

NORTH CAROLINA'S SINGING ORTHOPTERA¹

By B. B. FULTON

The study of insect songs has four things to recommend it. (1) It may become an interesting hobby that one can pursue out of doors, after regular working hours, and which is satisfying to both the hunting and collecting instincts. (2) For the animal ecologist it may serve as a tool in the study of ecological distribution. The range and relative abundance of singing insects can be determined with comparative ease and accuracy. (3) To the student of evolutionary problems the interest lies in the fact that the songs of insects often serve as indicators of physiological varieties within the species. In the process of evolution physiological differentiation sometimes precedes the appearance of morphological characters and is most readily detected by differences in song habits. (4) To the taxonomist or collector a study of insects songs is valuable because it aids in the detection and capture of new or rare species.

Among our native species of Orthoptera there are three methods of sound production. The crickets (*Gryllidae*) and the katydids or long horned grasshoppers (*Tettigoniidae*) all sing by vibrating the front pair of wings. The edge of one wing scrapes a rasp on the under side of a specialized vein of the other wing. The short horned grasshoppers (*Acrididae*) have two other methods of producing sounds. Some make a loud clattering noise while flying by striking the front wings against the hind wings. When not in flight, some produce a faint rasping noise by rubbing the hind femora against the outer side of the front wings. Either the leg or the wing may be provided with a fine rasp. Sounds produced by the *Acrididae* have few characteristics to distinguish one from the other and have been omitted from the key. They are active only during the day. Most if not all of the *Gryllidae* and *Tettigoniidae* sing at night although many of them also sing during the day.

Some species have the ability to vary their songs somewhat and several have two types of songs so distinct that they would not be recognized as coming from the same insect. In cases where both types are

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commonly heard they have been included in the key with a number in parenthesis after the species name. In the Tettigoniidae the factors influencing the use of one kind of song or the other are not clearly understood but they seem to involve light and temperature. The large angular-winged katydid, *Microcentrum rhombifolium*, is the best example of a versatile songster in this family. The sound most commonly heard is a rapid series of ticking sounds made by drawing the wings together slowly so that each tooth of the file makes a distinct sound. At certain times nearly all of this species will be heard making a single loud rasping note by closing the wings quickly.

With the Gryllidae having more than one type of song, the choice seems to be influenced by the psychological state rather than physical environment. Some species have a special song which is used only when actively courting the female. Several species of *Nemobius* have this peculiarity, the mating song differing from the usual calling song in length and frequency of notes or in rhythm. Even more versatile is the mole cricket, *Scapteriscus acletus*, which is common in the southeastern part of the state. Its calling song is a continuous loud whistle, which is usually heard at night while the male is sitting at the entrance of a burrow. When courting the female it uses a rhythmical intermittent note. At other times, single chirps may be heard, especially when a colony is disturbed by an entomologist trying to dig them out of the ground. It seems probable that the single chirp may be a signaling or warning note. While relatively few species have more than one distinct type of song, the rate of wing movement in all species is so influenced by temperature that on extremely cool nights the character of the song may be considerably altered. Lowering the temperature prolongs the notes, reduces the frequency and lowers the pitch. Thus some songs that normally appear as continuous sounds may on cool nights become a series of distinct notes, or a note that usually lasts only a few seconds may be prolonged for a half a minute.

RHYTHM AND SYNCHRONISM

In the quality of rhythm the songs of the Orthoptera exhibit all possible degrees. Some have absolutely no rhythm, the notes being delivered at irregular intervals. Some show a slight regularity in rate of delivery while others have a repetition of notes that is definitely rhythmical but which does not hold constant at all times. Finally some have a constant rhythm, influenced only by temperature changes. A few of the last class go a step further and synchronize their notes so

that a group of singers gives the effect of being under the direction of a leader. Among the Orthoptera of this state only three species are known to synchronize. These are *Oecanthus niveus*, *Cyrtoxipha gundlachi columbiana*, and *Neoconocephalus exiliscanoris*. The first is the well known snowy tree-cricket and is found in this state only in the mountain regions. The second is a smaller cricket, common in trees in the piedmont and probably more widely distributed. The third is a large cone-headed grasshopper which appears to be rare in the state.

PHYSIOLOGICAL VARIATIONS

There are three races of a small ground cricket, *Nemobius fasciatus*, which have distinct songs and live in different habitats. The physiological variations in this case are accompanied by slight structural differences so that it is possible to give these races subspecific rank although it is very difficult to separate them on morphological characters alone.

The large ground cricket, *Gryllus assimilis*, has been observed to have at least two types of songs, which are associated with certain habitats and seasons. This species was formerly split into several species on the basis of a few extremely variable characters. The writer has not yet attempted to discover whether the recognized song types are correlated with any of these structural characters.

The small bush cricket, *Anaxipha exigua*, displays three kinds of songs in different individuals but so far no correlation has been discovered between these song types and habitat. Another member of this genus, *Anaxipha pulicaria*, has two song types which are definitely associated with different habitats. All that have been heard in fresh water marshes have a continuous song, while in the salt marshes all have an intermittent song. The wingless bush cricket, *Cycloptilum bidens*, occurs among clumps of sea oats on the coastal dunes and inland among the underbrush of pine woods. In the former habitat it sounds its notes at about twice as fast a rate as in the latter habitat.

Some song differences seem to be a matter of regional dialect. The true katydid, *Pterophylla camellifolia*, acquired its common name from its constant repetition of a three-syllable song phrase. In this state it sings in a southern dialect, usually with four syllables in each phrase and as often with five as with three. Snodgrass (4) states that in New England the katydid generally sounds only two syllables. It would seem that the name "katydid" must have been given to it at some point between North Carolina and New England.

The small round-winged katydid, *Amblycorypha rotundifolia*, in the sand hill region has an entirely different song than the same species in the mountains, and neither song entirely fits the descriptions of its song as observed in other places.

KEY TO SONGS OF NORTH CAROLINA KATYDIDS AND CRICKETS

The preparation of a key for anything so intangible as insect songs is a difficult task. Probably other observers perceive qualities in a song different from those which have impressed the writer. The time element is the only feature which can be measured with any accuracy and unfortunately this is subject to the effect of temperature, for which some allowance must be made. A thermometer has not often been at hand when the observations were made, but unless otherwise mentioned the descriptions found in the key do not apply to abnormally low temperatures. The writer believes that the key will be useful to students of insect songs and that its publication may stimulate others to take up this interesting study.

Group I. Tettigoniidae (katydids or long horned grass hoppers).

Rasping, buzzing, fluttering, or ticking sounds, having no quality of musical tone. Divided below into 5 groups, A to E.

A. Continuous buzzing or fluttering sound, or with breaks of only a fraction of a second occurring at irregular intervals.

1. Loud buzzing sound; night.

a. Midsummer to late summer, very loud. In tall grass, weeds or bushes.

Neoconocephalus robustus crepitans (Scudder)

b. Late summer and fall, not as loud as last. Usually in grass.

Neoconocephalus retusus (Scudder)

c. In April and May, song sometimes with brief breaks occurring at intervals of a few seconds. In tall grass weeds or bushes.

Neoconocephalus triops (Linn.)

2. Very faint fluttering sound, audible only a few feet away. In grass; day and night.

Conocephalus strictus (Scudder)

B. Single notes or brief rapid series of 1 or 2 seconds duration; intervals between notes or series at least 2 seconds and not regular; never constant singers.

1. Brief single note, described as "zip" or "zeet;" made by a simple closing of the wings.

a. Very loud and sharp, often repeated at 2-3 second intervals for a minute or more; in trees and bushes; at night.

Microcentrum rhombifolium (Saussure) (1)

b. Less loud, sometimes repeated a few times at intervals of several seconds; in tall weeds, bushes, small trees; late afternoon and night.

Phaneroptera furcata furcata (Brunner) (1)

Phaneroptera cuneata (Morse) (1)

Phaneroptera curvicauda (De Geer) (1)

2. Short series of brief confluent notes, made by vibrating the wings a few times while closing them; late afternoon and night.

- a. Rasping sound, described as "zee-zee-zee-zeet," not regularly repeated.

Phaneroptera furcata furcata (2)

Phaneroptera cuneata (2)

Phaneroptera curvicauda (2)

Phaneroptera texensis (Saussure-Pictet) (1)

- b. Shorter, crisper rasps, like tapping two heavy walled glass bottles together lightly. Made by 2 or 3 rapid wing movements. Has been described as "it-z-zic" or "kizizik." Repeated a number of times at intervals of 3 or 4 seconds or longer. In tall weeds, bushes, trees; at night.

Amblycorypha oblongifolia (De Geer)

- c. More prolonged sound (1-1½ seconds); 8 to 12 confluent notes, rapidly repeated; a softer sound than any other under B; increases in volume after starting. Usually in low meadows or marsh; late afternoon and night.

Phaneroptera texensis (2)

- C. Each song distinct and running through a regular program, starting with a faint buzz which gradually increases in volume and develops a rapid beat or undulation, then it changes to a rapid series of louder lisping notes and terminates with a brief vibrant note like the shaking of a dry pod full of small seeds. This last phase is then repeated a few times, and is followed by a period of silence before the next song is started. In tall weeds and bushes; at night.

Amblycorypha uhleri Stahl

- D. Song a more or less regular repetition of similar notes; rest intervals not over 1 second, generally a small fraction of a second.

1. Notes in series of various length; series separated by longer and variable period of rest (at least 1 second).

- a. A rapid series of ticking or tapping sounds at rate of about 7 or 8 per second, series lasting about 2½ to 3 seconds. In trees and bushes; night.

Microcentrum rhombifolium (2)

- b. Rasping sounds.

- (1) Series of 8-10 at rate of 2 per second; loud. In salt marshes.

Homorocoryphus malivolans (Scudder)

- (2) Longer series, 10 to 30 notes, intervals between notes very brief, observed rates at night 5 to 16 per 10 seconds. Woods and thickets, May to Aug.; mostly at night.

Atlantiscus pachymerus (Burmeister)

- (3) Series of 12-16, the first 4 to 6 notes longer and at rate of about 2 per second, then notes become shorter and rate

increases to about 4 per second; entire series lasting 4 or 5 seconds (observed at 74°F.). On oaks in sand hills; at night.

Amblycorypha rotundifolia (Scudder)

- (4) Series of brief rasps, too rapid to count, probably 10 to 12 per second; each series $\frac{1}{2}$ to 2 seconds duration; occasionally longer; rest intervals 2 to 4 seconds. (Observed between 65° and 70°F.). On bushes in mountains; at night.

Amblycorypha rotundifolia (Scudder)

2. Loud harsh notes in series of 3 to 5, duration of series less than 1 second, series constantly and rhythmically repeated. With anyone individual the number of notes per series is fairly constant, with occasional series having 1 more or 1 less. Most individual have 4 notes as the most common number. In tops of trees; at night.

Pterophylla camellifolia (Fab.)

(True katydid)

3. Notes continuously repeated.

- a. Notes of harsh rasping quality, rhythmically repeated at rate of 3 or 4 per second. At close range the sound never entirely ceases and is in reality a continuous buzz with a pronounced beat or rhythmical pulsation. In spring only; at night.

Pyrgocorypha uncinata (Harris)

- b. Short, sharp notes repeated rhythmically faster than one can count. In high grass or weeds; mountains; some singing in daytime, more at night.

Neoconocephalus ensiger (Harris)

- c. Prolonged, weak fluttering notes at rate of about 4 notes in 10 seconds. In tops of pines; day and night.

Orchelimum minor Bruner

- d. Very faint buzzing notes, audible only a few yards away, 1 or 2 notes per second; occasional notes preceded by a few rapid lisps as if stuttering. In brush; mountains; day and night.

Conocephalus nemoralis (Scudder)

- E. Alternating phases of short and long notes.

1. Very faint, audible only a few feet away.

- a. A rapid series of faint lisps preceding a prolonged buzz, regularly repeated. In grass; day and night.

Conocephalus fasciatus (De Geer)

- b. Long phase may be repeated 2 or 3 times between each series of lisps which usually do not exceed 3 or 4 in number. Extremely faint. Grass in wet places, either in woods or open marsh.

Conocephalus brevipennis (Scudder)

- c. Very irregular repetition of long notes of about 2 to 3 seconds duration and series of short notes at varying rates of 3 to 6 per second. Short notes do not have the lisping quality as in

two preceding species, but are a brief buzz of the same quality as the long note. On low bushes in open woods; day and night.

Odontoxiphidium apterum Morse

2. Louder, distinctly audible at least 5 yards away.

- a. One (sometimes 2) brief lisps followed quickly by a long note ($\frac{1}{2}$ second) repeated regularly at rate of about 16 per 10 seconds. Low places, on tall grass, weeds, bushes; day and night.

Orchelimum erythrocephalum Davis

- b. Two brief buzzes and 1 long, repeated regularly at rate of 6 series in 10 seconds. Observed on bushes near salt marsh; mostly at night.

Amblycorypha floridana carinata Rehn and Hebard

- c. One to 5 brief lisps at rate of 2-3 per second; long note $\frac{1}{2}$ to 1 second duration, rather weak and fluttering. On dune grass and borders of salt marshes; day and night.

Orchelimum concinnum Scudder

- d. Four to 6 lisps at rate of 6 per second, long note $\frac{1}{2}$ to 3 seconds duration; long note usually followed by brief pause. Borders of ponds and streams; day and night.

Orchelimum pulchellum Davis

- e. Several short lisps too rapid to count; long note 2 to 6 seconds duration, loud, increasing in volume and ending abruptly; no pause between series or between phases. On tall plants in fields; day and night.

Orchelimum vulgare Harris

- f. Similar to last and often found in same places; differs in having perceptible pauses between lispings phases and the long notes; less loud; long note is of uniform volume throughout and does not end so abruptly; day and night.

Orchelimum agile (De Geer)

- g. Short notes a series of very rapid ticking sounds continued for 2 to 5 seconds, long phase a monotonous buzz of 10 seconds or longer; phases have no regularity of length and there are no pauses between. Edges of salt marsh; day and night.

Orchelimum superbum Rehn & Hebard

- h. Song weak, fluttering; short notes 1 to 7 at rate of 3 or 4 per second, but when undisturbed these are usually omitted for long periods and song is almost entirely long notes, 1 to 4 seconds duration, pauses not over 1 second. Pond borders near coast; day and night.

Orchelimum militare Rehn & Hebard

Group II. Gryllidae (Crickets).

Shrill sounds having at least a trace of musical quality although never pure. In many cases a buzzing undertone is so pronounced that it is difficult to determine the pitch. The wing movement is usually rapid so that the sound produced

by the teeth of the file may be extremely high and accompanied by a low note due to the wing movement alone. The least musical songs in this group are not very loud. Most of the Tettigoniidae producing weak sounds have the alternating phases of short and long notes which is exceptional among the Gryllidae.

A. Continuous sound or with breaks of a fraction of a second occurring at irregular intervals.

1. With brief breaks at irregular intervals.

a. Relatively low pitched, clear, musical sound; in trees or vines; at night.

(1) Mostly in oaks.

Oecanthus exclamationis Davis

(2) In vines, bushes, trees.

Neoxabea bipunctata (De Geer)

b. Less musical; on the ground; day and night.

(1) Moderately loud, shrill, with some tonal modulation or slurring; at close range with a rasping undertone; usually with a rapid vibrato produced by the wing strokes; in fields, spring and summer.

Gryllus assimilis Fab.

(2) Fainter, more buzzing and monotonous; breaks in song only a small fraction of a second so that sound is almost continuous; in upland grass, mostly on sterile soils; summer and fall.

Nemobius griseus funeralis Hart

2. Continuous sound, ordinarily without any breaks; day and night except as otherwise noted.

a. With rhythmical undulation or beat at least part of the time; with buzzing undertone; beats apparently due to variations in speed of movement, not to single wing strokes.

(1) Constant rhythmical pulsation or beat at rate of 5 to 7 per second; on ground in mesic forest; late summer and fall.

Nemobius maculatus Blatchley

(2) With a droning quality, variable in volume, part of time louder and with rapid beat, alternating with periods of reduced volume, lower pitch, without beat; on ground in low woods, marshes or under thick cover in moist spots in any habitat; summer and fall.

Nemobius carolinus Scudder

(3) See b (1) (e) below. *Phylloscyrtus pulchellus*.

b. Without rhythmical pulsation or beat.

(1) Not very musical sounds, with vibrato or buzzing undertone, or moderately weak and extremely high pitched.

(a) With a tinkling vibrato, a succession of sharp chirps at approximately 12 per second at ordinary summer temperatures; in grass; common only in mountains; late summer and fall.

Nemobius fasciatus fasciatus (De Geer)

- (b) Similar to last but higher pitched, weaker, vibrato more rapid and not perceptible at high temperatures; gravel beds and sandy stream banks, not in thick woods; late summer and fall.

Nemobius bruneri Hebard

- (c) Extremely high pitched, on marsh grass; late spring and early summer.

Anaxipha pulicaria (Burmeister)

- (d) Similar to last; observed only in woods; on or near the ground; summer and fall; an uncommon song form.

Anaxipha exigua (Say)

- (e) Shrill but not very clear sound, with a faint suggestion of the sound produced by a wooden Halloween rattle whirled on a stick; in bushes and underbrush of open woods; at times with a distinct beat.

Phylloscyrtus pulchellus (Uhler)

- (f) A steady loud trill without modulations, at close range with a distinct buzzing undertone; on ground or in burrows, fields and lawns; at night only.

Anurogryllus muticus (De Geer)

- (2) Clearer tone, like a whistle, not extremely high pitched.

- (a) Shrill, moderately, loud, resembling sound of a tin whistle; day and night.

x. State wide distributions; on weeds.

Oecanthus nigricornis quadripunctatus Beutenmuller

y. Mountains; on coarse weeds, brambles.

Oecanthus nigricornis nigricornis F. Walker

z. Rare; on pine. (2 specimens collected by C. S. Brimley, in Hebard collection)

Oecanthus pini Beutenmuller

- (b) Louder, clearer and lower pitched than last; mostly in bushes, vines in or near woodland. At night only.

Oecanthus latipennis Riley

- (c) Very loud, clear, low pitched, singing at night in openings of burrows, moist sandy soil in south-east section. Calling song.

Scapteriscus acletus Rehn and Hebard (1)

B. Song of separate distinct notes.

1. Limited series of notes, all alike, faint and high pitched.

- a. 3 or 4 notes in series; notes and rests about equal; rate of 6 per 10 seconds; very weak and with buzzing undertone. In dense thickets under trees or in woods; singing at night.

Cycloptilum trigonipalpus (Rehn & Hebard)

- b. 3 to 10 notes in series; rate of 14-16 per 10 seconds; otherwise similar to last; on the coast; singing at night.

Cycloptilum antillarum (Redtenbacher)

- c. 30 to 40 notes in series; rate about 2 per second; faint brief notes like a light tap on one of the high keys of a xylophone; among leaves or low undergrowth of woodland, most common in pine woodland, sings to some extent in daytime.

Cycloptilum bidens Hebard

- d. 10 to 20 notes in series; rate about 4 per second; quality same as last; in tufts of sea oats, coastal dunes; at night.

Cycloptilum bidens Hebard

2. Notes repeated continuously, for indefinite period.

- a. Notes over 1 second in duration. When several are singing at same time they give the impression of continuous sound since the notes are not synchronized and it is difficult to detect when they start and stop.

- (1) Notes and rests about equal, usually 5 to 15 seconds each; weak, very high pitch; on ground; day and night.

- (a) On sphagnum moss.

Nemobius palustris Blatchley

- (b) Under dense low cover in marshes or moist places.

Nemobius cubensis Saussure

- (2) Notes longer than rests (except when first starting to sing); lower pitched and more musical than last group. Usually in trees, bushes, vines. On warm nights the first two of this group sometimes sing with notes 15-30 seconds long and with very brief rests and for this reason have also been placed under continuous song, A, 1, a. When starting to sing before dark notes are 2-10 seconds with $\frac{1}{2}$ to 1 second rests. The last species seldom has notes more than 10 seconds long and rest periods are 1 to several seconds.

- (a) Usually in oaks.

Oecanthus exclamationis Davis

- (b) Not common. Vines, bushes and trees.

Neoxabea bipunctata (De Geer)

- (c) Various trees, sometimes found on herbs and bushes under trees.

Oecanthus angustipennis Fitch

- b. Notes not over one second in duration. This group does not yield readily to further subdivision. Any single factor leaves certain species in an intermediate position. They have been arranged roughly on a basis of frequency of notes. Reference to other possible groupings outlined below may indicate the species by elimination.

On ground. (2) (3) (4) (8) (9) (10) (12) (14)

On low plants. (5) (6) (13)

On large bushes, vines. (1) (7) (13)

In trees. (1) (7) (11)

Notes synchronized (7) (11)

Rhythm almost constant, not synchronized. (8) (9) (10)
(13) (14)

Regular repetition with somewhat changeable rate. (1) (2)
(4) (5) (6) (12)

Length of notes and rate changeable. (3)

Known distribution limited to southeast. (3) (5) (6) (9)

Limited to mountain region. (7)

Clear tonal quality (1) (7) (8) (9) (11) (13)

Less clear (3) (5) (6) (10) (14)

With distinct buzzing undertone (2) (4) (12)

Loudest (1) (7) (8) (9) (10)

Weakest (2) (4) (5) (6)

- (1) 5 to 8 notes in 10 seconds; rests distinctly longer than notes; clear, high pitched, moderately loud, trills, like "peep-peep;" in vines, bushes, trees; late afternoon and night.

Orocharis saltator Uhler

- (2) 6 to 11 notes in 10 seconds; weak sound with buzzing or rasping undertone; on ground; many habitats; few singing by day, mostly at night.

Miogryllus verticalis (Serville)

- (3) 6 to 10 notes in 10 seconds; weak, slightly creaky notes, increasing in volume and pitch after starting; very irregular in length, usually $\frac{1}{2}$ to 1 second but occasional notes 2 to 3 seconds long; when mating, brief chirps 3 or 4 per second; in salt marshes under plants; day and night.

Nemobius sparsalusus Fulton

- (4) 1 or 2 per second; weak buzzing notes. At a distance of a few feet each note can be heard to start with 2 (rarely 3) brief rises in volume after which it increases in volume to the end; sounding like a repetition of 2 short weak notes and one longer, louder note. On ground in woods; day and night.

Nemobius confusus Blatchley

- (5) 1 to $2\frac{1}{2}$ per second, rate variable, weak with buzzing undertone; underbrush on wooded sand ridges near coast; some singing during day, more at night.

Anaxipha pulicaria vittata (Bolivar)

- (6) 2 to 4 per second, similar to last; on *Juncus* in salt marshes or on *Iva* on dunes; mostly at night. Apparently a physiological race.

Anaxipha pulicaria (Burmeister)

- (7) 2 per second at 65°F., to 3 per second at 85°F., moderately low pitched, loud, clear notes with constant rhythm; synchronized with others near by; in trees or bushes in mountain region; at night.

Oecanthus niveus (De Geer)

- (8) 2 to 3 per second; lowest pitched cricket song; often thought to be a frog; loud, clear, rhythmical but not synchronized; in burrows or sometimes on ground at night; day and night.

Gryllotalpa hexadactyla Perty

- (9) Similar to last; occurs only in southeast portion of state; a mating song only of this species, more frequently heard in daytime. See A, 2, b, (2), (c).

Scapteriscus acletus Rehn and Hebard (2)

- (10) 3 to 5 per second; loud creaky notes; on ground in woods, and on coastal dunes; some singing in daytime, more at night.

Gryllus assimilis Fab.

- (11) 3 to 4 per second; high pitched, clear; with constant rhythm; synchronized with others near by; in trees, none observed less than 6 feet from ground; late afternoon and night.

Cyrtoxipha gundlachi columbiana Caudell

- (12) 3 to 7 per second, rate variable; with rasping undertone; sometimes in series of 7 to 9 notes with slight drag on last note (mating song); on ground, grass land; day and night.

Nemobius fasciatus socius Scudder

- (13) 4 to 8 per second (apparently two forms, one having rate about twice as fast as the other); very high pitched, tinkling notes; on tall grasses, herbs, bushes or vines; day and night.

Anaxipha exigua (Say)

- (14) 6 to 8 per second; sharp high pitched chirps, less clear than last; at times about half as fast (mating song); on ground, in pine or oak woodland; day and night.

Nemobius fasciatus tinnulus Fulton

NOTES ON SPECIES OMITTED FROM THE KEY²

No species were included in the key whose song is not known to the writer. Most of the species omitted are rare in the state or restricted in distribution.

Limited observations were made on a single caged specimen of the rare *Symmetropleura modesta* Brunner on July 25, 1930. It repeated a short, weak note, with abrupt termination, like "thk-thk," at a somewhat variable rate close to one note per second at a temperature estimated at about 85°F. At first it sang in short series with as few as 7 notes each, but later continued for sometimes as many as 50 notes. Whether it would keep up a continuous repetition under more normal circumstances is still open to question.

The song of the uncommon *Microcentrum retinerve* (Burmeister) has been described by Allard (1) as "several lisping or rasping phrases rapidly delivered, each successive phrase being shortened usually thus: Sh-sh-sh-sh—sh-sh-sh—sh-sh. The usual number is three, although rarely four may be given. In low temperatures only one phrase may be given. This succession of phrases is given at very irregular and infrequent intervals as the creatures are roaming over the crowns of trees, usually not oftener than one to three in a minute."

The large cone-headed grasshopper, *Neoconocephalus exiliscanorus* (Davis), has been found but not heard by the writer. It is an inhabitant of marshy places. The song is described by Rehn and Hebard (3) as a "vibrant rattling note rising and falling in intensity, often ceasing as if from exhaustion." On warm evenings the rate is about 3 per second and each series has from 14 to 26 notes. Allard (1) observed that singers near each other maintain perfect synchronism.

The song of *Neoconocephalus palustris* (Blatchley), an inhabitant of fresh water marshes, is described by Rehn and Hebard (3) as similar to *N. retusus*. Two other species of the same genus probably occur in the

² Two species not previously found in the state were found during 1931 in vicinity of Lakeview, N. C. (a) *Nemobius ambitiosus* Scudder: Song would come in key under II, B, 2, b. Notes of calling song about 6 in 10 seconds, weak, moderately clear, with noticeable tremolo, and slightly crescendo. Mating song weaker but faster, 15 to 20 notes in 10 seconds or at times notes are run together making continuous sound for 1 to 5 seconds. (b) *Belocephalus subapterus* Scudder: Song would come in key under I, D. It is a series of moderately loud, distinct rasps too rapid to count. Series lasts one or more seconds and repeated a number of times between longer periods of silence. The song of one generally stimulates others to sing.

state for they have been found both north and south of us. They are *N. melanorhinus* (R & H) and *N. caudellianus* (Davis). The former is confined to salt marshes and the latter is more widely distributed in marshy areas and fields. Rehn and Hebard (3) have described the songs of both species. The song of the former is a continuous buzz similar to *N. robustus crepitans*, but weaker and less harsh. The latter has an intermittent song described as "loud, resonant and constant dzeeet-dzeeet-dzeeet, always the same, not rising and falling, the notes given deliberately, counted as averaging 12 in 10 seconds."

Two other species of *Orchelimum*, whose songs the writer has not found described, are known to occur in the state. *Orchelimum fidicinium* Rehn & Hebard³ occurs in salt marshes from Long Island to Florida and *O. bradleyi* Rehn & Hebard³ is a fresh water marsh inhabitant found at Greenfield Pond near Wilmington and southward.

The writer has not heard the songs of five other species of *Conocephalus* known to occur in the state, and no published descriptions of them could be found. Three of these are salt marsh species, namely *aigialus* Rehn & Hebard, *nigropleuroides* (Fox) and *spartinae* (Fox).³ *Conocephalus strictomerus* Rehn & Hebard has been found in both fresh and brackish marshes. *Conocephalus saltans* (Scudder), a common species in xeric grassland, has very small tegmina and probably has a very weak song. Another species, *C. allardi* (Caudell) has been found in the mountain regions of Virginia and Georgia and probably occurs in North

³ During 1931 the author observed the songs of several of the above species:

Orchelimum fidicinium: Similar to *O. militare* except that notes are only about $\frac{1}{2}$ second in length. Both species have notes of distinct fluttering quality. In *O. minor* this quality is even more pronounced and in *O. concinnum* it is less distinct but the other members of the genus have a steady buzz in the long notes.

Orchelimum bradleyi: Comes closest to the song of *O. erythrocephalum* but slower and not so loud. Song usually a fairly regular repetition of a brief flutter followed immediately by a crescendo buzz, at a variable rate of 6 to 10 in 10 seconds. At times the preliminary short note is hardly audible and occasionally it may be repeated several times.

Conocephalus aigialus, *C. nigropleuroides*, and *C. spartinae*: These three species (both sexes) were caged in the laboratory for several days, a few brief songs of the last two were heard. They were very weak like *C. brevipennis* and they did not sing long enough to bring out any characteristic qualities. Apparently they are all poor singers and it is doubtful if they could ever be heard in the salt marsh where much louder singers are abundant.

Atlanticus monticola: Song observed at 55°F. Audible about 30 or 40 feet, a soft rasping sound, each note plainly of 3 wing movements. Notes repeated about two per second when regular, but there are many longer pauses so that the actual rate varies from 10 to 16 in 10 seconds.

Carolina. Its song has been described by Blatchley (2) from notes by Allard as soft, faint, and often greatly prolonged phrases with no short lisping notes.

No descriptions could be found of the song of the three other species of *Atlanticus*, known to occur in North Carolina, namely, *monticola* Davis,³ *gibbosus* Scudder, and *americanus* (Saussure).

Only two North Carolina species of crickets having a stridulatory mechanism have been omitted from the key. *Hapithus agitator* Uhler, a common, medium sized cricket has not been heard out of doors by the writer. It apparently seldom sings and the sound is so faint that it is doubtful if it could be heard where other insects are singing. A male caged with a female was once caught in the act of singing while following the female about the cage. Its song was a creaky, fluttering sound, continued for 15 to 25 seconds at a time, so weak that I had to hold one ear close to the top of the jar in which the insects were confined in order to hear it distinctly. The stridulatory vein of a specimen of *Hapithus* examined under a microscope showed only 35 rather widely spaced teeth.

Fallicula hebari Rehn, the other cricket omitted from the key, is one of our smallest crickets. It has no visible auditory organs on the front tibiae and the stridulatory vein is very small with only about thirty faint cross ridges. It is doubtful if it makes any sound audible to the human ear.

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