

Contrasts in the Orthopteran Faunas of Grassland, Forest, and Transitional Areas in Southern Indiana*

IRVING J. CANTRALL and FRANK N. YOUNG

The obvious fact that grassland and forest contrast sharply in physical conditions and vegetation has been recognized since prehistoric times, but the correlated contrast in faunas is less obvious today than it was before the large herbivores and predators were extirpated. In southern Indiana, an originally forested area has been largely converted into artificial prairies interspersed with woodlands. Under such conditions, when active cultivation ceases, forest plants and animals begin to reinvade the abandoned fields, but, since this process of succession is extremely slow, associations of plants similar to the tall grass prairie persist for a considerable length of time. The occurrence of such semi-natural situations presents a number of problems of interest from both the theoretical and practical point of view.

One of these problems in which the writers have been interested for many years is the relation between abundance and habitat of various species of Orthoptera. It is obvious that any disturbance in a habitat is accompanied by population fluctuations with the increase of some species and the decrease of others. The appearance of the migratory locust, *Melanoplus mexicanus* migratory phase *spretus*, following reduction of the great buffalo herds may be a classical example of this phenomenon. Similar fluctuations in populations of insects followed the clearing of the woodlands. Few of the forest insects were able to survive in the open areas, and the newly available niches were filled by forms which were originally restricted to narrow strips along streams or other special situations. Some species of grasshoppers, such as *Spharagemon bolli*, must have increased greatly in southern Indiana as the woods were cut or thinned, while others, such as *Melanoplus punctulatus griseus*, must have decreased. Unfortunately, the historical details of these processes are lost to us, but it is possible to surmise some of the probable events by examining the existing conditions.

The area selected for a study of the contrasts in the Orthoptera of a grassland area, a woodland, and the intervening ecotone is located on the property of Indiana University in Monroe County (T. 9 S., R. 1 W., Sec. 35). It is near the former site of the small pond studied by Dr. Will Scott in the early part of the century (*Proc. Indiana Acad. Sci.*, 26, 1910). The grassland is on a flat hilltop on eroded Bedford Silt Loam, while the forest is in an adjoining valley with Frederick Silt Loam predominating on the slope. The shrubby ecotone between the two lies on gently sloping areas not subjected to periodic mowing.

Collecting in the three types of situations was restricted to the same length of time on Oct. 13, 1951, Sept. 27, 1952, and Sept. 26, 1953. The collections therefore can be roughly compared quantitatively as well as

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TABLE I
Distribution by Habitats of Orthoptera Collected in the Vicinity of Scott's Pond

I. CHARACTERISTIC SPECIES OF MIXED GRASS-HERBACIOUS HABITATS	GRASSLAND		ECOTONE		FOREST	
	1951	1952	1951	1952	1951	1952
<i>Nomotettix cristatus compressus</i>	—	10	—	2	—	—
<i>Syrbula admirabilis</i>	—	7	47	3	—	—
<i>Orphulella speciosa</i>	—	—	1	—	1	—
<i>Arphia xanthoptera</i>	3	5	7	3	—	—
<i>Chorthopaga viridifasciata</i>	—	—	1	—	—	—
<i>Encyrtolophus s. sordidus</i>	25	23	30	9	11	4
<i>Hippiscus rugosa</i>	5	17	57	7	2	4
<i>Disosteira carolina</i>	—	1	—	—	—	—
<i>Trachyrhachis kiova fusifrons</i>	—	—	1	—	—	—
<i>Melanoplus d. differentialis</i>	—	12	5	—	—	—
<i>Melanoplus f-r. femur-rubrum</i>	16	25	41	4	7	2
<i>Melanoplus m. mexicanus</i>	5	11	8	1	2	1
<i>Melanoplus keeleri luridus</i>	2	15	2	4	10	5
<i>Neonococephalus retusus</i>	—	—	—	—	—	—
<i>Conocephalus brevipennis</i>	19	25	1	—	16	2
<i>Conocephalus nemoralis</i>	—	1	7	—	—	8
<i>Acheta assimilis</i>	12	13	8	13	3	7
<i>Nemobius f. fuscatus</i>	2	2	5	—	—	—
<i>Oecanthus nigricornis quadripunctatus</i>	2	4	—	—	17	7
<i>Oecanthus n. nigricornis</i>	—	—	—	—	—	2

II. CHARACTERISTIC SPECIES OF SHRUB AND TERRESTRIAL STRATA OF OPEN WOODS AND WOODLAND BORDERS	GRASSLAND		ECOTONE		FOREST	
	1951	1952	1951	1952	1951	1952
<i>Stagmomantis carolina</i>	—	—	—	1	—	1
<i>Tenodera aridifolia sinensis</i>	—	—	—	—	—	1
<i>Spharagemon bolli</i>	—	4	—	3	—	—

<i>Schistocerca d. daaniflica</i>	—	—	—	1	2	—	—	—
<i>Schistocerca a. americana</i>	—	2	1	4	24	—	—	—
<i>Melanoplus viridipes eurycercus</i>	—	1	—	1	—	—	—	1
<i>Amblycorypha rotundifolia</i>	—	—	—	—	—	—	—	—
<i>Nemobius maculatus</i>	—	—	1	—	—	—	—	2
<i>Oecanthus latipennis</i>	—	—	—	2	4	—	—	—
<i>Hapithus a. agitator</i>	—	1	—	2	—	—	—	2

III. CHARACTERISTIC SPECIES OF TREE-TOP, TALL SHRUB, AND SHRUB STRATA OF WOODS

	GRASSLAND		ECOTONE		FOREST	
	1951	1952	1951	1952	1951	1952
<i>Diaperomera femorata</i>	—	—	—	—	4	5
<i>Melanoplus punctulatus griseus</i>	—	—	—	—	—	1
<i>Microcentrum retinerve</i>	—	—	—	—	—	1
<i>Pterophylla c. camellifolia</i>	—	—	—	—	H*	H*
<i>Oecanthus angustipennis</i>	—	—	—	—	4	5

IV. CHARACTERISTIC SPECIES OF THE TERRESTRIAL STRATUM OF WOODS

	GRASSLAND		ECOTONE		FOREST	
	1951	1952	1951	1952	1951	1952
<i>Parcoblatta sp.</i> , juveniles.....	—	—	—	—	7	7
<i>Ceuthophilus sp.</i> , juveniles.....	—	—	—	—	5	6

V. ERRATICS—CHARACTERISTIC OF HABITATS NOT WELL REPRESENTED IN THE AREA

	GRASSLAND		ECOTONE		FOREST	
	1951	1952	1951	1952	1951	1952
<i>Tetrix granulata</i>	—	—	—	—	1	1
<i>Tettigidea lateralis parvipennis</i>	1	1	—	6	—	1
<i>Dichromorpha viridis</i>	—	1	—	—	—	—
<i>Scudderia texensis</i>	—	—	—	2	—	—
<i>Scudderia f. furcata</i>	—	1	—	1	—	1
<i>Orchelimum vulgare</i>	—	—	—	1	—	—
<i>Nemobius c. carolinus</i>	—	—	—	2	—	1

* Song heard.

qualitatively. The forest collections are probably the least comparable of the three since they represent largely the ground and lower shrub and tree-trunk strata; the arboreal fauna being poorly represented.

The contrasts in the physical conditions in the three situations are very marked. The open areas have a higher evaporation rate and greater fluctuations in diurnal temperatures. Decided differences in soil moisture are evident. These varying physical factors are reflected in differences in vegetation. Both the open grassland and the ecotone show patches of very early stages in old-field succession with lichens and mosses being the principal plants.

The grassland has been prevented from succeeding to second-growth woodland by frequent mowing, but it has not been plowed or pastured for many years. In the area where collections of Orthoptera were made the principal grass is *Aristida oligantha*. This is interspersed with clumps or patches of *Andropogon virginicus*, *Poa compressa*, *Eragrostis* sp., *Digitaria saguinalis*, and *Phleum pratense*. Some *Danthonia spicata*, *Triodia flava*, and a single plant of *Panicum* sp. were also noted. The relative abundance of these forms changed somewhat over the three-year period. The principal herbs are species of *Solidago*, *Aster*, *Lespedeza* and *Plantago* together with *Acalypha* sp., *Achillea millefolium*, *Antennaria* sp., *Chrysanthemum leucanthemum*, and *Ambrosia elatior*. No small trees or shrubs were noted in the area in which collections were made, but seedlings of elms and other trees are present wherever protected from mowing. The ground cover is nowhere very dense, and the only shade is that provided by the grasses and herbs themselves. Lichens and mosses occur on numerous small bare spots, and a large erosion gully with bare, steep banks transects the area. This gully has grown progressively larger and longer over the period of the study.

The ecotonal zone, between the woods and the mowed field, consists of an old-field succeeding to second-growth woodland. The grasses noted here are principally clumps of *Andropogon virginica* intermingled with scattered patches of *Poa compressa*, *Triodia flava*, and a few others. Herbs are principally species of *Plantago*, *Euphorbia*, *Solidago*, *Desmodium* and *Vernonia* with scattered individuals of *Solanum* sp., *Hieracium* sp., *Aster* spp., and *Antennaria* sp. Small shrubs of *Rhus glabra* and *Rubus* sp. are fairly numerous. Transgressives include seedlings of *Liriodendron*, *Prunus*, *Crataegus*, and *Ulmus* species. Small trees are moderately abundant, but do not form a canopy. They consist primarily of *Cercis canadensis*, *Ulmus americana*, *Prunus* sp., and *Acer saccharum*. A single small *Acer saccharinum* was also noted. Near the woods where collections were not made there are some sycamores and oaks.

The cut-over and second-growth woodland varies from relatively dense and undisturbed to very sparse on the steeper slopes. The composition varies from place to place. Some areas approach the mixed mesophytic climax forest, while others are more hygic or xeric depending upon their position on the slopes of the valley. The canopy is complete over most of the area immediately adjacent to the grassland studied, and except for some places along the stream the ground is shaded and covered with a mat of decaying leaves. The principal trees present are *Acer sac-*

charum, *Fagus grandifolia*, and *Liriodendron tulipifera*. On most of the middle slopes beeches and tulip poplars are scattered among sugar maples six to eight inches in diameter. Oaks and hickories are relatively scarce, and occur mostly on the upper slopes of the valley. *Juglans nigra* and *Ulmus americana* are common along the stream bottom, but many of the larger elms have died for some unknown reason. No *Castanea dentata* seems to have occurred in this area. The shrub and small tree layers are poorly developed, except in a few restricted areas where *Asimina triloba* forms dense stands. *Cercis canadensis* and a few *Cornus florida* occur in scattered sites. *Rhus radicans* occurs as a low shrub on some of the slopes, and grows as a vine on trees along the stream. The herb layer is rather rich in spring flowers, but in summer and fall a very few clumps of grass *Elymus sp.*, and sedges, *Carex sp.*, are the only low plants to be seen except in sunny areas along the stream.

Mr. Dale M. Smith of the botany department of Indiana University kindly determined the grasses and checked the other plant determinations.

Collections of Orthoptera were made from the three habitats in the fall of three consecutive years. Weather conditions were similar for each year. The collecting dates were all before the first frost, and in each case followed a prolonged period of late summer and early fall drought. Drought conditions in the grassland were most evident in 1953.

The most precise quantitative data, of the type here presented, cannot be meaningful unless an analysis of the correlation of the animals with the environment under consideration is made in terms of the animals themselves. Less precise data can give much information when so considered. The Orthoptera listed in Table I are grouped not only with relation to those habitats wherein they were found but also with regard to years of study of the behavior and habits of these insects. An inspection of the table will indicate that this treatment is justified and that without it the correlation of animal to habitat would be less real.

Correlated with an animal's ecological valence, vagility and its reaction to stimuli is the degree of occupancy of that species of environment which, for that species, represents submarginal conditions. This is well demonstrated in Section I of the table. The six most abundant forms have flooded out of the grassland and into the ecotone; occupying those portions of the ecotone which are small versions of their characteristic habitat. These six orthopterans are wide-ranging, quite plastic species. It will be noted that *Conocephalus brevipennis*, although optimum conditions for the insect require more moisture than is to be found in the grassland, is, comparatively speaking, a common insect in this environment. The only orthopteran which occurs in all three areas is *Acheta assimilis*. Recent work has shown that this "species," as now known, is very probably a complex of forms, the limits of which are now unknown.

The ecotone represents a combination of a variety of micro-environments and, for this reason, those forms listed in Section II are found in the grassland as well as the woodland. However, it will be noted that they occur most abundantly in the ecotone. Correlation of species to habitat in Sections III and IV is striking.

The orthopterans listed in Section V are insects of the wet-terrestrial stratum and of moist meadow environments and in 1951 and 1952 were undoubtedly erratics from the vicinity of Scott's Pond. The pond was filled during the winter of 1952-53. Nineteen fifty-three records, in all probability, represent remnants of dying populations.

Of the forty-two forms here listed, only two can be called prairie elements. *Orphulella speciosa* and *Trachyrhachis kiowa fuscifrons* are prairie species and now, owing to the clearing of woodlands, are possibly more widespread in Indiana. However, since both grasshoppers are open field forms and because of the pressure of agricultural activities they probably have not been able to invade newly available habitat as effectively as those species which occupy the open, shrubby growths of woodland margins.

One species, *Tenodera aridifolia sinensis*, is an established advent. The remaining forms are distributed over portions of the eastern United States or all of the United States in such a manner as to leave little doubt that they were present in southern Indiana before any disturbances made by man.

The effect of man's activities upon the orthopteran fauna of southern Indiana is undoubtedly one of change in frequency and abundance of those species present prior to his coming rather than gross changes in the faunal composition owing to invasion and establishment of prairie species upon newly created prairie-like environments.