The Great Lakes Entomologist

Volume 8
Number 4 - Winter 1975 *Number 4 - Winter 1975*

Article 4

December 1975

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Benedict C. Pinkowski

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Recommended Citation

Pinkowski, Benedict C. 1975. "Pesticide Effects on Orthopteroid Distribution in Southern Michigan Farmlands," *The Great Lakes Entomologist*, vol 8 (4)
DOI: https://doi.org/10.22543/0090-0222.1261
Available at: https://scholar.valpo.edu/tgle/vol8/iss4/4

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Pinkowski: Pesticide Effects on Orthopteroid Distribution in Southern Michig

PESTICIDE EFFECTS ON ORTHOPTEROID DISTRIBUTION IN SOUTHERN MICHIGAN FARMLANDS

Benedict C. Pinkowski[1]

ABSTRACT

The occurrence and abundance of 22 species of orthopteroids is compared for isolated farm yards surrounded by corn fields which were either treated or not treated with a pesticide combination consisting of the herbicides Sutan and AAtrex, and the insecticide Dyfonate. All 22 species were present in the untreated plots, whereas only 12 were recorded in the treated plots, a 45.5% reduction.

Species characteristics determining the observed differences, in the order of decreasing importance, are: general abundance in non-treated areas, seasonal periodism, and vagility. More common species and fewer uncommon species were present in the treated areas, apparently because of the more diverse feeding habits of the former. Nearly all vernal species were absent from the treated areas, possibly because of direct mortality incurred at the time of pesticide application (spring). Those species with greater flight ability were better represented in the treated areas; evidently the corn fields to which the pesticides were applied formed an effective barrier that inhibited immigration of at least the short-winged or flightless species.

INTRODUCTION

Farmlands in southern Michigan often consist of a small, relatively undisturbed plot on which the residence and other buildings are located. This area is quite isolated, being surrounded by land used for growing a single crop, such as field corn or a small grain. The trend in recent decades has been away from diversity, and at present this trend is accentuated by two other increasingly common practices: 1) an increase in leasing of farmlands, which often leads to a reduction in crop rotation; and 2) the use of pesticide "combinations" consisting of one or more herbicides and an insecticide directed at specific pests of the single crop grown in the area.

The purpose of this paper is to examine the effects of one pesticide combination on the distribution and abundance of orthopteroids in a heavily farmed region of southern Michigan. The pesticide complex consisted of the herbicides Sutan 6-E (butylate) and AAtrex 80W (atrazine), and the insecticide Dyfonate 4-E (O-ethyl S-phenyl ethylphosphonodithioate). The occurrence of orthopteroids on two isolated, generally undisturbed, four and five acre plots surrounded by land planted with field corn and treated with these pesticides was studied during 1972 and 1973. This was compared with the occurrence of orthopteroids in four similar plots adjacent to untreated corn fields and surveyed during the same period.

METHODS

All three pesticides are liquid pre-emergents incorporated at depths up to three inches. The double herbicide is designed for complementarity; AAtrex controls yellow nutsedge (*Cyperus esculentus* L.), ragweed (*Ambrosia* spp.), and other broadleaf weeds, while Sutan is more effective against grasses, especially fall panicum (*Panicum dichotomiflorum* Michx.), giant foxtail (*Setaria magna* Griseb.), and crabgrass (*Digitaria* spp.). Dyfonate is applied mainly for control of corn rootworms (*Diabrotica* spp.), which are a serious pest on leased farmlands due to lack of crop rotation.

Observations were made in southeastern Lapeer County, and general census methods were similar to those of Bland (1972). Sampling was done both day and night once a week throughout the year, and sweep-nets were the principal sampling method. Abundance levels were assigned as follows: C—common, and noted on virtually all sampling

[1]Fraser, Michigan 48026.

Published by ValpoScholar, 1975

attempts during the appropriate season (determined from my records and the summary of Cantrall, 1968); I–infrequent, or present and noted occasionally but not always; and A–absent, never or rarely recorded. No attempt was made to count individuals.

Plots used in the analysis are categorized as "treated" (surrounded by corn fields to which the pesticides were applied in prescribed dosages) and "untreated" (adjacent corn fields without pesticides applied). All areas surveyed were within two or three km of another area of the opposite category. An effort was made to examine plots of similar size, floral composition (chiefly grass-goldenrod-milkweed, bordered by various trees and shrubs), soil moisture, etc., but, of course, duplication was never exact.

RESULTS

GENERAL OCCURRENCES.–The abundance levels for 22 species of orthopteroids identified on either the treated or untreated plots are summarized in Table 1. All 22 species were present on the untreated areas, while only 12 (54.5%) were present on treated areas. Thus a marked reduction in diversity occurs on the treated areas. The data are too meager to permit comparative conclusions for the different families represented. Acridids, however, appear to suffer a slightly greater reduction in the treated area than do non-acridids.

UBIQUITY.–The most noteworthy result obtained from the analysis is that the treated plots contained more common species and fewer uncommon species (Table 2). These results are significant ($P < 0.001$, Chi-square = 18.16), and presumably indicate that only the hardiest species are able to survive in the more sterile environment (see discussion below).

Table 1. Abundance levels for 22 species of orthopteroids identified in the treated and untreated areas.*

Species	Treated Areas	Untreated Areas
Mantis r. religiosa (Linnaeus)	C	C
Pseudopomala brachyptera (Scudder)	A	I
Chorthippus c. curtipennis (Harris)	C	C
Arphia p. pseudonietana (Thomas)	A	I
Arphia sulphurea (Fabricius)**	A	I
Chortophaga viridifasciata (De Geer)**	A	I
Encoptolophus s. sordidus (Burmeister)	A	C
Pardalophora apiculata (Harris)**	A	I
Dissosteira carolina (Linnaeus)	I	C
Melanoplus bivittatus (Say)	C	C
Melanoplus confusus Scudder**	I	C
Melanoplus f-r. femur-rubrum (De Geer)	C	C
Melanoplus s. sanguinipes (Fabricius)	I	C
Melanoplus viridipes eurycercus Hebard**	A	I
Neoconocephalus ensiger (Harris)	C	C
Orchelimum gladiator (Bruner)	C	C
Atlanticus testaceous (Scudder)**	A	1
Gryllus pennsylvanicus Burmeister	I	C
Gryllus veletis (R. D. Alexander and Bigelow)**	A	I
Nemobius fasciatus (De Geer)	C	C
Oecanthus fultoni T. J. Walker	C	C
Oecanthus nigricornis F. Walker	C	C

*Listed as C: common, I: infrequent, and A: absent (see text).
**Vernal species as defined in the text.

Table 2. The effect of abundance of orthopteroid species in untreated areas on the abundance of the same species in treated areas.

	Abundance in treated areas		
Abundance in untreated areas	Common (Number)	Infrequent (Number)	Absent (Number)
Common	9	4	1
Infrequent	0	0	8

SEASONAL PERIODISM.–Seven species indicated in Table 1 are designated as vernal, i.e., adulthood for these is attained by early June in the study area. Out of these seven, none was common in the treated plots, one was infrequent, and six were absent. By contrast, out of the remaining (summer or fall) species, nine were common, three were infrequent, and three were absent. This significant difference ($P < 0.01$, Chi-square = 9.33) is apparently due to the timing of the pesticide applications (spring). Adults of vernal species are more mobile than nymphs of summer species and may be more apt to enter the treated corn fields soon after pesticide application.

VAGILITY.–Seven of the species listed in Table 1 are either short-winged or flightless or nearly so. These are: *Pseudopomala brachyptera, Chorthippus curtipennis, Atlanticus testaceous, Gryllus pennsylvanicus, G. veletis, Melanoplus viridipes eurycercus,* and *Nemobius fasciatus.* A trend emerges when we compare the distribution of these species with other species possessing greater flight capability. Only three of these seven species (43%) are present on the treated area, whereas 10 of the remaining 15 species (67%) are present. Thus the more mobile species tend to be more abundant on the treated area than do species with less mobility.

DISCUSSION

It must be concluded that considerations relating to ubiquity, seasonal periodism, and vagility of the species studied all determine the distribution of orthopteroids following pesticide treatment. Ubiquity appears most critical, vagility the least critical.

Ecologically, the reduced diversity and abundance of orthopteroids in the treated areas translates into lower food web complexity. This effect appears to be an indirect consequence of the pesticide applications, since observations were made in areas removed from the actual land to which the pesticides were applied.

The observed differences in species abundance in the treated and untreated areas could result from direct mortality due to contact with the biocidal agents, indirect mortality due to elimination of foods, or to the fact that the treated corn fields formed an impassible barrier which prevented re-population of the isolated plots once species were eliminated or reduced in number by predators or other natural causes. There is evidence for all three of these effects.

The paucity of uncommon species in disturbed areas is usually attributed to the fact that such species are generally more aggregated (Hairston and Byers, 1954; Lussenhop, 1973). This, in turn, may be related to diet and food availability. In the treated areas a "relative" food shortage (in the sense of Andrewartha and Birch, 1954, 1960) existed because of the herbicide applications. Among acridids, for example, four of the six species present were Cyrtacanthacridinae, suggesting that this group is less affected by pesticides than other acridids. Gangwere (1961), in summarizing the food-habits of this sub-family, stated that they "...select very widely from among forbs, grasses, and woody plants." By contrast, the Oedipodinae and Gomphocerinae, both poorly represented on the treated plots, are largely graminivorous (Gangwere, *op. cit.*).

Hence, we can conclude that indirect mortality due to elimination of foods explains, in part, the observed differences. This is apparently why the more common species were better represented in the treated area. However, evidence for direct mortality is obtained from the fact that vernal species were uncommon on the treated area, as already noted. Finally, only those species with greater vagility were able to move readily to the isolated plots, indicating that an effective barrier was established by the pesticide applications.

ACKNOWLEDGMENTS

The author is grateful to Dr. S. K. Gangwere and Mr. M. Tyrkus, both of the Biology Department, Wayne State University, for their help in identifying the insects.

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DOI: 10.22543/0090-0222.1261