Effect of a prescribed burn on the flying insect population in a glade at Blackacre State Nature Preserve, Jefferson County Kentucky

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Abstract

In 2005, a prescribed burn was conducted to restore the herbaceous native flora in a dolomite glade at Blackacre State Nature Preserve, Jefferson County, Kentucky. To measure the procedure's effectiveness, a Malaise trap was used to survey the flying insect population pre- and post-burn, in 2004, 2005 and 2009. By 2009, the increase in total insect families from 2004 was 77.7%. The increase in Diptera and Hymenoptera families, important glade flora pollinators, was 72.2%. The number of individual Cicadellidae (Hemiptera) - insects also associated with herbaceous plants - increased 710.0%. Together, these population changes suggest recovery of the glade flora and habitat.

Introduction

In March, 2005 the Kentucky State Nature Preserves Commission conducted a prescribed burn to restore the herbaceous flora in a dolomite glade at Blackacre State Nature Preserve, Jefferson County Kentucky. Plant cover on the glade, located on a hillside near the geographic center of Blackacre, consisted of Eastern Red Cedar (*Juniperus virginiana*) and non-native grasses, left over from earlier agriculture. The glade contained remnants of native wildflowers including Hoary Puccoon (*Lithospermum canescens*) and St. John's Wort (*Hypericum dolabriforme*), (Jones, 2005).

A survey of the flying insect population was made in order to measure the effectiveness of the burn. Diptera and Hymenoptera are important pollinators of the herbaceous plants, characteristic of a dolomite glade ecosystem (Campbell et al, 2006; Cane, J.H. Tepedino, V.J., 2001). Malaise trap collections were used to compare numbers of Diptera and Hymenoptera families, as well as other flying insect families, preceding the burn, the year of the burn, and four

years after the burn. Such traps are especially effective in surveying Diptera and Hymenoptera (Guler, 2008 and Marston, 1965).

Methods

From July 25 to July 31 2004, the year prior to the burn, a malaise trap (BioQuip model #2875D Townes Pattern) was set up in the glade area (38 degrees 11 48.06 N 85 degrees 32 03.30 W). The traps collecting head was charged with 70% ethanol (Figure 1). The malaise trap was placed at the same location in the glade from July 25 to July 31 2005, after the burn had been conducted that spring. A third collection was taken four years later in 2009. The trap was placed in the same location at the same time of year in order to minimize seasonal fluctuations. Insects were identified to family level using stereomicroscopes (Wolfe StereoPro) and taxonomic keys (Arnett, 1985; Borror and White, 1998; Triplehorn and Johnson, 2005). (Figure 2) Tables and graphs summarizing data were created using Microsoft Excel, 2007.

Figure 1. Malaise Trap

Figure 2. Identification of collection.

Results

In 2004, 86 insects were collected in 18 families. Of those 18 families, 15 were either Diptera or Hymenoptera. In 2005, 123 insects were collected in 24 families, 17 of which were Diptera or Hymenoptera. In 2009, 218 insects were collected in 32 families, 28 of which were Diptera or Hymenoptera. (Table 1)

The increase in total families from pre-burn 2004 to post-burn 2005 was 33%. The increase in Diptera/Hymenoptera families from 2004-2005 was 13.3%. Five years after the burn, the increase was 77.7% in total families and 72.2% in Diptera/Hymenoptera (Figure 3). Another notable increase occurred in Cicadellidae (leafhoppers) where number of individuals collected increased 710% from 2004-2009 (Figure 4).

Table 1. Blackacre Glade Malaise Trap Data. (Taxonomy follows Triplehorn and Johnson, 2005.)

Order	Family	2004	2005	2009
Orthoptera	Locustidae	0	1	0
Hemiptera	Lygaeidae	0	1	0
	Cercopidae	1	3	3
	Cicadellidae	3	18	25
	Flatidae	0	0	1
	Dasydemellidae	0	0	1
Neuroptera	Myrmeleonflidae	1	1	0
Coleoptera	Lampyridae	0	1	0
	Mordellidae	0	1	0
Diptera	Culicidae	0	0	4
	Dixidae	0	0	5
	Anisopodidae	1	0	0
	Mycetophilidae	0	0	1
	Stratiomyidae	1	0	0
	Sciaridae	1	0	0
	Tabanidae	0	0	1
	Asilidae	3	5	2
	Dolichopodidae	0	0	19
	Phoridae	1	1	0
	Syrphidae	0	1	0
	Anthomyiidae	0	4	2
	Calliphoridae	3	1	15
	Muscidae	0	3	29
	Sarcophagidae	10	21	9
	Tachinidae	1	1	9
	Micropezidae	0	0	1
	Tephritadae	0	0	3
	Ulidiidae	0	4	2
	Platystomatidae	0	0	1
	Sciomyzidae	0	0	1
	Drosophilidae	0	0	2
Hymenoptera	Braconidae	2	2	1
	Ichneumonidae	7	3	18
	Chalcididae	0	0	1
	Chrysididae	1	6	0
	Dryinidae	0	0	14
	Sphecidae	2	0	10
	Colletidae	1	0	0
	Halictidae	1	2	4
	Andrenidae	0	19	13
	Megachilidae	0	1	0
	Apidae	2	0	0
	Anthophoridae	0	0	1
	Tiphiidae	45	22	21
	Pompilidae	0	1	3
Total Families		18	25	32
Total Diptera/Hymenoptera		15	17	28

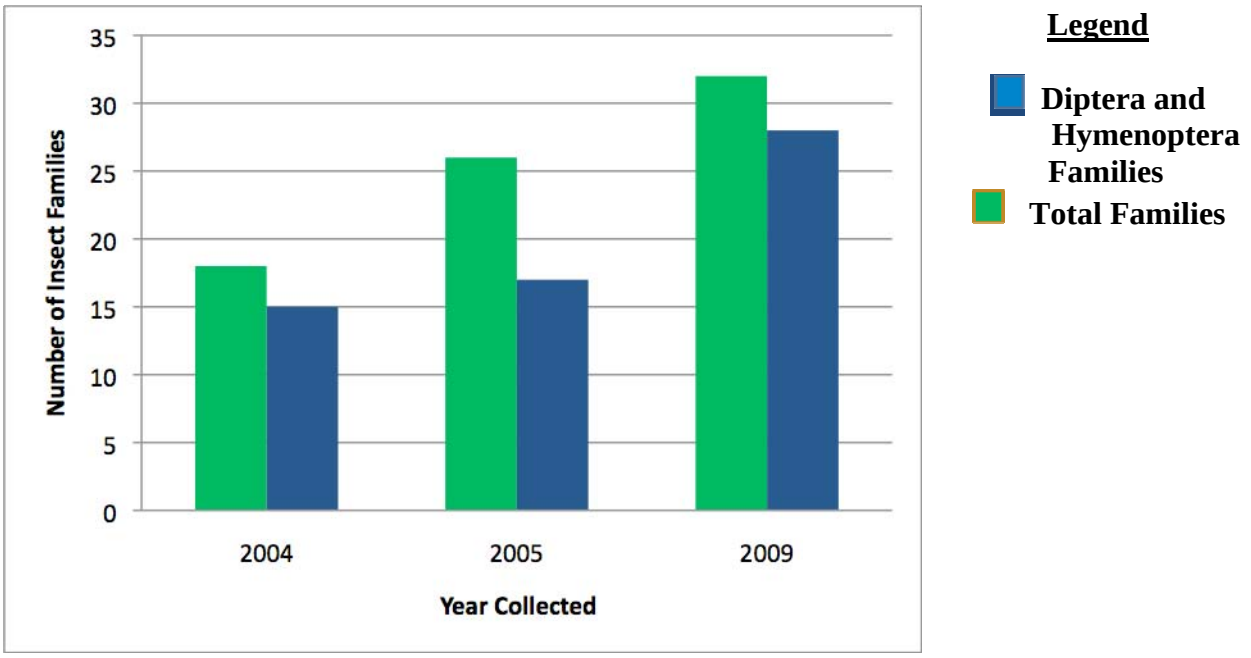

Fig. 3 Malaise trap data from Blackacre glade

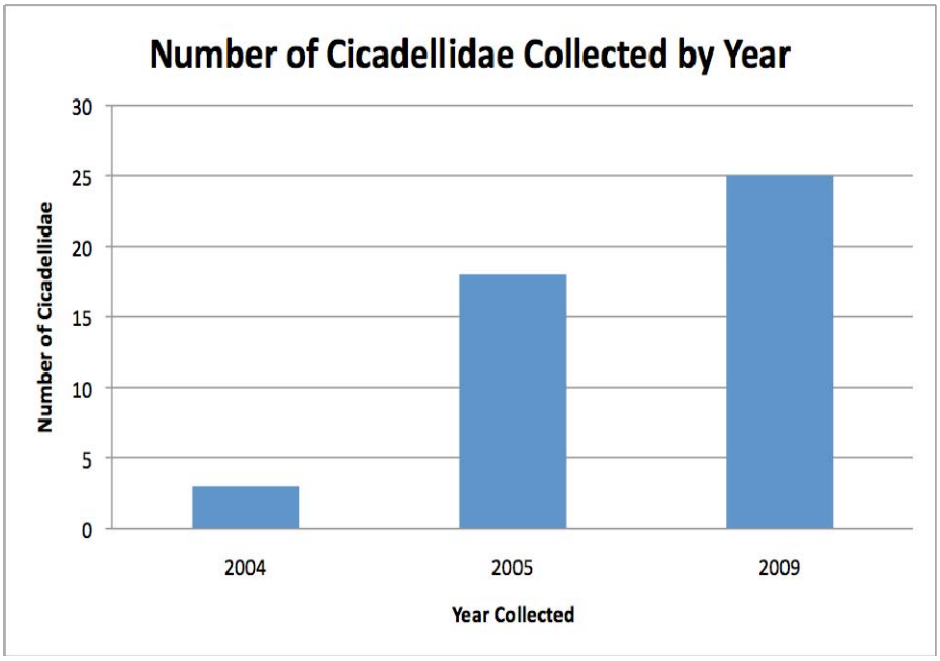

Fig. 4 Number of Individual Cicadellidae Collected

Discussion

A notable increase was observed in total number of insects and diversity of families, especially Hymenoptera and Diptera. Both Hymenoptera and Diptera are essential in the pollination of native flowers and forbs. Lepidoptera are also important pollinators, however the small size of the collecting head opening excludes many larger species of Lepidoptera. Small Lepidoptera collected were in poor condition from lying in the ethanol collecting fluid and thus were not used in the study.

The 72% increase in Diptera/Hymenoptera and the 710% increase in Cicadellidae (leafhoppers) is a positive indicator that the glade ecosystem is recovering. Findings would suggest that our data is in alignment with that of other studies (Campbell, et al 2007; Panzer, 2002), in which similar increases were observed after a prescribed burn.

There were also significant changes in the populations of four families of Diptera and three families of Hymenoptera. In the Diptera, Dolichopodidae, Calliphoridae, and Muscidae increased between 2004 and 2009. In that same period, the number of Sarcophagidae collected doubled from 2004 to 2005, but the number collected in 2009 returned to the 2004 level. Among the Hymenoptera, Ichneumonidae, Sphecidae and Andrenidae showed marked increases in numbers. The Tiphiidae declined.

The number of Dolichopodidae (long-legged flies) collected increased from zero in 2004 and 2005 to 19 collected in 2009. Muscidae (house flies) also appeared in large numbers in 2009 (29 individuals collected) after not being trapped in 2004 and only three individuals having been trapped in 2005. These jumps in population, as well as the 97% increase in Calliphoridae (blow flies) from 2004 to 2009 may be due to the unseasonably wet climate (rainfall several inches

above normal) Louisville experienced during the month of July, 2009. Adults and larvae of each of these families prefer moist environments and high humidity. (Pollet, 1992.)

Sarcophagidae, the flesh flies, are common insects that feed on dead or decaying tissues and sugar-containing materials. Some species parasitize grasshoppers and beetles (Triplehorn and Johnson, 2005). Many Sarcophagidae lay their eggs in the nests of various bees and wasps, where their larvae feed on the host insects. The andrenid bees are one type of bee that the sarcophagids are known to parasitize (Polidori et al, 2005).

The andrenid bees (Family Andrenidae) nest in burrows on the ground, often in large colonies, in areas of sparse vegetation. The Andrenidae would have found the post-burn, sparsely vegetated glade an ideal habitat for their nests in 2005, causing their numbers to rise from 0 to 19 collected in a year's time. Their numbers dropped between 2005 and 2009, most likely due to the increase in vegetation that led to a decrease in their nesting habitat potential. There appeared to be a direct correlation between the rise in populations of Andrenidae and Sarcophagidae between 2004 and 2005, and then both families' populations dropped by 2009. It would stand to reason that without plentiful nesting habitat, the andrenids moved on, and that without andrenid nesting sites in which to lay their parasitic larvae, the sarcophagids also found more suitable habitat.

The number of Ichneumonidae (ichneumon wasps) increased 257% from 2004 to 2009, after a decline in numbers in 2005. These wasps favor leaf litter and woody plant material for habitat, which would have decreased after the 2005 burn and would not have been available to them. Numbers recovered as the glade recovered. Ichneumonidae also are parasitoids and use other Hymenoptera and Diptera, among other insects, as their hosts (Gauld and Bolton, 1988). Therefore, it makes sense that their numbers increased with increase in host populations.

Tiphiids are small, solitary wasps that were introduced to the United States in the 1920s to control Japanese beetles (*Popillia japonica*), whose grubs they parasitize (Triplehorn, and Johnson, 2005). The numbers of Tiphiidae collected dropped from 45 in 2004 to 22 in 2005 and were virtually the same, at 21 in 2009, for an overall decrease of 53%. Since the wasps locate the grubs from the odor of their frass (Rogers and Potter, 2004), the initial burn may have interfered with this ability and caused the number of wasps in the glade to decline. Or perhaps the burn destroyed plants inhabited by the grubs thus causing the decreased numbers of t

Tiphiids in the glade. There may also simply have been a decline in the beetle population unrelated to the burn and a corresponding decline in the wasps that parasitize them.

A continuation of the study is recommended for the next five years, possibly adding new locations throughout the glade. This would help with the interpretation of data that may have been a result of 2009 weather conditions. In addition, sampling during different seasons may also provide useful information about the glade ecosystem.

Acknowledgements

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Literature Cited

ARNETT, R.H., JR. 1985. American Insects: A Handbook of the Insects of America North of Mexico, Van Nostrand Reinhold Co., New York.

BORROR, D. J. AND R.E. WHITE. 1998. A Field Guide to the Insects of America North of Mexico. Houghton Mifflin Co., Boston.

CAMPBELL, J.W., J.L. HANULA, AND T.A. WALDROP. 2007. Effects of prescribed fire and fire surrogates on floral visiting insects of the blue ridge province in North Carolina. Biological Conservation 134: 393-404.

CANCELADO, R. AND T.R. YONKE. 1970. Effect of prairie burning on insect populations. Journal of the Kansas Entomological Society 43: 274-281.

CANE, J.H. AND V.J. TEPEDINO. 2001. Causes and extent of declines among native North American invertebrate pollinators: detection, evidence, and consequences. Conservation Ecology 5 (1): 1-10.

GAULD, I. AND B. BOLTON. 1988. The Hymenoptera. Oxford University Press, Oxford.

GULER, Y. 2008. Malaise trap. Mellifera 8 (15): 26-32.

JONES, R.L. 2005. Plant Life of Kentucky: An Illustrated Guide to the Vascular Flora. University Press of Kentucky, Lexington.

MARSTON, N. 1965. Recent modifications in the design of malaise insect traps with a summary of the insects represented in collections. Journal of the Kansas Entomological Society 38:154-162.

PANZER, R. 2002. Compatibility of prescribed burning with the conservation of insects in small, isolated prairie reserves. Conservation Biology 16 (5): 1296-1307.

POLIDORI, C., B. SCANNI, E. SCAMONI, M. GIOVANETTI, F. ANDRIETTI, J. PAXTON. 2005. Satellite flies (Leucophora personata, Diptera: Anthomyiidae) and other dipteran parasites of the communal bee Andrena agilissima (Hymenoptera: Andrenidae) on the island of Elba, Italy. Journal of Natural History 39 (29): 2745-2758.

POLLET, M. 1992. Impact of environmental variables on the occurrence of dolichopodid flies in marshland habitats in Belgium (Diptera: Dolichopodidae). *Journal of Natural History* **26**: 621-636

ROGERS, M. E. AND D.A. POTTER. 2002. Kairomones from scarabaeid grubs and their frass as cues in below-ground host location by the parasitoids *Tiphia vernalis* and *Tiphia pygidialis.* Entomologia Experimentalis et Applicata 102: 307-314.

TRIPLEHORN, C.A. AND N.F. JOHNSON. 2005. Borror and DeLong's Introduction to the Study of Insects, 7th ed. Thomson Brooks/Cole, Belmont, Calif.