



Characterization of Prairie Mole Cricket Chorus Sites in Oklahoma

Caryn C. Vaughn, Susan M. Glenn, Ian H. Butler

American Midland Naturalist, Volume 130, Issue 2 (Oct., 1993), 364-371.

Your use of the JSTOR database indicates your acceptance of JSTOR's Terms and Conditions of Use. A copy of JSTOR's Terms and Conditions of Use is available at <http://www.jstor.org/about/terms.html>, by contacting JSTOR at jstor-info@umich.edu, or by calling JSTOR at (888)388-3574, (734)998-9101 or (FAX) (734)998-9113. No part of a JSTOR transmission may be copied, downloaded, stored, further transmitted, transferred, distributed, altered, or otherwise used, in any form or by any means, except: (1) one stored electronic and one paper copy of any article solely for your personal, non-commercial use, or (2) with prior written permission of JSTOR and the publisher of the article or other text.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

American Midland Naturalist is published by University of Notre Dame. Please contact the publisher for further permissions regarding the use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/notredame.html>.

American Midland Naturalist
©1993 University of Notre Dame

JSTOR and the JSTOR logo are trademarks of JSTOR, and are Registered in the U.S. Patent and Trademark Office. For more information on JSTOR contact jstor-info@umich.edu.

©2001 JSTOR

Characterization of Prairie Mole Cricket Chorusing Sites in Oklahoma

CARYN C. VAUGHN, SUSAN M. GLENN AND IAN H. BUTLER

*Oklahoma Natural Heritage Inventory, Oklahoma Biological Survey, University of Oklahoma,
2001 Priestly Ave., Bldg. 605, Norman 73019*

ABSTRACT.—Prairie mole crickets *Gryllotalpa major* were known historically from the southern tallgrass prairie region of North America, but have declined substantially and are now restricted to prairie fragments in Missouri, Kansas, Arkansas and Oklahoma. Surveys of calling males in Oklahoma from 1987 through 1991 located sixty distinct chorusing sites, 70% of which were located within the historical tallgrass prairie biome. Chorusing sites were characterized by higher silt content and higher plant diversity than sites where crickets did not call. Adequate silt content of the soil may be critical to proper burrow construction. Higher plant species diversity on chorusing sites is probably the result of past land management practices such as mowing for hay. Although presently secure in Oklahoma, prairie mole cricket populations may be threatened in the future by land use changes and continued habitat fragmentation.

INTRODUCTION

Prairie mole crickets (*Gryllotalpa major*) are secretive grassland insects with shovel-shaped forelegs modified for digging. They are among the largest insects in North America, measuring up to 6 cm long (Helfer, 1987). The crickets live in underground burrows, but come to the soil surface in the spring for courtship and reproduction. Males construct burrows that contain a bulblike acoustic chamber which amplifies their call. Males call concurrently from these burrows to attract females on warm, dry, still nights in April and May. Calling is restricted to a 50 to 60 minute period following sunset. Calls can be heard up to 0.4 km away (Walker and Figg, 1990). Females fly over the calling males and select mates. Mate selection is probably based on call intensity (Forrest, 1983). In this paper we refer to synchronous calling by males as “chorusing” (Greenfield and Shaw, 1983), although Walker (1983) used the term “spree” to describe a concurrent display by most sexually active males in a population. We use the term lek in its broadest sense as an assembly area for communal courtship display (Lincoln *et al.*, 1982; Morse, 1980).

Gryllotalpa major was known historically from the southern tallgrass prairie region of North America, occurring in Kansas, Missouri, Illinois, Kentucky, Tennessee, Mississippi, Arkansas and Oklahoma. The cricket has experienced a substantial decline throughout its range and is no longer believed to be extant in Illinois, Kentucky, Tennessee and Mississippi (Figg and Calvert, 1987). Outright loss of prairie and the fragmented nature of remaining prairie grasslands are the most significant factors contributing to the decline of the prairie mole cricket. Figg and Calvert (1987) recently found prairie mole cricket populations in Missouri to be small, isolated, and as a result, highly vulnerable to extinction. The largest extant populations appear to be associated with remaining clusters of prairie fragments. Based upon this information, the prairie mole cricket was proposed for federal listing as a threatened species (Federal Register, 25 April 1990) in 1990.

The habitat of the prairie mole cricket is believed to be high quality tallgrass or mixed-grass (tallgrass with some components of shortgrass) prairie with a history of light or no grazing (Figg and Calvert, 1987). It was thought that one factor contributing to the decline of this species was its apparent intolerance for land with a history of cattle grazing (Figg

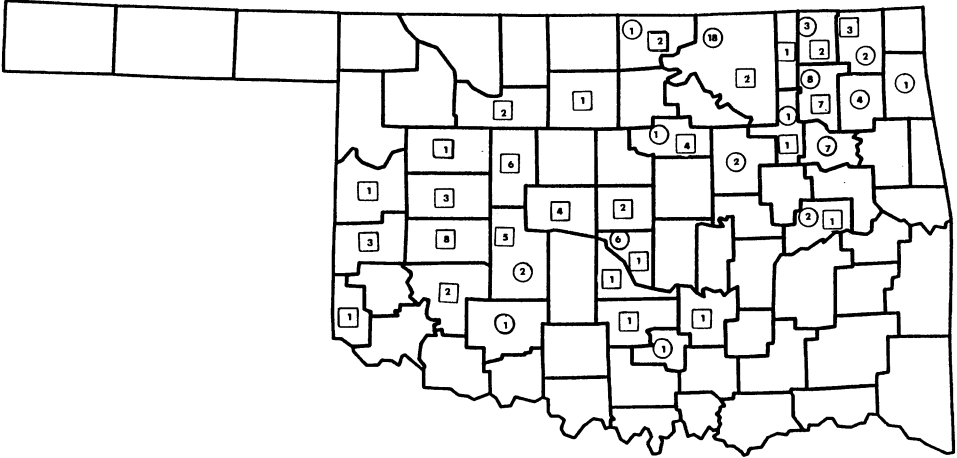


FIG. 1.—Distribution and abundance of sites surveyed for prairie mole crickets in Oklahoma, by county, from 1987–1991. Numbers enclosed by circles represent the number of sites within a county where prairie mole crickets were found. Numbers enclosed by squares represent sites that were surveyed which did not contain prairie mole crickets

and Calvert, 1987). However, surveys in Oklahoma in 1989 and 1990 indicated that these crickets in some cases occurred on sites that had a history of grazing and/or other forms of land disturbance. Little is known regarding the crickets ability to withstand various disturbances, including grazing.

In January 1992 the Fish and Wildlife Service withdrew the proposed rule to list the prairie mole cricket as a threatened species (Federal Register, 21 January 1992). This decision was based on (1) additional field surveys in Kansas and Oklahoma during the spring of 1991 that revealed that the species was more abundant and widespread than previously thought and (2) the assumption that the species is found in types of native grass cover that are not under immediate threat of destruction or modification.

This study was undertaken to (1) determine the status of *G. major* in Oklahoma by determining the distribution and abundance of chorusing sites and (2) to characterize these sites in terms of vegetative composition, soil characteristics, and land-use practices.

METHODS

Surveys for prairie mole crickets were performed by Oklahoma Natural Heritage Inventory staff and volunteers from 1987 through 1991 using the protocol developed by Figg (Figg and Calvert, 1987). The call of the prairie mole cricket is quite distinctive and can be distinguished from tree frogs by its pulsed rhythmic chirp and from the more common northern mole cricket by a chirp rate which is at least one third faster (Walker and Figg, 1990). Surveyors listened to audio tapes of the prairie mole cricket call immediately before surveying. Surveys were conducted by walking transects in the spring, beginning at sunset, listening for calling males, and recording the number of males heard on a standard form. In 1991 some surveys of large areas were made by driving predetermined routes and stopping and listening for calls every 0.8 km (a technique developed by B. Busby, Kansas Biological Survey). Accurate counts of chorusing males can be difficult to obtain, vary with the experience of the surveyor, and are hampered by the short duration of nightly activities and variable weather conditions in the spring. Therefore, while we have population size data,

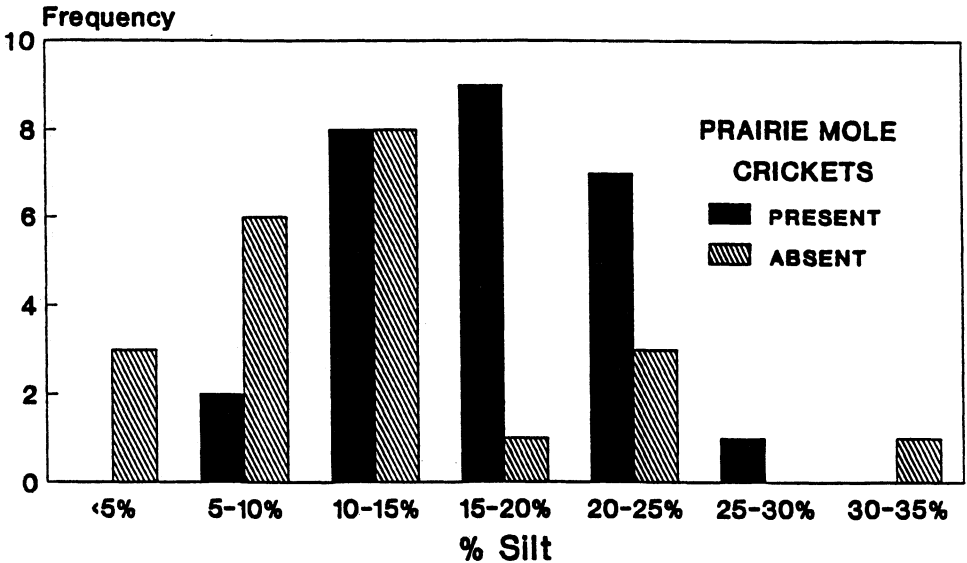


FIG. 2.—Percent silt at sites where prairie mole crickets were present versus sites where prairie mole crickets did not occur

in this paper we restrict our analyses to presence or absence of calling prairie mole crickets at a site.

We evaluated vegetative composition, soil composition, and land-use history of mole cricket sites selected from survey reports received from volunteers from 1989 through 1991 (Fig. 1). From these sites, we randomly chose 30 prairie mole cricket 'positive' sites (crickets were heard or found there), and 30 prairie mole cricket 'negative' sites (no crickets were found or heard). Sites considered to be native grassland and sites considered "marginal" habitat were included.

At each site, vegetation was sampled in 30 0.5-m² plots, using rectangular, metal quadrat frames. Samples were spaced approximately 10 paces (=approx. 17 m) apart, generally within the middle of the site as described, but not in rigidly defined transects. A subjective effort was made to encompass, by sampling, as much diverse vegetation within the area as possible. At every 6th sample, a soil core was drawn (a column ca. 2-cm diam × 26-cm long). The five soil samples from each site were mixed together and analyzed for the percentage of sand, clay, silt and organic matter.

Plant material was collected for unknowns, and observations on land use and species composition were recorded on data sheets for most sites. Sites were sampled throughout the growing season of 1991, but each site was sampled only once. For each plant species, cover in the plot was estimated in cover classes. Species with less than 1% cover were assigned to class 1, 1–5% cover was class 2, 5–25% cover was class 3, 25–50% was class 4, 50–75% was class 5, 75–95% was class 6 and species with over 95% cover were assigned to class 7. Cover classes were converted to the midpoint of the cover range. For example, cover class 1 was converted to 0.5%, and cover class 2 was converted to 3%. All subsequent analyses were performed on the cover values. Average cover and frequency (number of quadrats in which species occurred) of each species were calculated for each site. Relative cover of a species was calculated as a percent of the total cover of all species. Average cover was used to

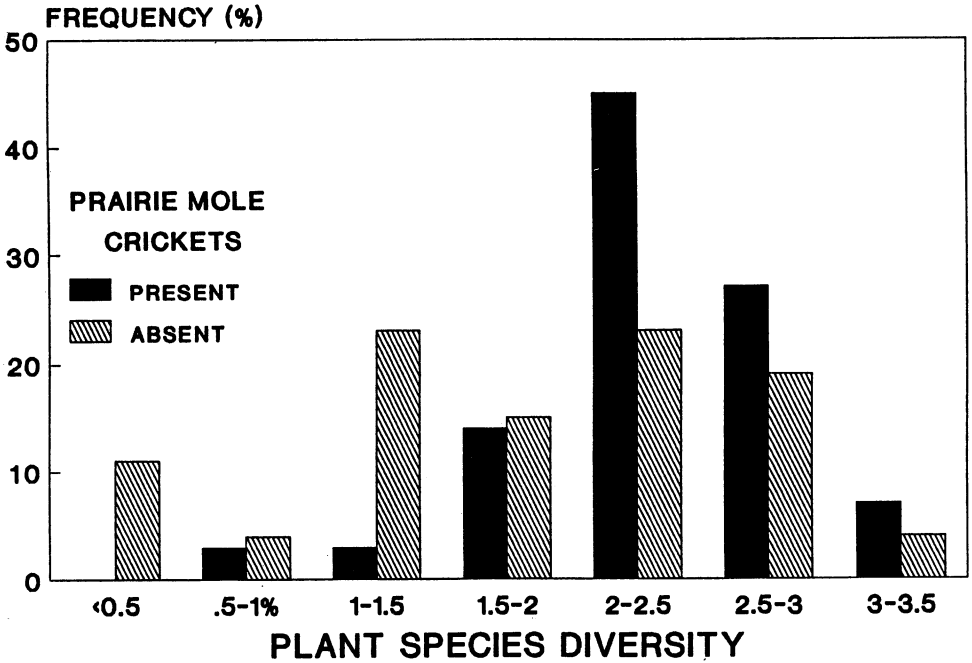


FIG. 3.—Plant species diversity at sites where prairie mole crickets were present versus sites where prairie mole crickets did not occur

calculate total site diversity, which is an index that reflects the number and relative distribution of species at the site. For example, sites with few species, or in which one or two species dominate have low values of diversity. Diversity (H) was calculated as the sum of the relative cover values of each species scaled by the logarithm of their relative cover values $\sum_i(-p_i \ln p_i)$.

Data were preliminarily analyzed using single classification analysis of variance with species cover, soil variables and diversity as the dependent variables, and the presence/absence of prairie mole crickets as the independent variable. Soil characteristics were compared at positive versus negative sites using t-tests. Plant diversity and individual plant species relative abundances were compared at positive versus negative sites using two-factor analysis of variance with mole cricket presence/absence and time (spring versus fall) as the treatment variables. Land-use history (grazing and haying) were compared at positive versus negative sites using chi-square tests. All analyses were done using PC-SAS.

RESULTS

Forty-eight percent of the 125 sites surveyed contained prairie mole crickets, and 70% of these positive sites occurred within the boundaries of the historical tallgrass prairie region of northeastern and northcentral Oklahoma (Fig. 1). The other 30% of positive sites were found in the mixed-grass prairie region.

Sites with mole crickets contained a significantly higher percentage of silt than sites lacking crickets ($t = -2.38, df = 31, P < 0.02$) (Fig. 2). Percentages of sand, clay and organic matter did not differ significantly between sites with and without crickets.

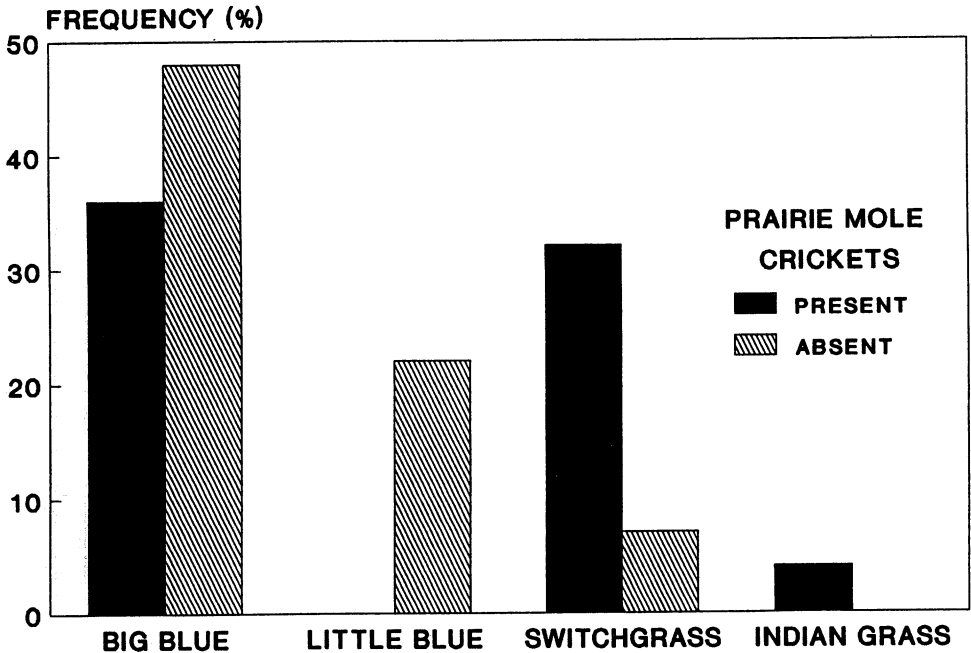


FIG. 4.—Frequency of four prairie grasses at sites where prairie mole crickets were present versus sites where prairie mole crickets did not occur

Three hundred and three species of plants were found on the sites. Of these, 124 occurred only at one site. Plant species diversity was significantly higher at sites with mole crickets ($F = 5.95$, $df = 1$, $P < 0.02$) (Fig. 3). There were no significant time or interaction effects. Average cover of ten plant species varied significantly between positive and negative sites (Table 1). Very few sites, either positive or negative, contained high frequencies of “typical” (Diamond and Smeins, 1988) prairie grasses (Fig. 4).

Chi-square tests revealed no significant differences between the occurrence of *G. major* and recent grazing ($\chi^2 = 0.38$, $P < 0.5$) or haying ($\chi^2 = 0.38$, $P < 0.5$) activities.

TABLE 1.—Results of t-tests for differences in average cover of nine plant species between sites where prairie mole crickets occurred versus sites where they did not occur. The degrees of freedom (df) are dependent on unequal variance in the two groups

Species	t	df	P
<i>Ratibida columnifera</i>	-2.3	28	0.03
<i>Elymus canadensis</i>	-2.65	30.1	0.01
<i>Carex</i> sp.	-2.2	35.6	0.03
<i>Ruellia humilis</i>	-2.38	45.5	0.02
<i>Andropogon saccharioides</i>	2.18	28.6	0.04
<i>Paspalum floridanum</i>	-2.7	28	0.01
<i>Andropogon virginicus</i>	-2.17	28.6	0.04
Unknown Lilliaceae	-2.16	28	0.04
Clover	-2.2	28.3	0.04

DISCUSSION

Sites with calling prairie mole crickets had higher silt content and higher plant diversity than sites without crickets. Observations by Figg and Calvert (1987) indicated that most prairie mole cricket populations occur on well-drained silty to sandy loam dry-mesic prairies. Adequate silt content of the soil may be critical to proper burrow construction because silt maintains a loose soil texture that should be more pliable to burrowing prairie mole crickets. Soil compaction, due to heavy grazing, could inhibit burrow construction. Alternatively, this soil type may not really represent optimal habitat for prairie mole crickets, but simply habitat that is presently available and acceptable, as historically these areas were less likely to be plowed for crop land and were often used for grazing and hay production (Figg and Calvert, 1987).

These survey results are for chorusing sites, which are not necessarily the sites crickets live on all year long. Locations of calling males are not evenly distributed in prairie habitat but appear to be aggregated (Figg and Calvert, 1987; Vaughn, pers. observ.). Prairie mole crickets may aggregate in areas of shorter vegetation to call, but live in other areas the rest of the year (Dennis Figg, pers. comm.). Males in orthopteran choruses often are aggregated spatially in the vicinity of resources important to females (Greenfield and Shaw, 1983) forming resource-based leks (Alexander, 1975). Females of another species of mole cricket, *Scapteriscus vicinus*, use male calls to locate oviposition sites as well as males (Forrest, 1983). Unfortunately, very little is known about what resources are important for *G. major*. Limited gut analyses of seven individuals indicated that they can feed on both plants and insects (Figg and Calvert, 1987), however the significance of different types of vegetation or insects in the diet of the species is not known. It is also not known if females oviposit at chorusing sites.

The higher plant species diversity at chorusing sites is probably a result of a recent disturbance such as light grazing, fire or mowing for hay (Collins and Gibson, 1990). These disturbances reduce the dominance of the major prairie grasses, such as *Andropogon gerardii*, *Sorghastrum nutans* and *Panicum virgatum*, which results in higher species diversity (Collins and Glenn, 1988). Therefore, prairie hay meadows are often highly diverse examples of tallgrass prairie. Many of the sites where prairie mole crickets occurred were hay meadows. The chronic nutrient loss by haying may have resulted in more *Andropogon virginicus* on the prairie mole cricket sites (Fig. 4). *Andropogon virginicus* is able to spread through nutrient poor areas and actually inhibits the growth of microorganisms that are responsible for increasing soil nutrient content (Rice, 1972). The correlation of positive prairie mole cricket sites with plant species diversity may be a result of previous land management as opposed to a factor controlling prairie mole cricket distribution.

Four years of surveys indicate that *G. major* occurs throughout the historical tallgrass prairie area of Oklahoma and in some mixed grass areas. However, we do not know how these chorusing sites relate to habitat that mole crickets may use during other times of the year. Burrows dug up during the winter contain no crickets (D. E. Figg, pers. comm.; Vaughn, pers. observ.). We do not know how numbers or the distribution of chorusing males may relate to the distribution and abundance of nonchorusing, "satellite" males (Forrest, 1983), females, immatures or egg-laying sites. We also do not know what the minimum viable population size (Murphy *et al.*, 1990) is for prairie mole crickets. Most chorusing sites in Oklahoma contained fewer than 10 calling males and were less than 20 acres in size. Very few had over 30 males. However, chorusing sites that occur within large tracts of undisturbed prairie, such as The Nature Conservancy's White Oak Prairie Preserve in Oklahoma and Paint Brush Prairie in Missouri, typically contained over 100 calling males. Prairie mole crickets are powerful fliers and can travel up to 2.5 km in a single night

(Figg and Calvert, 1987). It is reasonable to presume that they, like many insects, evolved to exploit a habitat that was patchy in both space and time (Schowalter, 1985). Fragments in close proximity probably reinforce the overall vigor of the species by distributing mole crickets among the range of habitat and management influences. However, mole cricket populations inhabiting individual fragments remain threatened by changes in land-use and vulnerable to extinction. The viability of a species depends on a reservoir of genetic variability maintained through population diversity (Ehrlich, 1992). If habitat fragmentation continues and these populations continue to be lost, the species becomes threatened.

Acknowledgments.—We thank the numerous volunteers who surveyed prairie mole crickets in Oklahoma over the past few years and the largely cooperative landowners for permission to sample on their property. Prairie mole cricket surveys by volunteers were initiated in Oklahoma in 1987 by Dennis Figg and Harley Brown, and coordinated in 1988 and 1989 by Pat Mehlhop. The U.S. Fish and Wildlife Service, the Oklahoma Department of Wildlife Conservation, and The Nature Conservancy also contributed to the mole cricket survey effort. We thank Ernie Steinhauer for assisting with vegetation sampling, Carter Miller for landowner contact, soil analysis, and data entry and Tandra Browning for data entry. Forrest Johnson assisted with plant identification. Portions of this project were funded by the U.S. Fish and Wildlife Service and the Oklahoma Department of Wildlife Conservation with Endangered Species Act funding (Project E-16-1), the Bureau of Land Management, and The Nature Conservancy.

LITERATURE CITED

- ALEXANDER, R. D. 1975. Natural selection and specialized chorusing behavior in acoustical insects, p. 35–77. *In*: D. Pimental (ed.). *Insects, science, and society*. Academic Press, New York.
- COLLINS, S. L. AND D. J. GIBSON. 1990. Effects of fire on community structure in tallgrass and mixed-grass prairie, p. 81–98. *In*: S. L. Collins and L. L. Wallace (eds.). *Fire in North American tallgrass prairies*. University Oklahoma Press, Norman. 169 p.
- AND S. M. GLENN. 1988. Disturbance and community structure in North American prairies, p. 131–143. *In*: H. J. During, M. J. A. Werger and J. H. Wellens (eds.). *Diversity and pattern in plant communities*. SPB Academic Publishing, The Hague.
- DIAMOND, D. D. AND F. E. SMEINS. 1988. Gradient analysis of remnant True and Upper Coastal Prairie grasslands of North America. *Can. J. Botany*, **66**:2152–2161.
- EHRlich, P. R. 1992. Population biology of checkerspot butterflies and the preservation of global biodiversity. *Oikos*, **63**:6–12.
- FEDERAL REGISTER. 1990. Endangered and threatened wildlife and plants: proposed threatened status for the prairie mole cricket. 25 April 1990.
- FEDERAL REGISTER. 1992. Endangered and threatened wildlife and plants: withdrawal of the proposed rule to list the prairie mole cricket (*Gryllotalpa major*) as threatened. 21 January 1992.
- FIGG, D. E. AND P. D. CALVERT. 1987. Status, distribution, and life history of the prairie mole cricket *Gryllotalpa major* Saussure. Missouri Department of Conservation, Jefferson City, Missouri, 40 p.
- FORREST, T. G. 1983. Calling songs and mate choice in mole crickets, p. 185–204. *In*: D. T. Gwynne and G. K. Morris (eds.). *Orthopteran mating systems: sexual competition in a diverse group of insects*. Westview Press, Boulder, CO.
- GREENFIELD, M. D. AND K. C. SHAW. 1983. Adaptive significance of chorusing with special reference to the Orthoptera, p. 1–27. *In*: D. T. Gwynne and G. D. Morris (eds.). *Orthopteran mating systems: sexual competition in a diverse group of insects*. Westview Press, Boulder, CO.
- HELPER, J. R. 1987. *How to know the grasshoppers, crickets, cockroaches, and their allies*. Dover Publ., New York. 363 p.
- LINCOLN, R. J., G. A. BOXSHALL AND P. F. CLARK. 1982. *A dictionary of ecology, evolution and systematics*. Cambridge University Press, 298 p.
- MORSE, D. H. 1980. *Behavioral mechanisms in ecology*. Harvard University Press. 383 p.

- MURPHY, D. D., K. E. FREAS AND S. B. WEISS. 1990. An environmental metapopulation approach to population viability analysis for a threatened invertebrate. *Conservation Biology*, 4:41-51.
- RICE, E. L. 1972. Allelopathic effects of *Andropogon virginicus* and its persistence in old fields. *Am. J. Botany*, 59:752-755.
- SCHOWALTER, T. D. 1985. Adaptations of insects to disturbance, p. 235-252. In: S. T. A. Pickett and P. S. White, (eds.). The ecology of natural disturbance and patch dynamics. Academic Press, New York.
- WALKER, T. J. 1983. Diel patterns of calling in nocturnal Orthoptera, p. 45-72. In: D. T. Gwynne and G. K. Morris (eds.). Orthopteran mating systems: sexual competition in a diverse group of insects. Westview Press, Boulder, CO.
- WALKER, T. J. AND D. E. FIGG. 1990. Song and acoustic burrow of the prairie mole cricket, *Gryllotalpa major* (Orthoptera: Gryllidae). *J. Kansas Entomol. Soc.*, 63:237-242.

SUBMITTED 29 OCTOBER 1992

ACCEPTED 9 MARCH 1993