

THE TRUE KATYDID, PTEROPHYLLA CAMELLIFOLIA (FABRICIUS)  
(ORTHOPTERA: TETTIGONIIDAE) IN IOWA: TWO POPULATIONS  
WHICH DIFFER IN BEHAVIOR AND MORPHOLOGY

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ABSTRACT. Two populations of the true katydid, Pterophylla camellifolia (Fabricius), distinctive in calling sound and dimensions of the male's subgenital plate, occur in Iowa. The northern population, previously characterized by Alexander and Shaw (unpublished) and Alexander (1967b, 1968), is widely distributed across the central and north central parts of the eastern United States, including Iowa. The recently discovered, western population is, at present, only known from a few areas along a roughly north-south line through central Iowa. The calling sounds of males of the northern and western populations differ only in number of pulses per chirp. The subgenital plates of western males are distinctively larger than those of northern males. Populations of P. camellifolia intermediate to northern, southwestern and southeastern populations of P. camellifolia in certain characteristics of the calling sound and dimensions of the subgenital plate suggest hybridization between members of the different populations (Alexander 1967b, 1968). Male calling sounds intermediate in chirp length (i. e., pulse number) have been heard in Iowa City suggesting the possibility of gene exchange between members of the northern and western populations. However, restriction of P. camellifolia males to oak, hickory and other deciduous trees of uplands along rivers and streams, and the disruption of the continuity of these trees by the clearing activities of man, may prevent gene flow and pockets of incipient species may be present.

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The true katydids are large, green insects whose heavily-veined tegmina look like leaves. Although pictures of these insects are found in many elementary zoology and entomology textbooks, few biologists have seen them. They reside in the tops of the tallest trees. Night after night, they will be heard calling from approximately the same site which is usually between 25 and 100 feet from the ground. Most people in the eastern United States have heard their raucous calls, but few have discovered the source of the sound.

The onomatopoeic interpretation of the calling sound of Pterophylla camellifolia is ka-ty-did which is the common name of all the members of the family Tettigoniidae. Each syllable of the interpretation corresponds to a pulse (sound produced by a single wingstroke), thus, ka-ty-did represents a 3-pulse chirp. The number of pulses per chirp is distinctive and characteristic of each of several populations of P. camellifolia. Thus, the onomatopoeic interpretation (e.g., ka-ty, ka-ty-did-n't, ka-ty-did-she-did, etc.) will depend upon which population you hear. The interpretation of a recently discovered, previously undescribed, population in Iowa might be ka-ty-did-she-did-she-did-n't-she-did-she-did-n't-she-did (i. e., a 15-pulse chirp)! Any attempt at onomatopoeia would be limited by this species' relatively short period of maturity which, in Iowa, may extend from late July (or early August) to late September (or early October).

P. camellifolia is a deciduous (oak-hickory) forest species. Although extremely abundant in the forested regions of the eastern and southeastern United States, in Iowa, these katydids are limited to the oak-hickory associations of the uplands along the rivers. This limitation in distribution, along with man's disruption of the continuity of the trees along the rivers, may be important in the future differentiation of populations of this species.

Hebard (1941) points out that the members of the Pseudophyllinae in the United States form a variable, plastic group. He believes that two of the current genera, Paracyrtophyllus and Lea, might be reduced to subgenera of Pterophylla and that two subspecies of Pterophylla furcata "may eventually prove to represent two extreme developments reached in Pterophylla camellifolia along one of its lines of racial differentiation." He also states that "incipient racial differentiation is definitely indicated in the northern, southern and southwestern portions of the range."

On the basis of differences in their calling sounds, Alexander and Shaw (unpublished) differentiated three populations of P. camellifolia which correspond to the three areas of racial differentiation reported by Hebard (Fig. 1). Although these populations make contact, mixed groups of individuals from the two populations do not occur. Instead, between pairs of these populations, there is a zone of intergradation in calling sound and in the dimensions of the subgenital plate (Fig. 1) (Alexander 1967b, 1968). As one moves across this zone, there is a gradual change in pulse rate and pulse number (i. e., chirp length) (Fig. 2). The intergrade zone, which, presumably, is the result of hybridization, varies in width from a few yards to more than a hundred miles.

Mixed populations have not been encountered and are unlikely because members of this species cannot fly. When disturbed, they spread their tegmina and "parachute" to the ground or onto a lower branch which may

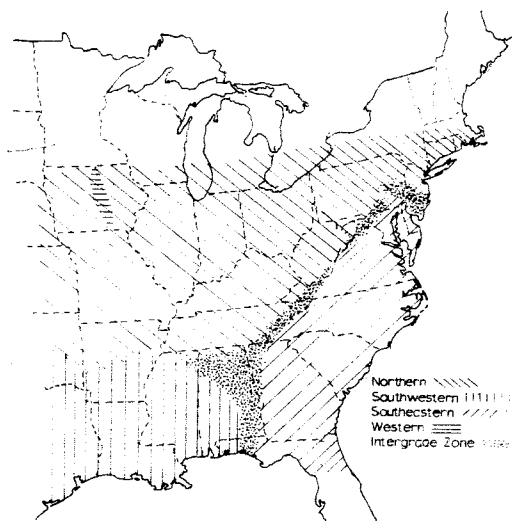


Figure 1. Geographic distribution of populations of *Pterophylla camellifolia* in the United States. A map of the intergrade zone (representing intergradation in calling sounds and dimensions of the male's subgenital plate) was published previously by Alexander (1967b). The intergrade zone probably extends farther west but its limits have yet to be determined. The southeastern population corresponds to Hebard's (1941) southern population (see text).

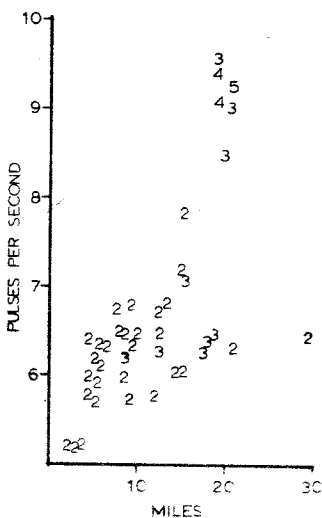


Figure 2. Change in pulse rate and pulse number of *P. camellifolia* males between Liverpool and New Cumberland, Pennsylvania. (From Alexander, 1968).

belong to an adjacent tree. Therefore, geographic distribution, and the meeting of a female of one population with the male of another, depends upon an individual jumping or falling from his arboreal perch. If an individual lands on the ground, he apparently walks until encountering a tree trunk after which he begins to ascend. This negative geotaxis is easily demonstrated by simply presenting a vertically oriented finger to a katydid that is walking on a horizontal surface.

In the summer of 1968, a "western" population, also distinctive in calling sound (Fig. 3) and morphology of the subgenital plate (Fig. 4), was discovered along the Skunk River between Ames and Story City. Prior to this discovery, katydids of the northern population were encountered in Ledges State Park, Boone County. The sparsity of both populations was evident from further attempts to discern their distribution.

Tracing the Skunk River south through Story, Polk and Jasper Counties failed to reveal a single calling katydid, even in the forested Chicaqua Wildlife Preserve. During August, 1968, the authors drove to Rice Lake State Park in Worth County where, at dusk, a drive was initiated which carried us through Cerro Gordo, Floyd, Franklin, Butler, Hardin, Hamilton and Story Counties while zig-zagging the Shell Rock, West Fork of the Cedar and Story Counties while zig-zagging the Shell Rock, West Fork of the Cedar (Winnebago), Iowa and Skunk Rivers. No katydids were evident until two northern *P. camellifolia* were recorded at Eldora (Hardin Co.). Approximately eight miles from this spot, a small group of western katydids was encountered in a group of oaks between New Providence and Union (also in Hardin Co.), a few miles west of the Iowa River.

Sounds of these populations differ only in the number of pulses per chirp (Fig. 3). The pulse rate and the frequency spectrum of both sounds are very similar. Pulse rate is directly dependent upon environmental temperature; however, both calling sounds (Fig. 3) were recorded at 25°C. The calling sound of *P. camellifolia* is a noise extending to 100 kilocycles and possibly higher. However, the dominant frequencies typically occur between 2 and 6 kilocycles (Fig. 3).

As indicated, the arboreal habitat of this species makes collection of specimens difficult. Comparison of the dimensions of the subgenital plate of one northern katydid collected in Ledges State Park (Boone Co.) and three western katydids from Soaper Mill (Story Co.) indicated differences in the overall length, width of the narrowest region, and the length of the distal slit (Fig. 4). An examination of nine male specimens in the Iowa State Insect Collection revealed that they also could be classified as northern or western *P. camellifolia* on the basis of the same measurements of the subgenital plate (Table 1).

The distribution of *P. camellifolia* in Iowa (Fig. 5) was based on the specimens examined, song records, and locality records reported by Froeschner (1954) for which specimens were not available for examination. There is not yet enough data to indicate whether or not hybridization is taking place. However, sound records from Iowa City (Johnson Co.) reveal chirp lengths of 4 to 6 pulses which are intermediate to the mode of northern (2 to 3 pulses) and western (8 to 15 pulses) populations (Fig. 3). The existence of the two populations within eight miles proximity in Hardin Co., 3 miles in Story Co., and 5 miles in Van Buren Co., suggests that there has been opportunity for hybridization. The search for intermediate populations continues.

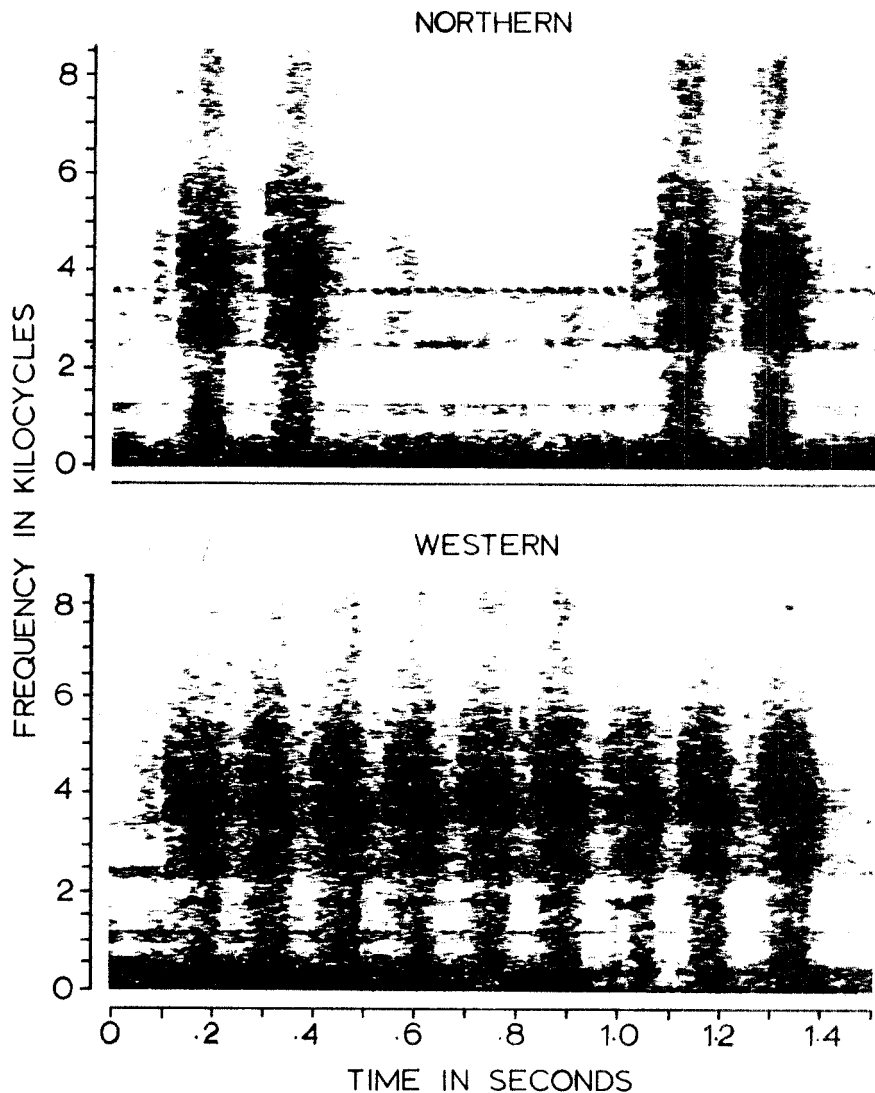


Figure 3. Calling sounds of katydids from the northern and western populations of *P. camellifolia*. The upper audiospectrograph illustrates two, 2-pulse chirps of a northern katydid, while the lower audiospectrograph illustrates one, 9-pulse chirp of a western katydid.

Table 1. Measurements of the subgenital plates of *Pterophylla camellifolia* males used to distinguish members of northern and western populations. All measurements in millimeters. a - Dried exudate covering proximal portion of subgenital plate prevented measurement of overall length.

Population	Locality	Overall Length	Length of Distal Slit	Width of Narrowest Region
Northern	Fairfax, Linn Co.	11.8	3.92	1.52
	Ames, Story Co.	12.7	5.15	1.72
	Lacy Keosauqua State Park, Van Buren Co.	12.2	4.80	1.42
	Marion Co.	a	4.36	1.62
	Ledges State Park, Boone Co.	13.2	4.26	1.47
	Soaper Mill, Story Co.	16.8	7.00	1.96
Western	Soaper Mill, Story Co.	15.4	6.20	1.72
	Soaper Mill, Story Co.	15.9	6.60	1.81
	New Providence, Hardin Co.	14.7	5.59	2.16
	New Providence, Hardin Co.	15.7	6.66	2.01
	Zearing, Story Co.	15.4	6.22	1.96
	Worth Co.	15.7	6.66	1.96
	Selma, Van Buren Co.	16.7	6.96	1.96

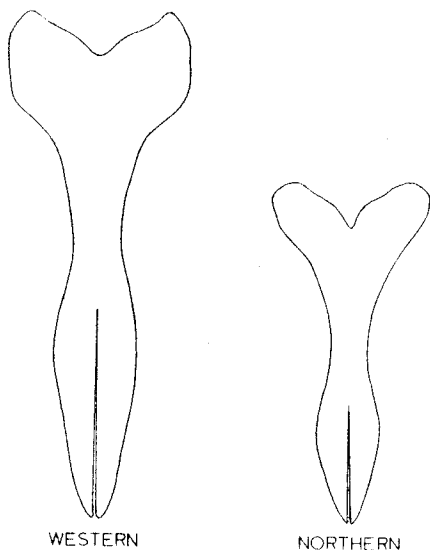


Figure 4. Dorsal view of the subgenital plates of males from the western and northern populations of *P. camellifolia*. The upper, wide region of the subgenital plate is proximal and represents the point of attachment to the abdomen. Because of difficulty in determining the limits of the lateral, proximal extensions of the subgenital plate, the total length was measured along the midline from the bottom of the V-like depression at the proximal end to the tip of the slit at the distal end.

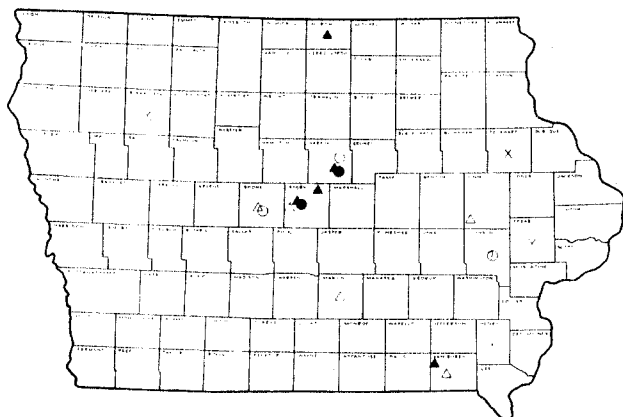


Figure 5. Distribution of *P. camellifolia* in Iowa.  $\Delta$  = northern population based on measurements of subgenital plate;  $\blacktriangle$  = western population based on measurements of subgenital plate;  $\circ$  = northern population based on calling sound;  $\bullet$  = western population based on calling sound;  $\odot$  = possible intermediates between western and northern males based on calling sound; X = records reported by Froeschner (1954) but specimens not seen by author.

It is generally agreed that the calling sounds of Orthoptera are species-isolating mechanisms serving to bring conspecific males and females together. This is supported by the species specificity of the calling sounds of every sympatric, synchronic species and by experimental evidence that individuals are selectively attracted to the sounds of their conspecific mates (Alexander 1967). Of the more than 200 species of singing katydids, crickets, and cicadas in the United States, only four species show geographic variation in calling sound (Alexander, personal communication). Of these four species, only P. camellifolia shows zones of intergradation in calling sounds where two distinctive populations come into contact.

It is likely that P. camellifolia was divided into at least four populations during Pleistocene glaciation and that, at least in the southern and eastern parts of the United States, three populations are coming together again and are interbreeding. In other words, the differences in their calls which apparently developed during geographic isolation are not sufficient for the calling sounds to serve as species isolating mechanisms. However, the dynamics of interaction between the northern and newly discovered western populations are not yet determined, and there is still the possibility that the western population is a new species.

In Iowa, the restriction of oak and hickory groves to uplands along rivers and streams may prove a more effective means of separation of northern and western populations than in the still relatively large forested areas of the southern and southeastern United States. In addition, man's clearing of woodlands along rivers and streams (e. g., by the Corps of Engineers) will undoubtedly contribute to the isolation of pockets of northern and western katydids. In other words, even if some gene exchange has taken place in the past, a thorough investigation of the distribution of P. camellifolia in Iowa may indicate pockets of incipient species.

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