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PRESENCE OF THE “THREATENED” *TRIMEROTROPIS HURONIANA* (ORTHOPTERA: ACRIDIDAE) IN RELATION TO THE OCCURRENCE OF NATIVE DUNE PLANT SPECIES AND THE EXOTIC *CENTAUREA BIEBERSTEINII*

Jordan M. Marshall¹ and Andrew J. Storer²

ABSTRACT

Trimerotropis huroniana Wlk. is a “Threatened” species in Michigan and Wisconsin with a distribution limited to open dune systems in the northern Great Lakes region of North America. Pitfall traps were utilized in the Grand Sable Dunes of Pictured Rocks National Lakeshore, MI, along with an herbaceous plant survey, to identify the relationship of *T. huroniana* with native dune plant species, *Ammophila breviligulata* Fern. (American beachgrass, Poaceae), *Artemisia campestris* L. (field sagewort, Asteraceae), and the exotic invasive plant *Centaurea biebersteinii* DC. [= *Centaurea maculosa*, spotted knapweed, Lamarck] (Asteraceae). The absence of *C. biebersteinii* resulted in an increased likelihood of capturing *T. huroniana*. This was most likely due to the increased likelihood of encountering *A. campestris* in areas without *C. biebersteinii*. The occurrence of *A. breviligulata* was independent of *C. biebersteinii* presence. A significant positive linear relationship occurred between the percent cover of *A. campestris* and the traps that captured *T. huroniana*. There was no significant relationship between *A. breviligulata* percent cover and the traps that captured *T. huroniana*. The occurrence and distribution of *T. huroniana* is closely related to the presence and abundance of *A. campestris*. Habitat conservation and improvement for *T. huroniana* should include increases in *A. campestris* populations through the removal of *C. biebersteinii*.

INTRODUCTION

With its U.S. distribution limited to sensitive open dune systems of the northern Great Lakes in Michigan and Wisconsin, *Trimerotropis huroniana* Wlk. (Orthoptera: Acrididae) is considered critically imperiled and listed as “Threatened” by Michigan and “Endangered” by Wisconsin (Hubbell 1929, Otte 1984, Ballard, Jr. 1989, Sjogren 2001, Scholtens et al. 2005). This locust has historically occurred in similar dune systems in Ontario, Canada (Hubbell 1929, Otte 1970). Now, however, *T. huroniana* may be extirpated from Ontario (Ontario Ministry of Natural Resources 2005).

Ammophila breviligulata Fern., *Artemisia campestris* L., and *Calamovilfa longifolia* (Hook.) Scribn. (prairie sandreed, Poaceae) are three native dune plant species identified as the most likely food plants for *T. huroniana* (Rabe 1999, Scholtens et al. 2005). Scholtens et al. (2005) suggested that the presence of *T. huroniana* was not related to the presence of native plant species. The landscape scale of their survey efforts in an attempt to delineate population distribution within the known range of this locust species may not have been adequate to determine finer scale correlations. Also, Scholtens et al. (2005) performed a qualitative assessment of the plant communities within dunes

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where *T. huroniana* occurs. Such a survey technique may not have provided the detail necessary to identify relationships between a rarely occurring organism and its food resources. A localized comparison of *T. huroniana* occurrences with the important dune food plants may provide a clearer understanding of mechanisms influencing the distribution of *T. huroniana*.

Centaurea biebersteinii DC is an exotic plant species introduced from Europe into North America in the late 1800s (Watson and Renney 1974). Since its introduction, *C. biebersteinii* has become established throughout North America and has locally decreased native plant diversity, altered arthropod distributions, reduced wild and domestic ungulate productivity, and indirectly increased runoff and sedimentation rates (Lacey et al. 1989, Thompson 1996, Kedzie-Webb et al. 2001, Olson and Wallander 2001, Marshall et al. 2008). The introduction of *C. biebersteinii* to sensitive dune plant communities may alter the occurrences of the "Threatened" *T. huroniana*, which already experiences limitations to population size and distribution.

The objective of this study was to test the hypotheses that *T. huroniana* occurrence was independent of the presence of *C. biebersteinii*, *A. campestris*, and *A. breviligulata*.

METHODS AND MATERIALS

Areas with and without *C. biebersteinii* were utilized within the Grand Sable Dunes of Pictured Rocks National Lakeshore in the Upper Peninsula of Michigan (46°39'38"N, 86°1'54"W). *C. biebersteinii*, along with other major vegetation cover types, was mapped within the Grand Sable Dunes during the summer of 2000 (B. Leutscher, personal communication). The majority of the Grand Sable Dunes are covered by herbaceous dune plant communities, with natural dune stabilization occurring as *Pinus banksiana* Lamb. (Jack pine, Pinaceae) and Northern Hardwood forests invade.

The three largest delineated areas of *C. biebersteinii* (10.7, 6.3, 4.8 ha), which had been established for at least five years (B. Leutscher, personal communication), were selected for this study. A transect (500-600 m) was established along the long axis of each area of *C. biebersteinii*. In areas of native dune plant communities without *C. biebersteinii* adjacent to each *C. biebersteinii* area, transects of comparable length were established. Along each transect in the survey area, two arrays of five pitfall traps (8.5 cm diameter, 12.5 cm height) were installed on a linear 5-meter spacing following the transect approximately 200-250 m apart (10 traps per transect). Approximately 75 ml of 50 percent propylene glycol (Preston LowTox® Antifreeze) was used in each trap as a killing agent and preservative. Pitfall traps were open for one week and then closed for approximately three weeks to reduce the likelihood of population depressions due to trapping. At the time of closing, traps were emptied and upon re-opening, new propylene glycol was added to each trap. A total of five trapping cycles were carried out from 2 May 2003 to 28 August 2003, however for analysis, only the final two trapping cycles from 23-30 July and 21-28 August (3 transects × 2 trap groups × 5 traps × 2 trapping cycles = 60 traps/treatment with and without *C. biebersteinii*) were used. These cycles were the only with *T. huroniana* captures due to the late season activity of adults (Rabe 1999).

A plant survey was conducted within five 1-m² quadrats along each transect within 5 m of each trap (3 transects × 2 trap groups × 5 quadrats = 30 quadrats/treatment with and without *C. biebersteinii*) identifying percent cover of *C. biebersteinii*, *A. campestris*, and *A. breviligulata*. Mean percent cover for each taxon was calculated for individual transects. A chi-squared analysis was used to test the hypothesis that traps capturing *T. huroniana* were independent of *C. biebersteinii* presence, as well as to test the hypothesis that the presence of *A. campestris* and *A. breviligulata* were independent of *C. biebersteinii* presence.

Simple linear regression was used to test for the relationship between the percent cover of *A. campestris*, as well as *A. breviligulata*, and the traps that captured *T. huroniana*.

RESULTS AND DISCUSSION

Traps that captured *T. huroniana* were not independent of the presence of *C. biebersteinii* (Table 1). Traps installed in areas without *C. biebersteinii* were more likely to capture *T. huroniana* than traps in areas with *C. biebersteinii*. This relationship may be due to the increased likelihood of encountering *A. campestris* in quadrats without *C. biebersteinii* (Table 2). Along with *A. campestris*, two dune grasses occurred in the Grand Sable Dunes, however, *C. longifolia* was rare and *A. breviligulata* was the dominant grass species. Usually these two grass species singularly dominate, as in the Grand Sable Dunes, or co-dominate suitable *T. huroniana* habitat and are also known plants fed on by this locust (Scholtens et al. 2005), however, the presence of *A. breviligulata* was independent of the presence of *C. biebersteinii* ($\chi^2 = 0.33$, $df = 1$, $P = 0.567$). The number of traps that captured *T. huroniana* was not related to the percent cover of *A. breviligulata* ($F = 0.25$, $df = 1, 4$, $P = 0.644$, $R^2 = 0.059$).

As *A. campestris* percent cover increased, the number of traps along each transect that captured *T. huroniana* also increased (Fig. 1). This relationship corroborates the suggestions made by Rabe (1999) and Scholtens et al. (2005) that *A. campestris* is one of the important plant species in the distribution of *T. huroniana*. As a native dune plant species and an important component of *T. huroniana* habitat, changes in *A. campestris* distribution and occurrence would be expected to alter *T. huroniana* distribution and occurrence.

Trimerotropis huroniana habitat conservation may be enhanced by increasing the dune coverage of *A. campestris* by reducing the coverage of *C. biebersteinii*. The occurrence of *A. breviligulata* was independent of *C. biebersteinii* presence and suggests that this dune grass may not be the most influential

Table 1. Traps capturing *Trimerotropis huroniana* in areas with and without *C. biebersteinii* in the Grand Sable Dunes, Pictured Rocks National Lakeshore, MI.

		<i>Trimerotropis huroniana</i>	
		Captured	Not Captured
<i>C. biebersteinii</i>	Present	3	57
<i>C. biebersteinii</i>	Absent	10	50
		$\chi^2 = 4.23$, $df = 1$, $P = 0.039$	

Table 2. Number of quadrats sampled encountering *Artemisia campestris* and *C. biebersteinii* in the Grand Sable Dunes, Pictured Rocks National Lakeshore, MI.

		<i>Artemisia campestris</i>	
		Present	Absent
<i>C. biebersteinii</i>	Present	0	27
<i>C. biebersteinii</i>	Absent	14	19
		$\chi^2 = 13.01$, $df = 1$, $P < 0.001$	

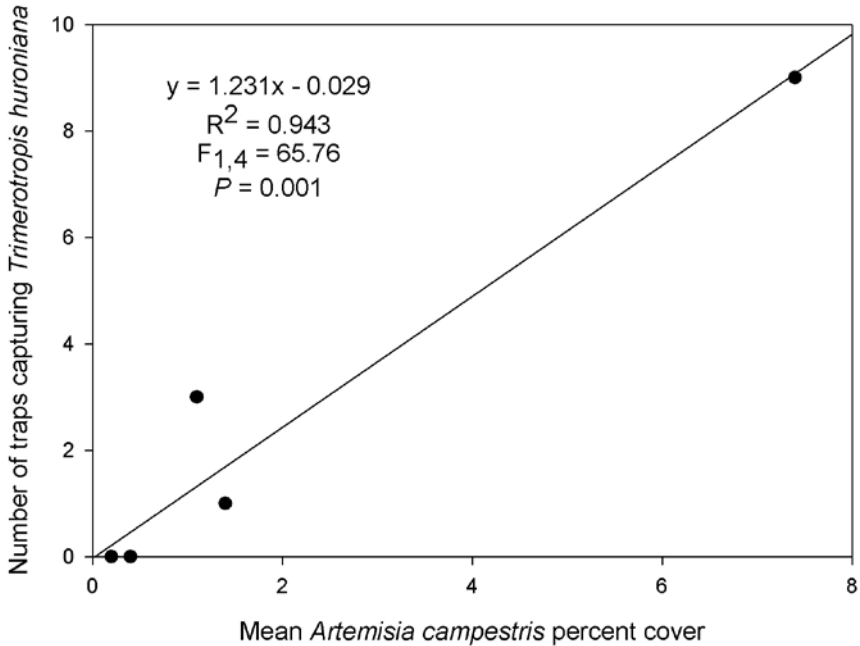


Figure 1. Linear regression relationship between mean *Artemisia campestris* percent cover and number of traps capturing *Trimerotropis huroniana* in the Grand Sable Dunes, Pictured Rocks National Lakeshore, MI.

factor in determining the occurrence of *T. huroniana* in the Grand Sable Dunes, however, increasing the coverage and distribution of this dune grass would also be beneficial to *T. huroniana*.

Efforts within the Grand Sable Dunes, Pictured Rocks National Lakeshore, to control *C. biebersteinii* by hand pulling have been carried out by the National Park Service but the availability of funding has limited the size and recurrence of such operations (B. Leutscher, personal communication). A more viable option may be classical biological control. While early biological control agents selected for *C. biebersteinii* control have been plagued with limited efficiency, parasitoid activity, and predation, more recent control agents have demonstrated effective reductions in *C. biebersteinii* density and biomass (Myers 2000, Long et al. 2003, Marshall et al. 2005, Corn et al. 2006, Story et al. 2006). Based on the results of this study, reducing the populations of *C. biebersteinii* in the dune habitat of *T. huroniana* would increase populations of *A. campestris* to the benefit of this "Threatened" locust.

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