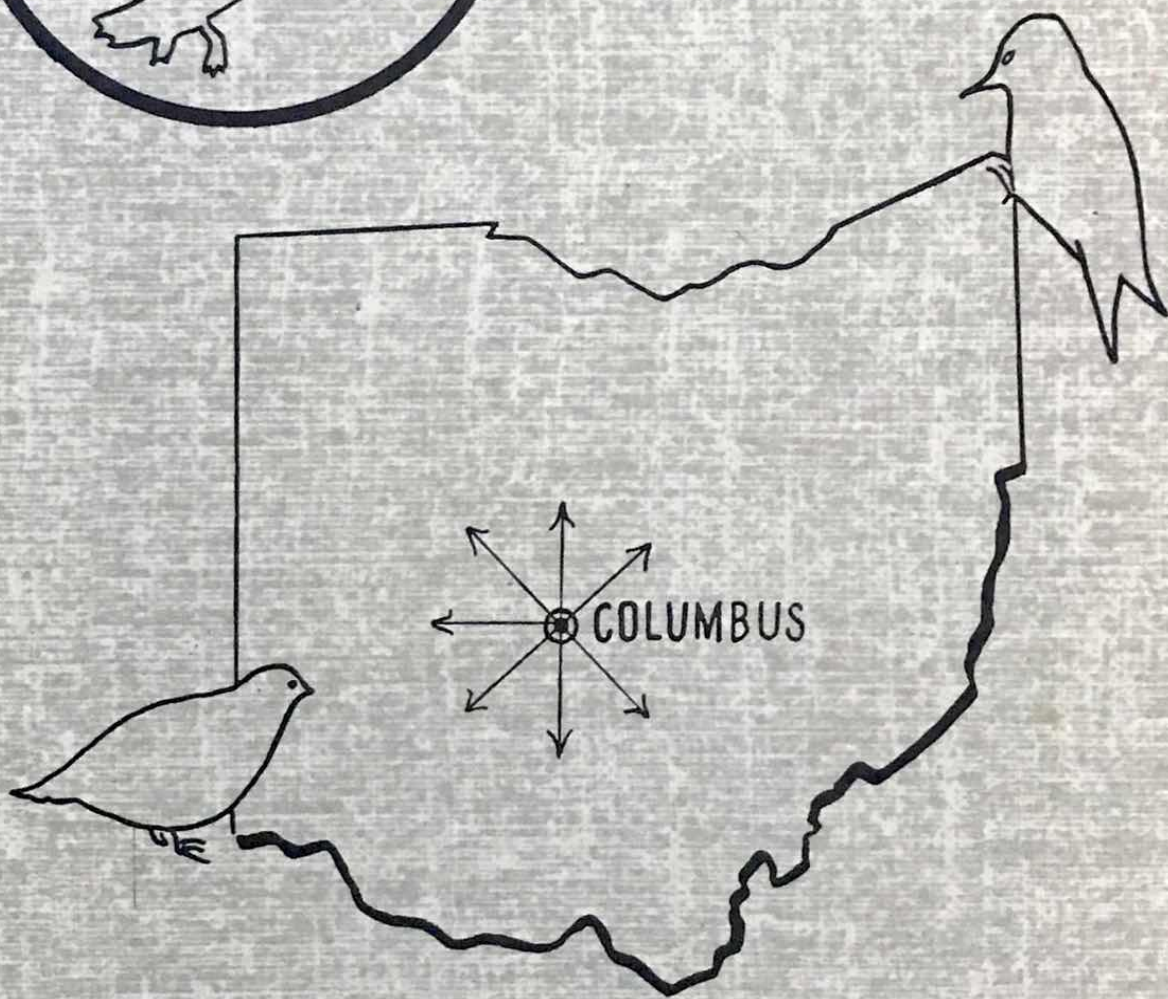


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THE PERIODICAL CICADAS

Richard D. Alexander

Another brood of periodical cicadas is due in Ohio this spring, to the delight of some entomologists, the consternation of others, and the utter dismay of those peculiar groups of individuals who feel compelled to spend their Mays and Junes in southern Ohio listening to (and recording) bird songs. The volume and monotony of noise that accompanies the emergence of these insects is well known, and this fact in addition to their tremendous numbers and extended life cycle has placed them among the most fascinating and widely discussed insects in existence.

Seventeen-year and thirteen-year cicadas are strictly an American phenomenon and in fact are peculiar to the eastern United States. Consequently the first written account of them did not appear until 1666 ("Some Observations of Swarms of Strange Insects and the Mischiefs done by Them, by Henry Oldenburg, Phil. Trans, London 1(8):137). Interestingly enough, this reference was to Brood XIV, the same brood which will appear this spring, chiefly in Kentucky, Tennessee, and Pennsylvania, and also in southern Illinois, Indiana, and Ohio. Oldenburg referred to these insects as "locusts", and the name has remained their popular designation ever since. The true locusts are short-horned grasshoppers, and it has been generally supposed that the confusion arose because the sudden appearance of the cicadas in tremendous numbers reminded early observers of the hordes of migratory locusts or grasshoppers with which they were familiar in the Old World.

By 1907 over 300 papers had been written on the periodical cicadas, and the number probably exceeds 500 today, since every sizeable brood brings out a new flood of articles. The classical publication is C. L. Marlatt's 1907 paper, "The Periodical Cicada" (U.S.D.A. Bur. Ent. Bul. 71:3-173), in which he summarized all the available information, plotted the distribution of all the broods of both the 13-year and the 17-year cicadas, and numbered these broods consecutively according to the year of their appearance as adults. According to Marlatt's classification there are 14 broods of 17-year cicadas and 11 broods of 13-year cicadas, which means that periodical cicadas can be found as adults in some part of the eastern United States almost every spring.

As might be expected, the origin of the 13- and 17-year life cycles, and of the different broods, has been a subject of much discussion and speculation. There is another aspect of the problem of the origin and evolution of periodical cicadas which has received a proportionately small amount of attention, and is still not clarified in the mind of entomologists and the general public even to the extent that proper interpretation of the information already contained in the literature will allow. This is the relationship of the two forms which are found together in all or almost all broods of both 13-year and 17-year forms. One of these, in both cases apparently, is a small, almost or entirely black insect, and the other, generally more abundant, is larger and has more brown in its coloration. There are minor differences in the male genitalia, and drastic differences in the songs of these two forms. The name Magicicada septendecim (Linnaeus), was apparently first applied to the larger form with the 17-year life cycle, and the name Magicicada tredecim (Walsh and Riley), 1868 was applied to

the larger form with the 13-year life cycle. In 1851, J. C. Fisher described the smaller form with the 17-year life cycle as cassinii, but apparently no formal name has ever been applied to the smaller form with the 13-year life cycle, if such a form does exist, as is indicated several places in the literature. Entomologists, taxonomists, and people in general have referred to these four forms as races, varieties, song forms, etc., but only rarely have discussed them as if they were distinct species, probably because of overlap in the morphological characters compared among them. Many writers have continued to refer to the periodical cicada, scarcely recognizing that any kind of polymorphism exists at all. In view of the interest provoked by periodical cicadas in entomologists and laymen alike, this lack of concern seems rather surprising. If the four forms described above are considered as distinct species then the problem of the origin of their life history and distributional relationships becomes quite a different proposition, and perhaps even more complicated.

The two 17-year forms were studied last spring in Brood XIII in northern Illinois in an attempt to at least settle their relationship in this one brood. The information gathered indicates that these two forms are distinct species. About 2000 songs of about 100 individuals were tape recorded and compared and it was observed that the males of each species have three sound responses, (1) a calling or congregational song produced by both lone males, and males congregated in close proximity, (2) a courtship or mating song produced during precopulatory maneuvers, and (3) a squawk produced by captured or disturbed individuals. Each of these sounds is distinct in the two species, and the different individuals of each species produce the same sound in the same situation. There is no overlap in any of these sound responses, and in fact they are so distinct that a superficial comparison of their differences with those generally occurring between the songs of closely related species of Orthoptera and Cicadidae might cause one to believe that these two cicadas should be placed in different genera.

Morphological comparison of individuals having one song pattern with those having the other song pattern revealed differences in color, size, and the structure of the male genitalia. An examination of over 150 mating pairs showed no instance of cross-copulation between these two morphological and song forms.

Several factors indicate that the song differences are significant to the insects themselves. The two species are apparently geographically sympatric and seasonally synchronic in this brood. However, the two species definitely congregated in separate groups during the daily song period in a way which was not obviously correlated with any ecological factors. Septendecim did most of its singing in the morning, while scarcely an individual of cassinii could be heard before noon, though this species dominated the chorus by mid-afternoon in most localities. Finally, in areas where the species were mixed together and could be heard singing in approximately equal numbers in early afternoon, cassinii individuals synchronized their song bursts, while septendecim individuals did not.

This study was carried out on a single brood, but song descriptions in the literature and morphological comparisons of specimens indicate that the same two forms occur throughout all the broods of 17-year cicadas, and that two very similarly related forms occur in all the broods of 13-year forms. This not only indicates that there are probably four species

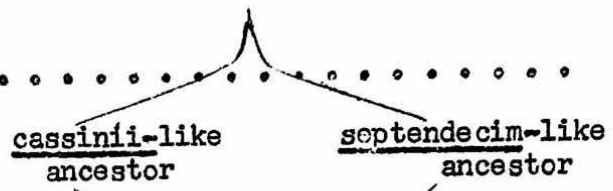
since 13-year and 17-year forms co-exist in the same localities in certain years, but it also indicates that at least until very recently the different broods have been interbreeding sufficiently probably as a result of stragglers, to prevent their developing into distinct species.

Based on these facts and assumptions, the following diagram has been constructed to illustrate the probable history of the development of the species and broods of periodical cicadas. The distance between the lines indicates distributional relationships. Where the lines run close together and parallel, the forms are sympatric. Where the lines diverge, geographic isolation is suggested, and the later convergence of such lines indicates a break-down of this isolation.

Phylogenetic and Distributional Relationships of Periodical Cicadas

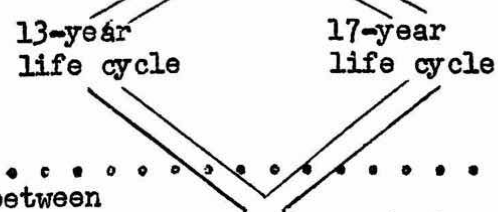
Single ancestral species

Geographic isolation and subsequent development of septendecim and cassinii as distinct species.

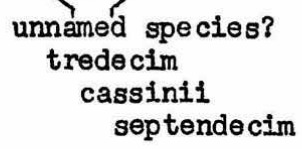


Break-down of geographic isolation resulting in complete sympatry between cassinii and septendecim, both in space and in time.

Geographic isolation of two segments of the total population, each segment containing parts of both species, probably on a north-south plane, and the subsequent development of 13- and 17-year life cycles, respectively.



Break-down of geographic isolation between the two groups, leaving four distinct species.



It will be interesting to check Brood XIV this spring and see if two species are present, and if their song, behavioral, and morphological relationships are the same as those of the two species observed in Brood XIII in northern Illinois last year. Recordings made by Dr. Borror and Dr. Reese in 1953 in central Ohio indicate that the same two species exist in Brood X. For those who would like to observe and listen this year, cassinii and septendecim can be easily separated by the characters summarized below.

Magicalcicada septendecim: The larger species, with more brown or red in its coloration; the congregational song is the famous Pharoah call, which to me sounds like Z-R-R-R-R-R-R-R-Ruhh.-----Z-R-R-R-R-R-R-R-Ruhh. This song begins at or before dawn and continues all day, though dropping off considerably in late afternoon. The individual males in a colony

do not synchronize their songs, so the total sound is an even continuous roar. The courtship song is a continuous repeating of brief even bursts of the same sound as above, but without the drop in volume and pitch at the end, and delivered at rates of 3.5-5.0 per second. This sound is much less commonly heard.

Magcicada cassinii: The smaller species, usually solid black and at the most with very little brown or red in its coloration; the congregational song is a series of rapidly delivered ticks followed by a loud, shrill tsh-e-e-e-e-E-E-E-E-e-ou. This song begins around noon and reaches its greatest volume in mid-afternoon, and the males in a colony synchronize the ticking and the buzzing parts of the song, so that the total sound rises and falls in volume. The courtship song is a continuous repeating of single or double ticks at rates of 3.5 to 7.0 per second.