conspicuous groove or sulcus about one-sixth the pronotal length caudad of the anterior margin and parallel to it, with a median sulcus commencing on the shoulders and angling forward and downwards to the emargination on the anterior third of the lateral lobes of the pronotum; the lobe in front of this emargination more evenly rounding into the anterior margin of the pronotum than in *Stenopelmatus*, where it is more angularly produced downwards. Sternal plates similar to those observed in *Stenopelmatus.* Supra-anal plate semicircularly rounded; subgenital plate very broadly triangular; ovipositor typical of *Stenopelmatus.*

Leg spination as followts: forelegs with enlarged femora smooth, the dorsal margin quite arcuately rounded; tibiae with 5 typical calcars surrounding the apical margin (see A of plate) and with only two ventral apical conical spurs in linear alignment; tarsi quadrimerous, the first segment equal to the remaining three in length. Meso legs with mesofemora more slender than fore femora and less arcuate along the dorsal margin; meso tibiae with five terminal calcars, each dorsal margin bearing a subapical toothlike spur proximad of each lateral calcar; tarsi as in the forelegs, the first segment giving evidence that it is formed of two fused segments. Caudal legs with caudal femora short and heavier than in *Stenopelmatus*, the inferior margin straight, the superior or dorsal margin strongly arched with both dorsal margins bearing long brown setae; caudal tibiae more tumid than in *Stenopelmatus*, the external and internal dorsal margins without teeth except for a large spathulate tooth at the internal apex and a smaller similar tooth on the external apex, the latter having a minute tooth just proximad of it and both margins lined with long brown setae. Ventral surface with only one apical spur of generic import. The caudal tibiae bear apically the 6 spathulate calcars so typical of the new genus (see figs. B and K of plate). Caudal tarsi similar to those in the fore and middle legs, except that the first segment is slightly longer.

Caliper measurements in mms.: body length 31.0; pronotum 5.8 long by 7.5 in width; caudal femora 9.0 x 3.2; caudal tibiae 8.8 x 2.2; ovipositor 2.0 mms.

Paratypes: 12 females from the same habitat as the Allotype at the Kelso Dunes, 1 female adult, 1 subadult, Oct. 25, 1957, the latter living until July 15, 1960, 1 adult June 14, 1957, 1 adult Oct. 21, 1961, 5 small female nymphs April 20, 1963, 3 adults April 27, 1963. Two of April 20, 1963, females still alive and subadult on Sept. 7, 1965.

Paratypes identical to the Allotype except for variations in the ventral apical spur of fore tibiae and caudal tibiae. Oct. 25, 1957, 1 adult and 1 subadult, have one extra ventral apical spur on caudal tibiae. One Oct. 20, 1963 female and one April 27, 1963 paratype possess only single spurs ventrally on the fore tibiae and caudal tibiae. One paratype from Oct. 20, 1963, has one spur on fore tibiae but two spurs on caudal tibiae.

Range in measurements of adult paratypes: body length 29.0—31.0; pronotum 5.0 x 7.3—5.8 x 7.5; caudal femore 8.8 x 3.1 x 9.0 x 3.2; caudal tibiae 8.7 x 2.2 x 8.8 x 2.2; ovipositor 2.2 — 2.0 mms.

Date of Night Collecting Trips

1954: June 25; 1955: June 15; 1956: July 13; 1957: June 14, June 30, Oct. 25; 1958: April 19, June 10, July 1, Sept. 22; 1959: March 27, April 9, May 9, May 22, Oct. 17; 1960: April 30, Oct. 19; 1961: April 15, Oct. 21; 1962: April 28, Oct. 20; 1963: April 20, 27, Oct. 21; 1964: May 2, Oct. 24.

From 1959 on, all April and October night collecting was assisted by 25 to 50 teachers with Coleman lanterns and flashlights.

Collecting Notes

1955: June 15. one crippled adult crawling across dunes in early morning.

1957: June 14: 1 small nymph, 1 adult. Air and sand temp. 20 C. Oct. 25. light drizzle on the dunes commencing about 5 p.m. 1 small nymph, 1 adult.

1961: Oct. 21 adult, temp. 25°C.

1963: April 20. 5 young nymphs collected between 8-9 p.m. when air tem. 13.2 C and sand surface 13.0 C. Rained and sleeted during night. At 7:00 a.m., air 6.0 C and sand in shade 2.0 C. April 27. 8-10 p.m. 3 adults. Air and sand surface were 11°C.

Habitat: *Ammopelmatus* has been found only in a limited area at the north base of a sand declivity, some 15 to 25 feet high, that lies about 200 yards southwest of the main camping area and about 1½ miles ENE of the main peak of sand that is about 700 feet high. In this area there are scattered clumps of Sandpaper weed, *Petalonyx Thurberi*, Croton, *Croton californicum*, Sand dune grass, *Oryzopsis hymenoides*, and in wetter years a great variety of other plants such as *Dicoria canescens*, *Euphorbia* spp., *Astragalus* sp. and many others.

Orthopteran Associates: Nocturnal associates on the sands include: *Macrobaenetes kelsoensis* Tinkham 1962, *Ammobaenetes*, n.sp., the sand roach *Arenivaga*, sp., *Ceuthophilus fossor* and in the creosote growing from the sands in the marginal area close by such decticids as: *Anoplodusa arizonensis*, *Capnobotes fuliginosus*, *Eremopedes* n.sp., as well as the Creosote leaf katydid *Insara covilleae*. Diurnal associates include: *Coniana snowi* on its host *Coldenia plicata*, *Xeracris minimum* on *Petalonyx Thurberi*, the ever present *Trimerotropis p. pallidipennis*, *Ligurotettix c. kunzei* on Creosote stems, *Tanaocerus k. koebeli* on marginal *Franseris dumosa*, *Parabacillus coloradus* on the common Galleta grass *Hilaria rigida* and the ground mantid *Litaneutria minor*.

Faunal Designation: As camp on the Kelso Dunes lies about 2550 feet elevation, the Kelso Dunes lies entirely within the confines of the Gila Desert which is characterized chiefly by vast mesas and bajadas of Creosote.

Life History Studies

Egg: The egg of *Ammopelmatus kelsoensis* is roundly oval, pearly white in coloration and measures 5.2 mms. in length by 3.3 mms. in maximum diameter. Only one egg has been found in captivity during the decade; partly due to the fact that the rearing has been mainly of nymphs.

Nymphal Stages: The small nymph collected the night of Oct. 25, 1957, lived until mid-July, 1960, when it died during my absence on a trip back east. No record of moltings was obtained.

The cold night of April 20, 1963, when temperatures dropped to 37°F., 5 small nymphs were found immobile on the sand. These were given Numbers 1 to 5, and fed lettuce nightly, but it was not always possible, due to my great preoccupation with other duties to screen the sand as often as it should have been screened. Consequently some molts can be expressed only as "early" or "late" in a particular month while others were observed in the act of molting. As the eggs of *Macrobaenetes* Tinkham and *Ammoboenetes* Hubbell hatch in late September or early October with the advent of the first rains, as do other forms of desert insect life, and as the nymphs have been found in the fall, all evidence indicates that these five young nymphs had hatched in the fall of 1962. As such they were either first stadium nymphs or possibly some that were a little larger may have been in the second stadium.

The salient features of each will be given below followed by a short summary of the life history of the new genus and species.

No. 1:

1963: April 20: small nymph collected
late June; molted, small pieces of exuvium found July 4.
chewing up of cast skin occurs some days after molt
Aug. 5: found pieces of complete molt.
Sept.: molt in late Sept.
Oct.: molted night of Oct. 16-17

1964: Sept. molted in late September.

1965: Aug.: molted in early part of month.
Sept.: still living at time of writing manuscript.

No. 2:

1963: April 20: small nymph collected
July 4: found complete exuvium
Sept.: molted night of Sept. 2-3
Oct.: molted night of Oct. 20-21

1964: summer: molted but time not known
Oct.: molted between Oct. 20 and Oct. 30

1965: Sept.: died on fourth, was molting Sept. 2 but failed to get out of exuvium; tried to remove creature from old skin but failed to survive.

No. 3:

1963: April 20: collected small nymph
June: found complete skin in late June

Sept.: late, found parts of 2 legs
Dec.: 13, found parts of body, 1 leg, parts of palpus

1964: Aug.: died on the third

No. 4:

1963: April 20: collected small nymph
June: molted in late June
Aug.: molted on 3rd
Sept.: 25: found lying on side at 10:30 p.m., having just molted. Temp. 28°C (82.4°F). Sept. 28 only part of cast skin remained after feeding on it.
Oct. 29: found feeding on freshly molted exuvium

1964: July: died

No. 5:

1963: April 20, collected small nymph
June: molted in late June
Aug.: found pieces of abdomen, front and coudal tibiae indicating molt in early August.
Nov.: molted at 10:30 p.m. 19-20th. Exuvium at head end of freshly molted cricket

1964: Sept. 14, molted, lying on side. Sleeping upside down on 17th at noon.

1965: Sept.: 18, found lying on back at 10:30 p.m. with cast skin.

LIFE HISTORY SUMMARY: As far as is known the egg hatches in the early part of the fall; probably having been laid the previous spring. Whether there is a molt in the fall or early spring is not known at the present time. The first known molt is in late June or very early July; Second molt in late July or very early August, usually; Third molt usually in late September or up until late October. The Fourth molt occurs in the summer of the second year and the Fifth molt about September of that same year. The Sixth molt happens about early September of the third year from the evidence at hand. It is believed that adults maturing in September of the third year live through to the following spring when the eggs will be laid, thus giving a life span from egg to egg laying of four years.

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RECORDS OF ATHERINID FISHES AT INLAND LOCALITIES IN TEXAS AND NORTHERN MÉXICO

W. L. Minckley[1,2]

On June 3-4, 1964, seining collections from the Río Conchos, Chihuahua, México, 1.1 miles east of Las Varas (near Ciudad Delicias), and at Ciudad Camargo, included specimens of the tidewater silverside, *Menidia beryllina* (Cope) (Arizona State University Nos. 881 and 894, respectively). The collection from Camargo also included one individual of *Chirostoma sphyraena* Boulenger (ASU 1533), and one specimen of an unidentified *Chirostoma* (ASU 1534). These. records published by Tilton and White (1964), some provided by L. S. Campbell (*pers. comm.*), and localities given in Fisheries Reports of the Texas Parks and Wildlife Department, are the basis for this paper (Fig. 1).

Records for *M. beryllina* from Texas (Fig. 1) were obtained from Federal Aid to Fisheries Project Reports[3] as follows: between El Paso and the Big Bend National Park, in the Río Grande (presumably above the mouth of the Río Conchos); and listed as "an invader that dominates localities in Dove Creek and the South Concho River [Colorado River system, Texas]. Especially abundant in the reservoir created by the Guinn Dam [on Dove Creek]." Campbell (*pers. comm.*) provided two record localities for the Pecos River drainage—Imperial Reservoir, Pecos County, and Red Bluff Reservoir, Reeves and Loving counties. The following information was provided for other Texas areas: "We have also taken these silversides [*M. beryllina*] from Lake Brownwood, Colorado River drainage, Brown County [reported on by Tilton and White, 1964], and from the Concho River, Colorado River watershed, Tom Green County. I cannot account positively for the spread of these fish, but I suspect that they were introduced through the actions of bait dealers. Tidewater and Mississippi silversides [*M. audens* Hay] are also reported from some areas of the Red River system. We did not find silversides in our earlier work (1957-1958), but apparently once introduced they experienced an enormous expansion. Since 1963 the populations have been drastically reduced through unknown factors." Additional records in the Colorado River (Tilton, 1961; Tilton and White,

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2. I thank Mr. L. S. Campbell of the Texas Parks and Wildlife Department for providing information used in this report. Collections in México were made while en route to collect elsewhere for NSF Project GB-2461, the support of which is gratefully acknowledged. Permits to collect fishes in México were cordially granted by the Direccion General de Pesca e Industrias Conexas, México D. F., México. Able assistance in collecting was provided by Arthur C. Echternacht, Richard K. Koehn, and Alan P. Wick.

3. *Menidia beryllina* is listed in the following Job Completion Reports from the Texas Parks and Wildlife Department that are available to me: Job B-32, "Fisheries Reconnaissance," Fed. Aid Proj. F-5-R-9 (1962), F-5-R-10 (1963), and F-5-R-11 (1964); Job B-33, "A Preimpoundment Survey of Twin Butts Reservoir and its Included Watershed," F-5-R-10 (1963), and Job B-34, "An Investigation of Waters of the El Paso Area in Order to Evolve Efficient Management of the Game Fish Resource," F-5-R-11 (1964).

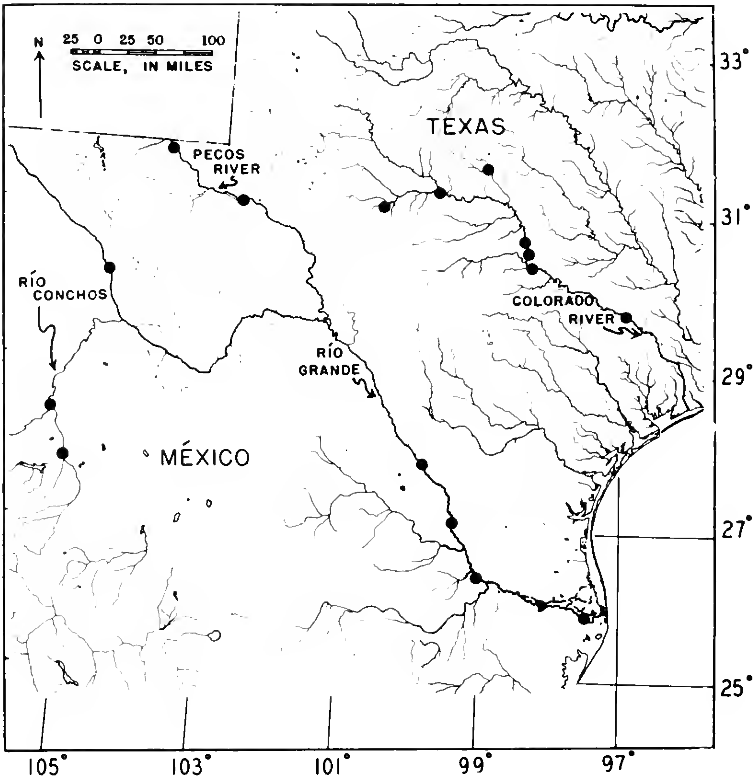

Fig. 1. Distributional records for *Menidia beryllina* in streams of Texas and northern México. The numerous records of Robinson (1959), from the lower Río Grande, are spanned by the five localities plotted; others are from Tilton (1961), Tilton and White (1964), and from data in the present paper. The most southern record station in México is Ciudad Camargo; *Chirostoma* spp. also were obtained at that locality.

1964) are from near La Grange, Texas, and from Lakes Inks, Buchanan, and Marble Falls.

Prior to 1951, *M. beryllina* had been recorded in the Río Grande system from the mouth at Brownsville, to 35 miles upstream from Laredo, Texas (Robinson, 1959; Tilton and White, 1964). Hubbs (1957), however, suggested earlier that the fish might inhabit most of the Tamaulipan Biotic Province of Texas (Blair, 1950), and this would extend its possible range to near the mouth of the Devil's River, Val Verde County. It is conceivable that it invaded upstream in both the Colorado and Río Grande, perhaps in response to decreasing discharges and increasing salinities that result from irrigational use, but the distances involved and inhospitable habitats that exist make this less probable than is direct introduction by man.

Experimental introductions of marine fishes into Imperial and Red Bluff reservoirs of the Pecos River system, the same impoundments from which *M. beryllina* has been caught, raises the possibility of accidental introduction of *Menidia* in those areas as eggs or larvae in water used for transport of the larger species.[4] Because atherinids are difficult to transport as adults it seems unlikely that *Menidia* was transferred a long distance as such. The promiscuous spawning of species of *Menidia* (Bumpus, 1898; Bigelow and Schroeder, 1953) would make eggs available for accidental collection, and *M. beryllina* occurs abundantly in Texas coastal waters from which many of the marine fishes were obtained for stocking (Gunter, 1945). Movement down the Pecos River, then through the Río Grande and into the Río Conchos, may explain the origin of the Mexican stocks. With styrofoam coolers and other types of bait containers now available, short-distance transfers to the Colorado River basin, for example, might have occured as suggested by Tilton and White (1964) and by Campbell (see above).

Stream occurrences of *M. beryllina* are few and it seems worthwhile to give the following habitat notes. At Las Varas the Río Conchos was 50 to 75 feet wide and four feet deep at the deepest point. Pools alternated with riffles and bottoms were gravel except in quiet backwaters where silt occurred. Aquatic macrophytes were absent, but the shore was lined with a thick gallery of trees and shrubs. The water had a milky color and was salty to taste; discharge was estimated at about 125 cubic feet per second. At Ciudad Camargo there was a large pool upstream from the highway bridge and small pools and riffles near the bridge. Again the water was Milky in color and was malodorous, appearing polluted with sewage. Vegetation on the banks was cattail (*Typha*), low grasses, and small shrubs. Various aquatic plants were on riffles (*Chara*, *Najas*, and *Potamogeton*), but pools were unvegetated. Bottoms were of deep silt except on the swiftest riffles. Discharge was about 80 cubic feet per second. At both localities the atherinids were concentrated below riffles in moderate current, or were in eddies. They were obviously in mid-water and appeared to avoid the banks. Five specimens of *M. beryllina* were obtained at Camargo and 134 at Las Varas. In the latter collection, specimens are from near 35 to more than 60 mm. in standard length.

Of the two additional atherinids obtained at Camargo, *Chirostoma sphyraena* is endemic to the Río Lerma basin of south-central México, in the Pacific watershed (Meek, 1904). It could occur in the relatively well-collected Río Conchos only through introduction. The unidentified specimen of *Chirostoma* may also have come from the Lerma basin, from which a number of species of that genus are described.

Movement of fishes by man from place to place in México is undoubtedly increasing with construction of reservoirs and develop-

4. For data on these introductions refer to Job Completion Reports F-1, "Experimental Stocking of Marine Fish Species in Saline Waters of Western Texas," Fed. Aid Proj. F-5-R-9 (1962), F-7-R-9 (1962), F-7-R-10 (1963), and F-5-R-11 (1964), and other reports listed therein. Species of marine fishes that are reported as introduced are as follows: *Roccus saxatilis* (Walbaum), *Cynoscion nebulosus* (Cuvier), *Leiostomus xanthurus* Lacépède, *Micropogon undulatus* (Linnaeus), *Sciaenops ocellata* (Linnaeus), *Pogonias cromis* (Linnaeus), and *Paralichthys lethostigma* Jordan and Gilbert.

ment of sport fisheries. Solórzano (1963) discussed the biology of *Chirostoma estor* Jordan in reference to its possible artificial propagation and introduction into areas other than its native range as a food fish; perhaps attempts have already been made to introduce some species of *Chirostoma*. Eggs of some species of the genus, at least of those from lake Pátzcuaro, float (Solózano, 1961, 1963), and easily could be pumped into holding tanks meant for other fishes and inadvertently transferred outside of their native ranges.

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A LIST OF SCARABAEIDAE BEETLES OF THE NEVADA TEST SITE[1]

Dorald M. Allred and D Elden Beck[2]

In August, 1959, Brigham Young University initiated an ecological study at the Nevada Test Site as a basis for determining the effects of nuclear testing on native animals (refer to Brigham Young Univ. Sci. Bull., Biol. Ser., II(2):1-52; 1963). During the succeeding five years, studies dealing with selected groups of arthropods yielded a number of beetles of the family Scarabaeidae. These were submitted to Dr. Henry F. Howden, Canada Department of Agriculture, Ottawa, to whom we are grateful for the identification of the specimens. For the most part, specimens were trapped in pit cans as described by Allred, *et al.* (*Ibid.*, pp. 8-9). In some cases, however beetles were taken by hand directly from the host plant.

In the listing that follows, the plant community and the host plant are given when known (for a description of the plant communities refer to Brigham Young Univ. Sci. Bull., Biol. Ser., II(4):1-5; 1963). When no host plant is listed, the specimens were taken from pit cans in the plant community indicated.

Aphodius fucosus Schm.

Of a total of 222 beetles of this species, 219 were taken from the Grayia-Lycium community during March, April, and May. Three specimens were taken from the Coleogyne community in March. The majority were found during April.

Aphodius militaris Lec.

Five of 13 specimens taken were from the Grayia-Lycium community in March, May, and June. One specimen was taken from *Lycium andersonii* in January, and another from *Lycium* sp. in November, both in the Larrea-Franseria community. Six were taken from a Mixed community in November and December.

Aphodius nevadensis Horn

Two of a total of 127 specimens were taken from a Grayia-Lycium community in February. Seven were taken from a Coleogyne community—one in January, three in February, one in November, and two in December. One was collected from the Pinyon-Juniper community in November. A total of 117 was taken from the Mixed community—one in November, 106 in December, and nine

1. BYU-AEC Report COO-1355-11. Field work completed under Contracts AT(11-1)786 and AT(11-1)1326 between the Atomic Energy Commission and Brigham Young University.

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in January. Over the whole test site, the predominant number of specimens was taken in December.

Chnaunanthus flavipennis Horn

One specimen was taken from the Grayia-Lycium community in May.

Cyclocephala longula Lec.

Two of a total of seven specimens were taken from a Grayia-Lycium community in August, three from a Larrea-Franseria community in August, and two from a Coleogyne community in July and August.

Diplotaxis deserta Fall

A total of 19 specimens was taken from a Mixed community. Eighteen were taken in June and one in August.

Diplotaxis haydeni Lec.

Five specimens were taken from a Pinyon-Juniper community in July.

Diplotaxis incuria Fall

Five specimens were taken from the Larrea-Franseria community in June.

Diplotaxis insignis Lec.

One specimen was taken from the Pinyon-Juniper community in July.

Diplotaxis moerens moerens Lec.

A total of 77 specimens was taken. Thirty-five were found in the Larrea-Franseria community in August, and one was taken from *Lycium pallidum* in the same community in July. One specimen was taken from the Atriplex-Kochia community in September, 13 from the Coleogyne community in August, and four from the Grayia-Lycium community in July. Twenty-two were taken from a Mixed community—11 in July, four in August, and seven in September. With reference to the whole test site, the greatest number of individuals was taken in August.

Diplotaxis pacata Lec.

One specimen was found in a Larrea-Franseria community in June.

Diplotaxis subangulata Lec.

Thirty of 167 specimens taken were from the Grayia-Lycium community—one in May, four in July, 24 in August, and one in September. Forty-two specimens were found in a Larrea-Franseria community—five in June, two in July, and 35 in August. Four were taken from a Coleogyne community in July, and 52 from a Mixed community—one in June, 43 in July, six in August, and two in September. With reference to the whole test site, the predominant numbers were taken in July and August.

Ochodaeus sparsus Lec.

One specimen was taken from a Grayia-Lycium community and two from a Coleogyne community, all in August.

Paracotalpa granicollis Hald.

A total of 226 specimens was taken. From the Grayia-Lycium community 25 were taken in January and 34 in February. Five were found in the Salsola community in February. In the Larrea-Franseria community 19 were taken in January and 10 in February. In the Atriplex-Kochia community 99 were taken in January, four in March, and two in April. In the Mixed community 26 were taken in January, one in February, and one in March. Over the whole test site, the predominant number was taken in January.

Jorgensen (Pan-Pacific Ento., 39(3):154-6; 1963) noted some aspects of the biology and distribution of this species at the Nevada Test Site. He mentioned specifically the flight and mating activities of the adult males and females.

Serica alternata Lec.

Thirty-four specimens were taken from the Pinyon-Juniper community in July and 15 from a Mixed community in August.

Serica perigonia Dawson

Five specimens were found in the Pinyon-Juniper community in July.

Summary

In addition to those listed above, others collected for which data are not complete are *Aphodius* (near) *talpoidesi* Brown, *Phyllophaga* (*Listrochelus*) sp., *Serica curvata* Lec., and *Serica falli* Dawson.

In sequence of greatest abundance, the most common species known to occur at the test site are *Paracotalpa granicollis*, *Aphodius fucosus*, *Diplotaxis subangulata*, and *Aphodius nevadensis*, respectively. Seasonally, the greatest numbers of species in the adult stage were most active in July, June and August, and May, respectively, although greatest numbers of individuals were found in January, July, April, August, and December.

It is expected that further collecting specifically oriented toward the scarabeids will reveal additional species.

ANGUS MUNN WOODBURY
1886-1964

Vasco M. Tanner[1]

Angus Munn Woodbury, Professor of Biology, Emeritus, University of Utah, Salt Lake City, and his wife, Grace Atkin Woodbury, were killed in a two-car head-on collision Saturday, August 1, 1964, a mile north of Loveland, Colorado, on U.S. Highway 287. Dr. Woodbury was employed, at the time of his death, as a lecturer at the BSCS Institute at the State University of Colorado, Fort Collins.

Angus M. Woodbury was born in Saint George, Utah on July 11, 1886. His parents, John Taylor Woodbury and Mary Evans Woodbury, were early settlers in St. George. They were highly respected members of this isolated pioneer settlement. Dr. Woodbury early took advantage of educational opportunities. He attended the Brigham Young University in 1906, after which he became assistant Forest Ranger in 1908. He retired from the forest service in 1920, having advanced to that of deputy supervisor. From 1920 to 1926 he was engaged in agricultural work and was teaching assistant at Dixie Junior College. In 1926 he again attended Brigham Young University, graduating in 1927 with a Bachelor of Science degree, with a major in zoology.

In the fall of 1927 Dr. Woodbury began his graduate work in zoology at the University of Utah. He was granted a Master of Science Degree in the spring of 1928. After serving as an instructor in 1929 he made preparations to continue his training in zoology at the University of California, Berkeley, from which institution he graduated with a Doctor of Philosophy Degree in 1931. In 1925 he was appointed Park Naturalist at Zion National Park which position he held during the summers until 1933. It was while serving as a pioneer naturalist that he became interested in ecology which resulted in his two major contributions in this field: *Biotic Relationships of Zion Canyon, Utah with Special Reference to Succession*, 1933, and *Principles of General Ecology*, 1953.

In 1931 Woodbury attained the rank of Assistant Professor at the University of Utah, and advanced to Associate Professor in 1939, and Professor in 1942. He was made head of the Department of Vertebrate Zoology in 1948 and retired as Emeritus professor in 1952.

Retirement had no deterring effects on Woodbury's activities since he served as director of Ecological Research at Dugway Proving Grounds from 1952 to 1956. In 1957 he was made director of Ecological Research on the Colorado River Project which position he held until 1964. His ability to organize and direct research work on the Ecology of Disease Transmission in native animals at Dugway met with great favor by the Army Chemical Corps. The monographic reports on the flora and fauna of the Upper Colorado River Basin carried out in connection with several collaborators, laid the founda-

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Angus M. Woodbury, general ecologist, biologist; University of Utah, 1928-1964.

tion for future work on the ecology of this new recreational waterway, Lake Powell. One of the convincing arguments made in support of the protection of Rainbow Bridge without building a dam on Aztec Creek, was made by Dr. Woodbury—Science, 1961, 133(3464): 1572-1583.

His accomplishments were many. One that stood out was his teaching ability. He was a devoted leader of his students. His quiet, kindly manners endeared him to his students and friends. His lectures were well oragnized and frequently interspaced with clever, meaningful jokes followed by a "whisper-soft laugh". He drew from his scholarly background and wide field experience many clinching examples to buttress his reasoning.

Professor Woodbury's publications, which include several books, number over 100 and cover a wide range of subject matter. He was greatly interested in the history of Utah, as evidenced by his several papers including: *The Route of Jedediah S. Smith in 1826 from the Great Salt Lake;* and *A History of Southern Utah and its National Parks.* He was well informed on Utah birds. As a senior co-author with Clarence Cottam and John Sugden, a sizeable manuscript on the birds of Utah awaits publication. These three authors did, however, publish in 1949: *An Annotated Checklist of the Birds of Utah.* In 1945 Woodbury and Henry N. Russell published: *Birds of the Navajo Country,* 158 pages. Woodbury's interest in the reptiles of Utah resulted in two published reports: *Catalogue of the Reptiles of Utah* and *Studies of the Desert Tortoise, Gopherus agassizii* (with Ross Hardy), which will long be useful references when dealing with this class of Utah animals. A complete list of all of Dr. Woodbury's published papers is included as a part of this paper.

Professor Woodbury was an active and enthusiastic supporter of a number of professional organizations. He was punctilious as to his attendance and participation in society meetings, even though it necessitated his traveling long distances outside of Utah. Some of the scientific organizations of which he was a member and his rank follow: Fellow of the American Association for the Advancement of Science; Fellow of the American Ornithological Union and a member of the council of this organization; Fellow of the Herpetological League; Fellow, Utah Academy, Science, Arts and Letters; Member, Population Reference Bureau; Member, American Society Ichthyologists and Herpetologists; Member, Ecological Society of America; Member, Cooper Ornithological Society; Member, Biological Society of Washington; Member, Nature Conservancy; and Member, American Museum Natural History. He was active in the Audubon Society Program in Utah.

Angus M. Woodbury and Grace Atkin were married on January 15, 1909. They are survived by their four sons and two daughters: Lowell Angus; Marian (Mrs. A. Herbert Gold); Max Atkin; Edith Rae (Mrs. Robert C. Pendelton); Dixon Miles; and John Walter. The sons all have Ph.D. degrees in the biological sciences, having followed in their father's footsteps. The daughters did not depart from the field of biology since they are married to Ph.D. biologists.

I have never known a more devoted couple than Angus and Grace Woodbury. After marriage their ontogony was such that their lives, home life and research activities resulted in an integrated family life. They traveled together in field study activities and made their home a haven for biology students. Mrs. Woodbury once said, "I early learned to live in peaceful coexistence with a scientist."

Few native sons of Utah have risen to such prominence in the field of biology as did Angus M. Woodbury. His untimely death came as a great shock to his family, colleagues, and host of friends. At the time of his death he was actively engaged in several research projects. His accomplishments and influence as a teacher will live on in the enrichment of the lives of others.

List of Angus M. Woodbury Published Papers 1927-1964

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