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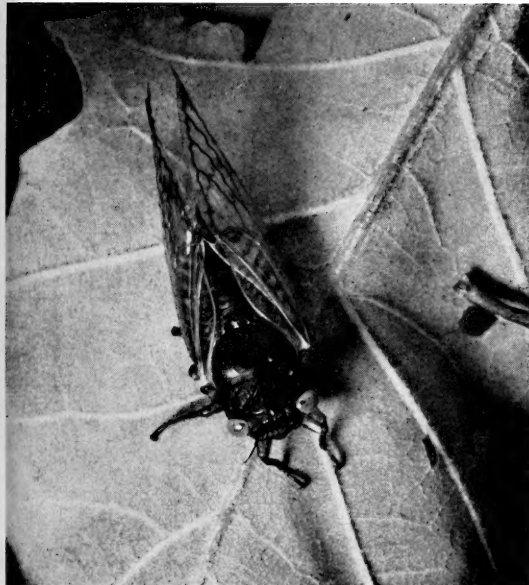


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THE DISTRIBUTION OF PERIODICAL CICADAS IN ILLINOIS

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The Distribution of Periodical Cicadas in Illinois

Lewis J. Stannard, Jr.

For decades, entomologists have relied upon Marlatt's (1907) compilation of the distribution of the broods of the periodical cicada to forecast emergences of these insects. Such forecasts are especially important to persons concerned with protecting trees and shrubs. Unfortunately, as will be shown in this report, many of Marlatt's records are in error. In their place, a more accurate picture of cicada distribution in Illinois, as observed over the past 10 years, is given here. Additional surveillance of periodical cicadas could be continued profitably to pinpoint exact boundaries of their ranges in some of the central counties of our state, to determine the rates of their dispersal to new areas or extirpation from original areas, and to obtain information on the possibility of introgressive hybridization between broods.

To orchardists, nurserymen, and horticulturists, periodical cicadas are more than mere curious and interesting insects. Even though they occur infrequently (once every 13 or 17 years), they may damage more than 95 percent of the terminal shoots of young fruit trees (Hamilton 1962) or ruin the shapes of specimen trees or choice shrubs. When one considers that as many as 20,000 cicadas may emerge from beneath one apple tree, it is easy to understand how so many twigs can be destroyed during the cicadas' egg-laying process (Hamilton 1962). Trees whose terminal shoots are killed by cicadas usually recover by epicormic branching, according to my observations, but fruit production in orchards can be severely curtailed, causing substantial economic loss.

This report is presented primarily as an aid to fruit growers in making accurate predictions of emergences of periodical cicadas and as a contribution to our basic knowledge of these unusual insects.

ACKNOWLEDGMENTS

I wish to express my appreciation to the staff of the Illinois Natural History Survey, extension entomologists of the University of Illinois, county extension advisers of the state of Illinois, and the many persons in our state who have helped to collect specimens and have shared their observations on the distribution of cicadas over the past 10 years. Without their assistance the state could not have been covered thoroughly in the approximately 3 weeks of the par-

tical years when these insects exist above ground as adults.

My particular thanks are extended to Drs. Thomas E. Moore and Henry S. Dybas for their advice, suggestions, and many favors, especially to Dr. Dybas for reviewing the manuscript. I am further obliged to Mr. Wilmer D. Zehr, who photographed the specimen appearing on the cover; to Mr. Lloyd Le Mere, who prepared the maps; to Mrs. Bernice Sweeney, who typed the manuscript; and to Mr. Robert M. Zewadski, who edited it for publication.

THE ILLINOIS BROODS

With the exception of woods in certain areas that are predominantly sandy (in extreme northeastern Lake County, in eastern Iroquois and Kankakee counties, and in areas in Lee, Ogle, Mason, and a few other counties) almost every wooded section of Illinois is inhabited by a brood of periodical cicadas. Of the five Illinois broods, three have 17-year life cycles and two have 13-year life cycles. A report of their distributions, based mostly on data gathered over the 10 years from 1963 to 1973, is presented here. Documentary notes for this report and the specimens are kept in the collections of the Illinois Natural History Survey (INHS). The research for this report was essentially completed in 1973, and the report was submitted for publication in December 1973.

HISTORICAL RECORDS

One of the first entomologists to record Illinois broods of periodical cicadas was Asa Fitch in 1856. Fitch thought, as did everyone at that time, that all cicada broods in the USA had life cycles of 17 years' duration. The first brood he mentioned as being from Illinois ("Southern Illinois") was the 13-year Great Southern Brood (Marlatt's XIX), which emerged in 1855 simultaneously with an adjacent eastern brood (Marlatt's XIV). Fitch lumped these together as his "third" brood, later analyzed by Walsh & Riley (1868). The other Illinois brood mentioned by Fitch was the 17-year Northern Illinois Brood (Marlatt's XIII) as his "sixth" USA brood. He stated that this brood extended across northern Illinois, ranging as far south as Peoria, in 1854.

Shortly after the appearance of Fitch's work, Cyrus Thomas, the "father" of the Illinois Natural History Survey, learned of records of a third brood of cicadas

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in Illinois, the 13-year Lower Mississippi River Valley Brood (Marlatt's XXIII), which emerged in Union and Jackson counties in 1859. Thomas thought that this brood also had a 17-year life cycle (Thomas 1865:458-459).

In 1868 Benjamin Walsh and C. V. Riley raised the number of Illinois broods to four, adding the 17-year Iowan Brood (Marlatt's III). These authors also suggested that another brood, Marlatt's IV, might occur in Illinois, but this has not proved to be the case. Further, they outlined the range of the Great Southern Brood (Marlatt's XIX) in Illinois, and with few exceptions the range is the same today, according to my 1972 findings.

In the same year, 1868, Riley reported that not all broods had 17-year life cycles but that some had 13-year life cycles. Riley's discovery was made during his study of the Great Southern Brood (Marlatt's XIX), wherein he noted an 1803 record from Alton, Illinois. According to Marlatt (1907), Dr. D. L. Phares of Mississippi probably was the very first, in 1845, to "announce the 13-year period for the southern broods," but because the article was published in a newspaper with local circulation, this notice did not come to the immediate attention of entomologists.

In the following year (1869) Riley published his first annual report on the insects of Missouri and expanded his and Walsh's previous treatment of periodical cicadas by incorporating information from a manuscript written by Dr. Gideon B. Smith of Maryland, then deceased. (This manuscript was published in its entirety by Marlatt in 1898.) From the 16 broods estimated to exist in the USA in 1868, Riley increased the list to 22 broods, changing the numbers of all broods except Brood I. Riley continued his surveillance of periodical cicadas, publishing on them and including Illinois records, until 1894 just before his untimely death from a fall in 1895.

By 1869, therefore, the literature referred to broods numbered separately and differently by Fitch (1856), Walsh & Riley (1868), and Riley (1869). The records included well-documented data as well as mere recollections, some of which were considered questionable at the time and some of which have since proved to be in error.

A couple of years later in 1871, William LeBaron (1872) wrote that "one of the special duties of the State Entomologist of Illinois, in the season of 1871, [was] to determine, as nearly as possible, the range of the present brood, and to make a record of it, which may be consulted by those who may take an interest in this matter, seventeen years hence." His detailed report of the distribution of this brood, the

Northern Illinois Brood (Marlatt's XIII), fits well within the broad limits mentioned by Fitch in 1856 and confirmed by my own survey in 1973. LeBaron personally noted the absence of this brood in Mason County, supposedly because of some effects of the sandy soils in this county. However, a Mr. J. Cochrane of Havana, Mason County, convinced LeBaron that a brood emerged in large numbers in Mason County in 1859 or 1860, which LeBaron thought might really be 1861, the year when the Iowan Brood (Marlatt's III) emerged. This supposed emergence, inexactly recalled some 10 years after its alleged occurrence, does not fit with recent data and probably should be discarded as questionable evidence.

It was not until 1885, when Riley made special inquiry of many persons, that the 17-year Great Eastern Brood (Marlatt's X) was proved to occur in Illinois at the eastern border and became the fifth Illinois brood. Some scattered precocious or late emergences of out-of-season broods undoubtedly were included in these Illinois records, but in general, Riley's limitations of the range of this brood in Illinois are the same as those noted in recent years. A sixth Illinois brood, mentioned by Riley in 1885, is probably incorrect, according to my data.

U.S. government entomologists L. O. Howard, C. L. Marlatt, F. M. Webster, M. V. Slingerland, and others became active in the survey of the USA cicada broods in the 1890's and early 1900's. At the Bureau of Entomology, Washington, D.C., at first under Riley, Marlatt eventually took over as the principal compiler of the ranges of the broods. In 1907 (reissued in 1923) Marlatt published what was then the most complete and definitive work on the periodical cicada. In it he compiled all the principal literature and records for each brood, including, unfortunately, the questionable records. He increased the number of broods to 30 even though he considered some doubtful. It was as if Marlatt wanted the total number of broods to equal the sum of the two life cycles ($17 + 13$), and to achieve this equality, he appeared willing to include any record he could find. Furthermore, he renumbered the broods differently than had Riley in 1869. Generally, Marlatt's numbered designations have been accepted and are in use today. Instead of 30 broods, Alexander & Moore (1962) believe that there may be no more than 18 valid broods in the eastern USA.

S. A. Forbes, head of the predecessor organizations of the Illinois Natural History Survey, his staff, teachers, and others continued to gather data on the Illinois broods and supply Riley, Howard, Marlatt, and others with information. Most of the early cicada specimens, if any were kept, are no longer in the Survey's collections. The Survey has only a few

specimens from 1894, a few from the first decade of the 1900's, and a few collected in central Illinois over the next 50 years.

In 1956 the Northern Illinois Brood (Marlatt's XIII) again emerged in high numbers and inspired Henry S. Dybas of the Field Museum of Natural History, Chicago; Thomas E. Moore, then at the Illinois Natural History Survey, Urbana; and Richard D. Alexander, formerly of White Heath, Illinois, to begin new studies on cicadas. Their discoveries caused renewed interest in these insects, opening new types of inquiry and leading to new conclusions on the nature and origin of the possible species involved and the broods. They, along with Monte Lloyd, D. Dwight Davis, and James Heath, made and are making in-depth studies on the exact niches of the species, their songs, and their possible dispersal after deglaciation.

EXCLUDED BROODS

Several broods besides those whose distribution is treated here were purported by Marlatt and others to occur in Illinois. One of these, Marlatt's XIV, was said to extend across the northern border of Illinois. Although observations on periodical cicadas of Illinois have not been regularly made until recent times, the lack of records of this brood in the INHS collections has some significance. Alexander & Moore in 1957 (an emergence year for Brood XIV) did record single specimens in Illinois and Iowa, but they considered these cicadas to be stragglers from the previous year's emergence of the Northern Illinois Brood (Marlatt's XIII) (Alexander & Moore 1962:18). Very few cicadas were found in intensive searches in 1974, and this fact, coupled with the negative evidence of previous years, would indicate that Brood XIV does not, and probably never did, occur in Illinois.

Another brood (Marlatt's XII) reported by Marlatt (1907) to be in Illinois almost certainly does not exist in our state, if indeed it is a valid brood anywhere in the USA. In 1972, when this brood was to emerge, I made repeated trips to Jo Daviess County and neighboring counties, and enlisted the help of naturalists, state park rangers, and landowners in attempts to locate populations of this alleged brood. No cicadas were found. Marlatt, himself, felt that this was a doubtful brood and reported that Forbes had failed to locate it in northwestern Illinois. Probably the records of this brood in Illinois were based on precocious cicadas of the Northern Illinois Brood (Marlatt's XIII) which emerged a year early.

Marlatt's I was recorded by Marlatt (1907) as being questionably present in Madison County, but the Illinois Natural History Survey has no records or specimens of this brood. Alexander & Moore (1962)

did not list any Illinois records of this brood, which they studied in detail in the East in 1961.

Marlatt's VI was purported to occur in Illinois from localities where cicadas were said to have emerged in abundance in 1898. In the S.A. Forbes correspondence of 1898 in the archives section of the University of Illinois Library is a request from L. O. Howard of the Bureau of Entomology, Washington, D.C., for cicada information. This request prompted Forbes to send a circular letter to teachers and superintendents of schools asking for data on cicadas emerging in 1898. Besides Forbes, Howard asked other correspondents for information on these cicadas. By June 20, 1898, Howard informed Forbes that he had received a large amount of data from Illinois. The records received by Forbes and Howard from Crawford, Jackson, Jasper, Lawrence, Perry, Pulaski, Union, Wabash, and Wayne counties can be referred to the Lower Mississippi River Valley Brood (Marlatt's XXIII), and this distribution fits well with our present-day records. The other records reported by Howard, especially those supposedly of Marlatt's VI in central Illinois, must be considered doubtful, as we have no specimens in the Natural History Survey collection from this region in 1898 or the following years during which this brood appeared. It should have reappeared in 1966 if it really exists in Illinois, but no observers at the Illinois Natural History Survey have any notes or recollections of this brood's emerging at that time.

THE SPECIES OF PERIODICAL CICADAS

During the years when the surveillance of periodical cicadas was dominated by Riley and Marlatt, it was generally thought that two races existed, the 17-year cicada, *Tibicen (Cicada) septendecim* (Linnaeus), and the 13-year cicada, *Tibicen (Cicada) tredecim* Riley, with a dwarf form known as *cassini* Fisher. Walsh argued (Marlatt 1907:17; Lloyd & Dybas 1966b), and even corresponded with Charles Darwin on the subject, that the 13-year race was an incipient species because the 13-year race and the 17-year race occasionally have opportunities to interbreed; yet no intermediate emergences (14-, 15-, or 16-year intervals) result.

In 1931 Beamer, in 1958 Alexander & Moore (see also Moore & Alexander 1958), and in 1962 Dybas & Lloyd, on the basis of morphological and behavioral distinctiveness, independently arrived at the conclusion that *Magicada septendecim* and *M. cassini* were separate species. In 1962 Alexander & Moore recognized six full species, *M. septendecim*, *M. cassini*, and *M. septendecula* Alexander and Moore for the 17-year broods, and *M. tredecim*, *M. tredecassini* Alexander and Moore, and *M. tredecula* Alexander and Moore

for the 13-year broods. Apparently no differences exist between the matching pairs of species of the 13- and 17-year broods; they are merely more or less isolated from each other for 13-17 generations.

In Illinois, at least, one 13-year brood, the Great Southern Brood (Marlatt's XIX), is not as isolated from 17-year broods as might be expected. Along the border of the range of this brood, contacts with all of three 17-year broods may occur within 221 years, and contact with one of these three 17-year broods could and possibly does occur every 65 years (five generations) or 78 years (six generations), as indicated in Table 1. If such contacts are made, enough hybridization may occur to prevent isolation of the "incipient species."

TABLE 1. — Dates of simultaneous emergences of a 13-year brood and each of three 17-year broods of periodical cicadas in Illinois. (Mathematically, 65 and 78 are functions of 13.)

Interval in Years	Broods and Years of Emergences			
	Great Southern (XIX) (13-year) 1972	Northern Illinois (XIII) (17-year) 1973	Great Eastern (X) (17-year) 1970	Iowan (III) (17-year) 1963
	1582	1582		
65	1647		1647	
78	1725			1725
78	1803	1803		
221				
65	1868		1868	
78	1946			1946
78	2024	2024		
221				
65	2089		2089	
78	2167			2167
78	2245	2245		
221				

If the matching pairs of 13- and 17-year cicadas are merely phases of the same species, three full species might remain. Each would have its own niche, the small *M. cassini* living on roots of bottomland trees, the large *M. septendecim* living on roots of upland trees, and *M. septendecula*, intermediate between the first two and rarer, developing primarily on hickory and walnut roots (Dybas & Davis 1962; Dybas & Lloyd 1974).

It seems hardly possible that *M. septendecim* is a single species with three forms, resulting from development in separate and different habitats, and with two phases — 13-year and 17-year — primarily resulting from environmental influences. However, the order Homoptera, to which these cicadas belong, is well known for having species that develop highly

divergent forms in response to their feeding substrates. Some scale insects, for example *Aspidiotus ancylus* (Putnam), produce divergent forms according to whether they feed on bark or leaves or on certain trees and vines; these forms once were considered to belong to separate genera (Stannard 1965). Some leafhoppers produce forms with radically different types of genitalia, depending on temperature influences (Müller 1957). Even so, the possibility that there is just one species with forms having their own songs, their own times of day for singing, preferences for mating with their own kinds, and their own feeding niches appears remote in the light of our present knowledge and contradicts generally accepted concepts of species.

In this report only the broods will be considered; the nature of the species and their evolution have been well discussed by Lloyd & Dybas (1966a and 1966b) and Dybas & Lloyd (1974).

STRAGGLER CICADAS

Stragglers from the 13- and 17-year sequence do occur with some frequency. Usually, according to most records, only a few individuals emerge at these off times, and there seems little chance for mating and production of progeny. In 1969, however, a large number of stragglers emerged in the Chicago area. This emergence was of further singularity because it occurred at the close of a 13-year interval in a region where only a 17-year brood was known. Dybas (1969) made an extensive study of these "13-year stragglers" and concluded that he may have had a "ringside seat" along the evolutionary pathway on which 13-year cicadas were derived from 17-year cicadas. He assumed that the cicadas of this particular emergence probably would not develop into a new brood because of the usually cold climate of Chicago. Dybas postulated that the heat effect of the city may have had some influence on these particular stragglers, causing them to emerge so early.

Stragglers that emerge in the fall of the year can be positively identified as deviates, but those that emerge in the regular season (May and June) need to be analyzed with considerable care. These spring stragglers seem to have provided the basis for all the false broods listed by Marlatt and others. Most stragglers emerge early, in the year before the main brood is due.

Supposed Illinois Stragglers

Unless otherwise stated, data refer to single specimens in the INHS collection.

1904. Riverside, Cook County. Possibly not 1907, as given by Alexander & Moore (1962). The last digit appears to be a 4 rather than a 7. This

is a possible 1-year-early emergence of the 17-year Northern Illinois Brood (Marlatt's XIII) of 1905.

1932. Urbana, Champaign County, University Woods, September 6. Rocky Branch, Clarksville, Clark County, June 24. These are possibly 1-year-early emergences of the 13-year Great Southern Brood (Marlatt's XIX) of 1933.
1957. Sullivan, Moultrie County, "late in season," H. B. Cunningham, six specimens. This is possibly a 1½-year-early emergence of the 13-year Great Southern Brood (Marlatt's XIX) of 1959.
1969. Lisle, DuPage County, June 6, L. J. Stannard, just emerged at edge of a lowland woods in Morton Arboretum. Chicago Heights, Cook County, June 11, H. B. Petty. Chicago area, many specimens reported to the Natural History Survey extension staff. (See Dybas 1969 for extensive list of localities in the Chicago region.) These are assumed to be 4-year-early emergences of the 17-year Northern Illinois Brood (Marlatt's XIII) of 1973.
1971. Barry, Pike County, June 9, J. Cruttenden, several specimens. Tentatively assigned to *M. tredecassini* by T. E. Moore (personal communication 1971). These are probably 1-year-early emergences of the 13-year Great Southern Brood (Marlatt's XIX) of 1972. Mr. Cruttenden recalls the presence of this brood in the area in 1959.
1972. Lisle, DuPage County, October 12, J. Appleby, one adult next to its shed skin, emerged after flood in Morton Arboretum. This is possibly a half-year-early emergence of the 17-year Northern Illinois Brood (Marlatt's XIII) of 1973.
1973. Mahomet, Champaign County, Nettie Hart Memorial Woods, June 6, M. W. Sanderson. This is a possible 1-year-late emergence of the 13-year Great Southern Brood (Marlatt's XIX) which emerged in 1972.
1974. Lisle, DuPage County, May 29, J. Appleby, one adult on bush. Ohio, Lee County, May 23, Gene R. Kritsky, one adult in flight hit car. These are probably 1-year-late emergences of the 17-year Northern Illinois Brood (Marlatt's XIII).

Other supposed stragglers in the USA have been listed by Alexander & Moore (1962) and in the Chicago area by Lloyd & Dybas (1966b).

DISTRIBUTION OF THE BROODS OF ILLINOIS

Because many of Marlatt's broods probably do not exist and because several numbering systems, each

differing from the others, have been used, the Illinois broods listed here are designated by geographical names with the corresponding Marlatt numbers for easy reference. These geographical names should be more meaningful than numbers and indicate relationships with populations outside the state.

The Iowan Brood (Marlatt's III)

The Iowan Brood has a 17-year cycle and most recently emerged in 1963. Records (Fig. 1) were obtained from May 26, 1963 along the Spoon River,

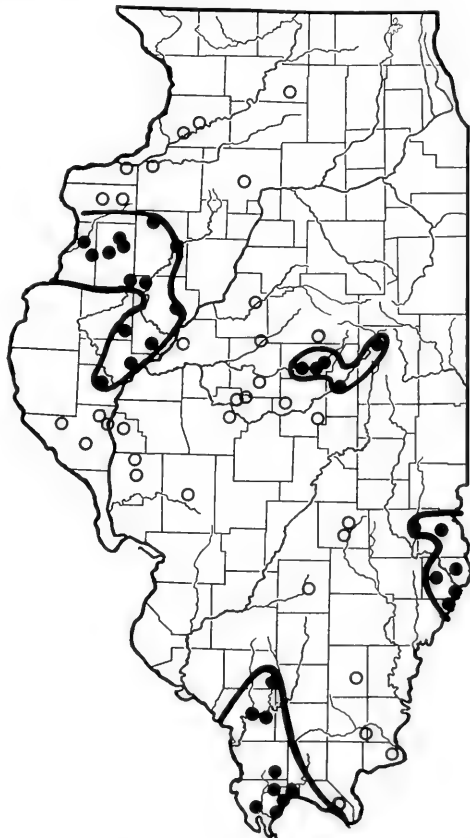


FIG. 1. — Distribution of periodical cicadas in Illinois. The two upper enclosed areas show the locations of the Iowan Brood (Marlatt's III), and the two lower enclosed areas indicate the locations of the Lower Mississippi River Valley Brood (Marlatt's XXIII). Black dots indicate positive records of adult specimens, skins, holes in the ground, flagging tree branches, or singing. Circles indicate negative records in areas carefully searched.

Fulton County, to June 28 in De Witt County. Singing was heard until June 28, also in De Witt County, and flagging (wilted branches that were girdled in the egg-laying process) was noticed on the same date in that county.

Apparently this brood is disjunct in Illinois, the western counties which it inhabits being Brown, Fulton, Henderson, Knox, McDonough, Schuyler, and Warren, and the eastern counties being Champaign, De Witt, and Piatt. Intervening counties, particularly Logan and Mason, did not seem to have populations of these cicadas. In the western counties mentioned and De Witt County large numbers of cicadas emerged, whereas Champaign and Piatt counties had only limited emergences.

This brood must have emerged simultaneously, in 1946, in some instances in adjacent areas or even in the same woods, with the Great Southern Brood (Marlatt's XIX), and these broods will again emerge simultaneously in 2167. Unfortunately, we have no records of the 1946 emergences in the INHS collection. Both broods may occupy the same woods in Champaign County if our records are correctly interpreted. Woods along the Spoon River, Knox County, should be carefully observed in the future to determine whether some of the woods harboring the Iowan Brood also support populations of the Great Southern Brood.

In 1963 Clarence E. White, an INHS entomologist, collected specimens and reported a large emergence in woods at the junction of Illinois 150 and the Spoon River. In 1972 Kent R. Buffington reported in a letter a large emergence in woods north of that area along the Spoon River near Truro, or Williamsfield, as that town is now called. The 1963 population could be assigned to the Iowan Brood and that of 1972 to the Great Southern Brood unless the 1972 emergence was made up of an unusually high number of stragglers of the 1973 Northern Illinois Brood that is known to have colonies nearby.

The Lower Mississippi River Valley Brood (Marlatt's XXIII)

The Lower Mississippi River Valley Brood has a 13-year cycle and last emerged in 1963, the year of the Iowan Brood's most recent emergence. Records in 1963 (Fig. 1) were obtained from late May until the middle of June. In Illinois this brood is also disjunct, being confined to Alexander, Jackson, Perry, Pulaski, and Union counties in the southwest and to Crawford, Jasper, Lawrence, and Wabash counties in the southeast. Several Illinois counties harboring no cicadas of this brood intervene between these populations, but the distribution of this brood probably continues to the south in Kentucky and Missouri.

A wide gap exists between the locations of this brood and those of the Iowan Brood within the state.

The Great Eastern Brood (Marlatt's X)

The Great Eastern Brood has a 17-year cycle and most recently emerged in 1970. Although reported to be well distributed along the eastern border of Illinois and even in southern Illinois (Marlatt 1907) in 1970 this brood was found in only a few counties (Vermilion, Edgar, and Clark) despite careful searches elsewhere (Fig. 2). Adults were found from May 21 at Kickapoo State Park, Vermilion County, until June 30, when a small chorus was heard by Dr. R. W. Larimore at nearby Fairmount. A shed skin was found

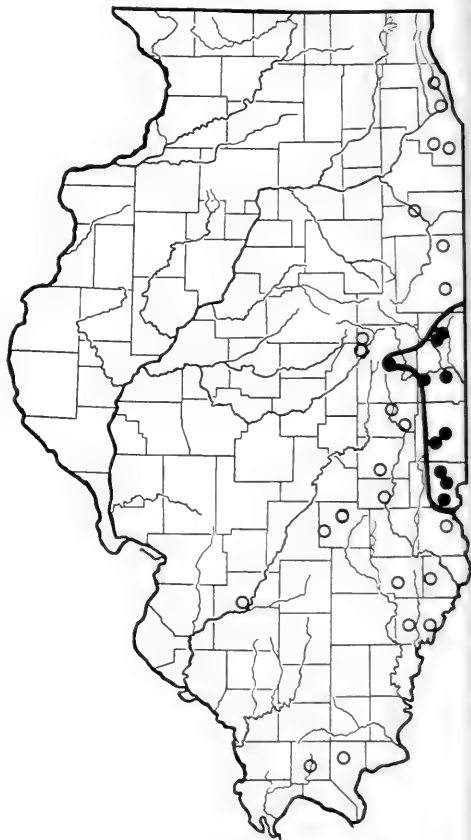


Fig. 2. — Distribution of the Great Eastern Brood (Marlatt's X) of periodical cicadas in Illinois. Black dots indicate positive records of adult specimens, skins, holes in the ground, flagging tree branches, or singing. Circles indicate negative records in areas carefully searched.

in Urbana, Champaign County, on a *Liriodendron* tree, a non-native tree, planted there 8 years previously. Seventeen years earlier in 1953 when this brood emerged, a straggler was also found in Urbana by Dr. R. J. Dysart on August 12. Despite the scanty records in Champaign County, it is possible that the Great Eastern Brood occurred and still persists in small numbers in the Big Grove of Urbana and that eastern Champaign County should be included in the list of counties inhabited by this brood.

The 17-year Great Eastern Brood (Marlatt's X) must have emerged in Illinois adjacent to and at the same time as the 13-year Great Southern Brood (Marlatt's XIX) in 1647 and 1868, and they should appear together again in 2089. Furthermore, the Great Eastern Brood must have emerged adjacent to and at the same time as the 13-year Lower Mississippi River Valley Brood (Marlatt's XXIII) along the border of Clark and Crawford counties in 1664 and 1885, and they should occur together again in 2106.

According to Marlatt (1907) and as reinterpreted by Dybas (1970), this brood has three main but almost certainly disjunct centers: a broad portion of Indiana and western Ohio, a wide area primarily bordering the Mason-Dixon line in Maryland and Pennsylvania, and an area in the southern Appalachians.

The Great Southern Brood (Marlatt's XIX)

The Great Southern Brood has a 13-year cycle and emerged last in 1972. This brood emerges in abundant numbers largely outside the limits of the Wisconsin moraine, except through the east-central region of the state, and outside the areas occupied by the Great Eastern Brood (Marlatt's X) and the Lower Mississippi River Valley Brood (Marlatt's XXIII) (Fig. 3). An isolated colony of "extremely heavy populations of cicadas" was reported to us by K. R. Buffington on May 18-20, 1972 along the Spoon River near Truro, now called Williamsfield, in Knox County. Along the upper Sangamon River in Champaign County both the 13-year Great Southern Brood and adventive or relict colonies of the 17-year Iowan Brood may occur together. In these woodlands in western Champaign County, the Great Southern Brood emerged in greater numbers in 1972 than did the supposed Iowan Brood in 1963.

The 1972 INHS records show that the Great Southern Brood started to emerge as adults as early as May 14 in Pope County, on May 20 in Olney in Richland County, on May 23 at Fox Ridge State Park near Charleston in Coles County, and on May 25 in Piatt County. Singing continued as late as June 30 at Robert Allerton Park near Monticello in Piatt County.

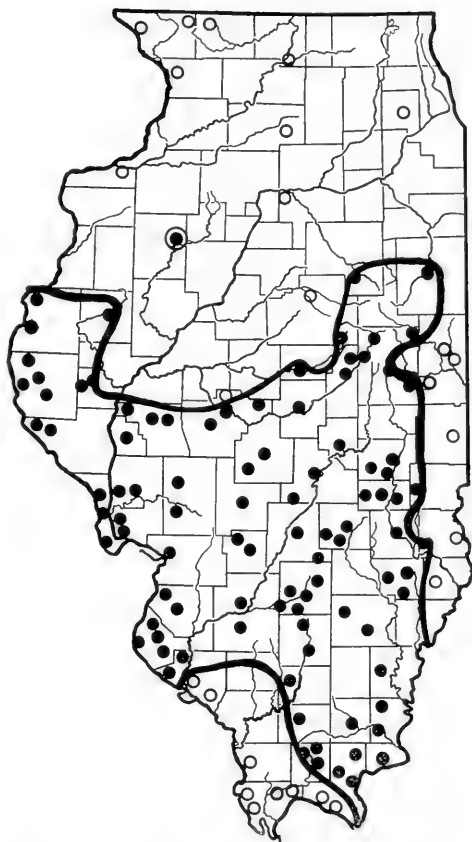


Fig. 3. — Distribution of the Great Southern Brood (Marlatt's XIX) of periodical cicadas in Illinois. Black dots indicate positive records of adult specimens, skins, holes in the ground, flagging tree branches, or singing. Circles indicate negative records in areas carefully searched.

In Illinois the 13-year Great Southern Brood probably emerged adjacent to and at the same time as the 17-year Iowan Brood in 1725 and in 1946, and they should emerge together again in 2167. In the Springfield area the Great Southern Brood probably emerged at the same time as and adjacent to the 17-year Northern Illinois Brood in 1752 and in 1803, and they should emerge together again in 2024. The Great Southern Brood probably emerged simultaneously with the 17-year Great Eastern Brood in 1647 and 1868, and they should do so again in 2089. The opportunity for this 13-year brood to interbreed with these 17-year broods appears highly likely to occur

every 65 or 78 years at some part of the Great Southern Brood's total range in Illinois, but only once every 221 years at each specific locality.

A limited number of specimens of this brood were collected in the twin cities of Champaign-Urbana in 1959 and in 1972. They were taken even in those parts of the cities which were originally prairie or were cultivated land less than 25-50 years previously but which are now studded with trees. Moderate singing also was heard by competent observers in both of these years. It would seem, therefore, that colonizing cicadas succeeded in expanding their range at least a few miles into new parklands and that the population level for survival need not be extremely high.

Although bird populations are low in some parts of these cities, where birds are present, cicadas are eagerly sought. In one instance a dozen live cicadas were placed on a hedge in Urbana near a bird-feeding tray. Within 1 minute a blue jay appeared and seized one of the sluggish cicadas. Shortly, this jay returned and was joined by another. All, or at least 11, of the cicadas were quickly taken by the jays; the fate of the last cicada was not determined in the confusion of the jays' visits to the hedge. Other birds, including hawks, were found to have fed heavily on these cicadas in southern Illinois (Dr. R. R. Graber personal communication 1972).

Unpublished reports by Dr. G. W. Bennett indicate that game fish benefited from the abundance of this brood in 1972. Fishes at Fox Ridge State Park, Coles County, fed voraciously on these insects. Cicadas at that site weighed from about ½ gram to nearly a full gram.

The Northern Illinois Brood (Marlatt's XIII)

The Northern Illinois Brood has a 17-year cycle, and its most recent emergence was in 1973. Possibly because a wet, cool spring delayed the emergence, the earliest 1973 records of this brood (Fig. 4) were not taken until May 31 (Tazewell and Sangamon counties) and June 2 (Cook County). Singing was heard in Tazewell County at the end of May and in Jo Daviess, Cook, and Lake counties as late as June 20.

This brood occurs primarily on the Wisconsin glacial drift area except for areas in east-central Illinois. These east-central Illinois regions are occupied by the 13-year Great Southern Brood. Several competent observers noted the absence of this brood from the Zion sand areas in Lake County, and my associates and I failed to find any specimens in the sand areas of Iroquois, Mason, and Lee counties.

The Northern Illinois Brood ranges south to Carpenter Park, north of Springfield, and to Petersburg,

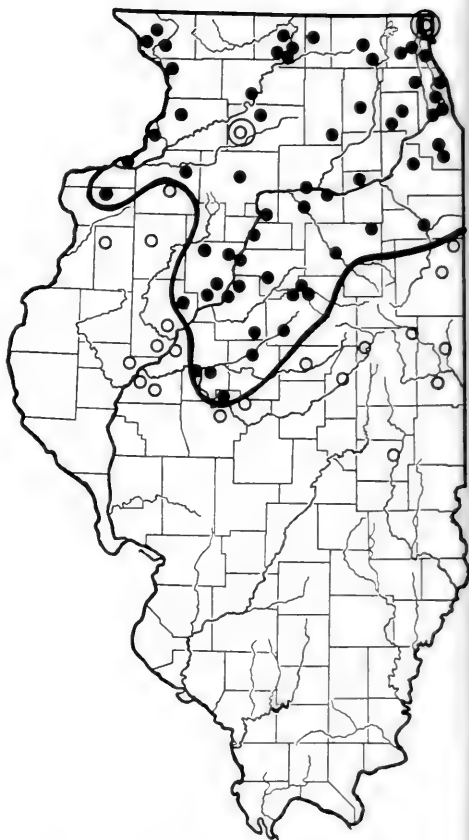


Fig. 4. — Distribution of the Northern Illinois Brood (Marlatt's XIII) of periodical cicadas in Illinois. Black dots indicate positive records of adult specimens, skins, holes in the ground, flagging tree branches, or singing. Circles indicate negative records in areas carefully searched.

Woods south of Springfield and woods near Mechanicsburg showed no evidence of cicadas (specimens, singing, skins, or holes in the ground). During the preceding year, 1972, the Great Southern Brood emerged in these woods (A. L. Koelling personal communication 1973). At the Springfield and Mechanicsburg area, at least, this brood and the 13-year Great Southern Brood probably emerged simultaneously in 1582 and 1803, and will do so again in 2024 and 2245.

The persistence of this brood in old parts of cities was noted in Chicago and Rockford. Mrs. Barbara Fell noted a few skins in her back yard at 819 North

Main Street, Rockford, indicating the survival of this brood, despite low numbers, over the past 136 or so years of human occupancy of that city.

In a woods at Castle Rock, Ogle County, the eastern portion contained no cicadas, whereas the western portion, having the same terrain but possibly less sand in the soil, contained a good singing population. There I found adults, skins, and holes in the ground. This observation and others bear out the contention that each woods is not necessarily uniformly inhabited.

FUTURE EMERGENCES OF PERIODICAL CICADAS IN ILLINOIS

Future twentieth-century emergences of periodical cicadas in Illinois are shown in Table 2.

TABLE 2. — Future twentieth-century emergences of periodical cicadas in Illinois.

Year of Emergence	Brood	Cycle in Years
1976	Lower Mississippi River Valley Brood (Marlatt's XXIII)	13
1980	Iowan Brood (Marlatt's III)	17
1985	Great Southern Brood (Marlatt's XIX)	13
1987	Great Eastern Brood (Marlatt's X)	17
1989	Lower Mississippi River Valley Brood (Marlatt's XXIII)	13
1990	Northern Illinois Brood (Marlatt's XIII)	17
1997	Iowan Brood (Marlatt's III)	17
1998	Great Southern Brood (Marlatt's XIX)	13

DISCUSSION

A composite map of the distribution of the Illinois broods of periodical cicadas is shown in Fig. 5. The borders of the range of each brood are only approximate except in a few regions, as critical areas and woods which should have been put under close surveillance for more precise information could not be recognized until after two or three emergences had been surveyed. In general, the distributions of these broods fit nicely with the distributional patterns of other organisms viewed in relation to geological events. Most of the region occupied by the Northern Illinois Brood lies within the Wisconsin glacial plain. The Iowan Brood, except for the region inhabited by the disjunct population in De Witt, Piatt, and Champaign counties, occupies a western spur on eroded hills of the northern part of the Illinoian glacial plain. The Great Southern Brood, except for the east-central Illinois extension and the corridor in the Shawnee Hills, is mostly on Illinoian glacial plains onto which most of our southern biota also extends. The Great Eastern Brood occupies an area which supports many other relict or adventive eastern spe-

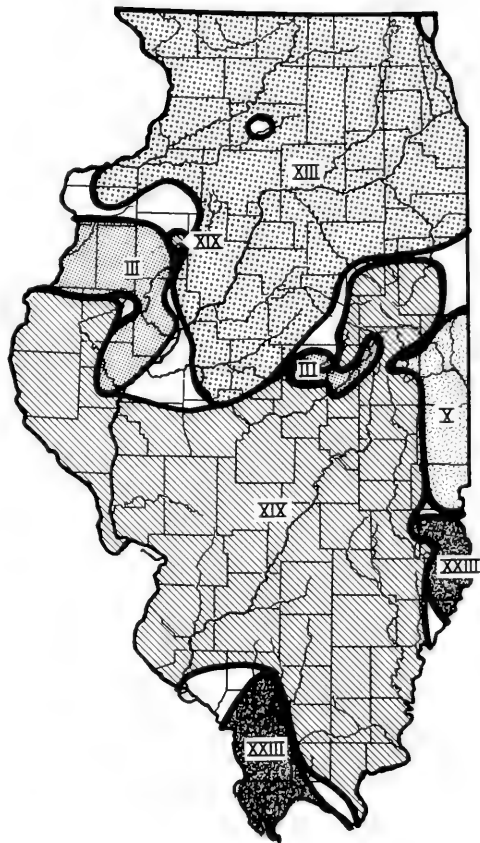


Fig. 5. — Distribution of periodical cicadas in Illinois. The ranges of the five Illinois broods are shown on the map. Each brood is identified by Marlatt's number.

cies: beech, tulip poplar, and some fishes and salamanders. The Lower Mississippi River Valley Brood occurs for a considerable part in the region where the bald cypress also meets its northern limits.

Occupation of a woods by two or more broods is extremely rare, according to my data. Woods can be almost adjacent, but each woods usually supports one brood only. Sand areas are usually, if not always, devoid of cicadas.

The opportunity for 13-year and 17-year broods to meet and hybridize may occur every 65 or 78 years within the total range of the majority of the periodical cicadas of Illinois. It is highly possible that no more

than three species exist, each closely regulated by climatic influences producing 13- or 17-year strains, operating under either-or genetic controls.

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