Singing Insects of the Chicago Region

A Guide to Crickets, Katydids, Grasshoppers and Cicadas with Audible Displays

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Introduction

When people think of singing animals, birds come first to mind. We welcome the warmth of spring and all of its associated sensory impressions. Among these, bird songs stand out as the sounds we most enjoy. Bird songs are displays with particular biological functions, however, and as those functions are completed for the year the birds become quiet. Fortunately for those of us who love the sounds of the out-of-doors, as the birds fade out the singing insects are well into their crescendo.

I long had been fascinated by insect songs, but as a vertebrate ecologist did not have a very good handle on sources of information about singing insects. That changed as I began to find university websites devoted to these groups. First I found the University of Michigan cicada website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html). I was pleased to find, as I listened to the recordings posted there, that I recognized and could distinguish the songs of several species. (A more recently developed site, Cicada Mania, https://www.cicadamania.com/, contains more comprehensive information about that group.)

Then I found the incredible resource of the Singing Insects of North America website (SINA: https://sina.orthsoc.org/index.htm). That site brings together details about the continent's crickets and katydids. My focused study began as I went through those species accounts, noting those whose ranges fell into the Chicago area.

Other published resources came to my attention, and appeared in print, as my studies continued. The most accessible and attractive of these was the book and its enclosed CD of insect song recordings, *The Songs of Insects* by Lang Elliott and Wil Hershberger (2007, now out of print). Hershberger continues to add species to their website (http://songsofinsects.com/). A recently added source of excellent photographs, sound recordings and information is Lisa Rainsong's website (https://www.listeningtoinsects.com/). Though focused on the Cleveland area, otherwise it is fully relevant here. Other sources are listed at the end of this publication.

As my fieldwork and its associated wonders and frustrations accumulated, I realized that I was assembling a set of locally focused information that might be of interest to others. I presented an introduction to our local singing insects at the regional Wild Things conference in Chicago in early 2007, and was pleased at the size of the audience. I knew that sooner or later I would need to provide the information in a digestible form. For a while I thought that it would take a long time for me to learn enough to share through any kind of formal publication, but we live in a day when the flexibility of digital documents and on-line resources makes available a range of options. Therefore I have drafted this document, understanding that it will continue to grow and to be revised annually. Doing so has the significant advantage that I can hope to get readers' tips, additional information, and alerts to necessary corrections that need to be made. Contact me via e-mail at wildlifer@aol.com.

Geographic Extent. The Chicago region is defined here as a 22-county area extending from southeastern Wisconsin, through northeast Illinois and northwest Indiana to Berrien County, Michigan (Fig. 1, next page). These counties provide an area large enough to permit tracking of range changes, mainly northward shifts, which clearly are taking place in several species. The east-west gradient of forest to prairie is represented, as is a wide range of soil types, which has proven to be significant. Finally, a number of species have ranges with their edges within this region, and there are enough counties in the study area to trace those edges.

Species Pages. The information in this guide focuses on the habitat, season and songs of the singing insect species. I have included photos when I have them, and links to websites with photos and recordings of songs when these are available.

Seasonal information is summarized in a graphic below the title (which includes only the range of song dates in our area; this is subject to expansion especially in species for which I have few observations). More detail about seasons is given in the text, with ranges of the dates when I have heard the first

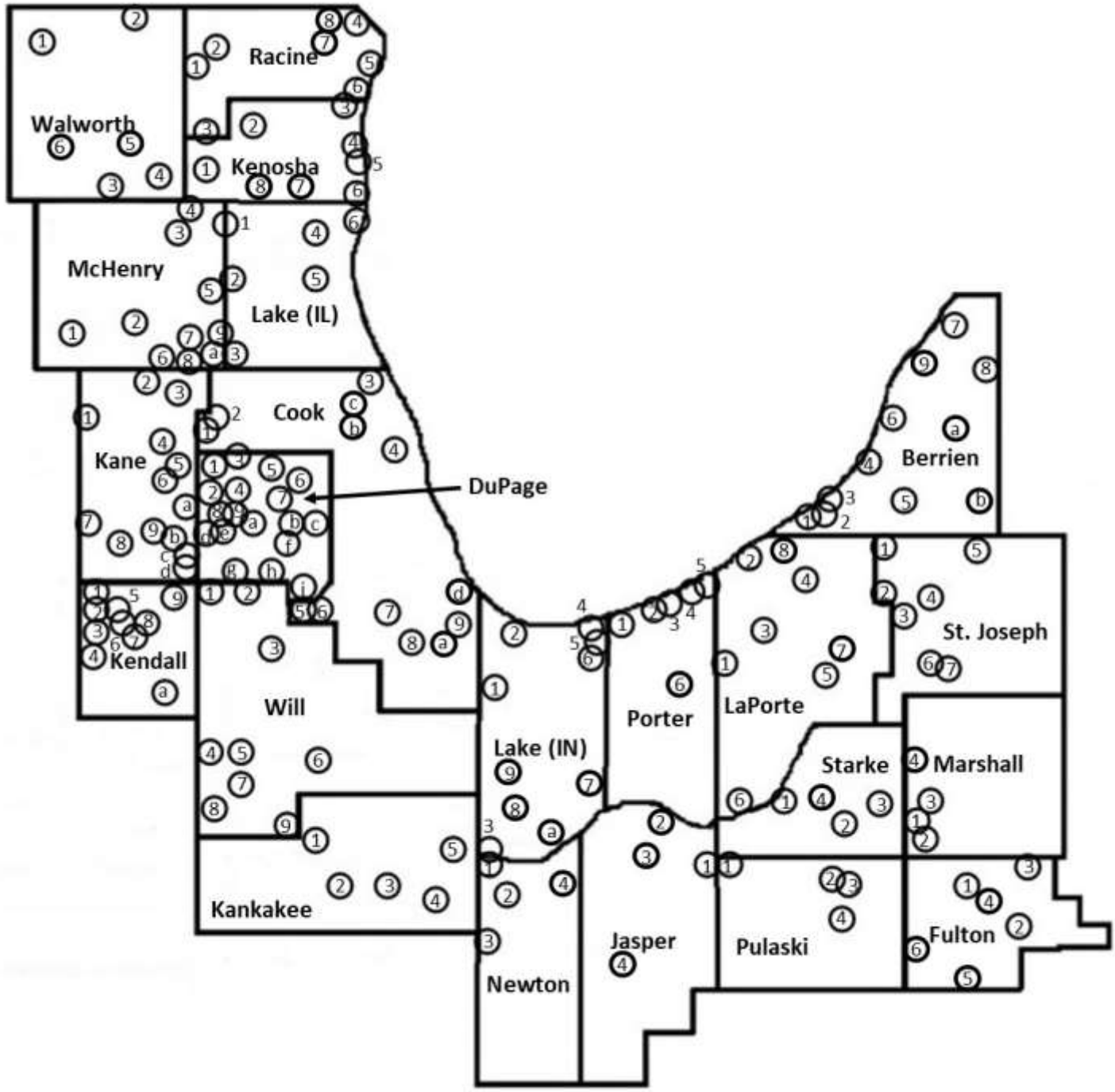


Fig. 1. Reference map of the 22 counties included in this study. Key to sites, which include adjacent areas: **Walworth County:** 1 Kettle Moraine; 2 Lulu Lake; 3 Linn; 4 Bloomfield; 5 Como; 6 Comus. **Racine County:** 1 Honey Creek; 2 Wadewitz; 3 Karcher; 4 Cliffside; 5 North Beach; 6 Sanders; 7 Nicholson; 8 Corney. **Kenosha County:** 1 New Munster; 2 Bong; 3 Petrifying Springs; 4 Alford; 5 Southport; 6 Chiwaukee; 7 Bristol; 8 Camp + Peat Lakes. **McHenry County:** 1 Coral Woods; 2 Pleasant Valley; 3 Glacial Park; 4 Elizabeth Lake; 5 Moraine Hills; 6 Exner Marsh; 7 Hollows; 8 Fox River Bluff; 9 Hickory Grove + Main Street Prairie; a Prairie Trail. **Lake County (IL):** 1 Chain O'Lakes; 2 Volo Bog; 3 Flint Creek; 4 Sedge Meadow; 5 Lake Carina; 6 Illinois Beach. **Kane County:** 1 Burlington Prairie; 2 Freeman Kame; 3 Fox River Shores; 4 Otter Creek; 5 Ferson Creek; 6 Horlock; 7 Lone Grove; 8 Prairie Kame; 9 Nelson Lake; a Fabyan; b Les Arends + Red Oak; c Shoemaker; d Oakhurst. **Cook County:** 1 Bluff Spring Fen; 2 Carl Hansen; 3 Somme; 4 North Park Village; 5 Sagawau; 6 I&M Trail; 7 Katherine Lake; 8 Gensburg Prairie; 9 Burnham; a Sand Ridge; b Belleau + Axehead; c River Trails + Beck; d Big Marsh + nearby parks. **DuPage County:** 1 Pratts Wayne; 2 West Chicago Prairie; 3 Hawk Hollow; 4 Timber Ridge; 5 Meacham Grove; 6 Songbird Slough; 7 Churchill; 8 Blackwell; 9 St. James Farm; a Herrick Lake; b Hidden Lake; c Fullersburg; d Big Woods; e McDowell; f Belmont Prairie; g Springbrook Prairie; h Greene Valley; i Waterfall Glen. **Kendall County:** 1 Plano; 2 Marramech; 3 Silver Springs; 4 Millbrook; 5 Subat; 6 Hoover; 7 Harris Woods; 8 Richard Young; 9 Jaycee Park; a Baker Woods. **Will County:** 1 Vermont Prairie; 2 Knock Knolls; 3 Lockport Prairie; 4 Des Plaines; 5 Midewin; 6 Laughton; 7 Forsythe Woods; 8 Braidwood; 9 Kankakee River SP. **Kankakee County:** 1 Kankakee River SP; 2 Gar Creek; 3 Hieland; 4 Kankakee Sands; 5 Momence Wetlands. **Lake County (IN):** 1 Hoosier Prairie; 2 Pine Station; 3 LaSalle; 4 Miller Woods; 5 Calumet Prairie; 6 Cressmoor Prairie; 7 Stoney Run; 8 Lowell; 9 Cedar Lake; a Shelby. **Porter County:** 1 West Beach; 2 Cowles Bog; 3 Indiana Dunes SP; 4 Great Marsh; 5 Central Ave. Beach; 6 Moraine. **LaPorte County:** 1 Bluhm; 2 Michigan City; 3 Pinhook Bog; 4 Springfield Fen; 5 Kingsbury; 6 Kankakee River FWA; 7 Fish Lake; 8 Wintergreen. **St. Joseph County:** 1 Spicer Lake; 2 Bendix Woods; 3 Jasinski; 4 Chamberlain Lake; 5 St. Patrick's; 6 Potato Creek; 7 Pleasant Lake. **Berrien County:** 1 Galien River; 2 Glassman; 3 Chikaming; 4 Warren Dunes; 5 Mud Lake Bog; 6 Grand Mere; 7 Sarett; 8 Butternut; 9 Riverview; a Wolf's Prairie; b Niles. **Newton County:** 1 LaSalle; 2 Kankakee Sands; 3 Willow Slough; 4 Roselawn. **Jasper County:** 1 Jasper-Pulaski; 2 Aukiki + NIPSCO; 3 Stoutsburg; 4 Rennselaer. **Starke County:** 1 Kankakee River FWA; 2 Round Lake; 3 Ober Savanna; 4 Knox. **Pulaski County:** 1 Jasper-Pulaski; 2 Winamac FWA; 3 Tippecanoe River SP; 4 Winamac. **Marshall County:** 1 Houghton Lake; 2 Maxinkuckee; 3 Memorial Forest; 4 Ancilla. **Fulton County:** 1 Germany Bridge + Ruth Kern; 2 Judy Burton; 3 Menominee; 4 Menominee; 5 Fletcher; 6 Kewanna.

song and the last song over the years beginning, in most cases, in 2006.

Another graphic represents the times of day when a species sings. It takes the form of a 24-hour clock, with daylight hours in white and nighttime in black. Green lines represent the range of times within the 24 hours that the species sings. Some species expand their singing timespan later in the season, and so I have added a second, late season clock in those cases. Here is an example of the form, representing a species which begins singing at noon and continues to midnight:

As with the seasonal information, these clocks are based on current knowledge and are subject to revision.

Size of the insect is given in a graphic form, a red bar with range of sizes in millimeters from various sources in the literature. The bar has the same length (on the printed page) as the midpoint of that range.

Range information for each species takes the form of an outline version of the map in Fig. 1. In most cases, small back dots represent sites where I have found each species. There are species which I have not found but which occur in historical records, usually from 30 or more years ago. In those cases, open dots are centered in counties where those species were found. These maps need to be loosely interpreted. DuPage County is my home, and most of my early survey work was there, so it frequently shows more sites than other counties. Large spaces in some counties sometimes indicate cities or agricultural expanses, but sometimes mean that I have concentrated my work in just a few sites in those counties. Very rough range indications and relative abundances often are reflected in these maps, but the text should be consulted before drawing any conclusions.

How to Find Them. Usually of course we find singing insects when we hear males singing. The challenge here is that most of the singing insects' sound displays are high-pitched. The lowest-frequency song among our widespread species is that of the northern mole cricket, at 1.7 kHz. That means 1.7 kilohertz, or 1700 vibrations per second (hertz). Members of a symphony orchestra check their tuning against the oboe's A, at 440 hertz. Middle C is 262 hertz. So even our lowest-pitched insect songs are much higher than that.

The personal significance of this is that as we age we progressively lose our ability to hear the highest pitches. Using my experience as an example, when I began this study I was 55 years old and already could not hear most of the lesser meadow katydids (genus *Conocephalus*). I still could hear the northern bush katydid at 13-15 kHz, but within a couple years lost that ability. Note that these singers are loud, just high-pitched. I could not hear them in the same way that people cannot hear the foraging screams of bats. They are just too high-pitched for our hearing range. Now, at age 69, I find that I cannot hear many larger meadow katydids (genus *Orchelimum*) that gave me no trouble just a few years ago. I can continue seeking all the species thanks to an electronic device called the SongFinder, which I handle carefully because they no longer are made. It takes sounds and cuts their pitch, feeding them back into the headphones at 1/2 to 1/4 of the incoming frequency.

Here is my suggestion. Go to one of the online hearing frequency tests. This is not a medical recommendation, just a way to get an idea of which singing insects you can expect to hear. I provide the song frequencies in the species pages, and you can use your test results to determine whether you are likely to hear each species' song. The ones you cannot hear still are out there, and except for the ones that live in tree canopies you may find them by wading through the vegetation where they occur and keeping your eyes open. I find this much more effective than sweep netting. I do not despair at the species I cannot hear. I still can hear all the cicadas, all the crickets, most of the grasshoppers, and most of the katydids with my current limit of 11 kHz.

Species Near the Edge of Their Ranges. As I traveled through the 22-county region, it became clear that some species are near the edge of their range, as populations showed clines, mainly in the North-South direction. Species diminishing from south to north include the tinkling ground cricket, confused ground cricket, spring trig, handsome trig, jumping bush cricket, broad-winged tree cricket, common true katydid, Nebraska conehead, long-spurred meadow katydid, round-tipped conehead, and lyric cicada. All of these have their northern boundary within the region. Species diminishing from north to south are the sphagnum ground cricket, broad-winged bush katydid and dog day cicada. The last two extend to the south end of the region in small numbers, but may not reach much farther. My notes from past years suggest that in Marshall County, to-

ward the southern end of the region, dog day cicada numbers may vary considerably from year to year, though I have heard many in some years. In addition there are two species that are abundant throughout the region, but whose mapped ranges extend only down to central Indiana and Illinois. The sword-bearing conehead and striped ground cricket should be watched for changes, as they potentially could be pushed northward by global climate change trends. Populations of these edge species are not uniformly distributed. For instance, there are large areas in McHenry County where common true katydids are few or none, and the same is true of dog day cicadas in Pulaski and Starke Counties.

There are a few instances of eastern or western range boundaries within the region. Examples of species with eastern boundaries are prairie species such as the prairie meadow katydid, short-winged toothpick grasshopper, Kiowa rangeland grasshopper and prairie cicada. The swamp cicada has its western boundary within the region.

Finally, there are distributional lacunae within the general ranges of a few species, and these are not always easy to explain. Examples here are the oblong-winged katydid and the scissor-grinder cicada.

Landscape Ecology of Singing Insects. Though the focus in most of this guide is on the individual species of singing insects, the field of landscape ecology (With 2019) provides a framework of broader patterns and questions for which the ecologically diverse singing insects provide a suitable lens.

Landscape ecology considers geographical patterns and dynamics of their change across time. Any complete biological understanding of the Chicago region must include not only what is here now but also how it got that way. Fortunately, we don't have to go back too far geologically speaking, as our landscape is less than 20,000 years old (Camp and Richardson 1999, Dott and Attig 2004, LaBerge 1994, Schuberth 1986, Wiggers 1997). Three major lobes of the most recent continental glacier flowed down from the North and scoured our region's bedrock, then began their final retreat around 18,000 years ago. As the glacier melted, with occasional periods of stalling when the push from the North was balanced by melting at the edge, it left behind a variably deep layer of various kinds of deposits. The topography was more elevated in the morainal arcs where the melt was stalled for a time, lower and flatter when the melt-back was more uniform and rapid. Occasional pocks formed where blocks of glacial ice were buried and later melted, resulting in small lakes, bogs and other wetlands. Our rivers had their start as glacial meltwater drainage streams. The Lake Michigan Lobe of the glacier picked up and crushed the softer shale from the bottom of what was to become that lake, so it left behind deposits heavy in clay west and southwest of the lake. When glacial crunching and meltwater eroded harder igneous and metamorphic rocks the ice had transported from Canada, gravel and sand resulted. Quartz sand, the most erosion-resistant component of such rocks, accumulated especially around the edge of Lake Michigan and the tributaries of the Kankakee River, which started as a glacial meltwater drainage stream originating in the part of the region covered by the glacier's Saginaw Lobe.

This glacial history impacted our singing insect fauna in various ways. Some species require, or at least are only abundant, on sandy soils. These include the green-winged and northern dusk-singing cicadas, whose nymphs live on buried plant roots, and some of the grasshoppers, for which the sandy substrate for egg-laying and/or a poor-soil plant community is an important habitat component. A couple of species, the gray ground cricket and the seaside grasshopper, are limited to the beaches and dunes around the Lake Michigan edge. Kames are gravel hills formed by waterfalls within the melting glacier, and they provide a well-drained substrate. Isolated populations of sulfur-winged grasshoppers and tinkling ground crickets live on a kame in the Lulu Lake Nature Preserve in northern Walworth County.

All species were pushed south by the glacier, surviving in what is now the southern U.S. and being influenced by selective forces then and during the advance north as the climate moderated and plant communities spread back over the barren glacial deposits. Most of our familiar prairie and forest plant species were restricted to rather small refuges in the South during the glacial maximum, though oaks and hickories occupied a large part of the southern U.S. As the glacier melted back, open sedge tundra with some black spruce trees invaded first, then white spruces filled in to form a recognizable northern coniferous forest until around 15,000 years ago. By around 12,000 years ago most of our landscape was a mix of deciduous species, including woodlands with lots of oaks. Beginning around 10,000 years ago there was a drying period, which led to the spread of prairie through our area. The prairie then retreated as the climate became wetter, so that by 6200 years ago the western part of our region was a prairie with islands of woodlands and wetlands, grading to forest in the eastern part. This reflects a gradient of increasing moisture from west to east,

mediated by the flow of wet air circulating north from the Gulf of Mexico. The drier prairies were maintained by fires which frequently knocked back woody plants that otherwise would have converted even the western part of the region into woodlands. The wooded islands within the prairie were not randomly located, but survived where rivers, other wetlands, and topographic breaks shielded certain spots from prairie fires pushed by the prevailing westerly winds. The upshot for our singing insects is a diverse landscape that to this day contains species specializing in prairie, woodland and various wetland habitats, as well as some that thrive around the edges between habitat types. A few species may be relicts of earlier changes in this history. For instance, the delicate meadow katydid, now apparently extinct in the region, is abundant in prairies to the west and probably accompanied the prairie advance. By the early 20th Century it was known in a very few scattered locations. I have not been able to find it anywhere in the present day.

The previous paragraph illustrates that the Chicago region has been a dynamically changing landscape through the recent millennia, but that now is overshadowed by the alterations our own species has made. Burgeoning human numbers have overwhelmed the planet's ecosystems, and the native habitats described above mostly have been replaced by agriculture and urban growth in the Chicago region. One of the more dramatic changes is the loss of the Kankakee wetland, once described as the Everglades of the North. That vast wetland was drained for agriculture, and only a few pockets of it survive in preserves. Much of the Kankakee River in Indiana is now a straight channel with constructed high levee banks. Other smaller wetlands received similar treatment, with drainage ditches spreading across the agricultural portion of the region (Fig. 2). This is not universally devastating to wetland species. Northern mole crickets, for instance, occasionally can be found along drainage ditches. The vegetated fringes of the ditches also support populations of upland species, most notably the woodland meadow katydid. Prairie mostly has been replaced by agricultural fields, and fire suppression has led to its invasion by woody plants. Specialists such as the prairie meadow katydid, prairie cicada and short-winged toothpick grasshopper are hard to find.

My work in compiling this book has required a lot of driving to reach the relatively tiny surviving preserves and parks to which many of the singing insects are now restricted. Much management effort is required in these little islands to maintain their habitats. There are exceptions, of course. Many species

Fig. 2. Drainage ditch, rural Kankakee County.

have thrived under our influence. These are mainly weedy ones such as the striped ground cricket, short-winged meadow katydid and Carolina grasshopper, which live in disturbed habitats, along with woodland edge species such as the greater angle-wing, snowy tree cricket, and jumping bush cricket, which can meet their needs in residential neighborhoods dominated by lawns and scattered trees and shrubs.

Habitat destruction is not the only human influence, however. Climate change is the probable cause of northward range expansions by several singing insect species (detailed in the next section of the introduction), and it likely will lead to the extinction of the sphagnum ground cricket from the region as the sphagnum bogs dry up. Say's cicada and some northern grasshoppers already appear to be pushed out. Climate change isn't simply a matter of rising temperatures, as the term "global warming" may seem to imply. Global warming is an accurate enough term, as the simplest way to measure climate change is to track the global average temperature. But the point is that our changes to the Earth's thin skin of atmosphere are increasing its held solar energy. That energy alters patterns of atmospheric flow and the behavior of storms. Droughts, more frequent flood-causing rains, and seasonal increases or decreases in temperature that seem abnormal are examples of results we observe locally. The singing insects are forced to adjust as best they can. Droughts force sphagnum ground crickets into the wettest parts of their bogs. The severe drought of 2012 concentrated wetland meadow katydids and marsh coneheads into the small portions of the Great Marsh in the Indiana Dunes National Park that remained wet. Oblong-winged meadow katydids may be preadapted to such year-to-year variability. Blatchley

(1920) observed that their eggs, laid in moist soil, can take 2-3 years to hatch. In my travels through the region I failed to hear a single individual in the years 2010 and 2019, but in other years they have been abundant and widespread. Some of the cicadas and other species may have similar flexibilities.

People also have introduced plant species from other parts of the world which, released from the consumers and competitors which hold them in check in their native lands, have become invasive plants here. Their unfair competitive advantage has led to their displacing the region's native vegetation in an increasing number of places. This is most evident in our wetlands. Wetland meadow katydids and other singing insects are limited to places where native wetland grasses have not been supplanted by reed canary grass, common reed, purple loosestrife, and hybrid cattails. These invasive plants are proving difficult to control, and the outlook is not good for species such as the dusky-faced meadow katydid and marsh conehead. To my knowledge the once relatively widespread stripe-faced meadow katydid now is confined to a single site, and the slender conehead, never known from many locations, apparently is gone from the region.

Introductions have not been limited to plants. Several species of singing insects also have been imported. Roesel's katydid is the most common of these in our region. A European predaceous katydid, Roesel's was introduced to the Montreal, Quebec, area several decades ago and expanded from there. They occur in open habitats with tall herbaceous vegetation throughout the Chicago region. Japanese burrowing crickets arrived at coastal ports and have spread out from there. They are abundant as far north as Indianapolis, and common in Rensselaer in the southern part of our region. With new appearances each year occurring as far north as DuPage, Cook and Berrien Counties, so far, I expect them to become widespread and abundant here. The tropical house cricket represents the possibility of other, short-term introductions that are unlikely to persist in our climate.

Some of the formalism developed by landscape ecologists (With 2019) clarifies the current status of our singing insects and their prospects for survival. From the standpoint of a given species, the landscape is viewed as patches of habitat imbedded within a matrix of non-habitat. If that matrix is hostile to the species, the habitat edge is a "hard boundary," and unless the species is good at dispersing long distances, they will be confined to their habitat island. To different degrees that extreme may not be met if there are steppingstones or corridors that can act as acceptable temporary refuges for dispersing individuals. I suspect that such is the case with pine tree crickets, for example. These habitat specialists are common in conifer groves across the region, many of which seem too isolated for such a small, specialized insect to cross the intervening distances. Nancy Collins, a Wisconsin specialist on the subfamily, has noticed that pine tree cricket nymphs can live, at least temporarily, in non-conifer, herbaceous habitats. Edges of conifer groves thus are not hard boundaries for pine tree crickets. In other cases, river corridors and highway rights-of-way can serve as travel lanes. Thus, the little-known dispersal abilities of our various species are key to understanding their status.

In some of the crickets and katydids which normally are short-winged and flightless, long-winged morphs occasionally appear. Roesel's katydid, mentioned above, essentially is never long-winged in its native Europe, but commonly is so here, where the species is expanding its range. There is a tradeoff in play for such species. Long-winged variants are good dispersers, but their fecundity is reduced.

Dispersal also can be facilitated by humans. I have seen examples, with Japanese burrowing crickets and jumping bush crickets, of individuals and small groups showing up far ahead of the front of their range expansion, in places where landscape materials are stored or sold.

Mate finding motivates some movement by singing insects. The females in general must travel to meet up with singing males. The males themselves also may need to change their position. In DuPage County, where swamp cicadas are relatively few and scattered, I have observed males frequently changing position between songs by tens of meters at a time. Walker's cicadas may be our most extreme species in this regard. An Iowa study (Shaw, Bitzer and North 1982) found that sword-bearing coneheads shifted position an average of 6.2m between nights, but otherwise remained associated with their group of other males.

The singing insects whose habitat needs are met by landscape alterations for agriculture and residential areas are the abundant, widespread ones. They are easily picked out by the large number of sites marked on their maps in this guide. Dispersal is relatively easy for them as there are large habitat blocks well connected by amenable corridors. Even they can suffer local extinction as land is cleared of vegetation for buildings or roadways. As new vegetation

grows into such places, the weedy species are quick to re-establish themselves, but this underlines the dynamism of the habitat patch mosaic.

Of greater interest, and greater concern, are those species whose needs are not met by human-created habitats. Here the habitat patches are only a small percentage of the landscape, and elements of patch size, patch isolation, and insect dispersal ability become critical to understanding. Theory suggests that when a habitat falls below 10-20% of the landscape, dispersal ability is expected to drop dramatically in the absence of viable corridors or steppingstones; such is certainly the case for many of our habitat specialists. A few species anecdotally are good dispersers. I have reports, or have seen myself, instances of slender meadow katydids and long-tailed meadow katydids showing up in locations remote from their respective habitats. These individuals were unusual among the small meadow katydids in being long-winged morphs; most cannot fly. Patch isolation in some cases is such that successful dispersal is impossible. Distances among the few surviving sphagnum bogs, for example, are too great to be crossed by sphagnum ground crickets. Prairie cicadas can fly, but apparently are disinclined to do so far enough to matter. At one of their sites, the West Chicago Prairie in DuPage County, they remain confined to one area of mixed grasses and forbs. They have not crossed the 350 meters of grasses, small shrubs and wetlands that separate them from a similar area within the same preserve. So far, their populations have persisted in remnant prairies ranging from one to a few acres. Can such small populations survive long term?

That question raises another concept from landscape ecology: extinction debt. This is the idea that a species' habitat may have been so reduced that the species still may be present but is doomed to fade away to extinction because its numbers are inadequate to maintain reproductive viability. Such may or may not be the case for prairie cicadas. I suspect this is what happened to northern wood crickets (NWC) in the region. NWC were known from two forested areas in northern Indiana at the beginning of the 20th Century (Blatchley 1903). One of these was in Marshall County. Years ago I used the original survey notes and county soil map to reconstruct the pre-

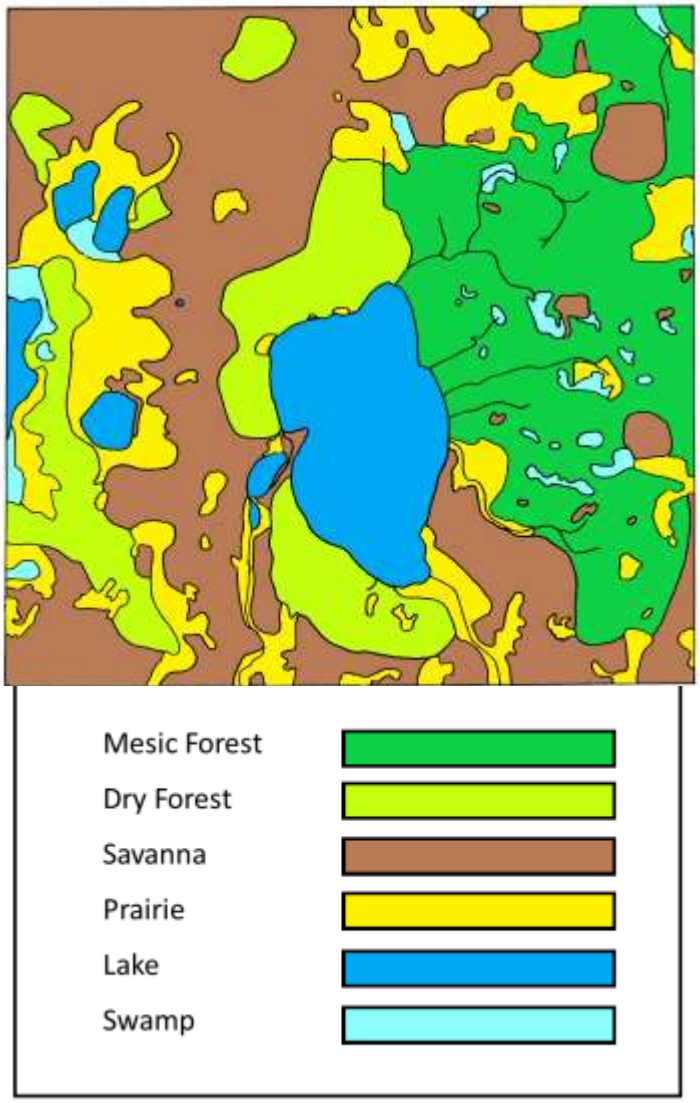


Fig. 3. Presettlement vegetation map of Union Township, which occupies the southwest corner of Marshall County, Indiana. The map is based on notes from the original land survey of 1834, plus the Marshall County soils map.

settlement landscape of the township in question (Fig. 3). Blatchley found NWC in the area of mesic forest which, in 1834, was very large. By the end of the 19th century agricultural clearing would have been well under way, and today only a tiny portion of that forest remains, the rest having been converted to pasture and crops. The same is true of forested areas in Lake County, Indiana, the presettlement vegetation of which was mapped by Bacone and Campbell (1980). These areas also were at the northern extreme of the NWC's range. Though fragments of the forests where Blatchley found NWC remain, the crickets are gone, and I have checked all the other relatively large forests in the region without finding them. This raises the disturbing question: how many other species presently in the Chicago region are in a state of extinction debt? Patch size needed to maintain a species is dependent upon the characteristics of the species, its pop-

ulation dynamics, and patch quality. These are unknowns for all the uncommon species.

I will close this section with a case study on the periodical cicadas in DuPage County (Strang 2013). In pre-settlement times the county was, from the cicadas' perspective, a matrix of prairies and wetlands with 18 forested areas of various sizes scattered throughout. Historical maps and aerial photos allowed me to trace changes in those forests from the early 19th Century to the present day. I measured the forest sizes, noting their smallest (bottleneck) extents and how those were reflected in the presence of periodical cicada choruses in the 2007 emergence. There was a clear threshold of local extinction: forests which had remained above 61ha (hectares) still had cicadas, those which had fallen below 52ha did not, even when they had grown larger subsequently.

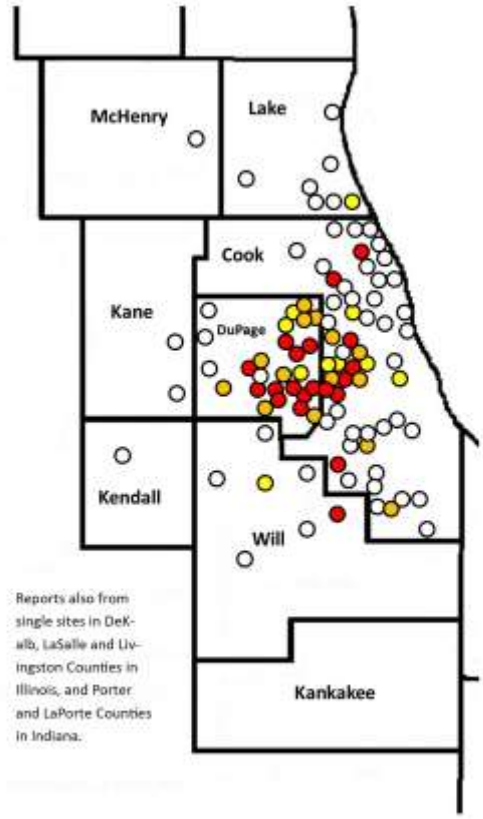


Fig. 4. Locations of periodical cicadas observed in 2020, either by me or reported through social media. White dots indicate towns or parks in which at least one or a few cicadas were documented. Yellow dots mark countable numbers, i.e. from one spot you could hear multiple cicadas singing. Orange dots mark small choruses (though sometimes occurring over large areas), in which the cicada songs were blended to the point where individuals no longer could be picked out, but the choruses were not organized. Red dots mark areas with full choruses, formed into periodic waves of song, loud and with both species audible.

Old newspaper accounts placed cicadas in at least some of these. Three forests which fell between those sizes appeared to have been affected by isolation, a remote one lacking cicadas, and two near persisting populations having them. The human history peculiar to the county is important here. DuPage County is immediately west of Chicago. The western half of the county quickly became agricultural, with forests cut back to make room for fields and pastures. Forests lacking cicadas in 2007 were mainly in the west. The eastern half developed residential commuter communities, with forests being protected and expanded as people planted trees around their homes. The largest area with cicada choruses in 2007 was lobular in shape, the various lobes following the routes of commuter-serving railways and the towns that expanded along them, connecting several of the pre-settlement forest locations. When the cicada choruses reached their peak in the first half of June, numbers of the insects suddenly appeared in flight, crossing over highways and other hostile environments. Subsequently, small groups showed up in places remote from the concentration areas. Whether these will result in significant expansion of the species in the county remains to be seen, but this observation supports the notion that competition and population pressure produce responses by the cicadas. They have the advantages of stronger flight capabilities and better vision than other singing insect groups.

The story of periodical cicadas in DuPage and adjacent counties is complicated by the repeated 4-year-early emergence of significant numbers of the insects over a large area, first noted by Dybas (1969) and repeated in the 3 subsequent cycles to date. Though Dybas and Phil Nixon of the Illinois extension service listed towns where the off-year emergences occurred, there was little quantitative information. It was not clear whether this phenomenon was the result of a splinter population's reproduction or whether separate groups of 13-year-old cicadas were making independent emergences each time. In 2020 I documented large choruses and reproduction in enough communities to support the idea that this is indeed a self-sustaining, separate population from that of the main emergence (Fig. 4). It was, interestingly, limited to residential areas. In only one forest was there a short-lived large chorus. The main factor here appears to be a relative lack of predators in the residential areas, supporting a model proposed by Lloyd and White (1976) in which "out of control" population growth results in severe underground competition for space by nymphs, driving some to take advantage of an ability to accelerate their maturation by four years (Marshall, Hill and Cooley

2017). In this case it appears that enough have done so to establish the new, separate population coexisting with that of the main emergence.

Range Extensions. As detailed in the landscape ecology section, the landscape is not static, and its ecology is not in equilibrium. Furthermore, climate change has been cited as a factor in northward range extensions in insects (Sánchez-Guillén et al. 2015). As mentioned earlier, several singing insect species are actively extending their ranges. Gonzalez (2012) mentioned a calculation, based on work in Gonzalez et al. (2010), indicating that the region's climate has undergone a change equivalent to a southward shift in latitude of 100 km in the 20th century. This half-state shift is consistent with the magnitude of several observed range changes. Species with half-state northward advances since the early 20th Century are the jumping bush cricket, broad-winged tree cricket, handsome trig, slightly musical conehead, and round-tipped conehead. Tinkling ground crickets and common true katydids have made smaller advances of a few counties. Such rapid advances cannot be attributed to post-glacial recovery or habitat change. Climate change therefore seems the most likely underlying cause. There are counterexamples in the confused ground cricket, long-spurred meadow katydid and Nebraska conehead, which have not extended their ranges in the same time span. These are species of forests and woodland edges, but that may or may not be significant. The most impressive northward spreads, several states in scale, have been by the Japanese burrowing cricket, an introduced species, and the Cuban ground cricket. The latter is unobtrusive, and though common across the Chicago region might have been missed by earlier researchers. Another introduced species, Roesel's katydid, spread into the region from the east, having first appeared in the Montreal area.

Shifts of species' ranges and projections of future shifting have attracted the attention of many researchers. Chen et al. (2011) reviewed studies of a broad range of species and found an overall average northward advance of 16.9 km per decade. On average, latitudinal shifts matched expectations based on temperature change, but "variation is so great within taxonomic groups that more detailed physiological, ecological and environmental data are required to provide specific prognoses for individual species." This last point was emphasized in a modeling study of projected responses by 80 tree species in the eastern U.S. (Iverson and Prasad 1998). Their model of climate, soils and other factors first was tested against current observed distributions and showed good agreement. They then predicted what will happen based on a doubling of current atmospheric carbon dioxide. The expectations for the various species were diverse, and it is reasonable to expect a similarly variable response by singing insects. About half of the tree species showed a shift in their ecological optimal conditions of at least 100 km to the north, with 7 species more than double that amount. In contrast, 5 species had their optima shift southward. The authors acknowledged that barriers to migration will limit species' abilities to track the changing conditions. Another study (Malcolm et al. 2002) looked at global biome responses, again to a doubling of carbon dioxide, modeled over a 100-year time span. Biomes just north of the Chicago region showed needed rates of migration of at least a kilometer per year in 35% of cases, but a lower 15% in our region's biomes. All these observations and models are consistent with what our singing insects are showing us.

A major question in all such studies is the degree to which the southern range boundary will be affected. The models and some observations suggest that the impact will be less for that edge. If that is not the case, and the southern boundary shifts to a similar degree, the loss of our sand-soil species is to be expected as that soil type is geographically bounded in the region, except perhaps for Berrien County. I should note that many of our singing insects have range boundaries that are outside the region, and so they have not been mentioned in this section.

Community Ecology of Singing Insects. Community ecology is the study of species interactions and resulting patterns of diversity. Predation, competition and species diversity are included here. Mutualism, a category of interaction in which both species benefit, does not appear to be important in the singing insects. The only possible example I have observed is occasional visitation by fork-tailed bush katydids to flowers, but those katydids are relatively slow moving and I doubt that they play a significant role as pollinators.

Populations of singing insects appear to be small relative to the vegetation that supports them. Plant damage is very limited. This implies that the insects' numbers are limited not by food but by other factors, particularly predators and parasitoids, a process referred to as top-down control. Predators of singing insects include vertebrates, spiders and wasps, including members of genus *Sphex* which collect katydids to feed their young, and cicada killers, which do the same with cicadas. Parasitoids lay their eggs on singing insects, in many cases using the songs of males to locate their hosts. Many species of wasps

and flies (genus *Ormia* and other members of the fly family Tachinidae being particularly important on host species of crickets and katydids) are included here. Horsehair worms are common parasites of meadow katydids, which pick them up when they include smaller insects in their omnivorous diets. Having entered the katydid via such an intermediate host, the worm grows to the point where the katydid is removed from the reproductive population. Roughly half of males in some species die before they sing a single song (Feaver 1977).

Classical community ecology emphasized competition as an organizing process. The degree to which singing insects compete with one another is an open question. The top-down population control which apparently limits the insects' numbers may also act to prevent competition. This was found in a study of tropical forest floor crickets (Szinwelski et al 2015). I have noticed considerable overlap in habitats of our ground crickets, as many as three species commonly occurring together. Co-occurrence is not the same as ecological equivalence, however. For instance, melodious ground crickets commonly share their floodplain forest habitat with Carolina ground crickets and confused ground crickets. The melodious ground crickets associate closely with rotting logs, males often singing at them and females presumably laying their eggs in them. The other species are more associated with leaf litter, Carolina ground crickets apparently preferring moister locations, confused ground crickets drier ones. Such niche separation has been referred to as the ghost of competition past, selective forces having pushed species into different locations in niche space. Another possible example is provided by the conehead katydids (genus *Neoconocephalus*). A genetic study (Frederick-Hudson 2015) found that these species (seven in our region) diversified from a tropical ancestor in post-glacial times, all within the past 12,000 years. They share a diet of seeds but most of them separate from one another by habitat.
Species also miss competing with one another by separating in time and space. Spring field crickets and fall field crickets are identical to one another except that the former overwinter as nymphs and are active from May to July. Fall field crickets overwinter as eggs and become mature as the spring field crickets are fading away. Often the two occur in the same places, though the stringency of winter apparently forces spring field crickets into a narrower range of habitats. Long-tailed meadow katydids and black-sided meadow katydids are small wetland species that almost never occur together, though that may simply reflect a preference for coarser vegetation, e.g. cattails and shrub willows, by the latter. An interesting case under study by Lisa Rainsong in Ohio is the abutment of ranges in the Forbes's tree cricket and black-horned tree cricket, two sibling species reliably identified by song quality rather than morphology.

The ghost of competition past is a potential cause of niche separation that no longer can be observed readily. Comparisons of putative competitors in areas where they co-occur to areas where they do not provide one approach. For instance, Jang and Gerhardt (2006) found that northern wood crickets and southern wood crickets both preferred forests in portions of their ranges where only one species was present, but in areas of sympatry the latter species shifted to grasslands. The two species had broadly overlapping song parameters where they were separate, but that overlap vanished in regions where both occur. We may have an opportunity to observe competition in action as Japanese burrowing crickets spread into our region. Will they compete with fall field crickets?

Another possible example of competition that remains to be studied is among cicadas that feed on sap from roots in the nymph stage. This would seem to be a resource that is difficult for different species to subdivide, though one could imagine habitat differences, host plant differences, and root size differences as possible niche axes for subdivision. Another possibility is active competition, with larger or more aggressive individuals taking the prime spots.

Community ecology also includes the study of species diversity, which is made up of species richness (the number of species in the community) and species evenness (the relative population sizes of the species). The various groups of singing insects are so different from one another ecologically that I am disinclined to regard them all as being in the same community. It would make more ecological sense to look at groups separately (ground-dwelling crickets, tree-dwelling crickets and katydids, etc.). My data are limited in this regard, as I have been focusing on presence-absence and not population size.

One pattern that has been much studied by ecologists is a gradient in numbers of species from equator to poles. This certainly is evident even within the relatively narrow latitudinal range of our region, as species drop out as you move north. Median numbers of species I have found to date are 60 in the southernmost rank of counties, progressing northward through 5 more ranks: 60.5, 57, 53, 44.5 and ending with 43 in Racine County.

Population Conservation Concerns. As I drive the many miles through the region gathering data, I pass through a landscape that largely is barren except for the subset of species that can tolerate human alterations. My work nearly all is done in the relatively small areas of native habitats, preserved by governments and private conservancies, that are the remnants of a once rich and diverse wild land. The change has taken its toll. Several singing insect species once described as common or at least present in the region have resisted my attempts to find them. Most of these are wetland katydids. I have yet to find the delicate meadow katydid and the slender conehead, and I have only one location for the stripe-faced meadow katydid. For the most part, species I have not found which were known in the region historically either had few past records, or were at the edges of their ranges.

Scott Namestnik and Michael Homoya in Indiana have drafted a standard for endangered and threatened plant species that might be translatable to singing insects: "To be listed as Endangered, there must be one to five occurrences of the plant statewide. Plant species with six to 10 known occurrences are listed as Threatened. Rare species are those with 11-20 known occurrences statewide. Watch List species include those that were previously on the Endangered, Threatened, and Rare list but that have been removed, often because enough occurrences to surpass the Rare category exist." Roger Hedge points out that judgments need to be made as to which "occurrences" truly are separate or might be portions of connected populations. Listing for animals in Indiana is less quantitative, and is based more on the judgments of specialists. In Illinois the standards likewise are not quantitative, and are based on terms such as "low populations."

This study does not focus on any complete state, but rather on a few counties in each of four states. Its results therefore should not be the sole basis for determining species of conservation concern. It can, however, narrow the focus, pointing to species that might be regarded as candidates for consideration. In addition to the species mentioned above, some others with few sites to date are the sphagnum ground cricket, prairie meadow katydid, dusky-faced meadow katydid, and prairie cicada. There are others that I have not found in many places yet, but expect to do so and thus do not mention here.

The current Indiana list contains some species of interest to this study (status indicated): sprinkled grasshopper ("sprinkled locust") rare, prairie meadow katydid rare, slightly musical conehead ("a katydid") rare, Nebraska conehead ("a katydid") rare, spotted-wing grasshopper ("green desert grasshopper") rare, short-winged toothpick grasshopper ("bunch grass locust") threatened, longhorn band-winged grasshopper ("sand locust") rare, seaside grasshopper ("the dune locust") threatened. Some of these in fact I have found to be locally abundant in the region: slightly musical conehead, Nebraska conehead and seaside grasshopper.

Conservative Species. Some of the singing insects are locally common, but occur only in narrowly defined habitats. This is clearest in the sphagnum ground cricket, which lives only in sphagnum bogs. The melodious ground cricket seems to be a similar case. Its occurrence appears limited to swampy woodlands with an abundance of decaying wood. Finally, the prairie cicada appears to be limited to remnant prairies, but is capable of persisting on just a few acres (though, as mentioned in the landscape ecology section, that persistence may represent an extinction debt). This invites experimentation with introducing the species to high-quality restored prairies.

Dispersal Ability. At the other end of the spectrum are species that are abundant and widely distributed. These appear to be species that are tolerant of disturbance, or perhaps adapted to disturbed ecosystems, and so can thrive in agricultural, residential, or degraded environments. They also are good at dispersing, either because they can travel long distances or because they are so abundant that population pressure pushes some of their number outward. I found an example of this on the extensive grounds of a hospital in Mishawaka, Indiana. This hospital was opened in 2010, and a mix of native prairie plants was established around it. Early season species that had become established there within a few years provide examples of those that are quick to disperse into new habitats: spring and/or fall field cricket (I was there during the seasonal transition between the two), striped ground cricket, Allard's ground cricket, Roesel's katydid, sword-bearing conehead, and Carolina grasshopper. No doubt other, later season species could be added to this list.

Acknowledgements. Without the resources provided by others, this project would not have been possible. I'll begin with Tom Walker, professor emeritus at the University of Florida, whose Singing Insects of North America website is unmatched particularly for the more obscure species not covered elsewhere in the general literature. Lisa Rainsong, who along with her partner Wendy Partridge is conducting a comparable singing insect survey of the Cleveland

region, continues to be an important correspondent and sounding board. Nancy Collins is a dedicated student and promoter of all things tree cricket, and provides valuable information from her base in the northern portion of the Chicago region. Another researcher in tree crickets is Laurel Symes, who generously has shared her results, clearing up much of my confusion regarding *nigricornis* group tree crickets. Fellow nature blogger and outstanding Indiana field botanist Scott Namestnik has been a great collaborator on the Roesel's katydid range extension study, and introduced me to a variety of sites in northwest Indiana. As singing insects grow in interest among students of natural history, more projects and studies are emerging. The earliest of these, the New York Cricket Crawl, is a monitoring project led by Sam Droege. The Chicago Park District has begun its own singing insects monitoring program, led by Kathleen Soler. Negin Almassi has extended that program into the Forest Preserve District of Cook County.

My early work was boosted by the Forest Preserve District of DuPage County's natural resources team, notably Scott Meister, Tom Velat and Rachel Reklau, who provided abundant support in my work on those preserves. I also need to mention two DuPage botanists, Scott Kobal and Wayne Lampa, whose definition and mapping of ecosystem units placed a habitat context around my fieldwork.

Beginning in 2012, as I extended the study outside DuPage County, I needed to obtain permits and support from others. This expansion of the study placed me in contact with many people who have helped with information, permitting, and other support. All were critical to my progress, and so the following list is in no particular order other than roughly alphabetical: Nina Baki (Forest Preserve District of Will County); Greg Behm, C. Michael Moomey, Brad Semel, and Saki Villalobos (Illinois Department of Natural Resources); Craig Brabant (University of Wisconsin entomology collection), Gail Brown and Tom Simpson (McHenry County Conservation District), Brad Bumgardner (Indiana Dunes State Park), Bill Glass and Renee Thakali (Midewin National Tallgrass Prairie), Greg Courtney (Iowa State University entomology collection), Chris Dietrich (Illinois Natural History Survey), Karl Gnaedinger and Rob Littiken (The Nature Conservancy in Illinois), Ralph Grundel and Sam Droege (U.S. Geological Survey), Dave Guritz and Judy Strohm (Forest Preserve District of Kendall County), Roger Hedge (Indiana Department of Natural Resources), Wil Hershberger (who continues to expand the Songs of Insects website, and came out to exchange ideas and pick up some live insects for photographing and recording at his studio), Scott Holaday (who welcomed me onto his Marshall County property); Jeff Holland, John T. Shukle, and Alyssa Collins of Purdue University's entomology department, Dale Huizenga (Kankakee River Valley Forest Preserve District), Stacy L.Iwanicki (Illinois Department of Natural Resources), Michaele Klingerman and Evie Kirkwood (St. Joseph County Parks), Joy Marburger, Gia Wagner and Desi Robertson (Indiana Dunes National Lakeshore), Kelly L. Neal (Illinois Nature Preserves Commission), Gino Nearns (Purdue University entomology collection), Gideon Ney (a University of Missouri graduate student who has taught me much about coneheads; we share a renewed frustration at our inability to find slender coneheads) and his colleague Nathan Harness, Mark O'Brien and Erika Tucker (University of Michigan entomology collection); John Shuey, Stuart B. Orr, Stephanie Frischie and Brian Dugan (The Nature Conservancy in Indiana), Bob Rieser (DuPage Forest Preserve volunteer), Cassi Saari (Chicago Park District), Gary Strang (who helped with early season fieldwork in 2016 and 2017), Mark Swanson (for information on some grasshoppers), and Jerry Ziegler (The Nature Conservancy in Wisconsin).

In 2020 I benefited from the many people who contributed observations of periodical cicadas to social media. Also I appreciate Phil Nixon's sharing of the reports he received in 1986 and 2003 at his entomological extension office. I was helped in my interpretation of those observations by John Cooley and David Marshall of the University of Connecticut cicada lab led by Chris Simon. As you can see it's a long list, and I very much hope I have remembered everyone.

The Singing Insects

In this document I am focusing on insects that produce auditory displays that people can hear. That doesn't mean all people can hear them, however. As I rise through my 60's I find my ability to hear the highest pitches gradually diminishing. I can no longer hear the songs of the small meadow katydids (*Conocephalus* spp.), for example. Children can hear them, and young adults whose hearing remains undamaged, so those species need to be included here.

The singing insects fall into four groups: crickets, katydids, grasshoppers and cicadas. The first three of these groups belong to order Orthoptera (orders are the major subdivisions of insects). Crickets and katydids are in one suborder, Ensifera, grasshoppers in another, Caelifera. The fossil record and DNA study have shown (Song et al 2015) that the order appeared in the Carboniferous Period, many millions of years before the first dinosaurs emerged in Mesozoic times. The two suborders diverged in the Permian Period, just before the Mesozoic Era began. The crickets separated out in the Triassic Period (first of the three periods in the Mesozoic), and had a major diversification in the Triassic and Jurassic. Katydids appeared in the Jurassic Period and diversified in the Cretaceous (last of the Mesozoic periods), along with flowering plants. Grasshoppers diverged and diversified later, in the Cenozoic Era, along with grassland ecosystems.

One consequence of all this is that the katydids, despite their apparent similarity to grasshoppers in their body, leg, and wing shape, are in fact more closely related to the crickets. That relationship is shown by the long, threadlike antennae shared by crickets and katydids, in contrast to the thicker stubby grasshopper antennae. More relevant to this document is the fact that both crickets and katydids produce sounds by rubbing together rasping structures on the two wings. The few grasshoppers that sing either rattle their wings in flight (crepitation), or rub the legs against the wings (stridulation).

The cicadas are in a separate order, Hemiptera. They produce sounds in a completely different way, by vibrating drumhead-like membranes on the sides of their bodies.

Only adult males sing. The point of the singing is to attract females for mating. Therefore it is very important that the songs be distinct enough that the females can recognize those produced by males of their species. This principle has some interesting corollaries. First, the singing insect species are not as visually distinctive as, say, butterflies or dragonflies which identify their kind by seeing color patterns. Consequently there are many pairs and clusters of sibling species in all the major groups of singing insects. Sibling species are reproductively separate, but to our eyes appear to be identical or nearly so.

Another consequence of female identification of male song is that, in a few cases, they can make distinctions that we cannot, at least not without help (for example, differences in song pulse rate). Examples of this occur in both crickets and katydids.

Once mating has occurred the females lay eggs. In most crickets, katydids and grasshoppers the egg stage is the wintering stage. Eggs hatch in spring, and the development of nymphs takes time, which explains why most singing insects do not reach maturity until July or August. Cicada eggs may hatch in the same season they are laid, the nymphs tunneling into the ground and taking years to develop by sucking sap from plant roots. A few crickets, katydids and grasshoppers overwinter as nymphs or adults; their cases will be taken up later.

Crickets
Superfamily *Grylloidea*

Technically the crickets are separated from katydids in having feet with three rather than four segments. Informally we see that katydids generally resemble grasshoppers but with long, threadlike antennae (like crickets). Crickets do not resemble grasshoppers. They appear to have wings flat on their backs in contrast with the roof-like positioning of katydid wings.

Song production involves the rubbing of a toothed, file-like structure on one wing against a plectrum, a hardened vein on the edge of the other wing (Mhatre 2012). The wing size, shape and venation are balanced in such a way as to produce the pleasant tones characteristic of cricket songs (a single dominant frequency is what we hear, rather than the often discordant mix of frequencies characteristic of other singing insects' buzzing or droning sounds). The wing structure of a field cricket is such that the same pitch is produced regardless of temperature (the vibration of a particular portion of the wing, the harp cell, produces the sound). In tree crickets, the entire wing is involved, with different portions dominating at different temperatures, so the pitch can vary with temperature (the wing vibrations slow down as the temperature drops, and this change brings different parts of the wing into play).

Males often provide treats to females who respond to their songs. In the ground crickets, females typically chew at certain spines on the males' feet when mating. Tree cricket males have a gland on the dorsal abdomen just behind the bases of the wings that produces a secretion the females consume. Crickets may lay their eggs in the soil or in plant tissues. Most spend the winter in egg form, though there are exceptions such as the spring field crickets that overwinter as nymphs. Cricket nymphs develop through several stages, or instars, molting the old exoskeleton and expanding into a new one for each graduation between instars. Only the adults may have fully developed wings, though these sometimes may be short and appear to be undeveloped in some species.

Our crickets are mainly vegetarians and scavengers. None are exclusively predatory. This broad dietary range raises the ecological question of how so many species manage to coexist in local communities. The ground crickets are a case in point. Open areas often have Allard's, striped, and variegated or Cuban ground crickets together, joined sometimes by Carolina ground crickets. Wooded areas often have confused, spotted, and Carolina ground crickets, sometimes joined by melodious ground crickets. Tinkling ground crickets prefer dry woodland edges, but often spill into the woodland or open areas on either side, joining those respective groups. Microhabitat variation in soil moisture and texture may account for some of this overlap, but it also may be an example of potential competition being suppressed by other factors which keep numbers low, resulting in "functional redundancy" (an interesting case study and discussion in Scheffer et al. 2015). Possibilities here include parasitism and resource limitation, the latter demonstrated for tropical forest floor crickets by Szinwelski et al. (2015).

Our crickets are in two families, Gryllotalpidae (the mole crickets) and Gryllidae (all the rest). It is useful, therefore, to look at how the Gryllidae further are separated into subfamilies, as is done in the following scheme.

Family Gryllidae

Subfamily Gryllinae (field crickets: local species include the spring and fall field crickets, the northern wood cricket, the eastern striped cricket, and the Japanese burrowing cricket).

Subfamily Eneopterinae (bush crickets: our local species are the jumping and restless bush crickets)

Subfamily Nemobiinae (ground crickets: local species include Allard's, striped, gray, spotted, tinkling, Carolina, confused, melodious, Cuban, sphagnum and variegated ground crickets).

Subfamily Oecanthinae (tree crickets: local species include the two-spotted, Davis's, Forbes's, snowy, tamarack, broad-winged, narrow-winged, pine, and four-spotted tree crickets).

Subfamily Trigonidiinae (sword-tail crickets: local species include Say's, spring and handsome trigs).

Family Gryllotalpidae (mole crickets: the northern mole cricket is our only representative).

Tropical House Cricket (*Gryllodes sigillatus*)

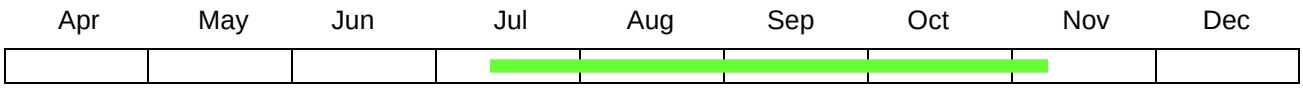
This species appeared in my residential neighborhood in DuPage County in 2019. At least a dozen males were singing, so it seems likely that they emerged from an egg mass transported from the South. They lived in seams between sidewalk blocks and around curbs. This is a southwest Asian species that has become established along the Gulf of Mexico coast and points west. Though they may have mated and laid eggs, these did not survive the northern winter. I include this page in the guide to represent a variety of species that potentially could be short-term imports from other parts of the world.

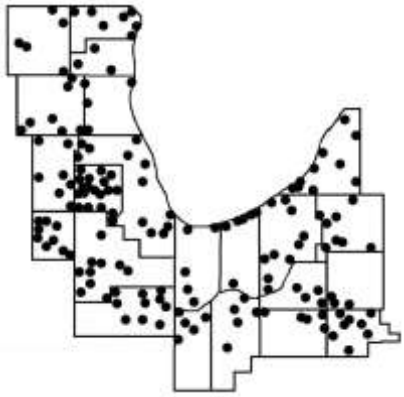
Season. I first heard males singing in the late summer, and at least one survived into early October.

Similar Species. These are much larger than ground crickets, and smaller and paler than other field crickets in the region. The black posterior edge of the pronotum is distinctive, as is the song.

Song. The song consists of rapid-fire brief chirps, 5 or more per second, each with 2 strong pulses. The tone is buzzy rather than musical, peak frequency 6.2 kHz. Tropical house cricket recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/501a.htm), and my blog (https://natureinquiries.wordpress.com/2019/10/11/strangers-in-the-neighborhood/).

Fall Field Cricket (*Gryllus pennsylvanicus*)



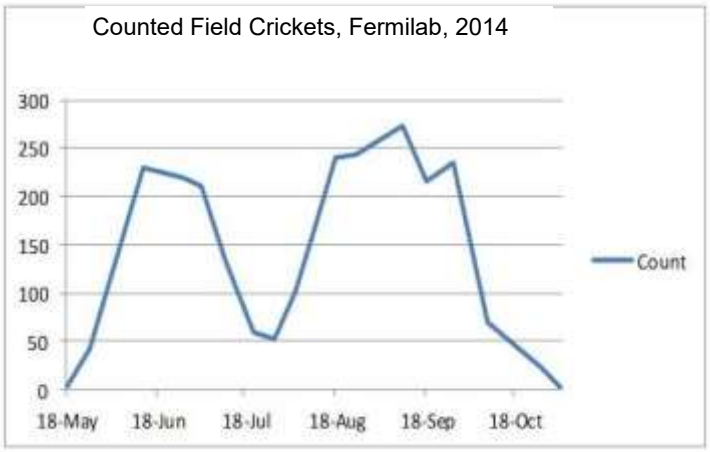


This is the common late season species of large black cricket in our area. The fall field cricket's habitat is broader than the spring field cricket's, more often extending into mowed lawns, wetland edges, and woodlands, though open areas with taller herbaceous vegetation are the most common habitat.

Season. Eggs overwinter in the ground and hatch in spring. Nymphs begin to mature in July. As indicated in the spring field cricket account, numbers of singing field crickets build again after the middle of July (see graph, below; fall field crickets were first heard singing on dates ranging from 9 to 30 July across the years, at a DuPage County site where the spring species was absent). There are no days in July when neither species is singing. Numbers of singers peak in late August or early September, and hold high densities for at least a month. They sing until the growing cold and frost silences them; last observed song dates have ranged October 16-November 8 in different years.

Similar Species. The only other large black cricket in our area is the spring field cricket, but it is a sibling species so similar to the fall field cricket that it can be distinguished only by the season in which it is active. Morphologically and by song, the two are identical. The northern wood cricket is smaller, blacker, and differently proportioned, and its season finishes before the fall field cricket's begins.

Song. The fall field cricket produces moderately high-pitched, fairly loud chirps, at 4.7 kHz well within the hearing range of most people, each chirp a bundle of 2-5 pulses or notes that lasts about a quarter second. The chirps are produced at a rate of 1 per second, or as many as 3-4 per second in hot temperatures. The song is indistinguishable to the ear from that of the spring field cricket. Fall field cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/489a.htm), at the Songs of Insects website (http://songsofinsects.com/crickets/spring-and-fall-field-crickets), my blog (https://natureinquiries.wordpress.com/2014/01/13/sound-ideas-an-odd-trio/), and at Lisa Rainsong's website (https://www.listeningtoinsects.com/fall-field-cricket).

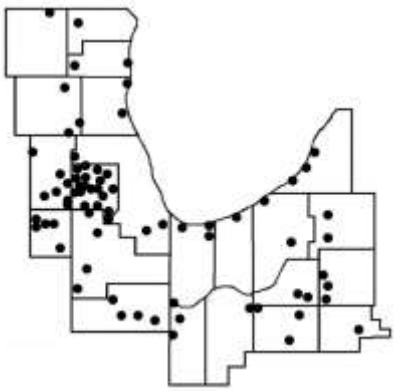


Graph of counted singing field crickets through 2014 along a standard transect route through Fermilab in DuPage County.

Photos: Female, above left, distinguished by the long hypodermic-like ovipositor extending from the end of the abdomen. Male, below, lacks this structure.

Spring Field Cricket (*Gryllus veletis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



This is our common early season large black cricket. Spring field crickets prefer open, dry to mesic habitats with mixes of tall grasses and forbs, and are most abundant in areas with a mix of shrubs, grasses and forbs. They are not in lawns as a rule, but rarely can be found there as well if the lawn is adjacent to good habitat or especially if the mowing leaves the grass relatively high. They also can be found under leaf litter in dry open woods and forest edges in sand soil regions. This is not a species of wetlands.

They are common throughout our area, and widely distributed in their habitat, but their slightly more limited habitat breadth, as described above, places them in fewer locations than the fall field cricket. A possible explanation of the spring field cricket's more limited habitat range is that its overwintering requirements are more stringent. The nymphs need better protection than the buried eggs of the fall field cricket.

Season. Eggs hatch in the same season they are laid. The small crickets overwinter, and complete their growth in early spring. They begin singing in May, the observed starting date ranging 5-31 May in different years. The transition to its sibling species, the fall field cricket (whose song is identical to the ear), is not demarcated by a period with none singing, but the second half of July brings minimal singing (see fall field cricket) and so is taken to be the transition time between the two sibling species. Both species sing through the 24 hours, but spring field crickets peak in the morning, fall field crickets before sunrise (French and Cade 1987). This helps keep the species apart during their overlap period, as hybridization is lethal (Bigelow 1960).

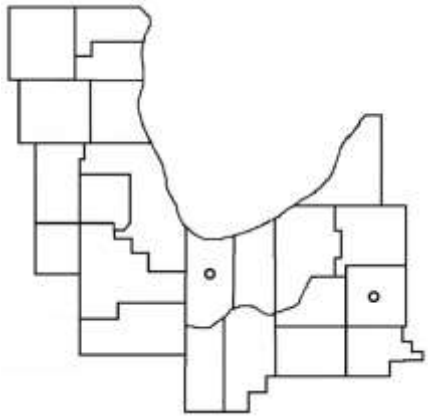
Similar Species. The only other meadow-dwelling large black cricket in our area is the fall field cricket, but it is a sibling species so similar to the spring field cricket that it can be distinguished only by the season in which it is active. Morphologically and by song, the two are identical. The northern wood cricket has a broad seasonal overlap with the spring field cricket, but lives in forests where the canopy cover is greater than the spring field cricket's tolerance. It is all black and smaller, the head is narrower in proportion, and the pronotum is widest at the posterior end, at the anterior end in the spring field cricket.

Song. The spring field cricket produces moderately high-pitched, fairly loud chirps, at 4.9 kHz well within the hearing range of most people, each chirp a bundle of 2-5 notes or pulses that lasts about a quarter second. The chirps are produced at a rate of 1 per second or as many as 3-4 per second in hot temperatures. Spring and fall field cricket songs are indistinguishable. See the northern wood cricket account. Spring field cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/488a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/spring-and-fall-field-crickets), and Lisa Rainsong's website (https://www.listeningtoinsects.com/spring-field-cricket).

Photos: Female, above. Male, right.

Northern Wood Cricket (*Gryllus vernalis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	■	■	■					



This is a forest-dwelling member of the field cricket group. The only past records of *vernalis* in the Chicago region were by Blatchley (1903) in Lake and Marshall Counties, Indiana. The map in that publication shows where he did his survey work, and my searching revealed that those forests no longer harbor the species. Those woods are no doubt smaller than they were in the early 20th Century and before, and it is possible that even in Blatchley's time they had been cut back to the point where they no longer could support populations long term. In 2019 I hunted for *vernalis* in the largest surviving forests in the Indiana portion of the region and failed to find them. It appears that forest clearing has eliminated this cricket from the Chicago region. My experience with this species is limited to central and southern Indiana, including a captive male I brought home for study in 2018.

Season. This is an early season cricket, as the name *vernalis* suggests. Alexander (1957) said *vernalis* matures 1-2 weeks before *veletis* in southern Ohio, but the two species' seasons largely overlap, with *vernalis* peaking in early June and finishing in mid-July. Singing is infrequent until late afternoon, increases at dusk, peaks in the early night, and diminishes toward midnight (Jang and Gerhardt 2005 and my observations at Eagle Creek Park in Indianapolis, the farthest north place where I have found them).

Photos: Male, above. Female, right.

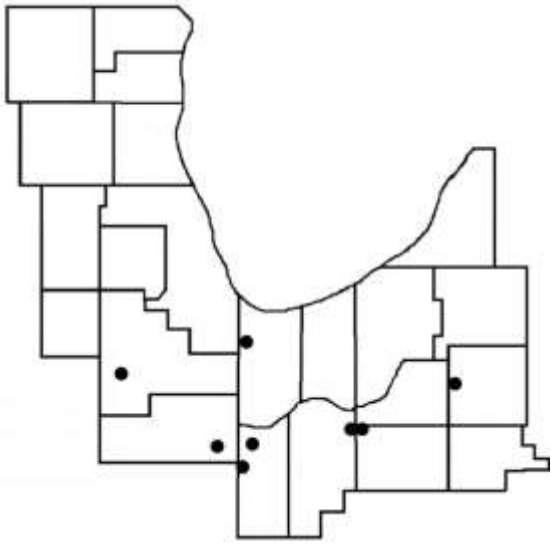
Similar Species. This cricket is black without the brown wings of the spring and fall field crickets, and slightly but distinctly smaller (up to 17mm body length, with spring field cricket 18mm or more). The pronotum is widest at its posterior end, the opposite of the spring and fall field crickets. The song also is different. In females, the ovipositor length is less than 12mm, shorter than the spring field cricket's.

Song. The song is similar to that of the spring field cricket, consisting of separate chirps. When I compare my recordings of *vernalis* and *veletis* I find that the former have a lower dominant frequency. Values below 4.9 kHz nearly all are *vernalis*, low temperature responsible for at least some low-pitched *veletis*. Also, *vernalis* almost never show 4-pulse chirps, *veletis* almost always do (here I include in the count the tiny pulse that begins the chirp in both species; all *veletis* recordings to date below 5 kHz have some 4-pulse chirps). Chirp length tends to be shorter in *vernalis*, 0.07-0.08 seconds being common.

Northern wood cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/470a.htm) and in my blog at https://natureinquiries.wordpress.com/2015/06/18/northern-wood-crickets/

Eastern Striped Cricket (*Miogryllus verticalis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



For the first decade of my study, I regarded this as a hypothetical species for the region, as previous records placed its northern range limit to the south and west. On June 21, 2014, I recorded a series of brief buzzes coming from the trail edge at Hoosier Prairie in Lake County, Indiana, which I interpreted as the song of an unusually early striped ground cricket. Over the following seasons I made a few more such observations, most consistently at the Midewin National Tallgrass Prairie in Will County. Finally in 2017 I realized that I should consider other possibilities, and found that my recordings fit this species better than the striped ground cricket. With much effort on June 28 at Midewin I flushed out the female in the above photo. She escaped before I could get additional angles, but the identification was confirmed. Subsequent searching has continued to reveal scattered areas where this species can be found. This member of the field cricket subfamily lives on the surface, its habitat described variously as dense herbaceous growth or dry wooded slopes under rocks and logs. So far I have found it most frequently in grassy areas, including occasionally-mowed trails. Some sources apply the name *saussurei* to this species.

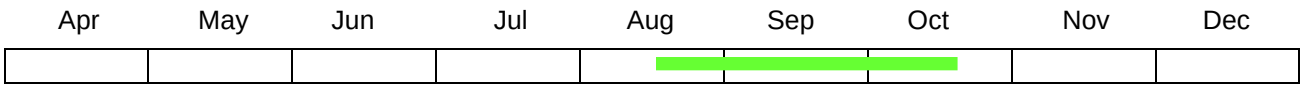
Season. This is a relatively early species, its season reported as June and July. Most of my observations so far have been in June, as early as June 10 with a late date of July 2. They are singing by mid-morning, and I have heard them as late as 9:00 p.m.

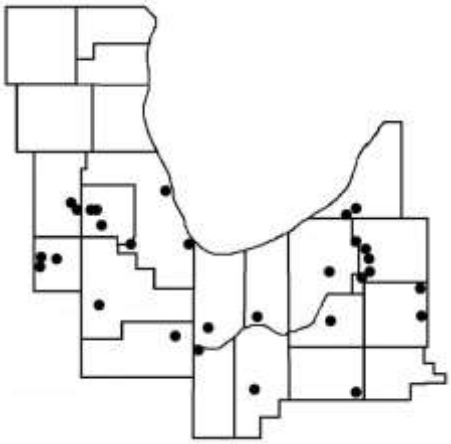
Similar Species. It is smaller than *Gryllus* species at 10-17mm. It has a variable mottled color pattern reminiscent of the slightly larger Japanese burrowing cricket, but usually is darker, and lacks a white line on the front of the head between the compound eyes .

Song. The song consists of brief buzzy precise chirps at 6.9-7.8 kHz, superficially similar to those of the striped ground cricket, but spaced farther apart, often at intervals of a second or more, and with a more even tone. Though each chirp rises slightly in pitch and volume from beginning to end, this difference is subtle and not readily noticeable. I find their buzzes vaguely reminiscent of a woodcock's distant peents.

Recordings of its song can be found at the Singing Insects of North America website (https://sina.orthsoc.org/521a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/eastern-striped-cricket), and in my blog (https://natureinquiries.wordpress.com/2017/07/06/a-mystery-solved-miogryllus/).

Japanese Burrowing Cricket (*Velarifictorus micado*)





On September 19-20, 2014, at the Bendix Woods bioblitz in St. Joseph County, I found a population of Japanese burrowing crickets in gravel parking lot dividers in the most heavily used portion of the park. This species had not been on my hypothetical list of singing insects in the region, as they never had been documented here and range maps placed them in southern Indiana, but not in the northern half of the state. Since then they have turned up at an increasing rate in scattered sites over the region. They are common in Rensselaer in southern Jasper County, and probably will become so in cities and towns throughout at least the southern half of the region. In 2020 I found them to be common along drainage ditches in rural Indiana. The founders of at least some of these cricket populations may have been brought in with landscaping materials or plants transported from farther south, as they often are near buildings and roads. Bowles (1918) suggests that they may be able to fly to new sites.

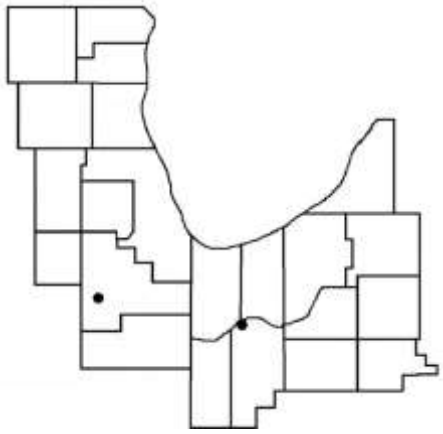
Season. Our locations are among the farthest north shown for the species in the Singing Insects of North America website. The full singing season at this latitude therefore remains to be determined. So far my scattered observations in the region have ranged from August 16 to October 18. I have heard them singing from mid-morning into the night.

Similar Species. This ground dwelling cricket is nearly the size of a fall field cricket, but instead of being all black, has a pattern of cream colored lines and blotches as illustrated in the photos. The individual shown was obtained only by digging several inches into the gravel at Bendix Woods, and so this cricket may not often come up into the open. The eastern striped cricket can be similarly marked, but is a slightly smaller, darker, surface-dwelling species that lacks the white line between the compound eyes that distinguishes this species. The songs and seasons also are much different.

Song. The song consists of fairly loud chirps, 2-4 per second, with the musical quality of the spring and fall field crickets but with a simpler, level tone and more rapidly produced at a given temperature. The lower-pitched (3.6 kHz) chirps commonly are produced in groups of 5 or so, in contrast to the field crickets' continuous performance. In addition there is a less musical sound, lower pitched, again with a level tone, about 1 per second, and introduced with a very brief, high-pitched note. Japanese burrowing cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/551a.htm), the Songs of Insects website (http://www.songsofinsects.com/crickets/japanese-burrowing-cricket), and my blog (https://natureinquiries.wordpress.com/2020/10/06/japanese-burrowing-crickets-spreading-rapidly/).

Restless Bush Cricket (*Hapithus agitator*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



On 26 August 2018, as I was starting back south from where a county road meets Hodge Ditch along the Kankakee River in Jasper County, I noticed a male cricket that had jumped onto my windshield. It was not a species I had encountered before, but vaguely familiar as I thought I had seen a photo. It was somewhat larger than a trig, with wings that were brown edged in yellow. I caught it and brought it home, and found it was a restless bush cricket. This was one of the northernmost locations where it had been found. In 2019 Bill Glass photographed a specimen at Midewin National Tallgrass Prairie in Will County.

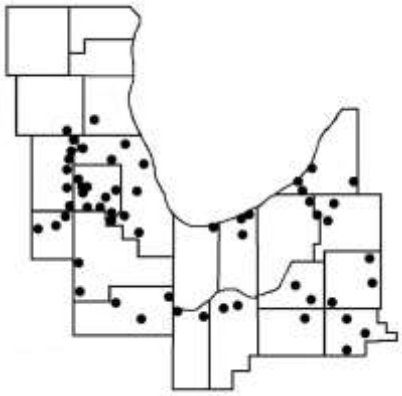
Season. I do not have enough data to define a season in the region.

Similar Species. The size and distinctive coloration separate this cricket from all others in the region.

Song. This species is not known to sing outside of Texas and Florida. The Jasper County male did not sing. Song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/671a.htm).

Jumping Bush Cricket (*Orocharis saltator*)

Photos: Top, male side view and female dorsal view. Right, male dorsal view showing a slightly different wing color pattern from the female.



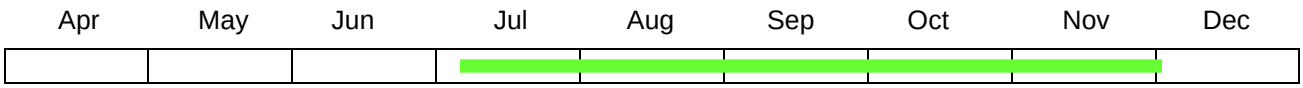
Thomas Walker, in a 1969 review of the genus, showed this species extending no farther north than the latitude of Indianapolis in either Indiana or Illinois. As the site map here indicates, they have extended their range well into our region since then. They occur in residential neighborhoods but also in forested areas, and are abundant and conspicuous enough that they would not have been missed in the past. Their population has increased noticeably in DuPage County since I first observed them in 2007, and they have continued to expand northward since then. They have been observed laying eggs in dead tree twigs, and consuming tender leaves, flowers and fruits, according to the literature.

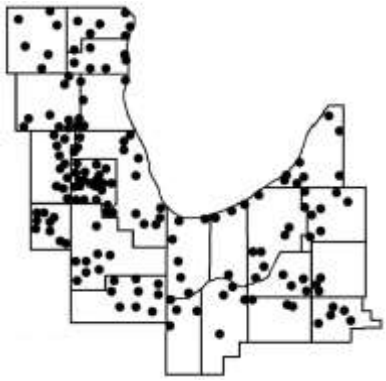
Season. Usually they begin in the second half of August, but I have heard them singing as early as July 27 and as late as November 18. Their singing peaks in the first hour after sunset and then continues intermittently through the night. Later in the season on cooler days they may begin at mid-afternoon, and may continue to mid-morning.

Similar Species. This cricket's presence usually is indicated by the song, which points to a location lower than where the singer actually is, possibly in part because tree foliage reflects the sound downward. They typically sing at least 10 feet up in trees, on the trunk most of the time, and seem to prefer trees with vines that apparently provide hiding places. That location, along with their relatively large size and angular appearance (though they are difficult to locate and see), distinguishes them from other local species. Cleveland-area jumping bush crickets often are easier to find, as they sometimes move actively on branches and foliage and often live in low shrubs. They are capable of pausing, flashing the wings upward for a quick song, and lowering them to move on, all within a split second.

Song. The song could be described as fairly loud, brief burry chirps or very short trills, about 1 per second or 1 per 2 seconds, at 5.1 kHz well within the hearing range of most people. There is a noticeable variation in pitch among the individuals singing in the same place at the same time. Jumping bush cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/686a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/jumping-bush-cricket), and Lisa Rainsong's website (https://www.listeningtoinsects.com/jumping-bush-cricket).

Allard's Ground Cricket (*Allonemobius allardi*)





Like the other ground crickets, Allard's is heard more than seen. Often found in lawns, Allard's ground cricket is more abundant in open areas of taller grasses, and is frequent along grassy sections of our recreational trails. This is not a forest species, though it can turn up in small open areas surrounded by forest. Occasionally it occurs in small remote parking lot islands.

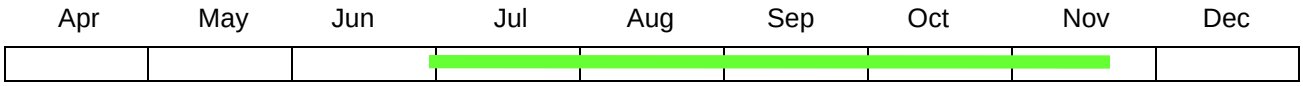
Season. Singing begins in July in our area, with first song dates ranging July 5-22 . Generally a few sing into November, with last song dates over the years ranging October 29 to December 1. The earliest noted singing time was 7:30 a.m., latest 9:30 p.m.

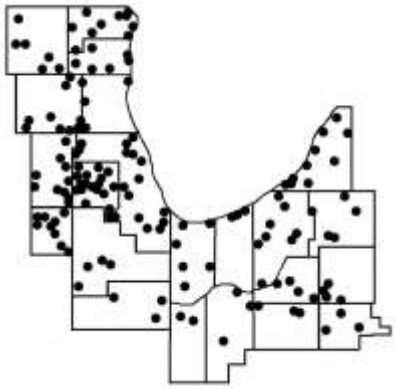
Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the foot spines, ovipositors and other microscopic characters. All are small and brown, gray or black. See the discussion under tinkling ground cricket.

Song. Incessant, separate quick high-pitched notes (6-7.7 kHz) that sound like 4-6 per second but sonographs show twice that rate. The notes sound more separate than those of what here are called trills. There are fairly frequent, brief pauses interrupting the rhythm. Especially later in the season, the notes sometimes may be more widely spaced, but the pauses distinguish such songs from those of tinkling ground crickets. Allard's ground cricket songs and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/539a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/allards-ground-cricket), my blog (https://natureinquiries.wordpress.com/2014/02/24/sound-ideas-common-ground-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/allard-s-ground-cricket).

Photos: Male above, female right.

Striped Ground Cricket (*Allonemobius fasciatus*)





The striped ground cricket is our common lawn ground cricket. It lives in open grassy areas, and is common along grassy sections of trails. Thanks to their extreme abundance, high dispersal ability and association with relatively disturbed habitats, striped ground crickets could be regarded as our weediest cricket species. They usually are out of sight. This species has been known as far south as the Indianapolis area, and so that range boundary conceivably could shift northward into the Chicago region as climate change proceeds. This will be difficult to discern, however, because it probably will be followed by the northern boundary of the southern ground cricket (*A. socius*), whose song is practically identical.

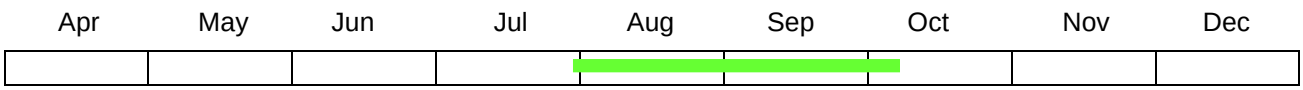
Season. Like the other ground crickets these usually begin singing in July, noted first dates ranging June 29-July 24 . They are among the latest of our singing insects, along with other ground crickets, their observed latest song dates ranging October 26-November 19. They sing day and night, the earliest local noted singing time 5:30 a.m., latest 3:45 a.m.

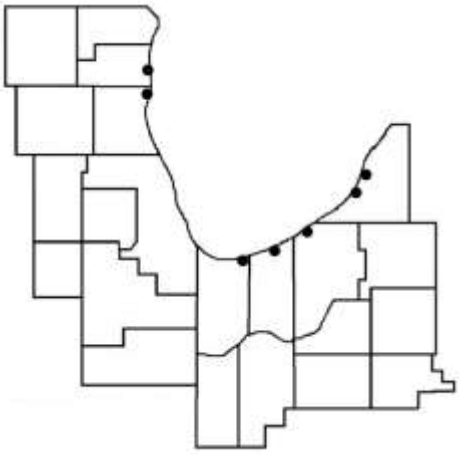
Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the spines of the feet, ovipositors and other microscopic characters. All are small and brown, gray or black. The striped ground cricket is somewhat exceptional in having several stripes on the top of its head, running front to back (see the discussion under tinkling ground cricket). Most individuals are short-winged.

Song. The song consists of separate brief rough buzzes, continuously produced at 2 to 3 per second. It is low enough in pitch to hear easily, with much of the buzz's sound range below the peak of 7.4 kHz. The striped ground cricket's songs and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/543a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/striped-ground-cricket), my blog (https://natureinquiries.wordpress.com/2014/02/24/sound-ideas-common-ground-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/striped-ground-cricket).

Photos: Female, above. Ground crickets occasionally climb up into vegetation, as in the striped ground cricket female above right, or as forced by flooding, as in the male, below right.

Gray Ground Cricket (*Allonemobius griseus*)





North America website (https://sina.orthsoc.org/523a.htm) and in my blog (https://natureinquiries.wordpress.com/2013/12/30/sound-ideas-gray-ground-cricket/)

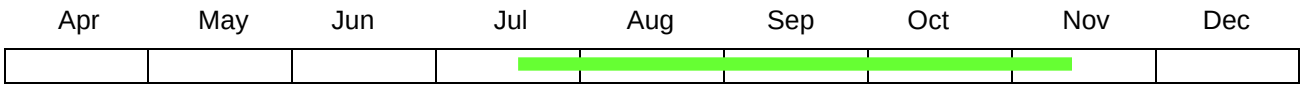
This is a sand soil species, best known from the Great Lakes dunes (typical habitat in photo, right). It also has been found inland in sandy areas, though so far not in the Chicago region.

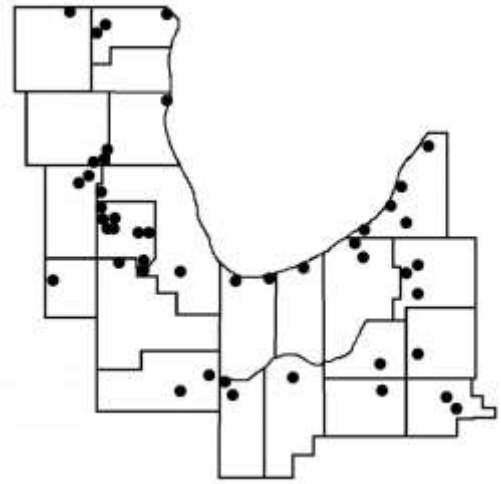
Season. Across the region, song dates have ranged July 30 - October 5. In 2012 they were not yet singing at Illinois Beach State Park on August 7, but were singing by August 28. Though they may sing in the morning, usually they begin early in the afternoon, peak in the late afternoon, and stop singing at dusk.

Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the spines of the feet, ovipositors and other microscopic characters. All are small and most are brown, though this one is grayer than the others as its name suggests, and has distinctive head striping and (at least in the female) wing spotting patterns.

Song. The song is a trill that comes close to seeming composed of discrete notes, like those of *allardi*, but is much more rapid (at least twice as fast; *allardi* singing nearby confirm this). There are brief pauses interrupting the trill at intervals that are regular in some individuals, but vary greatly in others. The recordings I have made of these crickets all have peak frequencies in the 8-9 kHz range. The most similar songs are those of the variegated and Cuban ground crickets. The gray ground cricket's song has abrupt rather than crescendo starts, and breaks that are momentary rather than lasting several seconds. Recordings of the gray ground cricket's song can be found at the Singing Insects of

Spotted Ground Cricket (*Allonemobius maculatus*)





Spotted ground crickets prefer closed-canopy forests or woodlands with some accumulations of leaf litter, where forest floor vegetation is sparse. The soil needs to be well drained yet moist. Most commonly this seems to mean soils heavy in sand or gravel, but hillsides with denser soils sometimes have spotted ground crickets, too. I have found them in several clay-soil woodlands, and have found them in every county in the region except Kenosha.

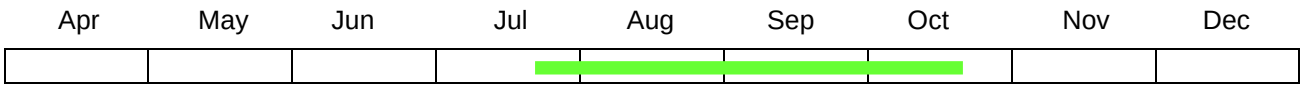
Season. Observed song dates for this species have ranged July 18-November 15 in the region. So far I have heard them from mid-morning through the afternoon until more than an hour after sunset.

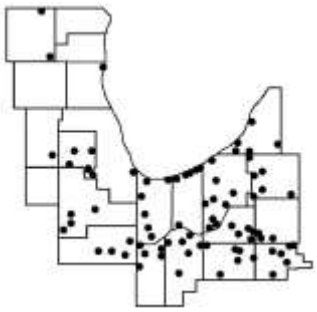
Similar Species. The mottled, spotted pattern especially of the female's abdomen is a source of the name. The yellowish rims around the compound eyes are a prominent distinguishing feature of this generally brown species.

Song. The main challenge here is to distinguish the spotted and Carolina ground cricket songs. Both species have continuous, pulsing songs, but in spotted ground crickets the regular pulses seldom break into the steady, non-pulsing sections characteristic of Carolina ground crickets. The spotted ground cricket's sound is rougher, grittier, and I would not describe it as a purr, at 7.2 kHz. The frequent non-pulsing portions of the Carolina ground cricket's song have a distinctive purring quality, and the pulses are not as regular, often accelerating from brief to longer pulses. When a Carolina ground cricket stops singing, it usually does so at the end of a non-pulsing purr. Spotted ground crickets end abruptly at the end of a series of pulses. At lower temperatures late in the season, Carolina ground cricket songs can acquire a gritty quality and so cannot be distinguished as reliably. Recordings of the spotted ground cricket's song can be found at the Singing Insects of North America website (https://sina.orthsoc.org/540a.htm), Lisa Rainsong's website (https://www.listeningtoinsects.com/spotted-ground-cricket), and in my blog at https://natureinquiries.wordpress.com/2015/10/09/spotted-ground-cricket/

Photos: Male, above.; female, right.

Tinkling Ground Cricket (*Allonemobius tinnulus*)





Tinkling ground crickets are a species of woods edges and open dry woodlands. The isolated locations in Walworth County, Wisconsin and Lake County, Illinois, may seem suspect, but these are significant populations at the Lulu Lake and Illinois Beach State Park sites. The gravel and sand soils, respectively, in these locations may be the telling habitat feature. When they are present with the confused ground cricket, the latter is more abundant in the more shaded forest interior with the deeper leaf litter, while the tinkling ground cricket is more to be found in the edges and openings. Where woods give way to open areas, tinkling ground crickets may be found in close proximity to Allard's ground crickets. Tinkling ground crickets in the southern part of the region in Indiana are unusual in their willingness to venture away from woodlands into meadows, corn and especially soybean fields late in the season, though it is the rare individual that wanders more than 100m from the edge of the woods. Clay soil counties such as DuPage and Kane provide a bit of a puzzle, as widely scattered single males and tiny groups can be heard singing, but so far not in the same spot in more than one year. Much of the above is subject to revision in future years, as I learned late in 2020 of the possibility that slow-tinkling trigs (*Anaxipha tinnulenta*) also may occur in the region (see Hypotheticals, page 128). There are indications that at least some of my records and observations may have been of this other species. I plan to sort this out in 2021. I have photographic confirmations of tinkling ground crickets in Lake County, Illinois, Lake County, Indiana, and Jasper and Pulaski Counties.

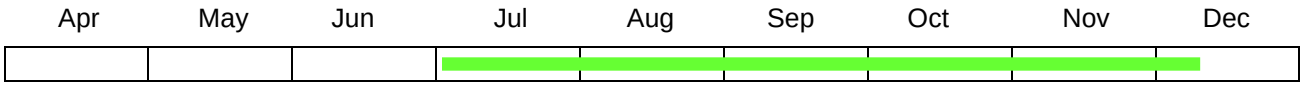
Similar Species. Alexander and Thomas (1959) regarded *allardi*, *tinnulus* and *fasciatus* as being very closely related, but distinguishable by the intensity of head striping as well as by song. The stripes are bright and sharp on *fasciatus*; faint to nonexistent in *tinnulus*, which also has pale, reddish tones especially on top of the head; and stripes present in *allardi*, but not as bright and sharp as in *fasciatus*. There also are differences in ovipositor length and stridulatory vein size and teeth. Howard and Furth (1986) described the striped's "head with dark longitudinal stripes from base onto vertex between eyes." *Tinnulus*: "General coloration lighter (than *A. allardi*, *A. fasciatus*, …), yellow or orange (especially head, legs, tegmen); without distinct stripes on head, rarely with faint indication of nonbristled striped areas (only between eyes)…lateralmost edge or crease…of male tegmen very light (white)." *Allardi*'s head they described as having stripes indistinct at the base but distinct apically, between the eyes.

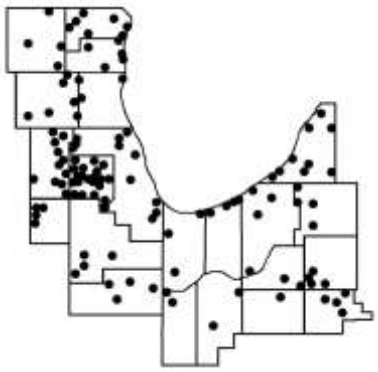
Season. Over the years, song dates in the region have ranged July 18-October 20. Early in the season they don't start to sing until mid-morning, but by the second week of August they can be heard throughout the 24 hours.

Song. The song consists of individual notes at 4-8 kHz, like those of Allard's ground cricket but distinctly slower (2-8 notes/second) at a given temperature. It often is rendered "tink-tink-tink…" The song lacks the frequent breaks characteristic of Allard's ground cricket (this is especially helpful late in the season, when *allardi* often slows down). The slow-tinkling trig's song quality is practically identical (frequency 5-8.4 kHz, note rate 2-8 notes/second but around 2/second slower at a given temperature). Tinkling ground cricket song recordings and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/530a.htm) and the Songs of Insects website (http://songsofinsects.com/crickets/tinkling-ground-cricket).

Photos: Male, above.; female, right.

Carolina Ground Cricket (*Eunemobius carolinus*)





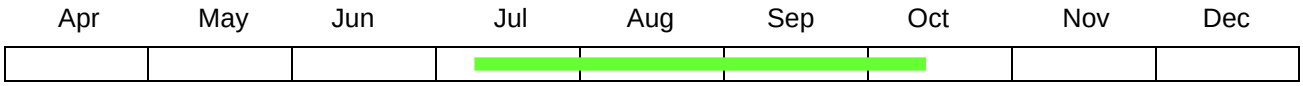
We have three common ground crickets in our area. The striped ground cricket is typical of mowed lawns, Allard's ground cricket reaches its peak abundance in open areas with taller herbaceous vegetation, and the Carolina ground cricket spans a broad habitat range, from wet and mesic areas with dense herbaceous vegetation to woodlands. Like the others it occurs in residential neighborhoods, but usually will be found around bushes or in dense herbaceous plantings. In woods it need not be in ground cover as long as there is some leaf litter and the soil is wet to moist.

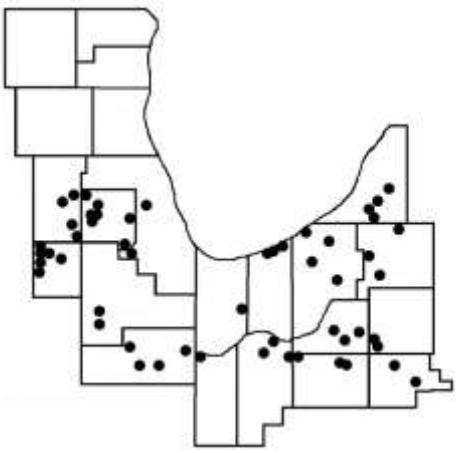
Season. Observed first song dates have ranged 1-27 July. Usually this is among the latest of our singing insects, with observed last song dates ranging 6 November-12 December in different years. Heard as early as 8:00 a.m., as late as 3:45 a.m.

Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the spines of the feet, ovipositors and other microscopic characters. All are small and brown, though the *Eunemobus* species are darker, with more black than most. They are distinctly larger than the *Neonemobius* species, and lack the distinctive head striping or reddish tones of the common *Allonemobius* ground crickets. The Carolina ground cricket female is somewhat distinctive in having a relatively short ovipositor, as is evident in these photos. They lack the confused ground cricket's white palps. See also the melodious ground cricket account.

Song. A continuous, irregularly pulsed drone, purr or trill with periods when the pulsing vanishes into a steady purr. It is low enough in pitch to be heard by most, at 6.1 kHz. The spotted ground cricket song is similar in quality, but has rapid rhythmic pulsations, a grittier quality, and usually lacks the non-pulsing sections. That distinction largely is lost at lower temperatures, as the slowed Carolina ground cricket song then acquires a gritty quality and pulsations are difficult to hear. Carolina ground cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/533a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/carolina-ground-cricket), my blog (https://natureinquiries.wordpress.com/2014/02/24/sound-ideas-common-ground-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/carolina-ground-cricket).

Confused Ground Cricket (*Eunemobius confusus*)





We are at the northern limit of this species' range, and if it is expanding northward it is doing so very slowly. It certainly has a more spotty distribution than some of our other ground crickets. This species usually prefers dry forest areas with little or no herbaceous vegetation, just leaf litter, but seems to like the litter relatively deep. Occasionally, however, flood plain forests can harbor high densities of confused ground crickets. Sometimes a few individuals sing in prairies or meadows a short distance out from the forest edge, and in 2020 I found them far from any woodland in a prairie area at the Nachusa Grasslands west of the Chicago region. They are not to be expected in every forest, and are not a species of residential neighborhoods. When they occur with tinkling ground crickets, as at Indiana Dunes National Park, they occur more in the deeper litter and shade of woodland interiors, while the tinkling ground crickets are more at the edges.

Season. First song dates have ranged July 12-August 2, last dates usually in September or early October (latest, October 12). They sing from first light until dusk, rarely singing into the night.

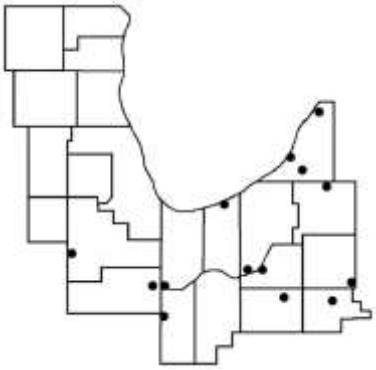
Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the spines of the feet, ovipositors and other microscopic characters. All are small and brown. The confused ground cricket is distinguished from the others in being blacker than most, and having all-white palps extending from the front of the head.

Song. Under ideal conditions, the song is heard as chirps, trills or buzzes about a second long with stuttering notes in the 1-second space between. Sometimes the stuttering notes are faint and not readily heard, so it sounds like 1 second on, 1 second off. The pitch is low enough to be heard easily, at 6 -6.9 kHz. There are uncommon song variations in black-legged meadow katydids and Say's trigs which superficially resemble this species' songs, so careful listening or visual confirmation is needed. Confused ground cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/538a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/confused-ground-cricket), and my blog (https://natureinquiries.wordpress.com/2018/08/28/less-confused/).

Photos: Male, top; female, above and right.

Melodious Ground Cricket (*Eunemobius melodius*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



One highlight of the 2012 field season was finding melodious ground crickets at Indiana Dunes State Park. This species had not been documented in many places, and it apparently is idiosyncratic in its habitat choice. Thomas and Alexander's (1957) first description of the species provides much of what has been published about it, at least in the North. They characterized it as a marsh species, but their more detailed site descriptions often, if not usually, placed it among woody plants. "The majority of our specimens of *melodius* were secured by tearing apart a soggy, decayed log, honey-combed with insect burrows, about 20 feet from the marsh proper." At Indiana Dunes State Park I found abundant melodious ground crickets in the forest south of the Great Marsh, and extending well into that marsh, the State Park portion of which is better described as a shrub swamp. That forest is low and wet, with depressions and many rotting logs. Singing males often were associated with those logs, though not always. In 2013 I found melodious ground crickets at two locations in Berrien County, Warren Dunes and Warren Woods State Parks, in similar habitat.

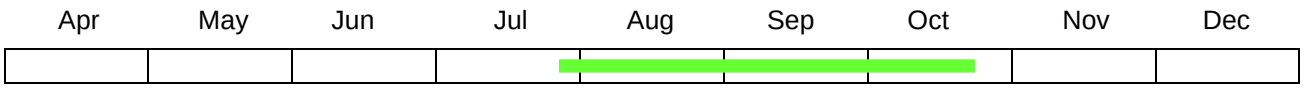
In 2016 I heard a single individual at Tippecanoe River State Park in Pulaski County. Subsequently I pursued the possibility that this cricket may occur in other bottomland riparian forests in the region. That effort has paid off, as I found melodious ground crickets in floodplain forests along the Kankakee, St. Joseph and Tippecanoe Rivers. They probably occur on private property along the Kankakee River in Jasper County. Searches in southern Cook, DuPage and Kane Counties have been fruitless. Though all of these habitats are wet forests or shrub swamps, Lisa Rainsong has recorded what sound like melodious ground crickets in other wet habitats in the Cleveland area. Confirmation of that identification may reveal a broader habitat breadth at least across the northern portion of this species' range.

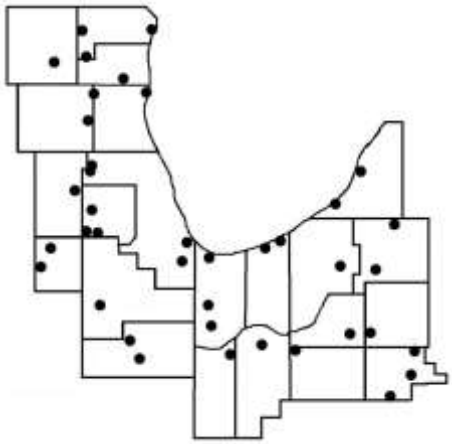
Similar Species. Physically this insect is very similar to *E. carolinus*; the female has a much longer ovipositor, and the male has many more teeth on the stridulatory vein of his wing, which can be determined only through a microscope. Song and habitat are the main way to distinguish this species (see song description).

Season. I have found them singing on August 10 to September 14. That last date seems solid, but they probably begin earlier. My observations have ranged mid-morning to dusk.

Song. The song is a steady musical trill, similar to that of Say's trig (which can occur nearby), but lower in pitch (4.5-6.4 kHz) and usually slower in pulse rate, a mellower tone lacking the trig's "silvery" quality, and without the trig's frequent brief pauses or breaks. See Appendix A for a graphic representation of some of these differences. Also, melodious ground crickets sing from the ground or in a rotting log, while trigs usually sing from elevated perches in vegetation. Melodious ground cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/534a.htm) and in my blog (https://natureinquiries.wordpress.com/2017/09/23/even-more-melodious/).

Cuban Ground Cricket (*Neonemobius cubensis*)





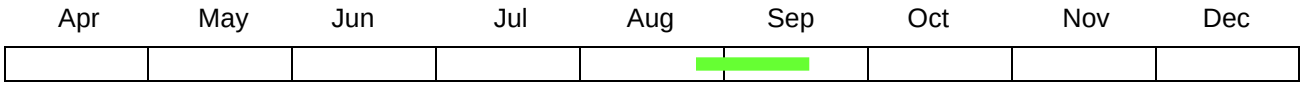
This had been known mainly as a southern species, in the longitude range of the Chicago region not previously documented north of Tennessee. However, Lisa Rainsong found them to be common in the Cleveland area, and so I was alerted to the possibility that they might appear in the Chicago region. In 2016 I found a population of tiny ground crickets that appeared to belong to this species near the southern boundary of the region at Gar Creek Forest Preserve in Kankakee County. Recordings of captive individuals, and voucher specimens, confirmed the identification in 2017. In 2018 I collected a male from north Blackwell Forest Preserve in DuPage County, fulfilling a prediction made from a graph comparing Cuban and variegated ground cricket song parameters (Appendix B). Further confirmations in 2019 have validated the graph, and I have used it to fill out the maps for both species. Cuban ground crickets occur in every county and are relatively easy to find, as their preferred habitat is open mesic grassy areas, prairies or meadows, sometimes edges with woody plants. They thin out in the northern part of the region, however, occurring in a smaller percentage of sites. They are easier to flush into view than variegated ground crickets, as they more often are up on the soil surface. At Gar Creek and a spot in Potato Creek State Park in St. Joseph County I have found both species together in shaded spots near open water with leaf litter and some bare soil, but this is anomalous for *cubensis*. Nevertheless, there is no habitat that is exclusive to either species.

Similar Species. Our smallest ground crickets are the three *Neonemobius* species, and they are strikingly tiny. The sphagnum ground cricket is the smallest, but is limited to sphagnum bogs. Cuban ground crickets are smaller than variegateds when you see them side by side, but are readily distinguished by their all black bodies and white palps with black end segments. Variegated ground crickets look brown or gray at first glance, but in a closer look prove to be multicolored. Their endmost palp segments are pale with dark tips.

Season. I have made recordings that fit Cuban ground cricket parameters as early as July 27 and as late as October 22. They sing at least late morning to late afternoon.

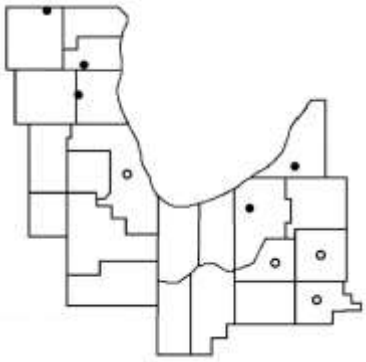
Song. A complicating factor is that the song sounds nearly identical to that of the variegated ground cricket: a 7-9 kHz trill that builds in volume from a weak start, holds for several seconds, and then ends abruptly, followed by a few seconds' pause before being repeated. At a given temperature, the variegated ground cricket's song is higher pitched with a lower pulse rate (generally 40 pulses/second or below) and the Cuban ground cricket's song is lower pitched with a higher pulse rate (above 40 pulses/second; see Appendix B). Both species show increases in pulse rate and pitch (dominant frequency) with temperature. The crescendo start is critical, as there is overlap with Say's trigs in other song parameters at some temperatures. Cuban ground cricket trills average shorter than those of variegated ground crickets, 139 recorded trills ranging 4-25.5 seconds with a median of 10 and mean of 11.1 seconds. Variegated ground cricket trills (55 measured) ranged 4-104 seconds with median of 17 and mean of 21.9 seconds. A striking 29% of *variegatus* trills were longer than the longest *cubensis* trill. Cuban ground cricket recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/537a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/cuban-ground-cricket), and Lisa Rainsong's website (https://www.listeningtoinsects.com/cuban-ground-cricket).

Sphagnum Ground Cricket (*Neonemobius palustris*)



This distinctive species is an extreme habitat specialist, and apparently does not occur at all apart from a sphagnum moss substrate. That habitat is extremely limited in the Chicago region. There is but one sphagnum site (Rutland bog, on private property) in Kane County, for example, and most of the region's counties have none. The sphagnum ground cricket can occur in large numbers in sites such as Lulu Lake Nature Preserve in Walworth County, Volo Bog in Lake County, Illinois, and Pinhook Bog in Indiana Dunes National Park. In the drought of 2012 they retreated to pockets of sphagnum that remained well saturated with water. I have not found them in 4 counties where they had been known in the past, and climate change threatens them in the region, though not globally as they are common in the North.

Photos: Male, top.; female, right; nymph, above. Females and nymphs show more brown, especially red-brown on the head, than do adult males.

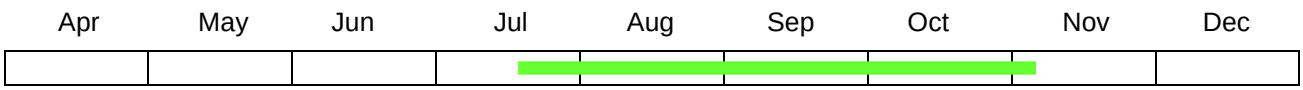


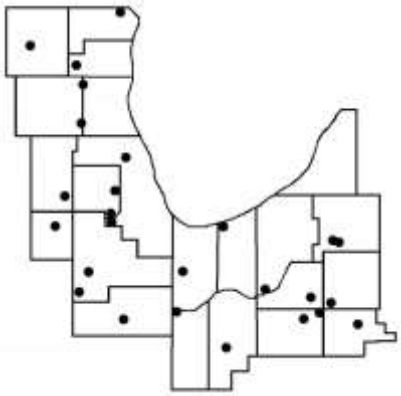
Season. They were singing when I found them at Mud Lake Bog in Berrien County on August 23, 2015, and at Lulu Lake in Walworth County on September 16, 2015.

Similar Species. The ground crickets are very similar in appearance, with even genera distinguished by fine details of the spines of the feet, ovipositors and other microscopic characters. All are small and brown. Apart from the association with sphagnum moss, mature male sphagnum ground crickets have more black in their coloration, and along with other *Neonemobius* species are smaller in body size (less than 9 mm.) than members of the other genera. Immature individuals and females may have much brown, however.

Song. The song is a relatively high-pitched (8.6-9 kHz) trill, lower in volume and feebler than the similar songs of the gray ground cricket and Say's trig. In the habitat the overlapping individuals make it sound continuous, but most observers describe the individual songs as around 10 seconds long, with significant breaks between. The pitch is much higher than that of Say's trig. Sphagnum ground cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/524a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/sphagnum-ground-cricket), and my blog (https://natureinquiries.wordpress.com/2015/02/25/sound-ideas-3-ground-crickets/).

Variegated Ground Cricket (*Neonemobius variegatus*)





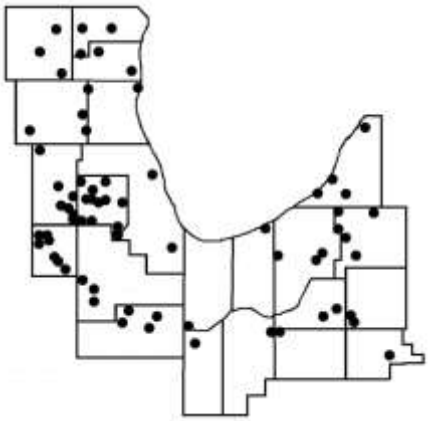
The variegated ground cricket's song superficially resembles those of other fast-trilling ground crickets, and Say's trigs. That similarity, and the cricket's relative inaccessibility in holes in the ground such as cracks and earthworm tunnels, may explain why there are so few mentions of it in the literature. The preferred habitat is shaded mesic areas, often with bare soil, gravel or rocks, but occasionally I have found them in wet to mesic open areas with dense herbaceous vegetation. They are widely distributed, and I have found them in every county in the region except Berrien, but they thin out in the northern and eastern portions of the region. This may represent an eastern, rather than a northern, range boundary; they apparently do not occur in the Cleveland area, as Lisa Rainsong's intensive searching has failed to turn them up there.

Season. Usually singing begins in July (as early as July 21), and I have heard them as late as November 5. Songs can be heard morning into the night. They seem disinclined to come out in the open during daylight hours, at least until later in the season.

Similar Species. It is small even for a ground cricket, with a 9mm maximum length, and it is distinctively patterned. There are several horizontal bands of color across the head: black or dark brown on the back, alternating red-brown and yellow-tan stripes on the top, red-brown on the top of the front, and black on the lower front. The palps are pale with dark tips. Otherwise they are mottled gray and brown. The dark back of the head stands out when viewed from above. No other species has this combination of features. Say's trigs usually sing from elevated perches. See Cuban ground cricket.

Song. The typical song is a rapid 7-9 kHz trill with a weak beginning, a crescendo, and a hold at full volume for 10 or more seconds (rarely a minute or more) before an abrupt end (see Cuban ground cricket). It lacks the abrupt "chuwee" start common in Say's trig. Trigs usually sing from elevated perches, variegated and Cuban ground crickets always from the soil. There is a quiet time between songs of 5 seconds or more in *variegatus*, sometimes 15 seconds or more. Cuban ground crickets have a nearly identical pattern, but *variegatus* usually have higher-pitched songs at a given temperature, with a lower pulse rate (below 40/second, *cubensis* above 40; see Cuban ground cricket, and Appendix B). Sound recordings are at the Singing Insects of North America website (https://sina.orthsoc.org/546a.htm) and in my blog: https://natureinquiries.wordpress.com/2015/01/16/sound-ideas-variegated-and-cuban-ground-crickets/

Two-spotted Tree Cricket (*Neoxabea bipunctata*)



Two-spotted tree crickets are fairly common in woodland edges and residential neighborhoods with woody plants. Males sing from trees and bushes. On several occasions I have found males singing at small circular holes they chewed in the centers of larger leaves, positioning their wings above the holes.

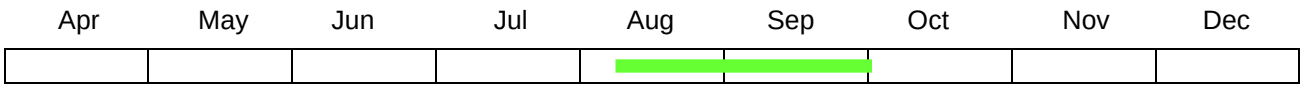
Season. First song dates have ranged July 12-August 2. I have heard them as late as November 2. They sing at night, beginning at dusk, peaking in the second hour after sunset, then continuing intermittently to at least 5:00 a.m. Late in the season they may sing at mid-day.

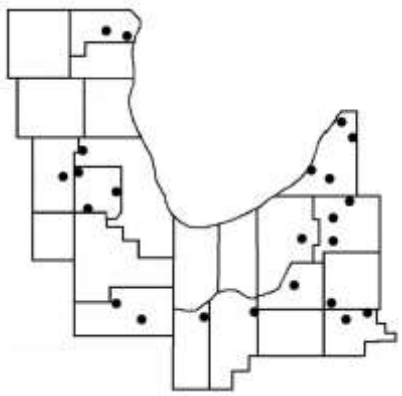
Similar Species. The elongated shape is shared with other tree crickets. Other species lack the two-spotted female's large dark wing spots that give the species its name. The dark red-brown head and thorax are distinctive.

Song. Two-spotted tree cricket songs are variable-length, dissonant trills, 1 second to 7 seconds or longer duration. Intervals between trills can be very short (much less than a second) or longer, but when longer usually are filled by a stuttering sound. That variability of trill length and spacing is a key identification feature, especially in comparison to the narrow-winged tree cricket. Early in the season their song seems more discordant, frantic or strained than those of our other tree-dwelling tree crickets (narrow-winged and Davis's), but that quality diminishes and becomes more tone-like as the season progresses. At 3.4 kHz, the pitch of their song sounds higher than those of Davis's and snowy tree crickets, but close to that of the narrow-winged. At a given temperature, the two-spotted tree cricket's pulse rate is 20/second higher than that of Davis's, and 30/second higher than the narrow-winged's (Walker 1962). Song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/601a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/two-spotted-tree-cricket), and Lisa Rainsong's website (https://www.listeningtoinsects.com/two-spotted-tree-cricket). Lisa also provides a helpful tutorial for distinguishing these species at https://www.listeningtoinsects.com/tree-cricket-introduction

Photos: Female top, male below. Right: A male sings, amplifying and directing his song through a hole he has chewed in a grape leaf. Male tree crickets lift their wings so they are at a right angle to the body axis when singing. He is approached by a female who may sample his abdominal secretions.

Davis's Tree Cricket (*Oecanthus exclamationis*)





This species poses some challenges. Davis's tree cricket is more strictly arboreal than the others. It lives up in the tree canopies, and its song is easily lost in the general nighttime clamor of all the singing insects. They do, however, sometimes sing from shorter trees out from the forest edge, or climb down into the lower branches of large trees. They also occur in the scattered trees of parks and residential neighborhoods. With practice their relatively low-pitched trills can be recognized, and I expect to find them in every county.

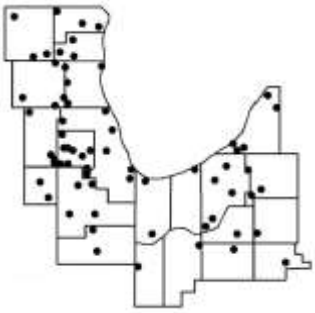
Season. My limited observations have ranged July 12-October 1. I have heard them singing in the first hour to the third hour after sunset. Later in the season they begin in the late afternoon.

Similar Species. I never have seen one apart from the specimens illustrated here, and so must rely on information from others. The male's relatively narrow wings rule out two woodland species, the snowy and broad-winged tree crickets. This is a pale insect, which separates it from the two-spotted tree crickets with their dark heads and thoraxes, and the female's large wing spots. The orange-brown cap characteristic of the narrow-winged tree cricket reportedly is absent in Davis's tree cricket. The dark spot on the basal antenna segment is straight (photo, right), lacking the hook evident in the narrow-winged.

Song. The song is an interrupted trill, lower in pitch (2.6 kHz) than those of the other tree-dwelling cricket songs at the same temperature. Trills are more variable in length and spacing than those of narrow-winged tree crickets, but typically the trills are longer than those of two-spotted tree crickets. The lower pitch becomes easy to recognize with experience, especially as one or both other species usually are singing nearby. Walker (1962) points to pulse rate as possibly the most reliable distinguishing feature, about 10/second faster at a given temperature than that of the narrow-winged, and 20/second slower than in two-spotteds. Davis's tree cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/590a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/daviss-tree-cricket), and Lisa Rainsong provides a helpful tutorial for distinguishing the three tree-dwelling species at https://www.listeningtoinsects.com/tree-cricket-introduction

Forbes's Tree Cricket (*Oecanthus forbesi*)

Apr May Jun Jul Aug Sep Oct Nov Dec



Forbes's tree cricket has a sibling species, the black-horned tree cricket (*O. nigricornis*), but recent research by Laurel Symes (2013) revealed a transition zone between the two species in Ohio (currently being detailed by Lisa Rainsong), with only Forbes's occurring in the Chicago region. This species usually is found in areas with mostly tall forbs. Vines and woody plants also may be present, but not necessarily tall grasses. Males sing up in the tops of meadow plants on warm days, lower when cooler. Females lay eggs in woody stems. They are common throughout the region.

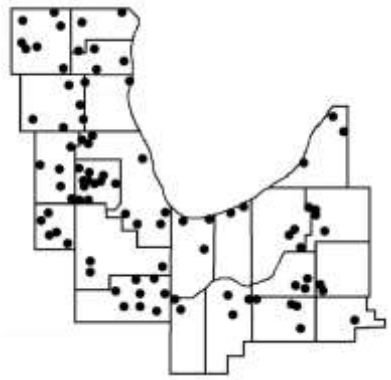
Season. Noted first songs have ranged August 3-September 5, and last song dates September 30-November 10. Singing begins in the morning, continuing into the night.

Similar Species. The elongated shape is shared with other tree crickets. The black leg segments, black antennas, broad dark zones down the ventral center of the abdomen, and (often, not always) a narrow black stripe down the center of the pronotum, are distinguishing characteristics. These insects are highly variable in the amount of dark pigmentation they show. Even the patterns of spots on the basal two antenna segments, once regarded as important in tree cricket identification, are highly variable in this species (see photos). Blacker individuals are more common in Indiana than in the Illinois portion of the region.

Song. The song is a long, loud, 3.7 kHz trill. At a given temperature, Forbes's tree crickets have faster pulse rates than their relatives (above 60/second at 25C), but this difference becomes less reliable at lower temperatures (Symes 2013). Pulse rate determination is done in a computer from recordings. Forbes's tree cricket songs and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/594a.htm), my blog (https://natureinquiries.wordpress.com/2014/01/27/sound-ideas-trilling-tree-crickets/), and at Lisa Rainsong's website (https://www.listeningtoinsects.com/forbes-s-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

The female in the top photo shows the darker colors displayed by some individuals, while the male represents the pale end of the range. An intermediate pattern is represented in the photo above right. The two photos to the lower right show the range of antennal spot patterns. In the larger basal antenna segments, the pairs of spots may be partly obscured by diffuse pigment as on the left, or may be sharply defined as on the right. The outer spot is oval or comma-shaped rather than circular, however. On the second segment there is a clear separation between the two marks, comparable to the width of the inner mark. Center right, a female laying a line of eggs in a woody stem, producing a 3-inch scar line. She has arched her body to bring her ovipositor into the stem at a right angle.

Snowy Tree Cricket (*Oecanthus fultoni*)



Well distributed and common locally, the snowy tree cricket prefers low woody vegetation, open areas (including residential yards with bushes) and forest edges. As the season progresses, snowy tree crickets also may move into meadows.

Season. Males usually begin singing in mid-July and continue into October. Local observed first song dates have ranged July 7-August 1, and last dates September 2-November 2. The song typically begins around sunset (peaking 1-2 hours after sunset), then continues intermittently, noted as late as 5:30 a.m. when there was significant light. Later in the season (October) they often sing during the day.

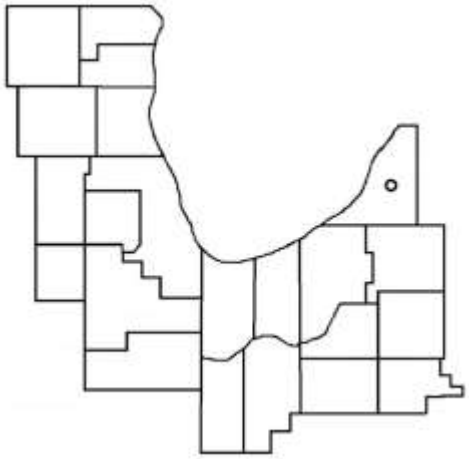
Similar Species. This is a pale tree cricket, the male's wings wider than most. The spots on the basal antenna segments are round, rather than short lines or curves (photo). The broad-winged tree cricket has even wider wings, and has raspberry colors around the bases of the antennae instead of the orange-brown typical of the snowy tree cricket.

Song. The snowy tree cricket's song consists of smooth, rhythmic chirps (2.9 kHz). It is famous for its chirping rate increasing or decreasing as the temperature goes up and down (though that is common among singing insects, it is more easily observed in this species). One formula is to count the chirps in 13 seconds and add 40 to get the temperature in degrees Fahrenheit. Movie sound tracks often incorporate snowy tree cricket recordings to convey a calm nighttime mood. Snowy tree cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/585a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/snowy-tree-cricket), my blog (https://natureinquiries.wordpress.com/2014/01/13/sound-ideas-an-odd-trio/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/snowy-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

Photos. Above, some tree crickets like to nibble at human skin. Right, spots on basal antenna segments, and singing posture of male.

Tamarack Tree Cricket (*Oecanthus laricis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



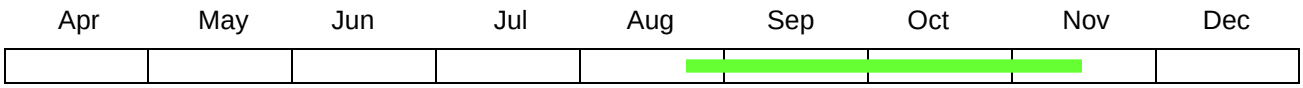
This could be regarded as a sibling species of the pine tree cricket, being physically very similar. It is limited to a narrower habitat of tamarack trees (*Larix laricina*), which occur in sphagnum bogs. Its known range is more limited, southern lower Michigan and northeastern Ohio. In the past it has been found at only one site in our region, in northeastern Berrien County. Nancy Collins and I failed to find them there in 2018, but the weather was unfavorable that day.

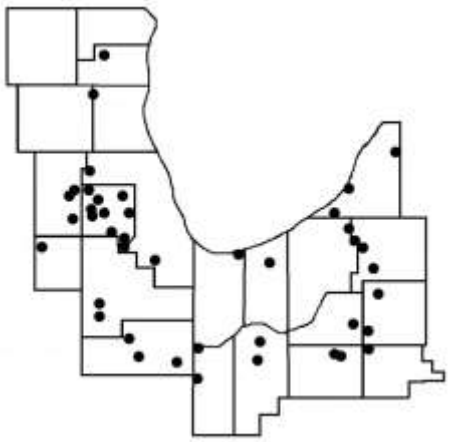
Season. The season is described as August and September.

Similar Species. Nancy Collins, after reviewing the literature, gives differences between tamarack and pine tree crickets. The former has no antenna marks visible in the field, brown head and antennae. The latter has basal antenna spots of 3 posts and a slant, rust head and antennae. Tamarack tree crickets are slightly smaller, 13-15mm vs. 13-16mm. The forewing length is less than 12mm, longer than 12mm in pine tree crickets.

Song. The song is similar to that of the pine tree cricket. Song parameters are 3.5 kHz, 37 pulses/sec at 25C (45 pulses/sec in the pine tree cricket). Song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/591a.htm). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

Broad-winged Tree Cricket (*Oecanthus latipennis*)





my blog (https://natureinquiries.wordpress.com/2014/01/27/sound-ideas-trilling-tree-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/broad-winged-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

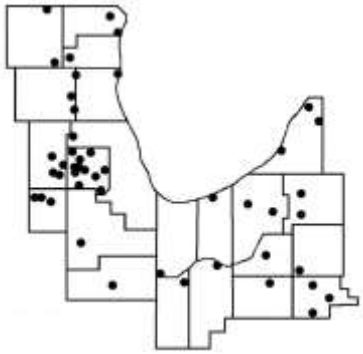
The broad-winged tree cricket occurs in the woodland understory, and occasionally in patches of woody shrubs or coarse herbaceous plants away from the edge of the trees. This species has extended its range well north since Hebard's 1934 Illinois study, which did not place it north of the state's midpoint. I have found broad-winged tree crickets throughout DuPage County in appropriate habitat, often in large numbers. Farther north the species occurs in scattered small groups. In 2018 Nancy Collins discovered a new north for them, at the Bong Recreation Area in Kenosha County. According to Blatchley (1920), females lay eggs in the pith of vines and other plant stems.

Season. This is the latest tree cricket, and perhaps the latest singing insect generally, to begin singing. First observed song dates have ranged August 22 -September 24 , and last song dates October 1-November 16. Population density varies considerably from year to year, perhaps a consequence of its recent northward range extension. They sing mainly late afternoon into the evening.

Similar Species. This is our largest tree cricket (though not a huge insect as the photos show). The extremely wide wings and raspberry coloration around the face and bases of the antennae distinguish this species from all other tree crickets in the region.

Song. The broad-winged tree cricket's song is a beautiful long, slow, bell-like trill of the same pitch (2.9 kHz) and tonal quality as the notes of the snowy tree cricket. Broad-winged tree cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/592a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/broad-winged-tree-cricket),

Narrow-winged Tree Cricket (*Oecanthus niveus*)



The narrow-winged tree cricket is common throughout our area, occurring in every county, and like the broad-winged tree cricket has a more northern range than the literature indicates. Expect it in deciduous forests and in residential neighborhoods with trees and bushes. Males sing from elevated perches in trees, bushes and associated herbaceous plants.

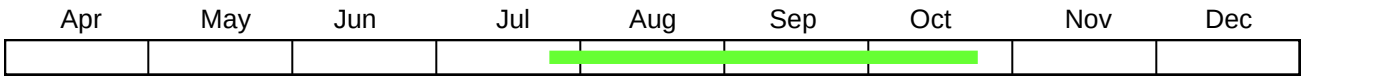
Season. This species' singing season starts later than those of many singing insects. First observed song dates have ranged August 5-26, usually in the earlier part of that span. Last song dates have ranged September 2-November 2. Usually they begin to sing toward dusk, but later in the season can be heard at mid-day. Most singing is at night, however.

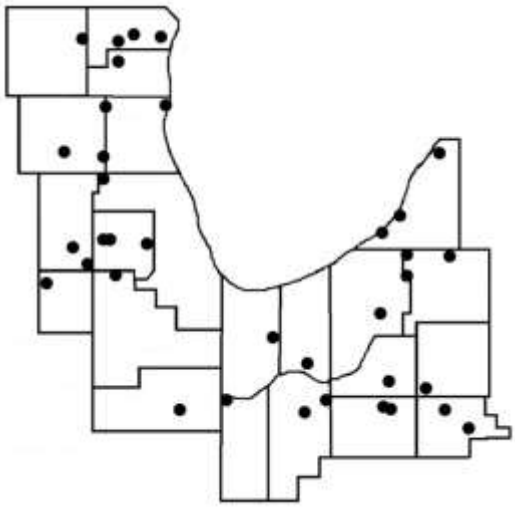
Similar Species. The male's narrow wings rule out two woodland species, the snowy and broad-winged tree crickets. The orange-brown cap contrasting with an otherwise pale insect is the best distinguishing feature for the narrow-wing. Two-spotted tree crickets have dark heads and thoraxes, and the female two-spotteds have the large wing spots. Davis's tree cricket lacks the narrow-wing's cap, and the black line on the basal antenna segment is straight rather than hooked.

Song. The narrow-winged tree cricket's song consists of short trills as does that of the two-spotted tree cricket, but their tone is not so discordant or strained as in the latter species, at least early in the season. The frequency is 3 kHz. The trill length and the spaces between trills are very consistent in the narrow-wing, forming a regular rhythm, unlike the variable rhythm nearly always present in the two-spotted's song and usually in Davis's. Also, the intervals between trills always are distinct, longer than the brief pauses most characteristic of the two-spotted tree cricket's song and sometimes Davis's. The two-spotted's song can have some longer pauses, but the narrow-wing's pauses do not contain the stutters that usually fill the longer two-spotted pauses. Also, the narrow-wing's trills seldom exceed 6 seconds, the two-spotted's frequently do, and Davis's usually do. Narrow-winged trills often have a "chuwee" beginning lacking in the two-spotted but shared with Davis's tree cricket (see that species account). There is some overlap in the two species' singing seasons, but the two-spotted tree cricket dominates the earlier air waves (July) while the narrow-wing is the one you probably are hearing later in the season (September-October). Care is needed, however, as the strained or discordant quality of the two-spotted tree cricket converges on the more soothing quality of the narrow-winged as the season progresses. Narrow-winged tree cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/584a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/narrow-winged-tree-cricket), and Lisa Rainsong's website (https://www.listeningtoinsects.com/narrow-winged-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

Photos. Above, male. Right, spots on basal antenna segments, and below, female.

Pine Tree Cricket (*Oecanthus pini*)





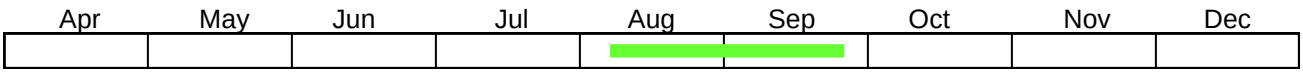
The pine tree cricket associates strictly with coniferous tree species. Though they are limited to conifers, they apparently are excellent dispersers, as I often find them in widely separated groves of spruces, cedars and pines. Nancy Collins has observed them on herbaceous vegetation early in the season, which could be an important dispersal time. They occur in every county in the region.

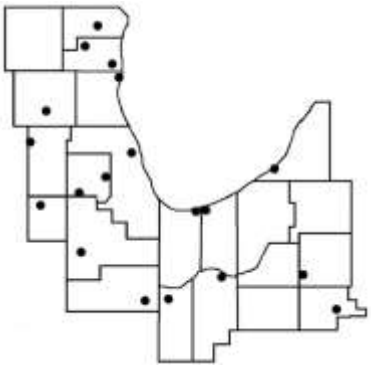
Season. Pine tree crickets sing until frost, mainly at night, though they can begin during the afternoon in the last half of their season. Observed first song dates have ranged July 26-August 29, last dates October 1-23.

Similar Species. This beautifully marked tree cricket is a magnificent match to its habitat, as the above photo shows. No other tree cricket has this habitat association in the region, nor this color pattern. The similar, slightly smaller tamarack tree cricket (*O. laricis*) has been found in southern Michigan, but its present status in Berrien County is uncertain. It is a bog species, occurring on tamarack, a deciduous conifer. The pulse rate of its song (37 pulses/sec) is slower than that of the pine tree cricket (45/sec) at the same temperature.

Song. The song is a continuous 3.5 kHz trilling tone, but the absence of resonating surfaces in conifer foliage limits the volume. A chorus of many individuals is beautiful and unmistakable, however, once one learns to recognize it. Pine tree cricket song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/587a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/pine-tree-cricket), my blog (https://natureinquiries.wordpress.com/2014/01/27/sound-ideas-trilling-tree-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/pine-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html. I am grateful to Nancy Collins, who owns that site, for introducing me to this species.

Four-spotted Tree Cricket (*Oecanthus quadripunctatus*)





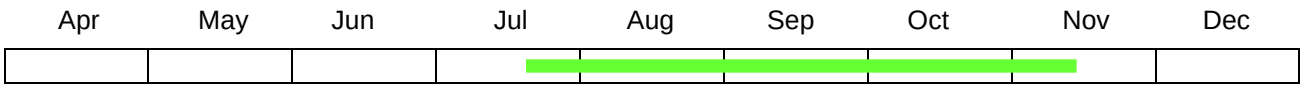
This species shares our meadows and prairies with the Forbes's tree cricket. It seems to have a stronger association with herbaceous plants, most commonly found on grasses and fine-stemmed, soft forbs, and seldom in trees. Queen Anne's lace was reported as popular for oviposition at a New York site, with occasional use of asters, small goldenrods, and common ragweeds.

Season. Members of this species sing from late morning into the night. I have found them as early as August 6 and as late as September 26, but their full season probably extends both earlier and later than those dates.

Similar Species. While this cricket is consistently pale, so too are some Forbes's tree crickets. Patterns of spots on the basal two antenna segments help to identify members of this species. In particular the well-separated smaller, rounder outside spots on the basal antennal segments (see photo, lower right) are characteristic.

Song. Continuous high-pitched (4.2 kHz) trilling may be indistinguishable (to the ear) between this and other meadow-dwelling tree cricket species. However, it has a distinctly lower pulse rate than the others, 40/second at 25C, and so its presence can be established through sound recordings. Four-spotted tree cricket song recordings can be found at the Songs of Insects website (http://songsofinsects.com/crickets/four-spotted-tree-cricket), the Singing Insects of North America website (https://sina.orthsoc.org/582a.htm), my blog (https://natureinquiries.wordpress.com/2014/01/27/sound-ideas-trilling-tree-crickets/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/four-spotted-tree-cricket). An excellent site for tree crickets generally is http://oecanthinae.com/index2.html.

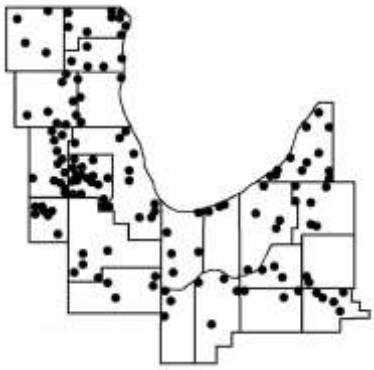
Say's Trig (*Anaxipha exigua*)



Say's trigs occur in every county and are contenders for the region's most abundant cricket. They are ecologically diverse, the greatest numbers occurring in two distinct habitats. When close to the ground they are creatures of thick herbaceous wetland vegetation. They also can be found in the dense canopies of trees at woodland edges, often forming lek-like aggregations that chorus loudly. It is possible that these distinctive habitat associations will prove to harbor separate species. Scattered individuals also occur in the forest understory.

Season. These crickets can be heard any time through the 24 hours of the day. First song dates have ranged July 18 -August 6. Last song dates have ranged October 1-November 13.

Similar Species. Say's trig is small, usually hidden, and not seen nearly as often as it is heard. It is tan with the end of the abdomen black. Distinctive darker stripes form a V on the face, sometimes with added lines between the eyes and on the front, as in the above photo. The paler overall color and dark facial stripes readily distinguish this species. The photos show a female (above) and a male (right). There are occasional long-winged forms. The spring trig has a different head color pattern, an earlier season

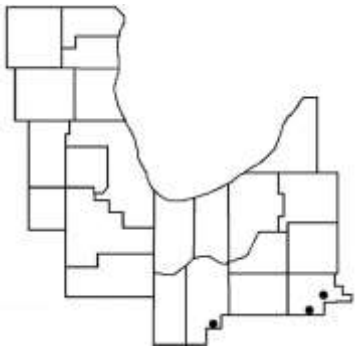


(the possibility of overlap in early July needs to be sorted out), and a different habitat of mesic meadows and prairies.

Song. The song is a rapid trill, the pulses too fast to count. The tone, which has been described as "silvery," has a beautiful quality. The long trill usually begins with a distinctive, abrupt "chuwee…" Usually the male sings from a perch elevated above the ground, though his exact location can be difficult to place. The song is audible to most people at 7 kHz, and fairly loud when the male finds a good song perch. The song of the handsome trig is composed of sharper pulses that seem to have a clicking or percussive attack, and is higher pitched. Melodious ground crickets have a mellower trill, usually lower-pitched (see Appendix A), and continuous rather than frequently, briefly paused. Occasionally, Say's trigs produce a song composed of short trills rhythmically alternating with spaces, the pattern resembling that of the confused ground cricket but lacking the stuttering sound between trills.
Say's trig's song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/616a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/says-trig), my blog (https://natureinquiries.wordpress.com/2014/03/10/sound-ideas-says-trig-variations/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/say-s-trig).

Spring Trig (*Anaxipha vernalis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



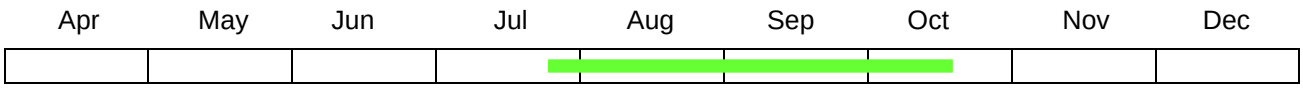
This is a southern, early season species of mesic to moist, grassy prairies and meadows. Rarely they may extend short distances into adjacent forests. They don't seem to require high quality habitat, as long as it is grassy (unmowed) and open. They may stay closer to the ground than Say's trigs, but at Eagle Creek Park of northern Indianapolis I found them frequently climbing up into herbaceous and adjacent woody plants. The species first was described by Walker and Funk in 2014. They are common as far north as northern Indianapolis. The species occurs as small widely scattered populations in the southern edge of the Chicago region; so far I have found these only in southern Fulton and Jasper Counties. Lisa Rainsong also has noted a thinning of spring trigs northward in the Cleveland area.

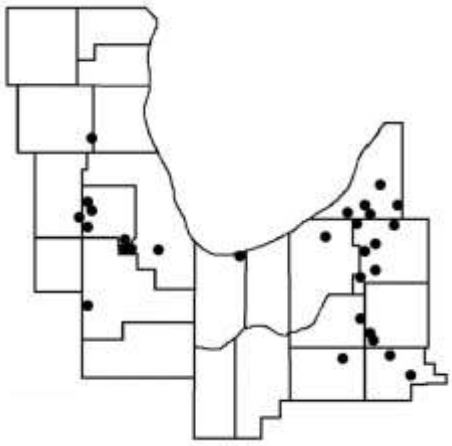
Season. My few observations in the region sketch this species' season as early to late June, but this needs to be refined. Most of my contact with spring trigs has been in central and southern Indiana, through the bioblitzes organized by the Indiana Academy of Science. Those observations indicate that spring trigs sing mainly at night, beginning in the late afternoon and continuing to mid-morning, with only occasional scattered singers in the middle part of the day.

Similar Species. Physically the spring trig resembles Say's trig. In addition to the habitat and season difference, spring trigs have a different head color pattern, lacking the Say's trig's diagonal darker stripes forming a V on the face. There may be sexual dimorphism or at least some color variability in this species: the male I caught at Connor Prairie (photo, below right) had a uniformly dark head, and the females at nearby Eagle Creek Park had pale heads with thin dark lines (other photos). Say's trig has a dark stripe on the femur that is lacking in the spring trig.

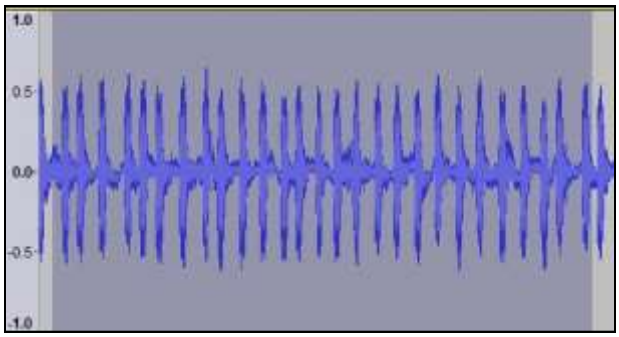
Song. The song is, to the ear, much like Say's trig's "silvery trill" with a "chuwee" start. Trills were shorter at mid-day than at other times at Goose Pond, sometimes lasting only 5 seconds. I also heard one producing the short trill variation described for Say's trig. Recordings I have made to date have had pulse rates that overlap with the Say's trig range, but corresponding frequencies are lower, at 5.6 kHz (see Appendix A). Spring trig song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/632a.htm), Lisa Rainsong's website (https://www.listeningtoinsects.com/spring-trig), and my blog (https://natureinquiries.wordpress.com/2013/11/18/sound-ideas-trigs/)

Handsome Trig (*Phyllopalpus pulchellus*)





(https://www.listeningtoinsects.com/handsome-trig), and my blog (https://natureinquiries.wordpress.com/2013/11/18/sound-ideas-trigs/).



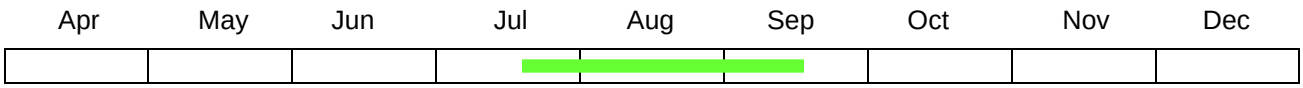
This is an edge species, usually found where woody shrubs are mixed with denser herbaceous vegetation, and often adjacent to ditches or other wet areas. Males typically sing from the underside of leaves no higher than 4 feet above the ground. Early in the 20th Century they were limited to southern Illinois and southern Indiana, but they are another species that has expanded its range northward and, apparently, is continuing to do so. They recently were found in southeast Michigan for the first time (O'Brien and Craves 2016), and I have found them to be common in southern Berrien County. Their numbers in the region generally are low and their distribution spotty. Numbers seemed higher in 2017, when I suddenly found them in scattered pockets across the southern half of DuPage County (though my notes mention suspicious songs as early as 2014). In 2018 I found them in Kane County and, surprisingly, well north in the southeast corner of McHenry County.

Season. My observations have ranged between July 26 and October 15. I have heard them from early morning to midnight.

Similar Species. This tiny cricket's black, red-brown and yellow color pattern is distinctive.

Song. Their songs are of the same pattern (rhythm and speed) as the widespread and common Say's trig, an irregular or broken trill at 7 kHz, but each sharp pulse (sonogram, right) seems to begin with a mechanical click, giving it a percussive sound. Handsome trig song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/641a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/handsome-trig), Lisa Rainsong's website

Northern Mole Cricket (*Neocurtilla hexadactyla*)



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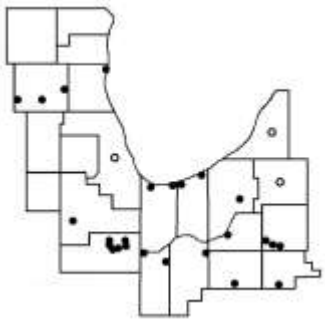


Northern mole crickets are dramatically structured for digging their tunnel dwellings. I first found them at Houghton Lake, the Nature Conservancy site in Marshall County, where their deep chirping came from wet prairie areas within the site's lake plain. Subsequently I have found them around edges of ponds and lakes, in marshes, and in drainage ditches. Intensive searching, focused on ditches, satisfied me that I am not going to find them in the Wisconsin counties or any additional Illinois ones. According to information in the Singing Insects of North America website, mole crickets eat both animal and plant matter. They emerge from their tunnels to forage mainly at night. Females lay eggs in their tunnels and stay with them, but it is not known whether they actively protect them. They overwinter as nymphs, and may need two years to mature. They are capable of flight (a specimen in the collection at the Illinois Natural History Survey has the note, "flying in garage").

Season. Singing observations so far have ranged from July 19 to September 14. In most places they wait until dusk to begin, but at Houghton Lake they often sing in the afternoon. My median observation time is sunset.

Similar Species. This is our largest cricket by far, its length reaching 2.5 inches. The front legs are modified for digging, resembling those of a mole. They normally remain out of sight in their tunnels, but if seen could not be mistaken for anything else.

Song. The song is a relatively low-pitched (1.7-2 kHz), deep rhythmic chirp that could be rendered "warg warg warg…" or "dirt dirt dirt…" The chirps are produced at a rate of 1-3 per second. Females are capable of stridulating, but why they may do so is unknown. Northern mole cricket songs and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/351a.htm), the Songs of Insects website (http://songsofinsects.com/crickets/northern-mole-cricket), my blog (https://natureinquiries.wordpress.com/2014/01/13/sound-ideas-an-odd-trio/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/northern-mole-cricket).

Katydids
Family *Tettigoniidae*

Technically the katydids are separated from crickets by having feet with four rather than three segments. In our informal practice we see that katydids generally resemble grasshoppers but with long, threadlike antennae instead of the grasshoppers' short stubby ones. Though the antennae and song production are similar to those of crickets, they may have evolved their singing behavior separately (Gwynne 2001). Family Tettigoniidae separated from other Orthoptera in the late Jurassic (Mugleston et al. 2018).

Like the crickets, most katydids spend the winter in the egg form. In some species, eggs may range 1-3 years in dormancy before hatching, apparently a way of dealing with environmental variation between years (Gwynne 2001; see oblong-winged katydid account). Katydid nymphs likewise develop through several stages, or instars, molting the old exoskeleton and expanding into a new one for each graduation. Only the adults have fully developed wings, though these are short and may appear to be undeveloped in some species.

During courtship there often is fencing-like antennal contact between male and female. Practically all katydids include courtship feeding (*Microcentrum* an exception), the males providing females with a nutritious mass called a spermatophylax (Gwynne 2001). The female consumes the spermatophylax while fertilization is taking place, which protects the sperm and enhances offspring survival.

The predaceous katydids are predators and scavengers. Otherwise, our katydids are vegetarians (especially Phaneropterinae) or omnivores. Coneheads (*Neoconocephalus* spp.) mainly eat seeds (Gangwere 1965). Katydids in turn are preyed upon by birds and mammals, and are the targets of insect predators and parasites including horsehair worms, wasps and flies. The horsehair worms get into katydids that consume other insects containing the immature worms. Wasps and flies home in on singing males.

Here I am following the systematic scheme on the Singing Insects of North America website, as it is the most comprehensive and up-to-date compendium for the entire group and is so accessible. It places all our katydids in family Tettigoniidae. Our species then fall into five subfamilies. There are enough species that I expand the following scheme down to the genus level for clarity.

Subfamily Conocephalinae (meadow katydids: two genera included locally).

> Genus *Conocephalus* (smaller meadow katydids: local species include the long-tailed, short-winged, slender, woodland, black-sided, prairie, and straight-lanced meadow katydids).
>
> Genus *Orchelimum* (larger meadow katydids: local species include the gladiator, black-legged, long-spurred, delicate, dusky-faced, stripe-faced, nimble and common meadow katydids).

Subfamily Copiphorinae (coneheaded katydids: local species, all in genus *Neoconocephalus*, include the sword-bearing, Nebraska, round-tipped, robust, marsh, and slightly musical coneheads).

Subfamily Phaneropterinae (false katydids: local species are in three genera).

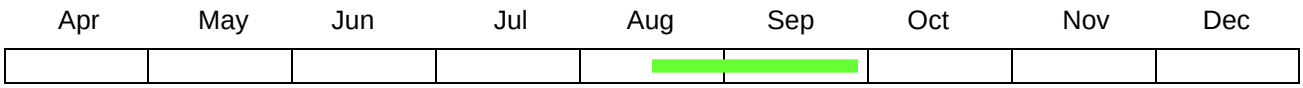
> Genus *Amblycorypha* (round-headed katydids: local species include the common virtuoso, oblong-winged and rattler round-winged katydids).
>
> Genus *Microcentrum* (angle-wing katydids: our local species is the greater angle-wing).
>
> Genus *Scudderia* (Scudder's bush katydids: local species include the curve-tailed, treetop, fork-tailed, broad-winged, northern and Texas bush katydids).

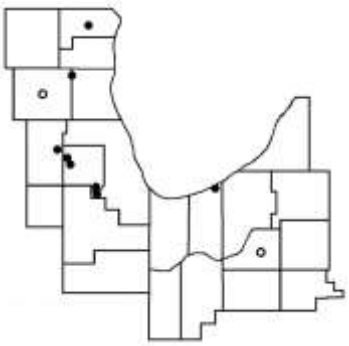
Subfamily Pseudophyllinae (true katydids: one local species, the common true katydid).

Subfamily Tettigoniinae (shieldback katydids: local species are in two genera).

> Genus *Atlanticus* (protean shieldback).
>
> Genus *Roeseliana* (Roesel's katydid).

Long-tailed Meadow Katydid (*Conocephalus attenuatus*)





The long-tailed meadow katydid is a wetland species that can be locally abundant, but occurs in relatively few places and seldom with the black-sided. They are, however, capable of dispersal between wetlands, as some long-winged variants have been attracted to lights well away from suitable habitat. So far I have not found them in the southern portion of the region, but it is too soon to tell whether their numbers are attenuating to the south.

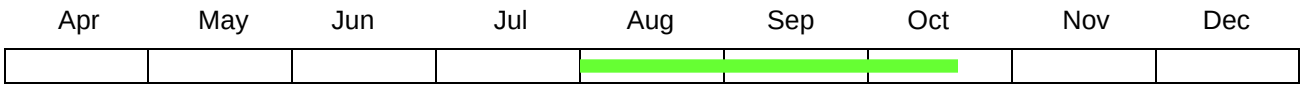
Season. According to references, this species is active August to September. My observations of adults have ranged from August 16 to September 26.

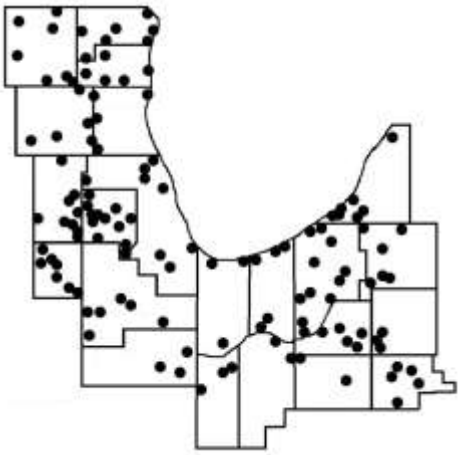
Similar Species. Meadow katydids have relatively stout bodies and membranous wings that do not cover much of the abdomen when viewed from the side. They thus resemble grasshoppers more than do other katydids (though all the katydids are more closely related to crickets than to grasshoppers). The long-tailed meadow katydid is unusual in having two color variations: one is all brown, the other is a mix of brown and green colors. Both forms can occur together, and both genders can occur in either color. The English name comes from the female's extraordinarily long ovipositor, which is straight as are those of the other members of its genus.

Song. In reference recordings the song is a continuous steady buzz with clearly distinguished though fairly rapid pulses (pulse rate about twice that of the black-sided meadow katydid's song). The song of this species is too high-pitched for older ears to hear, peaking at 16 kHz and with little energy in lower pitches (I once saw a male whose wings vibrated without my hearing anything, from a meter's distance). Long-tailed meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/228a.htm) and at Lisa Rainsong's website (https://www.listeningtoinsects.com/long-tailed-meadow-katydid).

Photos: typical brown male above, green-legged male top right, female center right. Male, bottom right, showing the extraordinarily long antennae common among *Conocephalus* meadow katydids.

Short-winged Meadow Katydid (*Conocephalus brevipennis*)





This may be the most abundant katydid of our region, forming dense aggregations of singing males in tall grass and sedge areas, at woods edges and along trails as well as in the open.

Season. So far, observed song dates have ranged August 1-October 21.

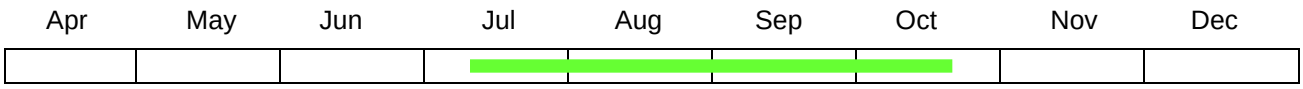
Similar Species. This is a relatively small species, and members of its *Conocephalus* genus in general are smaller than the *Orchelimum* meadow katydids. Also, female *Conocephalus* have straight ovipositors while those of *Orchelimum* females are curved. The short-winged meadow katydid is green with a brown back. The male's most distinctive feature is the yellow-orange or orange-brown rear part of its abdomen. Nearly all have wings covering slightly more than half the abdomen, but occasional long-winged individuals can be found. Nymphs are a brighter green; mature individuals often become somewhat browner. The hind femur pattern of twin brown stripes with a clean green area between them appears to be distinctive, in nymphs as well as adults. See the accounts for the prairie meadow katydid (*C. saltans*) and straight-lanced meadow katydid (*C. strictus*).

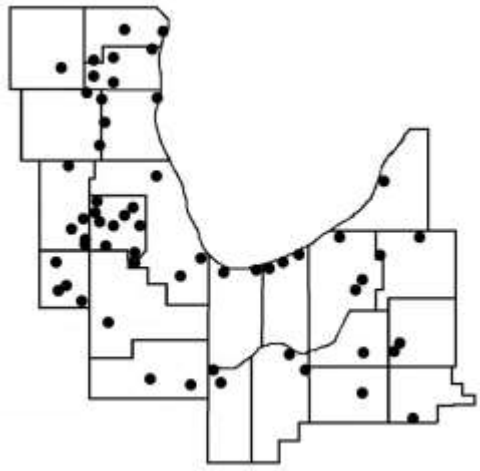
Song. Its song is a continuously repeated 2-second pattern, 2-3 evenly spaced ticks for 1 second alternating with a rattling buzz that also lasts 1 second (can be faster at warmer temperatures, slower when cold). The rhythm is so precise as to seem mechanical, metronome-like. Though children and young adults have no trouble hearing it, the song is high enough in pitch (peaking at 13 -15 kHz) to be inaudible to older ears (reference recordings can be misleading in this regard; in a quiet room the low-energy, lower pitched portions of the buzz may be easier to hear).

Short-winged meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/234a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/short-winged-meadow-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/short-winged-meadow-katydid).

Photos: male, top. In right column, above left, the shapes of the cerci, or male abdominal appendages, are helpful in distinguishing some meadow katydid species; above right, unusual long-winged male; below, female.

Slender Meadow Katydid (*Conocephalus fasciatus*)





The slender meadow katydid's preferred habitat appears to be areas of tall grass and forbs, especially damp spots, in prairies, meadows, and wetland edges. It is locally common but not so universally distributed as the short-winged meadow katydid. I have found them in every county in the region.

Season. So far, observed song dates have ranged July 10-October 21. The July 10 date was in the unusually early season of 2012. Otherwise, first song dates have been in early August. These begin singing earlier than do short-winged meadow katydids.

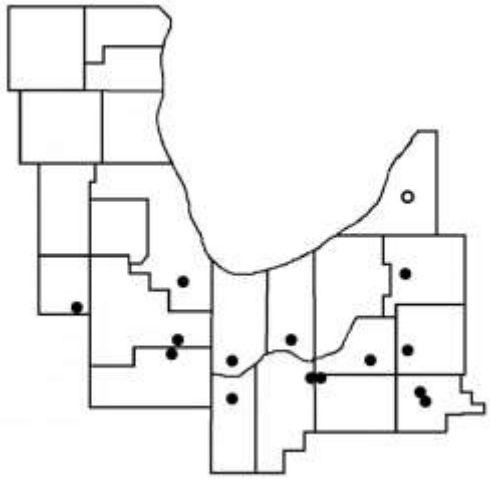
Similar Species. Among the small meadow katydids of our area, this is the only one that always has long wings. In contrast with the rare long-winged individuals of other small meadow katydid species, slender meadow katydids have green abdomen tips, including male cerci and most of female ovipositors. Hind femurs of nymphs and adults are green with scattered black specks.

Song. The song is like that of the short-winged meadow katydid in being too high pitched for older unaided ears (peak energy 15-17 kHz). The rattling buzz is longer (often 10 or more seconds), preceded by usually 3-4 (sometimes more) irregularly spaced buzzing or tupping ticks. Singing is continuous except when the male is disturbed. The song's timing clearly lacks the metronomic precision of the short-winged's song. The wings do not visibly vibrate. Members of this species seem to prefer higher song perches than do short-wingeds, and on the stems of forbs rather than grasses or sedges. Slender meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/231a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/slender-meadow-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/slender-meadow-katydid).

Photos: Female above, male right.

Woodland Meadow Katydid (*Conocephalus nemoralis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



This has been regarded as a species of open woodlands and woods edges, but that generalization appears to be less true in the Chicago region. Prior to 2020 my only Illinois site was at the Gensburg Prairie, mainly in an isolated shrub thicket there. In 2020 I was surprised to find them along drainage ditches in southeastern Kendall County. Subsequent searching that year produced ditch locations in two more Illinois counties and five in Indiana. Generally they associated with grasses in the dry levee tops of the ditches, but usually there were a few trees or shrubs nearby, though sometimes tens of meters away from the singing katydids. The remaining counties where I expect to find them are LaPorte and Berrien. Bland reports that they can be found at edges between dune vegetation and woods along the edge of Lake Michigan, providing another habitat in which to seek them. Blatchley mentions that they have been observed ovipositing in decaying wood.

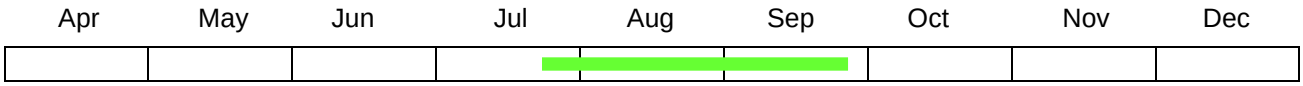
Season. So far, the observed song dates in this study have ranged August 18-September 27. Some observers have found them singing well into the fall in other parts of their range. So far I have heard them singing between 10 a.m. and dusk.

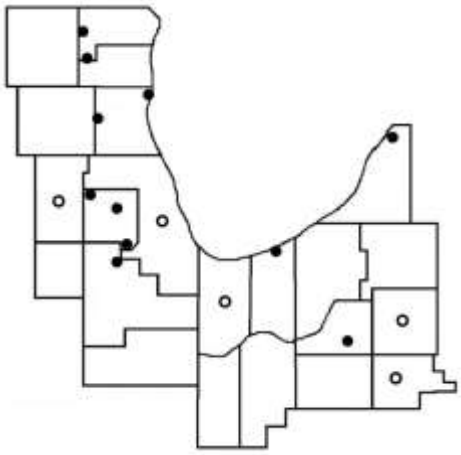
Similar Species. Among the meadow katydids of our area, only this species, the long-tailed meadow katydid and the prairie meadow katydid are all brown. The woodland meadow katydid occurs in dry areas in or adjacent to woods or ditches, the long-tailed meadow katydid is a wetland species and the prairie meadow katydid occurs in remnant prairies and savannas. Prairie meadow katydids have much shorter wings.

Song. The song's pattern resembles that of the striped ground cricket, with occasional bursts of stuttering ticks added between the brief, rapid buzzes. It is softer and higher pitched than the ground cricket's song, though, the peak frequency range 14-15 kHz. Singing is continuous except when the male is disturbed. Song perches are within 3 feet of the ground. Woodland meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/233a.htm) and at the Songs of Insects website (http://songsofinsects.com/katydids/woodland-meadow-katydid).

Photos: Male above, female right.

Black-sided Meadow Katydid (*Conocephalus nigropleurum*)





pitched at 14 kHz for many people (including me) to hear unaided. In most areas where I have found it, its song was drowned out by the songs of black-legged meadow katydids. Black-sided meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/229a.htm) and Lisa Rainsong's website (https://www.listeningtoinsects.com/black-sided-meadow-katydid).

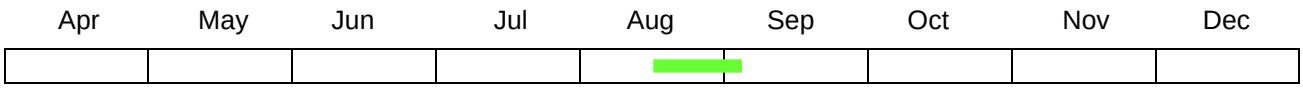
I have found black-sided meadow katydids in marshes with tall grasses and sedges, but always among or adjacent to coarse-stemmed plants including cattails, willows or other woody plants. They seem to occur in relatively few places, but sometimes are locally common. I have found them with long-tailed meadow katydids at the east end of the dolomite prairie at Waterfall Glen Forest Preserve in DuPage County, and at Indiana Dunes State Park, but usually those two species do not seem to occur together despite similar habitat preferences. Some old references point to pine cone-like bud galls of willows as one oviposition site for this species, Blatchley (1920) mentions grasses as another, and Lisa Rainsong has observed oviposition in cattails in Ohio. She also has seen them feeding on cattail leaves and seeds.

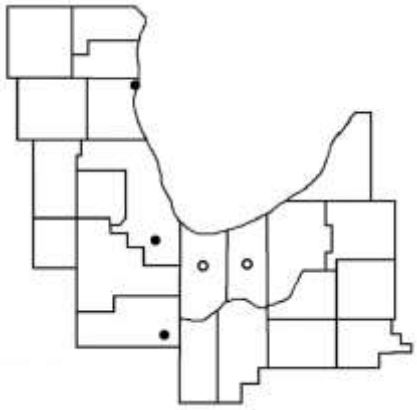
Season. I have found adults as early as July 24 and as late as September 24.

Similar Species. No other local katydid has so much black on the abdomen. The head and the sides of the thorax are brown, eyes black. Otherwise there are two color variants dominated by green or brown, with varying amounts of yellow or tan in the legs.

Song. Sounds like a tiny snare drummer, with a rapid tapping quality. Its song goes on for minutes at a time, but is too high

Prairie Meadow Katydid (*Conocephalus saltans*)





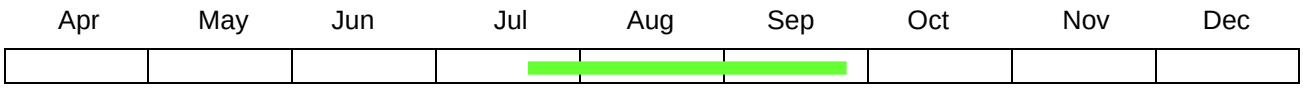
To date I have found this species in black oak savannas and an elevated prairie. According to references, this species prefers grasses on dry poor soil, and may be limited to remnant prairie and savanna habitats on sandy soils in the region. Hebard said the prairie meadow katydid ranges throughout Illinois, but he found it only in sand areas along Lake Michigan and close to the Kankakee River. Most if not all records from northern Indiana appear also to be from sandy areas. Blatchley describes it as relatively less active than other *Conocephalus*, spending much time on the ground rather than on plant stems.

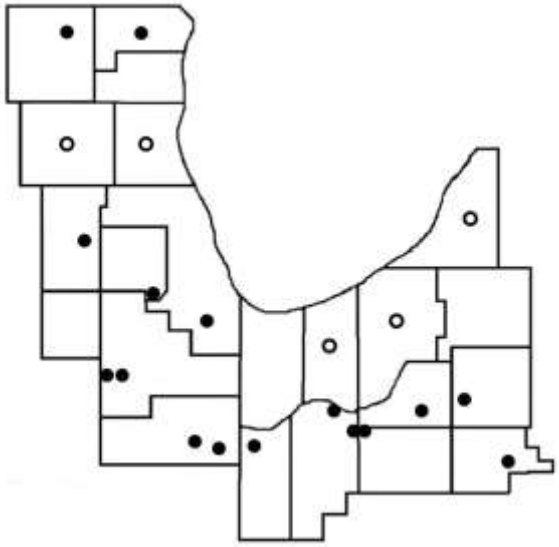
Season. References give the season as August and September. My few observations to date all have been in that time frame, August 16-September 2. The few singing individuals observed were mid-day through the afternoon.

Similar Species. The three species of *Conocephalus* most likely to be confused in the region are *brevipennis*, *saltans*, and *strictus*. By far the most abundant, widely distributed and broadest in habitat range is *brevipennis*. It is distinguished by wings that are more than half the length of the abdomen, hind femurs that generally are green with a pair of narrow brown lengthwise lines, and a tip of the head that narrows anteriorly. Next in abundance is *strictus*, a dry soil species. It is larger than the others, the wings are about half the length of the abdomen, the hind femur has a prominent diffuse-edged black lengthwise line, and there is a slight swelling at the tip of the head. In *saltans* the wings are only a quarter the length of the abdomen, the femur pattern is like that of *brevipennis* but with a brown rather than green ground color, and the tip of the head expands significantly both in profile and as viewed from above. The ovipositor is much longer than the others in *strictus*, more curved in *saltans*. All three species can have occasional long-winged individuals.

Song. The tiny wings do not produce a very loud song, faint even in comparison to other members of its genus, peaking at 14 kHz. The song is a rapid ticking sound which resolves to brief buzzes at close range. Prairie meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/225a.htm).

Straight-lanced Meadow Katydid (*Conocephalus strictus*)





The straight-lanced meadow katydid prefers grasses growing on poor soil in dry areas. The only places I have found large numbers of them have been in sandy soil areas.

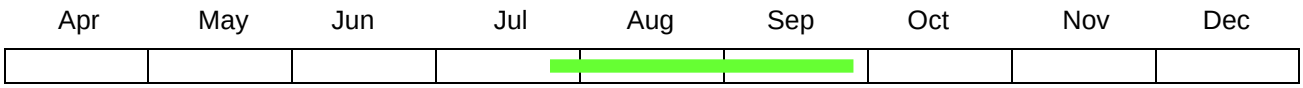
Season. According to the literature, the activity period for this species is August to October. They were singing by July 20 at Kankakee Sands in 2012, but many species were singing early that year. I found a male as late as September 26 in 2015.

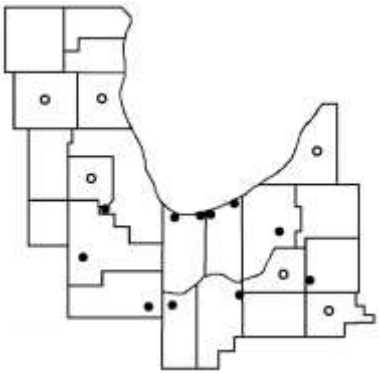
Similar Species. This species typically is short-winged like most *Conocephalus* meadow katydids, but the male lacks the yellow abdomen tip of the short-winged meadow katydid and, as usual, the cerci are different. The cerci are brown, relatively long and straight, with elongated flattened tips, and inward pointing teeth set well back toward the base. In both *brevipennis* and *saltans*, the cerci have shorter tips that bend outward. The teeth are slender and as long as the tips in *saltans*, fatter and proportionately shorter in *brevipennis*. The female's straight ovipositor usually exceeds the body length in *strictus*. The tip of the insect's head is slightly swollen, but not as much as in *saltans*. Another feature that may prove helpful is a diffuse black stripe down the side of the hind femur. See also the prairie meadow katydid account.

Song. The song is a continuous rattling buzz at 10-20 kHz. That buzz changes speed, alternately slowing and speeding up about every 15-30 seconds (Alexander, Pace and Otte 1972). Much of the song's energy is well above 10 kHz, and its lack of stops and starts can make it difficult to separate from the chorus of sounds around it. Straight-lanced meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/238a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/straight-lanced-meadow-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/stright-lanced-meadow-katydid).

Photos: male top, female above (uncommon long-winged variation), cerci magnified right.

Dusky-faced Meadow Katydid (*Orchelimum campestre*)





Thomas and Alexander (1962) found the dusky-faced meadow katydid to be common, occurring in a wide range of marshes, and especially associated with grasses. I have found it only in marshes dominated by native plants, especially grasses, and these are becoming rare in the region as invasive wetland plant species push them out. The largest populations in the region are at Midewin National Tallgrass Prairie in Will County, and in the Jasper-Pulaski Wildlife Area in Jasper County. They may be more abundant south of the region, where invasive plants are not so dominant.

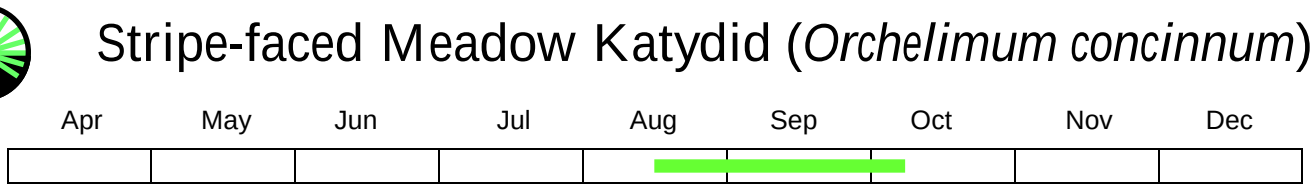
Season. Observed song dates have ranged July 25 to September 28, with an increase in singing from early afternoon into the night.

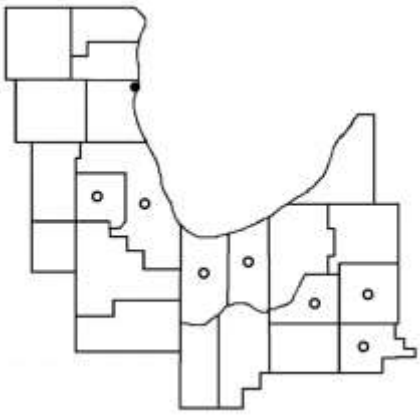
Similar Species. The appearance of this species is distinctive, its green legs very unlike those of the black-legged meadow katydid, and the head pigmented rather than pale. The head typically is amber-colored and marked with fine lines and dots of reddish brown, while that of the stripe-faced meadow katydid has a bright stripe down the center of the tan to white face. Some *campestre* in populations close to Lake Michigan have green-tinged to bright green faces. This makes them similar to delicate meadow katydids (*O. delicatum*), which may now be extinct in the region, but the females' ovipositors are too short, and the males' songs lack the doubled ticks of that species.

Song. The song is much quieter than that of the black-leg, thanks to its peak frequency of 16 kHz. The buzz can be very long (from 4 seconds up to 3 minutes), commonly preceded by at least 6-8 ticks, but sometimes as many as 150 ticks without a buzz., and sometimes there are buzzes without ticks. The ticks are fairly quick but irregularly spaced, and not doubled. Dusky-faced meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/266a.htm) and Lisa Rainsong's website (https://www.listeningtoinsects.com/dusky-faced-meadow-katydid).

Photos: above, whole insect, and head of a green-faced one. Above right, face view of a recently mated female, still consuming part of the spermatophylax, and dorsal and ventral views of a male's cerci. Below right, lateral view of the female's ovipositor, with the rest of the spermatophylax visible below the base..

Stripe-faced Meadow Katydid (*Orchelimum concinnum*)





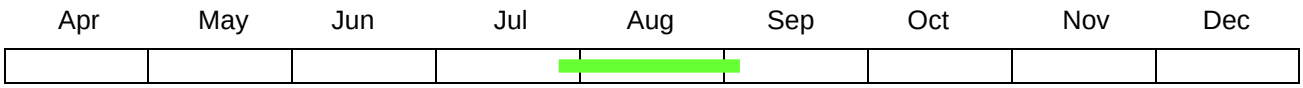
The only place I have found this species to date in the region is Illinois Beach State Park. There it is abundant in swales and in wet grassy areas along the Dead River that are free of hybrid cattails and other invasive wetland plants. Hebard gives swamps and bogs as habitat. Early descriptions placed it in dense grasses and sedges near ponds and streams, and around tamarack swamps and lakes. Thomas and Alexander found it to be very limited in its distribution, occurring in "a few northern relict marl bogs and other alkaline situations."

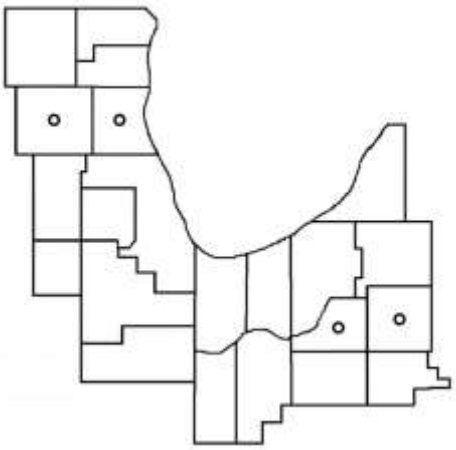
Season. My earliest first song date for this species is August 16. I have found them continuing into the first week of October. They begin singing around mid-day and continue into the night, peaking in the late afternoon into early evening.

Similar Species. This species has an interesting color development sequence. Nymphs and newly matured adults are mostly red-brown, both in body color and in the central facial stripe. The ground color of the face is pale tan, and the edges of the facial stripe are a little diffuse. As the season progresses, the body becomes entirely green to blue-green, the facial stripe darkens to black or very dark brown, and the face ground color lightens, in some cases to white.

Song. The song is high pitched, peaking at 15 kHz. The songs at Illinois Beach State Park begin with 3 or 4 ticks in some individuals, 6 or 7 in others, a little irregularly spaced, the last one leading quickly and directly into the buzz, which lasts a few seconds. The buzzes and tick sequences are longer, generally, in dusky-faced meadow katydids. Stripe-faced meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/253a.htm) and my blog (https://natureinquiries.wordpress.com/2015/02/11/sound-ideas-three-meadow-katydids/).

Delicate Meadow Katydid (*Orchelimum delicatum*)





According to Thomas and Alexander (1962), early authors stated that this species occurred in low meadows near large lakes in the Indiana counties of Marshall and Starke. Thomas and Alexander themselves say it is "largely restricted to swales adjacent to sand dunes or sand beaches, where it is often associated with … *Calamagrostis canadensis* [a grass]."

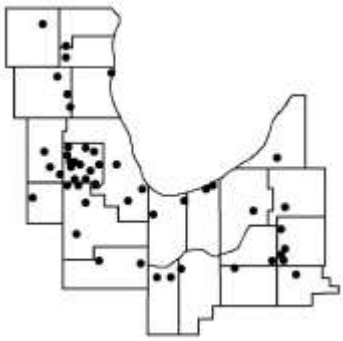
I have put much effort into seeking this and other uncommon wetland singing insects, and so far have not been successful with this species. I have nearly run out of sites to check, and am concerned that delicate meadow katydids may be regionally (though not globally) extinct. This is primarily a species of the Great Plains, and Thomas and Alexander suggested that it extended its range eastward during a postglacial time when the region's climate was drier, and prairie extended as far as New York state.

Season. Historical records range from July 25 to September 1 in Illinois and Indiana, July 23 to September 28 in northern lower Michigan. According to Thomas and Alexander (1962), some sing during the day, but most singing is done dusk into the night.

Similar Species. The ground color of the head is green, but given the frequent occurrence of green-tinged *O. campestre* in the region, especially in the counties bordering Lake Michigan, this is not a diagnostic feature. Females with ovipositors well over half the length of the hind femur (as in the photo below of the female specimen), and males whose songs feature doubled ticks, will be needed to establish this species.

Song. The song is described as resembling those of the dusky-faced and stripe-faced meadow katydids, peaking at 11-14 kHz, but with consistent doubled ticks. A sound recording can be found at Singing Insects of North America, https://sina.orthsoc.org/250a.htm

Gladiator Meadow Katydid (*Orchelimum gladiator*)



This is the common, early season large meadow katydid species widely distributed in our area. They begin in relatively wet places, though they may later move into drier meadows adjacent to low spots. Sometimes they can be found in pure stands of reed canary grass (an invasive species few insects can tolerate).

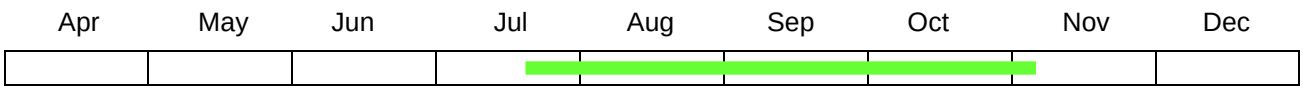
Season. Gladiator meadow katydids begin singing in June or early July (observed first song dates June 14-July 6 in different years). Usually they are done in late July, but a few may extend later (observed range of last song dates July 12 -September 3). A few singing in a marsh in McHenry County on September 3, 2015, were anomalous. I have heard them singing as early as 8 a.m., as late as 9 p.m.

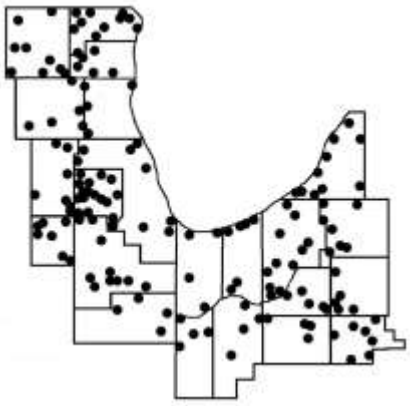
Similar Species. No other generally green large meadow katydid matures this early, or is this abundant. That said, there is little to separate this one structurally from the relatively uncommon, later season, drier habitat, common meadow katydid. Careful study of the precise contours of the very similar cerci, and of the shape of the edges of the sides of the pronotum (the saddle-like covering of the thorax) are needed to separate the two species (see the account for the common meadow katydid). Their songs also are different.

Song. The song is a somewhat rattling, often long whirring buzz (commonly 6-8 seconds), increasing in volume at the end and usually followed by 2-3 very soft ticks. The sound of the buzz can be confusingly similar to that of another early season katydid in a completely different group, the protean shieldback (gladiator peak 11-15 kHz, shieldback 13-15). The shieldback's buzz is continuous or at least much longer than that of the gladiator, and lacks the gladiator's distinctive ending. The lack of loud ticks, their lesser number, or their more regular spacing when present, along with the habitat difference, separates the song from that of the common meadow katydid. The ticks are more separate and deliberate relative to the black-legged meadow katydid, and seem attached to the end rather than the beginning of the buzz, but there is little overlap between the seasons of the two species. Gladiator meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/263a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/gladiator-meadow-katydid), my blog (https://natureinquiries.wordpress.com/2014/03/24/sound-ideas-early-season-katydids/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/gladiator-meadow-katydid).

Photos: above, male; above right, female; below right, male cerci.

Black-legged Meadow Katydid (*Orchelimum nigripes*)



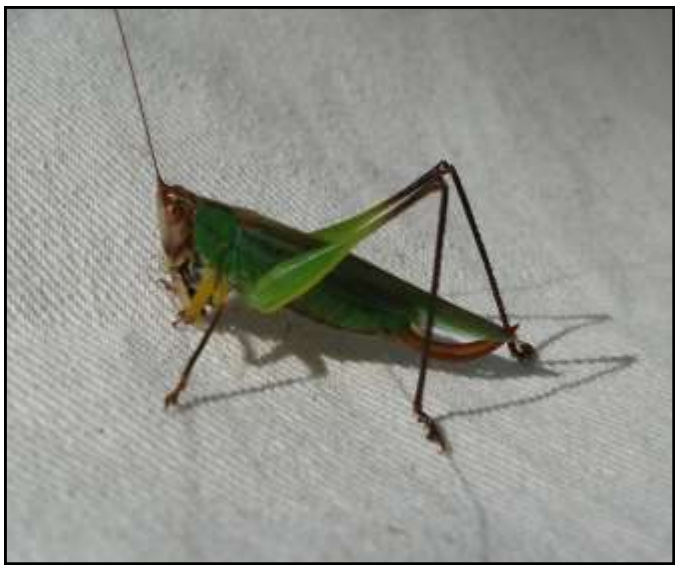


The black-legged meadow katydid starts out as a species of the water's edge, but ultimately may disperse 50 or more meters (observed more than 200) from the water into dry meadows and thickets. It remains most abundant near water, however. Late in the season they sometimes sing from up in trees. This becomes by far the most abundant *Orchelimum* after late July. Females mate only once, preferring territorial dominant males, and lay eggs in plant stems (Feaver 1977). Feaver also found heavy mortality from horsehair worms in this species, killing 50% or more shortly after they molt into their adult instar.

Season. Males sing mid-July to late October or early November (first songs ranged July 18-August 15 in various years, last song dates October 9-November 5). They begin to sing 4-5 days after their final molt (Feaver 1977). Songs are produced early morning (by at least 8:20 a.m., later on cool days) until after dark.

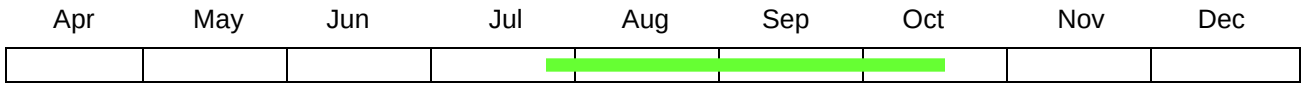
Similar Species. The black-legged meadow katydid is the common, colorful *Orchelimum* of our area, green of the body having a slightly bluish tinge, with yellow on the femurs of the first two pairs of legs, black tibias, whitish heads and red eyes. None of our other species have this combination of characteristics.

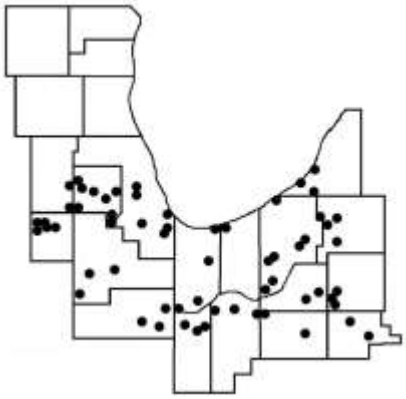
Song. Meadow katydid songs all are based on a tick-and-buzz pattern, the ticks being separate single sounds and the buzzes being continuous rasps of the sound-producing structures of the wings rubbing together. Black-legged meadow katydids have just a few (commonly 3) quick, evenly spaced ticks between the buzzes, the ticks running into the buzzes, and there is a regular continuing rhythm of alternating ticks and buzzes. A tick-and-buzz set lasts 2-4 seconds: "tickety-buzz." Though much of the song is very high pitched, peaking at 11-15 kHz, there is plenty of energy down to 10 kHz. See gladiator and common meadow katydid song descriptions for further distinctions. Black-legged meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/262a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/black-legged-meadow-katydid), my blog (https://natureinquiries.wordpress.com/2015/02/11/sound-ideas-three-meadow-katydids/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/black-legged-meadow-katydid).



Photos: male above, female below right, cerci (claspers at end of male's abdomen) above right.

Long-spurred Meadow Katydid
(*Orchelimum silvaticum*)





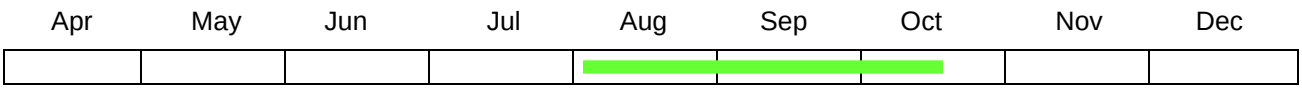
This one is arboreal, often found at woods edges. Males may sing from trees, shrubs or herbaceous stems. The northern edge of this species' range occurs in the region, and it appears to be stable. I have found them to be abundant in suitable habitat in the southern counties, but haven't found them at all in the northern ones.

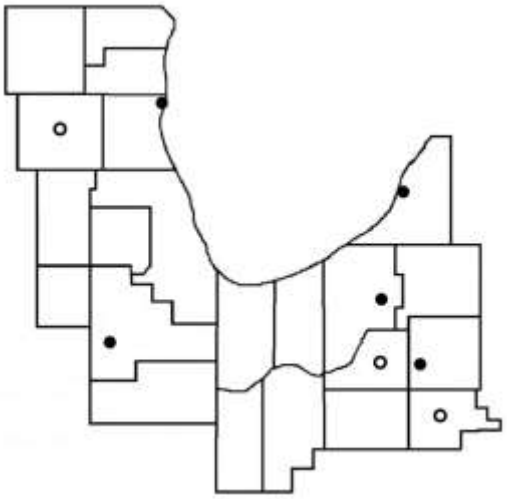
Season. I have found these singing as early as July 23 and as late as October 17. I have heard them as early as 10 a.m. and later than 10 p.m.

Similar Species. The long-spurred meadow katydid has the general body form of the large meadow katydids. It is a late season species that often prefers woody plants. Its activity period does not overlap significantly with that of the early season gladiator meadow katydid. Common meadow katydids are more typical of herbaceous vegetation in open habitats. Black-legged meadow katydids are much more colorful. The extraordinarily long, pointed inward cerci teeth (photo lower right) give the species its English name, and are unmatched by our other *Orchelimum* species. Also, the eyes often are a brighter red than those of other species, the head a cleaner solid green, and the dorsal abdomen often has black pigmentation.

Song. The ticks are so fast that they are almost like a rattling slower buzz. They accelerate directly into the actual buzz, then there is a space of quiet between tick-and-buzz groups. Unlike other meadow katydids, the tonal quality of the ticks is identical to that of the buzz (or perhaps they are better described as very brief buzz segments rather than ticks). The frequency range is very broad, at 8-20 kHz, but a relatively small amount of the song's energy is in the 8-12 kHz range. Long-spurred meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/261a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/long-spurred-meadow-katydid), and my blog (https://natureinquiries.wordpress.com/2015/02/11/sound-ideas-three-meadow-katydids/).

Nimble Meadow Katydid
(*Orchelimum volantum*)





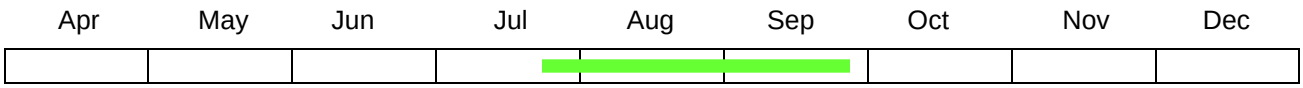
This species is limited to pickerel weeds, arrowheads and aquatic knotweeds growing in relatively deep water. There is a large population in the Grand Mere lakes in Berrien County, and good numbers are in Fish Lake in LaPorte County, with smaller populations in a few other places. The population at Illinois Beach State Park may be on the verge of extinction, and much effort has failed to turn them up in the lakes of southeastern Wisconsin. Hebard found them only where the water was at least waist deep. They are well named, quick to fly up to 20 feet when approached. One did something totally unexpected: he dove beneath the water and hid among the submerged stems. This behavior is not totally unique, as I have seen a dusky-faced meadow katydid do the same thing, but it speaks of adaptation to life over deeper water. This poses limits, however, especially considering that they apparently cannot live in heavier-stemmed emergents such as the yellow pond lily or the lotus, which have come to dominate waters once known to host this meadow katydid.

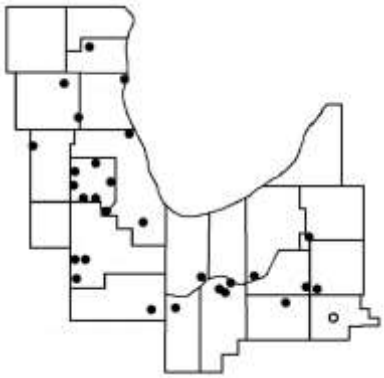
Season. Blatchley and Bland give their season as August to mid-October. My limited observations have ranged August 10 to September 24.

Similar Species. The head is colored like that of the black-legged meadow katydid, the hind femora green like those of dusky-faced meadow katydids, but with brown tibias, and it is the same size as those species, but the most distinctive feature is the yellow end of the abdomen, reminiscent of the much smaller short-winged meadow katydid. The pointed cerci are distinctively shaped, yellow with brown tips.

Song. The song reminds me of the woodland meadow katydid's pattern, rapidly repeated brief striped-ground-cricket-like buzzes, except that the ticks between the buzzes are none to few and the buzz slows at the end. The peak frequency is high at 18 kHz, but there is plenty of energy down to 9 kHz. The buzzes have a slightly rattling quality and are produced at a rate of about 2 per second. Nimble meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/248a.htm) and in my blog (https://natureinquiries.wordpress.com/2015/10/02/nimble-meadow-katydid/).

Common Meadow Katydid (*Orchelimum vulgare*)





The name is misleading, as these are not nearly as abundant as the gladiator and black-legged meadow katydids (though Blatchley described them as the most common katydid in Indiana in 1920). Nearly every spot I have found them has been drier and more distant from water than the typical gladiator or black-leg site. They can occur in recently disturbed sites as well as established prairies, and seem to be most abundant over sand soils. Some places with relatively large populations are the Bong Recreation area in Kenosha County, Braidwood Dunes in Will County, and Gensburg Prairie in Cook County. So far I have failed to find them in the northeastern portion of the study region. Females lay eggs in plant stems, and may prefer dry plant stems (Feaver 1977).

Season. So far I have heard them as early as July 20 and as late as September 27. They sing at least from mid-morning until late dusk.

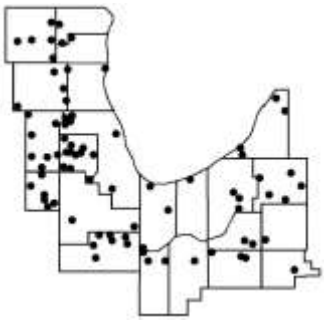
Similar Species. As this is a large meadow katydid and generally green in color, it is similar to the gladiator and long-spurred meadow katydids. Cerci shape, in particular the short teeth, as well as song differences, easily distinguish it from the long-spurred, if there is uncertainty about the habitat. Song and season should be enough to separate common and gladiator meadow katydids, but there are slight differences in the contours of the cerci (see https://sina.orthsoc.org/g248a.htm) and of the pronotum boundaries (see photos below).

Song. The song is distinct from that of the gladiator: the buzz often is shorter (up to 5 seconds), faster, and less rattling in quality (though not always), but more characteristic are the ticks. In fact the main need for distinction is between the common and black-legged meadow katydids, because these are active in the same part of the season. The common meadow katydid's ticks extend over a longer time span than those of the black-leg, generally there are more ticks than in either the gladiator or the black-leg, but the most distinctive feature of their song is the irregular spacing of ticks. Usually there is a noticeable pause just before the buzz, but those at the Kankakee Sands site in Indiana produced an ending flurry of rapid ticks that blended with the buzz. Their song varies considerably with temperature, the buzz slowing to a rattle at lower temperatures. The irregular tick pattern is retained, though slowed. There is plenty of energy down to 10 kHz, below the peak frequency of 15 kHz. Common meadow katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/258a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/common-meadow-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/common-meadow-katydid).

Photos: above, male common meadow katydid. Right, comparison of pronotum contours: common meadow katydid, left; gladiator meadow katydid, right. In particular note the relatively deep cut in the posterior edge adjacent to the wing base on the common meadow katydid.

Sword-bearing Conehead (*Neoconocephalus ensiger*)

45-64mm



Meadows and roadsides are home to this, our most common conehead. Numbers appeared to be quite low in the drought year of 2012, but quickly bounced back the following year. This is the conehead with the greatest dispersal ability among our species. Its southern range boundary has been mapped only to central Indiana and Illinois, and so it is one to watch for thinning in the southern part of the region as climate change continues. Iowa males aggregate in groups with individuals spacing themselves within the groups, and individuals change singing perches from night to night by an average of 6.2m (Shaw, Bitzer and North 1982). Females have been seen ovipositing on bluestem grasses, between the stem and the basal leaves. The young hatch in May in central Indiana (Blatchley 1920).

Season. Observed first song dates have ranged July 11-August 15. Last observed dates have ranged August 20-October 22.

Similar Species. The coneheads are distinguished from all other katydids by the protruding, cone-shaped extension of the top of the head past the eyes. The cone head may facilitate a nose-dive escape tactic, the insect holding still after dropping so as to blend with the grass stems (Faure and Hoy 2000). The cone of this one is longer than that of the round-tipped conehead, with edges that are rounded out rather than pinched in as in the Nebraska conehead. The amount of black on the underside of the cone is intermediate between those other two species.

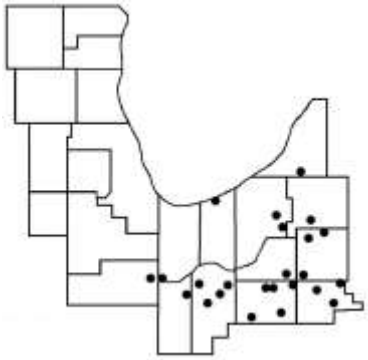
Song. The song consists of continuous rapid (4-6/second) ticks or short buzzes, at first starting at dusk and continuing into the night, but later in the season sometimes can be heard in afternoons (earliest noted 4:30 p.m.). The overall impression variously has been described as a distant steam locomotive and as a sewing machine. Though the peak frequency is at 12-13 kHz, there is plenty of energy down to 9 or 10 kHz, at least on warm evenings. Sword-bearing conehead song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/194a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/sword-bearing-conehead), my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/sword-bearing-conehead).

Photos: above, male. Below right, female, (note the long straight ovipositor, its tip extending past the end of the wings, which gives the species its common name). Above right, face showing cone markings. All coneheads can be green or brown.

Slightly Musical Conehead (*Neoconocephalus exiliscanorus*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

49-74mm



References placed this species only as far north as central Indiana, so it was surprising when, cruising the roads of the Indiana Dunes National Park at night in 2012, Gideon Ney and Nathan Harness of the University of Missouri recognized its songs and found one for me to photograph. Subsequently I found them in all of the region's Indiana counties, with good densities in Fulton County around Lake Manitou, and along rural roads in Marshall County. This is a wetland katydid in which the males sing from shrubs or tall, coarse herbaceous plants. They also can be heard in surprisingly sparse roadside ditches in some areas, including my first Illinois find in eastern Kankakee County. In 2019 I found them in a roadside marsh in southern Berrien County. The slightly musical conehead was thought by its namer, Davis, to have a faint song, hence the name, but two decades later he described the volume as variable (temperature can be an important factor here). He observed them devouring seed heads of *Spartina* grass. A female has been seen ovipositing in a grass blade at dusk.

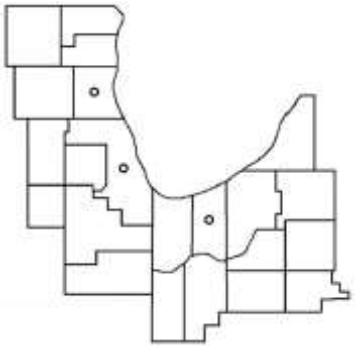
Season. Observations to date have ranged August 8-September 26. More observations are needed to determine their season. Like nearly all other coneheads, they are nocturnal singers.

Similar Species. The coneheads are distinguished from all other katydids by the protruding, cone-shaped extension of the top of the head past the eyes. This species has by far the largest cone of any of our species, and it is entirely black beneath. The wetland habitat also rules out some others. As the photos show, both brown and green variants may occur. The enormous size range, typical of coneheads, results from females being much larger than males.

Song. The song is a continuous series of quick buzzes, around 3 per second. Perhaps the most remarkable aspect of this is that the males sing in unison, and are compelled to join the chorus. If one is disturbed, he quickly rejoins the production. The pitch is a little lower than the sword-bearing conehead's, peaking at 11-12 kHz, but the individual buzzes are slower, sharper and more distinct than in that species. They are rougher, much briefer and more closely spaced than those of the Nebraska conehead. Slightly musical conehead song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/197a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/slightly-musical-conehead), and my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/).

Slender Conehead (*Neoconocephalus lyristes*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



Hebard thought the slender conehead was at its northwest range extreme in the dunes area along Lake Michigan, "in swamps and on sand ridges." Subsequently some were found in Carroll County in northwest Illinois. Chicago region records are limited to Cook and Lake Counties in Illinois, and Porter County in Indiana. All but two northwest Indiana and northeast Illinois records of slender coneheads are dated 1935 or older (the photos are of a 1906 specimen from the Illinois Beach State Park area). Sometimes it was found in association with stripe-faced meadow katydids. Gideon Ney, who has found this species in other parts of its range, suspects that sedges in fens may be the best bet. So far, much searching has failed to turn up this species in the region in the present study, and it may well be extinct here.

Season. August to September. Bland gives Michigan dates (east of Berrien County) of August 14 to September 15. Hebard's Illinois records likewise are in that range. Thomas says it begins to sing in full sunlight late in the afternoon, but that there are reports of morning singing as well. This is unusual, as all our other coneheads except *retusus* are strictly nocturnal singers.

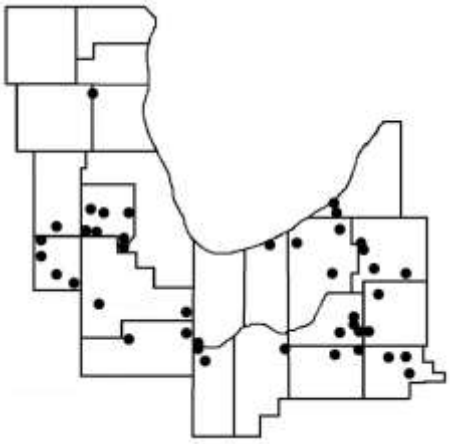
Similar Species. The slender conehead is described by Alexander, Pace and Otte as a sibling species of the Nebraska conehead, different in its song and in being limited to marshes. The entire underside of the cone is black, but the cone length is not as extreme as in the slightly musical conehead. Also, the songs of those two species are much different. There is a distinctive right-angle bend in the posterior edge of the pronotum's side (photo, lower left), and the stridulatory area has distinctive features depicted in Thomas (1933).

Song. Its song is described in the Singing Insects of North America website (https://sina.orthsoc.org/204a.htm) as "A high-pitched, smooth, continuous buzz produced in afternoon as well as evening." Thomas (1933) adds the adjectives "loud, thin."

Nebraska Conehead (*Neoconocephalus nebrascensis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

44-56mm



August 15, 2013, I found an unusual concentration of Nebraska coneheads singing at 3:45 in the afternoon, and singing in unison, at Houghton Lake in Marshall County.

Similar Species. None of our other non-wetland coneheads show this much black on the underside of the cone. Also, the side edges of the cone curve inward slightly. As in the other *Neoconocephalus* species, the overall color can be green or brown.

Song. Very loud, shrill, 1.5-second-long buzzes with 1-second pauses between, forming a distinctive continuous rhythm. The buzzes approach tones in their quality, but can hardly be called pleasing or musical, and are readily audible to most people at 9-10 kHz. Nebraska conehead song recordings and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/196a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/nebraska-conehead), my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/nebraska-conehead).

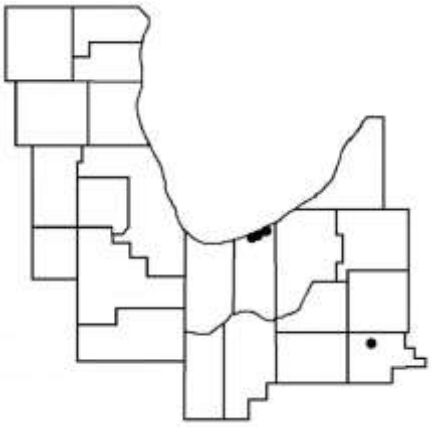
The Nebraska conehead's habitat is a vegetative mix, tall herbaceous and shrub understories of open woods, or scattered shrub areas in prairies or meadows not far from woods. It became clear in 2013, when I first spent time in every county in the region, that the Nebraska conehead decreases in abundance from south to north. They are very common in Fulton and Marshall Counties, I know of only one location in DuPage County where they exceed widely scattered individuals, and it took years for me to find a few in McHenry and Lake Counties, Illinois, at Chain O'Lakes State Park. That is the only site for them north of central DuPage.

Season. The range of first song dates I have observed in the region is July 14-August 14. I have heard them as late as September 28. Nebraska coneheads often begin to sing right around sunset, when there is plenty of light, and continue into the night. On

Photos: above, a green male in singing posture. Right, a brown male.

Marsh Conehead (*Neoconocephalus palustris*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



Gideon Ney, Nathan Harness and I found abundant marsh coneheads at the Indiana Dunes National Park, and I later found them in the adjacent State Park. In 2019 I added the Ruth Kern Nature Preserve in Fulton County. They live in tall, dense, herbaceous vegetation in wetlands. This species previously was documented only as far north as Tippecanoe County in central Indiana, and far southern Illinois, though it had been found farther north in Ohio (Erie County). The species was first described from Vigo County, Indiana.

Season. My observations have ranged August 8 to September 8. Like most coneheads, these are nocturnal singers.

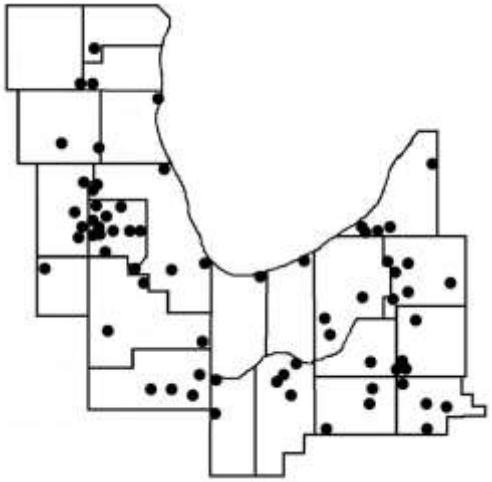
Similar Species. So far, this is the only wetland conehead species I have found in the region with moderate-length, pinched, unmarked cones. The false robust conehead (see hypothetical species section) has a length of 49-68mm, and its ovipositor is more than 1.2 times the length of the hind femur. The marsh conehead female's length is 40-62 (smaller), and the ovipositor shorter than the hind femur. Male marsh coneheads are 37-46 mm long, smaller than the female as is generally the case among the coneheads.

Song. The song is a fairly typical continuous conehead buzz, peak frequency 10 kHz, loud but not nearly so loud as the robust conehead. A definite crackle is audible in the song. It lacks the distinctive pulse pattern of the false robust conehead. Marsh conehead song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/186a.htm) and my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/).

Photos: above, a green female. Above right, lateral view of ovipositor. Below left, female photographed at mid-day with frontal view of face and cone. Below right, a brown male, photographed at night. Note the darkened appearance of the cone.

Round-tipped Conehead (*Neoconocephalus retusus*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



The round-tipped conehead can be found in roadsides and meadows, ranging from grassy areas to mixes of grasses, forbs and shrubs. Historical records indicate that this species has advanced half a state northward since the first half of the 20th Century. It is reasonably widespread and common as far north as DuPage County, but rapidly thins out and becomes more locally distributed north of there. Oviposition is little known in coneheads. A round-tipped female was observed biting off the top of a grass stem and inserting her ovipositor into the revealed hollow end, according to the Singing Insects of North America website.

Our North American coneheads are relatively very new species, having evolved from neotropical ancestors that shifted north and diversified during the last 12,000 years, following in the wake of the last retreating continental glacier (Frederick-Hudson 2015).

Season. First noted song dates have ranged August 4-30. Last song dates have ranged September 23-November 3. Males sing afternoons into the night (this is our only routinely day-singing conehead), extending into the morning later in the season.

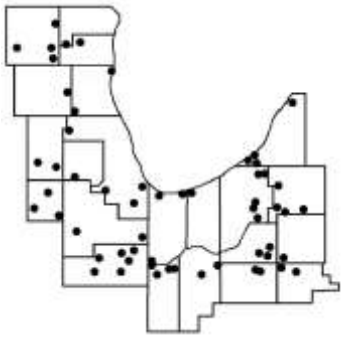
Similar Species. The cone is relatively short and round, compared to our other local conehead species. The robust conehead has a similarly proportioned cone, but lacks the black band near the tip, though there may be a smaller, diffusely darkened area in some individuals.

Song. Long, loud buzzes, much longer than those of the Nebraska conehead though not as loud as those of the robust conehead. Sometimes there is a crackling quality that reminds some of an electrical short. Most people can hear the songs, which peak around 14 kHz but extend below 10 kHz. Round-tipped conehead song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/193a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/round-tipped-conehead), my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/round-tipped-conehead).

Robust Conehead (*Neoconocephalus robustus*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

To 75 mm



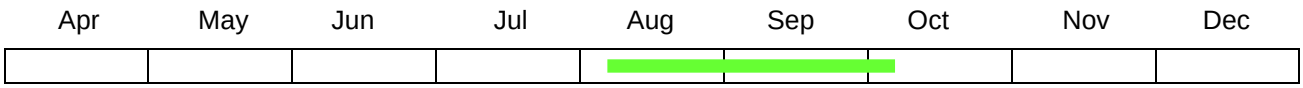
Song. The song is a very loud, continuous fast buzz, at 7-8 kHz readily audible at a distance from a moving car. At close range it is unpleasantly much louder than the song of any other conehead. Robust conehead songs show evenly spaced strong pulses, while false robust coneheads have pairs of pulses, one stronger in each pair, the spaces dividing the members of the pair being shorter than the spaces between pairs. Robust conehead song recordings and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/195a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/robust-conehead), and my blog (https://natureinquiries.wordpress.com/2014/02/10/sound-ideas-coneheads/).

Hebard connected robust coneheads with sand areas, and while they are more abundant in such areas than elsewhere, I have found pockets of them or scattered individuals in clay soil areas (e.g., DuPage and Kane Counties). McCafferty and Stein associated them with "secondary field growth." I have found them in open woodlands, woods edges, weedy roadsides, prairies, and cornfields. Thus far, all sound recordings I have made in the region in an attempt to find false robust coneheads (*N. bivocatus*) either have been unambiguously this species or show an intermediate pattern. Gideon Ney has found such intermediates elsewhere in the *bivocatus* range, and is attempting to sort out the problem.

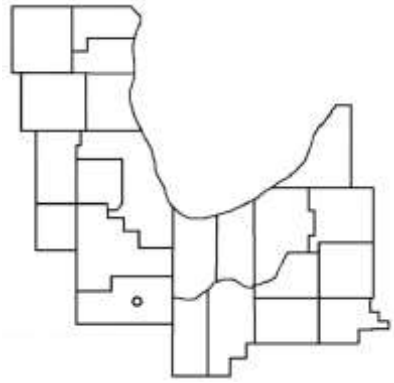
Season. Observed song dates in the region have ranged July 19-September 28. These are nighttime singers.

Similar Species. The robust conehead has a cone similarly proportioned to that of the round-tipped conehead, but it lacks the black band near the tip, though reportedly there may be a smaller, diffusely darkened area in some individuals. Walker, Whitesell and Alexander (1974), in distinguishing the robust conehead from its sibling species the false robust conehead, described it as preferring taller, more rank vegetation, and flying when disturbed rather than dropping into the vegetation. The *bivocatus* song is not as loud, and has distinctive qualities in its pulses (see below) that give it more of a rattling sound. All our coneheads have both green and brown forms.

Common Virtuoso Katydid (*Amblycorypha longinicta*)



29-37 mm



There is a single 1935 record of this species in the Chicago region, at Hopkins Park in Kankakee County (very close to the Kankakee Sands Nature Conservancy preserve). Otherwise in Illinois and Indiana it is known only from the southern halves of those states. It occurs in low herbaceous vegetation in open areas, according to some references. Blatchley limits it to sedges, willows, and other herbaceous and woody plants in or near bottomland woods. In older references it is called Uhler's katydid, *A. uhleri*, but that species has been split so that the *uhleri* designation now refers to a Texas species.

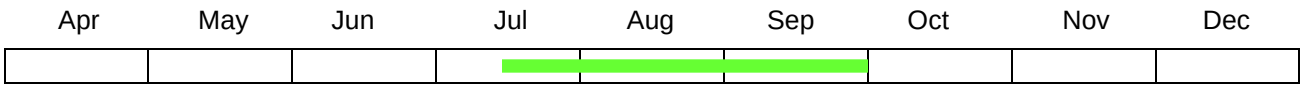
Season. At this northern extremity of its range, this species is not expected before August, continuing through September. The Kankakee specimen, a female, was dated October 1.

Similar Species. The common virtuoso katydid shares the rounded head of its genus, and has wing proportions similar to those of the oblong-winged katydid. In contrast with the other members of its genus in the region, the tibias and feet are brown, and there are a few brown spots on the wings. The size range is 29-37mm, smaller than the oblong-winged and about the same as the rattler round-winged katydid. The female's ovipositor is somewhat expanded toward the tip.

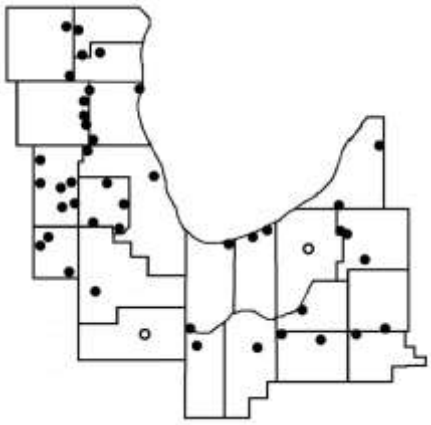
Photos of museum specimens: male above, female right.

Song. Its song is a very high-pitched (15 kHz), complex sequence of clicks, rattles and buzzes. Song recordings can be found at the Singing Insects of North America website, https://sina.orthsoc.org/004a.htm,
and at the Songs of Insects website,
http://songsofinsects.com/katydids/common-virtuoso-katydid

Oblong-winged Katydid (*Amblycorypha oblongifolia*)



40-50mm



The oblong-winged katydid lives in the forest understory, and shrubs and tall herbaceous plants in moist places. When they occur in open areas of tall herbaceous plants, there usually are woody plants nearby. Locally distributed and usually few, in some places in some years they can be heard singing in large numbers. I heard none in 2010 and 2019. This amount of variability implies that they can delay emerging from eggs for a year or more. According to Blatchley (1920), eggs are laid in the ground in moist soil, and take 2-3 years to hatch. There also may be holes within the species' general range. Much of the area of Marshall and Starke Counties seems to lack this katydid, though the habitat appears suitable. I observed a female making single clicks in response to the songs of males around her, at Indiana Dunes National Park.

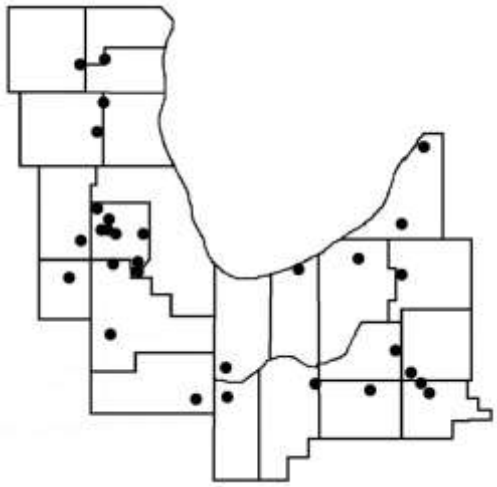
Season. The overall range of song dates over the years has been July 13-October 1. Early in the season they wait until after dark to sing, but later occasionally sing at mid-day.

Similar Species. The false katydids are larger than the meadow katydids, with less membranous, larger and more solid-colored wings. They lack the coneheads' cones, and are less heavy-bodied than the common true katydid. Round heads are a prominent feature. This species and the rattler round-winged katydid have a rounder, less stretched out overall shape than do the bush katydids. They are smaller and lack the angularity of the greater angle-wing. The oblong-wing is most similar to the other common member of its genus, the rattler round-wing. They are larger, their wings are proportionately longer, and there are other technical features outlined at the Singing Insects of North America website at https://sina.orthsoc.org/g001k.htm

Song. The oblong-winged katydid's song sounds like "katydid," with the first syllable relatively drawn out as though drawled ("deeyig-a-dig" is another possible rendering). Sometimes it sounds two-syllabled, "scratch-it" (Himmelman 2009) or "zeee-dik!" (Elliott and Hershberger 2007). The songs are several seconds apart, and are readily audible to most people at 9 kHz. Oblong-winged katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/007a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/oblong-winged-katydid), my blog (https://natureinquiries.wordpress.com/2015/03/10/sound-ideas-katydids-that-katydid/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/oblong-winged-katydid).

Photos: above, male. Right, female

Rattler Round-winged Katydid (*Amblycorypha rotundifolia*)



The rattler round-wing is an insect of the undergrowth in open woodlands and forest edges. Song perches typically are closer to the ground than are those of oblong-winged katydids. Its range extends somewhat farther north than the literature indicates, as it occurs well into Wisconsin. Its song is not nearly as loud as that of the oblong-winged katydid, and much of its singing energy is in higher frequencies, so I used the SongFinder pitch-lowering aid to discover most county records noted on the map. It can be spottily distributed, but is common in the woodlands where it occurs.

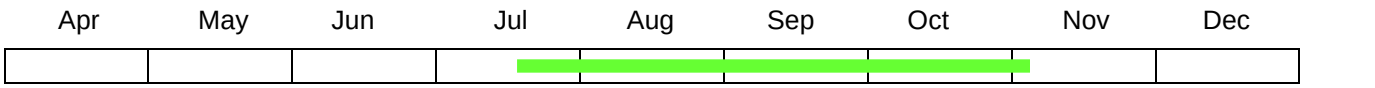
Season. First observed song dates have ranged July 7-August 3. Last observed dates have ranged July 26-October 4. This species sings at night, often beginning close to sunset.

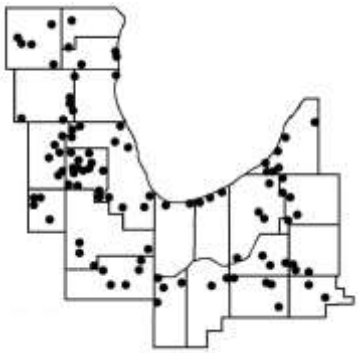
Similar Species. See the account for the oblong-winged katydid (in sum, this one is smaller and rounder of wing; an additional feature is that the pronotum's posterior edge curves gently, rather than sharply as in the oblong-wing). As the photos illustrate, females have a color that is more blue-green than in males.

Song. The rattler round-wing's continuous or long (2 seconds) slow rattling buzzes have distinguishable vibrations, hence the "rattler" name (vaguely reminiscent of a rattlesnake). The song's moderately loud volume at a peak frequency of 12 kHz can be largely buried when common true katydids are abundant in the same area. Sometimes the long rattle is preceded by a few shorter ones. Rattler round-wing song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/008a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/rattler-round-winged-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/rattler-round-winged-katydid).

Photos: above, and above right, female. Below right, male.

Greater Angle-wing Katydid (*Microcentrum rhombifolium*)





Greater angle-wings are common on trees. Find them in forests, shade trees in residential neighborhoods, also in shrubbery and fencerows. Blatchley had no records north of Lafayette, Indiana, but said that it "probably occurs in small numbers in all parts of the state." The eggs are glued in double rows on the sides of slender twigs roughened by biting (sometimes on the edge of a leaf or on another surface). They are grayish brown, oval, flat, 5.5x3mm. Each female lays at least 150-200. The eggs are deposited in September, usually at night, and hatch in May. Hatchlings have bodies 1/8 inch long, but with legs and antennae their overall length is an inch. Almost immediately they seek out leaves to eat (Blatchley 1920).

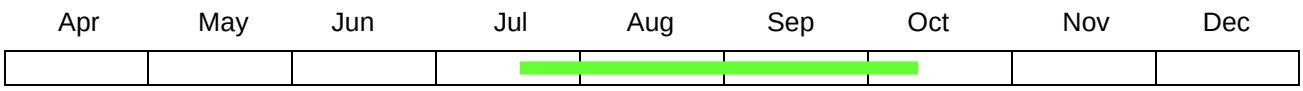
Season. First song dates have ranged July 22-August 17; last song dates have ranged October 2-November 3. Sings at night (noted as late as 3:45 a.m.), also sometimes in daytime especially later in its season (as early as 9:40 a.m.).

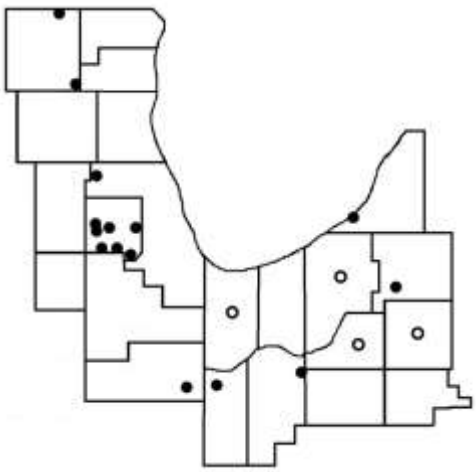
Similar Species. These katydids usually are out of sight in tree canopies, but occasionally one may fly low, landing on the ground or a low tree branch before climbing back to the heights. Its angular, relatively wide overall profile is distinctive. It is larger than either the oblong-winged or rattler round-winged katydid.

Song. The most typical song consists of distinct, fairly rapid separate ticks or clicks at 9 kHz, in clusters, reminiscent of a rapidly ticking watch and lasting a few seconds. An alternate song, often beginning earlier in the season, consists of a loud "zik" or "tsip," similar to the song of the fork-tailed bush katydid but louder, sharper edged, and usually produced from high in the canopy. To make these sounds he opens the wings, then closes them slowly to produce the ticking, but rapidly to make the short song.

Greater angle-wing song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/031a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/greater-anglewing), and Lisa Rainsong's website (https://www.listeningtoinsects.com/greater-angle-wing).

Curve-tailed Bush Katydid (*Scudderia curvicauda*)





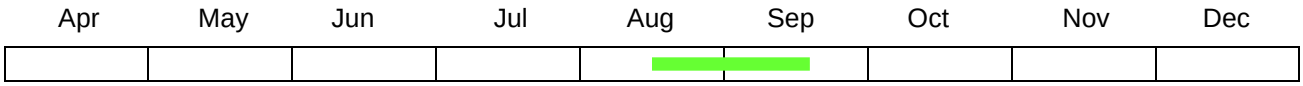
The curve-tailed bush katydid is found in shrubby meadows near woods edges, and open woodland understories. Though it may not occur in every such habitat, it is fairly well distributed. So far it seems to occur in small numbers where it is found. Females have been observed depositing eggs between the upper and lower surfaces of leaves (Riley 1874).

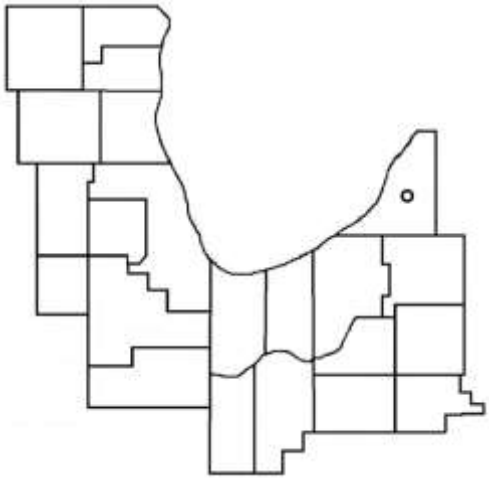
Season. The limited first song dates observed so far have ranged July 23-August 19, and last song dates August 2-October 10. They begin at dusk, and sing into the night.

Similar Species. The bush katydids are very similar in overall appearance. Structurally distinguishing specimens requires close examination of external reproductive structures, drawings of which may be found in the Singing Insects of North America website at
https://sina.orthsoc.org/g060a.htm
The female's ovipositor is green with a brown tip, and does not bend as sharply as the Texas bush katydid's.

Song. The curve-tailed bush katydid's song is a strange loud sound, like sand blocks being rubbed together deliberately 2-4 times ("zik-zik-zik"). Often these take the form of simple counting sequences (e.g., 2-3, 3-4, 2-3-4, 3-3-4). Each group in a sequence may take 1-3 seconds, the groups separated by 4-6 seconds, and sequences separated by more than 10 seconds. The volume increases from beginning to end in each group, and the songs are readily audible at 8-9 kHz. The number of syllables may be an indicator to females of a male's quality. The sound quality is louder, sharper and raspier than the thinner sound of our other counting katydid, the broad-winged bush katydid, there are fewer buzzes in the largest groups, and the buzzes are more spaced within the group. Curve-tailed bush katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/061a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/curve-tailed-bush-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/curve-tailed-bush-katydid).

Treetop Bush Katydid (*Scudderia fasciata*)





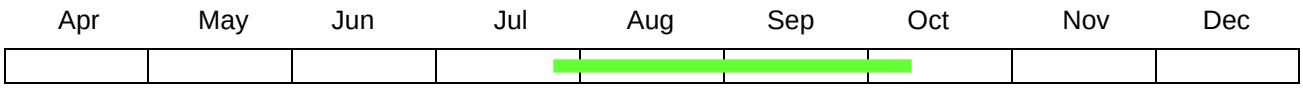
Alexander (1972) reported finding this species after dark in conifers at Warren Dunes State Park, in association with pine tree crickets. He regarded this habitat as a reliable indicator separating treetop and fork-tailed bush katydids. This is the only record to date for the region, and represents a dramatic extension of the otherwise eastern species' range. Though the treetop bush katydid reportedly prefers conifers, particularly hemlocks and pines, it also has been found in deciduous trees and shrubs. Some refer to this species as the hemlock bush katydid, others as the striped bush katydid.

Season. Alexander's date was September 3.

Similar Species. This bush katydid is practically identical to the fork-tailed, differing in having a black stripe along the edge of the forewing. The pigment typically colors the veins as well as the cells between them. There seems to be some ambiguity in this characteristic, however, as some fork-tailed bush katydids show some black tinging of cells between the veins in the same portion of the wing (see example next page). Some who have worked with both species in the East point to a sharply defined white stripe down the face, and magenta bands down the length of the underside of the abdomen, as features of treetop bush katydids which are lacking in fork-taileds. Specimens from our region do not show a difference in face markings. See the account on this species in the BugGuide website: http://bugguide.net/node/view/144925

Song. Its song is indistinguishable from that of the fork-tailed bush katydid, peak frequency 14 kHz. Recordings are available at the Singing Insects of North America website, https://sina.orthsoc.org/067a.htm, and at the Songs of Insects website, http://songsofinsects.com/katydids/treetop-bush-katydid

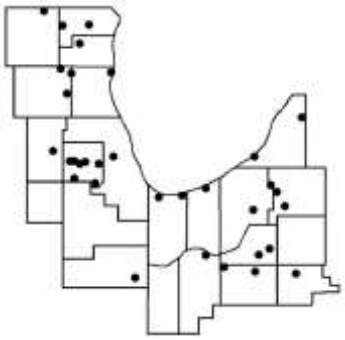
Fork-tailed Bush Katydid (*Scudderia furcata*)



The fork-tailed bush katydid can be found on tall grasses, flowers, trees, and bushes, especially in edges of meadows, marshes, etc. It perhaps mainly occurs in trees, both scattered and in forests. Egg-laying has been observed: a bit of the leaf edge is bitten off to provide admittance to the ovipositor, which creates a cavity between the surfaces before one or more eggs are injected (Blatchley 1920). They feed on plant material, including flowers.

Season. First song dates have ranged July 26-August 31. Last song dates have ranged August 16-October 11. Singing begins at dusk and continues into the night.

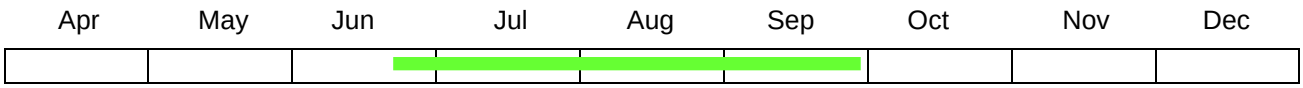
Similar Species. The fork-tailed bush katydid is smaller than most others in its genus. Reproductive structures are needed to distinguish this from other bush katydids, except the nearly identical treetop bush katydid (the forked structure visible in the male photos is the source of the species' common name). The ovipositor is brown rather than the green of similar species, again excepting the treetop bush katydid. The latter is almost identical to this species, but has a black stripe along the top or inner edge of the forewing. This characteristic is not absolute, however, as some individual katydids that for other reasons seem to be fork-taileds have some diffuse black tinging of the cells between the veins along the wing edges. An example is shown in the below left photo, which was taken in McHenry County, far west of the treetop bush katydid's established range. Also, several individuals identified as fork-tailed bush katydids in the authoritative Singing Insects of North America website show this ambiguity. See treetop bush katydid in this guide. As shown in the photo below, early-instar *Scudderia* nymphs are very colorful.

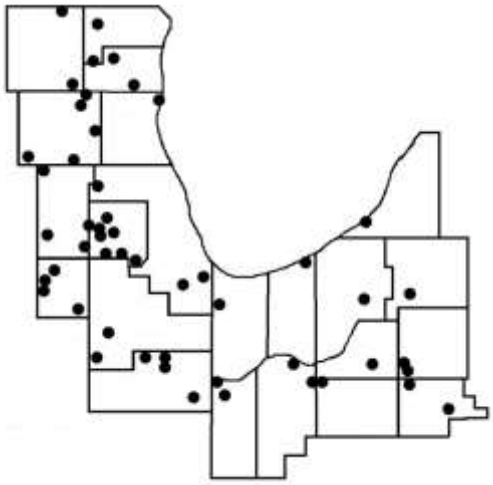


Song. Single "tsk" sounds, widely separated or sometimes at regular intervals of 2-3 seconds. These are similar to the secondary song of the greater angle-wing, but are lispy rather than sharp-edged in quality, are significantly higher pitched (11-15 kHz vs. the greater angle-wing's 9 kHz), and the song perch usually is relatively low. Fork-tailed bush katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/063a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/fork-tailed-bush-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/fork-tailed-bush-katydid), which includes a nice comparison to the greater angle-wing's similar song.

Photos: male top above, female below. Right column, clockwise from upper left: early instar nymph, female's brown ovipositor, male reproductive structures lateral view and dorsal view.

Broad-winged Bush Katydid (*Scudderia pistillata*)





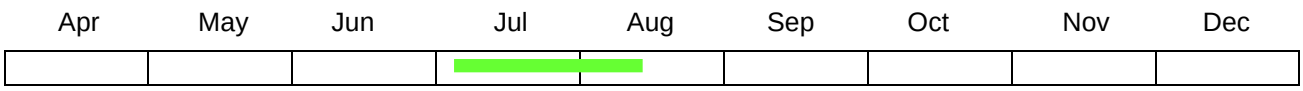
I find broad-winged bush katydids in upland meadows, especially those with shrubs and forbs mixed into grasses. Their density seems to decrease from north to south in the region, though their range extends to the southern edge. They are relatively shy and flighty. I find them difficult to approach, and usually detect them by their songs.

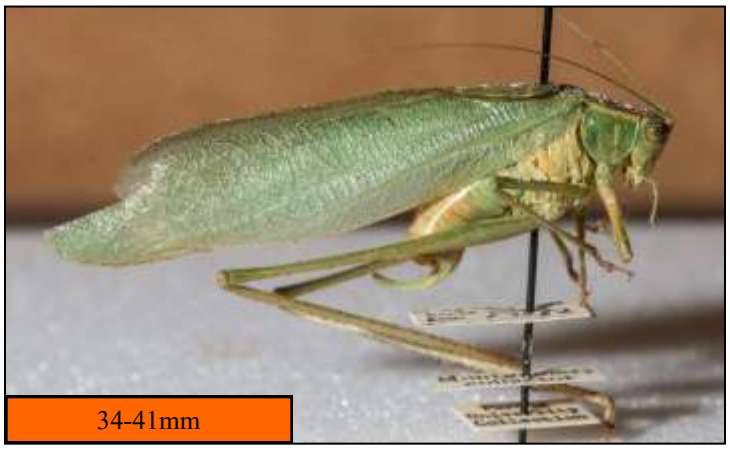
Season. First song date observations have ranged June 23-July 26. Last song dates have ranged August 4-September 28. Occasional counting songs (see below) may be produced during the afternoon, but those mainly occur after sunset. The day song is the main one broad-wingeds produce during daylight.

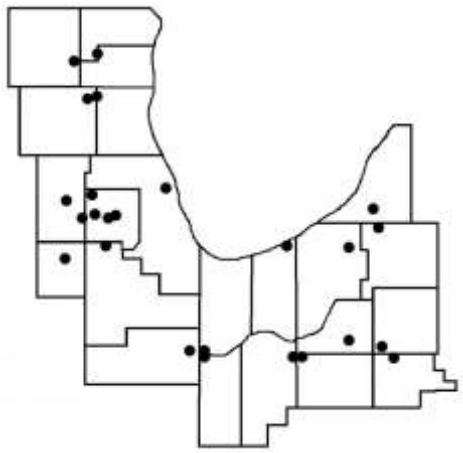
Similar Species. Wing proportion can be used to distinguish the broad-winged bush katydid (forewing length a maximum of around four times the width), but that ratio of length to width needs to be measured; it is not something that can be eyeballed. Hind tibias have a bright magenta color.

Song. The broad-winged bush katydid, like the Texas bush katydid, has several songs. One seldom heard locally consists of single spaced clicks, slower than those of the greater angle-wing. The broad-wing also has fast-pulsed songs in daytime, each like a very quick, buzzing "katydid" and very similar to the corresponding song of the Texas bush katydid. The notes are more blended or blurred, less distinct than those of *texensis*, and with more (4-5) syllables. More distinctive is the nighttime song, which is the broad-winged bush katydid's claim to fame. It has been described as the counting katydid, as it produces series of pulsed buzzes, adding 1-2 buzzes per group as it goes through a sequence of 5 or more such groups. It is distinguished from the counting sequences sometimes produced by curve-tailed bush katydids in the higher-pitched (9-10 kHz) buzzes being less harsh, faster and more run together within their group, the sequences usually containing more than 3 groups, and the number of buzzes in groups increasing to more than 4. Broad-winged bush katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/066a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/broad-winged-bush-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/broad-winged-bush-katydid).

Northern Bush Katydid (*Scudderia septentrionalis*)







I had formed the impression that this species is rare, because I had heard only two individuals back in 2007. Then in 2016 I listened through the SongFinder pitch-lowering device and found them to be common. My ability to hear high pitches had diminished with age. Subsequently I found them in every county in the region. The species is arboreal, and also can be found in the undergrowth of open woodlands. Lisa Rainsong has found that northern bush katydids are attracted to light, and brought a male down to a bench with a pair of bright flashlights.

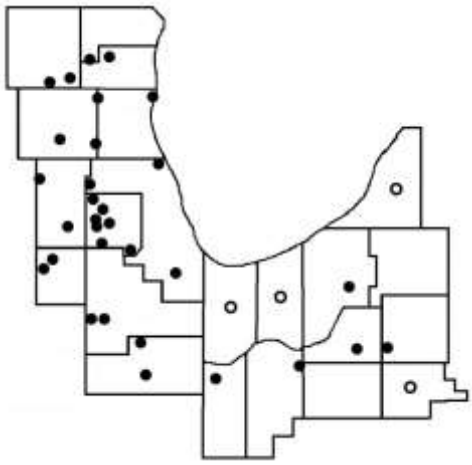
Season. This is the earliest bush katydid to sing. My observations have ranged July 6 to August 13. They may be active later than that date, but by then the overlap between loud cicadas at dusk and loud common true katydids in the early evening drowns out their fainter songs. They begin to sing half an hour after sunset, occasionally with a few warm-up songs in the earlier dusk.

Similar Species. The song is distinctive. This species is smaller than other bush katydids, but distinguishing a specimen from other bush katydids requires study of external reproductive structures (see photo to right of male terminal appendages, and drawings at https://sina.orthsoc.org/g060a.htm).

Song. The northern bush katydid produces a distinctive, complex song in which series of at least six separate, quick ticks alternate with series of 5-9 discrete brief buzzes, a single round of ticks and buzzes extending over 5-10 seconds. The songs are fairly loud, but high pitched at 13-15 kHz. Males also are known to produce low, spaced ticks which I have not observed. Northern bush katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/065a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/northern-bush-katydid), and Lisa Rainsong's website (https://www.listeningtoinsects.com/northern-bush-katydid).

Texas Bush Katydid (*Scudderia texensis*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



The Texas bush katydid is a species of meadows, prairies and old fields, and seems to prefer wetter sites. It often shares such habitats with broad-winged bush katydids, maturing and peaking later in the season than that species. It appears to be much less abundant east of the Illinois-Indiana line. Females lay eggs between the upper and lower surfaces of leaves (Blatchley 1920).

Season. First observed song dates have ranged August 2-28. Last song dates have ranged August 5-October 17. I did not hear this species at all in the drought year 2012, and only a few the following year.

Similar Species. The broad-winged bush katydid is the *Scudderia* species most likely to be found with the Texas bush katydid. Though the broad-winged has proportionately wider wings, in practice the distinction is not always easy to make in the field. The broad-winged has an earlier-season activity period than does the Texas bush katydid, but the two overlap. The easiest way to distinguish them is by their songs, especially their nighttime songs (see description below). The female is similar to the fork-tailed bush katydid, but her ovipositor is green rather than brown, bends sharply, and she is larger. The male's reproductive structures have different shapes than those of other *Scudderia* species.

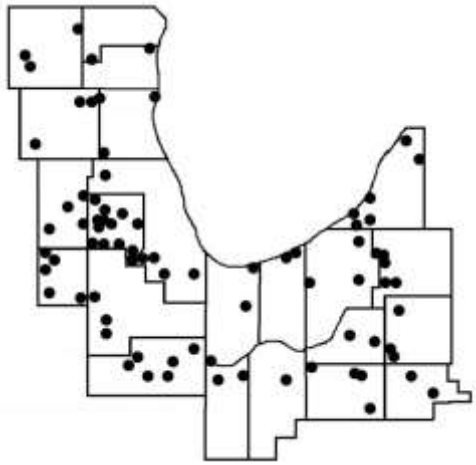
Song. The typical song produced after dark is called by some the slow-pulsed song. It lasts about 4 seconds, with some crescendo, like "dig-a-dig-a-dig…**dig**" (final note emphatic). During the day you are more likely to hear the fast-pulsed song, which is like a super-quick "katydid" ("dig-a-dig"), spaced as much as 3 or more minutes apart. The Texas bush katydid's fast-pulsed song is distinguished from the similar day song of the broad-winged bush katydid in having 3 (occasionally 4) distinct syllables, not run together as those of *pistillata*. An exception that proved the rule was a *texensis* with a damaged wing that had a blurred song with 3 syllables (that individual is featured on the cover of this guide). The peak frequency is 12-14 kHz, but there is good energy extending down to 10 kHz. There is a transitional time at dusk when both the slow-pulsed and fast-pulsed songs are produced. A final song, seldom heard locally in my experience, is a ticking, with faint individual ticks at 1-2 per second. Texas bush katydid

song recordings and photos can be found at the Singing Insects of North America website (https://sina.orthsoc.org/062a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/texas-bush-katydid), my blog (https://natureinquiries.wordpress.com/2015/04/07/sound-ideas-texas-bush-katydid/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/texas-bush-katydid).

Photos: above, male. Above right, close-up of male reproductive structures. Below right, female reproductive structures.

Common True Katydid (*Pterophylla camellifolia*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec



The common true katydid is abundant in our local forest tree canopies, especially in the southern part of the region. Its distribution becomes more spotty in the Wisconsin and northernmost Illinois counties, and it may have advanced its range northward by a few counties in the last half-century. Many katydids can fly, but this one is practically flightless. Sometimes they descend to the lower canopy, and rarely can be found on the ground, but their usual place high up in trees results in their being heard much more than seen. At least some males show strong fidelity to their singing trees, sticking to the same tree through the entire season. True katydids lay eggs in bark crevices or plant tissue, and overwinter in egg form. Blatchley reports that the eggs are dark slate color, flat and pointed at the ends, 6.5x2mm. Common true katydids eat tree leaves.

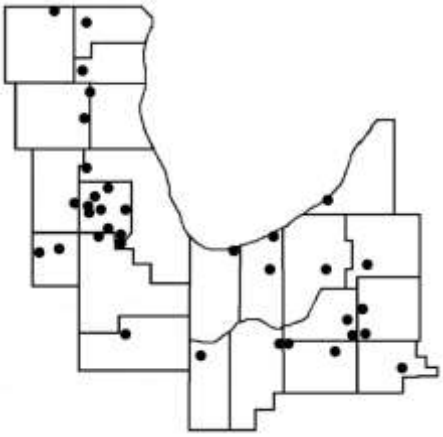
Season. Their singing season usually extends from July to October. Local first observed song dates have ranged July 7-31, and last dates September 23-November 5. Songs begin within the first half hour after sunset, though later in the season occasional songs can be heard during daylight hours. I have noted songs as late as 6:20 a.m., shortly before sunrise.

Similar Species. The heavy looking body, round profile and large size distinguish this species from all our others.

Song. The song is very loud, consisting of rasping pulses (usually two in our area, though members of some local populations produce sets of as many as four notes). Songs are separated from one another by spaces of one to a few seconds, with longer intervals and slower songs in cooler temperatures. One reason the songs seem so loud is their relatively low pitch for a katydid, with peak energy in the 4-5 kHz range. Common true katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/141a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/common-true-katydid), my blog (https://natureinquiries.wordpress.com/2015/03/10/sound-ideas-katydids-that-katydid/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/common-true-katydid).

Protean Shieldback (*Atlanticus testaceus*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		▬	▬					



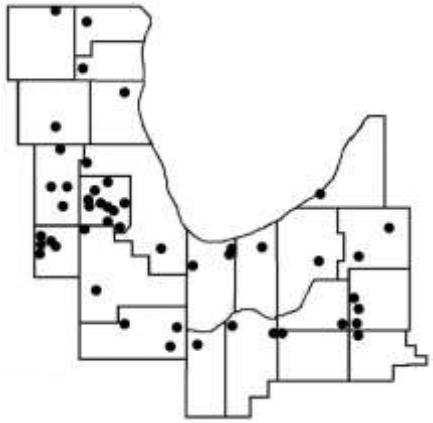
The protean shieldback is common in woods edges, open woods and brushy areas, to grassy fields with dense tall herbaceous plants (but usually near woods). They are predaceous katydids, feeding on smaller invertebrates alive and dead. In 2007 in DuPage County, some were seen consuming dead periodical cicadas.

Season. Protean shieldbacks have an earlier season than most other species because they don't need to wait for plant growth (the eggs hatch in early spring). First song dates have ranged June 5-28, and last song observations have ranged June 18-July 28. Some males sing late afternoon until at least 11:30 at night, but most do not begin until dusk.

Similar Species. The early season, heavy body shape, and brown or gray color are a distinctive combination. They are larger than Roesel's katydids, and lack the yellow crescent on the side of the pronotum. The flightless males (photo, above right) have short wings, females (photos above, and below right) can be wingless. A species hypothetical for the region, which could turn up in the southern counties later in the season, is the least shieldback (*A. monticola*). Its buzzes have a similar quality, but are distrinctly briefer and more rapid. It is nearly as large in body size, but has a different subgenital plate structure.

Song. The protean shieldback's song is a variable 1-15-second or longer, high-pitched rattling buzz, with brief pauses between buzzes. It can be hard for older people to hear, centering around 15 kHz and with little energy below 11 kHz. The sound quality is like a stage whisper, a rapid "thithithith…" The only song that might be confused with it is that of the gladiator meadow katydid, whose buzz has a very similar sound, but usually is shorter, has more distinct beginnings and endings, and is more consistent in length with longer pauses between. Soft ticks, usually added at the end of the buzz in the gladiator's song, are absent from the shieldback's. The shieldback is more likely to be in an upland area with woody plants, while the gladiator prefers grassier habitat in wetter areas. Protean shieldback song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/288a.htm),
the Songs of Insects website (http://songsofinsects.com/katydids/protean-shieldback),
my blog (https://natureinquiries.wordpress.com/2014/03/24/sound-ideas-early-season-katydids/),
and Lisa Rainsong's website (https://www.listeningtoinsects.com/protean-shieldback).

Roesel's Katydid (*Roeseliana roeselii*)



Roesel's katydid song recordings can be found at the Singing Insects of North America website (https://sina.orthsoc.org/301a.htm), the Songs of Insects website (http://songsofinsects.com/katydids/roesels-katydid), my blog (https://natureinquiries.wordpress.com/2014/03/24/sound-ideas-early-season-katydids/), and Lisa Rainsong's website (https://www.listeningtoinsects.com/roesel-s-katydid).

Roesel's katydid is a common species of open, grassy fields. It is native to Europe, and was introduced to the Montreal, Quebec, area between 1945 and 1951. Its range has expanded south and west from there, and can be found throughout our region. They reportedly lay eggs in leaf sheaths, pits of stems, and dry plants, biting a hole in the stem to facilitate this (Kevan et al. 1962). There are 6 developmental instars (Gwynne 2001). They can have short, long or intermediate wing lengths. This probably is connected to the species' rapid spread, wing length reflecting a tradeoff between dispersal and fecundity (Zera and Denno 1997, Zhao and Zera 2002).

Season. Roesel's katydid is one of the predaceous katydids, species which act as predators and as scavengers of dead insects. This diet allows it to mature relatively early in the season. The range of first song dates across the years so far has been May 29-June 29, and last song observations have ranged June 25-August 10. They usually begin singing at mid-morning, but may begin as early as 7:15 a.m. on warm days, and continue to at least 6:30 p.m.

Similar Species. The brown color, and the yellow-bordered black area on the side of the pronotum, separate Roesel's katydid from all other species in the region.

Song. The sound quality of the Roesel's katydid song is like a vocalized "zzzzz…" vibration. It is a fast buzz or drone, fairly loud but with much of the frequency range above the 13-15 kHz peak. In cold individuals the buzz is slowed, has a rattling quality, and sounds different from the usual song of a warm insect.

Roesel's katydid. Above, long-winged male in singing posture. Above right, short-winged male, wings vibrating as he sings. Below right, short-winged female. There has been some speculation that long-winged varieties may be associated with areas where the population is spreading (individuals with short wings cannot fly).

Grasshoppers
Suborder *Caelifera*

Grasshoppers are distinguished from katydids by their shorter, heavier antennae. Most lay their eggs in the soil, and most overwinter in the egg form, though some (including the green-striped grasshopper) overwinter as nymphs.

Our local singing species all are in family Acrididae, which genetic analysis suggests originated in South America in the Paleocene (Song et al. 2018). Grasshoppers are much less consistent than other singing insect groups in the frequency of their displays. I have noted several instances where species that seldom display as a general rule do so frequently when in high local densities. This is true, for example, in the clipped-wing grasshopper, a crepitating species, and the sprinkled grasshopper, a stridulating species. Counterexamples include the Carolina grasshopper, which usually is abundant but seldom displays, and the marsh meadow grasshopper, which often displays at all densities.

I have failed to find several of the species that historically occurred in the region, despite using search methods widely applied by grasshopper specialists. Habitat degradation no doubt is responsible for this in part, but the species I have not found all are in the fringes of their ranges here. These include northern species (northwestern red-winged grasshopper, clear-winged grasshopper, graceful sedge grasshopper, striped sedge grasshopper), southern species (wrinkled grasshopper, coral-winged grasshopper), and western species (Haldeman's grasshopper, white-whiskered grasshopper). Other western species are present but in limited locations (short-winged toothpick grasshopper in one site, Kiowa rangeland grasshopper in three).

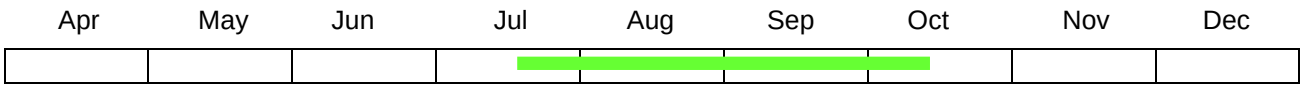
Descriptions of the three subfamilies of our local singing grasshoppers follow. As most genera are represented by only one or two species in the region, I list them only by subfamily.

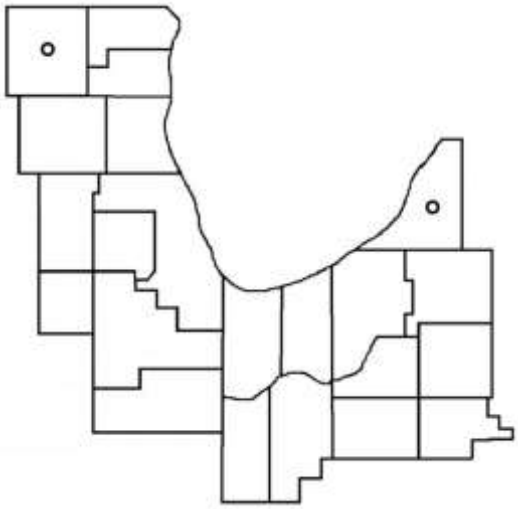
Subfamily Oedipodinae (band-winged grasshoppers: local species include the northwestern red-winged, sulfur-winged, autumn yellow-winged, clear-winged, green-striped, Carolina, clouded, wrinkled, coral-winged, Haldeman's, longhorn band-winged, Boll's, mottled sand, Kiowa rangeland, and seaside grasshoppers). These produce sounds by crepitation, rattling their wings in flight, though according to Alexander, Pace and Otte (1972) they also can stridulate, and a few species in this subfamily only stridulate.

Subfamily Acridinae (silent slant-faced grasshoppers: our local species is the clipped-wing grasshopper). The English subfamily name, taken from Capinera, Scott, and Walker, is misleading, as the males produce loud crepitations in displays that appear identical to those of Oedipodinae. Physically they resemble Gomphocerinae, but lack the structure needed to stridulate.

Subfamily Gomphocerinae (stridulating slant-faced grasshoppers: local species include the white-whiskered, sprinkled, marsh meadow, short-winged green, spotted-wing, pasture, short-winged toothpick, graceful sedge, striped sedge, and handsome grasshoppers). These produce sounds by stridulation, rubbing the legs against the folded wings.

Northwestern Red-winged Grasshopper (*Arphia pseudonietana*)





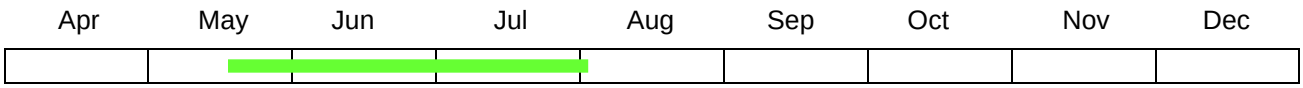
This northern species historically occurred in the northern portion of the Chicago region. Hebard had no Illinois locations, though he speculated that it would appear in the northernmost counties with a local distribution. Blatchley listed no Indiana locations, either. He mentions Berrien County, but Bland has no records for that county. This is a grassland species that feeds on forbs as well as grasses. Relatively open, dry sand or gravel sites are given as habitat.

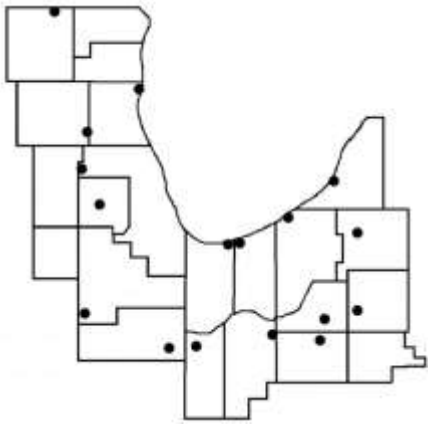
Season. The season given in the literature is July-November (mid-July to early October in Wisconsin, according to Kirk and Bomar, and July 10-October 3 in Michigan, according to Bland).

Similar Species. Its body and forewing color are very dark, often blackish, and can be strongly mottled. The basal part of the hindwings is bright red-orange with a black margin, sometimes yellow or pink (most often yellow in Wisconsin). The leading edges of the forewings can be contrasting pale, and with some variation in ground color care may be needed to distinguish early yellow-winged individuals from late sulfur-winged males. The pronotum profile is flat, with a low median ridge slightly notched by a crossing line, which will help distinguish it from the sulfur-winged and autumn yellow-winged grasshoppers. Sometimes the dorsal pronotum is contrasting pale colored. The pattern of ridges on the top of the head also is distinctive (drawings in Hebard and Bland). The hind tibias are dark brown or black with a yellow ring around the base (the black usually is interrupted by a bluish zone in the sulfur-winged). The size is close to the sulfur-winged grasshopper.

Song. Blatchley shares accounts of both stridulation and crepitation in this species, the latter described as relatively noisy. Bland (p. 106) describes “upward flights to about 1.5m, followed by fluttering and gliding downward to the ground.”

Sulfur-winged Grasshopper (*Arphia sulphurea*)





Blatchley (1920) described the sulfur-winged grasshopper as common throughout Indiana. Hebard (1934) listed Lake, Cook and Will County locations in Illinois with mainly June dates. Its habitat is dry upland pastures and meadows, along roadsides, and on rocky or gravelly wooded slopes. I encounter occasional individuals in places where the soil is dominated by clay, and they probably occur in all the region's counties, but they are abundant and easily found only in sand soil areas in the region. They do not seem to like the loose sand of dunes, however.

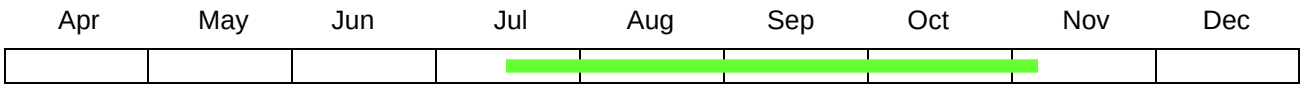
Season. This is an early species, wintering as a nymph and peaking in June, declining in July as the Autumn yellow-winged grasshopper becomes mature. My observations have ranged May 19-August 2.

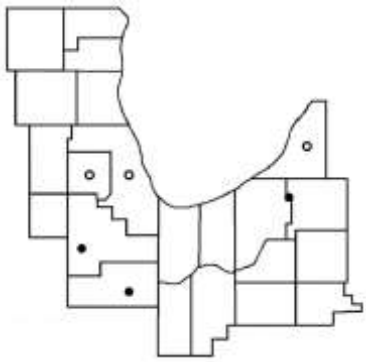
Similar Species. Its basal wing area is always yellow, sometimes tinged slightly orange, and it does not have the elevated, arched pronotal mid-ridge of the larger autumn yellow-winged grasshopper. Its season is earlier than those of other yellow-winged grasshoppers. Females are paler and more uniformly colored than males. Some males have pale edges to the forewings, which in the folded wings look like a blade of dry grass. When flushed, they often run a short distance after landing. See also northwestern red-winged grasshopper.

Song. Their crepitation displays are louder and more rattling, but performed less frequently, than those of the smaller green-striped grasshoppers, which are active in the same season.

Photos. Top, dark male; center, spread hind wing; below, female. Right, male showing pale forewing edges.

Autumn Yellow-Winged Grasshopper (*Arphia xanthoptera*)





I first found this grasshopper in 2014 on September 19-20 in a large mowed lawn area at Bendix Woods County Park, St. Joseph County. All individuals there had orange rather than yellow hind wings, and I thought they were northwestern red-winged grasshoppers. Study of a second population in the Midewin National Tallgrass Prairie in 2016, which has a roughly 50-50 mix of orange-winged and yellow-winged individuals, allowed me to correct the identification.

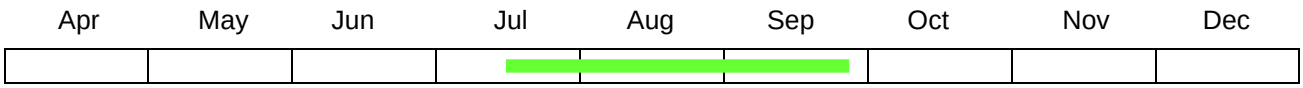
Our entire area is within the northern edge of the range. Hebard has many sites for it, mainly in the southern part of the state but also Chicago. Blatchley describes it as common throughout Indiana. Weedy borders, brushy fields and open woods outline a broad habitat range, but so far I have not found it in habitats that include woody plants.

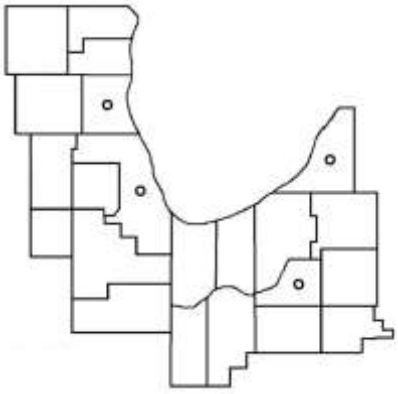
Similar Species. This is the largest of the *Arphia* species, at 31-38mm for males, 36-46 for females. It is distinguished from its congeners by the distinctly elevated arched ridge of the pronotum. The hind wings are yellow, orange or even pink in the base, bounded by a black band. Its body and forewings are largely brown to blackish and fairly uniform in color. The tibias are dark, especially the distal ends.

Season. The season is given as July-November in the literature. My observations have ranged August 9-September 20.

Song. This member of the band-winged grasshopper subfamily has a loud crackling crepitation flight, showing its brightly colored wings in the process.

Clear-winged Grasshopper (*Camnula pellucida*)





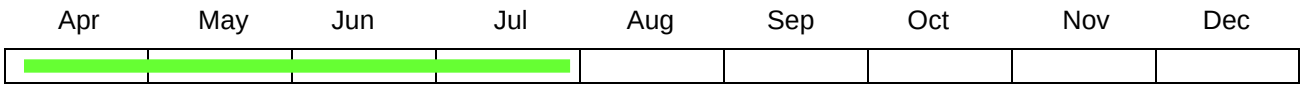
Its habitat is grassy meadows, pastures and roadsides, both wet and dry, though dry habitat is mentioned more often in references. I have observed it at Whitefish Point on Michigan's Upper Peninsula, in the area behind the dunes. The Chicago region is at the southern fringe of the species' range, and historically it was regarded as uncommon here. Hebard gives locations in Lake and Cook Counties, Illinois, and Starke County, Indiana. Blatchley only mentions the last, at Bass Lake, in the second half of August. I have not found this species in the region. Populations are known to fluctuate greatly in numbers from year to year.

Similar Species. The hind wings are entirely unmarked, unlike other members of the subfamily. The folded forewings have large spots, much like those of the handsome grasshopper, but it has a heavier body, and very little slant to the rounded head. The pale amber forewing edges converge to form a long V when viewed from above (not true in the handsome grasshopper). A small black spot behind/below the eye on the head, and another on the side of the pronotum, are variable in length and distinctiveness. The tibias are tan to brown. The sides of the femurs are variable in the presence and distinctiveness of darker barring. Bland describes nymphs as "strikingly colored black and white." A relatively small species: males 20-25mm, females 25-31mm.

Season. Hebard gave a few Illinois dates of July 18-August 16. Bland gives the season in Michigan as July 17-September 25.

Song. The Whitefish Point grasshoppers performed crepitation flights of up to 3m. The sound was relatively loud and strong.

Green-striped Grasshopper (*Chortophaga viridifasciata*)



The green-striped grasshopper occurs in prairies, tall grassy meadows, and grassy open woodlands, and can be found in practically all areas with such habitat.

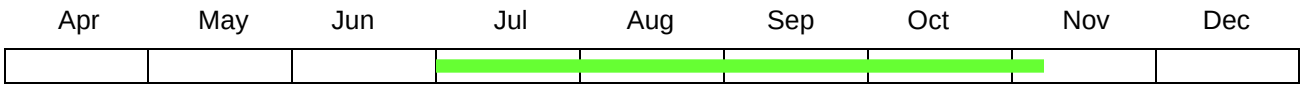
Season. This abundant species overwinters as a nymph, and is the first singing insect of our season. First display dates have ranged April 3-May 26, and latest displays have ranged June 25-July 30 in different years. To the south, as far north as Indianapolis, there are two annual generations with individuals occurring in September. Displays may begin as early in the day as 9:00 a.m. in warm weather, and continue at least until mid-afternoon, occasionally as late as 6 p.m.

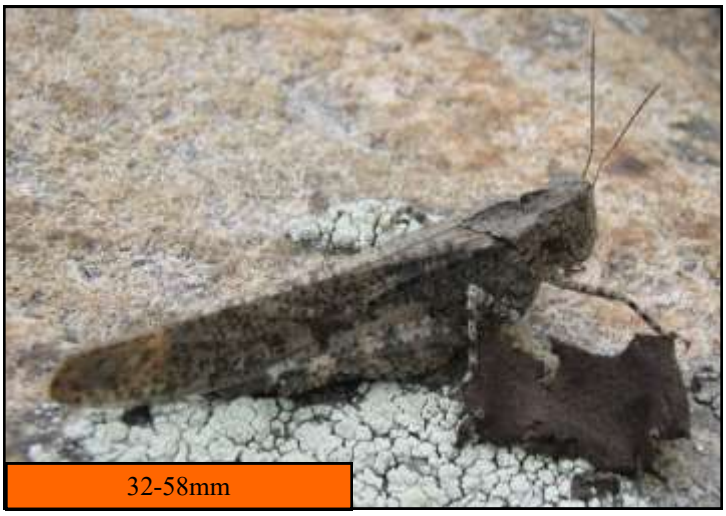
Similar Species. You are most likely to notice first the displaying (flying) brown males. The hind wings do not have bright colors as in other members of its subfamily, being pale yellow in the base. Female green-striped grasshoppers are usually green and a little larger than the males. Sometimes they lay eggs in trails (as the one in the photo apparently is about to do). Grasshoppers have short, stout antennae compared to katydids.

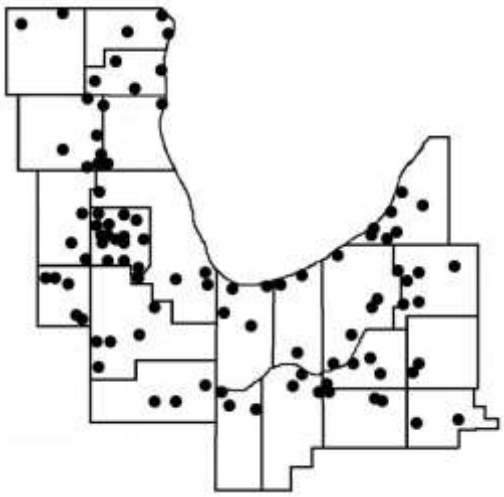
Song. Sound is produced by the wings (crepitation) during display flights, a soft whispery buzz, sometimes with a faint crackling quality, without a sharp start or finish. The frequency range is 3-15 kHz, peaking at 7.9 kHz. Sometimes a male performs a series of these at intervals of 20-30 seconds, but more commonly the interval is greater. These displays, though audible, can be difficult to see, because the sound is made during only the last 1-2 seconds of the flight, and by the time the listener orients to the sound, the camouflaged male has gone still. The flights may be as short as 1-2 feet, low and level, but usually are longer. A recording of the green-striped grasshopper's crepitation is in my blog (https://natureinquiries.wordpress.com/2014/04/21/sound-ideas-greenstriped-grasshopper/).

Photos: top, adult male. Above, adult female. Right, minimally colored hind wing, and a nymph from early October. As nymphs appear in both brown and green colors, the one in the photo probably is male.

Carolina Grasshopper (*Dissosteira carolina*)







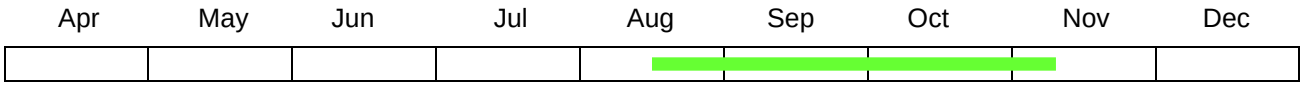
The Carolina grasshopper is common throughout the region in open grasslands, usually ones with some bare soil areas.

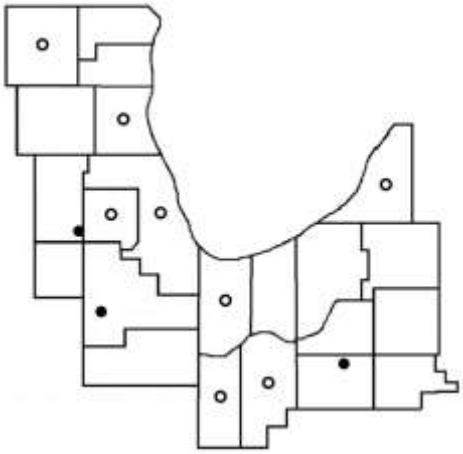
Season. Given the infrequent displays of this species, here I give the season as defined over the years by observations of mature adults (June 30-November 6).

Similar Species. This is the common large brown or gray grasshopper we encounter resting on the ground in summer into autumn. When flushed, its cream-edged black hind wings are distinctive, though a careless glance might confuse the flying grasshopper with a mourning cloak butterfly.

Song. Carolina grasshoppers do not display very frequently. Their display flights are partly visual, showing their cream-edged black wings, but also contain a crepitation element (a rattling sound produced by the wings) at 4 kHz. The displaying male flies up to an altitude of 2-3 feet, usually above a patch of bare soil or thin, very short vegetation, and hovers in place for up to 20 seconds. Carolina grasshopper sound recordings can be found at the Songs of Insects website (http://songsofinsects.com/grasshoppers/bolls-and-carolina-grasshoppers).

Clouded Grasshopper (*Encoptolophus sordidus*)





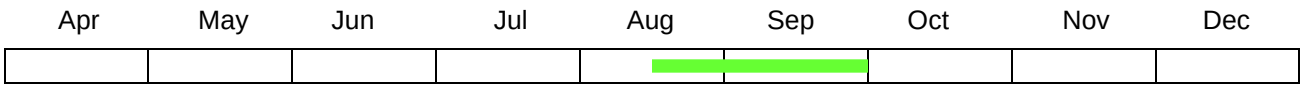
Our entire area is well within the range mapped in references for this species. Hebard describes it as common in northern Illinois, listing locations in Lake, Cook and DuPage County. Blatchley indicates it is common throughout Indiana, and describes its habitat as dry upland meadows, pastures and roadsides. To date I have found this species at three restored prairies where tall grass species dominate and there are some bare soil spots. One had sandy soil, the other two did not. I have heard late-season crepitation displays in a few other locations which may have been by this species. It is grayish brown with solid dark bands across the forewings. The median ridge of the pronotum is pronounced. Viewed from above, the pronotum is marked with a light X. The hind wings are nearly transparent, pale yellow with smoky outer edges. The hind femora have dark cross bands, and the hind tibias are brown. Though the body length is shorter than the green-striped grasshopper, males 16-24mm, females 22-31mm, its stout form makes it appear bigger.

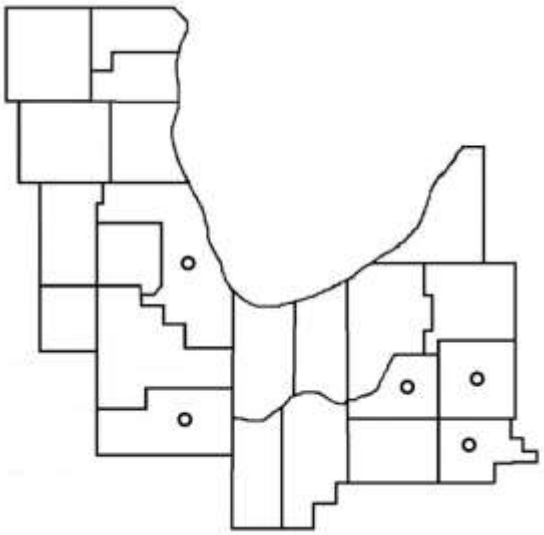
Season. This is a relatively late-season species. I have observed them in the narrow date range of September 17-22. Hebard gives dates from mid-August through November, with most observations in September.

Similar Species. The wrinkled grasshopper, another late-season species that can occur in prairies, also is described as having an X mark on the pronotum. Its pronotum is described in being rougher in texture, it has smaller and more numerous dark spots on the forewings, and the upper edges of those wings often are marked by a pale line.

Song. The sound during display flights is described as similar to a bumblebee's buzz. To my ear it often is softer, practically identical to that of the green-striped grasshopper, and like that species is produced as the male lands.

Wrinkled Grasshopper (*Hippiscus ocelote*)





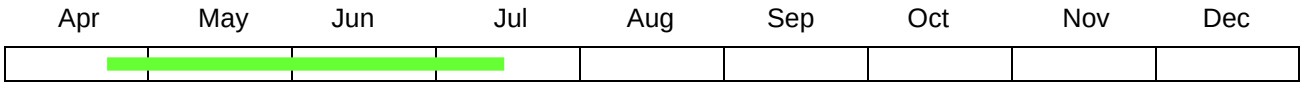
Hebard lists only Chicago as a location in our area, and suggests that this southern grasshopper would not be found north of Illinois. There are specimens from eastern Kankakee County in the Illinois Natural History Survey collection. Blatchley indicates it had been found only in Fulton and Marshall Counties in northern Indiana, though it was more common farther south. There is an undated specimen from Starke County in the Purdue University collection. Blatchley says its habitat is dry upland areas, especially open woodland pastures, meadows and roadsides. He also writes that males are quick to fly, when an approaching person still is some distance away. Older references (Blatchley and Hebard) give the species name as *rugosus*, and Blatchley includes our *Pardalophora* species in *Hippiscus*.

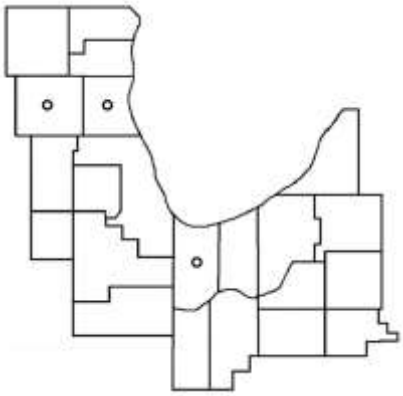
Season. Dates are late July to mid-October in Illinois generally, mainly well south of the Chicago region. Specimens from the Illinois portion of our region in the Illinois Natural History Survey collection are dated August 22 to September 7. There is a single specimen from southwestern Wisconsin dated September 30.

Similar Species. The wrinkled grasshopper keys closest to the larger *Pardalophora haldemani* in Blatchley. Hebard separates it from *Pardalophora*, indicating that the cut in the central pronotal ridge is at the center in *Hippiscus*, closer to the head in *Pardalophora* (Blatchley also indicates this difference). Details of the architecture of head and pronotum may be needed to distinguish this species from *haldemani*. The pronotum is rough and wrinkled, and has a pale dorsal X mark in males. The forewings have large dark spots and light bands, some of the latter producing the dorsal V when wings are closed. The bases of the hind wings vary from pale yellow to deep orange, but usually are pale pink or orange, bounded by a black band thinly pigmented toward the wingtip (Illinois specimens may most often have pale yellow hindwing bases). Males are 28-40mm, females 39-53mm.

Song. I have not found descriptions of sound displays in this species, and so far have no personal experience with it.

Coral-winged Grasshopper (*Pardalophora apiculata*)





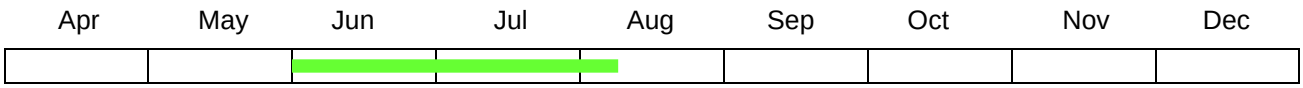
Blatchley and some other early authors have referred to this species as *Hippiscus apiculatus* or *H. tuberculatus*. Our area is at the northern edge of its historic range. Hebard indicated Lake and McHenry Counties in Illinois, and a specimen in the Purdue University collection came from Lake County, Indiana. Blatchley said it probably occurred throughout Indiana, but mainly was a species of the southern part of the state and of sand areas in the northwest. Specimens in the Illinois Natural History Survey collection include two from the area of the present-day Pine Station Nature Preserve in Lake County, Indiana. I have sought it there repeatedly and in several other sites where the species has been found in the past, or which match habitat descriptions, without finding any. The habitat is meadows, upland pastures, roadsides, and especially sandy areas with much bare soil.

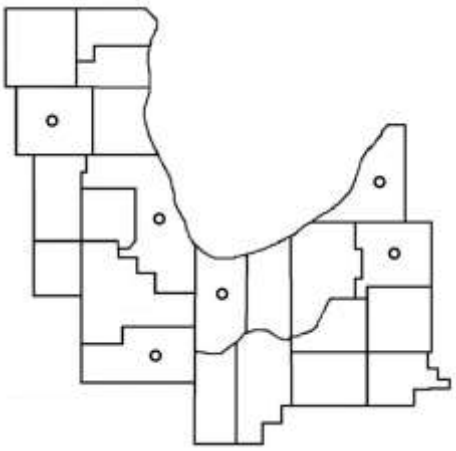
Season. The coral-winged grasshopper winters as a nymph, and so is one of the earliest singing insects to mature. Dates in Indiana (mostly south of the Chicago region) have ranged early April-June. In northeast Illinois, dates have ranged May 5-June 14, with most in May. Bland gives Michigan dates as May 12-July 16. Dates in Wisconsin range late April to early July, according to Kirk and Bomar.

Similar Species. It is one of the largest members of its subfamily in the region, males 36-42mm, females 45-55mm. It is gray and brown with large, dark brown spots on the forewings that sometimes are connected. There is a golden V on the folded forewings as viewed from above. The base of the hind wing is orange or rose colored, bounded by a black line. The tibias are pale brown to yellow. Haldeman's grasshopper is similar, but has a larger number of smaller spots on the forewings. The fastigium (top of the front of the head) narrows more evenly and protrudes more in *apiculata* than in *haldemani*.

Song. Both this species and Haldeman's grasshopper are described by Alexander, Pace and Otte (1972) as early spring grasshoppers that stridulate but do not crepitate. Blatchley, however, describes loud rattling sounds produced by flushed males.

Haldeman's Grasshopper (*Pardalophora haldemani*)





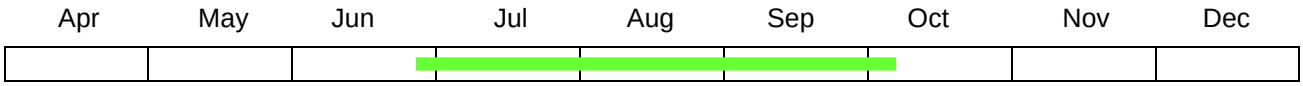
Some early authors name this species *Hippiscus haldemanii*, and there remains some holdover confusion among present day authors as to whether the species name should end with one or two I's. Our area historically was just within the eastern extent of this grasshopper's range. Hebard said it lives in sand areas, and mentions Cook and McHenry, as well as Lake County, Indiana, which is the only location given by Blatchley for that state (specifically at the current Pine Station Nature Preserve, in late June). That Indiana habitat was described as sparsely vegetated sandy areas a quarter mile back from Lake Michigan. There also is a specimen from St. Joseph County in the Purdue University collection. Kirk and Bomar suggest that the coral-winged grasshopper may be replacing this species in Wisconsin and Michigan.

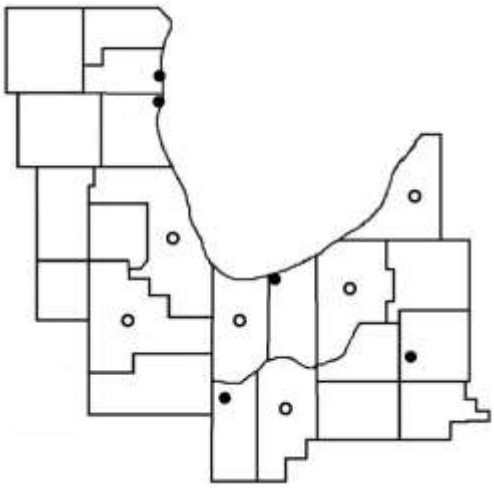
Season. Alexander, Pace and Otte describe this as an early season species (it overwinters as a nymph). Indiana and Illinois observations in the region have ranged June 20-August 4. Bland gives Michigan dates of May 27-August 30, and says that it appears as the coral-winged grasshopper declines, when both occur in the same location.

Similar Species. Haldeman's grasshopper is similar to its congener, the coral-winged grasshopper, and to the wrinkled grasshopper (see the descriptions for those species). Hebard mentions that some Illinois specimens have yellow inner areas of the hind wings, while all the others are various shades of pink. Blatchley reports considerable hind wing color variation (pink, orange-red, and yellow) at the Pine Station location. The inside of the hind femur needs to be checked for blue color, which would be indicative of the orange-winged grasshopper (*P. phoenicoptera*), a more southern species not expected in this region.

Song. Alexander et al. say that, like the coral-winged grasshopper, Haldeman's stridulates but does not crepitate. Bland states that it does neither.

Longhorn Band-winged Grasshopper (*Psinidia fenestralis*)





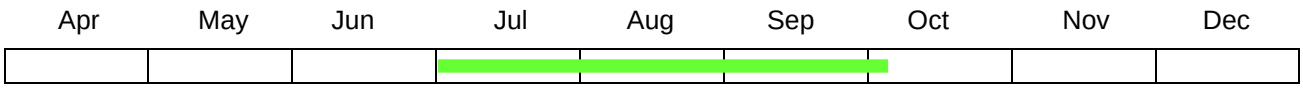
I first found this grasshopper in an open, sandy inland site at Memorial Forest in Marshall County. Later I found it to be the dominant grasshopper behind the foredune at West Beach in the Indiana Dunes National Park, likewise an open grassy area. Subsequently I have found it in similar habitats in several counties. The antennae are flattened in the base, and relatively long for a grasshopper. Usually gray or brown, the overall color pattern can be yellowish or blackish to match the habitat. A narrow yellow strip runs from the back of the eye onto the pronotum. There are alternating light and dark spots on the forewing. The central black band on the hind wing is unusually wide. The basal region is usually orange, sometimes rose or yellow. The hind tibias are bluish, usually with black and yellow bands. It is relatively small (males 20-32mm long, females 26-36mm).

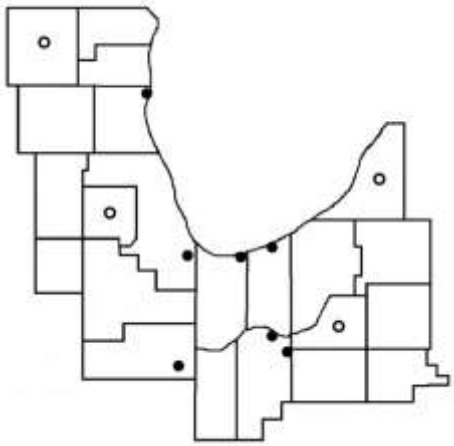
Season. According to references, adults are active June-October. My observations to date range August 2-September 26.

Similar Species. The small size, coupled to a bright red, yellow or pink hind wing base, are sufficient to rule out all but one other species in the region. So far, I have found them only with red wings except for one individual at Illinois Beach State Park which had transparent wing bases. The Kiowa rangeland grasshopper has transparent or yellow wing bases, and like the longhorn band-winged grasshopper is small and has a head that protrudes above the thorax in profile. In the longhorn band-winged grasshopper the antennae are longer than twice the head height (shorter in the Kiowa rangeland grasshopper, but its antennae can be slightly more than 1.5 times the head height). In the longhorn band-winged grasshopper, the basal quarter or so of the antenna is widened and thinly flattened, then rounded for the remainder of the antennal length. In the Kiowa rangeland grasshopper, the dorsal facet of the antenna can be flat, but its width and thickness are uniform throughout, lacking the broad flattened base. Both species can have hind tibias that are largely bluish, but in the longhorn band-winged grasshopper there is a black knee, a yellow band, then a black band before the blue color begins. That last black band is absent in the Kiowa rangeland grasshopper.

Song. This species belongs to the band-winged grasshopper subfamily, whose members generally include crepitation in their displays.

Boll's Grasshopper (*Spharagemon bolli*)





Boll's grasshopper is mainly a sand soil species that may be found in dunes behind the Lake Michigan beaches, as well as oak savannas and dry prairie-woodland boundaries. Places where they are common include the Indiana Dunes area and the savanna at Illinois Beach State Park.

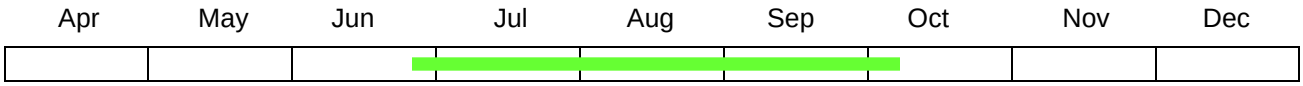
Season. According to references, adults are active June-October in Wisconsin, peaking in July. My observations have ranged July 15-October 5.

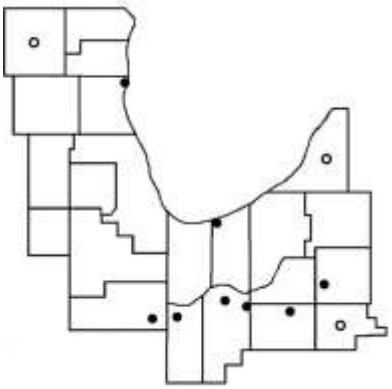
Similar Species. The forewings are crossed by a few dark bands. There is much yellow in the black-bordered hindwings, which show when the grasshopper flies. It is similar in size to the Carolina grasshopper, perhaps a little smaller. The angle of the back dorsal edge of the pronotum is greater than 90 degrees, in contrast with the smaller mottled sand grasshopper. As the photos show, there can be considerable variation in color pattern (the above photo is from Illinois Beach State Park, Lake County, Illinois; the photo to the right is from Miller Woods, Lake County, Indiana).

Song. As in other members of their family, display flights are partly visual, showing their yellow hind wings, but also contain a crepitation element (a rattling sound produced by the wings).

On-line Photographs. Additional photos of Boll's grasshopper may be found at the BugGuide website (http://bugguide.net/node/view/141123/bgimage).

Mottled Sand Grasshopper (*Spharagemon collare*)





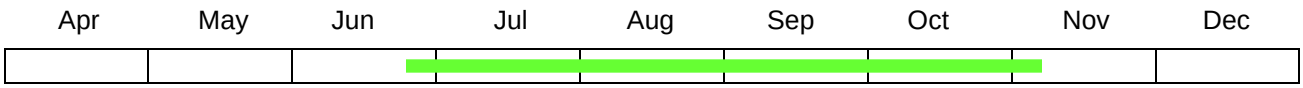
Our entire area is just within the southern boundary of this species' range. It lives in sandy grass areas, including ones with sparse vegetation. Hebard includes the sandy coastal area of Lake County, Illinois, among other locations. Blatchley (1920) indicates that it is common in sandy areas of northern Indiana, and mentions Fulton and Marshall Counties. Repeated searches have failed to turn this one up in LaPorte and St. Joseph Counties, and I am surprised that I have not yet found it in Berrien, where it has been known in the past.

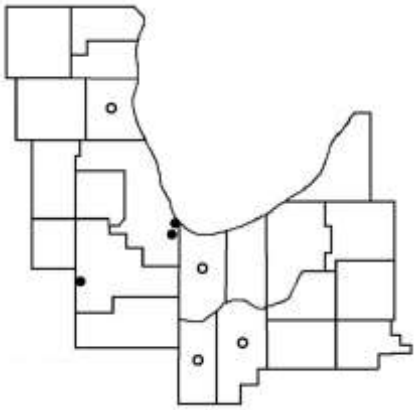
Season. Observations in the region have ranged June 28-October 5.

Similar Species. This little brother of Boll's grasshopper is yellowish brown to dark gray, with numerous dark speckles. There is a prominent median pronotal ridge. Forewing color is variable, sometimes with 3-4 irregular dark bands. The base of the hind wing is pale yellow, bounded by a black central band. The angle at the posterior edge of the pronotum is acute. Males 23-31mm, females 27-37mm.

Song. This grasshopper's crepitation displays are relatively noisy.

Kiowa Rangeland Grasshopper (*Trachyrhachys kiowa*)





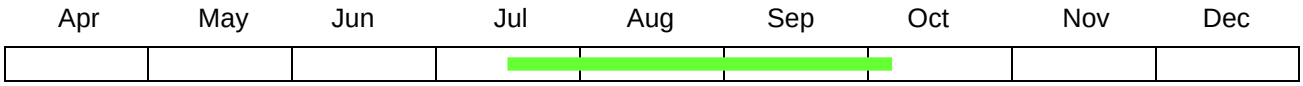
This is mainly a western species, with the range limit at our region's northern edge. I did not find it until 2017, at a sparsely vegetated area in Cook County's Burnham Prairie. In 2018 I found them in a Will County dolomite prairie. In 2020 I added Big Marsh, a Chicago Park, where the grasshoppers live in sparse vegetation on what appears to be old industrial slag. According to the literature, the Kiowa rangeland grasshopper lives in sandy or barren areas, feeding on grasses. It is small for a band-winged grasshopper (males 20-25mm, females 23-30mm), grayish brown or greenish yellow, with large black spots or bands on the forewings. It has an elevated central pronotal ridge with two notches. The large head is elevated above the pronotum. The forewings are long. The variable hind wings have transparent or yellow basal areas bounded by incomplete, mottled or pale black bands. The hind tibia usually are pale blue or blue-gray, usually with a yellow band of variable length at the proximal end.

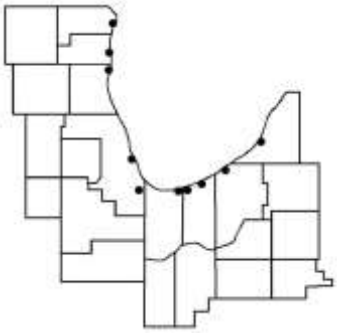
Season. According to references, adults are active June-November. I observed them on August 18 and September 9 and 25.

Similar Species. The longhorn band-winged grasshopper is similar, small with a head elevated above the pronotum. See that species' account for differences in hind wing color, antenna length and structure, and tibia color.

Song. This is a member of the band-winged grasshopper subfamily, whose members generally include crepitation in their displays.

Seaside Grasshopper (*Trimerotropis maritima*)





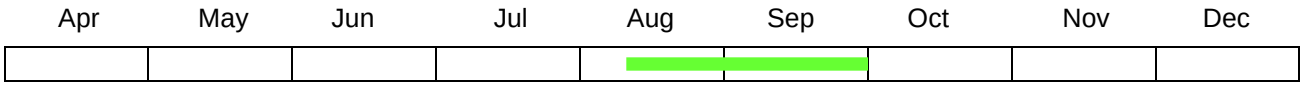
The seaside grasshopper is common on the Lake Michigan beaches, and in the grasses just above the beaches. In Racine and Kenosha Counties they are limited to municipal parks in the two cities for which the counties are named. They also occur in a barren area of cinders at Cook County's Burnham Prairie. They are very alert and difficult to approach. They fly strongly for short distances when flushed, often with wings crackling sharply. When one lands near another, they signal one another by flashing their hind legs in a stridulating-like motion that displays their hind tibia and inner femur colors (photo, lower right).

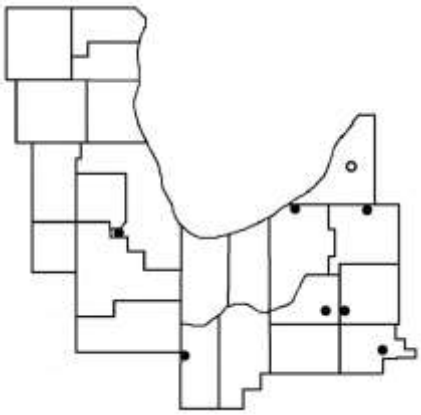
Season. My observations have ranged July 15-October 5. They reportedly may crepitate loudly after dark, as well as during the day.

Similar Species. The size, relatively elongate slender body profile, and habitat should separate this species from other yellow-winged grasshoppers. The tibias are yellow, the insides of the femurs banded yellow and black. General coloration matches the substrate: compare the Indiana dunes beach pattern, above, to that from Illinois Beach State Park, top right.

Song. As in other members of their family, display flights are partly visual, showing their yellow hind wings, but also contain a crepitation element (a rattling sound produced by the wings). Their crepitation can be loud and crackling.

Clipped-wing Grasshopper (*Metaleptea brevicornis*)





Similar Species. The habitat and array of physical features separate this grasshopper from all others in the region. The face is strongly slanted, the ends of the wings extend beyond the abdomen tip and have distinctive ends that appear to have been cut off at an angle. The hind wings are not strongly colored. The antennae are strikingly sword-shaped. Female colors can be dominated by green or brown. Males are much smaller than females, typically brown with green highlights as shown in the photo.

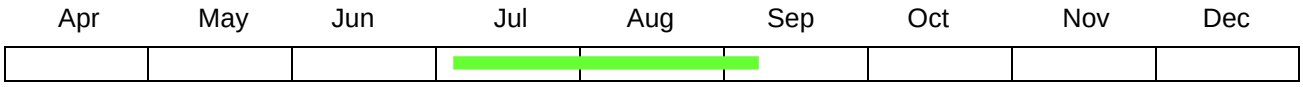
Song. Males crepitate loudly in displays that appear identical to those of subfamily Oedipodinae. I have observed such displays only in three locations with dense populations.

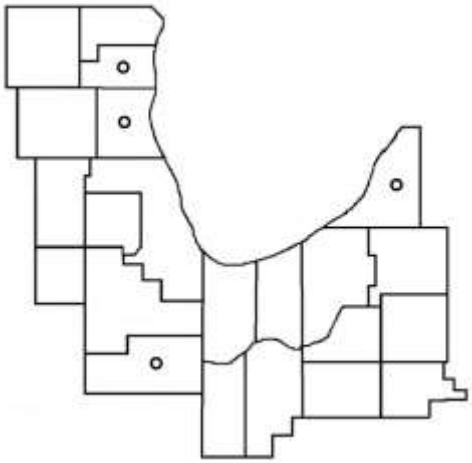
Though regarded as "silent" by some authorities, I have observed loud crepitation displays in three locations, and Alexander, Pace and Otte include it in their list of Michigan singing insects. Hebard had records only for central and southern Illinois. In 2020 I found them to be abundant in the Lemont Quarries-I&M Canal area of southwestern Cook County. Blatchley described its range as "throughout Indiana." It is a strong, agile flier, able to make quick turns and frequently curving to a chosen landing spot. This grasshopper seems to be locally distributed, but it can occur in large numbers where it is found in marshes and the edges of lakes, ponds and ditches. It feeds on grasses and sedges. Early authors refer to its genus as *Truxalis* or *Trynalis*.

Season. August-September, according to references. My observations range August 20-September 28.

Photos: top, adult male. Above, top of head and antennae. Right, female.

White-whiskered Grasshopper (*Ageneotettix deorum*)





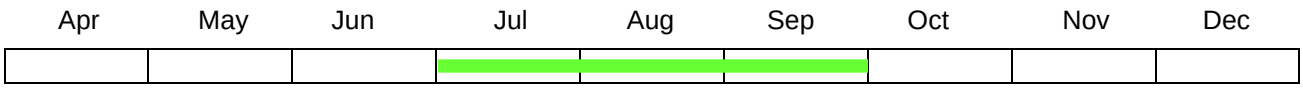
The white-whiskered grasshopper is a western species of mixed-grass and bunchgrass prairies. In tallgrass prairies it is described as a species of ridgetops with blue grama, and grazed pastures. Some refer to this species as the sand grasshopper. Its historic range extends eastward as a peninsula that includes northern Illinois, southern Wisconsin, northernmost Indiana and the lower peninsula of Michigan. It feeds on grasses and sedges, and lives in areas with little vegetation. Blatchley did not know it from our area in Indiana. Hebard described it as common and sand-loving in Illinois, and listed locations in Lake and Kankakee Counties. Kirk and Bomar refer to the 1912 record for Kenosha County as "labeled 'Kenosha dune region' ... a narrow sand dune area … now highly disturbed and existence of the species at the site is unlikely."

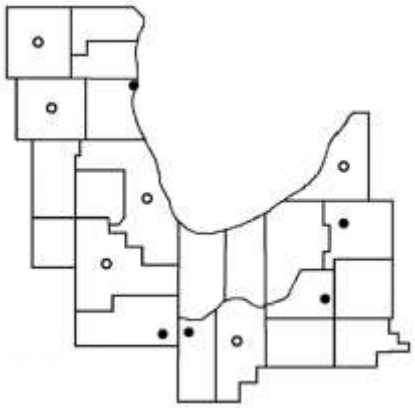
Season. Specimens in the Illinois Natural History Survey collection from Lake and Kankakee Counties range July 7 to August 28. Kirk and Bomar give a range of July-October for Wisconsin sites north of our region. The dates range July 12-September 10 in Michigan, according to Bland.

Similar Species. It is relatively small (males 11-28mm, females 15-28mm), brown on top and yellow below. It is named for its white antennae. A dorsal yellowish area extends back from the head along the upper pronotum, and the pronotum edges bend toward one another near the middle. The forewings are variable, usually about the length of the abdomen, and have central brown speckles. Hind femurs have dark crossbars on the dorsal surface, and the junctions with the tibias are black. The hind tibias are orange or red. It is most similar to the marsh meadow grasshopper, distinguished by the white antennae, the dark markings on the femurs, and a brown or gray rather than green ground color. The black triangles on the dorsal pronotum resemble those of the *Orphulella* species, but characteristics such as habitat, tibia color and other physical features should permit separation.

Song. I have no experience with this species, and have not seen accounts of stridulation.

Sprinkled Grasshopper (*Chloealtis conspersa*)





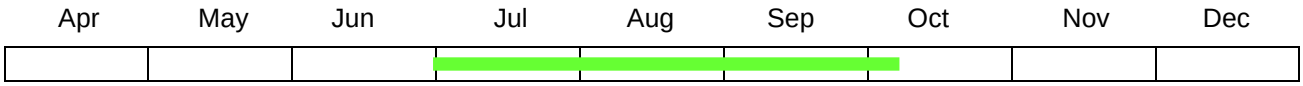
These small grasshoppers live in dry wooded areas and brushy pastures. They are mapped throughout our area in references. My finds to date have been in sand-soil savannas and adjacent grassy areas. They lay their eggs in rotting wood.

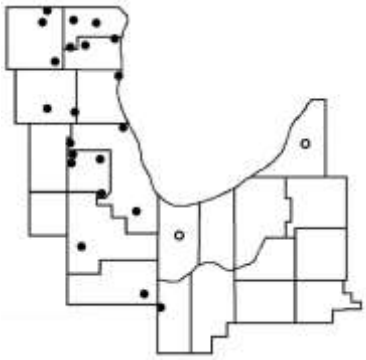
Season. July-September, according to references. My observations range July 6 to August 28.

Similar Species. They are fairly small (males 15-20mm, females 20-28mm), mainly brown but the sides of the adult male's pronotum are shiny black. In the female, the black area is limited to a small portion of the pronotum side. Those black areas separate this species from all other grasshoppers in the region. The face is slanted, the ends of the wings expanded and bluntly round, but do not reach the abdomen tip. The basal abdomen segments are black. The hind tibias are orange or red.

Song. Both genders stridulate. Stridulation, in which the sound is produced by rubbing the legs against the folded wings, results in a sound that could be rendered "zuzz zuzz zuzz…" In my limited experience there is nothing to distinguish the sounds of the various stridulating grasshoppers.

Marsh Meadow Grasshopper (*Chorthippus curtipennis*)





The marsh meadow grasshopper is a species of grassy areas, usually mesic to wet, most often in grassy marshes and wet prairies. They are common in the Illinois and Wisconsin portions of the region, but so far I have found them only at Willow Slough in Indiana.

Season. My observations have ranged July 4-October 7.

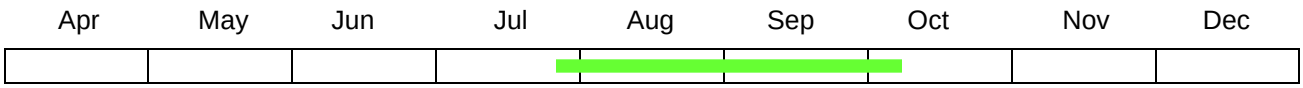
Similar Species. This is a small slant-faced grasshopper with orange or reddish legs, black femur-tibia joints in the hind legs, and yellow in the ventral abdomen. The rectangular sculptured areas above the antennae are another characteristic. The wings extend to the abdomen tip, more or less. Typical individuals have head and thorax mainly green, but there is much color variation in adults as well as nymphs. Females, especially, may have light brown, dark brown, and brighter, yellow-green color variants. See short-winged green grasshopper.

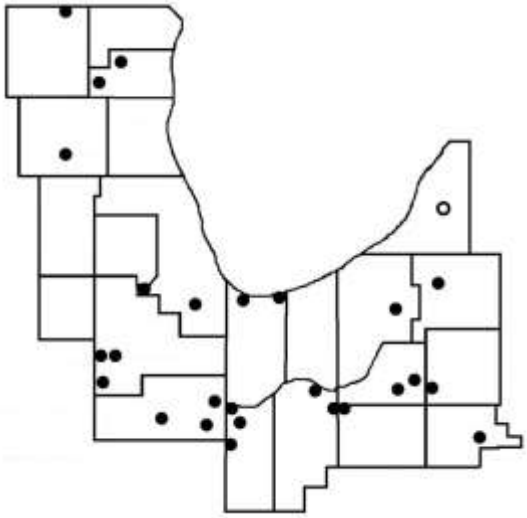
Song. There are two ways in which grasshoppers may produce sounds in display. Members of subfamily Oedipodinae rattle their wings, a sound production method called crepitation. The marsh meadow grasshopper uses the second method, called stridulation, in which the sound is produced by rubbing the legs against the folded wings. The resulting sound could be rendered "zuzzuzzuzz…" The song lasts up to several seconds. In this species the sound is not particularly loud, centering at 16 kHz, and seems to be infrequently produced, though more often than many others of its subfamily.

On-line Recording and Photograph. The Songs of Insects website has a photo and recording for the marsh meadow grasshopper (http://songsofinsects.com/grasshoppers/marsh-meadow-grasshopper).

Photos: above, adult typical male. Above right, close-up of head. Below right, one of the many potential color variations.

Short-winged Green Grasshopper (*Dichromorpha viridis*)





The short-winged green grasshopper is described as common in grassy areas both wet and dry, though I have found it mainly in wetter habitats. Males usually are green on top and brown on the sides, but there is an all-brown variant. Females are usually green with some brown markings in my experience, but short-winged green grasshoppers in Jasper County's Tefft Savanna show an interesting pattern of color dimorphism. Males and females are green in the wetlands, brown in the savannas. The wings are short, as the name suggests. Males 14-22mm long, females 23-30mm.

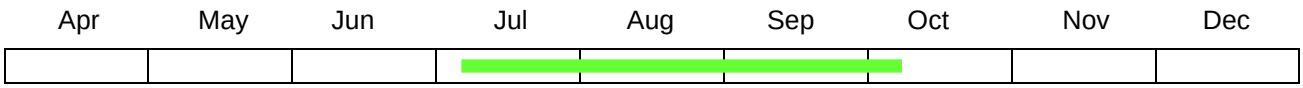
Season. My observations have ranged July 25-September 22. The literature indicates July-October

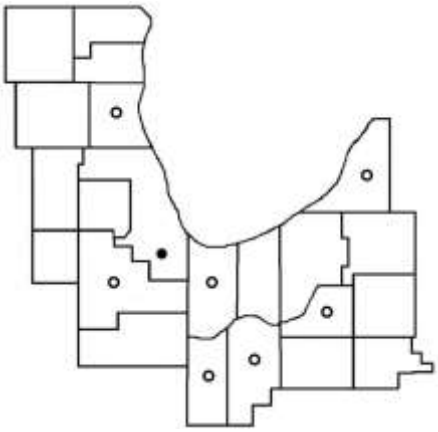
Similar Species. The typically bicolored males of this short-winged species are distinctive. Typical females are perhaps less so, but the short wings, dominant green color, and pattern of brown highlights should be enough to distinguish them. Occasional brown variants can be similar to marsh meadow grasshoppers. Short-winged green grasshoppers have much shorter wings and bigger eyes, especially in the male, and straight edges to the pronotum. Males have green or tan tops to the wings, the sides brown. Marsh meadow grasshopper pronotum edges bend inward. The rectangle in front of the eyes is not always depressed in its center, but is not a line as in the short-winged green.

Song. As in other members of subfamily Gomphocerinae, the short-winged green grasshopper stridulates, producing sound by rubbing the legs against the folded wings. The result could be rendered "zuzzuzzuzz…"

Photos: top, adult male. Above, a brown pair, with the male on the female's back. Right, a green pair.

Spotted-wing Grasshopper (*Orphulella pelidna*)





This grasshopper is found in a broad range of habitats except deeply shaded ones, though in low densities where it occurs. The photographed individual is the only one I have found to date, at the Gensburg Prairie in Cook County. It feeds on grasses. Blatchley found it in dune swales in Lake County, Indiana, and in low meadows near Bass Lake in Starke County. Hebard regarded it as widespread and common throughout Illinois.

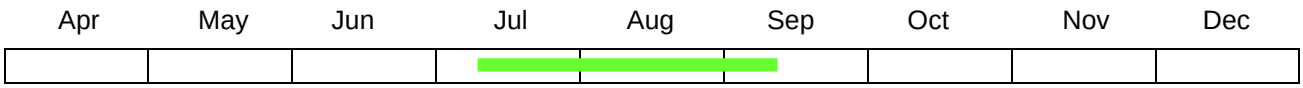
Season. According to references, adults are found July-October.

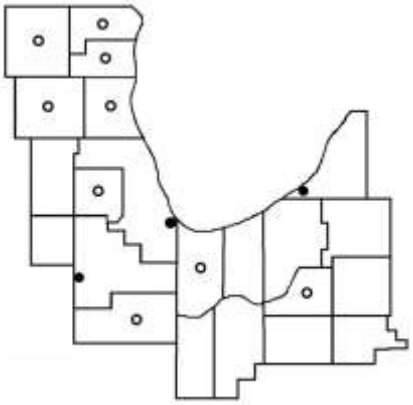
Similar Species. In appearance they are slender, variable and indistinctly marked. They may be brown or green, and have black and white accents. There are black triangles along the posterior portions of the lateral ridges on the dorsal pronotum. There is a series of small black rectangular marks down the forewings. Forewings normally extend beyond the end of the abdomen. The hind tibias usually are brown, but may be bluish. They are similar to the handsome grasshopper but smaller, with males 18-25mm and females 18-28mm, the forewings show speckling generally absent from the handsome grasshopper, and the lateral pronotum ridges bend toward one another strongly rather than slightly (photo, below). They also resemble their congener, the pasture grasshopper, differing most distinctively in having 2 cuts in each lateral pronotal ridge rather than just one (in the example shown, the anterior cuts do not extend across the dorsal surface).

Song. In addition to stridulating, it may produce brief crepitation sounds in flight.

Photos: above, adult female. Right, close-up of the distinctive shape and colors of the dorsal pronotum.

Pasture Grasshopper (*Orphulella speciosa*)





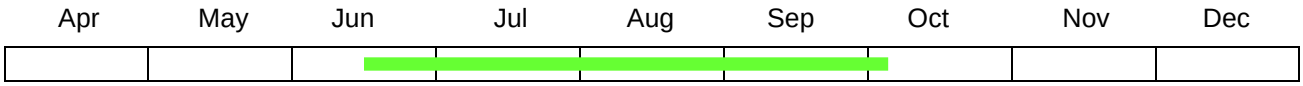
This species lives in areas with short-medium vegetation that includes grasses, including dry to wet habitats, but more likely dry ones. Can occur in open savannas. We are in the central part of its range, but it is described as locally distributed. Blatchley knew them from only 2 Indiana locations in our area, at Bass Lake in Starke County and near Hammond in Lake. He mentioned it as a hilltop and hillside species in Illinois. Hebard regarded it as common in Illinois and listed locations throughout the state. I have found it in three locations, a dolomite prairie with sparse grasses in the Des Plaines Conservation Area, Will County, at Big Marsh Park in Cook County, and in Glassman Park in Berrien County, off the I-94 right of way. The Wisconsin records are from Kirk and Bomar.

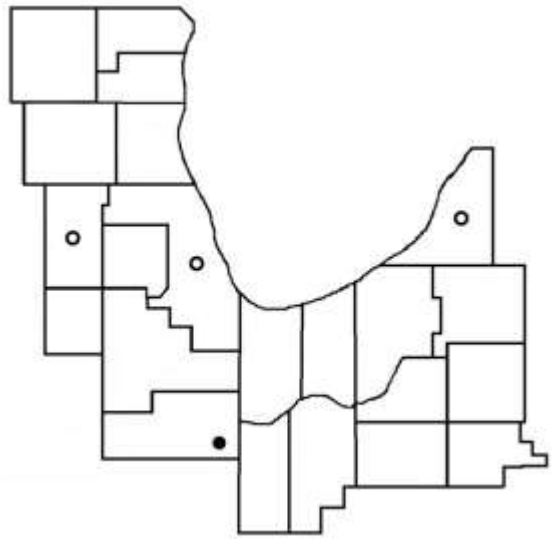
Season. Bland gives the season as July 9 to September 25 in Michigan. Kirk and Bomar give July to September (mostly late July to mid-August) in Wisconsin. Hebard's records range July 18 to September 7 in the Illinois portion of the region, mostly August. A specimen from McHenry County in the Illinois Natural History Suvey collection is dated July 9. My observations were on August 18 and 30, and September 9.

Similar Species. It can closely resemble its slightly larger congener the spotted-wing grasshopper, distinguished by having one rather than 2 cuts in each lateral pronotal ridge, and those ridges curving in toward one another less dramatically. The ground color can be brown or green or a combination of the two. Wings extend to the tip of the abdomen or beyond, but usually do not reach the knees of the hind femora in this species, are longer in *pelidna*. A series of elongate spots is on the center of the forewings. Males are a little smaller than those of *pelidna*, at 14-21mm, females the same at 18-27mm. The face is slanted, but not strongly. There are black triangles on the dorsal pronotum as in *pelidna*.

Song. I find no specific references to this species' sound displays, presumed therefore to be typical stridulation like most members of its subfamily.

Short-winged Toothpick Grasshopper (*Pseudopomala brachyptera*)





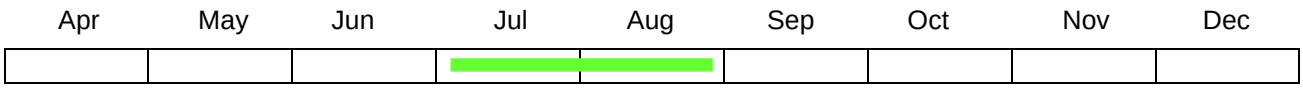
Also known as the bunchgrass grasshopper, this western species has a particular association with little bluestem grass and the dry habitats where it thrives. It is common in the prairie at the Nature Conservancy's Kankakee Sands site in eastern Kankakee County. Blatchley had no Indiana records as of 1920. It is listed as threatened in Indiana today. Hebard described it as scarce and local in Illinois. It is more slender than most grasshoppers, with pointed wings much shorter than the abdomen. Its color often is uniform brown or grayish, sometimes with light stripes on the head, thorax and abdomen. The face slants down and back sharply rather than being rounded. The hind tibias are brown. There are prominent lateral ridges on the pronotum. Males 23-27mm, females 27-30mm.

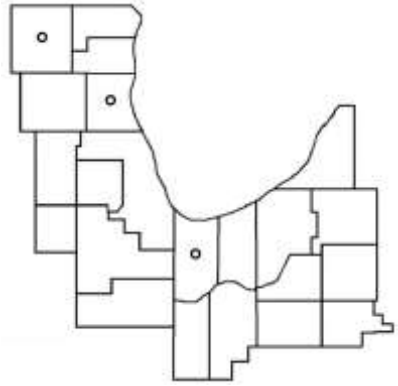
Season. According to references, adults are found June-October. I first found it at the Illinois Kankakee Sands site on June 28, 2016.

Similar Species. The extreme slenderness, head slant, and blade-like antennae of this short-winged species are unlike any other in the region.

Song. At Kankakee Sands they stridulated frequently and quite audibly.

Graceful Sedge Grasshopper (*Stethophyma gracile*)





Kirk and Bomar have a record for this northern species from Walworth County, probably from a fen in Kettle Moraine State Park. Specimens at the Illinois Natural History Survey museum are from Lake County, Illinois, and Lake County, Indiana.

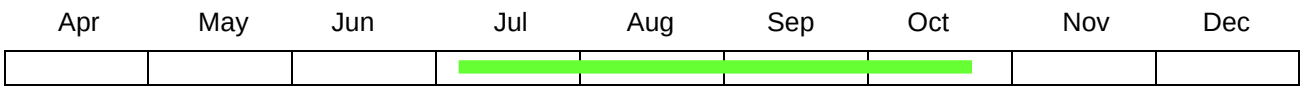
Blatchley mentions that the sedge grasshoppers have stridulatory pegs on the forewings. This feature leads some present-day authors to place them with the slant-faced stridulating grasshoppers of subfamily Gomphocerinae. Others combine them with the clipped-wing grasshopper into subfamily Acridinae. The habitat is described as sedge meadows, marshes, swamps and fens. This and its close relative the striped sedge grasshopper are described as quick to fly and difficult to approach.

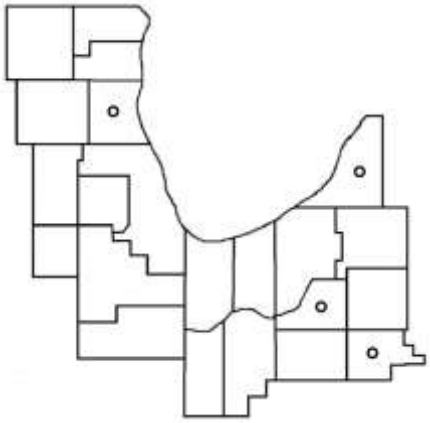
Season. The INHS specimens have dates from early July-late August.

Similar Species. The sedge grasshoppers are distinguished from other slant-faced species by having bright red lower surfaces of their hind femurs, combined with yellow tibias. This species is separated from the striped sedge grasshopper by the lack of a contrasting yellow or yellow-green stripe along the lower edge of the folded forewing. Kirk and Bomar indicate that the graceful sedge grasshopper is “slightly smaller” than the striped sedge grasshopper.

Song. I have not seen clear accounts of auditory displays, and have not observed this species myself.

Striped Sedge Grasshopper (*Stethophyma lineatum*)





Our area is at the southern extent of its historic range. Blatchley described it as a species of isolated low, boggy meadows, especially dense grassy areas around lakes or in swamps, and mentioned Starke and Fulton Counties (specimens in the Purdue University collection). Hebard listed only north central Lake County locations in our part of Illinois. Bland indicated a record for Berrien County. The males of this genus are described as very alert and quick to fly, needing a running pursuit with a net for capture.

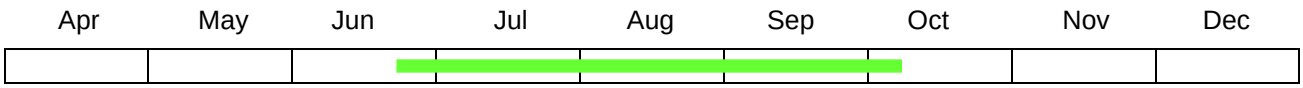
This species is named *Mecostethus lineatus* in some old references, including Blatchley. Blatchley mentions that the sedge grasshoppers have stridulatory pegs on the forewings. This feature leads some present-day authors to place them with the slant-faced stridulating grasshoppers of subfamily Gomphocerinae. Others combine them with the clipped-wing grasshopper into subfamily Acridinae.

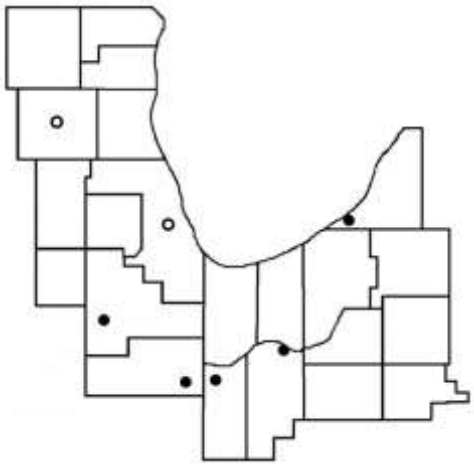
Season. July-October. Hebard gives a July 6 date and August dates for Lake County, Illinois. The Purdue specimens are from July 14 and October 24. Bland gives a date range of June 30-October 1 for Michigan.

Similar Species. The sedge grasshoppers are distinguished from other slant-faced species by having bright red lower surfaces of their hind femurs, combined with yellow tibias. This species is separated from the graceful sedge grasshopper by the contrasting yellow or yellow-green stripe along the lower edge of the folded forewing. Otherwise it is yellowish green (sometimes dark purplish brown according to Blatchley), with few contrasting markings. The wings are long with widened tips. There is black at the junction of hind femur and tibia, and the yellow tibias have black spines. Blatchley says that the underside of the femur can be yellow rather than red sometimes in this species, and that the yellow wing stripe can be "obscure" in females. Males 25-29mm, females 30-38mm.

Song. I have not seen clear accounts of auditory displays, and have not observed this species myself.

Handsome Grasshopper (*Syrbula admirabilis*)





Similar Species. It is slender with a slanted face and long, slender hind legs. The hind tibia are brown or gray. The pronotal lateral ridges bend in slightly near the middle, and are marked with white stripes. Body color can be largely brown or green, often with much black in males. Females usually are green, males brown. The forewing pattern is distinctive, with leading edges green or grayish, trailing edges brown or black. The edge between those areas typically is a wavy line in females; they may have spots between them in males. There are stripes on the sides of the head. It is most similar to the spotted-wing grasshopper, but is larger (males 22-31mm, females 35-49mm), the spotting pattern is different on the wings, and the dorsal pronotum has straighter edges.

Song. Both genders are known to stridulate.

This grasshopper is found among dry grasses, short to medium height, often on roadsides or on poor soils with scant vegetation. I have found it in the Kankakee Sands region in both Illinois and Indiana, at the Midewin National Tallgrass Prairie, in the roadside at the NIPSCO Savanna, and in Berrien County's Glassman Park, at the fringe of an Interstate right-of-way.

Season. According to references, adults are found June-October. My limited observations range August 1 to September 4.

Cicadas
Family *Cicadidae*

Cicadas are in a separate order from all our other singing insects. In the past that order was Homoptera, though present-day taxonomy places them in order Hemiptera. The cicadas had separated from their nearest relatives, the leafhoppers, by the late Triassic Period (Chen and Wang 2016).

Life history information is included in some of the species accounts.

Our local species fall into three subfamilies.

Subfamily Cicadinae (green-winged, northern dusk-singing, dog day, Linne's, lyric, Walker's, scissor grinder, and swamp cicadas).

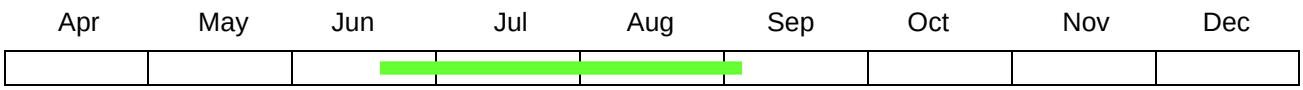
Subfamily Cicadettinae (Cassin's and Linnaeus' 17-year cicadas).

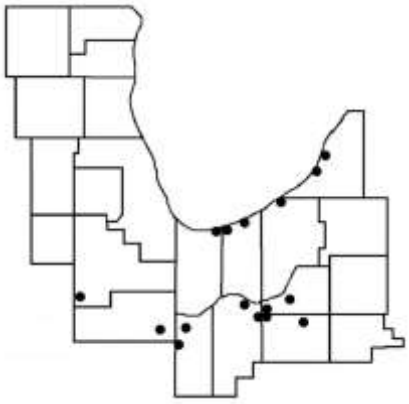
Subfamily Tibicininae (prairie and Say's cicadas).

There is an ongoing debate regarding the genera of the species that formerly were included in genus *Tibicen*. First came Hill et al. (2015), who split off the American species from the European ones and placed them in a new genus, *Neotibicen*. Their argument was convincing, and their new genus quickly was accepted among most cicada students. I have adopted their relatively conservative conclusion in this guide for most of these species.

New developments quickly followed, however, with other authorities splitting *Neotibicen* in various ways. First, Sanborn and Heath (2016) placed our species *auletes* and *pronotalis* in a new genus, *Megatibicen*, the name referring to their relatively large size. They also included *dorsatus*, the bush cicada, a prairie species that extends nearly into the Chicago region. Later that same year, Lee (2016) presented an even more radical split, placing *auletes* in *Gigatibicen*, and *dorsatus* and *pronotalis* in *Ameritibicen*. Sanborn and Heath quickly responded with arguments against Lee's conclusions. The precedence of their split and its apparent acceptance among specialists leads me to follow them for the two species in our area.

Green-winged Cicada (*Diceroprocta vitripennis*)





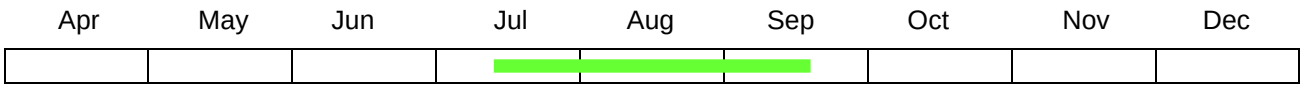
On July 29, 2013, while doing survey work in Indiana, I heard songs from members of this species in Newton and Jasper Counties, in oak woodlands on sand soils. I have added more counties since, but they always have been in that same habitat. They can be well up in trees in denser woodlands, but also on shrubs or widely scattered trees in more open areas. Sand soil with woody plants seems to be the necessary habitat feature, limiting them in our region to the dunes areas along Lake Michigan and the Kankakee River corridor. They do not, however, extend into the sandy portions of Marshall, Fulton, St. Joseph, and eastern Starke and Pulaski Counties as does the northern dusk-singing cicada, another sand-soil species.

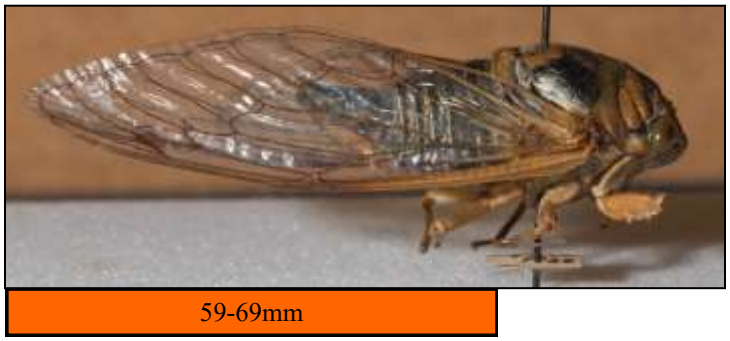
Season. According to Alexander, Pace and Otte (1972), this species begins singing in late May or early June, and it may show a 4-year periodicity. My observations in the region have ranged from June 23 to September 7, and year to year numbers have not seemed dramatically different. I have heard them singing as early as 9:30 a.m. and they continue until 3-4:00 p.m. Twice I have heard them starting up again at dusk, and I suspect that this may be common.

Similar Species. Like other early-season cicadas, these are relatively small. They are green-winged rather than red-winged like the periodical cicadas or brown-winged like the prairie cicada. Cassin's 17-year cicadas produce buzzes similar to cool-temperature *vitripennis* songs when connecting to females for mating (Court III signals; see the Michigan cicada website).

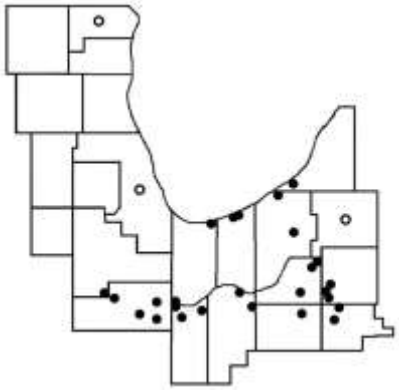
Song. A distinct, steady, rapid, continuous buzz, the individual pulses of which are readily discerned: sort of a mechanical twittering sound. The song somewhat resembles that of the sword-bearing conehead, but is much faster. The frequency range is 6-13 kHz, with a peak at 10 kHz. It is unlike the songs of our other tree-dwelling singing insects and is produced in the daytime. Green-winged cicada song recordings and photos can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/diceroprocta-vitripennis-say-1830-aka-green-winged-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Diceroprocta_vitripennis), at http://www.insectsingers.com/100th_meridian_cicadas/index.html, and in my blog post (https://natureinquiries.wordpress.com/2013/12/16/sound-ideas-green-winged-cicadas/).

Northern Dusk-singing Cicada (*Megatibicen auletes*)





59-69mm



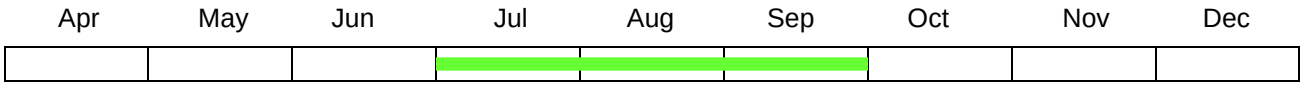
The northern dusk-singing cicada appears to be limited to woodlands and forests on sandy soils in the Chicago region. References extend its range into Wisconsin. The species recently has been split off from *Neotibicen*, Sanborn and Heath (2016) placing it in the new genus *Megatibicen*, and Lee (2016) in a different new genus, *Gigatibicen*. The former has been given precedence by most authorities.

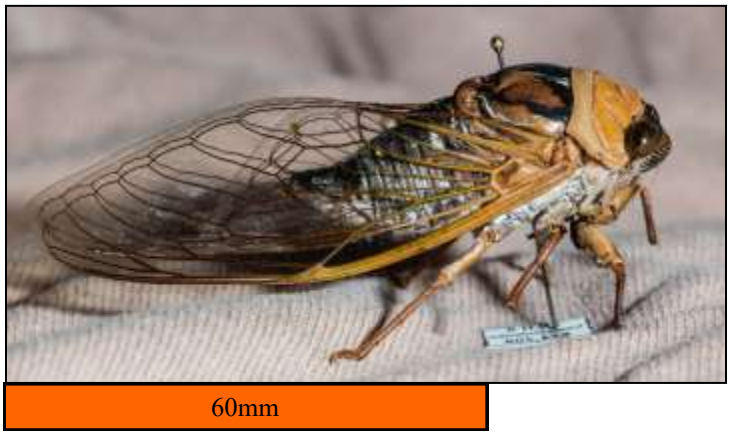
Season. My song dates for this species range July 13-September 16. Though they may sing occasionally during the day, they mainly sing at dusk, as their common name suggests. This point was made most clear to me in Kankakee County. I had spent the entire day surveying the county without hearing a single *auletes*. Then, in Kankakee River State Park, beginning around 15 minutes before sunset, a number of them began to sing. They did not continue after dark. Most of my other records likewise have been around dusk.

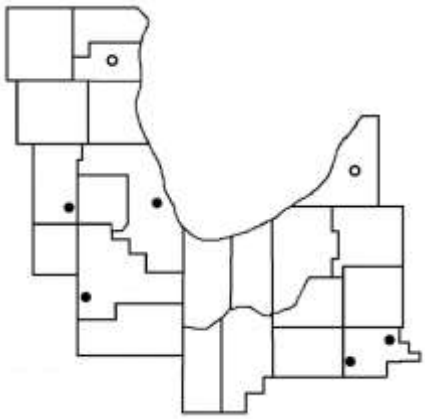
Similar Species. This is our region's largest cicada, with a wing length greater than 45mm. It has a green or brown pronotal collar.

Song. The song is similar to the scissor-grinder cicada's, being composed of slower pulses than the vibrato common to many *Neotibicen* cicadas. Those pulses often are a little faster than the scissor-grinder's, at 2/second. The song typically lasts at least 15 seconds. The northern dusk-singing cicada's song contrasts with the scissor-grinder's in having sharper phrasing, and sustaining a single tone (around 3 kHz) rather than a pitch drop in each phrase. It has been describes as resembling a roller skater's rhythm: "dirr-dirr-dirr…." Northern dusk-singing cicada song recordings can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/megatibicen-auletes-germar-1834-aka-northern-dusk-singing-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_auletes), the Songs of Insects website (http://songsofinsects.com/cicadas/northern-dusk-singing-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

Walker's Cicada (*Megatibicen pronotalis*)







On August 18, 2018, I heard my first Walker's cicada on the outskirts of Wilmington, Will County, singing from an isolated large catalpa in a large open mowed area. The cicada was half a mile from the Kankakee River. A few days later I heard a brief song from another individual, singing from a silver maple at the edge of the Fox River floodplain forest in Les Arends Forest Preserve in Kane County. In 2020 I made two more observations, both in Fulton County, both distant from any wetland. Furthermore, Cassi Saari of the Chicago Park District sent me a recording of a Walker's cicada she had made in a residential neighborhood of downtown Chicago.

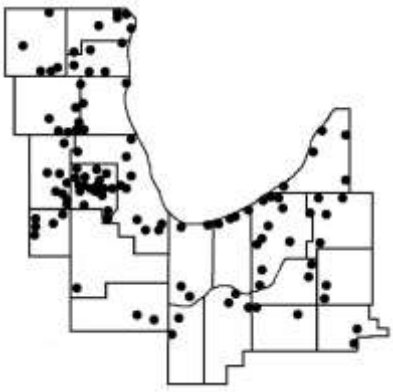
I now suspect that this uncommon species must wander widely to find a mate, facilitated by one of the loudest songs of any of the world's cicadas. The Fulton County observations taught me that the song is like that of an extra-loud Linne's cicada when heard from a moving car. The underlying continuous drone that accompanies the vibrato portion of the song requires the car's motor to be turned off to be readily heard. It is described as mainly a riparian species, associated most often with willows and cottonwoods. Some references retain the older name *marginalis* for this species, but Sanborn and Heath (2012) argue for *pronotalis*. The species recently has been split off from *Neotibicen*, Sanborn and Heath (2016) placing it in the new genus *Megatibicen*, and Lee (2016) in a different new genus, *Ameritibicen*. The former revision takes precedence for most specialists.

Season. According to the literature it often sings into the night, unlike other cicadas, with peak activity July-September. Both Fulton observations were made at dusk, as was Cassi's recording, and I suspect that Walker's cicada sings mainly in the hour surrounding sunset.

Similar Species. Walker's is one of our largest cicadas, and photos show that it usually has the collar and area between collar and head a solid green or tan (when green, often with an orange cast), and often with a central black oval adjacent to the head.

Song. The song is very loud, distinctive with a constant low drone and an overlay of quick short buzzes, the whole staying steady in pitch at 6 kHz. Song recordings are available at the Cicada Mania website (https://www.cicadamania.com/cicadas/megatibicen-pronotalis-walkeri-metcalf-1955-aka-walkers-cicada/), Songs of Insects website (http://songsofinsects.com/cicadas/walkers-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

Dog Day Cicada (*Neotibicen canicularis*)



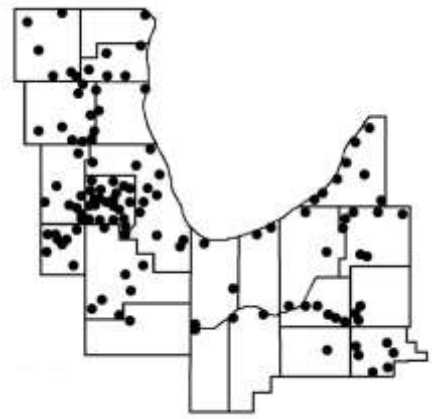
Similar Species. This is the smallest of our late-season cicadas, its wing length usually less than 38mm. The color of the pronotal collar (a narrow strip just behind the head) is brown or green rather than black.

Song. The drone starts low and slow, rises in pitch and volume, becomes siren-like at 7 kHz, holds, then weakens to a halt. The tympanum vibrations are so rapid that it sounds more like a tone than like a buzz. The songs are relatively brief, 5-11 seconds. Dog day cicada song recordings and photos can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/neotibicen-canicularis-harris-1841-aka-dog-day-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_canicularis), at the Songs of Insects website (http://songsofinsects.com/cicadas/dog-day-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

The dog day cicada is one of our four most common, widely distributed cicadas of late summer. It prefers open woodlands or scattered trees, and does not really seem to be a forest species. Occasionally one can be observed singing in herbaceous areas far (50-150m) from the nearest tree. Its distribution is northern, and it is the only *Neotibicen* to extend far into Canada. Its density diminishes southward in our region, and there are relatively few in Starke and Pulaski Counties. My southernmost observations are in Fulton County and at Willow Slough Fish & Wildlife Area in Newton County.

Season. Observed first song dates have ranged June 15-July 11, and last song dates August 30-October 19. There is an increase in numbers of singers in the second half of August, but singing becomes less frequent after the middle of September. This species sings mainly afternoons to dusk, but sometimes sings in the morning (care is needed, because early morning songs of other cicada species can lack vibrato and be cut short).

Linne's Cicada (*Neotibicen linnei*)



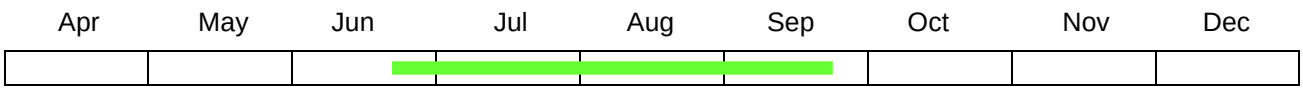
This probably is our most abundant "annual" cicada of late summer, thanks in large part to its wide habitat range, from scattered trees through residential neighborhoods to forest centers.

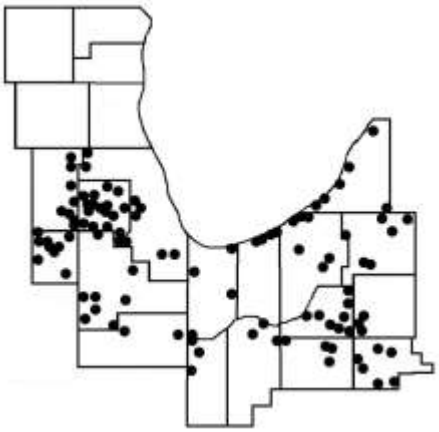
Season. Observed first song dates have ranged June 14-July 11. Last song dates have ranged September 10-October 20, but singing is infrequent late in the season and only on the warmer days (true of all our *Neotibicen* species). It sings mainly in the afternoon from trees, but like *canicularis* sometimes starts early in the morning. Singing continues until dusk.

Similar Species. Of all the *Neotibicen* cicadas you may find dead on the ground, this one and the dog day cicada are the most likely. Linne's is larger, with a wing length usually more than 38mm but less than 45mm. Its pronotal collar is brown or green.

Song. The song is a drone with slow vibrato (8-10 pulses/second), rising from a non-vibrato introductory section, with timed lengths of vibrato sections ranging 6-15 seconds (median 9 seconds). The pulses lack the percussive quality of the swamp cicada song. The drone is easily heard, as it centers at 7 kHz. The vibrato can vary in speed and quality among individuals and/or conditions, more so than in other local cicadas. In particular it slows as the temperature drops. The song is followed by the parasitic fly *Emblemosoma erro*, which larvaposits on the singing male ((Young 2020). Linne's cicada song recordings can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/neotibicen-linnei-smith-and-grossbeck-1907-aka-linnes-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_linnei), at the Songs of Insects website (http://songsofinsects.com/cicadas/linnes-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

Lyric Cicada (*Neotibicen lyricen*)





www.cicadamania.com/cicadas/neotibicen-lyricen-lyricen-de-geer-1773-aka-lyric-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_lyricen), at the Songs of Insects website (http://songsofinsects.com/cicadas/lyric-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

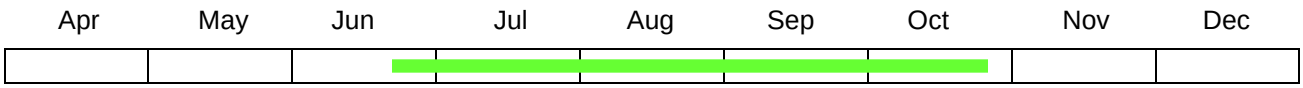
The lyric cicada is found in forests, and is especially abundant in riparian and other low woodlands where it often is much more common than any other late-season cicada. Residential neighborhoods generally won't have this species unless they are adjacent to a forest or wetland area. The lyric cicada shows a dramatic population cline through DuPage County, as I found in 2013. They were abundant in Kendall County on August 2, but I heard none in McHenry County the next day. The northernmost observations in the region bring them within 2 miles of the southern McHenry-Lake County border. Those at Sarett Nature Center bring it a little farther north in Berrien County.

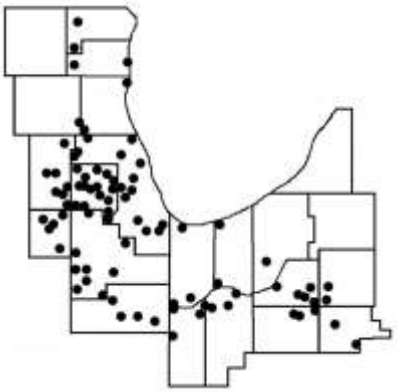
Season. The range of first observed song dates is June 24-July 20. The lyric cicada finishes earlier than other *Neotibicen* cicadas: last song dates have ranged August 10-September 24. Typically the lyric cicada sings early in the morning, and concentrates its singing in the mornings, but can go into late afternoon or early evening, especially in August.

Similar Species. Of our four common *Neotibicen* cicadas, this is the one with a black pronotal collar. Usually there are fairly large chestnut-colored spots on either side of the dorsal thorax. Wing length is less than 45mm. The abdomen beneath has a broad, shiny black midline.

Song. The drone resembles Linne's but is longer, with timed songs 18-62 seconds long (median 24 seconds). Also unlike *linnei*, the vibrating quality is held throughout, and is faster so as to be a rough buzz reminiscent of a power saw. It may sound like two pitches going simultaneously, while *linnei*'s song has two pitches in alternation. As in other common cicadas, the wide range of frequencies centers around 7 kHz. Lyric cicada song recordings can be found at the Cicada Mania website (https://

Scissor-grinder Cicada (*Neotibicen pruinosa*)





The scissor-grinder is found in trees, from open woodlands to forests. It is widely distributed in the western portion of the region, but extensive searching in St. Joseph and Berrien Counties has failed to turn any up. I thought the same was true for Fulton County until I heard a few at South Mud Lake. Furthermore, I have observed them only in western Marshall County. This apparent eastern range boundary in the region is consistent with Sanborn and Phillips 2013, whose map shows a hole in the distribution in northern Indiana. Scissor-grinders resume in the eastern half of northern Indiana, and a few counties south of my study region, and there is a single Michigan record well north of Berrien County. I consider the map complete for the species, though I will remain open to hearing them in the remaining counties of Walworth, Berrien and St. Joseph.

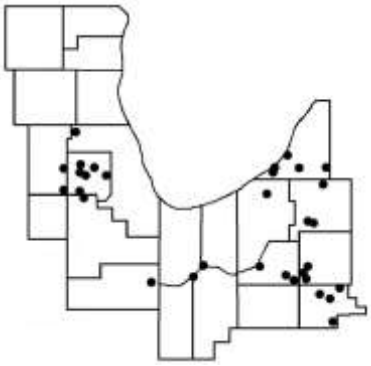
Season. First observed song dates have ranged June 19-July 24 in different years. Last song dates have ranged September 14-October 24. This is mainly a late afternoon and early evening singer, but occasionally may be heard in the morning.

Similar Species. The pronotal collar is brown or green, separating it from the lyric and swamp cicadas. It is larger than the dog day cicada, with a wing length larger than 38mm but less than 45mm. That leaves Linne's cicada. A comparison of wing shape and venation is needed to distinguish those two; consult the key in the Cicadas of Michigan website at http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/key.html

Song. The scissor-grinder's drone consists of long, level pulses rather than vibrato wavering, 1-2 pulses/second, loud and easily heard at 5 kHz, and with a few seconds of non-pulsing fade at the end. Each pulse or phrase ends with a drop in pitch. It has been rendered "eee-oowee-oowee…" The song can last 20 seconds. See also the song description for the northern dusk-singing cicada. Scissor-grinder cicada song recordings can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/neotibicen-pruinosus-pruinosus-say-1825-aka-scissors-grinder/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_pruinosus), at the Songs of Insects website (http://songsofinsects.com/cicadas/scissor-grinder-cicada), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

Swamp Cicada (*Neotibicen tibicen*)

Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			▬	▬	▬			



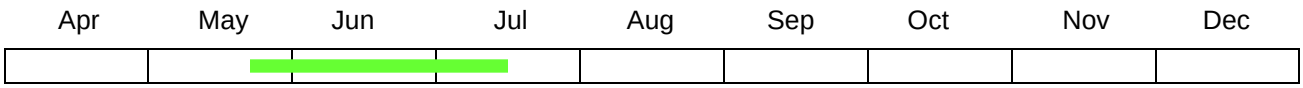
Swamp cicadas are common in the eastern portion of the region, but in the western Indiana counties I have observed them only along the Kankakee River, and that string extends to the Momence Wetlands in eastern Kankakee County, Illinois. Scattered individuals and small clusters occur in DuPage County and adjacent areas, but this appears to be a disjunct grouping, consistent with the review by Sanborn and Phillips (2013) which shows no records in the northern half of Illinois. Commonly swamp cicadas sing in the morning from trees, bushes and tall herbaceous vegetation in or near wetlands. Sometimes a male changes perches by up to 40m between songs, possibly to compensate for low population densities. The species name formerly was *chloromera*.

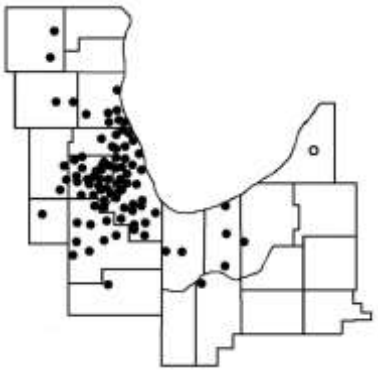
Season. My observations so far have ranged from July 12 to September 25. I have heard them as early as 8:30 a.m. and as late as 5:10 p.m. Their singing peaks in the morning and diminishes significantly at mid-day, but continues intermittently through the afternoon.

Similar Species. Like the lyric cicada, the swamp cicada has a black pronotal collar and a wing length less than 45mm. In contrast with *lyricen*, the swamp cicada's abdomen beneath has only an interrupted or at least little contrasting midline, the top of the head has much green, and the top of the thorax is mainly black without *lyricen*'s significant chestnut spots. There are prominent white patches on either side of the dorsal anterior abdomen.

Song. The song is similar to that of Linne's cicada but more percussive, the most extreme examples reminiscent of a rapidly struck tambourine (vibrato about 8 pulses/second). It rises in volume, holds, then fades, lasting 8-13 seconds (i.e., is significantly shorter than the lyric cicada's song). The peak frequency is 6 kHz. Swamp cicada song recordings can be found at the Cicada Mania website (https://www.cicadamania.com/cicadas/neotibicen-tibicen-tibicen-linnaeus-1758-aka-morning-cicada/), Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Tibicen_tibicen), the Songs of Insects website (http://songsofinsects.com/cicadas/swamp-cicada), at http://www.insectsingers.com/100th_meridian_cicadas/index.html, and Lisa Rainsong's website (https://www.listeningtoinsects.com/what-about-cicadas).

Cassin's 17-year Cicada (*Magicicada cassinii*)





This is one of two species of periodical cicadas in our area (note: some records on the map are from Cooley et al. 2016). It is extremely abundant during emergences in northeastern Illinois, densities reaching 1.5 million per acre, with a preference for floodplain forest. Elms, ashes and other floodplain species are preferred, and the introduction of these trees into residential areas (as well as disturbance of woodlands generally) can confuse the habitat preference indications of the periodical cicadas. History of land use also influences where these insects occur (Strang 2013). Removal of forests for agriculture caused local extinctions, but trees planted in residential areas have provided expansion opportunities. The long time between generations is slowing that expansion, and these insects have not yet recovered all the ground they historically lost to agriculture.

Periodical cicadas are known for mass emergences at 17-year intervals (at this latitude), most recently in 2007, but there is an offshoot group that appears in certain northeast Illinois locations four years early, and a few individuals come out a year or two before and after the main body. See pp. 11-12 for more details on the history of these species in DuPage County and on the 2020 early mass emergence. The next main emergence is expected in 2024.

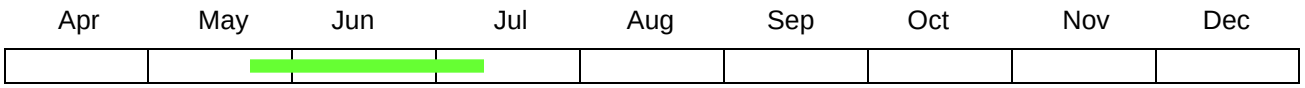
Life Cycle. As in our other cicadas, nymphs live on sap drawn from plant roots through needle-like mouthparts. Most mature nymphs emerge from the ground at night, though rainy days also can bring some out. They climb trees or other plants, the nymphal exoskeleton cracks open down the back, and the adult emerges. White at first, over a period of hours they adopt their mature colors. Males sing to attract females, which after mating lay clusters of eggs in the undersides of twigs through their saw-like ovipositors (photo, right). The eggs hatch later in the summer, and the tiny first-instar nymphs drop to the ground and make their way into the soil.

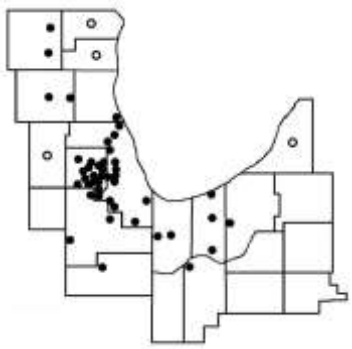
In the 2007 emergence they were singing in small numbers by May 21. Singing peaked in June, and was diminishing by the last week of that month. By mid-July, the last few individuals were nearly finished. A few scattered late-emerging individuals sang in late August to mid-September.

Similar Species. See Linnaeus' 17-year cicada for physical appearance, and green-winged cicada for song.

Song. The song begins with several quick ticks, then has a single smooth buzzing tone that rises in pitch and then falls. The buzzing quality easily distinguishes it from the song of Linnaeus' 17-year cicada. Most males congregate in large clusters high in trees. Their chorusing often takes the form of continuous synchronized rises and falls (waves) of song on a 6-second period. The volume of a chorus group's aggregate singing, at 5.6-5.9 kHz, is loud enough to be painful to someone standing beneath the tree. The singing diminishes by early evening, and quiets in the night. Recordings are available at the Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Periodical/Index.html#Magicicadacassini), and at http://magicicada.org/magicicada/, which has an excellent summary on periodical cicadas, with the most recent information on their broods.

Linnaeus' 17-year Cicada (*Magicicada septendecim*)





This is one of two species of periodical cicadas in our area (note: some records on the map are from Cooley et al. 2016). It is extremely abundant during emergences in northeastern Illinois, though not as abundant as *M. cassinii*. Densities have been measured at 133,000 per acre in northeast Illinois. In contrast with its congener, *septendecim* prefers upland forest. It also spreads into residential areas, but lags behind *cassinii*. Both local periodical cicadas emerge at the same time, and references to them can be found in local newspapers as far back as 1888 (Strang 2013). This species is much less prone than *cassinii* to emerge in years or at times other than peak emergences, except for the offshoot areas (described in the *cassinii* account and on pp. 11-12) where many of the insects appear to have shifted 4 years early.

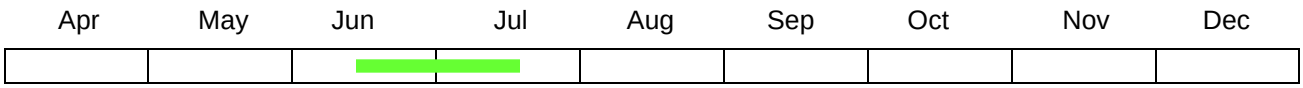
They are consumed by many kinds of birds, mammals, amphibians, reptiles, spiders and predatory insects. Their large numbers overwhelm these predators, allowing them to produce prodigious numbers of eggs. Only one specialized consumer exploits them, the parasitic fungus *Massospora cicadina*, the spores of which apparently infect them when they tunnel to the surface.

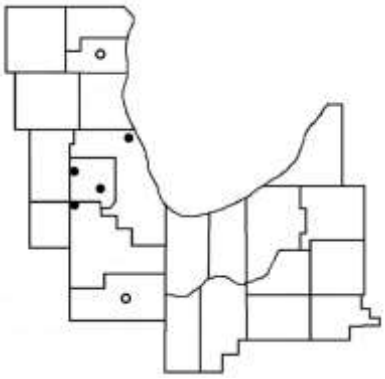
Life Cycle. See the description for *cassinii*. Nymphs tunnel to the surface 3-4 weeks in advance of emergence, and may monitor aboveground conditions to determine when to come out. Most emerge at night, though large numbers may leave the ground on rainy days. A percentage of them produce malformed wings or other structures, apparently most often when they do not quickly find a vertical surface from which to break out of their nymphal skins. In the 2007 emergence *septendecim* were coming out by May 21. As was the case for *cassinii*, *septendecim* peaked in June. They were finished, or nearly so, by July 10.

Similar Species. Periodical cicadas are distinctive in their black and orange colors, orange wing veins and red eyes. *Magicicada septendecim* is larger than *cassinii*. A thick orange line connects the eye with the base of the wing in *septendecim*, but that space is entirely black in *cassinii*. They are smaller than the annual cicadas. Their flight also is slower.

Song. The song of *septendecim* is more a tone than a buzz, held at a high pitch and then slurring downward (masses produce a steady tone at 1.3 kHz). The song has been described as a sung "pharaoh." The individual song is much lower in volume than that of the smaller *M. cassinii*. Sings dawn through morning, diminishing in the afternoon but some individuals continue until dusk. Recordings can be heard online at the Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Periodical/Index.html#Magicicadaseptendecim), at the Songs of Insects website (http://songsofinsects.com/cicadas/periodical-cicada), and at http://magicicada.org/magicicada/, which has an excellent summary on periodical cicadas, with the most recent information on their broods.

Prairie Cicada (*Okanagana balli*)





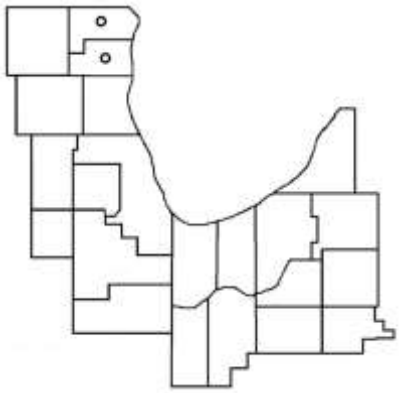
This species occurs in some remnant prairies. Research and monitoring has been conducted on this species by faculty and students at the University of Illinois, Chicago. They list several sites in Cook, Will and Kankakee Counties. Their own site, the Woodworth Prairie in northern Cook County, is remarkable for its small size (5 acres) and isolation from other prairies. The cicadas have maintained a population of a few hundred at that site. After first meeting the species there in early July 2013, I was inspired to seek it in other remnants, and found it at West Chicago Prairie and Belmont Prairie in DuPage County. They also persist at the tiny Vermont Prairie in northern Will County. Prairies in Kankakee County where it was known in the past have been degraded by invasive plants, and I cannot find prairie cicadas there now. It may be limited by poor dispersal ability. I observed one mating episode. A female flew to a plant near a singing male, then approached him. They exchanged a few wing-flicking displays, and then joined for 10 minutes (photo, right).

Season. Mid-June to mid-July, peaking in the last week of June or first week of July in most years. My observations have ranged June 21-July 12. The diurnal peak is 11:30 a.m.-2 p.m., with singing as early as 8:30 a.m. and as late as 4 p.m.

Similar species. This is smaller than our other cicadas, except for Cassin's periodical cicada, and its early season and prairie to savanna habitat should rule out all others. It is black generously marked with grayish brown, and has brown wing veins.

Song. The song is a high-pitched continuous buzz, but the rapid pulses are discernible. Except for the higher pitch the song resembles that of a *Neotibicen tibicen* or *N. lyricen*. Sound analysis shows a range of 5-15 kHz with a peak frequency of 10.5 kHz, 50 pulses/second. Some, singing from compass plant (*Silphium laciniatum*) leaves, were louder and easier to hear. More information from the UIC study can be found at https://prairie.bios.uic.edu/animal-species/prairie-cicada/. A recording of the song can be heard at http://www.insectsingers.com/100th_meridian_cicadas/index.html, and my own recording is posted in my blog at https://natureinquiries.wordpress.com/2013/12/02/sound-ideas-prairie-cicada/

Say's Cicada (*Okanagana rimosa*)



This is a species mainly of northern deciduous forests, but there are records for southeastern Wisconsin. It has mainly a 4-year emergence cycle, but a few individuals emerge each year.

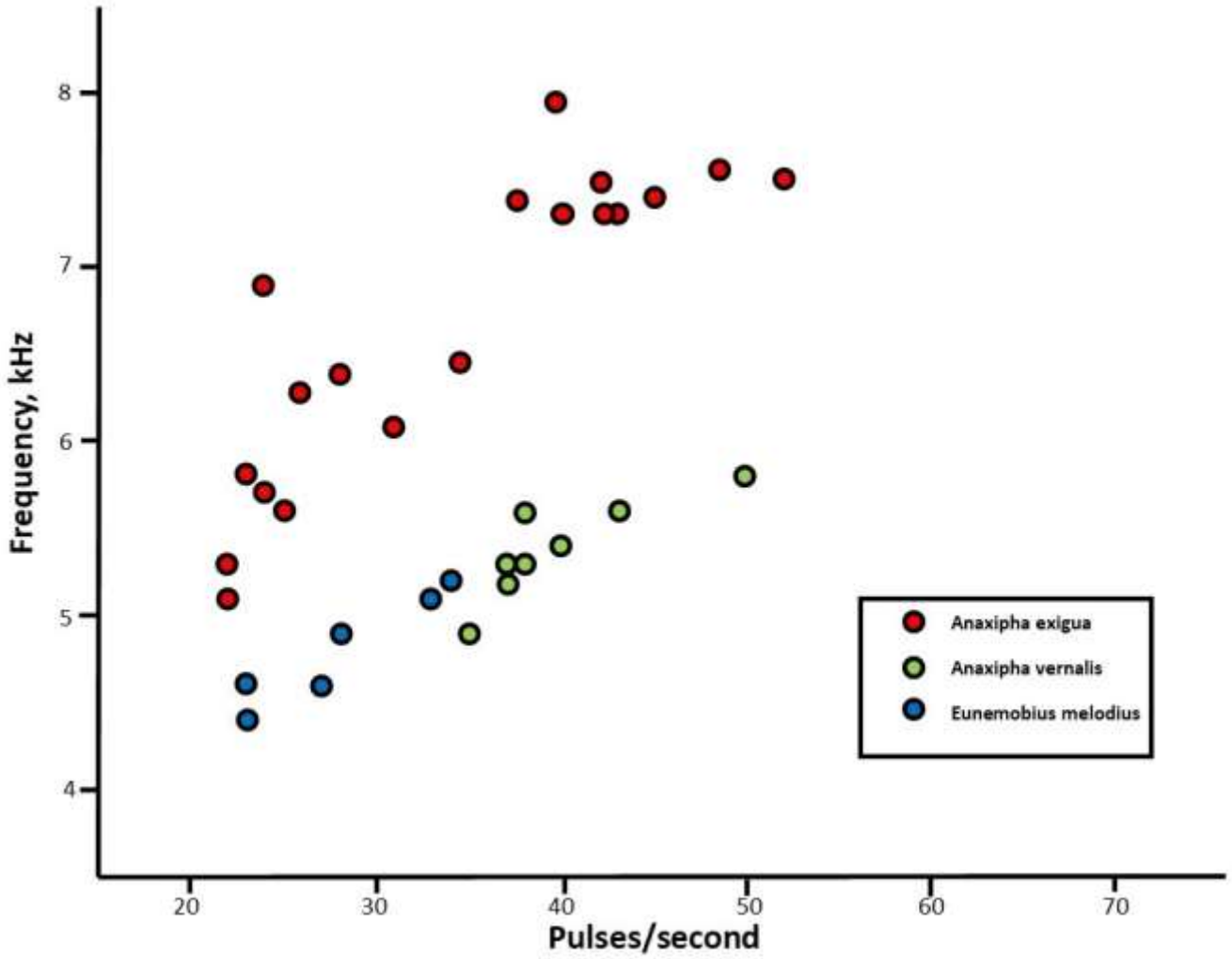
Season. Alexander, Pace and Otte describe it as an early season species, grouping it seasonally with the periodical cicadas and the green-winged cicada. It sings morning into early afternoon.

Similar Species. Say's cicada is generally black with bright orange markings on the underside of the abdomen, orange spots on the pronotum, and orange trailing edges of the dorsal abdominal segments. The small size, coloration, and season separate it from all other species in the region.

Song. Its song is a prolonged buzz, peaking at 10 kHz, similar to that of the lyric cicada but at a lower volume. Sometimes it gives shorter such songs in series.

Recordings of the song can be heard at the Cicada Mania website (https://www.cicadamania.com/cicadas/okanagana-rimosa-rimosa-say-1830-aka-says-cicada/), at the Songs of Insects website (http://songsofinsects.com/cicadas/says-cicada), at the Cicadas of Michigan website (http://insects.ummz.lsa.umich.edu/fauna/Michigan_Cicadas/Michigan/Index.html#Okanagana_rimosa), and at http://www.insectsingers.com/100th_meridian_cicadas/index.html

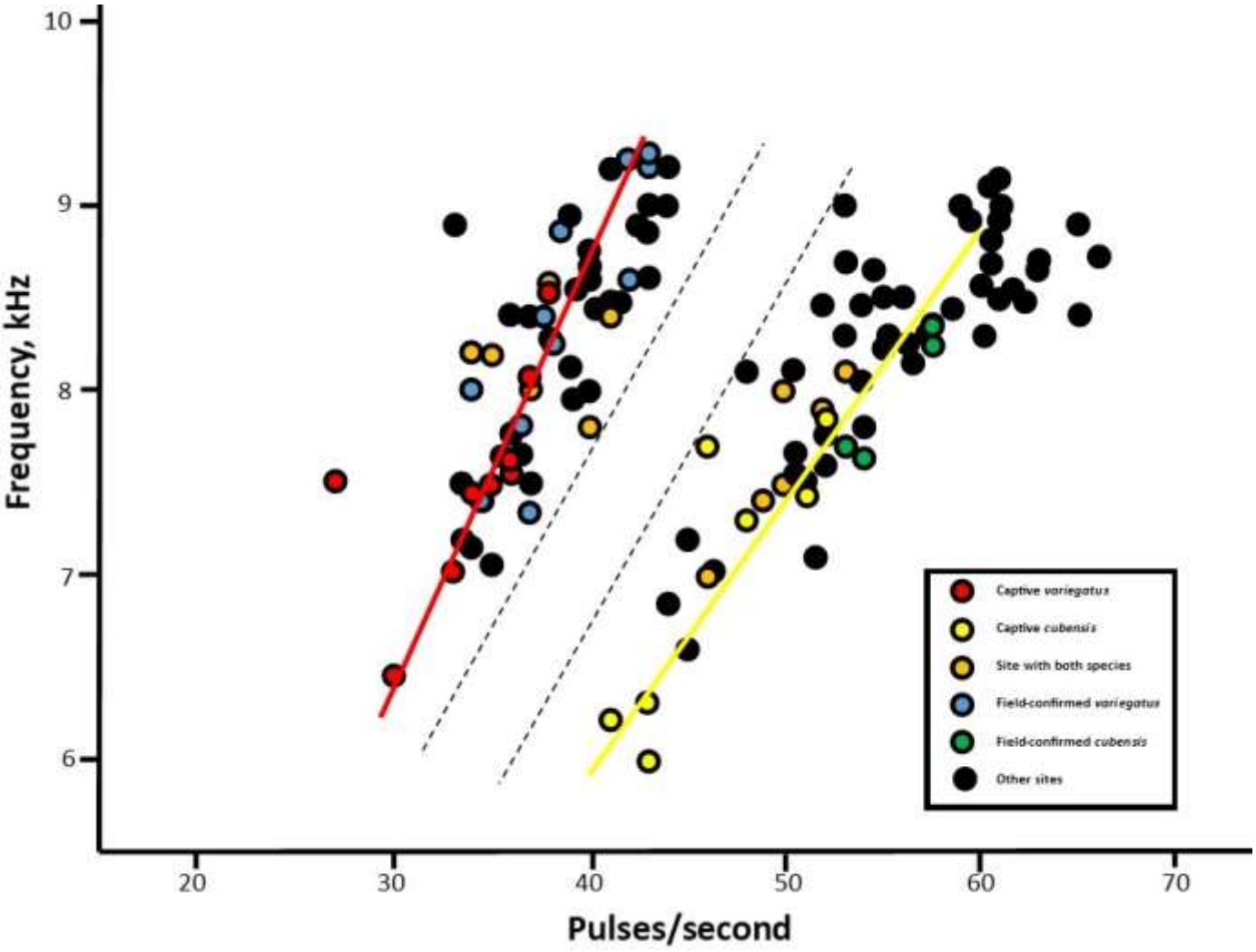
Appendix A



This graph illustrates data taken from sound recordings of Say's trigs (*Anaxipha exigua*), spring trigs (*A. vernalis*), and melodious ground crickets (*Eunemobius melodius*). The *vernalis* data are for informative purposes only. They are not needed for the identification of hidden singers, as their trills are distinctive and occur earlier in the season than either of the other species. The points for each species trend up and to the right, because both the frequency (pitch, or highness of the trills) and the pulse rate (a pulse coming from a single rubbing together of the singing male's wings) increase with temperature, which is difficult to measure reliably in the field. Frequency and pulse rate are taken from computer analysis of song recordings.

With experience one usually can distinguish Say's trig songs from melodious ground cricket songs, both often occurring in the same area so that the mellower, lower-pitched tone of the melodious ground cricket stands out. As the graph shows, however, there can be a confusing overlap between some Say's trigs singing at the lower end of their range, and some melodious ground crickets at the higher end of theirs. In such cases, if the singer cannot be found for a visual identification, sound recordings and this graph can be useful.

Appendix B



Plot of sound recording data from two species of *Neonemobius* ground crickets. Such songs are recognizable because of their source in the ground, the weak crescendo beginning of each trill, and their rapid-pulsing, high-pitched quality. Because the singing males can be out of reach in soil holes and cracks, sound recordings often are the best way to identify them. For the same reason, the temperature of the singer can be difficult to measure reliably. The two measures used to form this graph are taken from the recordings, and so do not rely on temperature, though both increase with temperature, thus the trends angling up and to the right.

The red regression line was calculated from a series of recordings made at different temperatures from a captive male *variegatus*, all but one of the red dots coming from that male. The same is true for a captive male *cubensis*, represented by yellow dots and regression line. The blue dots represent field recordings with *variegatus* identifications confirmed, and green dots represent the same for *cubensis*. Orange dots represent recordings from Gar Creek Forest Preserve at Kankakee, Illinois, where both species have been captured. The dashed lines are eye-estimates of the space separating the clusters of points. Black dots are from recordings made without visual identification of the singers.

Hypotheticals and Species with Undetermined Status

House cricket, *Acheta domesticus*
No free-living feral populations of this Asian species currently are known in the region. Past records for Will, Cook and Lake Counties of Illinois are from 1934 and earlier, and probably represent short-lived escapes.

Slow-tinkling trig, *Anaxipha tinnulenta*
This is one of the species first described by Walker and Funk in 2014. Its range still is being worked out. Records so far have been south of the Chicago region, but its song is so similar to that of the tinkling ground cricket that it is easy to overlook. I have made two recordings, one in Will County and one in Pulaski County, which fit this species better than the ground cricket. Song parameters are very similar, however (see tinkling ground cricket, page 30). Wil Hershberger suggests that distinguishing the two may come down to the shapes of the individual notes in sonographs. Visual confirmation, and observations of captive specimens, will be a priority in 2021. Slow-tinkling trigs look very much like Say's trigs, and so are easily separated from ground crickets. Their habitat is described as the forest understory, so the location of a singing trig will be close to the ground, where tinkling ground crickets occur. Photos and sound recordings of slow-tinkling trigs can be found at the Singing Insects of North America website (https://sina.orthsoc.org/615a.htm) and at the Songs of Insects website (http://songsofinsects.com/crickets/slow-tinkling_trig).

Prairie tree cricket, *Oecanthus argentinus*
The prairie tree cricket ecologically is similar to Forbes's tree cricket. It is described as having a like preference for coarse herbaceous vegetation, with occasional use of shrubs. The main range for this species is west and south of Illinois, and Laurel Symes failed to find them in the region during the surveys she conducted in her thesis work. The species is retained on the hypothetical list because of two 1930's records from Chicago which may have been erroneous. It is pale, with relatively heavy spots on the basal antenna segments. The outer marking on the basal segment sweeps up and to the side, and the markings on the second segment merge at their base to form a V. The pulse rate of its continuously trilling song is 51/second at 25C, falling between the slower four-spotted tree cricket's pulse rate of 40 and the faster rate of Forbes's tree cricket at 65.

False robust conehead, *Neoconocephalus bivocatus*
This is a sibling species of the robust conehead. McCafferty and Stein claimed records for Porter and LaPorte Counties in Indiana, but the specimens no longer exist or have been reassigned, and so may have been in error. The differences from *robustus* can be subtle, the females having different ovipositor lengths and males' songs with different pulse patterns and rates when recordings are analyzed (Deily and Schul 2004). See robust conehead account, p. 72. The species may yet appear in the region, but it generally occurs farther south.

Least shieldback, *Atlanticus monticola*
Though not yet known in the Chicago region, this very slightly smaller (19mm) relative of the protean shieldback is found just southwest of the region, and there is a disjunct area where it is found in the northern part of Michigan's Lower Peninsula. They have backs that are gray-brown or rarely green in different individuals. Females have a deeper notch in the subgenital plate. The males' extremely high-pitched rattling buzzes are produced about 2 per second. The habitat is described as weedy fields and brushy forest understory, as in *A. testaceus*. The season is July to autumn, with peak singing at dusk. Some authors split the species, and assign those in Michigan, Indiana and Illinois to *A. davisi* (Davis' shieldback).

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