

THE SEASONAL SUCCESSION OF ORTHOPTERAN STRIDULATION NEAR RALEIGH, NORTH CAROLINA*

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Two Figures

The singing Orthoptera belong mainly in two families, the Tettigoniidae and the Gryllidae. The members of the first family are commonly known as katydids or long-horned grasshoppers, while those of the second family are called crickets. These two families are mainly responsible for the insect chorus so familiarly associated with the late summer and fall, and are the only ones considered in the present study. A third family, the Acrididae, or short-horned grasshoppers, includes a number of species which produce a clattering sound during flight or make a faint rasping sound by rubbing the hind femora against the wings.

The songs of the katydids and crickets are produced by a file and scraper mechanism located near the base of the first pair of wings, a structure which is present only in the male sex. Structures of a different type but apparently having a sound-producing function have been found in the female sex in all local Tettigoniidae except *Atlanticus*. The sounds produced by the females of only a few large species have actually been heard by human ears. They are produced in response to the male song and are weak, brief, and infrequent. The katydids produce rasping or buzzing noises while the crickets generally produce sounds of more musical quality. Most of the songs in both families have some distinctive attributes so that anyone familiar with them can identify the species singing, just as an ornithologist can identify birds by their songs. Some closely related species or subspecies, however, have songs so similar that positive identification from the song alone is not possible. In some cases the habitat or the season of the year may serve as an additional clue to the identity of the species. A few species have more than one type of song which can be produced by the same individual insect. Song types having racial significance, however, occur in *Gryllus* and *Anaxipha* and in such cases each song type is listed separately even though there are no recognized morphological characteristics for separating them into subspecies.

In the vicinity of Raleigh, N. C., it is possible to hear some kind of orthopteran stridulation during ten months of the year, from March to December. Many species have a song period lasting only about two months, while some of the multiple-brooded species may be heard over a continuous period of six months. The seasonal succession starts in March with two species which may be heard during warm nights. The maximum number of species singing is reached in the latter part of August. The number of singers remains high through October,

* Published with the approval of the Director of the North Carolina Experiment Station as paper No. 372 of the Journal Series.

but drops off rapidly during November. The number of species recorded as singing during some part of each month is shown in the following table:

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Tettigoniidae.....	1	2	2	6	16	21	18	15	3	0
Gryllidae.....	1	2	5	10	18	26	24	22	13	6
Total.....	2	4	7	16	34	47	42	37	16	6

In northern states, nearly all of the singing Orthoptera mature in late summer, mostly about the first of August, and continue to sing until the first heavy frost. Many of these species also occur in North Carolina but not all of them follow the same seasonal pattern. Some mature at about the same time or possibly even a little later than they do in the north. Others mature in early summer and are followed by a second brood, or they are single-brooded and die during late summer or early fall. Heavy frosts during October may kill many singing Orthoptera in North Carolina but during some years the weather remains warm and most species die of old age or other natural causes before killing frosts occur. Two species hibernate as adults but do not sing until spring.

The seasonal succession in the stridulation of the Tettigoniidae and Gryllidae is presented in graphical form in Figures 1 and 2. The graphs are based on data compiled from twenty-two years of notes. Most of these notes have been casual lists, jotted down in the field, of species heard singing from time to time. During some years, however, a list of the common species was prepared and checked at fairly regular intervals. Since most of the species sing after dark, most of the observations were made in the evening around the writer's home or while riding in an automobile. The species represented in the graphs are nearly all of the singing Orthoptera known to occur in the Raleigh area. The list does not include a few species that are rare or very restricted in habitat and a few that do not have an audible song.

In the graphs a heavy bar is used to indicate the period between the first and last records. Marks along the top of the bar indicate the dates on which the species was heard singing. These data have been supplemented by date records from adult specimens, indicated by marks below the bar. Where two bars occur on the same line, it means that the species has two well defined singing periods, and that this is a matter of observation and not merely due to a lack of records. In some cases the bar is extended on the basis of specimen records only. This has been done only when the writer believes that the song period probably extends that far. In other cases, a question mark is placed at one end of the bar to indicate that it probably should extend farther, but that the records are incomplete or there is a question of the identity of the species. For species whose song period is not very accurately determined the heavy bar is omitted, and the song and specimen records are spotted in above and below the narrow line.

The beginning of the song period is probably more accurately determined than the end of the period. The observer notices a new song more readily than those

he has become accustomed to hearing. Young males usually sing more than older ones, while toward the end of the song period the number of singers is gradually reduced as the males die off. Since the records were taken during many

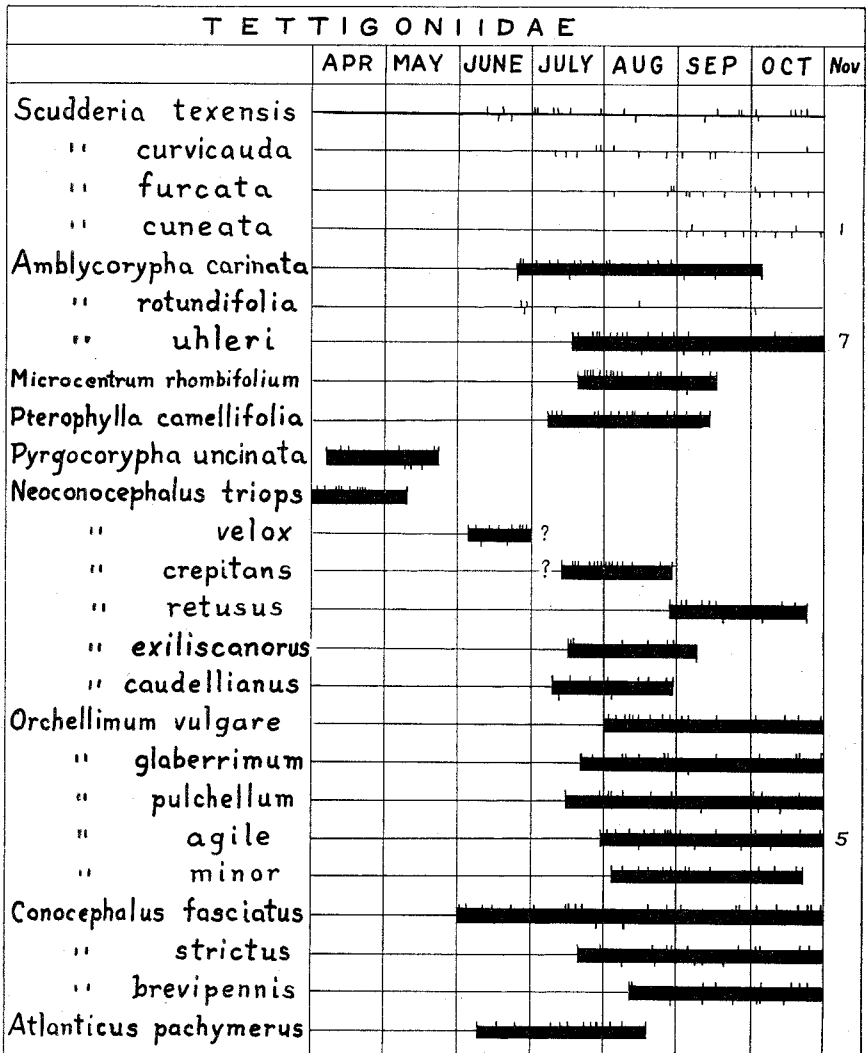


Fig. 1. Song periods of the common long-horned grasshoppers or katydids in the vicinity of Raleigh. See text for explanations.

years and include both early and late seasons, it is possible that the periods indicated may be somewhat longer than the period for a single year. Also, a gap between broods may be shorter than that found in a single year.

Descriptions of the songs have been omitted. Many of the songs have been described in the work of Blatchley (1920) which contains an excellent bibli-

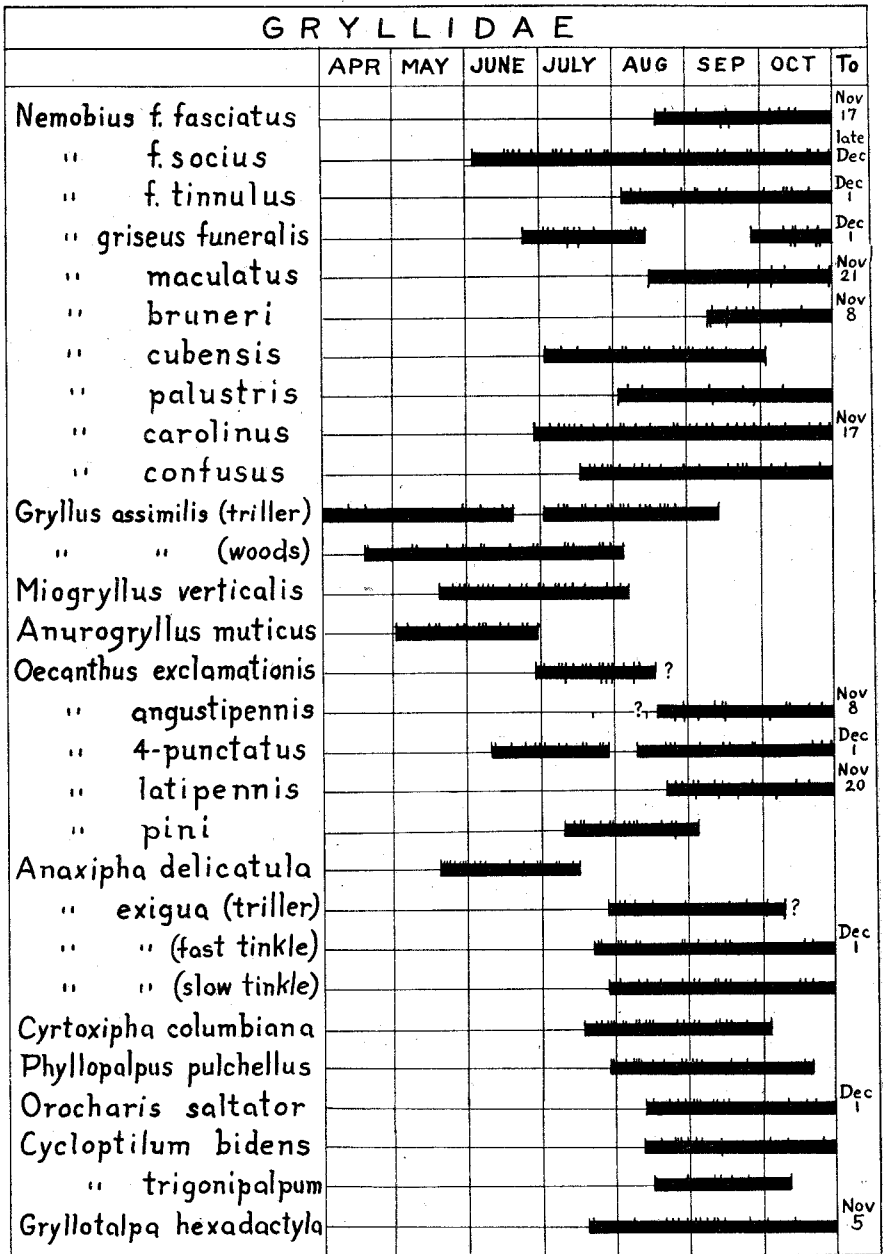


Fig. 2. Song periods of common crickets in the vicinity of Raleigh.

ography of publications up to 1920. Other song descriptions may be found in papers by Snodgrass (1925), Allard (1929), Cantrall (1943) and Fulton (1932). The last publication contains a key to the songs of most of the species mentioned in the present paper.

TETTIGONIIDAE

Scudderia texensis Saussure and Pictet. This species has one type of song that is not like any made by the other species of the genus. It is also less arboreal, frequenting tall grasses and weeds, so that specimens can usually be captured for verification. Adults are present over a long period which may indicate that it has more than one generation per year. The lack of records in late August and early September is probably just accidental, but could possibly be a gap between broods.

S. curvicauda (De Geer). Most of North Carolina is in an area of intergradation between the northern geographic race, *curvicauda*, and the southern race, *lati-cauda* Brunner. Raleigh specimens seem to the writer to be more like the latter race. Like other species of the genus, it sings only at occasional intervals. The song consists of a single short rasping note, or a rapid repetition of this note, three or four times.

S. furcata Brunner.

S. cuneata Morse. This and the preceding species sing very much like *S. curvicauda*. The collection dates indicate when these species are in the adult stage and probably can be heard.

Amblycorypha floridana carinata Rehn and Hebard. The status of the races of *floridana* is uncertain. Blatchley maintains they are all races of *A. oblongifolia* which has a northern distribution. Along the salt marshes on the North Carolina coast a form occurs with a distinct type of song, which may be typical *floridana*.

A. rotundifolia (Scudder). This species is not common near Raleigh, which accounts for the scarcity of records. Descriptions of its song from different localities do not always agree. Apparently it has a number of local dialects.

A. uhleri Stal. An insect with a very specialized type of song.

Microcentrum rhombifolium (Saussure). An arboreal species with two types of song.

Pterophylla camellifolia (Fabricius). This species is the true katydid, which is seldom seen because of its arboreal habits.

Pyrgocorypha uncinata (Harris). This species matures in the fall but sings only on warm nights in the spring.

Neoconocephalus. The first four members of this genus, *N. triops*, *velox*, *crepitans*, and *retusus* all have the same type of song, a loud continuous buzz. They divide the singing season between them. There seems to be a gap between the song periods of *triops* and *velox*. The song periods of *velox* and *crepitans* probably overlap in early July, so that records during that time should be verified by capture of specimens. The song of *crepitans* probably is louder but the difference is not great enough for identification as it is between *crepitans* and the weak-voiced *retusus*. *N. exiliscanorus* and *caudellianus* sing with rhythmically repeated synchronized notes and can be readily identified by the song.

N. triops (Linnaeus). This species has a seasonal history like *Pyrgocorypha*. It matures about the same time as *N. retusus* but remains silent until spring. It is the only species of katydid observed singing in March.

N. velox Rehn and Hebard. This species was considered rare until the writer discovered its June singing period.

N. robustus crepitans (Scudder).

N. retusus (Scudder).

N. exiliscanorus (Davis).

N. caudellianus (Davis).

Orchelimum. The songs of all members of this genus display some specific features, *glaberrimum* and *minor* being very distinct, while the other three follow a similar pattern.

O. vulgare Harris.

O. glaberrimum (Burmeister).

O. pulchellum Davis. This species is listed as *O. laticauda* Rehn and Hebard by Brimley (1938).

O. agile (De Geer).

O. minor Bruner.

Conocephalus. The members of this genus are very weak singers and can seldom be heard when other insects are singing.

C. fasciatus (De Geer). This species probably has more than one generation in North Carolina.

C. strictus (Scudder).

C. brevipennis (Scudder).

Atlanticus pachymerus (Burmeister). The abbreviated tegmina of this insect appear to be used only for stridulation.

GRYLLIDAE

Nemobius. All members of this genus have characteristic songs except the subspecies of *cubensis* as noted below.

N. fasciatus fasciatus (De Geer). This subspecies, which has only one generation per year, probably matures somewhat earlier in August than indicated by the graph. It can be heard in the Raleigh area only in certain restricted habitats.

N. fasciatus socius Scudder. This race has two and possibly three overlapping generations per year. It can be heard, day or night, for a continuous period from early June until late November and during some years can be heard on warm days until late December. This is the longest continuous song period of any local orthopteran. It is extremely abundant and has the widest habitat range of any member of the genus.

N. fasciatus tinnulus Fulton. A woodland race having one generation per year.

N. griseus funeralis Hart. This southern geographical race, once regarded as extremely rare, can be heard singing in almost any broomsedge (*Andropogon*) field, in midsummer or fall. It has not been recorded in late August or early September although an effort has been made to hear it during that time. Apparently the adults occur in two widely separated broods.

N. maculatus Blatchley. A species found in the climax forest or forest approaching that condition. The scarcity of records is due to the restricted habitat.

N. bruneri Hebard. This cricket is restricted to stream margins. According to the records its song period starts later than any other orthopteran.

N. cubensis cubensis Saussure. This race, which lives among marsh grasses, has a song indistinguishable from that of the *Sphagnum*-inhabiting race, *palustris*.

N. cubensis palustris Blatchley. This subspecies is listed as a species by Brimley (1938). It has been reduced to subspecific rank because it intergrades with *cubensis* in some parts of the United States. In North Carolina, the two races can be separated.

N. carolinus Scudder. The long song period of this species suggests the probability that it has more than one generation but no rearing has been done to prove it.

N. confusus Blatchley.

Gryllus assimilis Fabricius. Two well defined physiological races of the field cricket occur in the Raleigh area. These have not been separated on the basis of visible characters. One race has been called the "triller" because its song is a continuous trill. It lives in fields and has two generations per year. The first generation sings from March to at least the middle of June. This is followed by a period of one or two weeks during which the song disappears or becomes so rare that it has not been observed. In early July the second generation starts singing and continues into September. During some years a few adults sing in late fall. These are early-maturing individuals of the last generation which usually hibernate as large nymphs.

The other race, called "woods" because of its habitat, has only one generation a year. Its song consists of rhythmical chirps like the songs of two other races of *Gryllus* occurring in other parts of North Carolina.

Miogryllus verticalis (Serville).

Anurogryllus muticus (De Geer). Females of this species have been found as late as August 2, a month later than the recorded song period. They carry food to the young nymphs, which remain in the burrow until the second instar.

Oecanthus exclamationis Davis. This species and the following one have songs so similar that they cannot be distinguished with certainty. Both live mainly in the tops of forest trees so that it is difficult to obtain specimens. Probably the song periods overlap. There is no time in August when none can be heard but during some years there has been a noticeable drop in the number singing about the middle of the month.

O. angustipennis Fitch. The earliest adult captured was a recently matured one on July 21, 1930. This is an unusual record in view of the fact that on August 13, 1934, several nymphs were collected but only one adult and on August 25, 1934, some nymphs could still be found.

O. nigricornis quadripunctatus Beutenmuller. This species had two well defined generations per year. In late July or early August the song disappears for a week or two. The singing period of the second generation continues until the crickets are eliminated by heavy frosts.

O. latipennis Riley. The latest-maturing tree cricket. Its song can be identified by its pure tonal quality.

O. pini Beutenmuller. This specie appears to have only one generation per

year, unlike its close relative, *quadripunctatus*. Its song is like that of the latter species but can be identified because it is always in pine trees while the other is in herbaceous vegetation.

Anaxipha delicatula Scudder. This is the species listed by Brimley as *A. pulicaria*. It sings only in spring or early summer, stopping usually before the middle of July. The song is very much like that of the trilling race of *A. exigua* which starts singing about the last of July.

A. exigua (Say). This cricket has three different songs, which seem to differ only in the speed of the wing movements producing them. The race called the "triller" produces a high pitched continuous trill with a very rapid vibrato. It is usually heard in damp woods or shaded marshy places.

The other two forms produce a rhythmical series of distinct tinkling notes, each note apparently made by a single wing stroke. The two songs differ only in the frequency of notes, one being so slow that it is possible to count the notes and the other being a little over twice as rapid. Both tinkling songs are usually heard in the same places, most commonly in dense shrubs and thickets in sunny upland situations.

The distinct ecological distribution of the triller suggests that it may represent a distinct ecological race but the status of the other two is problematical. A few males caged alone were always observed to sing with only one type of song.

The observed periods of the fast and slow tinkle are almost identical. The shorter observed period of the triller may be due to its more restricted distribution as compared to the other two which can be heard about the observer's home.

Cyrtoxipha columbiana Caudell. The only cricket in the area known to synchronize its notes with other males in the same or neighboring trees.

Phyllopalpus pulchellus Uhler. Listed by Brimley as *Phylloscirtus*.

Orocharis saltator Uhler. A few individuals of this species have been recorded in August, but ordinarily the song begins about the first of September.

Cycloptilum bidens Hebard.

C. trigonipalpus (Rehn and Hebard).

Gryllotalpa hexadactyla Perty. The common mole cricket is the only species of mole cricket found in the Raleigh area. Its seasonal history in North Carolina has not been carefully investigated. The song period, extending from late July or August to November, seems clearly established but adult females have been found in April, May, and June, as well as during the song period. The writer's collection and that of the North Carolina Department of Agriculture contain only five male specimens, all of which were taken during the song period. Large nymphs have been found in May, June, July, and September and small ones in July.

An adult female and a large nymph, captured at New Bern, North Carolina, in May, were kept alive in a jar of sand. The adult deposited eggs on May 23 and again in early July. The eggs hatched in about sixteen days, but none of the offspring survived very long. The large nymph matured in July and mated with a male placed in the jar in October.

These data suggest the possibility of a two-year life cycle. According to this

theory the eggs are laid in the spring or early summer; the nymphs mature the following summer; the adults mate during the song period in late summer and fall; the males die during the winter while the females live and deposit eggs the following spring. This would account for the presence of both adults and nymphs at so many different times since there would always be two broods represented.

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