SEASONAL FORAGING RESOURCES OF MISSISSIPPI BOLL WEEVILS

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Abstract

Foraging resources of boll weevils *Anthonomus grandis* Boheman (Coleoptera: Curculionidae) in the Delta of Mississippi were determined from pollen analyses of adults captured from June 1996 through January 1997. Over 4,300 boll weevils were processed in 750 samples. There were 39,183 pollen grains and 208 pollen types found in the samples. Pollen from 75 families, 115 genera, and 27 species was identified in the samples. Four plant families contained ten or more taxa: Asteraceae, Fabaceae, Euphorbiaceae, and Malvaceae. Summer samples were dominated by pollen from families Caprifoliaceae (20%), Poaceae (17%), and Asteraceae (11%); Fall by Asteraceae (76%); and, Winter by Brassicaceae (57%). Asteraceae pollen occurred in more than 50% of the samples in all three seasons. Species diversity ranged from 4.4 in Summer's samples to 2.6 in Winter's, indicating a decrease in foraging resources from Summer to Winter. Our research indicates that boll weevils captured in Mississippi forage on pollen from a diversity of plant species regardless of the season.

Introduction

Today, the boll weevil, *Anthonomus grandis* Boheman (Coleoptera: Curculionidae), is still a major insect pest on cotton, *Gossypium hirsutum* C. Linnaeus. The larval stage is restricted to foraging on flower buds and fruits of the cotton tribe (Gossypieae). Adults, however, forage not only on a variety of malvaceous taxa outside the cotton tribe (Walker 1959, Stoner 1968, Cross et al. 1975, Chandler and Wright 1991, Jones et al. 1993), but also on a variety of non-malvaceous taxa (Rummel et al. 1978, Cross et al. 1975, Benedict et al. 1991, Jones et al. 1993, Jones and Coppedge 1996, Jones et al. 1997).

The increasing number of adult alternative foraging resources, indicates that adult boll weevils are more generalistic in their "choice" of food sources. These alternative food sources play a significant role in adult boll weevil survival especially when cotton is not available (Guerra et al. 1982, Summy et al. 1988, Jones et al. 1993). Although most boll weevil entomopalynological studies have centered around springtime, overwintering boll weevils (Jones and Coppedge 1996, Jones et al. 1997, Jones et al. 1998), little is known about boll weevil foraging resources during the rest of the year. As part of a three year study on boll weevil emergence and movement in the Delta of Mississippi, we wanted to determine the alternative foraging resources of boll weevils captured from summer through winter.

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Methods and Procedures

Adult boll weevils were captured in pheromone traps (Hardee et al. 1975) from June 1996 through January 1997 near Elizabeth (Washington Co.), Mississippi. Hardee traps (Hardee et al. 1996) were placed on the east and west sides of a 10-ha cotton field that is an historically active boll weevil site. In addition, traps were placed at approximately 1.7 km intervals for 13 km along four lines radiating from the cotton field. Boll weevils were collected from all traps twice weekly. When possible, 10 captured boll weevils were immediately frozen for pollen examination.

Prior to processing, each boll weevil was individually rinsed several times with 95% ethyl alcohol (**ETOH**) to remove external pollen. As many as 10 boll weevils per trap per date (samples) were processed together in a single centrifuge tube. Boll weevils were processed and analyzed following Jones et al. (1998). For analyses, samples were divided into seasons; Summer = June, July, and August; Fall = September, October, and November; and, Winter = December and January.

Percent of total pollen grains, frequency of occurrence, and species diversity, richness, and evenness were calculated for each season. Percent of total pollen grains was calculated by dividing a taxon's number of pollen grains per season by the total number of grains that season then multiplying the resultant by 100. Seasonal frequency of occurrence was calculated by dividing the number of samples in which a taxon occurred per season by the total number of samples that season and multiplying the resultant by 100. Shannon Index (H') was calculated to determine species diversity (Shannon and Weaver 1949, Ludwig and Reynolds 1988). Species richness was determined by using the Margalef formula (Margalef 1958), and species evenness followed Pielou (1975, 1977).

Results

Overall, 750 samples were examined with over 4,300 boll weevils being processed (Table 1). Although a greater percent of samples during Summer contained pollen (89%), more samples (479) were examined during Fall. Samples collected during Fall contained the greatest number of pollen grains (32,742), pollen types (187), and identified genera (89), while samples collected during Winter contained the least (Table 1). Overall, over 200 pollen types were encountered with pollen representing 75 families, 115 genera, and 27 species (Table 1).

Four families contained pollen from ten or more pollen taxa. The Asteraceae (sunflower family) had the highest number of taxa (22) including: sunflower (*Helianthus* sp.), goldenrod (*Solidago* sp.), and dandelion (*Taraxacum officinale* G. Weber *ex* Wiggers). Following the Asteraceae was the Fabaceae (bean family) with 13 taxa including: honey locust (*Gleditsia* sp.), soybean (*Glycine max* C. Linnaeus), bur-clover (*Medicago* sp.), sweet-clover (*Melilotus* sp.), and clover (*Trifolium* sp.). Euphorbiaceae (spurge family) was next with 11 including: croton (*Croton* sp.), spurge (*Euphorbia* sp.), and Chinese tallow [*Sapium sebiferum* (C. Linnaeus) W. Roxburgh]. Finally, the Malvaceae (mallow family) contained 10 taxa including: abutilon (*Abutilon* sp.), hibiscus (*Hibiscus* sp.), turk's cap (*Malvaviscus* sp.), and cotton.

Summer samples were dominated by pollen from three families Caprifoliaceae (20%), Poaceae (17%), and Asteraceae (11%) (Table 2). During Fall, Asteraceae pollen dominated (76%), while Brassicaceae pollen dominated (57%) during Winter (Table 2). Samples collected during Winter contained pollen from the fewest number of plant families (Table 2).

Pollen from Poaceae (71%) and Asteraceae (51%) had the highest frequency of occurrence during Summer (Table 3). During Fall, pollen from Asteraceae (92%), Anacardiaceae (53%), and Poaceae (40%) occurred more frequently. Asteraceae pollen occurred more frequently (90%) during Winter. Regardless of the season, Asteraceae pollen occurred in more than 50% of the samples (Table 3).

Species diversity was highest during Summer (4.35) and lowest during Winter (2.56) (Table 4). Samples collected during Winter also had the lowest species richness (2.52). Fall samples had the least species evenness (0.59) (Table 4).

Discussion

Our results are similar to those of spring-time boll weevils in Mississippi (Jones et al. 1998) and Texas (Jones and Coppedge 1996, Jones et al. 1997). Regardless of the season, boll weevils in Mississippi foraged on pollen from a variety of plant species. Boll weevils foraged on the largest variety of pollen in summer and the least in winter. This is not surprising because fewer plant species bloom during winter months. Somewhat surprising is that 80 boll weevils were collected during Winter.

Boll weevils captured from Summer through Winter foraged on a different assemblage of plants than those captured during Spring (Jones et al. 1998). This is due to the differences in species in bloom during the seasons. Springtime boll weevils foraged mainly on pollen from Fabaceae, Fagaceae (oak family), Rhamnaceae (buckthorn family), and Salicaceae (willow family) (Jones et al. 1998). Summer through Winter boll weevils foraged mainly on Caprifoliaceae (Summer only), Poaceae, Asteraceae, and Brassicaceae (mainly Winter) pollen.

Similar to spring-time foraging resources of boll weevils in Mississippi (Jones et al. 1998), Asteraceae and Poaceae pollen were abundant and occurred more frequently than other families. It is expected that Poaceae and Asteraceae pollen grains are common year-round because members of these families are in flower nearly all year and thus are in flower when other taxa are not. In addition, these two families contain more taxa than any other plant families in the area.

Species diversity decreased from Summer (4.4) to Winter (2.6) (Table 4). Species diversity is high when predicting the species of an individual is difficult, and low when an accurate prediction can be made (Pianka 1974). Winter's low species diversity indicates not only that boll weevils foraged on pollen from a limited number of foraging resources during winter, but also that one or two taxa dominated the pollen assemblage. As the seasons progress from summer to winter, fewer plant species are in bloom in Mississippi. Therefore during winter boll weevils are limited in their foraging resources, and utilize the few that are in bloom. Thus, foraging resources are more predictable during Winter.

Fall's samples had the lowest evenness. Species evenness expresses species diversity (H') relative to the maximum value that H' can obtain when all the species in a sample are perfectly even with one individual per species (Smith 1980). When one or two taxa dominate, species become clumped and are not evenly distributed. Although samples collected during Fall contained the greatest number of pollen grains and taxa, the majority of those pollen grains belonged to several Asteraceae species. This causes an uneven distribution and a clumping of species which lowers species evenness.

Species richness dropped dramatically from Summer (14.4) and Fall (18.0) to Winter (2.5). Richness is based on the relationship between the total number of species in the community and the total number of individuals observed (Ludwig and Reynolds 1988). Because the total number of pollen grains and taxa were low and clumped into only a few taxa during Winter, Winter's richness was extremely low.

Summary

Regardless of the season, boll weevils captured in Mississippi foraged on pollen from a variety of plant species. Pollen is rich in protein and other nutrients and provide significant energy and nutrition for boll weevils. Because of the diversity of plants, determination of alternative foraging resources can be used to help in understanding boll weevil habits and in many cases boll weevil movement.

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Table 1. Total number of samples (samples), boll weevils processed (BW processed), percent with pollen, and pollen data by season found in boll weevils captured in the Delta of Mississippi.

	Summer	Fall	Winter	Total
# samples	248	479	23	750
BW processed	1,043	3,218	80	4,341
% with pollen*	89	85	61	78
# pollen grains	6,185	32,742	256	39,183
# pollen types	126	187	14	208
# families	60	60	10	75
# genera	65	89	7	115
# species	15	13	1	27

* rounded to nearest whole number

Table 2. Seasonal percent of total number of pollen grains for the top 12 plant families encountered in boll weevils captured in Mississippi.

	Summer	Fall	Winter
# pollen grains	6,185	32,742	256
Anacardiaceae	5.26	5.56	--
Asteraceae	11.37	75.83	6.64
Brassicaceae	0.16	0.01	56.64
Caprifoliaceae	20.36	--	--
Cheno-Am**	5.62	2.16	1.17
Euphorbiaceae	0.39	0.22	21.88
Fagaceae	3.88	0.09	--
Malvaceae	7.82	6.59	--
Poaceae	16.90	2.44	5.08
Salicaceae	1.41	0.07	0.39
Scrophulariaceae	7.44	--	--
Ulmaceae	0.72	0.93	--
Other families and Unknowns	18.67	6.10	8.20
Total	100.00	100.00	100.00

** No differentiation was made between Chenopodiaceae and *Amaranthus* pollen grains.

Table 3. Seasonal frequency of occurrence for each plant family that occurred in more than 10% of the samples.

	Summer	Fall	Winter
Number of samples	248	479	23
Anacardiaceae	25.40	53.32	---
Asteraceae	51.21	92.16	90.00
Brassicaceae	2.02	0.74	13.04
Caprifoliaceae	10.89	---	---
Cheno-Am**	27.42	49.51	4.35
Cupressaceae / Taxodiaceae**	3.23	3.34	14.29
Cyperaceae	18.55	13.97	---
Euphorbiaceae	1.61	9.31	13.04
Fagaceae	39.11	4.17	---
Malvaceae	31.85	34.80	---
Oleaceae	15.32	1.96	---
Pinaceae	14.11	5.01	---
Poaceae	71.37	40.44	17.39
Potamogetonaceae	3.63	21.80	---
Salicaceae	15.73	3.19	4.35
Ulmaceae	12.50	30.64	---

** No differentiation was made between Chenopodiaceae and *Amaranthus* pollen grains nor between Cupressaceae and Taxodiaceae pollen grains.

Table 4. Seasonal species diversity (H'), evenness, and richness of pollen taxa found in boll weevils captured in the Delta of Mississippi.

	Summer	Fall	Winter
H'	4.35	3.11	2.56
Evenness	0.90	0.59	0.97
Richness	14.43	17.99	2.52