UPDATED DISTRIBUTIONS OF OKLAHOMA GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE) AND NOTES ON *MELANOPLUS MACCLUNGI*

By

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Abstract:

Grasshoppers (Order: Orthoptera, Families: Acrididae and Romaleidae) collectively pose the greatest pest threat to grazing land in the Great Plains of the United States. Annually, grasshoppers consume approximately 22% of all forage in the western United States. Despite the substantial damage that grasshoppers cause, the vast majority of research has been conducted on a handful of species that are considered the most economically important. There are over 120 species of grasshoppers known to occur in Oklahoma, but there have been no comprehensive surveys undertaken since the early 1960s. Many of the earlier studies neglected tribal lands that make up a large portion of Oklahoma, leaving the grasshopper diversity poorly sampled in the eastern half of the state. In the future, understanding shifts in species in response to climate change is also important for forecasting and preventing major grasshopper outbreaks. This study surveyed grasshopper diversity throughout Oklahoma to better understand the distributions of the species that occur in Oklahoma. Specimens were collected by combination of sweep and ariel netting at sites that were expected to have high grasshopper diversity. New species reported for Oklahoma include *Trachyrhachys aspera*, *Trimerotropis melanoptera*, *Metaleptea brevicornis*, *Melanoplus macclungi*, and *Phrynotettix tshivavensis*. *Melanoplus macclungi* is a poorly known species previously reported only from Barber County, Kansas. Recognizing how little was known about this species, I conducted surveys targeting it throughout Oklahoma. Utilizing the data from historical specimens and citizen-science, I also report *M. macclungi* from Arkansas and Missouri. Many individuals were collected alive, so that I could learn more about their host preferences, fecundity, and other aspects of their life history.

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CHAPTER I

INTRODUCTION TO THE GRASSHOPPERS OF OKLAHOMA

Review of Literature

Grasshoppers (Orthoptera: Acrididae) have played an important role as pests throughout human history. Records of locust swarms date back at least 4,000 years in Egypt and 3,500 years in China (Krall et al., 1997; Tian et al., 2011). In religious texts, locusts have been considered harbingers of death and destruction, as outbreaks often led to widespread famine. In the United States, swarms of *Melanoplus spretus* (Walsh) decimated crops through the late 1800s, forming swarms so dense they darkened the sky and so large that one swarm covered an estimated 300,000 square kilometers (Riley et al., 1878). During the 1850s to 1880s, large swarms of locusts caused significant damage throughout the Great Plains and Rocky Mountain states, including Indian Territory, which would later become Oklahoma (Riley et al., 1878; 1880). The species declined rapidly through the 1880s, and in 1902, the last known specimens of this once-widespread pest were collected in southern Manitoba (Lockwood, 2004).

While many possibilities have been suggested as to how *M. spretus* became extinct, one promising hypothesis is that the plowing of fertile riparian zones for agriculture disrupted the reproduction of *M. spretus* (Lockwood and DeBrey, 1990). While the species swarmed over a wide area, its breeding range was substantially smaller and centered around major rivers throughout the northern Great Plains and eastern Rocky Mountains. These were among the

first habitats in the region to be occupied by European settlers, and plowing would have caused significant mortality to the grasshopper's eggs. It is hypothesized that once the population fell beneath a certain threshold, the species gradually became extinct.

While *M. spretus* was the only true locust known to occur in North America, under certain environmental conditions, other species have exhibited locust-like tendencies. During the dust bowl, *Dissosteira longipennis* (Thomas) and *Schistocerca obscura* (F.) both reached significant pest status in Oklahoma. In the 1930s, the dust bowl was a period of extensive drought and dust storms that occurred throughout the southern Great Plains. Locust swarms that follow unusual weather likely occur because of one of two mechanisms. In the desert locust, *S. gregaria* (Forsskål), swarms commonly follow unusually favorable weather, characterized by rainy conditions that allow increased plant growth, contributing to a greater number of locust nymphs that survive to adulthood (Bennett, 1976). This increase in grasshopper density leads to more interactions between individual grasshoppers, and frequent stimulation of an individual's hind femora by nearby grasshoppers causes changes in gene expression and behavior (Simpson et al., 2001; Rogers et al., 2003). Subsequent generations express phenotypic traits associated with swarming, including aposematic coloration in nymphs, adults with longer wings than their solitary counterparts, and increased metabolism (Weis-Fogh, 1952).

While the swarming behavior of *S. gregaria* is well-documented to occur after an area receives abnormally high rainfall, *D. longipennis* and *S. obscura* both reached outbreak levels during a period of intense drought. The reason for this likely lies in the ability for Orthopteran eggs to lay dormant for multiple years before development occurs (Srygley, 2020). As a result, during a period of intense drought, the eggs of multiple grasshopper broods may accumulate underground, hatching together during an environmentally favorable year and producing the population explosion associated with grasshopper outbreaks.

Following its description by Thomas (1867), *D. longipennis* was considered at most a minor pest found in the shortgrass prairies of the High Plains region. While occasional outbreaks did occur, these were isolated, confined to small areas, and only lasted a single year (Wakeland, 1958). However, in 1933-1940, a large outbreak occurred throughout the range of *D. longipennis* that resulted in individuals occurring as far east as Iowa and the eastern edge of Oklahoma. While estimates of damage and crop loss are only noted at the county level in most cases, one report stated that in three days, a band of *D. longipennis* had consumed all the grass available on 25,000 acres of land (Wakeland, 1958). While *D. longipennis* prefers short grasses, losses were not confined to rangeland, with many counties in Colorado reporting tens of thousands of acres of crops destroyed (Wakeland, 1958). Unlike *M. spretus*, *D. longipennis* still persists throughout the high plains, though its range has reduced substantially. While it is not currently considered an economically important species, climate change and unusual weather patterns could cause it to become a widespread pest once again.

In addition to *D. longipennis*, an outbreak of *S. obscura* occurred in Oklahoma during the Dust Bowl. Duck (1944) mentions that *S. obscura* became unusually abundant and of minor economic importance. While there are few details on the *S. obscura* outbreak, likely overshadowed by the drought, dust storms, and *D. longipennis* swarms, *S. obscura* was reported to cause damage to a wide variety of crops including corn, *Zea mays* L., cotton, *Gossypium herbaceum* L., and wheat, *Triticum aestivum* L. (Duck, 1944).

Even without outbreaks of locusts destroying acres of crop and rangeland, grasshoppers still represent the most economically important pest of rangeland in North America (Hewitt and Onsager, 1983). It is estimated that grasshoppers collectively consume at least 21-23% of available forage annually (Hewitt and Onsager, 1983). This translates to an estimated economic loss of approximately $1.049 billion (converted to 2021 dollars) per year in North American forage (Hewitt and Onsager, 1983).

The vast majority of this economic loss can be traced back to relatively few species of grasshoppers. Most of the roughly 620 species of grasshoppers found in the United States have little economic impact, as they either feed on economically unimportant hosts, exist in low enough densities to have little economic impact, or have specific habitat requirements that do not coincide with cropland and rangeland. The set of species that are considered economically important varies geographically, and some species considered pests in one area may be unimportant in another. For example, *Camnula pellucida* (Scudder) is a widespread, economically important pest throughout the western United States, where it has been considered one of the three most destructive grasshopper species in North America (Parker, 1924). However, in the eastern half of the United States it is only locally common along the northern tier of states, where it is often confined to sandy habitats (Kirk and Bomar, 2005).

Parker (1952) estimated that, in the United States, five species of grasshoppers cause approximately 90% of the crop damage attributed to grasshoppers. These species are *Camnula pellucida*, *M. bivittatus* (Say), *M. differentialis* (Thomas), *M. femurrubrum* (De Geer), and *M. sanguinipes* (F.). Of these five species, all but *C. pellucida* are found abundantly throughout Oklahoma. Other species reported to be occasional pests in Oklahoma include *Ageneotettix deorum* (Scudder), *Aulocara elliotti* (Thomas), *Amphitornus coloradus* (Thomas), *Phlibostroma quadrimaculatum* (Thomas), *Brachystola magna* (Girard), *Aeoloplides turnbulli* (Thomas), *M. packardii* Scudder, *Dissosteira carolina* (L.), and *D. longipennis* (Coppock, 1962). With all of these species, the amount of damage varies greatly from year to year. While sampling in the fall of 2019 and throughout 2020, *Aulocara elliotti* and *Amphitornus coloradus* were uncommon, while *P. quadrimaculatum* was rare, with only eight specimens collected. Some of these species are only pests of a few species of crops as well. For example, *B. magna* is reported to cause localized damage to young cotton plants, while most of the Gomphocerinae feed primarily on grasses (Coppock, 1962).

Various methods have been used to manage grasshopper populations, with varying levels of success. Historically, fire was regularly used to combat grasshopper outbreaks (Skinner, 2000). Fire could be used to concentrate bands of grasshoppers to be killed, and flamethrowers were used to directly kill nymphs (Krall et al., 1997). One invention from the early nineteenth century was the "hopperdozer," a large pan of oil or tar was pulled through a swarm of grasshopper nymphs, causing them to flush into the pan and drown (Skinner, 2000). Around the same time, pesticides became popular to control grasshoppers, particularly as baits. The Criddle Mixture, consisting of one part Paris green (copper arsenic trioxide), two parts salt, and 40 parts horse manure, was used to effectively kill grasshopper swarms, which would be attracted to the mixture of salt and manure (University of Minnesota, 1903). In addition, it was discovered that plowing fields in the fall to disturb grasshopper eggs could effectively prevent outbreaks the following year. In Minnesota, a law was passed that if one suspected their neighbor of not plowing their cropland and, allowing grasshoppers to flourish and spread into neighboring fields, the county would serve them a notice requiring them to plow the field. If this were not done, the county itself would plow the field, and subsequently sue the landowner for the cost of the plowing (University of Minnesota, 1903).

Currently, most grasshopper management in the United States falls under three broad categories: chemical control, cultural control, and biological control. While Paris green and many other historical pesticides are banned because of their extreme toxicity to vertebrates and the potential for bioaccumulation, modern pesticides still play an important role in combatting grasshopper outbreaks. Dimilin® (diflubenzuron) is a widely used growth-inhibiting pesticide that disrupts the synthesis of chitin, causing death during molting. It has no effect on vertebrates and is thought to have no significant effect on populations and diversity of non-target arthropods (Catangui et al., 2000). Interestingly, Dimilin has considerable long-term effects on grasshoppers exposed to a non-lethal dose (Allred, 2020). The sublethal effects of Dimilin on grasshoppers

include malformed body parts, lethargy, including reduced feeding, and reduced fertility, making it a very effective tool to prevent grasshopper outbreaks. Often pesticides are applied, using protocols of Reduced Area and Agent Insecticide Treatments (RAATs). RAATs apply pesticides aerially to strips, leaving intermediate strips untreated. This allows some of the grasshopper natural enemies to survive and simultaneously provide biological control of grasshoppers (Lockwood and Schell, 1997).

Cultural control involves changing the environment in a way that reduces the number of grasshoppers present. While flamethrowers are no longer used to directly kill grasshoppers, fire can play an important role in managing certain pest species. Data collected in Woodward County, Oklahoma, showed that prescribed burns in the fall resulted in a significant decrease in the abundance of *Ageneotettix deorum*, an occasional pest of rangeland in the state (Vermeire et al., 2004). Interestingly, these fires did not cause an overall loss of grasshopper biomass, as many other species, such as *M. bowditchi* Scudder, laid their eggs deep enough that they were unaffected by fire. Other forms of cultural control include tilling to destroy eggs.

Biological control is the use of natural enemies of grasshoppers to limit their numbers. The role that insectivorous birds play in controlling grasshopper populations is discussed in greater detail later in this chapter, but other predators, including parasitoids and pathogens, play an important role. One organism widely researched to manage grasshoppers is the fungus *Paranosema locustae* Canning. This fungus causes substantial mortality by colonizing a grasshopper's gut, causing the grasshopper to become lethargic and starve. While it does not immediately kill grasshoppers after application, the fungus can spread from infected grasshoppers to healthy ones, causing significant long-term reductions in numbers (Henry, 1971).

While many grasshoppers are significant agricultural pests, most species have little negative effect on humans. On the contrary, some grasshopper species are viewed as beneficial

for agriculture. *Aeoloplides turnbulli*, one of the species discussed as an occasional crop pest, is known to favor the noxious and invasive Russian thistle, *Kali tragus* (L.) (Behrstock, 2015). *Hesperotettix viridis* (Thomas), is another species commonly viewed as beneficial, as it has a distinct preference for snakeweeds (*Gutierrezia* spp.). Snakeweeds are toxic to large herbivores (McDaniel and Sosebee, 1988), and considered undesirable in rangeland. Thompson et al. (1996) showed *H. viridis* to cause a significant decrease in the biomass of snakeweed, improving rangeland quality.

In addition to playing a role in noxious weed control, grasshoppers play an incredibly important role as prey for other organisms. Insectivorous grassland-nesting birds are one group of organisms known to feed heavily on grasshoppers. Kaspari and Joern (1993) found that Acridids make up approximately 40% of the diet of grasshopper sparrows, *Ammodramus savannarum* (Gmelin), western meadowlarks, *Sturnella neglecta* Audubon, and constitute over 50% of the arthropods consumed by lark sparrows, *Chondestes grammacus* (Say). In California, Bryant (1914) found that grasshoppers also comprise over 50% of the stomach contents of a killdeer, *Charadrius vociferus* L., burrowing owl, *Athene cunicularia* (Molina), western kingbird, *Tyrannus verticalis* Say, red-winged blackbird, *Agelaius phoeniceus* (L.), tricolored blackbird, *Agelaius tricolor* (Audubon), western meadowlark, Brewer's blackbird, *Euphagus cyanocephalus* (Wagler), and Bullock's oriole, *Icterus bullockii* (Swainson). Recently, it was found that a major component of the fall diet of the sharp-tailed grouse, *Tympanuchus phasianellus* (L.) was a single species of grasshopper, *Melanoplus dawsoni* (Scudder) (Meyhoff et al., 2020). While there were likely many factors contributing to the decline of the Eskimo Curlew, *Numenius borealis* (Forster) (Faanes and Senner, 1991), the extinction of *Melanoplus spretus* is one of the factors thought to have led to its extinction. This shorebird bred in the high arctic of Canada and wintered in Argentina. During migration, it would stop at sites left unplowed to feed on grasshopper eggs (Swenk, 1915).

Chemical management of grasshoppers has varying reported effects on birds, which are largely a result of the type of chemical used. In Argentina, the pesticide monocrotophos was determined to be the cause of death for 5,095 Swainson's hawks, *Buteo swainsoni* Bonaparte, after being sprayed to kill grasshoppers (Goldstein et al., 1999). Swainson's hawks are known to form large flocks to feed on grasshoppers (Johnson et al., 1987), which could make them vulnerable to mass die-offs when exposed to lethal levels of pesticides. In contrast, less toxic pesticides have been shown to have little immediate effect on insectivorous birds. In a study conducted in rangeland throughout the west, only the western meadowlark showed significant declines 10 and 21 days after grasshopper treatment; however, when collectively looking at exclusively insectivorous birds, no significant differences in abundance were found amongst the bird species present (George et al., 1995). When investigating the overall declines of grassland bird populations, pesticide use has been shown to exhibit a stronger correlation than the often-cited habitat loss (Mineau and Whiteside, 2013). When examining population trends in Canadian birds from 1970-2010, aerial insectivores and grassland birds, many of which are insectivores themselves, showed the greatest declines of all the tested subgroups (NABCI, 2012). While habitat loss undoubtedly plays an important role, acute or chronic pesticide poisoning and an overall decline in insect biomass, including grasshoppers, are likely two of the primary drivers of this decline.

While concern about grasshopper preservation is often justified by their role as food for birds, many species of grasshoppers themselves are of potential conservation concern. While it may seem odd to include one of the worst pests in American history in a discussion of conservation, *M. spretus*, and the lesser-known *Conozoa hyalina* (McNeill) are two species that have gone extinct in the United States. Currently, only one species of Acridid is listed as endangered by the U.S. Fish and Wildlife Service (USFWS). This species is *Trimerotropis infantalis* Rentz & Weissman, a species of band-winged grasshopper endemic to sand parkland in

the Santa Cruz Mountains of central California (Hoekstra, 1998). This species is threatened primarily by habitat loss, in particular sand mining, and at the time of listing was only known to occur at eight sites (USFWS, 2009).

While *T. infantalis* is the only grasshopper species listed as endangered by the USFWS, there are numerous species with small ranges that could be easily threatened by habitat destruction. *Trimerotropis infantalis* is one of three closely related species of *Trimerotropis* found in isolated areas along the California coast. *Trimerotropis occulens* Otte and *T. occidentiloides* Rentz & Weissman are also known from a very small number of specimens collected in a limited area, which could be threatened by habitat loss or degradation (Otte, 1984). Another similar species, *T. bernardi* Rentz & Weissman, has only been collected in dry riverbeds and surrounding forests in the vicinity of Forest Falls, California (Otte, 1984). Elsewhere, *Trimerotropis huroniana* Walker is state listed as a species of concern in Wisconsin (Marshall and Storer, 2007).

Although California likely has the highest number of grasshoppers of conservation concern, there are grasshoppers with limited ranges found throughout the United States. In Oklahoma alone, there are three species of *Melanoplus* that are thought to be endemic to the state. All specimens of *M. cohni* Hill have come from four counties in the southeast corner of the state where they are found in prairies at woodland edges in the Ouachita Mountains, often along roads (Hill, 2015). *Melanoplus decurvus* Hill is likely the species of greatest conservation concern of the three, as it has not been collected since 1955, when it was collected in an open swale and a dry creek bed (Hill, 2015). *Melanoplus oklahomae* Hebard, like *M. cohni*, is found along woodland edges in the Ouachita Mountains (Otte 2011). Given how little information is known about *M. decurvus*, the lack of generalized information regarding its habitat preferences, and how much time has passed since it has been collected, it is likely that this species is rare enough to warrant conservation action, if it is not already extinct. *Melanoplus cohni* and *M. oklahomae* are

likely more secure, because of their larger ranges and the extensive habitat that has been preserved throughout the Ouachita Mountains in national forests and state parks. However, climate change could affect precipitation patterns across the region, and the subsequent changes in the plant communities of the Ouachita Mountains would likely have a significant effect on these species.

Although conservation of insects usually focuses on species with small populations and limited ranges, this approach may not be sufficient with grasshoppers. As the extinction of *M. spretus* demonstrated, even a common and widespread species can become extinct in a short amount of time if conditions become unfavorable (Samways and Lockwood, 1998). The ranges and populations of some species are so dynamic that assessing them by their mean populations and distribution is insufficient. In order to successfully conserve grasshopper species, long-term monitoring of populations must take place.

References

Allred, D. 2020. “Dimilin, the Swiss army knife of insecticides – transovarial effect on grasshoppers and other interesting features and benefits.” *National Grasshopper Management Board Annual Meeting*. 4 Feb. 2020, Homewood Suites, Denver, CO.

Behrstock, R.A. 2015. Instars of narrow-winged saltbush grasshopper, *Aeoloplides tenuipennis* (Scudder, 1897) (Acrididae: Melanoplinae), with notes on habitat and identification. *Journal of Orthoptera Research*. 24(2): 49-54.

Bennett, L. 1976. The development and termination of the 1968 plague of the desert locust, *Schistocerca gregaria* (Forskål) (Orthoptera, Acrididae). *Bulletin of Entomological Research*. 66(3): 511-552.

Bryant, H.C. 1914. Birds as destroyers of grasshoppers in California. *The Auk*. 31(2): 168-177.

Catangui, M.A., B.W. Fuller, and A.W. Walz. 2000. "VII. 3 Impact of Dimilin® on nontarget arthropods and its efficacy against rangeland grasshoppers." Grasshopper Integrated Pest Management User Handbook: Washington, DC, US Department of Agriculture, Animal and Plant Health Inspection Service (2000): 1-5.

Coppock, S., Jr. 1962. The grasshoppers of Oklahoma (Orthoptera: Acrididae). Oklahoma State University Agricultural Experimental Station. Processed Series P-399. Stillwater, Okla.

Duck, L.G. 1944. The bionomics of *Schistocerca obscura* (Fabr). *Journal of the Kansas Entomological Society*. 17(3): 105-119.

Faanes, C.A. and Senner, S.E. 1991. Status and conservation of the Eskimo Curlew. *American Birds*. 45: 237-239.

George, T.L., L.C. McEwen, and B.E. Petersen. 1995. Effects of grasshopper control programs on rangeland breeding bird populations. *Journal of Range Management*. 48(4): 336-342.

Goldstein, M.I., T.E. Lacher, B. Woodbridge, M.J. Bechard, S.B. Canavelli, M.E. Zaccagnini, G.P. Cobb, E.J. Scollon, R. Tribolet, and M.J. Hopper. 1999. Monocrotophos-induced mass mortality of Swainson's Hawks in Argentina, 1995–96. *Ecotoxicology*. 8(3): 201-214.

Henry, J.E. 1971. Experimental application of *Nosema locustae* for control of grasshoppers. *Journal of Invertebrate Pathology*. 18(3): 389-394.

Hewitt G.B. and J.A. Onsager. 1983. Control of grasshoppers on rangeland in the United States-a perspective. *Journal of Range Management.* 36: 202–207.

Hill, J.G. 2015. Revision and biogeography of the *Melanoplus scudderi* species group (Orthoptera: Acrididae: Melanoplinae) with a description of 21 new species and establishment of the *Carnegiei* and *Davisi* species groups. *Transactions of the American Entomological Society*. 141(2): 252-350.

Hoekstra, J.M. 1998. Conserving Orthoptera in the wild: lessons from *Trimerotropis infantilis* (Oedipodinae). *Journal of Insect Conservation*. 2(3): 179-185.

Kaspari, M. and A. Joern. 1993. Prey choice by three insectivorous grassland birds: reevaluating opportunism. *Oikos*. 68(3): 414-430.

Kirk, K. and C.R. Bomar. 2005. Guide to the grasshoppers of Wisconsin. *Bureau of Integrated Science Services*. Wisconsin

Krall, S., R. Peveling, and B.D. Diallo. (1997). New Strategies in Locust Control. *Springer Science & Business Media*. pp. 453-454. ISBN 978-3-7643-5442-8.

Johnson, C.G., L.A. Nickerson, and M.J. Bechard. 1987. Grasshopper consumption and summer flocks of nonbreeding Swainson's hawks. *The Condor*. 89(3): 676-678.

Lockwood, J.A. 2004. Locust: The devastating rise and mysterious disappearance of the insect that shaped the American frontier. *Basic Books*. New York.

Lockwood, J.A. and L.D. DeBrey. 1990. A solution for the sudden and unexplained extinction of the rocky mountain grasshopper (Orthoptera: Acrididae). *Environmental Entomology*. 19: 1194–1205.

Lockwood, J.A. and S.P. Schell. 1997. Decreasing economic and environmental costs through reduced area and agent insecticide treatments (RAATs) for the control of rangeland grasshoppers: Empirical results and their implications for pest management. *Journal of Orthoptera Research*. 6: 19-32.

Marshall, J.M. and A.J. Storer. 2007. Presence of the "threatened" *Trimerotropis huroniana* (Orthoptera: Acrididae) in relation to the occurrence of native dune plant species and the exotic *Centaurea biebersteinii*. *The Great Lakes Entomologist*. 40(1 & 2): 17-22.

McDaniel, K.C. and R.E. Sosebee. 1988. Ecology, management and poisonous properties associated with perennial snakeweeds. p. 43-56. In: L.F. Jones, M.H. Ralphs, and D.B. Nielson (ed.). The ecology and economic impact of poisonous plants on livestock production. *Westview Press*. Boulder, Colorado.

Meyhoff, S.D., D.L. Johnson, and S. Bazinet. 2020. Fall diet in sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) and consumption of the grasshopper *Melanoplus dawsoni* in Alberta, Canada. *Food Webs*. 24: e00153.

Mineau, P. and M. Whiteside. 2013. Pesticide acute toxicity is a better correlate of US grassland bird declines than agricultural intensification. *PloS one*. 8(2): e57457.

North American Bird Conservation Initiative Canada (NABCI). 2012. The state of Canada's birds, 2012. *Environment Canada*. Ottawa, Canada.

Otte, D. 2011. Eighty New Melanoplus Species from the United States (Acrididae: Melanoplinae). *Transactions of The American Entomological Society*. 138: 73-167.

Otte, D. 1984. The North American grasshoppers, volume II: Acrididae: Oedipodinae. *Harvard University Press*. Massachusetts.

Parker, J.R. 1924. Observations on the clear winged grasshopper (*Camnula pellucida* Scudder). *Univ. Minn. Agr. Exp. Sta. Bull.* 214:1-44.

Parker, J.R. 1952. Insects, the yearbook of agriculture, 1952. *U. S. Govt. Print. Off.* 780 pp.

Riley, C.V., A.S. Packard, Jr., and C. Thomas. 1878. First annual report of the United States Entomological Commission. *Government Printing Office*, Washington, D.C.

Riley, C.V., A.S. Packard, Jr., and C. Thomas. 1880. Second report of the United States Entomological Commission. *Government Printing Office*, Washington, D.C.

Rogers, S.M., T. Matheson, E. Despland, T. Dodgson, M. Burrows, and S.J. Simpson. 2003. Mechanosensory-induced behavioural gregarization in the desert locust *Schistocerca gregaria*. *The Journal of Experimental Biology*, 206: 3991-4002.

Samways, M.J. and J.A. Lockwood. (1998). Orthoptera conservation: pests and paradoxes. *Journal of Insect Conservation*. 2(3): 143-149.

Simpson, S.J., E. Despland, B.F. Hägele, and T. Dodgson. 2001. Gregarious behavior in desert locusts is evoked by touching their back legs. *Proc. Natl. Acad. Sci*. 98: 3895-3897.

Skinner, K.M. 2000. The past, present, and future of rangeland grasshopper management. *Rangelands Archives*. 22(2): 24-28.

Srygley, B. 2020. "Climatic effects on Mormon cricket egg banks." *National Grasshopper Management Board Annual Meeting*. 4 Feb. 2020, Homewood Suites, Denver, CO.

Swenk, M.H. 1915. The eskimo curlew and its disappearance. *Proceedings of the Nebraska Ornithologists' Union.* 6: 25-44.

Thompson, D.C., K.C. McDaniel, and L.A. Torell. 1996. Feeding by a native grasshopper reduces broom snakeweed density and biomass. *Rangeland Ecology & Management/Journal of Range Management Archives*. 49(5): 407-412.

Tian, H., L.C. Stige, B. Cazelles, K.L. Kausrud, R. Svarverud, N.C. Stenseth, and Z. Zhang. 2011. Reconstruction of a 1,910-y-long locust series reveals consistent associations with climate fluctuations in China. *PNAS.* 108(35): 14521-14526

University of Minnesota, Agricultural Experiment Station. (1903). The Criddle mixture. A New remedy for grasshoppers with comments upon certain old methods. Press bulletin no.16. University of Minnesota. Agricultural Experiment Station. Retrieved from the University of Minnesota Digital Conservancy, https://hdl.handle.net/11299/190713.

US Fish and Wildlife Service. (2009). Zayante band-winged grasshopper (*Trimerotropis infantilis*) and Mount Hermon June beetle (*Polyphylla barbata*). 5-Year Review: Summary and Evaluation.

Vermeire, L.T., R.B. Mitchell, S.D. Fuhlendorf, and D.B. Wester. 2004. Selective control of rangeland grasshoppers with prescribed fire. *Rangeland Ecology and Management*. 57(1): 29-33.

Wakeland, C. 1958. The High Plains Grasshopper, A Compilation of Facts About Its Occurrence and Control, *USDA Technical Bulletin No*. 1167.

Weis-Fogh, T. 1952. Fat combustion and metabolic rate of flying locusts (*Schistocerca gregaria* Forskål). *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences.* 237(640): 1-36.

CHAPTER II

AN UPDATED SYNOPSIS OF OKLAHOMA GRASSHOPPER DISTRIBUTIONS

Abstract

Short-horned grasshoppers (Orthoptera: Acrididae and Romaleidae) are important components of most ecosystems with some species causing substantial damage to rangeland ecosystems. There are 127 species reported from Oklahoma, where the last comprehensive statewide inventory was conducted between 1959 and 1961. From June 2019 through October 2020, surveys for short-horned grasshoppers were conducted in all 77 Oklahoma counties. These surveys, and the examination of museum specimens that followed, resulted in five new state records and 708 new county records. As there were previously 2,101 county records of grasshoppers published for Oklahoma, this increases the number of known records by 34%, bringing the total number of county records for Acrididae and Romaleidae in Oklahoma to 2,809. The five state records are for *Trachyrhachys aspera*, *Trimerotropis melanoptera*, *Metaleptea brevicornis*, *Melanoplus macclungi*, and *Phrynotettix tshivavensis*. The subfamilies Leptysminae and Cyrtacanthacridinae had the greatest relative increases in county records, while Romaleinae and Melanoplinae had the lowest. These data help update current ranges of economically important species as well as species of potential conservation concern.

Introduction

The literature summarizes 2,101 county records for short-horned grasshoppers from Oklahoma. Most of these were compiled by Coppock's (1962) overview of Oklahoma grasshoppers but other sources have also contributed. Many of these surveys focused on specific areas, such as the grasshoppers of Fort Sill, Comanche County (Kondratieff et al., 2005) or Beaver River Wildlife Management Area, Beaver County (Maloski et al., 2014). Others focused on specific taxa, such as Leptysminae (Rehn and Eades, 1961) or the genus *Melanoplus* (Hill, 2015; Hilliard, 2001). The majority of published county records belong to the three most diverse subfamilies of Acrididae in Oklahoma, the Melanoplinae, Oedipodinae, and Gomphocerinae (Table 1).

The collection of grasshoppers in Oklahoma began in the early 1900s, before Oklahoma had been established as a state. Caudell (1902) published the first record of grasshoppers in Oklahoma, listing 33 species he collected from the eastern part of the state. Hubbell and Ortenburger (1927), compiled a list of 80 species and subspecies of grasshoppers known from Oklahoma at the time, based on previous literature and their personal collecting activities. Hebard (1938) published the results of a survey of Orthoptera of Oklahoma, excluding the Oklahoma Panhandle, during which 67 species of grasshopper were collected. Blaire and Hubbell (1939) utilized Acridids to study the biogeography of Oklahoma, dividing the state into biotic districts based on the assemblages of grasshoppers and mammals found in those regions. That same year, Bragg (1939) published a summary of the distribution of Acridid species in Oklahoma, reporting 92 species. The most recent and comprehensive survey of Oklahoma grasshoppers was conducted by Coppock (1962), who worked as a survey entomologist from

1956-1958. During that time, he surveyed all 77 Oklahoma counties, many of them multiple times, and reported 117 species for Oklahoma (Coppock, 1962).

Following Coppock's surveys, an additional 10 species have been reported, bringing the total for the state to 127 species. The high number of grasshopper species found in Oklahoma is due to its location, near the center of the United States, and the resulting precipitation gradient that exists across the state. The southeastern corner of Oklahoma receives an average of 142 cm of rain annually, while in the far western end of the panhandle, the average is 43 cm (ODWC, 2016).

There is also a significant elevation change as one goes westward, from approximately 91 m above sea level in the southeastern coastal plain to over 1494 m at Black Mesa, in the far western panhandle (ODWC, 2016). These two factors result in a wide range of habitats, from the moist deciduous forests of the Ouachita Mountains in southeastern Oklahoma to the dry, desert-like environment of the panhandle. The grasshopper fauna of Oklahoma reflects this wide range of habitats, with many eastern species reaching their western limits of distribution in Oklahoma, and many southwestern species occurring in Oklahoma at the western end of the panhandle.

While many attempts to classify the ecological regions of Oklahoma have occurred, (Bruner, 1931; Blaire and Hubbell, 1938; Duck and Fletcher, 1943; Hoagland, 2000), I chose to use the six ecoregions (Figure 1) developed by the Oklahoma Department of Wildlife Conservation (ODWC, 2016). These ecoregions are determined by geology and vegetation type, two factors that have a substantial effect on the fauna they support. A brief summary of locations and regions discussed in this chapter is as follows.

Ecoregions:

- Shortgrass prairie – arid, desert-like habitat with sparse vegetation. Also known as the high plains, in Oklahoma this ecosystem is largely confined to the panhandle.

- Mixed-grass prairie – the most extensive ecoregion in Oklahoma, encompassing most of the state's western half. This region was historically extensive grassland, but cedar invasion and agriculture have caused extensive habitat changes.
- Crosstimbers – this region represents an ecotone between the eastern forests and western prairies. Oak savannas historically dominated this region.
- Tallgrass prairie – confined to the northeast portion of Oklahoma, this region is characterized by tall, dense grasses with few trees. While the tallgrass prairie is one of the most threatened ecosystems in North America, there are substantial, well-managed remnants left in Osage County.
- Ozark – the dominant aspect of this region is the Ozark Mountains and the forests that grow upon them. Grasslands in this region were historically confined to small glades that grew on nutrient-poor, rocky soils.
- Southeast – the southeast region features a variety of habitats but is dominated by the Ouachita Mountains and the West Gulf Coastal Plain.

Other locations referenced in this paper:

- Panhandle – The western part of Oklahoma that juts out westward from the rest of the state, and consists of three large counties: Beaver, Texas, and Cimarron. In Oklahoma, this region coincides with the shortgrass prairie.
- Wichita Mountains – an isolated range of igneous mountains in the southern mixed-grass prairie, although the plant community there has characteristics of both the crosstimbers and the shortgrass prairie. This is the eastern limit for multiple shortgrass prairie species, such as the grasshoppers *Leprus wheeleri* (Thomas) and *Hippopedon capito* (Stål). Located primarily in Comanche County, it extends westward to Quartz Mountain in Greer and Kiowa counties.

- Arbuckle Mountains – an isolated range of small mountains in the southern crosstimbers ecoregion. Like the Wichitas, it has several isolated populations of grasshopper species more characteristic of areas further west, such as *Syrbula montezuma* (Saussure) and *Brachystola magna* (Girard). Located primarily in Murray County.
- Black Mesa – Specifically, a large, flat-topped mesa along the western edge of Cimarron County that represents the highest point in Oklahoma. The "Black Mesa area" is used to refer to Black Mesa, Black Mesa State Park 10 miles to the southeast, and the intervening area of rocky hills and mesas.

Materials and Methods

One of the goals of this project was to sample grasshoppers in each of the 77 counties in Oklahoma (Figure 1). From summer 2019 through October 2020, grasshoppers were collected throughout the state using a variety of techniques. Collection was done using a combination of sweep netting, aerial netting, and the use of ultraviolet lights. Sweep netting is widely used for grasshopper sampling due to the ease of standardization (Gardiner et al., 2005) but is biased against species that are wary and strong fliers, particularly those in the subfamilies Oedipodinae and Cyrtacanthacridinae. Aerial netting, in which grasshoppers are detected visually and actively pursued, was used to compensate for these limits. Ultraviolet lights are regularly used to collect nocturnal insects (Thomas and Thomas, 1984) and some species of grasshoppers, particularly those in Oedipodinae and Cyrtacanthacridinae, were often collected at these lights.

All adult grasshoppers collected were identified to species, as well as nymphs when it was easily possible. Many resources were used to identify the specimens, including Capinera et al. (2004), Hill (2015), Hilliard (2001), and Otte (1981, 1984). At least one specimen of each

species in each county was retained as a voucher specimen, all vouchers have been deposited in the Oklahoma State University K.C. Emerson Entomology Museum (OSEC).

In addition to field sampling, specimens were examined in the OSEC and the University of Oklahoma Sam Noble Museum (OMNH). While the majority of specimens in the OSEC were correctly identified, a few of the more challenging groups, such as the genus *Melanoplus* and the tribe Hippiscini, required correcting previous misidentifications. At the OMNH, approximately half the grasshopper specimens were undetermined, and an effort was made to add identifications to as many specimens as possible to include in this study. Museum records were only included if they had not been reported in previous literature and were not collected during my surveys.

Results and Discussion

The relative increases in county records varied widely between the different subfamilies (Table 1). The subfamily with the greatest relative increase in county records was Leptysminae, represented in Oklahoma by only *Leptysma marginicollis*, a species likely found throughout the state wherever wetlands with emergent vegetation are found. As this species is currently reported from only seventeen counties, there are likely more in which it remains undetected or overlooked. Cyrtacanthacridinae also had an increase in county records by over 50%, likely due to the difficulty of collecting most species, as adults are alert and strong fliers. Sweep netting, a common technique used when conducting grasshopper surveys, would likely be ineffective at collecting most *Schistocerca* spp. Interestingly, *S. damnifica* (Saussure) had the greatest increase in county records, despite being a poor flier. This is likely because of its occurrence in woodlands in early spring, a habitat and season not regularly studied for grasshoppers.

Romaleinae and Melanoplinae showed the lowest relative increase in county records (Table 1). Romaleids are large, flightless, easy to collect grasshoppers that are most abundant in

rangeland, making them a conspicuous component of a well-sampled grasshopper community. Melanoplinae tend to also be abundant and conspicuous in rangeland and other grassland habitats. This subfamily includes some of the most destructive, and therefore most well-studied, species in Oklahoma. Additionally, it seems that some species, such as *Melanoplus packardii* Scudder and *M. regalis* (Dodge), have declined throughout the eastern portions of their ranges, decreasing the likelihood of finding new records.

Five of the species collected during the survey and reported here were previously undocumented in Oklahoma. *M. macclungi* (Rehn) and *Trachyrhachys aspera* (Scudder) were both collected during the course of the survey. Chapter three discusses the collection of *M. macclungi* in more detail, but it is a widespread species in Oklahoma that was overlooked due to its arboreal habits, hostplant specificity, and similarity to *M. splendidus* Hebard and *M. punctulatus* (Scudder). *T. aspera* was found in the shortgrass prairie alongside twelve other Oedipodine species, including the similar *T. kiowa* (Thomas). As *T. aspera* is one of the smaller species of that assemblage, it could have easily been overlooked where it occurs in low densities.

In addition to *M. macclungi* and *T. aspera*, three species were found in the OSEC that were previously unreported in Oklahoma. *Trimerotropis melanoptera* McNeill is a large, distinctive band-winged grasshopper found in the northwest part of Cimarron County and is represented in the OSEC by a single specimen. While certainly not a species that is easily overlooked, during my visit to Black Mesa it seemed to be rare and was found in greater numbers by walking the prairie at night rather than during the day. *Metaleptea brevicornis* (L.) is a species usually associated with wetlands. Museum specimens were discovered from McCurtain County and an additional specimen was taken at an ultraviolet light in Muskogee County. Based on widely scattered records of *L. marginicollis* (Serville) and the hypothetical status of *Paroxya clavuliger* (Serville), it seems likely that wetlands are one of the most undersurveyed habitats for grasshoppers in Oklahoma. Lastly, a single specimen of *Phrynotettix tshivavensis* (Haldeman)

was collected in the vicinity of Black Mesa in NW Cimarron County. While this is a well-sampled area for grasshoppers, its cryptic coloration and superficial similarity to nymphs of the tribe Hippiscini may have led to it being overlooked by previous collectors.

Two species previously reported in Oklahoma are omitted from this list based on taxonomic changes or dubious occurrence. *M. scudderi* (Uhler) was reported by Coppock (1962) from ten counties in central and eastern Oklahoma. In Hill's revision of the *M. scudderi* species group, however, the range of *M. scudderi* was reduced to the eastern half of the United States, not reaching Oklahoma (Hill 2015). The majority of specimens in the OSEC were reassigned to *M. latus*, which is widespread throughout the central Great Plains.

The second species previously reported from Oklahoma but excluded from this work is *Trimerotropis cincta* (Thomas). This species is found primarily in coniferous forests in the Rocky Mountains, occurring as far east as the Black Hills of South Dakota and the Pine Ridge of Nebraska (Brust et al., 2008; Otte, 1984). Given its habitat preferences, this would be an unlikely species even in the panhandle. The two counties reported by Coppock (1962) were Muskogee and Payne which are in the eastern half of Oklahoma, over 600 km from the nearest known locality in New Mexico. The Payne County record was first reported by Caudell (1902), based on a specimen collected in Stillwater in 1892. Bragg (1939) suggested the record from Payne County was likely erroneous. This specimen could not be located in either the OSEC or the OMNH to confirm its identity, but even if the specimen were correctly identified as *T. cincta*, it would have almost certainly been a case of mislabeling a specimen collected elsewhere. The specimen from Muskogee County is housed in the University of Michigan Museum of Zoology (UMMZ). Due to Covid-19 restrictions, all UMMZ non-essential operations are suspended, so I was unable to examine the specimen in question.

There is one additional 'hypothetical' species to add to the list of Oklahoma grasshopper species, *Paroxya clavuliger*. This species has been reported with photos on bugguide.net and inaturalist.org, two citizen-science websites that allow users to upload photos of insects for identification. The photos were taken at Red Slough Wildlife Management Area in McCurtain County and Boehler Lake in Atoka County, both in the southeast corner of Oklahoma. Due to the lack of voucher specimens to confirm the identification, this species is excluded from current accounts. There are many species that are typically found along the Gulf Coastal Plain that reach southeast Oklahoma, so it is very likely this species occurs in wetlands throughout this region.

The two counties with the highest number of grasshopper species recorded were Cimarron and Comanche counties, each with 81 species. Cimmaron County lies within the species-rich shortgrass prairie ecoregion and has a more diverse landscape than neighboring Texas (71 spp.) and Beaver (66 spp.) Counties. The high diversity of Comanche County is likely due to the Wichita Mountains, which are both the eastern limit for many western species in Oklahoma and the western limit for many eastern species (at least two of these records are likely erroneous however, see species accounts for *Melanoplus splendidus* and *Schistocerca alutacea*). In addition, both Wichita Mountains National Wildlife Refuge and Fort Sill have been extensively sampled, contributing to the high species count. The county with the lowest number of species recorded was Coal County, with only 7 species. This is largely due to sampling bias, as adjacent Atoka (24 spp.), Pontotoc (29 spp.), and Hughes (32 spp.) counties all have substantially more species. County size also plays a role in determining grasshopper diversity. Osage County, the largest county in Oklahoma, is approximately six times larger than Marshall County, the smallest. Osage County has 50 species of grasshoppers recorded, while Marshall has 14, the second lowest following Coal County.

Counties that have large universities tend to have more thorough sampling coverage, because of a long history of experiments, surveys, and student collections. In Oklahoma, the

University of Oklahoma in Cleveland County and Oklahoma State University in Payne County are the two largest institutions with extensive entomological collections. Cleveland County has 49 species recorded, while Payne County has 64, the fifth highest species count following the panhandle counties and Comanche County.

Examination of new species records in these counties can help identify what habitats are likely undersampled throughout Oklahoma. While I collected no new species from Cleveland County in 2019-2020, I did collect five species previously undocumented from Payne County. Three are species typically associated with woodlands, *Melanoplus keeleri* Thomas, *Dichromorpha viridis* (Scudder), and *Amblytropidia mysteca* (Saussure). *L. marginicollis* is associated with wetlands and lakeshores, which, like forests, are often under-sampled by grasshopper researchers. The other new record for Payne County is *Phoetaliotes nebrascensis* (Thomas). While this species does occur in grasslands, its short wings may cause it to be mistaken for a nymph of another grasshopper species, particularly those in the genus *Melanoplus*.

To conclude, there is still much to be learned about the grasshoppers of Oklahoma. This includes three recently described species endemic to Oklahoma, one of which has not been collected since 1955. We have also observed a substantial westward shift in the ranges of many species. Many species that were previously found throughout Oklahoma were only collected in the western half of the state, and many previously widespread mixed-grass prairie species were only found in the panhandle. Whether these range shifts are a result of climate change, a change in land use, or another factor is currently unknown, but is something I hope to conduct additional research on in the future.

Species Accounts

All 128 species of grasshoppers known to occur in Oklahoma are included below, with notes about their range, seasonality, and habits, if they are known. All historical and new county records are included, with new records appearing in bold. Species are sorted alphabetically within the subfamilies they belong.

Oedipodinae

Arphia conspersa Scudder

Arphia conspersa is a western species with a scattered range in Oklahoma, where it is most abundant in the panhandle. It is often found on rock outcroppings, where it is one of the first species active in the spring. This is an uncommon species in Oklahoma and unlike the other *Arphia* species, does not seem to be found in large numbers even in favorable habitat.

PREVIOUS RECORDS: Alfalfa, Cimarron, Cleveland, Comanche, Harmon, Texas.

2019-2020 RECORDS: Cimarron, Harmon, **Kingfisher**, **Major**, **Murray**.

MUSEUM RECORDS: **Custer**, **Payne**, **Pontotoc**.

Arphia pseudonietana (Thomas)

This grasshopper is found primarily in the Oklahoma panhandle. The adults are found in the fall and can be very abundant in favorable habitat, which tends to be bare, flat ground. A previously published record from Bryan County (Coppock, 1962) was based on a misidentified specimen and has been reassigned to *A. simplex*. Adults are found late summer through fall.

PREVIOUS RECORDS: Cimarron, Texas.

2019-2020 RECORDS: Cimarron, Texas.

Arphia simplex Scudder

Arphia simplex is a species that was historically found statewide; however, it appears to have shifted westward in recent years. I collected it only on lightly vegetated ground in the mixed-grass and shortgrass prairie ecoregions, where it is found from late spring through summer.

PREVIOUS RECORDS: Alfalfa, Atoka, Beaver, Beckham, Caddo, Choctaw, Cleveland, Comanche, Cotton, Craig, Custer, Dewey, Ellis, Garfield, Grant, Harmon, Harper, Jackson, Jefferson, Kiowa, Le Flore, Major, Mayes, McClain, Murray, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Rogers, Tulsa, Washington, Woods, Woodward,

2019-2020 RECORDS: Beaver, Beckham, **Blaine**, Caddo, Comanche, Custer, **Greer**, Harmon, Harper, Jackson, Jefferson, **Kingfisher**, **Roger Mills**, **Texas**, **Tillman**, **Washita**, Woodward.

MUSEUM RECORDS: **Canadian**, **Bryan**, **Logan**, **Pottawatomie**.

Arphia sulphurea (F.)

This species is found throughout the eastern half of Oklahoma, with scattered records further west. It is primarily a spring-active species, although adults have been collected through late August. It is usually found on bare ground near woodlands, often along gravel roads.

PREVIOUS RECORDS: Adair, Alfalfa, Atoka, Bryan, Carter, Cleveland, Comanche, Craig, Custer, Delaware, Dewey, Johnston, Le Flore, Mayes, McCurtain, Murray, Oklahoma, Okmulgee, Ottawa, Payne, Pittsburg, Pushmataha, Rogers, Sequoyah, Tulsa, Washington.

2019-2020 RECORDS: Atoka, **Blaine**, **Cherokee**, Cleveland, Delaware, **Haskell**, **Kay**, **Kingfisher**, Le Flore, **Lincoln**, Mayes, McCurtain, **Muskogee**, **Noble**, Oklahoma, **Osage**, **Pottawatomie**, Pushmataha, Sequoyah, **Wagoner**.

MUSEUM RECORDS: **Creek**, **McIntosh**.

Arphia xanthoptera (Burmeister)

Arphia xanthoptera is essentially the fall counterpart to *A. sulphurea*. It is found throughout Oklahoma, excluding the panhandle, though it is more abundant in the east. It is found in a variety of habitats, ranging from open grassland to woodland trails, but is usually found near woodlands. Adults can be found from August through fall.

PREVIOUS RECORDS: Alfalfa, Beckham, Cleveland, Cimarron, Comanche, Creek, Delaware, Ellis, Harper, Hughes, Latimer, Le Flore, Mayes, McClain, Okfuskee, Okmulgee, Osage, Pawnee, Payne, Pottawatomie, Sequoyah, Tulsa, Wagoner.

2019-2020 RECORDS: **Adair**, **Caddo**, **Cherokee**, Comanche, Harper, **Haskell**, Hughes, Le Flore, Mayes, **McIntosh**, **Murray**, **Muskogee**, Payne, **Pittsburg**, **Seminole**, Sequoyah, **Stephens**, **Washington**.

MUSEUM RECORDS: **Love**, **Marshall**, **Oklahoma**, **Pontotoc**, **Woodward**.

Chortophaga viridifasciata (De Geer)

Chortophaga viridifasciata is likely the most abundant and widespread grasshopper in Oklahoma, being found in virtually any habitat, from lawns to clay banks to shortgrass prairie, though it is less abundant in the panhandle than elsewhere in the state. There appear to be two generations per year with adults active year-round, though they are most abundant in the spring and fall.

PREVIOUS RECORDS: Adair, Alfalfa, Atoka, Bryan, Caddo, Canadian, Choctaw, Comanche, Dewey, Ellis, Garvin, Grady, Grant, Harmon, Harper, Hughes, Jefferson, Kay, Kiowa, Latimer, Le Flore, Logan, Love, Mayes, McClain, McCurtain, Murray, Muskogee, Noble, Nowata, Oklahoma, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Rogers, Seminole, Sequoyah, Texas, Tillman, Tulsa, Wagoner, Washington, Woods, Woodward.

2019-2020 RECORDS: Adair, Alfalfa, Atoka, **Blaine**, Bryan, Caddo, Canadian, **Carter**, **Cherokee**, Choctaw, **Cimarron**, Comanche, **Cotton**, **Craig**, **Creek**, **Custer**, **Delaware**, **Garfield**, Grady, **Greer**, **Haskell**, Hughes, Jefferson, **Johnston**, Kay, **Kingfisher**, Le Flore, **Lincoln**, Love, **Marshall**, Mayes, McClain, McCurtain, **McIntosh**, Murray, Muskogee, **Okfuskee**, Oklahoma, **Okmulgee**, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, **Pushmataha**, **Roger Mills**, Rogers, Seminole, Sequoyah, **Stephens**, Tulsa, Wagoner, Washington, **Washita**, Woodward.

MUSEUM RECORDS: **Cleveland**

Circotettix rabula Rehn & Hebard

In 2020, this species was collected exclusively from the bare clay slopes of the Gloss Mountains in north-central Oklahoma. It likely occurs throughout the Gypsum Hills in adjacent counties, but most similar habitat is on private property. Adults can be found from June through October.

PREVIOUS RECORDS: Major.

2019-2020 RECORDS: Major.

Derotmema haydeni (Thomas)

This species is found on patches of bare ground in the shortgrass prairies of the Oklahoma panhandle. Adults were collected in late July and September.

PREVIOUS RECORDS: Beaver, Cimarron.

2019-2020 RECORDS: Cimarron.

MUSEUM RECORDS: **Texas**.

Dissosteira carolina (L.)

Unlike the closely related *D. longipennis*, *D. carolina* remains common throughout Oklahoma, where it likely benefits from human activity. *D. carolina* are more readily found on parking lots and sidewalks than in more natural habitats and are found from late May through November.

PREVIOUS RECORDS: Adair, Beaver, Beckham, Blaine, Canadian, Cherokee, Cimarron, Cleveland, Comanche, Custer, Dewey, Harper, Hughes, Jackson, Jefferson, Kay, Kiowa, Le Flore, Logan, Love, McCurtain, Murray, Muskogee, Okmulgee, Osage, Ottawa, Payne, Pittsburg, Pontotoc, Pottawatomie, Roger Mills, Sequoyah, Texas, Tulsa, Woods, Woodward.

2019-2020 RECORDS: Adair, **Atoka**, Beaver, Blaine, Cherokee, Cimarron, Cleveland, **Creek**, Le Flore, **McIntosh**, Murray, Muskogee, Payne, Pittsburg, **Pushmataha**, **Rogers**, Sequoyah, **Wagoner**, **Washington**.

MUSEUM RECORDS: **Alfalfa**, **Delaware**, **Kingfisher**, **Latimer**, **Major**, **Mayes**, **Noble**, **Oklahoma**, **Tillman**.

Dissosteira longipennis (Thomas)

Dissosteira longipennis has undergone perhaps the most significant range shift of any of Oklahoma's grasshoppers. During the dust bowl period (1930s), it was an economically important pest found throughout the state. Its range has since contracted westward, and it is now only known from the shortgrass prairie of the panhandle. Adults were collected in late July and late September.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Caddo, Canadian, Cherokee, Cimarron, Comanche, Custer, Dewey, Ellis, Garfield, Grant, Greer, Haskell, Harmon, Harper, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Le Flore, Love, Major, McIntosh, Okfuskee, Oklahoma, Okmulgee, Osage, Pawnee, Payne, Pittsburg, Roger Mills, Sequoyah, Texas, Tillman, Washita, Woods, Woodward.

2019-2020 RECORDS: Cimarron.

MUSEUM RECORDS: **Noble**.

Encoptolophus costalis (Scudder)

Encoptolophus costalis is an uncommonly collected species that is found at scattered localities throughout the state. Adults were found in midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Bryan, Cimarron, Comanche, Ellis, Grant, Harmon, Harper, Jefferson, Kay, Kiowa, Noble, Osage, Payne, Texas, Woods, Woodward.

2019-2020 RECORDS: **Atoka**, **Major**, Payne, **Pushmataha**, **Stephens**.

MUSEUM RECORDS: **Garvin**, **Lincoln**, **Love**, **Pottawatomie**, **Seminole**.

Encoptolophus sordidus (Burmeister)

Encoptolophus sordidus is a northern species typically found in weedy areas. While no counties have been specified, Otte (1984) reports a single occurrence in north-central Oklahoma, likely in either Woods or Alfalfa counties. Adults are active late in the season, likely occurring from September through November in Oklahoma.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: N/A

Hadrotettix trifasciatus McNeill

This species is found on rocky outcroppings and eroded hillsides throughout the state, though it is most abundant in the west. When comparing historical records, this species seems to have declined throughout the eastern half of the state, with a single individual from Sequoyah County representing the only eastern specimen collected in 2019-2020. *Hadrotettix trifasciatus* adults occur from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Craig, Creek, Custer, Delaware, Ellis, Harmon, Harper, Hughes, Jackson, Jefferson, Johnston, Kiowa, Le Flore, Logan, Major, Murray, Nowata, Osage, Pawnee, Payne, Pittsburg, Pushmataha, Roger Mills, Rogers, Texas, Tillman, Tulsa, Wagoner, Woods, Woodward.

2019-2020 RECORDS: Beaver, Caddo, Cimarron, Comanche, Harper, Murray, Roger Mills, **Sequoyah**, Texas, **Washita**.

MUSEUM RECORDS: **Adair**, **Carter**, **Dewey**, **Grady**, **Kay**, **Love**, **McClain**, **Oklahoma**, **Stephens**.

Hadrotettix magnificus McNeill

Hadrotettix magnificus is a rarely collected species in Oklahoma, known exclusively from the grasslands surrounding Black Mesa. The one specimen collected in 2020 was a female taken while walking through the prairie at night. Revisiting the site during the day yielded no additional specimens. The specimen was taken in late July.

PREVIOUS RECORDS: Cimarron

2019-2020 RECORDS: Cimarron

Hippiscus ocelote (Saussure)

This grasshopper is common throughout Oklahoma. Like *D. carolina*, it readily takes advantage of anthropogenic habitats, such as lawns and sidewalks. Unlike the other large Hippiscines found in Oklahoma, *H. ocelote* is a fall-active species that overwinters as an egg, with adults found from July-November.

PREVIOUS RECORDS: Adair, Alfalfa, Blaine, Bryan, Caddo, Canadian, Cherokee, Choctaw, Cleveland, Comanche, Creek, Custer, Grant, Harmon, Harper, Hughes, Jefferson, Kay, Kiowa, Latimer, Le Flore, Marshall, McClain, Noble, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee,

Payne, Pittsburg, Pottawatomie, Pushmataha, Rogers, Sequoyah, Texas, Tillman, Wagoner, Woods.

2019-2020 RECORDS: Adair, **Atoka**, **Beaver**, **Beckham**, Blaine, Bryan, Caddo, Canadian, Cherokee, Choctaw, **Cimarron**, Comanche, Custer, **Ellis**, **Grady**, **Greer**, Harper, Hughes, **Johnston**, Le Flore, **Love**, **Major**, McClain, **McCurtain**, **Murray**, **Muskogee**, **Okfuskee**, Payne, Pittsburg, **Roger Mills**, Rogers, **Seminole**, Sequoyah, **Stephens**, Texas, **Washita**, **Woodward**.

MUSEUM RECORDS: Carter, Garvin, Mayes,

Hippopedon capito (Stål)

Hippopedon capito has been collected in the Oklahoma panhandle and the Wichita Mountains in Comanche County, although it likely occurs in intervening areas. It is typically found in habitats with sparse vegetation. Adults are active midsummer through fall.

PREVIOUS RECORDS: Comanche, Cimarron, Texas.

2019-2020 RECORDS: Cimarron

Leprus intermedius Saussure

Leprus intermedius is found in the shortgrass prairie of the panhandle, where it is currently known only from the vicinity of Black Mesa. A single male specimen was collected in late July and was found while walking through the prairie at night. No adults were seen at that location during the day.

PREVIOUS RECORDS: Cimarron

2019-2020 RECORDS: Cimarron

Leprus wheeleri (Thomas)

Leprus wheeleri is found in western Oklahoma, where it is most readily found in the vicinity of Black Mesa in Cimarron County. It is found in the shortgrass prairie, especially around rock outcroppings or gravelly habitats. I found this species abundant in late September but is likely found throughout the fall.

PREVIOUS RECORDS: Caddo, Cimarron, Comanche, Texas.

2019-2020 RECORDS: Cimarron.

MUSEUM RECORDS: **Woodward**.

Mestobregma plattei (Thomas)

Mestobregma plattei has been collected throughout the western half of the state, although in 2020 it was collected exclusively from Cimarron County. It is usually found in habitats with little vegetation, such as rock outcropping and slopes. Adults are found from late summer through fall.

PREVIOUS RECORDS: Beckham, Cimarron, Harper, Major, Payne, Roger Mills.

2019-2020 RECORDS: Cimarron

MUSEUM RECORDS: **Beaver**, **Blaine**, **Kiowa**, **Woods**.

Metator pardalinus (Saussure)

This species is found in the shortgrass prairie ecoregion, where it is found on bare ground with little vegetation. Adults have been collected from May through September.

PREVIOUS RECORDS: Cimarron, Texas.

2019-2020 RECORDS: Cimarron.

MUSEUM RECORDS: **Beaver**.

Nebulatettix subgracilis (Caudell)

Nebulatettix subgracilis is found throughout the west-central portion of Oklahoma, usually on bare ground. Adults were collected midsummer through fall.

PREVIOUS RECORDS: Beaver, Comanche, Grant, Greer, Harmon, Harper, Jackson, Jefferson, Kiowa, Payne, Tillman.

2019-2020 RECORDS: **Atoka**, Jackson, **Major**.

MUSEUM RECORDS: **Kay**, **Love**.

Pardalophora apiculata (Harris)

This species is known from two records, one in the southeast corner of the state and one historical record from the Cherokee Nation (Caudell, 1902). Unfortunately, I could locate neither of these specimens to verify them. However, two specimens were located in the OMNH from Adair and Oklahoma counties. While the Oklahoma County specimen could possibly be mislabeled, the

Adair County specimen seems legitimate, and would support the species' occurrence in far eastern Oklahoma. Throughout most of its range, *P. apiculata* is a spring-active species found in sandy habitats, and adult activity would likely peak in March-April in Oklahoma.

PREVIOUS RECORDS: McCurtain

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Adair**, **Oklahoma**.

Pardalophora haldemanii (Scudder)

This species is recorded throughout Oklahoma, although none were collected in 2020. This species, much like other Hippiscines, would be expected on bare ground, such as gravel roads and clay banks. One specimen collected in Beaver County shows intermediate characteristic with *P. saussurei*, its southern counterpart. Adults would be expected April through August.

PREVIOUS RECORDS: Alfalfa, Beaver, Bryan, Caddo, Canadian, Cherokee, Cimarron, Comanche, Craig, Custer, Harper, Harmon, Kiowa, Latimer, Logan, McClain, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Roger Mills, Rogers, Texas, Tulsa, Woods.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Love**.

Pardalophora phoenicoptera Rehn & Hebard

Pardalophora phoenicoptera is most commonly collected in the eastern part of Oklahoma, extending west to Comanche County. It is often found in rocky habitats, particularly in open woodlands and glades. Adults are found primarily in June and July.

PREVIOUS RECORDS: Adair, Beaver, Carter, Comanche, Craig, Delaware, Le Flore, Mayes, McCurtain, Nowata, Ottawa, Pawnee, Payne, Pushmataha.

2019-2020 RECORDS: **Blaine**, Comanche, Delaware, **Love**, **Muskogee**, Pawnee.

MUSEUM RECORDS: **Creek**, **Osage**.

Pardalophora saussurei Rehn & Hebard

Pardalophora saussurei has historically been recorded throughout Oklahoma, excluding the eastern edge of the state. However, I collected it exclusively in the western half of the state. This species is found in open habitats with bare ground. Adults are active May through August.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Bryan, Caddo, Canadian, Choctaw, Cimarron, Cleveland, Comanche, Custer, Dewey, Ellis, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Kingfisher, Kiowa, Latimer, Logan, Love, Major, Noble, Oklahoma, Osage, Ottawa, Payne, Roger Mills, Rogers, Tulsa, Woods, Woodward.

2019-2020 RECORDS: Beaver, Caddo, Comanche, Ellis, Jackson, Kiowa, Woods.

MUSEUM RECORDS: **Craig**, **Grant**.

Psinidia fenestralis (Serville)

Psinidia fenestralis has been collected from sandy habitats in western Oklahoma. It occurs at low densities, as only one individual was observed at each of the four sites where it was collected in 2020. Adults of this species occur from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Delaware, Harper, Woodward.

2019-2020 RECORDS: Beaver, **Caddo**, Harper, **Woods**.

MUSEUM RECORDS: **Major**.

Spharagemon bolli Scudder

Spharagemon bolli is an eastern species characteristic of open woodlands found throughout the eastern two-thirds of the state, though it is rare in the western portions of its range. Adults are found from July through October.

PREVIOUS RECORDS: Adair, Atoka, Bryan, Cleveland, Comanche, Delaware, Hughes, Kiowa, Le Flore, Lincoln, Mayes, McCurtain, Murray, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pottawatomie, Rogers, Tulsa, Wagoner.

2019-2020 RECORDS: Atoka, **Caddo**, **Haskell**, Hughes, Le Flore, Murray, **Muskogee**, **Noble**, Osage, Payne, Pittsburg, **Sequoyah**.

MUSEUM RECORDS: **Alfalfa**, **McIntosh**, **Oklahoma**, **Pushmataha**.

Spharagemon cristatum Scudder

Spharagemon cristatum is found throughout the state in a variety of sandy habitats. In eastern Oklahoma, it is often found in sandy woodlands, while in the western parts of its range it is usually found in more open habitats, such as dune edges. Adults were collected midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Choctaw, Cimarron, Cleveland, Comanche, Custer, Delaware, Dewey, Ellis, Grady, Grant, Greer, Harman, Harper, Hughes, Jackson, Jefferson, Kiowa, Logan, Major, McClain, McCurtain, Okfuskee Osage, Payne, Pontotoc, Roger Mills, Stephens, Texas, Tillman, Tulsa, Woods, Woodward.

2019-2020 RECORDS: **Atoka**, Beaver, Caddo, Cimarron, Comanche, Dewey, Ellis, Harper, Jackson, **Kingfisher**, **Le Flore**, Major, Texas, Woods.

MUSEUM RECORDS: **Creek**, **Johnston**, **Kay**, **Love**, **Oklahoma**.

Spharagemon equale (Say)

Spharagemon equale is found throughout Oklahoma, though most recent records come from the western portion of the state. Usually found on bare ground in the west and rock outcroppings in the east, adults of this species can be found throughout the summer and fall.

PREVIOUS RECORDS: Beckham, Blaine, Canadian, Cimarron, Cleveland, Comanche, Cotton, Custer, Delaware, Ellis, Greer, Harmon, Harper, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Logan, Major, Mayes, McClain, Muskogee, Okfuskee, Payne, Roger Mills, Rogers, Texas, Tillman, Wagoner.

2019-2020 RECORDS: Cimarron, Comanche, Roger Mills.

MUSEUM RECORDS: **Love**, **Murray**, **Noble**, **Oklahoma**, **Osage**, **Washita**.

Trachyrhachys aspera Scudder

The specimen of *T. aspera* collected on well-grazed shortgrass prairie south of Black Mesa State Park (36.7960, -102.8086), represents a STATE RECORD for Oklahoma. The single female specimen was taken on September 26, 2020. This species is typically found at low densities in shortgrass prairie.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: Cimarron

Trachyrhachys kiowa (Thomas)

Trachyrhachys kiowa is found on bare ground throughout the state but is most abundant in the western half. Adults were collected from July through September.

PREVIOUS RECORDS: Beaver, Bryan, Cimarron, Comanche, Custer, Greer, Harmon, Harper, Hughes, Jackson, Johnston, Kiowa, Latimer, Le Flore, Logan, McCurtain, Nowata, Okmulgee, Payne, Pittsburg, Pottawatomie, Stephens, Texas, Woods.

2019-2020 RECORDS: Beaver, **Blaine**, **Caddo**, **Choctaw**, Cimarron, Greer, Jackson, **Muskogee**, Pittsburg, **Roger Mills**, **Rogers**, Stephens, **Woodward**.

MUSEUM RECORDS: **Beckham**, **Coal**, **Cotton**, **Delaware**, **Ellis**, **Jefferson**, **Love**, **Major**, **Pawnee**, **Pushmataha**.

Trimerotropis agrestis McNeill

Trimerotropis agrestis is well-known from sandy habitats, though more often in upland habitats than the similar *T. maritima* (Harris). This species was not collected during the 2019-2020 survey.

PREVIOUS RECORDS: Cimarron

2019-2020 RECORDS: N/A

Trimerotropis latifasciata Scudder

Trimerotropis latifasciata has been collected from the western half of Oklahoma, where it occurs on bare ground. I found it to be most abundant on the mesa top at Gloss Mountain State Park. Specimens from Cimarron County tend to have more extensive black on the hindwings than those from Major County.

PREVIOUS RECORDS: Beaver, Beckham, Cimarron, Comanche, Cotton, Ellis, Harmon, Harper, Jackson, Kiowa, Major, Osage, Pawnee, Payne.

2019-2020 RECORDS: Cimarron, Major.

MUSEUM RECORDS: **Greer**, **Love**.

Trimerotropis maritima (Harris)

Trimerotropis maritima is found throughout the state, usually along sandy riverbeds or lakeshores, but it has also been collected from upland sandy habitats and even gravel roads. Essentially, this species can be collected where open sand is present. The synonymized (Otte,

2009) *Eximacris phenax*, described from a single specimen collected in Le Flore County (Otte 1984), is now thought to represent a rare dark morph of *T. maritima*. Adults are found from late May through the fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Caddo, Canadian, Cimarron, Cleveland, Comanche, Cotton, Ellis, Grady, Harmon, Harper, Hughes, Jackson, Kay, Kingfisher, Kiowa, Le Flore, Marshall, McClain, McCurtain, Muskogee, Noble, Okfuskee, Oklahoma, Osage, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Sequoyah, Texas, Tulsa, Wagoner, Washington, Woods.

2019-2020 RECORDS: Alfalfa, **Cherokee**, Cleveland, **Creek**, **Dewey**, Harmon, **Haskell**, Jackson, Kingfisher, Kiowa, Le Flore, **Murray**, Payne, Sequoyah, Tulsa, Wagoner, Woods.

MUSEUM RECORDS: **Blaine**, **Love**.

Trimerotropis melanoptera McNeill

Trimerotropis melanoptera is an inhabitant of shortgrass prairie in Cimarron County, Oklahoma. I collected four adults (2 ♂, 2 ♀) at night by wandering the shortgrass prairie north of Black Mesa. No adults were collected in that area during the day, but a single male specimen was taken southeast of Black Mesa State Park the following afternoon. All specimens were collected in late September. The occurrence of *T. melanoptera* in the state has not yet been published, making this a new STATE RECORD for Oklahoma.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: Cimarron.

Trimerotropis pallidipennis (Burmeister)

Trimerotropis pallidipennis is found throughout Oklahoma but is most abundant in the west. Like most *Trimerotropis* spp. it is found on bare ground, but it is also found more often on anthropogenic habitats, such as parking lots and roads, than other *Trimerotropis* spp. Adults were collected from May through September.

PREVIOUS RECORDS: Beaver, Carter, Cimarron, Cleveland, Comanche, Cotton, Creek, Garvin, Greer, Harmon, Harper, Jackson, Kingfisher, Kiowa, Latimer, Le Flore, Okfuskee, Okmulgee, Pawnee, Roger Mills.

2019-2020 RECORDS: Cimarron, Greer, Jackson, **Kay**, **Lincoln**, **Oklahoma**, **Osage**.

MUSEUM RECORDS: **Bryan**, **Pushmataha**, **Texas**.

Trimerotropis pistrinaria Saussure

Trimerotropis pistrinaria is usually found on eroded, gravelly hillsides where it often occurs alongside the similar-looking *Hadrotettix trifasciatus*. Like *T. saxatilis*, its color varies to match the local environment, with individuals found amongst red clay appearing much redder than those found in other locations. This species if found throughout the western half of the state, with adults occurring late summer through fall.

PREVIOUS RECORDS: Beaver, Beckham, Cimarron, Harmon, Harper, Jackson, McClain, Texas, Woods.

2019-2020 RECORDS: Cimarron, **Custer**, Texas.

Trimerotropis salina McNeill

Trimerotropis salina is found in saline environments, usually on salt flats. I only encountered this species north of Great Salt Plains National Wildlife Refuge, but it likely occurs on all salt flats in the state, most of which are difficult to access. I collected *T. salina* in September, but it likely is found throughout late summer and early fall.

PREVIOUS RECORDS: Alfalfa, Comanche, Harmon, Pawnee, Woods.

2019-2020 RECORDS: Alfalfa.

MUSEUM RECORDS: **Jackson**.

Trimerotropis saxatilis (McNeil)

This species is found throughout the state, excluding the panhandle, on rock outcroppings, especially those with an abundance of lichens. Color varies to match the local rocks and lichens; populations in the Wichita Mountains of Comanche County are usually a reddish color that matches the surrounding granite. Adults were collected June through September.

PREVIOUS RECORDS: Cleveland, Comanche, Ellis, Hughes, Johnston, Osage, Pawnee, Pittsburg, Sequoyah.

2019-2020 RECORDS: **Caddo**, Comanche.

MUSEUM RECORDS: **Kiowa**, **McClain**, **Oklahoma**, **Tulsa**.

Tropidolophus formosus (Say)

This unique species is found in western Oklahoma, where it occurs on gravelly hillsides and bare patches of shortgrass prairie. Adults were collected in late July and late September in Texas County, though in Cimarron County, at a site approximately 1600 meters higher in elevation than the Texas County site, *T. formosus* were still third-instar nymphs in late July.

PREVIOUS RECORDS: Beckham, Cimarron, Greer.

2019-2020 RECORDS: Cimarron, **Texas**.

Xanthippus corallipes Rehn & Hebard

Xanthippus corallipes is found throughout the western two-thirds of Oklahoma. It is usually found on bare ground and the majority of specimens collected in 2020 were taken from rocky hillsides or unpaved roads. Adults are found April through August.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Carter, Cimarron, Cleveland, Comanche, Ellis, Harmon, Harper, Jackson, Kiowa, Logan, Major, Murray, Oklahoma, Osage, Payne, Pontotoc, Roger Mills, Rogers, Texas, Tulsa, Woods, Woodward.

2019-2020 RECORDS: **Caddo**, Cimarron, **Greer**, Harmon, **Kingfisher**, Major, Roger Mills, Texas, **Washita**.

MUSEUM RECORDS: **Blaine**, **Choctaw**, **Dewey**.

Xanthippus montanus (Thomas)

Xanthippus montanus is known only from the far western end of the panhandle in Oklahoma. It is usually found in sandy habitats, often associated with sand dunes. This species overwinters as a nymph and adults are likely found April through July in Oklahoma.

PREVIOUS RECORDS: Cimarron

2019-2020 RECORDS: N/A

Gomphocerinae

Acrolophitus hirtipes (Say)

This grasshopper is found in weedy areas, often with rock outcroppings or patches of open gravel. While historically found throughout the state, it now seems to be limited to the western half. Adults are active from late May through August.

PREVIOUS RECORDS: Alfalfa, Beaver, Cimarron, Cleveland, Comanche, Dewey, Harmon, Harper, Jackson, Jefferson, Latimer, Major, McClain, Okfuskee, Oklahoma, Pawnee, Payne, Roger Mills, Texas, Woods.

2019-2020 RECORDS: **Caddo**, Cimarron, Comanche, **Greer**, Harmon, Texas.

MUSEUM RECORDS: **Logan**, **Noble**, **Woodward**.

Ageneotettix deorum (Scudder)

Ageneotettix deorum is abundant throughout Oklahoma, where it is most abundant in the western half of the state. Preferred habitat is grasslands with open patches of bare ground. This species can be found midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Choctaw, Cimarron, Cleveland, Comanche, Custer, Dewey, Ellis, Garvin, Grady, Greer, Harmon, Harper, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Logan, Love, Major, McClain, Muskogee, Noble, Nowata, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pontotoc, Roger Mills, Rogers, Seminole, Sequoyah, Texas, Tillman, Tulsa, Wagoner, Washington, Woods, Woodward.

2019-2020 RECORDS: Beaver, Caddo, Cimarron, Comanche, Ellis, Harper, Kingfisher, **Le Flore**, Major, McClain, **Murray**, Payne, Roger Mills, Seminole, **Stephens**, Texas, **Washita**, Woods.

MUSEUM RECORDS: **Canadian**, **Coal**, **Creek**, **Grant**, **Oklahoma**, **Pittsburg**.

Amblytropidia mysteca (Saussure)

Amblytropidia mysteca is a unique species that overwinters as an adult, with adults occurring in late fall through spring and are occasionally active on warm winter days. It is usually associated with wooded habitats in the eastern half of Oklahoma.

PREVIOUS RECORDS: Bryan, Creek, Le Flore, Pittsburg, Pushmataha.

2019-2020 RECORDS: **Cherokee**, **Haskell**, **Love**, **McIntosh**, **Murray**, **Muskogee**, **Oklahoma**, **Pawnee**, **Payne**, Pittsburg, **Pottawatomie**.

MUSEUM RECORDS: **Hughes**, **Johnston**, **McCurtain**.

Amphitornus coloradus (Thomas)

This grasshopper is found throughout the summer in areas of scattered short grasses. While historical records depict it from throughout Oklahoma, it was collected only in the western half during the 2019-2020 survey.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Cherokee, Cimarron, Comanche, Cotton, Custer, Dewey, Harmon, Harper, Jackson, Major, Murray, Roger Mills, Texas, Tillman, Woodward.

2019-2020 RECORDS: Beaver, Cimarron, Harmon, Harper.

MUSEUM RECORDS: **Ellis**, **Kiowa**, **Woods**.

Aulocara elliotti (Thomas)

Aulocara elliotti has been recorded from the western half of Oklahoma, although I found it exclusively in the panhandle. It is often found in areas of sparse grasses and adults occur from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Caddo, Cimarron, Comanche, Custer, Dewey, Grady, Greer, Harmon, Harper, Jackson, Jefferson, Kay, Kiowa, Logan, Major, McClain, Roger Mills, Stephens, Texas, Tillman, Woods, Woodward.

2019-2020 RECORDS: Cimarron, Texas.

MUSEUM RECORDS: **Oklahoma**.

Aulocara femoratum Scudder

This species is found in the shortgrass prairie ecoregion, where it can be one of the more destructive species. It is found in grassy rangeland habitats with adults occurring from June through October.

PREVIOUS RECORDS: Beaver, Cimarron, Texas.

2019-2020 RECORDS: N/A

Boopedon auriventris McNeill

Boopedon auriventris is an uncommon species in Oklahoma, where it is found in savanna habitats, often with patches of bare ground or rock interspersed. This is the rarest of the three *Boopedon* species in Oklahoma and were only encountered singly during the 2019-2020 surveys. Adults occur from July through September.

PREVIOUS RECORDS: Bryan, Cimarron, Comanche, Delaware, Haskell, Hughes, McClain, Osage, Pawnee, Payne, Pittsburg, Pushmataha, Rogers.

2019-2020 RECORDS: Comanche, **Roger Mills**.

MUSEUM RECORDS: **Creek**, **Latimer**, **Love**, **McCurtain**, **McIntosh**, **Oklahoma**, **Woodward**.

Boopedon gracile Rehn

Boopedon gracile is found primarily in central Oklahoma and typically occurs in areas of dense grasses with interspersed bare patches. Adults occur from June through September.

PREVIOUS RECORDS: Cleveland, Comanche, Cotton, Craig, Dewey, Grady, Harmon, Jackson, Kingfisher, Logan, Love, Major, McClain, Murray, Oklahoma, Payne, Pawnee, Pottawatomie, Rogers, Seminole.

2019-2020 RECORDS: **Atoka**, **Greer**, **Okfuskee**, **Pushmataha**, **Washita**, **Woodward**.

MUSEUM RECORDS: **Blaine**, **Carter**, **Cherokee**, **Ellis**, **Garvin**, **Hughes**, **Jefferson**, **Kay**, **Kiowa**, **Lincoln**, **Mayes**, **Nowata**, **Osage**, **Pontotoc**, **Tulsa**.

Boopedon nubilum (Say)

Boopedon nubilum is found in grassy areas throughout the western half of Oklahoma, where it is most abundant in the panhandle. Adults are found from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Cimarron, Comanche, Cotton, Garfield, Grant, Greer, Harmon, Harper, Jackson, Murray, Rogers Mills, Seminole, Texas, Tillman, Washita, Woods, Woodward.

2019-2020 RECORDS: Beaver, Cimarron, Harper, **Kingfisher**, Roger Mills, Texas.

MUSEUM RECORDS: **Ellis**, **Kiowa**, **Major**.

Chloealtis conspersa (Harris)

Chloealtis conspersa is a northern species that barely reaches Oklahoma in the northeast and northwest portions of the state. This species is usually found in forests with grassy understories. Adults likely occur throughout the summer.

PREVIOUS RECORDS: Adair.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Woodward**.

Cordillacris occipitalis (Thomas)

Cordillacris occipitalis is typically found in areas of sparse vegetation, often on gravelly soils. It is found midsummer through fall.

PREVIOUS RECORDS: Beaver, Beckham, Cimarron, Harmon, Harper, Texas.

2019-2020 RECORDS: Cimarron.

Cordillacris crenulata (Bruner)

Cordillacris crenulata is typically found in areas of little vegetation, often on gravelly soils. It is usually found in vegetatively sparse areas compared to *C. occipitalis*. It is found midsummer through fall.

PREVIOUS RECORDS: Cimarron, Texas.

2019-2020 RECORDS: N/A

Dichromorpha viridis (Scudder)

Dichromorpha viridis is found in woodlands throughout the eastern two-thirds of Oklahoma. Adults are active from midsummer through fall. *Dichromorpha elegans* (Morse), a closely

related species currently undocumented in Oklahoma, could likely be found in the southeast corner of the state in wetland environments.

PREVIOUS RECORDS: Adair, Canadian, Cleveland, Comanche, Johnston, Le Flore, Mayes, McCurtain, Murray, Oklahoma, Pawnee, Tulsa.

2019-2020 RECORDS: **Atoka**, Canadian, **Cherokee**, **Craig**, Le Flore, **Muskogee**, **Ottawa**, **Payne**, **Pushmataha**, **Wagoner**, **Washington**.

MUSEUM RECORDS: **Caddo**, **Creek**, **Grady**.

Eritettix simplex (Scudder)

Eritettix simplex is an early season species found in the western two-thirds of Oklahoma. This species overwinters as a nymph, with adults appearing in early spring and remaining active through June. While collected regularly, it never seems to be abundant.

PREVIOUS RECORDS: Beaver, Beckham, Cimarron, Cleveland, Comanche, Logan, Payne, Roger Mills, Texas.

2019-2020 RECORDS: **Caddo**, Cimarron, **Greer**, **Kingfisher**, **Lincoln**, **Major**, **Noble**, **Oklahoma**, **Pottawatomie**, **Woodward**.

MUSEUM RECORDS: **Ellis**, **McClain**, **Pontotoc**, **Tulsa**.

Heliaula rufa (Scudder)

Heliaula rufa is a rarely collected species in Oklahoma, where it is known from very few specimens, most of which were collected in Cimarron County. This species is usually found in sparsely vegetated areas, usually with gravelly soil. Adults are found throughout the summer.

PREVIOUS RECORDS: Cimarron, Harmon.

2019-2020 RECORDS: N/A

Mermiria bivittata (Serville)

Mermiria bivittata is found throughout Oklahoma in open grassy habitats. Adults are found from summer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Creek, Custer, Garvin, Grady, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Latimer, Le Flore, Logan, McClain, McCurtain, Murray, Okfuskee, Oklahoma, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Rogers, Seminole, Texas, Tillman, Tulsa, Woods.

2019-2020 RECORDS: Alfalfa, **Atoka**, Beaver, Beckham, Caddo, **Carter**, Cimarron, Comanche, Cotton, Custer, **Dewey**, **Ellis**, Grady, Harper, Hughes, **Johnston**, Kingfisher, **Love**, **Major**, Murray, Osage, **Pushmataha**, **Roger Mills**, Texas, Tulsa, **Washita**, **Woodward**.

MUSEUM RECORDS: **Garfield**, **Grant**, **Sequoyah**, **Stephens**.

Mermiria picta (Walker)

This species, like *M. bivittata*, is found in grassy areas throughout the entire state with adults occurring summer through fall. While they are often found occurring together, usually one species predominates over the other.

PREVIOUS RECORDS: Alfalfa, Beaver, Blaine, Cherokee, Cimarron, Comanche, Custer, Harmon, Harper, Jefferson, Kiowa, Latimer, Logan, McClain, Payne, Pottawatomie, Roger Mills, Rogers.

2019-2020 RECORDS: Alfalfa, Beaver, **Caddo**, Cimarron, Comanche, Custer, Harper, **Hughes**, **Noble**, **Major**, **Murray**, **Muskogee**, Payne, **Pittsburg**, **Stephens**, **Texas**, **Woodward**.

MUSEUM RECORDS: **Beckham**, **Creek**, **Ellis**, **Garfield**, **Oklahoma**, **Osage**, **Pawnee**, **Tulsa**, **Washita**, **Woods**.

Mermiria texana Bruner

Mermiria texana is a southwestern species that is well-documented from Cimarron County, with a historical record from Osage County (Coppock 1962). The Osage County record was not verified as I was unable to examine the specimen, which is housed in the UMMZ. Interestingly, this label is from the same locality, 4 miles west of Turley, as the specimen of *Syrbula montezuma* from Osage County. At this time, both records should be considered tentative at best. No definite *M. texana* were collected in 2019-2020 but three specimens were collected that appear to represent hybrids between *M. texana* and *M. bivittata*. Two males from Pushmataha County have the characteristic cream-colored thoracic bands that converge midway down the tegmina but lack the distalmost white streak near the costa. These two were collected alongside typical *M. bivittata*. A female was collected in Comanche County that did possess all the usual

white streaks for *M. texana*, but the light thoracic bands were weakly separated and the patterns not as strongly contrasting as in typical *M. texana*. Jovonn Hill (pers. comm.) has also noted that *Mermiria* specimens in Texas occasionally show traits of both species.

PREVIOUS RECORDS: Beaver, Cimarron, Osage.

2019-2020 RECORDS: N/A

Metaleptea brevicornis (L.)

Metaleptea brevicornis is a rarely collected species in Oklahoma, previously known from a series of five specimens collected at Beavers Bend State Park in the southeast corner of Oklahoma. However, a male specimen taken at an ultraviolet light at Camp Gruber in 2020 would suggest it could be found along the eastern edge of the state, wherever appropriate habitat is available. *Metaleptea brevicornis* is typically found in wetlands and adults are active in late summer through fall. The occurrence of this species in Oklahoma has not been published, making this a new STATE RECORD.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: **Muskogee**.

MUSEUM RECORDS: **McCurtain**.

Opeia obscura (Thomas)

This species is found in grassy areas, usually interspersed with bare ground. It has been collected throughout Oklahoma but is regularly collected in the western third of the state. Adults are found throughout the summer to early fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Caddo, Canadian, Carter, Cleveland, Comanche, Cotton, Harmon, Harper, Kingfisher, Kiowa, Love, McClain, Noble, Osage, Washita.

2019-2020 RECORDS: **Cimarron**, Comanche, **Ellis**, **Greer**, **Roger Mills**, **Stephens**, **Texas**, Washita.

MUSEUM RECORDS: **Blaine**, **Creek**, **Dewey**, **Garfield**, **Grady**, **Grant**, **Logan**, **Oklahoma**, **Woodward**.

Orphulella pelidna (Burmeister)

Orphulella pelidna is a common species throughout Oklahoma but is regularly seen in the eastern half of the state. It is usually seen in partially wooded areas but can also be found in open grasslands. *O. pelidna* adults are found midsummer through fall.

PREVIOUS RECORDS: Adair, Alfalfa, Atoka, Beaver, Cimarron, Cleveland, Comanche, Custer, Grant, Harper, Hughes, Jackson, Le Flore, McCurtain, Noble, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Rogers, Sequoyah, Texas, Tulsa, Woods.

2019-2020 RECORDS: Alfalfa, Atoka, **Caddo**, **Choctaw**, **Haskell**, Le Flore, **Love**, **Muskogee**, Noble, **Seminole**, **Stephens**, Tulsa.

MUSEUM RECORDS: **Grady**, **McClain**, **McIntosh**.

Orphulella speciosa (Scudder)

Orphulella speciosa is commonly found throughout Oklahoma but is most abundant in the western half of the state. It can often be found alongside *O. pelidna*, but generally prefers drier upland habitats with shorter grasses. Adults can be found midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Blaine, Bryan, Caddo, Canadian, Cherokee, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Craig, Custer, Grady, Grant, Harmon, Harper, Hughes, Kay, Kiowa, Latimer, Le Flore, Logan, Love, McClain, McCurtain, Murray, Noble, Nowata, Okfuskee, Okmulgee, Osage, Pawnee, Payne, Pittsburg, Pottawatomie, Pushmataha, Roger Mills, Rogers, Texas, Tulsa, Washington, Woods.

2019-2020 RECORDS: **Adair**, **Atoka**, Bryan, Choctaw, **Greer**, **Haskell**, Hughes, **Jefferson**, Le Flore, **Marshall**, McCurtain. **McIntosh**, **Muskogee**, Okfuskee, Okmulgee, Payne, Pittsburg, **Pontotoc**, Pushmataha, Rogers, **Sequoyah**, **Wagoner**, **Washita**.

MUSEUM RECORDS: **Creek**, **Delaware**, **Garfield**, **Garvin**, **Mayes**, **Woodward**.

Paropomala wyomingensis (Thomas)

Paropomala wyomingensis found throughout the western half of the state, where it is typically collected in sandy habitats. Adults are active from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Cimarron, Harmon, Harper, Jackson, Roger Mills, Texas.

2019-2020 RECORDS: Beaver, Cimarron, **Woods**, **Woodward**.

MUSEUM RECORDS: **Ellis**.

Phlibostroma quadrimaculatum (Thomas)

This slant-faced grasshopper is recorded as being widespread throughout the western half of Oklahoma, where it occasionally is a major pest of rangeland. I collected this species only in the panhandle, suggesting that in recent years it has become less abundant in the eastern portion of its range. Adults are typically found on bare ground with sparse vegetation, where they are active midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Caddo, Cimarron, Comanche, Custer, Dewey, Ellis, Greer, Harmon, Harper, Jackson, Jefferson, Kiowa, Logan, Major, Payne, Roger Mills, Texas, Tillman, Washita, Woods, Woodward.

2019-2020 RECORDS: Cimarron, Beaver.

MUSEUM RECORDS: **Cleveland**, **Kay**, **McClain**, **Oklahoma**.

Pseudopomala brachyptera (Scudder)

Pseudopomala brachyptera is found in grassy habitats, primarily throughout the western half of the state. It is rarely collected but likely overlooked by collectors, as adults could easily be mistaken for the nymphs of a *Mermiria* spp. Adults are found throughout the summer.

PREVIOUS RECORDS: Alfalfa, Comanche, Harmon, McClain, Roger Mills.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Ellis**, **Payne**, **Tulsa**.

Psoloessa delicatula (Scudder)

This species is found in the sparse, shortgrass prairies of the Oklahoma panhandle. Adults are found spring through summer.

PREVIOUS RECORDS: Beaver, Cimarron, Texas.

2019-2020 RECORDS: Cimarron.

Psoloessa texana Scudder

Psoloessa texana is an uncommon species found in sparse, shortgrass habitats primarily in western Oklahoma. Adults are found spring through summer.

PREVIOUS RECORDS: Beaver, Beckham, Cimarron, Cleveland, Comanche, Hughes, Logan, Texas, Woodward.

2019-2020 RECORDS: **Blaine**, Cimarron, Comanche, **Kingfisher**.

MUSEUM RECORDS: **Ellis**, **Johnston**, **Major**, **Muskogee**, **Oklahoma**.

Syrbula admirabilis (Uhler)

Syrbula admirabilis is found commonly throughout the state, though it is less abundant in the panhandle. It occurs in a variety of grassy habitats, from lawns to prairies, and can be abundant in urban areas. Adults occur from July through the fall, with peak abundance in August and September.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Caddo, Canadian, Choctaw, Cleveland, Coal, Comanche, Creek, Custer, Delaware, Ellis, Grady, Grant, Harmon, Harper, Jefferson, Kay, Kingfisher, Kiowa, Le Flore, Love, Mayes, McClain, McCurtain, Muskogee, Noble, Nowata, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pontotoc, Rogers, Texas, Tillman, Tulsa, Wagoner, Woods.

2019-2020 RECORDS: **Adair**, **Atoka**, Beaver, **Bryan**, Caddo, Canadian, **Carter**, **Cherokee**, **Cimarron**, Comanche, **Craig**, Creek, Custer, **Garvin**, Grady, **Greer**, Harper, **Haskell**, **Hughes**, Jefferson, **Johnston**, Le Flore, Love, **Major**, Mayes, McClain, McCurtain, **McIntosh**, **Murray**, Muskogee, Nowata, **Okfuskee**, Okmulgee, Ottawa, Payne, **Pittsburg**, Pontotoc, **Roger Mills**, Rogers, **Seminole**, **Sequoyah**, **Stephens**, Tulsa, Wagoner, **Washita**, **Woodward**.

MUSEUM RECORDS: **Jackson**, **Latimer**, **Logan**, **Marshall**, **Pushmataha**.

Syrbula montezuma (Saussure)

This species occurs along the western and southern edges of Oklahoma, with a historical record from Osage County (Coppock 1962). Like the Osage County record for *Mermiria texana*, this should be considered tentative. While Coppock (1962) claims this species prefers tallgrass prairie, I have always encountered this species in open, lightly vegetated rocky habitats, which makes sense for a species found throughout the southwestern U.S., where tallgrass prairies are lacking. This species has been collected from August through October.

PREVIOUS RECORDS: Cimarron, Jefferson, Osage.

2019-2020 RECORDS: **Caddo**, Cimarron, **Comanche**, **Murray**.

Leptysminae

Leptysma marginicollis (Serville)

This toothpick grasshopper is known from a scattered set of counties that collectively encompass all of Oklahoma. While it is usually associated with emergent vegetation along the edges of ponds and lakes, I have collected multiple specimens of *L. marginicollis* from a grassy cedar glade in Love County. away from obvious water sources. Adults overwinter and can be found essentially year-round.

PREVIOUS RECORDS: Alfalfa, Beaver, Cimarron, Cleveland, Comanche, Harmon, Love, Pittsburg, Pushmataha, Woods.

2019-2020 RECORDS: Love, **Payne**, Pittsburg, Pushmataha.

MUSEUM RECORDS: **Blaine**, **Caddo**, **Harper**, **Major**, **McClain**, **McCurtain**.

Melanoplinae

Aeoloplides turnbulli (Thomas)

Aeoloplides turnbulli is found throughout the western half of Oklahoma, where it is commonly found in weedy habitats, such as roadsides. While it occasionally reaches pest status, this species also can be beneficial as it feeds heavily on *Kali tragus* (L.), an invasive tumbleweed. *A. turnbulli* adults are found throughout the summer and fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Cimarron, Cotton, Custer, Ellis, Greer, Harmon, Harper, Jackson, Major, Roger Mills, Texas, Woods.

2019-2020 RECORDS: Beaver, Cimarron, Harper, Texas.

MUSEUM RECORDS: **Dewey**, **Garvin**, **Kiowa**, **Woodward**.

Campylacantha olivacea (Scudder)

Campylacantha olivacea is found in weedy areas, such as overgrown fields and roadsides, throughout Oklahoma. While common, their mottled green color makes them easy to overlook. This species feeds on a variety of plants within the Asteraceae. Adults are found in late summer through early fall.

PREVIOUS RECORDS: Alfalfa, Atoka, Beaver, Bryan, Choctaw, Cimarron, Comanche, Ellis, Grady, Harmon, Harper, Jefferson, Kiowa, Latimer, Le Flore, Mayes, McCurtain, Noble, Osage, Ottawa, Payne, Pawnee, Pottawatomie, Pushmataha, Texas, Wagoner, Washita, Woods, Woodward.

2019-2020 RECORDS: **Caddo**, Comanche, **Creek**, **Custer**, **Garvin**, Le Flore, **Murray**, **Muskogee**, **Okmulgee**, Payne, **Pittsburg**, **Seminole**, **Washington**, Woods.

MUSEUM RECORDS: **Blaine**, **Canadian**, **Kingfisher**, **Love**, **Nowata**, **Oklahoma**, **Pontotoc**, **Sequoyah**, **Stephens**.

Dactylotum bicolor Charpentier

This strikingly colored grasshopper is found throughout the western half of Oklahoma, where it is typically found in areas of short vegetation interspersed with bare clay or rocks. Adults are found midsummer through fall.

PREVIOUS RECORDS: Blaine, Caddo, Cimarron, Comanche, Cotton, Custer, Dewey, Ellis, Greer, Harmon, Harper, Jackson, Kiowa, Major, Texas, Tillman, Woods.

2019-2020 RECORDS: **Beaver**, **Beckham**, Cimarron, Texas, **Washita**.

Dendrotettix quercus Packard

Dendrotettix quercus is an oak-associated species found throughout the eastern two-thirds of Oklahoma, where it is most abundant in the crosstimbers ecoregion. While typically uncommon, this species occasionally has population outbreaks that can defoliate oak trees. Adults occur from late May through early August.

PREVIOUS RECORDS: Adair, Carter, Cleveland, Comanche, Le Flore, Love, Okfuskee, Osage, Payne, Pushmataha, Seminole.

2019-2020 RECORDS: Cleveland.

MUSEUM RECORDS: **Creek**, **Lincoln**, **Murray**, **Pawnee**, **Pottawatomie**.

Hesperotettix speciosus (Scudder)

Hesperotettix speciosus is found throughout Oklahoma, where it is typically found in upland, weedy areas. It is most abundant in the western two-thirds of the state, where it is usually associated with sunflowers (*Helianthus* spp.), one of its principal foodplants. Adults can be found summer through fall but are most abundant August through September.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Custer, Delaware, Dewey, Ellis, Garfield, Grady, Greer, Harmon, Harper, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Logan, Major, Mayes, McClain, Murray, Noble, Oklahoma, Osage, Pawnee, Payne, Pontotoc, Roger Mills, Tillman, Texas, Tulsa, Washita, Woods, Woodward.

2019-2020 RECORDS: Beaver, Cimarron, Comanche, Dewey, Ellis, **Garvin**, Grady, Greer, Harper, Jackson, Major, Roger Mills, Texas, Woods, Woodward.

MUSEUM RECORDS: **Hughes**, **Pittsburg**, **Stephens**, **Washington**.

Hesperotettix viridis pratensis (Scudder)

Hesperotettix viridis pratensis is found throughout Oklahoma, excluding the panhandle. It feeds primarily on herbaceous plants, often in the family Asteraceae. Where it is found alongside *H. v. viridis*, the two often feed on different plants, and no hybrids were collected. It is likely that the two will be reclassified as separate species in the future (Hill, Brust, pers. comm.). Adults are found early through late summer.

PREVIOUS RECORDS: Comanche, Craig, Delaware, Greer, Hughes, Jackson, Mayes, Murray, Ottawa, Payne, Pontotoc, Rogers, Tillman, Tulsa.

2019-2020 RECORDS: **Major**, **Marshall**, **Noble**, **Roger Mills**.

MUSEUM RECORDS: **Cleveland**, **Creek**, **Custer**, **Kay**, **Lincoln**, **Logan**, **Okfuskee**, **Oklahoma**, **Pushmataha**.

Hesperotettix v. viridis (Thomas)

This subspecies of *H. viridis* has been reported throughout Oklahoma, although I collected it exclusively from the western half of the state. *H. v. viridis* feed primarily on shrubby plants, often in the family Asteraceae. Adults are found from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Cleveland, Comanche, Cotton, Custer, Garfield, Grant, Greer, Jefferson, Kay, Kiowa, Logan, Love, Major, Pawnee, Payne, Pittsburg, Pontotoc, Roger Mills, Rogers, Tillman, Tulsa.

2019-2020 RECORDS: **Cimarron**, Roger Mills, **Texas**, **Washita**, **Woods**.

MUSEUM RECORDS: **Ellis**, **Jackson**, **McClain**, **Oklahoma**, **Stephens**, **Woodward**.

Hypochlora alba (Dodge)

This species is found throughout central Oklahoma, west to the panhandle. In Oklahoma, *H. alba* is strongly associated with silver wormwood, *Artemisia ludoviciana* Pursh, on which it is well-camouflaged. Adults are typically collected in August and September.

PREVIOUS RECORDS: Bryan, Cleveland, Comanche, Harmon, Kay, Stephens.

2019-2020 RECORDS: Comanche, **Custer**, **Grady**, **Greer**, **Murray**.

MUSEUM RECORDS: **Garfield**, **Kingfisher**, **Oklahoma**, **Payne**.

Melanoplus angustipennis (Dodge)

This species is found in grasslands throughout Oklahoma, particularly those with sandy soils. Adults are found midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Atoka, Beaver, Beckham, Blaine, Bryan, Caddo, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Custer, Dewey, Ellis, Grady, Grant, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Logan, Love, Marshall, McClain,

McCurtain, Murray, Noble, Okfuskee, Okmulgee, Osage, Pawnee, Payne, Pontotoc, Roger Mills, Seminole, Sequoyah, Texas, Tillman, Tulsa, Wagoner, Woods, Woodward.

2019-2020 RECORDS: Beaver, Comanche, Ellis, Grady, Harmon, Harper, **Haskell**, Hughes, **Major**, Murray, Texas, **Washita**, Woodward.

MUSEUM RECORDS: **Canadian**, **Creek**, **Garfield**, **Johnston**.

Melanoplus arizonae Scudder

This species is found throughout the western half of Oklahoma, where it is found in dry, short grasslands. Adults have reportedly been collected from May through October.

PREVIOUS RECORDS: Beckham, Caddo, Custer, Greer, Harmon, Harper, Jefferson, Kiowa, Roger Mills, Texas, Tillman.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Beaver**, **Cimarron**, **Woodward**.

Melanoplus arkansas Hill

Melanoplus arkansas is found in the Arkansas Valley of eastern Oklahoma, where it is found in open woodland glades. All Oklahoma specimens were collected in September.

PREVIOUS RECORDS: Le Flore, Muskogee.

2019-2020 RECORDS: N/A

Melanoplus bispinosus Scudder

This species is found throughout Oklahoma. While it is found in a variety of grassy habitats (Coppock 1962), I found it to be strongly associated with sandy areas. Adults are found from midsummer through fall.

PREVIOUS RECORDS: Adair, Alfalfa, Atoka, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Choctaw, Coal, Comanche, Cotton, Custer, Dewey, Garvin, Grady, Harmon, Harper, Haskell, Jackson, Jefferson, Johnston, Latimer, Le Flore, Logan, Love, Major, McCurtain, Murray, Muskogee, Okmulgee, Osage, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Pushmataha, Rogers, Roger Mills, Seminole, Sequoyah, Stephens, Texas, Tillman, Tulsa, Wagoner, Woods, Woodward.

2019-2020 RECORDS: Caddo, Comanche, Haskell, **Kingfisher**, Pittsburg, Sequoyah, Tulsa.

Melanoplus bivittatus (Say)

Melanoplus bivittatus is a common and widespread species throughout Oklahoma, excluding the southeast corner of the state. It is a common species in weedy fields, road edges, and croplands, where it can attain pest status. The long-lived adults are active from June through October.

PREVIOUS RECORDS: Adair, Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Cherokee, Cimarron, Cleveland, Coal, Comanche, Cotton, Craig, Creek, Custer, Delaware, Dewey, Ellis, Garfield, Garvin, Grady, Grant, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Kay, Kingfisher, Kiowa, Latimer, Le Flore, Lincoln, Logan, Love, Major, Marshall, Mayes, McClain, McIntosh, Murray, Muskogee, Noble, Nowata, Okfuskee, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Roger Mills,

Rogers, Seminole, Sequoyah, Texas, Tillman, Tulsa, Wagoner, Washington, Washita, Woods, Woodward.

2019-2020 RECORDS: Beaver, Beckham, Cherokee, Cimarron, Comanche, Ellis, Garvin, Grady, Greer, Harmon, Jackson, Jefferson, Marshall, Mayes, Muskogee, Payne, Pittsburg, Roger Mills, Seminole, **Stephens**, Texas, Tulsa, Washita, Woodward.

Melanoplus bowditchi Scudder

Melanoplus bowditchi is found throughout the western half of Oklahoma, where it is associated with sagebrush, *Artemisia* spp., in sandy environments. Adults are found midsummer through fall.

PREVIOUS RECORDS: Beaver, Beckham, Canadian, Cimarron, Custer, Greer, Harper, Jackson, Roger Mills, Texas, Tillman.

2019-2020 RECORDS: **Woods, Woodward**.

MUSEUM RECORDS: **Ellis**.

Melanoplus cohni Hill

Melanoplus cohni is endemic to the Ouachita Mountains of southeast Oklahoma. Most specimens have been collected from roadside prairies bordering mixed forests, with all specimens collected in August and September.

PREVIOUS RECORDS: Latimer, Le Flore, McCurtain, Pushmataha.

2019-2020 RECORDS: N/A

Melanoplus confusus Scudder

Melanoplus confusus is found throughout Oklahoma in a variety of grassy habitats. This species is found earlier in the season than most other *Melanoplus* spp., with adults active from May through August.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Cimarron, Cleveland, Comanche, Cotton, Craig, Custer, Grant, Harmon, Jackson, Logan, Love, Major, Mayes, McCurtain, Murray, Noble, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Roger Mills, Rogers, Seminole, Texas, Tulsa, Washington, Woods.

2019-2020 RECORDS: **Greer**, Harmon, **Lincoln**, **Tillman**.

MUSEUM RECORDS: **Johnston**, **Woodward**.

Melanoplus decurvus Hill

Like *M. cohni*, *M. decurvus* is endemic to Oklahoma, where it is found in the southeast portion of the state. Specimens were collected from an open swale and a wooded dry creek bed, with all specimens collected in August.

PREVIOUS RECORDS: Atoka, Bryan.

2019-2020 RECORDS: N/A

Melanoplus differentialis (Thomas)

Melanoplus differentialis is one of the most common and widespread grasshoppers in Oklahoma. It has been recorded in every county except Latimer County, where it likely occurs. This species

utilizes a wide variety of open habitats and can be found commonly in rangeland, agricultural fields, and roadsides. Due to its large size and abundance, *M. differentialis* is one of the most important pest grasshoppers in Oklahoma. Specimens showing intermediate characteristics with *M ponderosus* (Scudder) were collected in Beckham, Garvin, and Major counties. Adults are long-lived and can be found from July through December.

PREVIOUS RECORDS: Adair, Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Cherokee, Choctaw, Cimarron, Cleveland, Coal, Comanche, Cotton, Craig, Creek, Custer, Delaware, Dewey, Ellis, Garfield, Garvin, Grady, Grant, Greer, Harmon, Harper, Hughes, Jackson, Jefferson, Johnston, Kay, Kingfisher, Kiowa, Le Flore, Lincoln, Logan, Love, McClain, McCurtain, McIntosh, Major, Marshall, Mayes, Murray, Muskogee, Noble, Nowata, Okfuskee, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Roger Mills, Rogers, Seminole, Sequoyah, Stephens, Texas, Tillman, Tulsa, Wagoner, Washington, Washita, Woods, Woodward.

2019-2020 RECORDS: Adair, **Atoka**, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Choctaw, Cimarron, Comanche, Craig, Creek, Ellis, Garvin, Grady, Greer, Harper, **Haskell**, Johnston, Le Flore, Love, Major, McClain, McCurtain, McIntosh, Murray, Muskogee, Nowata, Pittsburg, **Pushmataha**, Rogers, Sequoyah, Texas, Tulsa, Wagoner, Washington, Washita, Woodward.

Melanoplus discolor (Scudder)

Melanoplus discolor is found in the western third of Oklahoma, where it usually occurs on gravelly or clay slopes with sparse vegetation. This species is often encountered alongside *Dactylotum bicolor*. Adults are active throughout the summer.

PREVIOUS RECORDS: Beckham, Texas, Woods.

2019-2020 RECORDS: **Cimarron**, Texas, **Washita**.

MUSEUM RECORDS: **Ellis**, **Jackson**, **Woodward**.

Melanoplus femurrubrum (De Geer)

Melanoplus femurrubrum is commonly found throughout Oklahoma, where it is often found in habitats with denser grasses than other *Melanoplus* spp. This species was particularly abundant in the tallgrass prairie ecoregion, in the northeast part of the state. Adults can be found from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Carter, Choctaw, Cimarron, Cleveland, Coal, Comanche, Cotton, Craig, Creek, Custer, Delaware, Ellis, Garfield, Garvin, Grady, Harmon, Harper, Haskell, Hughes, Jackson, Kay, Kiowa, Le Flore, Lincoln, Logan, Love, Mayes, Marshall, McClain, McCurtain, McIntosh, Murray, Muskogee, Noble, Nowata, Okfuskee, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Pushmataha, Roger Mills, Rogers, Seminole, Texas, Tillman, Tulsa, Wagoner, Washington, Woods, Woodward.

2019-2020 RECORDS: Beaver, **Canadian**, **Cherokee**, Cimarron, Craig, Creek, Jackson, Mayes, McIntosh, Muskogee, Nowata, Okfuskee, Okmulgee, Ottawa, Pittsburg, Pushmataha, Rogers, Texas.

MUSEUM RECORDS: **Adair**, **Jefferson**, **Sequoyah**.

Melanoplus flavidus Scudder

Melanoplus flavidus is found throughout the western half of Oklahoma, where it is usually found in sandy areas. Adults are found midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Caddo, Comanche, Custer, Dewey, Ellis, Greer, Harmon, Harper, Jackson, Jefferson, Kingfisher, Payne, Roger Mills, Stephens, Texas, Tillman, Woodward.

2019-2020 RECORDS:

MUSEUM RECORDS: **Major**.

Melanoplus foedus Scudder

This species is found in sandy habitats throughout Oklahoma, often associated with riparian areas. Adults can be found from midsummer through early fall.

PREVIOUS RECORDS: Beaver, Beckham, Blaine, Bryan, Caddo, Choctaw, Cleveland, Comanche, Cotton, Custer, Dewey, Grady, Greer, Hughes, Jackson, Jefferson, Kiowa, Logan, Love, Mayes, Okfuskee, Okmulgee, Osage, Payne, Pittsburg, Pontotoc, Pottawatomie, Roger Mills, Seminole, Sequoyah, Tillman, Tulsa.

2019-2020 RECORDS: Beaver, Dewey, Jackson, **Texas**.

MUSEUM RECORDS: **Alfalfa**, **Cimarron**, **Harper**, **Lincoln**, **Major**, **Oklahoma**, **Washita**, **Woods**, **Woodward**.

Melanoplus gladstoni Scudder

Melanoplus gladstoni is apparently a rarely collected species in Oklahoma, known from few specimens. All were collected in shortgrass prairie areas in the panhandle between late July and September.

PREVIOUS RECORDS: Beaver.

2019-2020 RECORDS: **Cimarron**.

MUSEUM RECORDS: **Texas**.

Melanoplus glaucipes (Scudder)

This species is found throughout the western two-thirds of Oklahoma, where it is often encountered in habitats with sparse grasses and gravelly soil. Adults are found from midsummer through fall.

PREVIOUS RECORDS: Beckham, Blaine, Caddo, Cimarron, Comanche, Cotton, Custer, Harmon, Harper, Jackson, Jefferson, Logan, Major, McClain, Murray, Payne, Pontotoc, Roger Mills, Texas, Woods, Woodward,

2019-2020 RECORDS: **Beaver**, Comanche, **Grady**, Harper, **Kingfisher**, Murray, Payne, Roger Mills.

MUSEUM RECORDS: **Ellis**, **Kiowa**.

Melanoplus gracilis (Bruner)

This species has only been collected in Oklahoma from Mayes County along the Grand River, but likely occurs in weedy areas throughout the northeastern portion of the state. Adults are found from late summer through fall.

PREVIOUS RECORDS: Mayes.

2019-2020 RECORDS: N/A

Melanoplus impudicus Scudder

Melanoplus impudicus is known from the eastern half of Oklahoma, where it is found in the grassy understory of dry woodlands. Adults are likely found from midsummer through early fall.

PREVIOUS RECORDS: Choctaw, Le Flore, Pawnee

2019-2020 RECORDS: N/A

Melanoplus inconspicuous Caudell

Melanoplus inconspicuous appears to have a scattered distribution throughout Oklahoma, although most records come from the eastern half of the state. There appears to be no information discussing the habitat of this species, but adults are active June through August. The Texas County record is likely erroneous.

PREVIOUS RECORDS: Atoka, Bryan, Cleveland, Creek, Lincoln, Mayes, McIntosh, Okmulgee, Osage, Pawnee, Payne, Pushmataha, Sequoyah, Texas, Washington.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Craig**.

Melanoplus keeleri Thomas

Melanoplus keeleri is found throughout Oklahoma but is more abundant in the eastern half of the state. While it occurs in a variety of open habitats, I have regularly encountered it in sandy areas, often with scattered cedar trees. Adults are active late summer through fall.

PREVIOUS RECORDS: Bryan, Cherokee, Comanche, Delaware, Garfield, Hughes, Kiowa, Latimer, Le Flore, McCurtain, Osage, Pittsburg, Rogers, Wagoner, Woods.

2019-2020 RECORDS: **Adair**, **Caddo**, **Custer**, **Haskell**, **Murray**, **Muskogee**, **Noble**, **Payne**, Pittsburg, **Seminole**, **Sequoyah**, **Stephens**.

MUSEUM RECORDS: **Creek**, **McIntosh**, **Oklahoma**, **Tulsa**.

Melanoplus lakinus (Scudder)

Melanoplus lakinus is found throughout the western half of Oklahoma, where it is found in sparse weedy areas. Adults are found July through September.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Comanche, Cimarron, Custer, Dewey, Greer, Harmon, Harper, Kiowa, Roger Mills, Texas, Tillman, Woodward.

2019-2020 RECORDS: Cimarron, Greer, Texas.

MUSEUM RECORDS: **Blaine**, **Major**.

Melanoplus latus Morse

Melanoplus latus is a brachypterous species found in a variety of habitats, often associated with bare patches of gravelly soil. Specimens from the Arbuckle Mountains in Garvin and Murray counties, while currently were determined as *M. latus*, have a more evenly curved ventral edge to their cerci. Additional specimens and examination will be required to determine if these are just a variant of *M. latus* or something else. Adults are found in August through October.

PREVIOUS RECORDS: Caddo, Carter, Choctaw, Cleveland, Comanche, Grady, Love, McCurtain, Pottawatomie.

2019-2020 RECORDS: Caddo, Comanche, **Garvin**, **Murray**.

MUSEUM RECORDS: **Oklahoma**, **Pittsburg**.

Melanoplus macclungi Rehn

Melanoplus macclungi is an arboreal species that had not been reported from Oklahoma prior to this survey, although specimens misidentified as *M. splendidus* had been collected. *Melanoplus macclungi* is found on eastern redcedar, *Juniperus virginiana* L., throughout the mixed-grass prairie ecoregion. State and county records for *M. macclungi* were reported in a separate paper, with notes on their natural history. Adults are found from late summer through fall.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: **Blaine**, **Comanche**, **Murray**, **Woodward**.

Melanoplus occidentalis (Thomas)

A western species found most commonly in the Oklahoma panhandle, *M. occidentalis* is primarily found in short-grass prairie habitats with sparse grasses. This was the most abundant *Melanoplus* species I encountered in the Black Mesa area of the panhandle. Adults are active throughout the summer, into early fall.

PREVIOUS RECORDS: Beaver, Cimarron, Greer, Harmon, Harper, Roger Mills, Texas.

2019-2020 RECORDS: Cimarron.

MUSEUM RECORDS: Beaver, **Woodward**.

Melanoplus oklahomae Hebard

Melanoplus oklahomae is endemic to Oklahoma, where it is found in the southeastern corner of the state. It is noted to be found in grasslands by Coppock (1962) but based on the map depicted in Otte (2011), it is possible that some of Coppock's specimens are now known to represent other species, though all specimens examined from the OSEC keyed out to *M. oklahomae*. Adults have been collected in June and July.

PREVIOUS RECORDS: Adair, Le Flore, McCurtain, Pushmataha.

2019-2020 RECORDS: N/A

Melanoplus ouachita Hill

Melanoplus ouachita is found in the southeastern corner of Oklahoma, where it is only known from Ouachita National Forest in Le Flore County. Throughout its range, it has been collected

from grassy roadsides, glades, and open woodlands. Adults have been collected August through September.

PREVIOUS RECORDS: Le Flore.

2019-2020 RECORDS: N/A

Melanoplus ozarkensis Hill

Melanoplus ozarkensis is found in the southern Ozark Mountains, in eastern Oklahoma. It has been collected from forest edges, glades, and grasslands within that region. Adults have been collected August through September.

PREVIOUS RECORDS: Delaware, Mayes, Ottawa, Sequoyah, Wagoner.

2019-2020 RECORDS: **Muskogee**.

Melanoplus packardii Scudder

Melanoplus packardii has been recorded from throughout Oklahoma, although I collected it only in the western half of the state. This species can be very abundant in grassy areas and is commonly found along roadsides and on open rangeland, where it can be an important pest. Adults can be found from June through October.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Cimarron, Cleveland, Comanche, Cotton, Craig, Creek, Custer, Dewey, Ellis, Grady, Grant, Greer, Harmon, Harper, Jackson, Jefferson, Johnston, Kay, Kingfisher, Kiowa, Lincoln, Logan, Love, Major, Marshall, McClain, Murray, Muskogee, Noble, Oklahoma, Okmulgee, Osage, Pawnee, Payne,

Pittsburg, Pontotoc, Pottawatomie, Roger Mills, Rogers, Seminole, Texas, Tillman, Tulsa, Washita, Woods, Woodward.

2019-2020 RECORDS: Beaver, Beckham, Cimarron, Custer, Ellis, **Garvin**, Greer, Harmon, Harper, Kingfisher, Major, Roger Mills, Texas, Washita, Woodward.

MUSEUM RECORDS: **Stephens**.

Melanoplus plebejus Stål

This species is found along the southern edge of Oklahoma, where it occurs in dense grasses, often in moist areas. Adults occur in late summer through early fall.

PREVIOUS RECORDS: Bryan, Caddo, Choctaw, Comanche, Latimer, Marshall.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Hughes**.

Melanoplus ponderosus (Scudder)

This robust grasshopper is found throughout Oklahoma. It is usually found in association with trees and seems to be most abundant in open woodlands and along the edges of forests. Specimens showing intermediate characteristics with *M. differentialis* were collected in Beckham, Garvin, and Major counties. Adults are found from midsummer through late fall.

PREVIOUS RECORDS: Adair, Beckham, Blaine, Bryan, Caddo, Cleveland, Comanche, Cotton, Custer, Grady, Harmon, Harper, Hughes, Jackson, Jefferson, Kiowa, Latimer, Le Flore, Major,

Mayes, McClain, McCurtain, Osage, Payne, Pittsburgh, Pushmataha, Roger Mills, Rogers, Sequoyah, Texas, Tillman, Tulsa, Wagoner.

2019-2020 RECORDS: Adair, **Atoka**, Caddo, Comanche, McCurtain, **McIntosh**, **Murray**, **Noble**, Pittsburg, Roger Mills, **Seminole**, Sequoyah, Tulsa, **Woodward**.

MUSEUM RECORDS: **Ellis**, **Greer**, **Logan**, **Love**, **Oklahoma**, **Washita**.

Melanoplus punctulatus (Scudder)

This arboreal grasshopper is found throughout Oklahoma, excluding the panhandle. In Oklahoma, it is associated with a variety of deciduous trees, though eastern cottonwood, *Populus deltoides* W. Bartram ex Marshall, and common hackberry, *Celtis* spp., seem to be favored in Oklahoma. They are usually found in areas with scattered trees, allowing adults to bask on tree trunks. Adults can be found from late summer through fall.

PREVIOUS RECORDS: Alfalfa, Choctaw, Comanche, McCurtain, Payne.

2019-2020 RECORDS: Comanche, **Grady**, **Muskogee**, **Noble**, Payne.

MUSEUM RECORDS: **Canadian**, **Cleveland**, **Latimer**, **Le Flore**, **Oklahoma**, **Pottawatomie**, **Woodward**.

Melanoplus regalis (Dodge)

Melanoplus regalis has been found throughout Oklahoma, though most often in western portions of the state. While found primarily in grassy rangeland throughout its range, it has been collected in oak-pine forests in the southeast corner of Oklahoma. This boldly patterned, colorful species

was not collected in the 2019-2020 survey and all recent records have come from the panhandle. Adults are active from midsummer through fall.

PREVIOUS RECORDS: Beaver, Beckham, Blaine, Caddo, Cimarron, Comanche, Dewey, Ellis, Harmon, Harper, Kiowa, McCurtain, Logan, Oklahoma, Payne, Pottawatomie, Roger Mills, Texas, Washita, Woodward.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Greer**.

Melanoplus rusticus (Stål)

Melanoplus rusticus is found in the southeastern corner of Oklahoma, where it is found in dry woodlands. Adults were collected in August and September.

PREVIOUS RECORDS: Le Flore, McCurtain, Pittsburg.

2019-2020 RECORDS: Le Flore, **McClain**.

Melanoplus sanguinipes (F.)

Melanoplus sanguinipes is found throughout Oklahoma, although it is less common in the southeast. It is found in a wide range of habitats and is considered one of the most economically important species in the United States. Adults can be found June through November.

PREVIOUS RECORDS: Adair, Alfalfa, Atoka, Beaver, Beckham, Blaine, Bryan, Caddo, Canadian, Carter, Cherokee, Choctaw, Cimarron, Cleveland, Comanche, Cotton, Craig, Creek, Custer, Delaware, Dewey, Ellis, Garfield, Garvin, Grady, Grant, Greer, Harmon, Harper, Hughes,

Jackson, Jefferson, Kay, Kingfisher, Kiowa, Latimer, Le Flore, Lincoln, Logan, Love, McClain, McCurtain, McIntosh, Major, Mayes, Murray, Muskogee, Noble, Nowata, Okfuskee, Oklahoma, Okmulgee, Osage, Ottawa, Pawnee, Payne, Pittsburg, Pontotoc, Pottawatomie, Pushmataha, Roger Mills, Rogers, Seminole, Sequoyah, Stephens, Texas, Tillman, Tulsa, Wagoner, Washington, Washita, Woods, Woodward.

2019-2020 RECORDS: Caddo, Cimarron, Comanche, Custer, Garfield, Grady, **Haskell**, Jackson, Kingfisher, Le Flore, Murray, Muskogee, Payne, Sequoyah, Texas, Tillman, Wagoner.

Melanoplus splendidus Hebard

Melanoplus splendidus is an arboreal species found on cedars, *Juniperus* sp., in the Oklahoma panhandle. In Oklahoma, it is only known from the Black Mesa area of Cimarron County, with reports from Fort Sill in Comanche County most likely referring to *M. macclungi*. I collected a single adult in 2020, but it is likely this cryptically colored species is more abundant than it seems, based on my work with the similar *M. macclungi*. Adults are found late summer through fall.

PREVIOUS RECORDS: Cimarron, Comanche.

2019-2020 RECORDS: Cimarron.

Melanoplus texanus Scudder

Melanoplus texanus is found in south-central Oklahoma, where it is reported from grassy areas in open woodlands. Adults have been collected in June through July.

PREVIOUS RECORDS: Comanche, Grady, Murray.

2019-2020 RECORDS: N/A

Melanoplus warneri Scudder

Melanoplus warneri in Oklahoma is only known from Bryan County in south-central Oklahoma. This species is found in grassy oak woodlands. Both adults in the OSEC were collected in June.

PREVIOUS RECORDS: Bryan.

2019-2020 RECORDS: N/A

Paratylotropidia brunneri Scudder

Paratylotropidia brunneri is a seldomly collected species found primarily in the central portion of Oklahoma. Adults are found in mixed-grass prairies, often adjacent to woodlands. The single individual collected in 2020 was found deceased on an open salt flat. Adults occur from late May through August.

PREVIOUS RECORDS: Bryan, Comanche, Murray, Pawnee.

2019-2020 RECORDS: **Alfalfa**.

MUSEUM RECORDS: **Caddo**, **Garvin**, **Latimer**, **Okfuskee**, **Oklahoma**, **Payne**, **Tulsa**,

Paratylotropidia morsei Rehn & Rehn

This little-known species is found in the southeast corner of the state, where it has been collected from only four sites. It is reported from woodland undergrowth and grassy clearings (Rehn and Rehn, 1943). Adults were collected June through September.

PREVIOUS RECORDS: McCurtain, Pushmataha.

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Le Flore**.

Phoetaliotes nebrascensis (Thomas)

Phoetaliotes nebrascensis is found throughout Oklahoma in areas of dense grasses. I encountered this species most abundantly in the tallgrass prairie ecoregion of northeast Oklahoma. Adults are found from late summer through fall, sometimes remaining active through late November.

PREVIOUS RECORDS: Alfalfa, Beaver, Choctaw, Cimarron, Comanche, Harmon, Harper, Le Flore.

2019-2020 RECORDS: Alfalfa, **Caddo**, Cimarron, Comanche, **Craig**, **Okmulgee**, **Payne**, **Rogers**, **Stephens**, **Texas**, **Woodward**.

MUSEUM RECORDS: **Blaine**, **Canadian**, **Ellis**, **Kingfisher**, **Logan**, **Oklahoma**, **Pawnee**, **Washington**, **Washita**, **Woods**.

Cyrtacanthacridinae

Schistocerca alutacea (Harris)

Schistocerca alutacea is found exclusively in the southeast corner of Oklahoma, having been collected only from Beavers Bend State Park and the vicinity of Page, Oklahoma. Only one specimen was collected in 2020, along a dry riverbed south of Page. The report of *S. alutacea* from Fort Sill, Comanche County (Kondratieff et al., 2005) likely refers to *S. lineata*, which has been classified as a subspecies of *S. alutacea* in the past and is well known from the area but was not reported on the taxa list. This species should be sought in late summer and early fall.

PREVIOUS RECORDS: Le Flore, Comanche.

2019-2020 RECORDS: Le Flore.

MUSEUM RECORDS: **McCurtain.**

Schistocerca americana Drury

This species occurs throughout Oklahoma, excluding the panhandle, but is most abundant in the east. It is found in a variety of habitats, usually with scattered trees. One of the few grasshoppers in Oklahoma to overwinter as an adult, it can be found on warm days throughout the entire year.

PREVIOUS RECORDS: Alfalfa, Caddo, Cherokee, Choctaw, Cleveland, Comanche, Cotton, Craig, Delaware, Garvin, Grant, Jefferson, Kingfisher, Kiowa, Latimer, Le Flore, Major, McCurtain, Muskogee, Noble, Nowata, Osage, Payne, Pontotoc, Sequoyah, Tulsa, Wagoner, Washington, Woodward.

2019-2020 RECORDS: **Adair**, Caddo, Comanche, Delaware, **Grady**, **Haskell**, Le Flore, **Love**, **Mayes**, **Murray**, Muskogee, Noble, **Okfuskee**, **Oklahoma**, **Pittsburg**, Payne, **Rogers**, **Seminole**, **Stephens**, Tulsa.

MUSEUM RECORDS: **Kay**, **Logan, McLain**.

Schistocerca damnifica (Saussure)

Schistocerca damnifica is found throughout the eastern two-thirds of Oklahoma, although populations occur scattered in the mixed-grass prairie ecoregion. This species is found around wooded areas and appears to be most active in early spring.

PREVIOUS RECORDS: Cleveland, Murray, Payne.

2019-2020 RECORDS: **Adair**, **Cherokee**, **Delaware**, **Muskogee**, **Noble**, **Osage**, **Pittsburg**, **Tulsa**, **Wagoner**.

MUSEUM RECORDS: **Latimer**, **Le Flore**, **McCurtain**, **Oklahoma**, **Pontotoc**.

Schistocerca lineata Scudder

Schistocerca lineata is found widely throughout Oklahoma, except the eastern forests. It is usually found in grasslands and prefers more open habitats that *S. americana* or *S. obscura* (F.). Adults are collected from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Blaine, Bryan, Canadian, Cimarron, Cleveland, Comanche, Cotton, Custer, Ellis, Garfield, Garvin, Grady, Grant, Harper, Hughes,

Jackson, Jefferson, Kay, Kingfisher, Logan, Major, Noble, Okmulgee, Osage, Pawnee, Payne, Pottawatomie, Texas, Tillman, Tulsa, Wagoner, Washita, Woods, Woodward.

2019-2020 RECORDS: Alfalfa, Cimarron, Ellis, Garvin, Grady, **Haskell**, **Murray**, **Nowata**, Payne, **Stephens**, Washita.

MUSEUM RECORDS: **Caddo**, **Dewey**, **Kiowa**, **Oklahoma.**

Schistocerca nitens Thunberg

This is a rare species in Oklahoma, with all records coming from single individuals collected in the western third of the state. As this species is a strong flier, Oklahoma specimens are likely strays from Texas. Specimens have been collected in late fall or winter. While its occurrence in Oklahoma is well-noted, no references were found to specify in which Oklahoma counties *S. nitens* had been collected.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Ellis**, **Texas**.

Schistocerca obscura (F.)

This bird grasshopper is found throughout Oklahoma. It is the most encountered *Schistocerca* species in urban settings, where it can be common in gardens. It is usually found in areas with scattered trees or along forest edges. Adults are found midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Atoka, Beaver, Bryan, Cleveland, Comanche, Cotton, Custer, Delaware, Harper, Kay, Kiowa, Love, Murray, Noble, Nowata, Okmulgee, Osage, Pawnee, Payne, Texas, Tulsa, Washington, Woodward.

2019-2020 RECORDS: Comanche, **Grady**, **Le Flore**, **McIntosh**, Murray, Noble, Payne, **Sequoyah**, Woodward.

MUSEUM RECORDS: **Blaine**, **Cherokee**, **Jefferson**, **Major**, **Marshall**, **Mayes**, **Oklahoma**.

Romaleidae

Brachystola magna (Girard)

Brachystola magna is found throughout the western third of Oklahoma, although it has historically been reported as far east as Osage and Tulsa counties (Coppock 1962). This species is usually found in areas of short or sparse vegetation in open grassland. Adults are found from midsummer through fall.

PREVIOUS RECORDS: Alfalfa, Beaver, Beckham, Cimarron, Comanche, Ellis, Grant, Harmon, Harper, Kay, Logan, Major, Osage, Roger Mills, Texas, Tulsa, Washita, Woods, Woodward.

2019-2020 RECORDS: Beaver, Beckham, Cimarron, Harmon, Roger Mills, Texas, Washita.

MUSEUM RECORDS: **Blaine**, **Jefferson**, **Kiowa**, **Murray**.

Phrynotettix tshivavensis (Haldeman)

This species is known in Oklahoma from a single specimen collected in Cimarron County by D.C. Arnold. It was collected on July 14, 1971 in rangeland approximately five miles north of

Kenton. This was most likely on the northern side of Black Mesa, a known locality for several western species that barely reach Oklahoma. As this record appears to be unpublished, this specimen represents a STATE RECORD for Oklahoma.

PREVIOUS RECORDS: N/A

2019-2020 RECORDS: N/A

MUSEUM RECORDS: **Cimarron**

References

Blair, W.F. and T.H. Hubbell. 1938. The biotic districts of Oklahoma. *American Midland Naturalist.* 20: 425-454.

Bragg, J.H. 1939. The geographic distribution of Acrididae in northern Oklahoma. *The American Midland Naturalist*. 22: 660-675.

Bruner, W.E. 1931. The vegetation of Oklahoma. *Ecological Monographs*. 1: 99-188.

Brust, M.L., W.W. Hoback, and R.J. Wright. 2008. A synopsis of Nebraska grasshopper distributions. *Journal of The Kansas Entomological Society*. 81(3): 208–255.

Capinera, J.L., R.D. Scott, and T.J. Walker. 2004. Field guide to grasshoppers, katydids, and crickets of the United States. *Comstock Publishing Associates*. New York.

Caudell, A.N. 1902. Notes on Orthoptera from Oklahoma and Indian Territory with descriptions of three new species. *Transactions of the American Entomological Society*. 28: 83-91.

Coppock, S., Jr. 1962. The grasshoppers of Oklahoma (Orthoptera: Acrididae). Oklahoma State University Agricultural Experimental Station. Processed Series P-399. Stillwater, Okla.

Duck, L.G. and J.B. Fletcher. 1943. A game type map of Oklahoma. A survey of the game and fur-bearing animals of Oklahoma. Oklahoma Department of Wildlife Conservation, Oklahoma City.

Gardiner, T., J. Hill, and D. Chesmore. 2005. Review of the methods frequently used to estimate the abundance of Orthoptera in grassland ecosystems. *Journal of Insect Conservation*. 9: 151–173.

Hebard, M. 1938. An ecological survey of the Orthoptera of Oklahoma. *Oklahoma Agricultural Experiment Station Technical Bulletin*. 5: 1-31.

Hefley, H.M. 1937. Ecological studies on the Canadian River floodplain in Cleveland County, Oklahoma. *Ecological Monographs.* 7:3 345-402.

Hill, J.G. 2015. Revision and biogeography of the *Melanoplus scudderi* species group (Orthoptera: Acrididae: Melanoplinae) with a description of 21 new species and establishment of the *Carnegiei* and *Davisi* species groups. *Transactions of the American Entomological Society*. 141:2 252-350.

Hilliard, R.H. Jr. 2001. Two new grasshopper species in the *Texanus* group of the genus *Melanoplus* (Orthoptera: Acrididae: Melanoplinae) with biological notes on the group. *Transactions of the American Entomological Society*. 127:1 31-68.

Hoagland, B. 2000. The Vegetation of Oklahoma: A Classification for Landscape Mapping and Conservation Planning. *The Southwestern Naturalist*. 45:4 385-420.

Hubbell, T.H. and A.I. Ortenburger. 1927. Notes on Oklahoma Orthoptera with a list of species from the State. *Proceedings of the Oklahoma Academy of Science*. 6: 149-183.

Kondratieff, B.C., J.P. Schmidt, P.A. Opler, and M.C. Garhart. 2005. *Insects of western North America 4. Survey of selected arthropod taxa of Fort Sill, Comanche County, Oklahoma. Part 3.* Colorado State University. Accessed 13 March 2021. https://mountainscholar.org/bitstream/handle/10217/81137/BSPMGILL_InsectsofWesternNorthAmerica4.pdf?sequence=1&isAllowed=y.

Masloski, K., C. Greenwood, M. Reiskind, and M. Payton. 2014. Evidence for diet-driven habitat partitioning of Melanoplinae and Gomphocerinae (Orthoptera: Acrididae) along a vegetation gradient in a western Oklahoma grassland. *Environmental Entomology*. 43:5 1209-1214.

Oklahoma Department of Wildlife Conservation. 2016. Oklahoma comprehensive wildlife conservation strategy: a strategic conservation plan for Oklahoma's rare and declining wildlife. Accessed 13 March 2021. https://38.66.12.38/sites/default/files/Oklahoma%20Comprehensive%20Wildlife%20Conservation%20Strategy_0.pdf.

Otte, D. 2011. Eighty New Melanoplus Species from the United States (Acrididae: Melanoplinae). *Transactions of The American Entomological Society*. 138: 73-167.

Otte, D. 2009. New status for the grasshopper genus *Eximacris* Otte 1984 (Orthopera: Acrididae). *Transactions of the American Entomological Society*. 135(4): 493-495.

Otte, D. 1984. The North American grasshoppers, Volume II: Acrididae: Oedipodinae. *Harvard University Press*. Massachusetts.

Otte, D. 1981. The North American grasshoppers, Volume I: Acrididae: Gomphocerinae and Acridinae. *Harvard University Press*. Massachusetts.

Rehn, J.A.G. and D.C. Eades. 1961. The tribe Leptysmini (Orthoptera; Acrididae; Cyrtacanthacridinae) as found in North America and Mexico. *Proceedings of the Academy of Natural Sciences of Philadelphia.* 113: 81-134.

Rehn, J.A.G. and J.W.H. Rehn. 1943. The North American locust genus Paratylotropidia (Orthoptera, Acrididae, Cyrtacanthacridinae). *Transactions of the American Entomological Society*. 69:1 33-60.

Thomas, A.W. and G.M. Thomas. 1994. Sampling strategies for estimating moth species diversity using a light trap in a northeastern softwood forest. *Journal of the Lepidopterists' Society*. 48: 85–105.

CHAPTER III

NEW STATE RECORDS FOR *MELANOPLUS MACCLUNGI* (ORTHOPTERA: ACRIDIDAE) AND NOTES ON ITS BIOLOGY

Abstract

Melanoplus macclungi Rehn is a little-known grasshopper previously recorded from a single site, south of Sun City, Kansas. As part of a survey of Oklahoma grasshoppers, I collected this species throughout western Oklahoma and northeast Arkansas. Analysis of citizen-science data found additional records for *M. macclungi* in central Arkansas and southwest Missouri. From these specimens, I obtained information on habitat preference, parasitoids, and fecundity.

Introduction

The *Melanoplus punctulatus* species-group contains three species: *M. punctulatus* (Scudder), *M. splendidus* Hebard, and *M. macclungi* Rehn (Rehn, 1946). Behaviorally, these species differ from most other *Melanoplus* by being arboreal. The adults feed exclusively on the leaves or needles of the trees on which they occur, and females of *M. punctulatus* have been observed to oviposit within bark crevices of living trees (Capinera *et al*., 2004), allowing this species to complete its entire life cycle without leaving the tree canopy. These arboreal habits have resulted in a relatively poor body of knowledge regarding the species in this group, despite being large, distinct, and collectively widespread grasshoppers. As recently as 2014, the discovery of *M. punctulatus* in Dawes County, Nebraska extended the species' known range 600 km west (Brust and Hoback, 2015). Shortly after, the collection of a specimen in northeastern Wyoming extended its known range an additional 250 km to the northwest (Harman and Brust, 2019). The habits of the *punctulatus* species-group are also little-known, with some authors suggesting that *M. punctulatus* is nocturnal (Capinera *et al*., 2004). However, the regularity with which individuals are found basking on tree trunks during the day may suggest otherwise (Brust and Harman, 2020).

While *M. punctulatus* is rare in collections (Coppock, 1962), it is reported regularly on citizen-science websites such as iNaturalist (2020). As of 2019, there were nine specimens of *M. punctulatus* within the Oklahoma State University K.C. Emerson Entomology Museum that were collected from Oklahoma, making it one of the least collected widespread *Melanoplus* species in the collection. In addition, grasshopper surveys conducted throughout 2019 and 2020 added only eight additional specimens to the collection. However, as of December 2020, there were 45 accurately identified photos of *M. punctulatus* submitted to iNaturalist from Oklahoma, excluding those submitted by myself (iNaturalist, 2020). This information, along with the high numbers collected from tree trunks in Nebraska, suggests that *M. punctulatus* can be common in the right

habitats but that conventional grasshopper sampling techniques, which usually involve sweeping a net through vegetation or actively pursuing grasshoppers as they flush to escape an approaching collector (Hill, 2012), are inadequate for collecting the species belonging to the *punctulatus*-group. In New Brunswick, Lindgren funnels deployed in tree canopies to sample cerambycid beetles collected four out of seven collection records of *M. punctulatus* in the province (Catling *et al.*, 2013; McAlpine *et al.*, 2015). However, citizen science submissions increased the number of known records dramatically. As of December 2020, there were 28 positively identified records of *M. punctulatus* for New Brunswick in iNaturalist (2020), four times the number of conventionally published records.

While recent observations have shed light on the habits and range of *M. punctulatus*, the same cannot be said for *M. splendidus* and *M. macclungi*. *M. splendidus* is similar to *punctulatus* but is typically pale gray in color with thinner male cerci and is found primarily on junipers (*Juniperus* spp.) (Hebard, 1920 Rehn, 1946; Knutson *et al.*, 2019). It was described from New Mexico and has since been found in Arizona, Colorado, and the northwest corner of Oklahoma (Rehn, 1946; Coppock, 1962). While most records just note "junipers" as its host, photographic records and personal experience suggest *Juniperus monosperma* (Engelmann) is likely one of its primary host species (Bugguide, 2020). Interestingly, this species is reported to have been taken in good numbers at lights in New Mexico (Tinkham, 1938), suggesting it may be nocturnal.

Like *M. splendidus*, little information is known about the life history of *M. macclungi*. It was described from an extensive series of specimens taken near Sun City, Kansas, a location that has resulted in the common name "Kansas juniper grasshopper" (Rehn, 1946). While it is most similar to *M. splendidus*, a number of differences in the reproductive structures of the males and females separate the two (Rehn, 1946). The entire type series of 174 specimens was collected from eastern red cedar, *Juniperus virginiana* L. (Pinales: Cupressaceae), approximately 9 km south of Sun City, located within Barber County in south-central Kansas (Rehn, 1946). Rehn

noted that specimens were collected from lower limbs of cedars, with specimens taken on August 20 and September 14. Since its description, there has been little additional information published about this species. The lack of recent records combined with its small range earned it the designation of 'missing' within the Recently Extinct Plants and Animals Database (Holmes, 2020). We have found this species to be extant and far more widespread than previously thought. The following observations provide new distribution records and descriptions of the behavior of *M. macclungi*.

Methods

In Comanche County, Oklahoma, on October 5, 2019, we collected a female specimen of *M. macclungi* in an area known as the Parallel Forest (34.751, -98.579). The Parallel Forest is a sixteen-acre rectangle of eastern red cedar trees, each planted approximately 2 meters (6 feet) apart. It was reportedly planted for use as fence posts in 1912, with the trees placed close together so that they would grow upward with straight trunks. However, this is uncertain, as other sources claim it was created as a windbreak experiment during the dust bowl. Regardless of the reasoning, the result is a unique forest primarily consisting of closely spaced cedar trees, crisscrossed by a network of trails. The *M. macclungi* specimen was the first documented individual collected outside of Kansas, at a site approximately 300 km south of the type location. In addition to expanding the known range of *M. macclungi*, this site also solved an additional question. Some have suggested that *M. punctulatus* and *M. splendidus* were variants of the same species (Harman and Brust, 2019). However, at the Parallel Forest, *M. macclungi*, which is most likely the closest relative to *M. splendidus* (Rehn, 1946), was found alongside *M. punctulatus*. Subsequent visits to the area have found no individuals showing intermediate characteristics, with the two species occurring on different tree species. If *M. macclungi* and *M. punctulatus* do not interbreed where they co-occur, then *M. splendidus* and *M. punctulatus* are almost certainly separate species.

Following the collection of *M. macclungi* in 2019, we investigated how widespread *M. macclungi* was in Oklahoma. Since the trees at the Parallel Forest were intentionally planted, it seemed plausible that an ootheca, deposited onto the bark of a young cedar, could have brought the grasshoppers to the area from wherever those trees had originated. Over the winter, we found two additional county records for Oklahoma. One record was found by examining unidentified grasshoppers on iNaturalist (2020), as Shawn Johnson had photographed *M. macclungi* on September 23, 2018 and September 1, 2019, on the spillway of Lake Fort Supply, in Woodward County, OK. The other record was found by reexamining museum specimens. A series of four specimens were collected west of Watonga, Blaine County, OK on August 7, 1980 but were labeled as *M. splendidus*. However, upon further examination, these were keyed to *M. macclungi*. Records of *M. splendidus* from east of the Oklahoma panhandle (Kondratieff et al., 2005) almost certainly refer to *M. macclungi* as well.

On September 6-7, 2020, we conducted a survey targeting *M. macclungi* in central Oklahoma. All of the sites chosen were located in the mixed-grass prairie ecoregion, because that ecoregion contained all three of the known records. Potential new sites were located by utilizing Google Maps to find areas with an abundance of red cedar trees, and known sites were visited to obtain voucher specimens. While some specimens were killed in the field, many were placed in vials in a cooler to bring back to the lab for observation.

Collecting was done between 0800 hrs. and 1830 hrs. While the type series was collected by sweeping red cedars (Rehn, 1946), we found that attempts to net the grasshoppers were usually thwarted by dense branches. We found that the most effective collecting technique consisted of beating cedar branches with the detached handle of an insect net, while holding the net below so that the grasshoppers would fall into the net where they could be easily collected. Visual searches also proved successful, as grasshoppers often were perched on the outer branches of red cedars where they were easily spotted. Sites were surveyed for approximately 15 minutes

if no *M. macclungi* were collected, and longer if *M. macclungi* were discovered in order to obtain additional specimens. The arrival time at each site, the approximate amount of time spent searching, and general notes about the trees (scattered versus dense, large versus small, exclusively cedars versus mixed trees) were recorded.

Results

A total of 28 adult *M. macclungi* were collected from four of 13 sites surveyed, with one site visited twice (Table 2). The majority of specimens were taken in Comanche County (15), while smaller numbers were taken in Woodward (5) and Blaine (8) Counties. No specimens were taken at sites in Major or Custer Counties. In all instances where *M. macclungi* were found, the trees were greater than 4 meters tall (Table 2). At three of the four successful sites, the trees were dense (with tree branches coming into contact with the branches of nearby trees) and consisted almost exclusively of red cedars, with few trees of other species present (Figure 22).

Discussion

At all sites except the Parallel Forest, grasshoppers were concentrated on just one or two trees. For example, at the Woodward County site we surveyed approximately 30 cedar trees, all of similar height and in similar habitat, over the forty-minute collecting period. All five grasshoppers were taken from the same tree. The two Blaine County sites were similar, with all grasshoppers taken from a few adjacent trees within a substantial area of seemingly suitable habitat. All grasshoppers from these three sites were collected on the southern edge of the cedar woodlands, suggesting that thermoregulation and the need to bask may contribute to their distribution.

In contrast, the Parallel Forest was not like the other sites. The lack of branches near the base of the trees made beating the branches impossible, so *M. macclungi* were collected in the understory of the forest. The majority of specimens were taken from the ground, though a few

were collected from tree trunks. All specimens from the previous sites were taken directly from red cedar trees, with none being found on the ground or in surrounding vegetation. Specimens collected at Parallel Forest represented an even ratio of males to females (7:8), and thus, it was not likely a case of females descending from trees to oviposit. Toward the middle of the forest there was an open, vegetation-free patch of ground shaded by two red cedar trees where two *M. macclungi* were collected during the 1230 hr. visit. After arriving at that spot during the 1630 hr. visit, two additional *M. macclungi* were seen, one on the ground and one on a tree trunk. After collecting these, another was spotted and collected. Suspecting that the grasshopper had fallen from the tree, the open area was scanned to make sure no others were present. Approximately three minutes later, a fourth *M. macclungi* appeared toward the middle of the bare ground, seemingly out of nowhere. *M. macclungi* are poor jumpers and fliers, so it seems likely that they were dropping from the cedar tree. This may be a form of predator avoidance or may have been due to the high winds that day.

Additional Records for *Melanoplus macclungi*.

Upon examination of a drawer of unidentified Orthopterans in the K. C. Emerson Entomology Museum, at Oklahoma State University, one specimen was immediately identified as *M. macclungi*. Unlike the other specimens examined, this specimen was collected in Arkansas, at Beaver Dam, Carroll County, on September 11, 1998. While the specimen was keyed to *M. macclungi*, the location represented a remarkable range extension. In addition, being located in the southern Ozarks, this location represented a substantially different ecosystem than that of the mixed-grass prairie where all previous records were collected. To verify this record, we visited the site on September 11, 2020. Our search began at 1625 hrs., surveying amongst a group of red cedars growing below the dam, at 36.4233, -93.8436. We searched unsuccessfully for approximately 40 minutes at the cedar grove and surrounding area, where both *Trimerotropis saxatilis* and *Spharagemon equale* were collected on rock outcroppings. At 1710 hrs., we moved

to the cedars growing above the dam, at 36.4200, -93.8448. Here, we encountered *M. macclungi* almost immediately. The grasshoppers were incredibly abundant compared to the sites in Oklahoma and 33 specimens were collected over the 50-minute collecting period. Similar to most Oklahoma sites, all specimens were collected from cedar branches. They seemed more widespread within the habitat, however, and were found on all the large cedar trees we examined. Six of the grasshoppers were taken as mating pairs. The cedar trunks and surrounding ground were searched for ovipositing females; however, none were found.

The following day we collected in Missouri. Both sites were in the White River Hills, a region of the Ozarks characterized by thin soils and rock outcroppings, conditions that have resulted in extensive cedar glades in the region. However, at both 36.6587, -93.2942 and 36.5925, -92.8296, Taney County, no *M. macclungi* were found.

On September 20, 2020, while sampling grasshoppers in south-central Oklahoma, an additional population of *M. macclungi* was discovered in Murray County at 34.4966, -96.9856. This area was located on a south-facing slope, where vegetation consisted of a series of glades with scattered trees separated by denser woodland. Sixteen *M. macclungi* were found on large, scattered red cedars in one of these openings. However, no specimens were taken from any of the trees along the edge of the clearings.

On October 9-10, we sampled junipers throughout northern Texas to search for populations of *M. macclungi*. Because the site in Murray County was close to the Texas border, most of our sampling took place around the nearby Dallas Fort-Worth area. The primary sites were in Wise (33.3449, -97.5948), Tarrant (32.8472, -97.4758), Dallas (32.6365, -96.9589), and Rockwall (32.9486, -96.4676) Counties. The Dallas and Rockwall sites had large stands of densely placed, tall red cedars similar to the Parallel Forest. However, despite hiking extensively through the cedars and sampling the edges of the cedar forests, no *M. macclungi* were collected.

Citizen-Science Records

While grasshoppers, *Melanoplus* species in particular, can be challenging to identify from photos alone, *M. macclungi* is distinct enough with strong dark and light patterning on the pronotum that differentiates it from most other species, and it can be reliably identified from photographs. Although a boldly marked *M. punctulatus* can appear similar, the pale subelliptical spot on the sides of the pronotum is distinct and is not as bold in *M. punctulatus* as it is in *M. macclungi* (Rehn, 1946) (Figure 19). *M. splendidus* is similar, but is found further west, lacks the bold pale spot present in *M. macclungi*, and is pale gray instead of dark olive gray as in *M. macclungi* (Figure 20).

Searches of online databases were performed by looking through all photos of short-horned grasshoppers (Caelifera) from Oklahoma and surrounding states (Kansas, Nebraska, Colorado, New Mexico, northern Texas, Arkansas, Louisiana, and Missouri). Both iNaturalist (2020) and Bugguide (2020) were used. Due to general unfamiliarity with *M. macclungi*, most observations were either unidentified as a *Melanoplus* sp., or mistakenly identified as *M. punctulatus*. Five additional records from three states were discovered.

The two most notable records were from Stone County, AR and Stone County, MO (Table 3). The Missouri record represents a state record for Missouri, while the Arkansas record is the easternmost known occurrence of *M. macclungi*, approximately 630 km ESE of the type locality near the eastern edge of the Ozarks in Arkansas.

Looking at the overall range of *M. macclungi*, it appears that there are two separate populations, one primarily within the mixed-grass prairie region of Oklahoma and Kansas, and another within the mountainous regions of Missouri and Arkansas (Figure 18). However, there has been very limited sampling specifically for *M. macclungi*, so it likely occurs at more sites.

Regional Variation

While looking at the series of *M. macclungi* across locations, we found variation present that was not indicated in the original species description. For example, the original description states that while the hind tibia coloration can vary from maroon to slate blue, the inner surface of the hind femur were always deep blood red. This is consistent with our findings from western populations, as all specimens taken from Blaine, Comanche, and Woodward Counties in Oklahoma showed deep red on the inner hind femur. However, this trait is variable in eastern populations, and of the 33 specimens collected in Carroll County AR, two males and two females exhibited slate blue coloring on the inner femur, while the others were red or gray. In Murray County OK, the coloration was also variable, but exact ratios are unavailable as the color is only discernable in live specimens. Western specimens also tended to have more strongly contrasting colors throughout, with Murray County *M. macclungi* falling in between the eastern and western specimens.

Size also varied among the populations. In order to get an accurate measurement not influenced by fecundity or other factors that could lengthen the abdomen, the length of the grasshoppers was measured from the front of the head to the end of the tegmina. The grasshoppers were grouped by the three regions where they were collected, western Oklahoma, Murray County, and Arkansas, and by sex. Male *M. macclungi* from Arkansas had a mean head-to-tegmen length of 29.25 mm. This was significantly smaller (ANOVA, $F = 9.86$; $df = 1, 26$; $P = 0.012$) than male specimens from western Oklahoma ($\bar{x} = 30.96$) and approached significance (ANOVA, $F = 4.96$; $df = 1, 26$; $P = 0.057$) when compared with the specimens from Murray County, AR ($\bar{x} = 31.37$). While the males showed some difference in length among populations, the female lengths were quite variable and did not reveal significant differences.

Biological Observations

Specimens of *M. macclungi* were kept alive for observation in the laboratory to learn more about their life history. As we collected more males than females, unpaired females were placed singly in condiment cups, while pairs were kept in 8 x 13 cm "critter carriers," that consisted of clear plastic containers with ventilated lids. Fresh *Juniperus* foliage was provided twice a week and the waste removed. Initially, foliage was collected from wild *J. virginiana*, however the ornamental *J. virginiana* 'Canaerti' and *J. chinensis* L. proved to be acceptable food sources as well. The grasshoppers were kept at room temperature (~24 ^{o}C).

One individual of *M. macclungi* survived in captivity until October 11, 2020 with the majority dying in early October. While most did not reproduce, on September 28 a female collected in Murray County oviposited in the bottom corner of the condiment cup. The hardened, brown ootheca was roughly oval shaped, and measured approximately 15 x 8 mm. The following day, corrugated cardboard was placed vertically along two sides of the critter carriers. This was done to mimic the texture of bark, in the hopes of stimulating oviposition, based on the assumption that, like *M. punctulatus*, *M. macclungi* would oviposit in crevices in the bark of its host tree. However, aside from a female producing a string of unfertilized eggs in a thin, brittle, white froth, no additional eggs were collected.

Parasitism

Three female *M. macclungi*, all collected from Blaine County, were killed by a parasitoid. Two were found dead on Sept. 17 with no obvious parasitoid emergence holes, but two large larvae, approximately half the length of their hosts, were found in the bottom of the container (Figure 21). The larvae were identified as belonging to the family Nemestrinidae, order Diptera, the tangle-winged flies, which contains well-known parasitoids of *Melanoplus* spp. (Prescott, 1955). On Sept. 18, another grasshopper was found with a parasitoid emerging from it.

However, the parasitoid died while emerging through the intersegmental membrane between the second and third abdominal segments on the ventral side of the grasshopper. All the parasitized grasshoppers were found dead following the parasitoid emergence.

Fecundity

Seven female *M. macclungi* were dissected in order to gain information about their fecundity. These females were collected at the Murray County site, where they were killed using ethyl acetate and stored frozen until dissection. All eggs were removed and subsequently counted under a microscope. Two size categories of eggs were observed: large (approximately 7 mm long) and small (approximately 3 mm long). *Melanoplus* are well documented to lay multiple clutches of eggs and large eggs would likely be deposited in the upcoming pod had the grasshoppers not been collected, while small eggs would be deposited in subsequent pods (Smith, 1966). Looking exclusively at the large eggs, the average number of eggs per clutch was 31.2 $\pm$ 5.0 (1 S.D.). This is well within the range of other *Melanoplus*, with the smaller *M. sanguinipes* laying an average 21.8 eggs per pod, while the larger *M. bivittatus* was recorded laying an average of 43.3 eggs per pod (Smith, 1966). The maximum number of eggs recorded was 91 (37 large, 54 small) and the minimum was 34 (34 large, 0 small).

Conclusions

Our surveys found *M. macclungi* in nine counties in three states where it was previously unrecorded and discovered new aspects of its natural history. While some feared this species might be at risk of extinction due to the lack of published records since its description and small known range, it currently seems to be secure and distributed in multiple states. In fact, given the westward expansion of eastern red cedar into the Great Plains, it seems likely that the range of *M. macclungi* is increasing. Because it is definitely not unique to, nor primarily found in Kansas, we would like to suggest that the common name “Kansas juniper grasshopper” be replaced. While it

is common for widespread insects to be named for the state they were described from, such as *Dissosteira carolina*, *Phoetaliotes nebrascensis*, and *Trimerotropis californica*, we would like to suggest "McClung's juniper grasshopper" as an alternative that reflects the scientific name, a patronym for Clarence Erwin McClung, who worked on grasshopper cytology at the University of Kansas.

Future surveys throughout eastern Oklahoma would be of interest, especially to determine whether the Ozark population is continuous with the western population. Genetic studies would also be useful to determine the relationship between *M. splendidus*, *M. macclungi*, and *M. punctulatus* and to determine if eastern populations of *M. macclungi* represent cryptic species. *M. macclungi* and *M. splendidus* are very similar, and as fire suppression allows *J. virginiana* to advance westward, it is possible that the two species may come into contact which could lead to hybridization if the two are not reproductively isolated. Additional surveys may be able to expand the known range of *M. macclungi*, which is likely more widespread in Kansas than has been recorded and the species could occur in northern Texas. Much remains to be learned about the life history of *M. macclungi*. When described, Rehn (1946) only encountered final-instar nymphs, and in our studies, no early instars were collected. Thus, additional study to describe early instars is warranted.

References

Brust, M.L. and A.J. Harman. 2020. New distribution records for *Melanoplus punctulatus* (Scudder) in western Nebraska and notes on behavior. *Transactions of the American Entomological Society*. 146(1):235-238.

Brust, M.L. and W.W. Hoback. 2015. Range extension for *Melanoplus punctulatus* (Uhler) (Acrididae) in western Nebraska collected on green ash. *Journal of Orthoptera Research*. 24(1):1-5.

BugGuide. 2020. https://bugguide.net. Accessed 15 Dec. 2020.

Capinera, J.L., R.D. Scott, and T.J. Walker. 2004. Field Guide to Grasshoppers, Katydids, and Crickets of the United States. *Cornell University Press*.

Catling, P., D.F. McAlpine, C.I.G. Adam, G. Belliveau, D. Doucet, A.D. Fairweather, D. Malloch, S.L. Sabine, and A.W. Thomas. 2013. New and noteworthy records of Orthoptera and allies in the Maritimes and the Îlesde-la-Madeleine, Quebec. *Canadian Field-Naturalist*. 127:332-337

Coppock, S., Jr. 1962. The grasshoppers of Oklahoma (Orthoptera: Acrididae). *Oklahoma State University Agricultural Experiment Station Processed Series* P-399. Stillwater, Oklahoma.

Harman, A.J. and M.L. Brust. 2019. Range extension and state record for *Melanoplus punctulatus* (Scudder) (Acrididae) in northeastern Wyoming. *Transactions of the American Entomological Society*. 145(1):39-41.

Hebard, M. 1920. New genera and species of Melanopli found within the United States (Orthoptera; Acrididae). Part III. *Transactions of the American Entomological Society*. 46(4):355-403.

Hill, J.G. 2012. Habitat associations of grasshoppers (Orthoptera: Acrididae) in the heterogeneous cedar glade landscape of the central basin of Tennessee. *Journal of Orthoptera Research*. 21(2):227-233.

Holmes. 2020. *Melanoplus macclungi* Rehn, 1946. Retrieved from: https://www.recentlyextinctspecies.com/database/recently-extinct-animals/82-orthoptera-grasshoppers-locusts-crickets-wetas-and-katydids/2586-melanoplus-macclungi-macclung-s-locust. Accessed 15 Dec. 2020.

iNaturalist. 2020. https://www.inaturalist.org. Accessed 15 Dec. 2020.

Kondratieff, B.C., J.P. Schmidt, P.A. Opler, and M.C. Garhart. 2005. *Insects of western North America 4. Survey of selected arthropod taxa of Fort Sill, Comanche County, Oklahoma. Part 3.* Colorado State University. https://mountainscholar.org/bitstream/handle/10217/81137/BSPMGILL_InsectsofWesternNorthAmerica4.pdf?sequence=1&isAllowed=y.

Knutson, E., J. Liu, and B. Kondratieff. 2019. Insects of dominant shrub communities at Pawnee and Comanche National Grasslands, Colorado. *Southwestern Entomologist*. 44(1):79-93

McAlpine, D.F., D. Sabine, J.H. Lewis, and R. Webster. (2015). First report of *Scudderia f. furcata* (Tettigoniidae) and other noteworthy records of Orthoptera from New Brunswick. *J. Acadian Entomological Society.* 11:1-4

Prescott, H.W. 1995. *Neorhynchocephalus sackenii* and *Trichopsidea clausa*, nemestrinid parasites of grasshoppers. *Annals of the Entomological Society of America*. 48(5): 392-402.

Rehn, J.A.G. (1946). On the *punctulatus* species-group of the genus *Melanoplus* (Orthoptera, Acrididae, Cyrtacanthacridinae), with the description of a new species from Kansas. *Proceedings of the Academy of Natural Sciences of Philadelphia*. 98:241-269.

Smith, D. (1966). Fecundity and Oviposition in the Grasshoppers *Melanoplus sanguinipes* (F.) and *Melanoplus bivittatus* (Say). *The Canadian Entomologist*. 98(6):617-621.

Tinkham, E. (1938). Western Orthoptera attracted to lights. *Journal of the New York Entomological Society*. 46(3):339-35.

APPENDICES

Table 1: The number of published and new grasshopper county records in Oklahoma by subfamily.

Family	Subfamily	Species	Literature Records	New Records	Percent Increase
Acrididae	Oedipodinae	42	667	221	33.1
Acrididae	Gomphocerinae	29	453	220	48.6
Acrididae	Leptysminae	1	10	7	70.0
Acrididae	Melanoplinae	48	857	204	23.8
Acrididae	Cyrtacanthacridinae	6	95	51	53.7
Romaleidae	Romaleinae	2	19	5	26.3
Total		128	2101	708	33.7

Table 2: Results of surveys for *Melanoplus macclungi* in Oklahoma in early September.

Date	Location	County	Arrival Time	Time Spent	Presence?	Number	Habitat Notes
9/6	36.3644, -98.5816	Major	0925 hrs.	35 min	No	N/A	Scattered, small, cedars
9/6	36.5278, -98.8799	Woods	1105 hrs.	20 min	No	N/A	Scattered, small, cedars
9/6	36.5629, -99.5689	Woodward	1220 hrs.	40 min	Yes	5	Scattered, large, cedars
9/6	36.5603, -99.5694	Woodward	1300 hrs.	15 min	No	N/A	Dense, large, mixed
9/6	36.5549, -99.5705	Woodward	1325 hrs.	15 min	No	N/A	Dense, small, cedars
9/6	35.9408, -98.4245	Blaine	1550 hrs.	15 min	No	N/A	Scattered, large, mixed
9/6	35.9149, -98.4110	Blaine	1620 hrs.	25 min	Yes	5	Dense, large, mixed
9/6	35.8413, -98.3289	Blaine	1710 hrs.	15 min	Yes	3	Dense, large, cedars
9/6	35.7661, -98.6795	Custer	1800 hrs.	15 min	No	N/A	Scattered, large, cedars
9/7	35.5321, -98.6556	Custer	0820 hrs.	15 min	No	N/A	Scattered, large, cedars
9/7	35.1761, -98.4521	Caddo	0930 hrs.	25 min	No	N/A	Dense, large, cedars
9/7*	34.7506, -98.5793	Comanche	1230 hrs.	60 min	Yes	9	Dense, large, cedars
9/7	34.7436, -98.5325	Comanche	1520 hrs.	30 min	No	N/A	Scattered, large, mixed
9/7*	34.7506, -98.5793	Comanche	1650 hrs.	30 min	Yes	6	Dense, large, cedars

Table 3: Citizen-science records of *Melanoplus macclungi*.

State	County	Location	Date	Observer	Site
Oklahoma	Blaine	35.9319, -98.4202	October 3, 2020	Daniel Martin	iNaturalist
Oklahoma	Caddo	35.4476, -98.3523	October 11, 2020	Buddy Brown	iNaturalist
Arkansas	Pulaski	Maumelle	August 19, 2018	"BugBoi1997"	Bugguide
Arkansas	Stone	35.9543, -92.1119	November 1, 2020	Drew Hoffman	iNaturalist
Missouri	Stone	36.6917, -93.3114	October 4, 2020	Nick Winstead	iNaturalist

Figure 1

Oklahoma County Map

The ecoregions of Oklahoma, as defined by Oklahoma Department of Wildlife Conservation

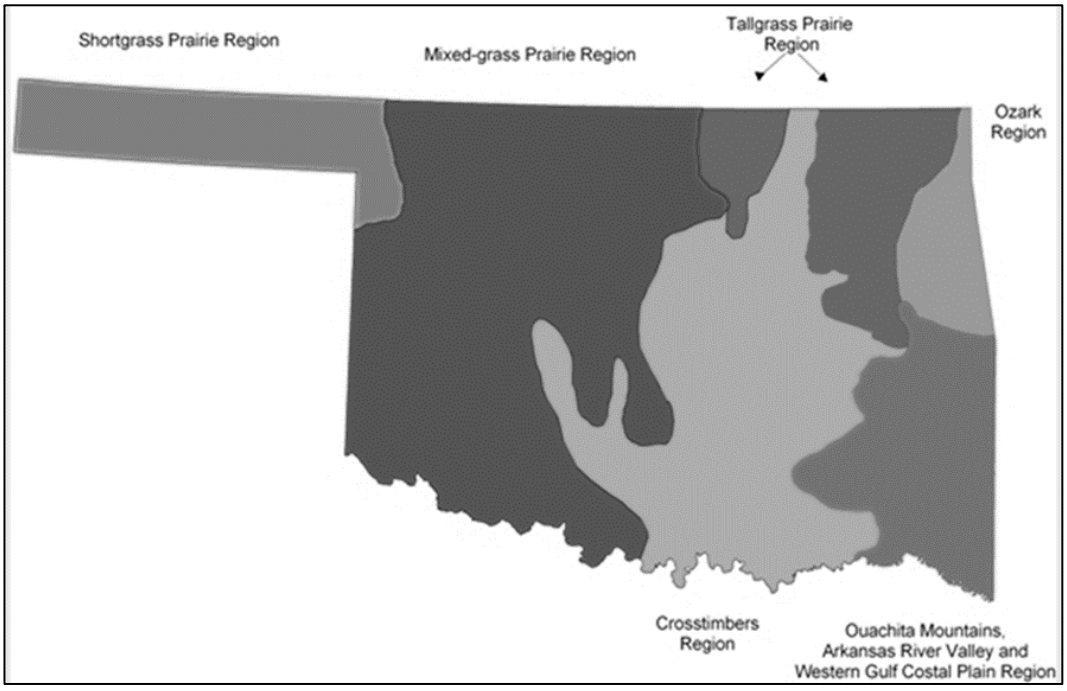
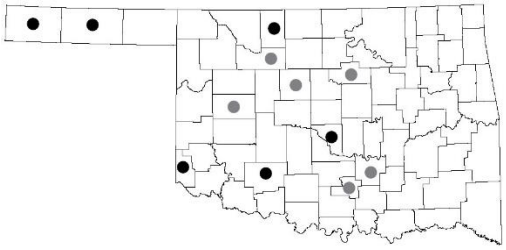
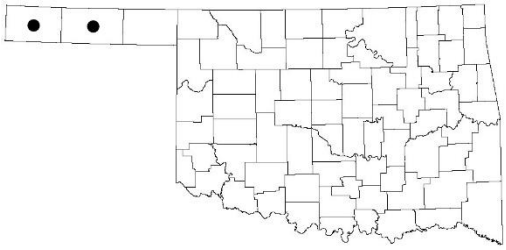


Figure 2: Species distributions of Oklahoma grasshoppers. Literature records are indicated by black dots, new records by gray dots.

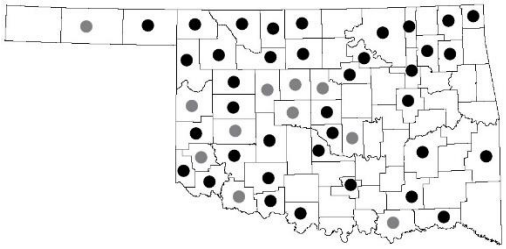
Arphia conspersa Scudder



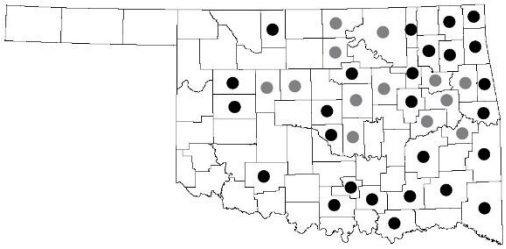
Arphia pseudonietana (Thomas)



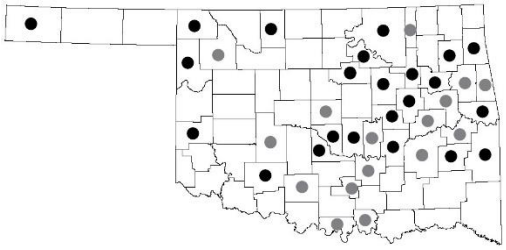
Arphia simplex Scudder



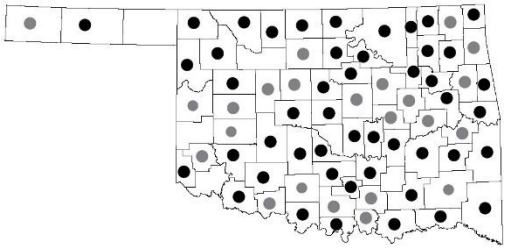
Arphia sulphurea (F.)



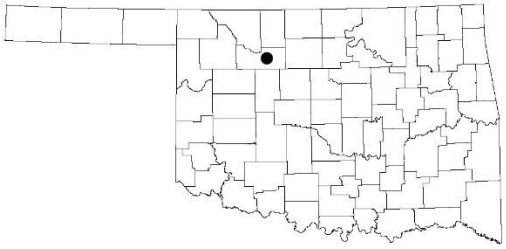
Arphia xanthoptera (Burmeister)



Chortophaga viridifasciata (De Geer)



Circotettix rabula Rehn & Hebard



Derotmema haydeni (Thomas)

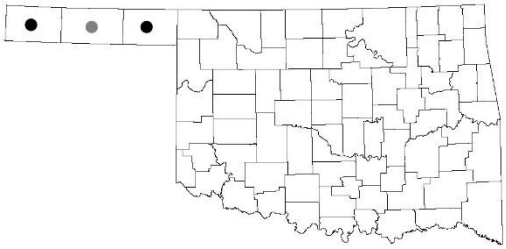
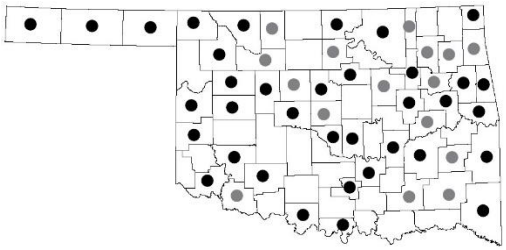
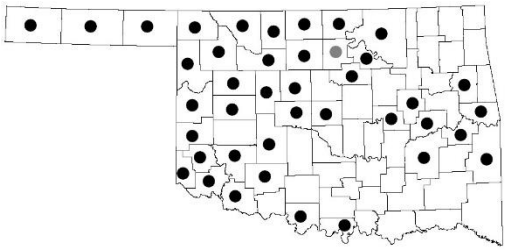


Figure 3

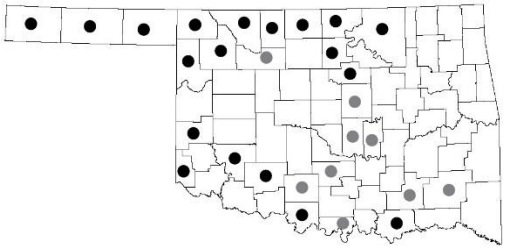
Dissosteira carolina (L.)



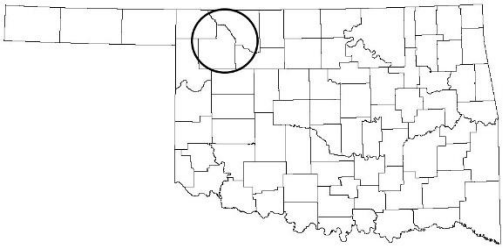
Dissosteira longipennis (Thomas)



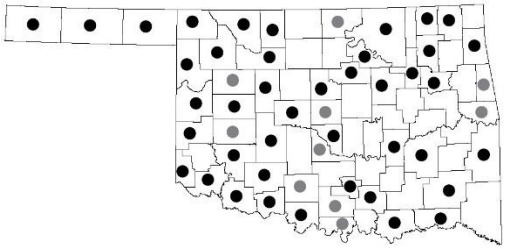
Encoptolophus costalis (Scudder)



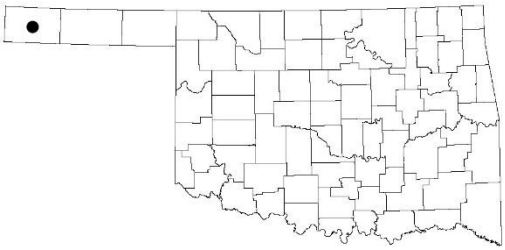
Encoptolophus sordidus (Burmeister)



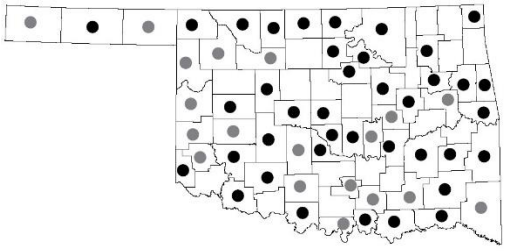
Hadrotettix trifasciatus McNeill



Hadrotettix magnificus McNeill



Hippiscus ocelote (Saussure)



Hippopedon capito (Stål)

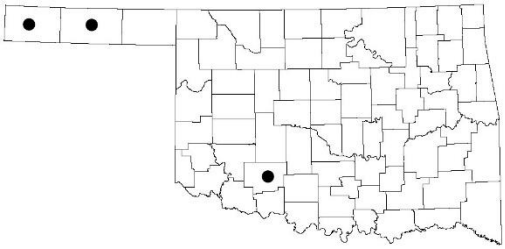
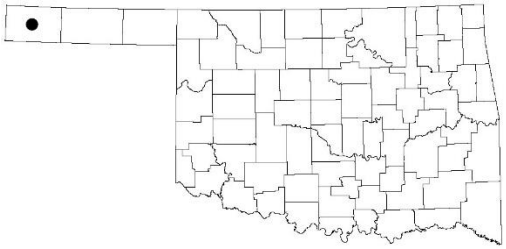
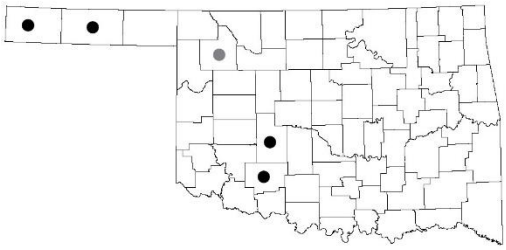


Figure 4

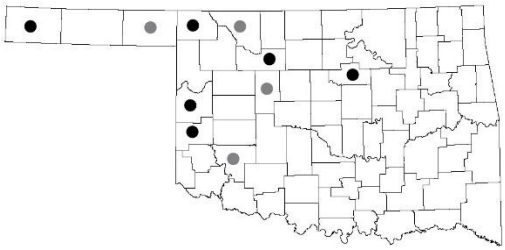
Leprus intermedius Saussure



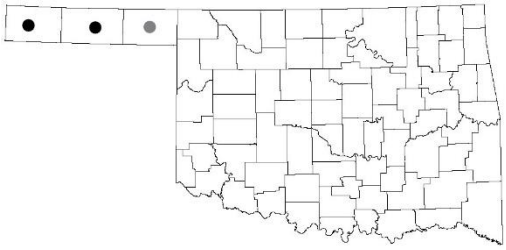
Leprus wheeleri (Thomas)



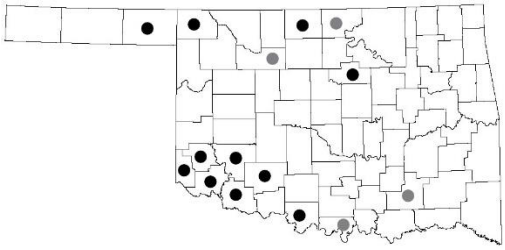
Mestobregma plattei (Thomas)



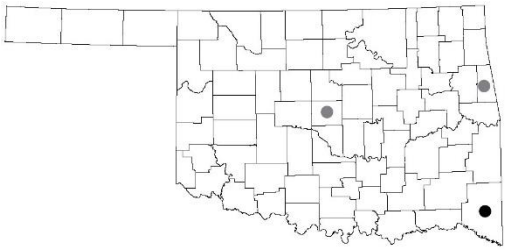
Metator pardalinus (Saussure)



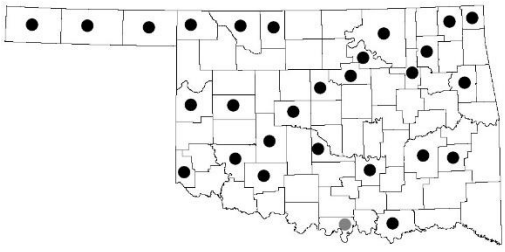
Nebulatettix subgracilis (Caudell)



Pardalophora apiculata (Harris)



Pardalophora haldemanii (Scudder)



Pardalophora phoenicoptera Rehn & Hebard

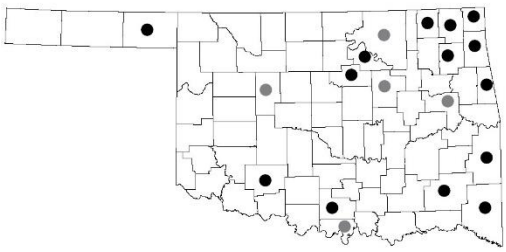
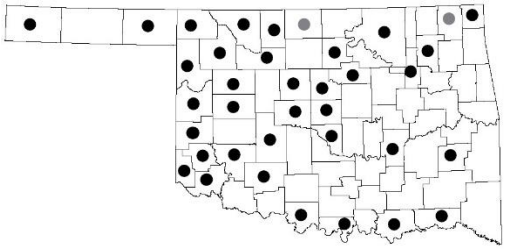
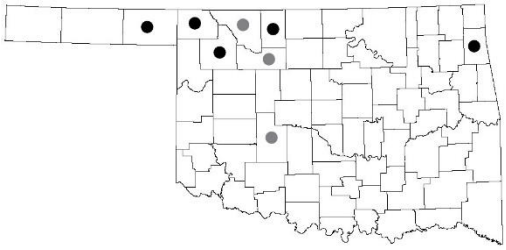


Figure 5

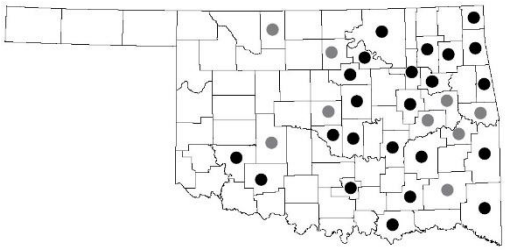
Pardalophora saussurei Rehn & Hebard



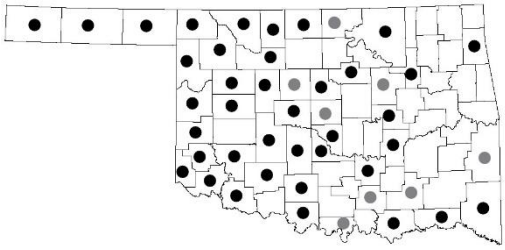
Psinidia fenestralis (Serville)



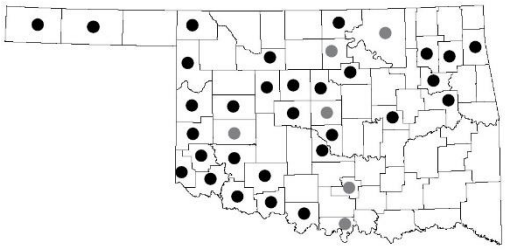
Spharagemon bolli Scudder



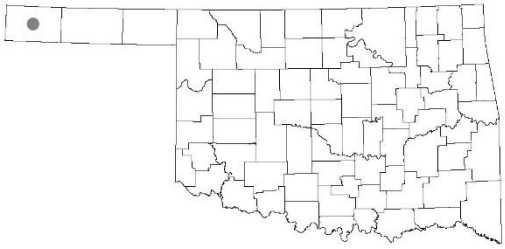
Spharagemon cristatum Scudder



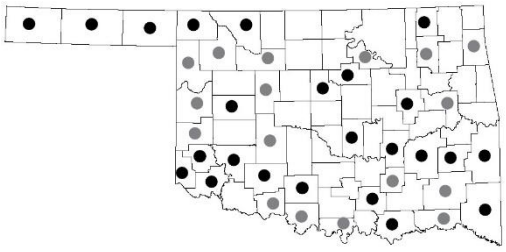
Spharagemon equale (Say)



Trachyrhachys aspera Scudder



Trachyrhachys kiowa (Thomas)



Trimerotropis agrestis McNeill

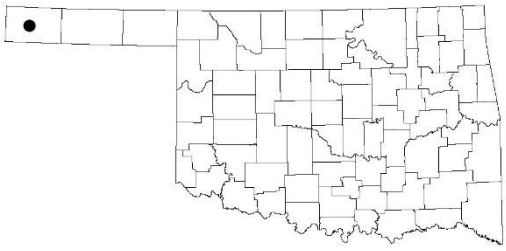
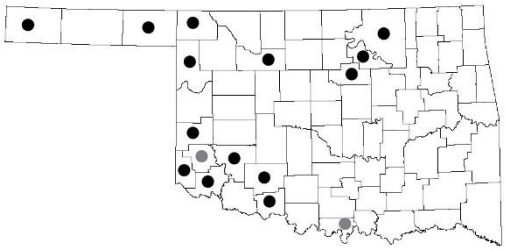
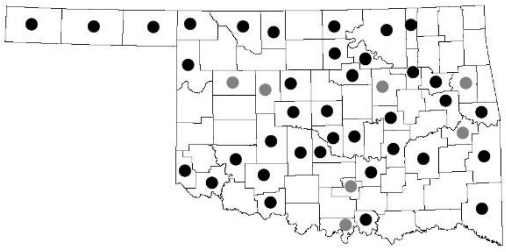


Figure 6

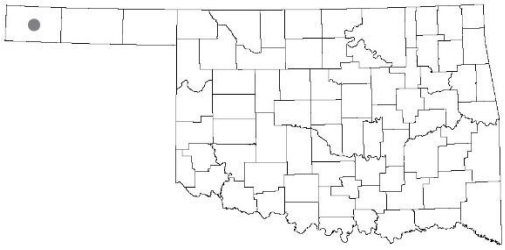
Trimerotropis latifasciata Scudder



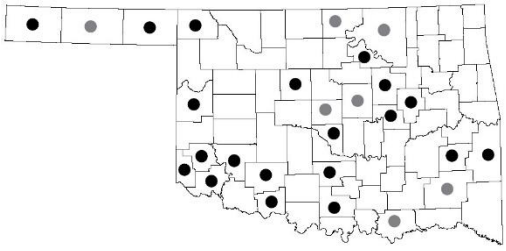
Trimerotropis maritima (Harris)



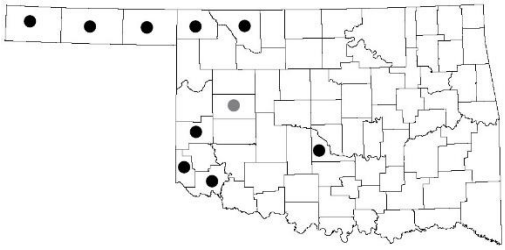
Trimerotropis melanoptera McNeill



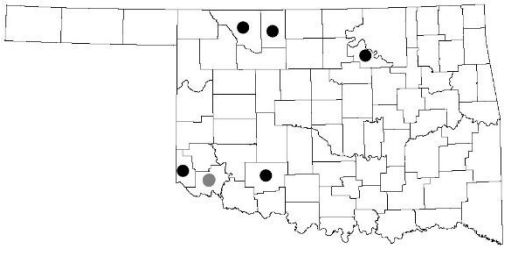
Trimerotropis pallidipennis (Burmeister)



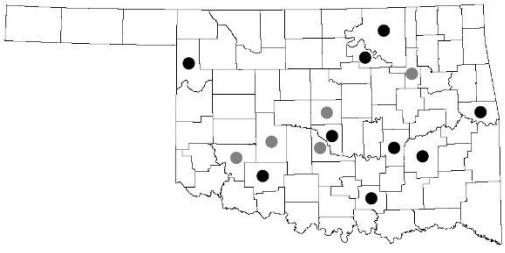
Trimerotropis pistrinaria Saussure



Trimerotropis salina McNeill



Trimerotropis saxatilis (McNeil)



Tropidolophus formosus (Say)

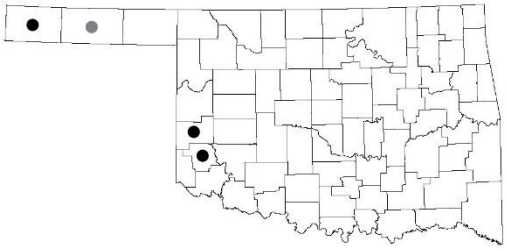
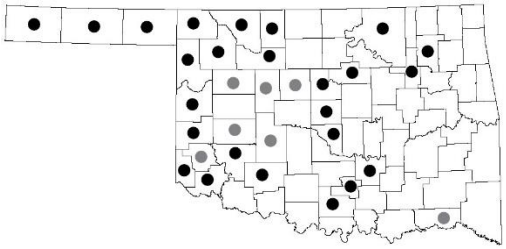
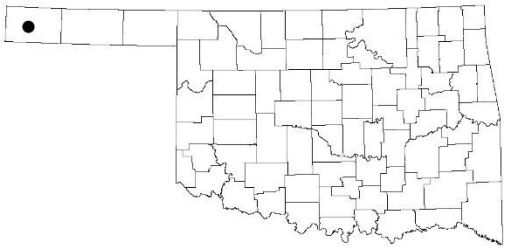


Figure 7

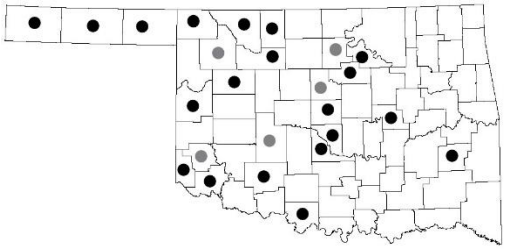
Xanthippus corallipes Rehn & Hebard



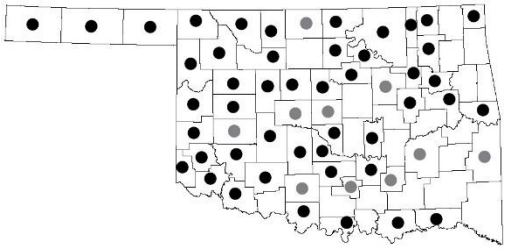
Xanthippus montanus (Thomas)



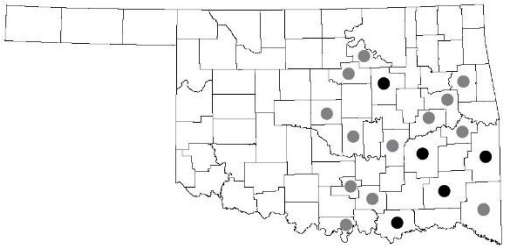
Acrolophitus hirtipes (Say)



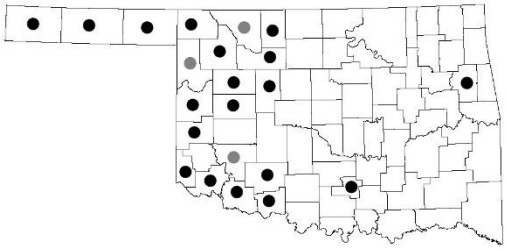
Ageneotettix deorum (Scudder)



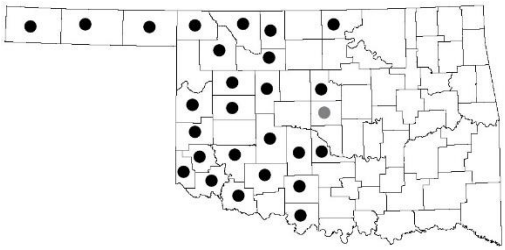
Amblytropidia mysteca (Saussure)



Amphitornus coloradus (Thomas)



Aulocara elliotti (Thomas)



Aulocara femoratum Scudder

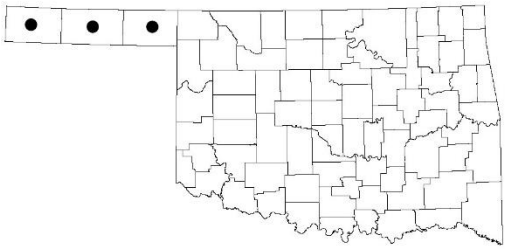
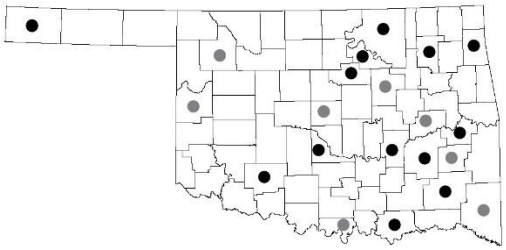
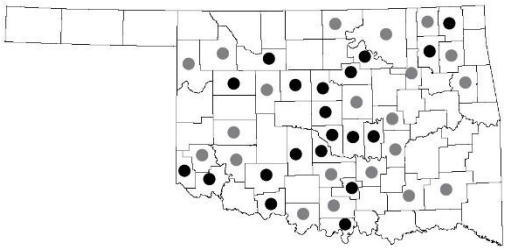


Figure 8

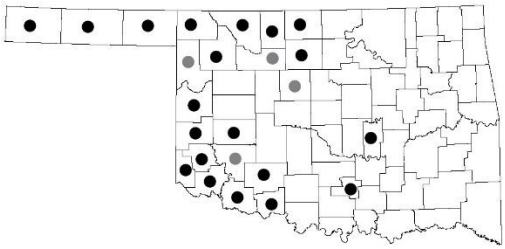
Boopedon auriventris McNeill



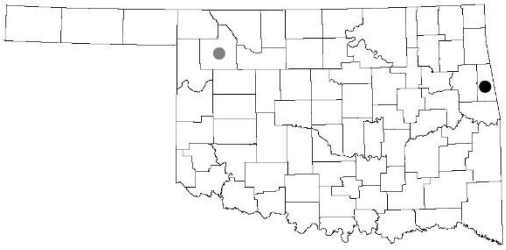
Boopedon gracile Rehn



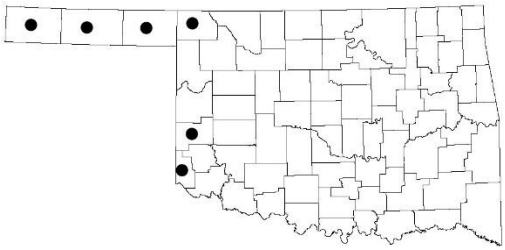
Boopedon nubilum (Say)



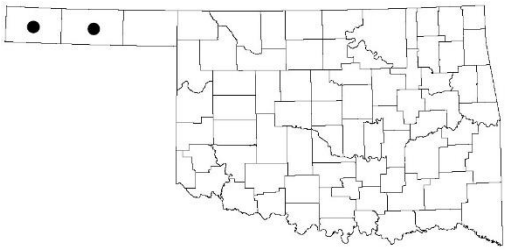
Chloealtis conspersa (Harris)



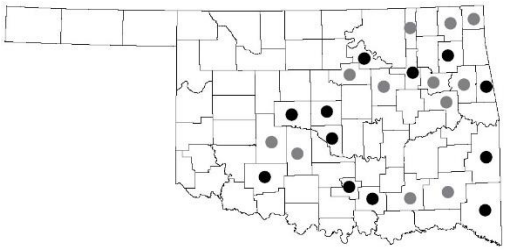
Cordillacris occipitalis (Thomas)



Cordillacris crenulata (Bruner)



Dichromorpha viridis (Scudder)



Eritettix simplex (Scudder)

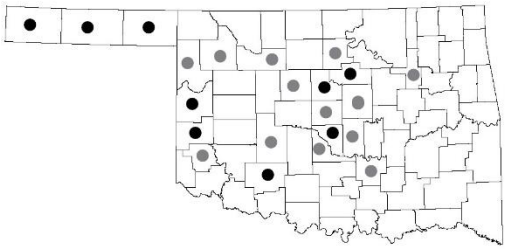
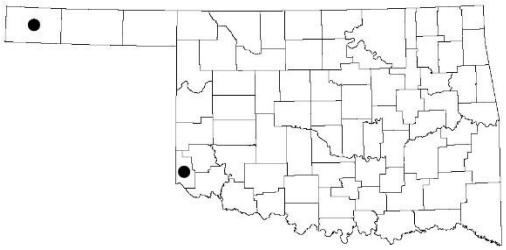
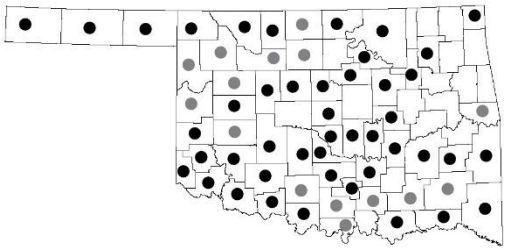


Figure 9

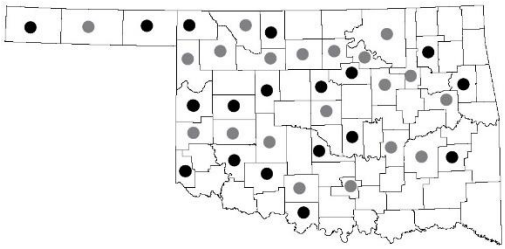
Heliaula rufa (Scudder)



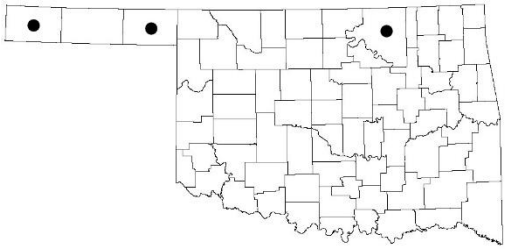
Mermiria bivittata (Serville)



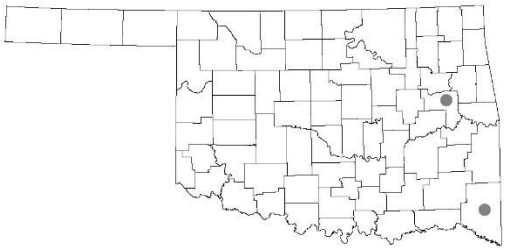
Mermiria picta (Walker)



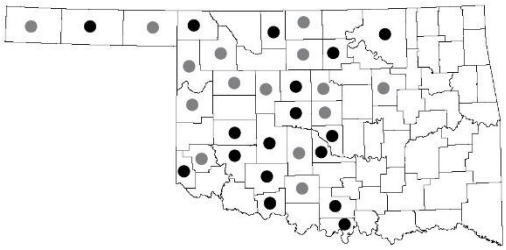
Mermiria texana Bruner



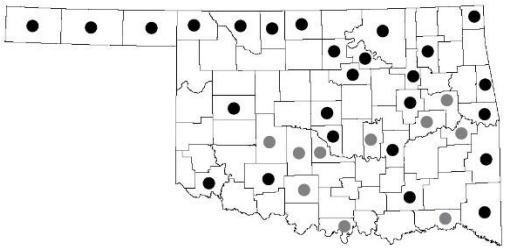
Metaleptea brevicornis (L.)



Opeia obscura (Thomas)



Orphulella pelidna (Burmeister)



Orphulella speciosa (Scudder)

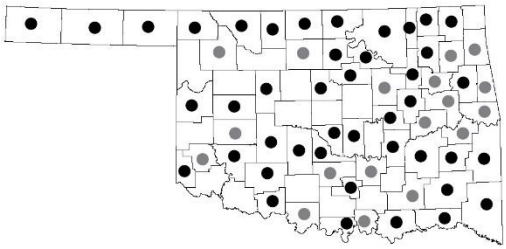
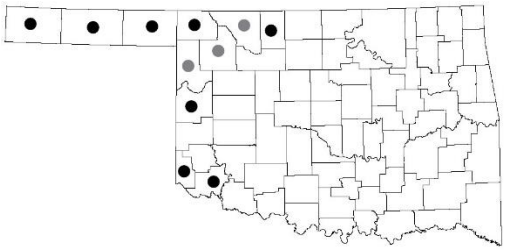
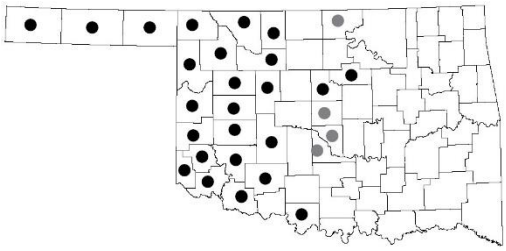


Figure 10

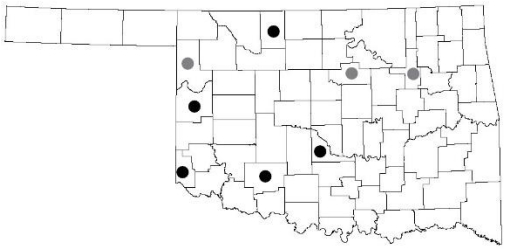
Paropomala wyomingensis (Thomas)



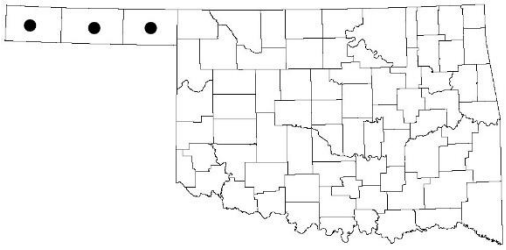
Phlibostroma quadrimaculatum (Thomas)



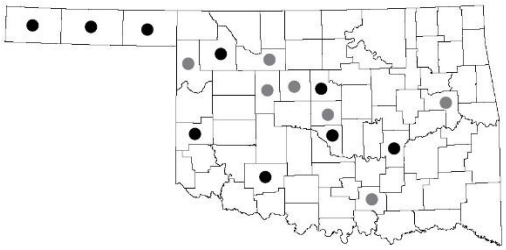
Pseudopomala brachyptera (Scudder)



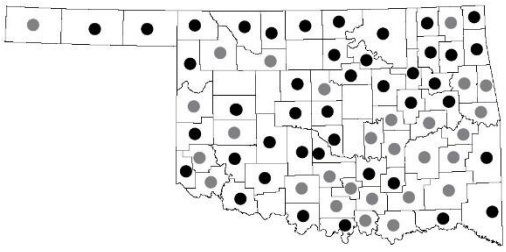
Psoloessa delicatula (Scudder)



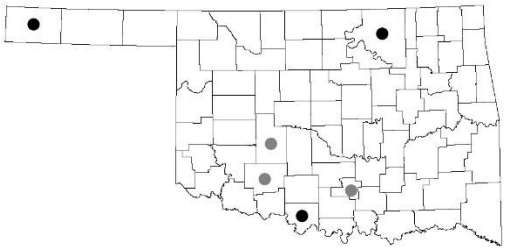
Psoloessa texana Scudder



Syrbula admirabilis (Uhler)



Syrbula montezuma (Saussure)



Leptysma marginicollis (Serville)

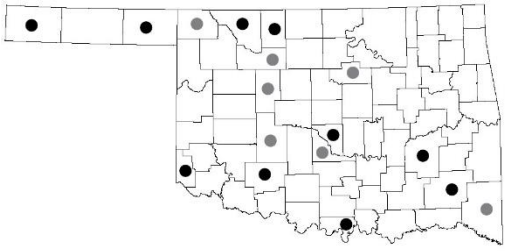
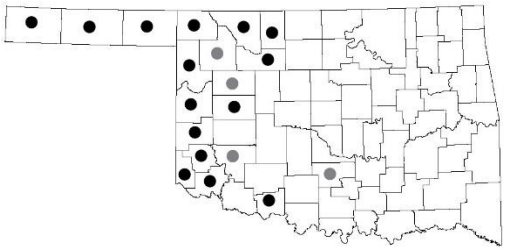
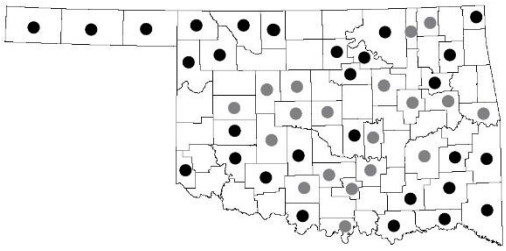


Figure 11

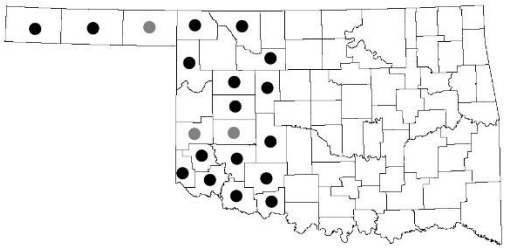
Aeoloplides turnbulli (Thomas)



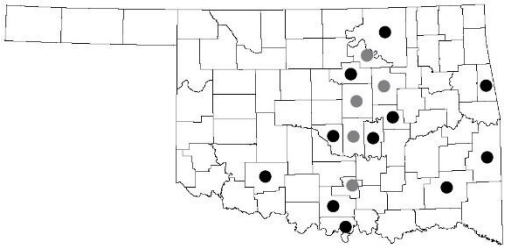
Campylacantha olivacea (Scudder)



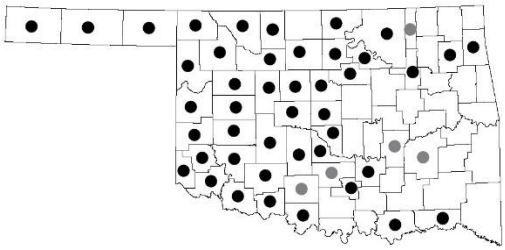
Dactylotum bicolor Charpentier



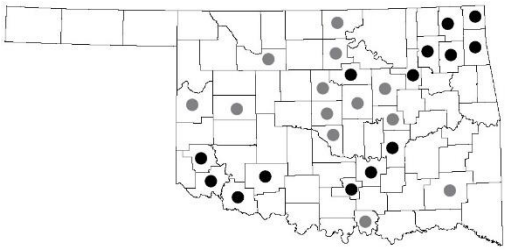
Dendrotettix quercus Packard



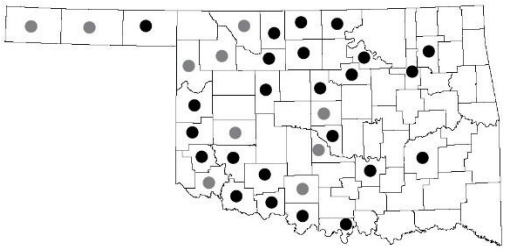
Hesperotettix speciosus (Scudder)



Hesperotettix viridis pratensis (Scudder)



Hesperotettix v. viridis (Thomas)



Hypochlora alba (Dodge)

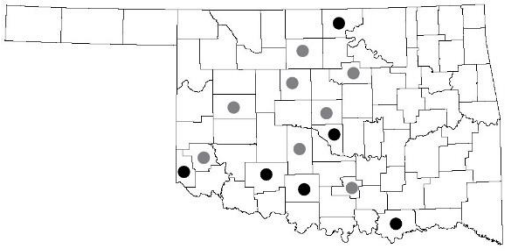
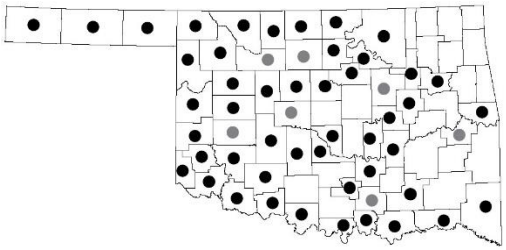
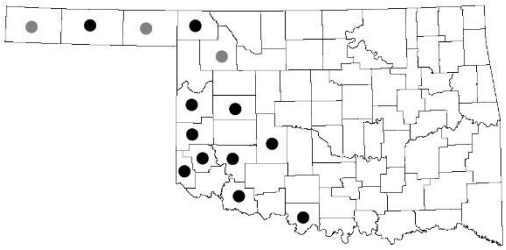


Figure 12

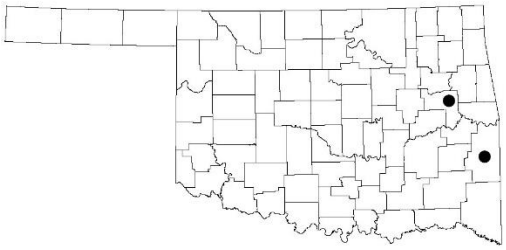
Melanoplus angustipennis (Dodge)



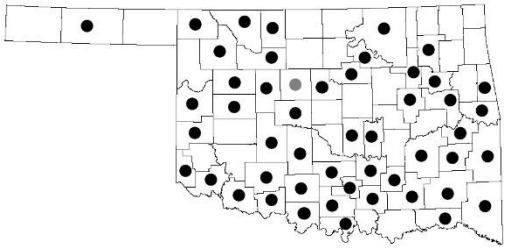
Melanoplus arizonae Scudder



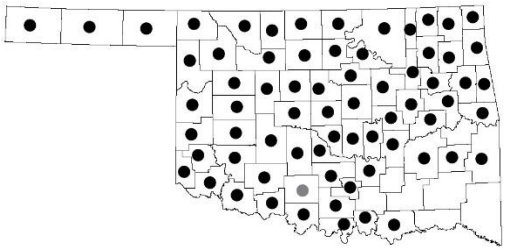
Melanoplus arkansas Hill



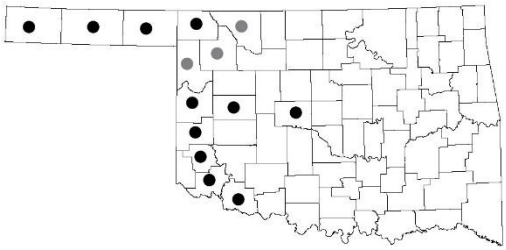
Melanoplus bispinosus Scudder



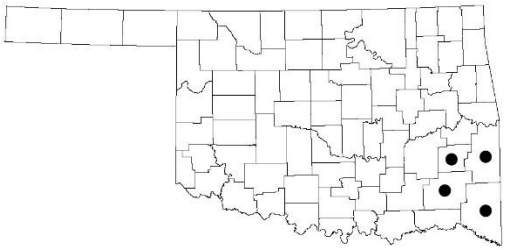
Melanoplus bivittatus (Say)



Melanoplus bowditchi Scudder



Melanoplus cohni Hill



Melanoplus confusus Scudder

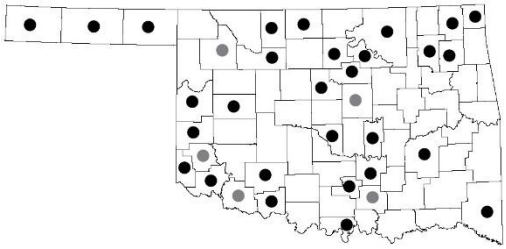
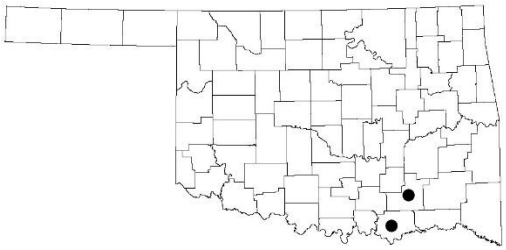
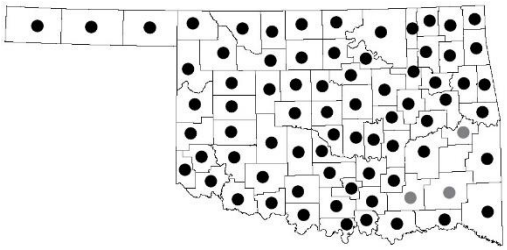


Figure 13

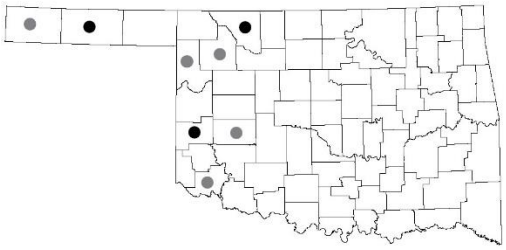
Melanoplus decurvus Hill



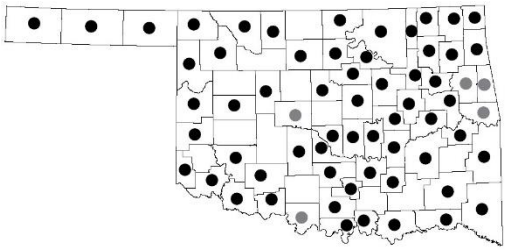
Melanoplus differentialis (Thomas)



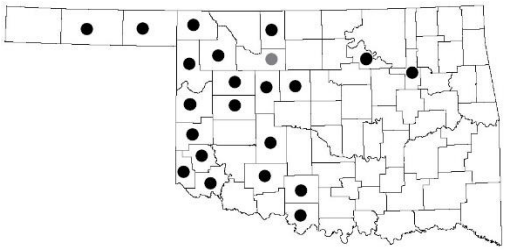
Melanoplus discolor (Scudder)



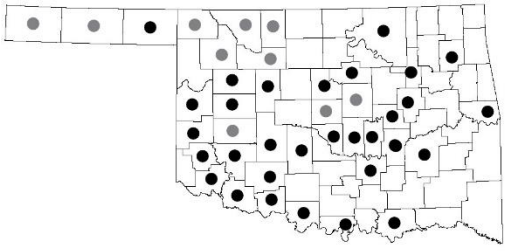
Melanoplus femurrubrum (De Geer)



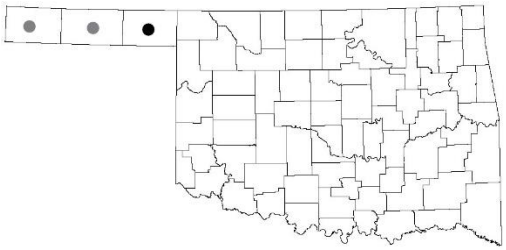
Melanoplus flavidus Scudder



Melanoplus foedus Scudder



Melanoplus gladstoni Scudder



Melanoplus glaucipes (Scudder)

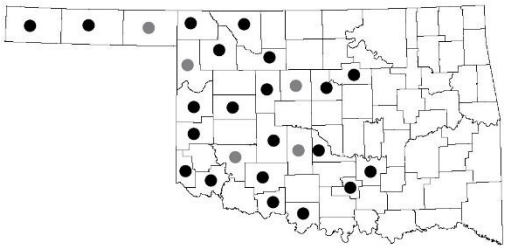
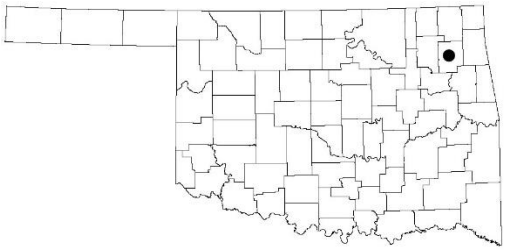
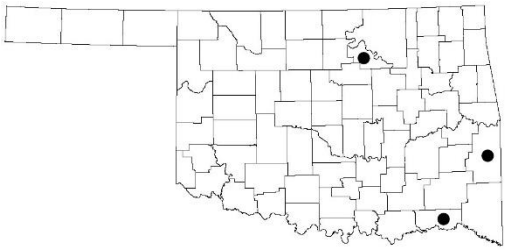


Figure 14

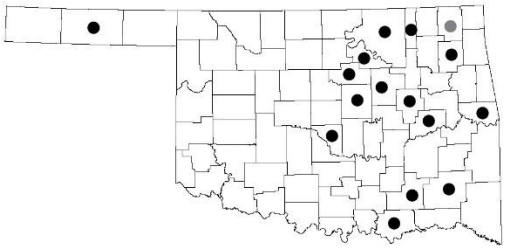
Melanoplus gracilis (Bruner)



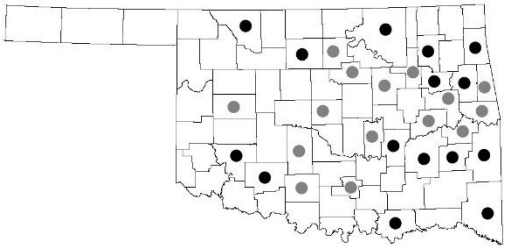
Melanoplus impudicus Scudder



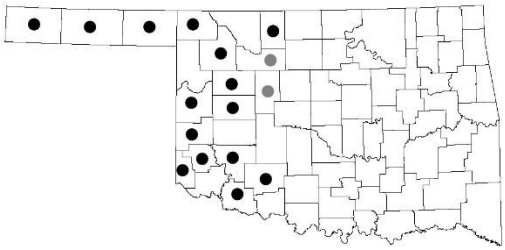
Melanoplus inconspicuous Caudell



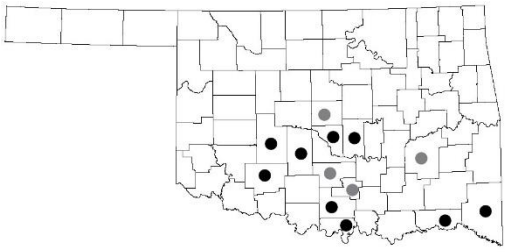
Melanoplus keeleri Thomas



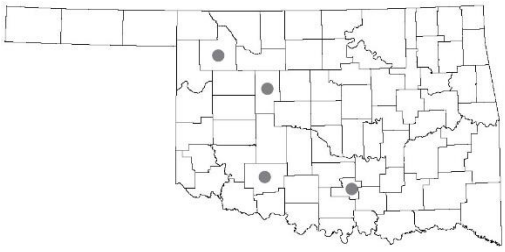
Melanoplus lakinus (Scudder)



Melanoplus latus Morse



Melanoplus macclungi Rehn



Melanoplus occidentalis (Thomas)

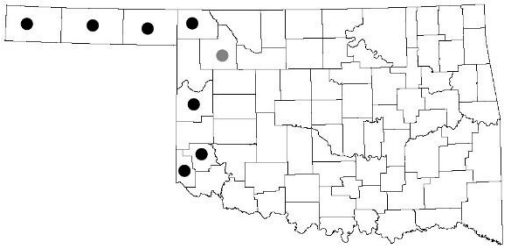
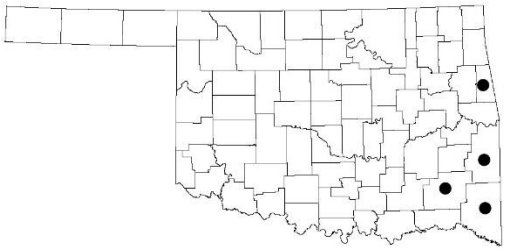
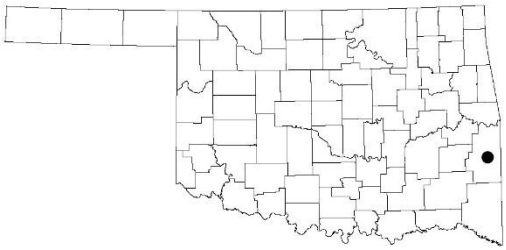


Figure 15

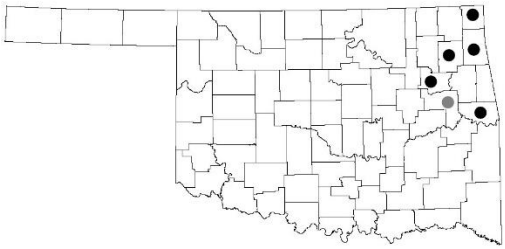
Melanoplus oklahomae Hebard



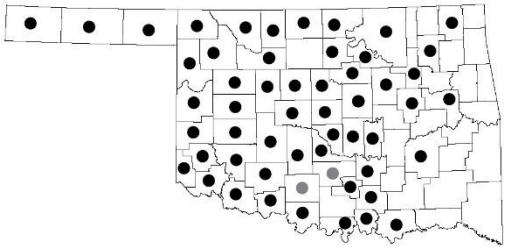
Melanoplus ouachita Hill



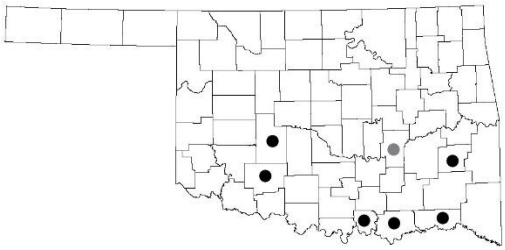
Melanoplus ozarkensis Hill



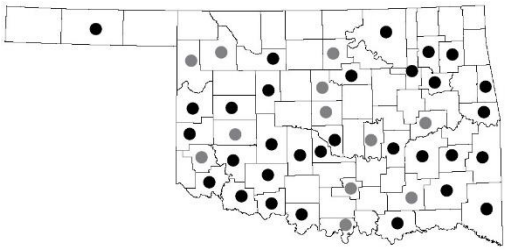
Melanoplus packardii Scudder



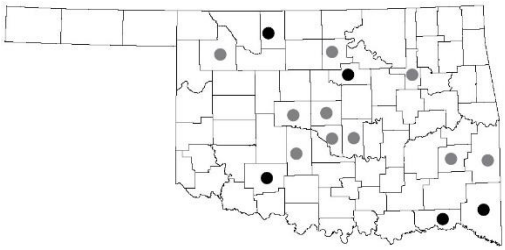
Melanoplus plebejus Stål



Melanoplus ponderosus (Scudder)



Melanoplus punctulatus (Scudder)



Melanoplus regalis (Dodge)

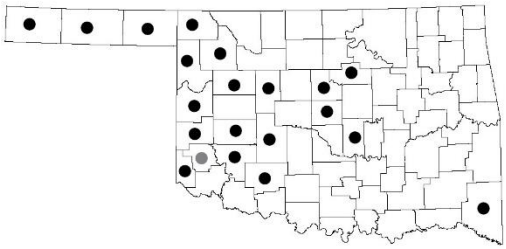
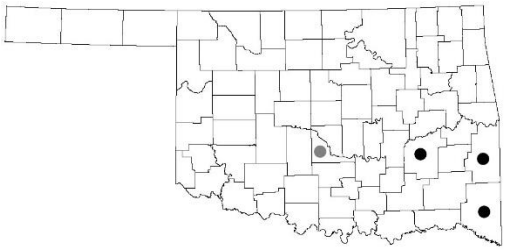
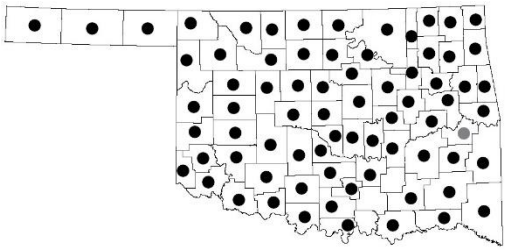


Figure 16

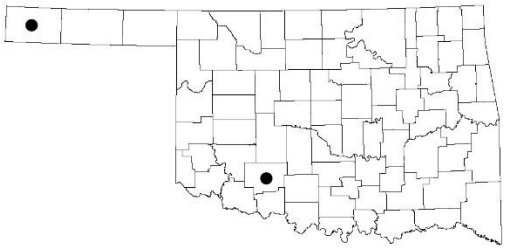
Melanoplus rusticus (Stål)



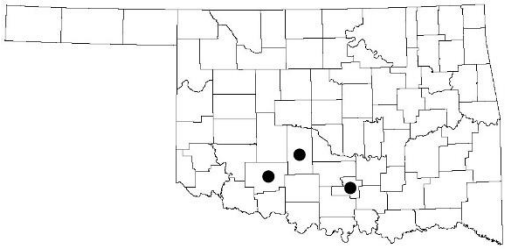
Melanoplus sanguinipes (F.)



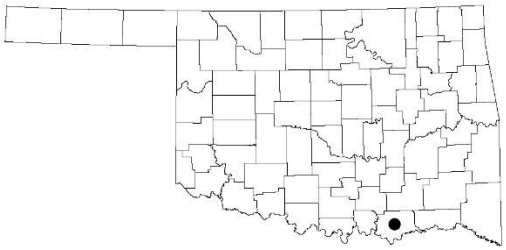
Melanoplus splendidus Hebard



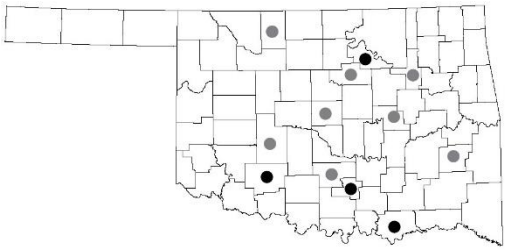
Melanoplus texanus Scudder



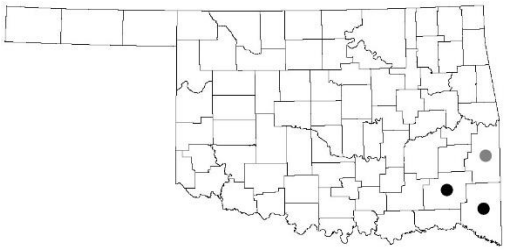
Melanoplus warneri Scudder



Paratylotropidia brunneri Scudder



Paratylotropidia morsei Rehn & Rehn



Phoetaliotes nebrascensis (Thomas)

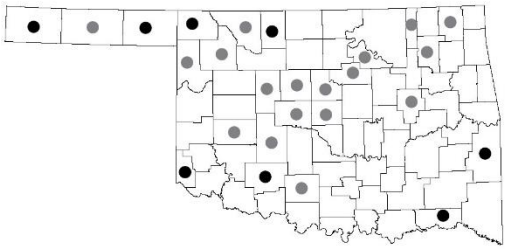
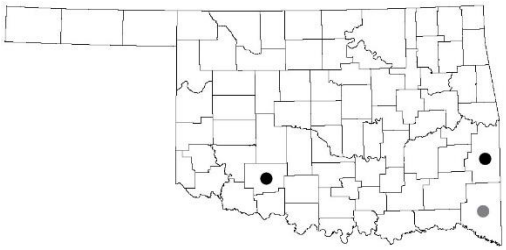
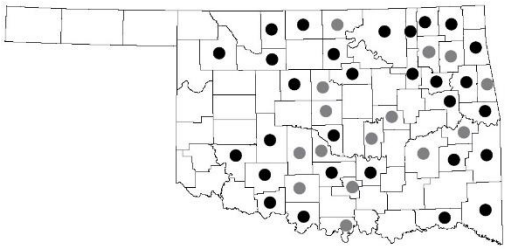


Figure 17

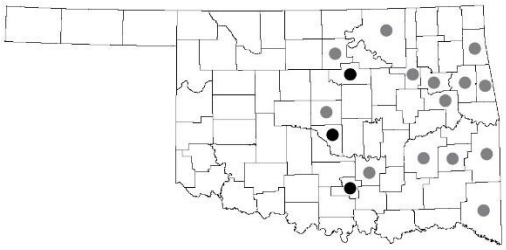
Schistocerca alutacea (Harris)



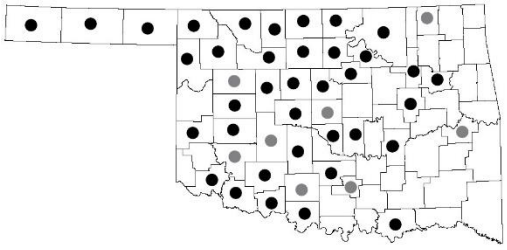
Schistocerca americana Drury



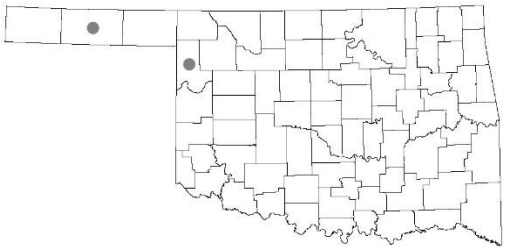
Schistocerca damnifica (Saussure)



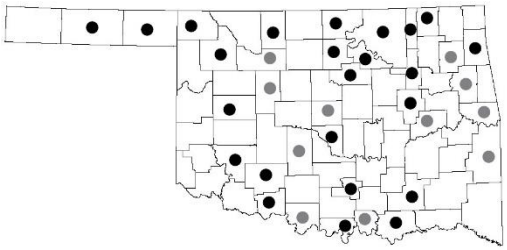
Schistocerca lineata Scudder



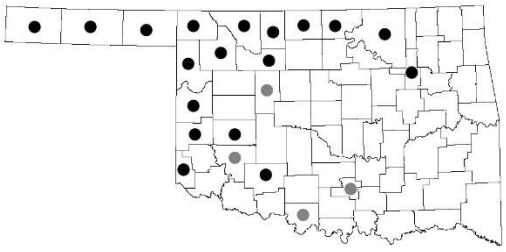
Schistocerca nitens Thunberg



Schistocerca obscura (F.)



Brachystola magna (Girard)



Phrynotettix tshivavensis (Haldeman)

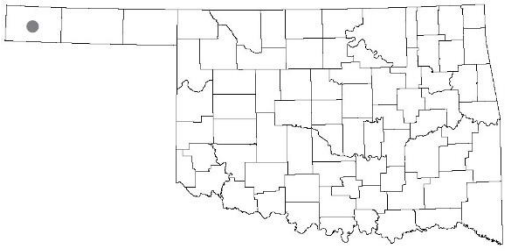


Fig. 18: Map of known sites for *Melanoplus macclungi*. Dark points have voucher specimens, light points are photographic records, and the large dot is the type locality.

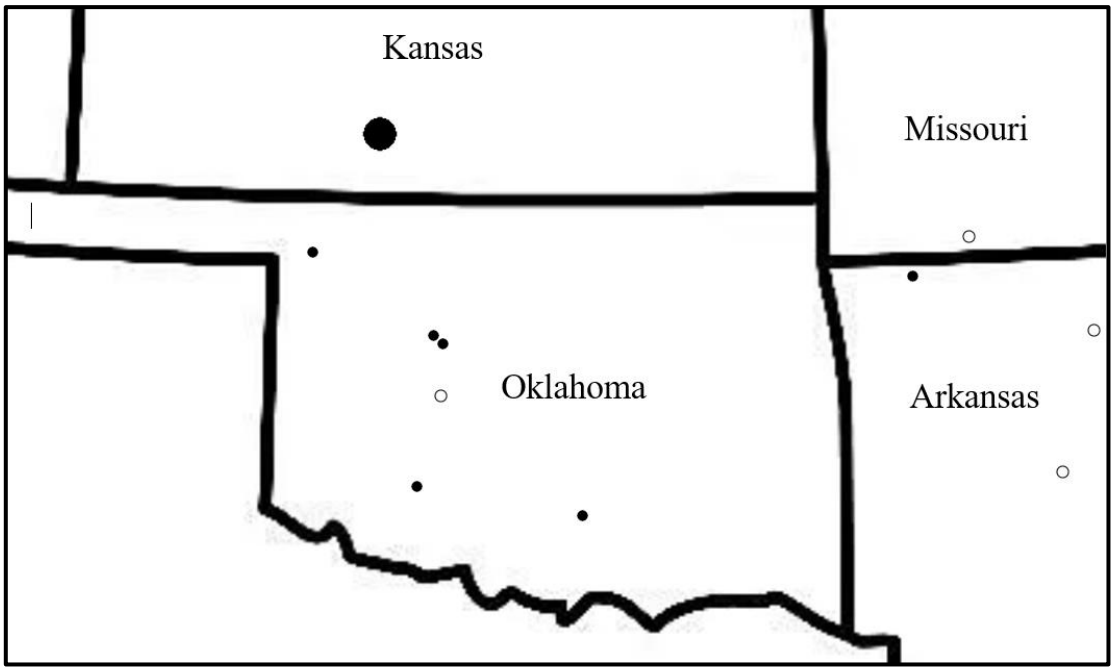


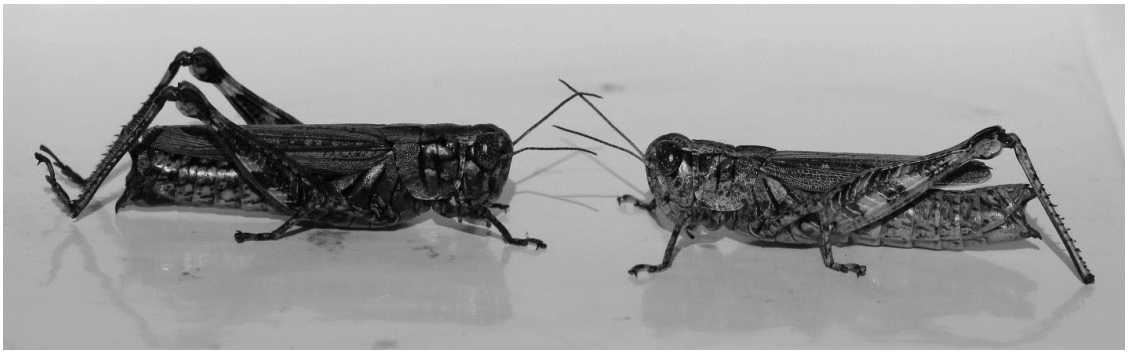
Figure 19: Photos showing the range of variation exhibited by *Melanoplus macclungi*.

Female *M. macclungi* from Comanche County OK. Note the bold white markings, particularly the light spot on the side of the pronotum which is an easily noticed field mark for this species.

Female *M. macclungi* from Blaine County OK. This individual was substantially paler than most individuals we encountered.

Female *M. macclungi* from Carroll County AR. This specimen is typical of those from the Carroll County population, with reduced light spotting resulting in a smoother coloration overall.

Figure 20: Comparison with *M. splendidus*.

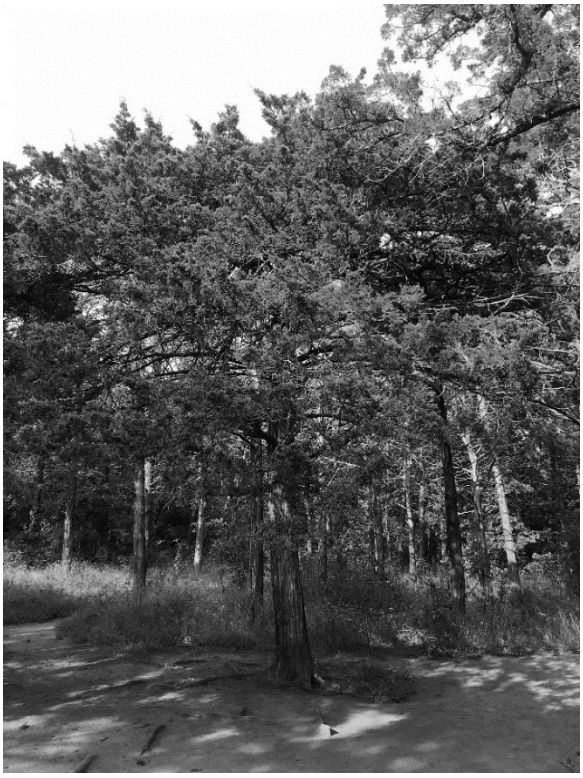


Comparison of *M. macclungi* (left) from Comanche County OK and *M. splendidus* (right) from Cimarron County OK. Key differences include the color, which appears to be a consistent difference between the two, as well as the boldness of the pronotal spot. While *M. splendidus* has a similar spot, the inner portion of the spot is roughly the same color as the rest of the pronotum, unlike in *M. macclungi* where the spot is substantially lighter in color.

Figure 21: Parasitoid emergence from *Melanoplus macclungi*.

Parasitized female *M. macclungi* from Blaine Co. OK. Note the Nemestrinidae larvae in the bottom left corner.

Figure 22: Habitat photos of locations where *M. macclungi* were collected.



Clockwise from top left: *Melanoplus macclungi* habitat in Comanche County OK, Carroll County AR, and Woodward County OK.

VITA

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Master of Science

Thesis: UPDATED DISTRIBUTIONS OF OKLAHOMA GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE) AND NOTES ON MELANOPLUS MACCLUNGI

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