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Insect Predation on *Astragalus Filipes* and *A. Purshii* Seeds

Abstract

Predispersal seed predation was measured during two growing seasons for *Astragalus filipes* Torr. and *A. purshii* Dougl. in eastern Oregon. Tortricid and weevil larvae were the primary seed predators on *A. filipes.* Larvae consumed 93 and 62 percent of the seed crop in 1980 and 1981, respectively. Pyralid larvae were the primary predators on *A. purshii* seeds. Forty-seven and 82 percent of the total seed crop survived predispersal predation in 1980 and 1981, respectively.

Introduction

An important role of legume seed predators in plant population biology may be their effect on natural colonization rates (Harper 1977). It may also be relevant to examine their effect on native seed reserves used for artificial recolonization.

While evaluating the feasibility of reestablishing original plant communities on deteriorated portions of the John Day Fossil Beds National Monument in eastern Oregon, fruits of many forb and shrub species were found to be preyed upon by insects. Available native seed sources were thereby severely reduced.

The magnitude of seed loss due to predators has been determined in only a few taxa. Lepidopterans (Ehrlich and Raven 1964, Breedlove and Ehrlich 1972, Green and Palmblad 1975), hemipterans (Green and Palmblad 1975), bruchids (Janzen 1969, Center and Johnson 1974), and cuclionid beetles (Platt *et al.* 1974) have been cited as avid legume seed predators.

A study was undertaken between 20 April and 25 June, 1980 and 1981 to (1) identify predispersal seed predators, (2) determine the extent of insect predation, and (3) note the stage of growth and season in which predation occurs on two native perennial *Astragalus* species. These species were chosen for study due to their relative importance in the undisturbed vegetation component.

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Study Area and Methods

Threadsilk milkvetch (*Astragalus filipes* Torr.), a tall herbaceous plant with numerous racemes and glabrous thin-walled pods, is found in the sagebrush zone of northern Nevada, southern Idaho and eastern Oregon (Barneby 1964). Woolly-pod milkvetch (*Astragalus purshii* Dougl.) is a low acaulescent taprooted plant with cottony pubescent pods. The latter species is variable and has many races within the Intermountain region of the western U.S. (Barneby 1964).

The study area was located within the John Day Fossil Beds National Monument in eastern Oregon. The steep rugged topography is dissected by the John Day River and the elevation ranges from 600 to 1200 m. The semiarid region has an average precipitation of 30 cm a year with the majority falling as rain during November through April. Average temperature for the spring-summer season is 15.5°C and 4°C for the fall-winter months. The vegetation, typical of the sagebrush biome, is dominated by Wyoming big sagebrush (*Artemisia tridentata* subsp. *wyomingensis* Beetle), western juniper (*Juniperus occidentalis* Hook.), and bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. and Smith). Much of the area has been invaded by cheatgrass (*Bromus tectorum* L.) and broom snakeweed (*Xanthocephalum sorothrae* (Pursh) Shinners).

Three sites within the monument were chosen to study each of the two *Astragalus* species. On each study site 25 plants were randomly selected, tagged and numbered consecutively. The same sites were monitored in both years, but different individual plants were sampled each year. Each site was visited at least once a week during the growing season, April through June. Phenology, number of flowers, number of nondamaged and damaged pods (those with a small hole in the pericarp) were recorded for each plant. Immediately prior to abscission, all of the damaged and nondamaged pods were collected and the number of seeds in each pod counted. Abortive fruits were not included in the seed total.

Seed potential/m² and actual seed survival/m² were determined for both species. Seed potential/m² was the product of the mean number of seeds per nondamaged pod and the mean number of pods/m². The mean number of seeds surviving per plant multipled by the number of plants/m² estimated actual seed survival/m². Percent seed success was estimated by dividing seed potential into seeds survived.

Three 10 m line transects (Canfield 1941) were used to measure cover of both *Astragalus* species on each site. All transects were located in relatively uniform areas. Rectangular plots, 20 x 50 cm, were placed at 1 m intervals on each transect to determine density. Plant density measurements were used to calculate seed potential/m² and seed survival/m².

Regression analysis were used to determine if seed predation level was related to the total number of pods per plant. Seed survival rates, the total number of flowers, undamaged pods and damaged pods per plant between 1980 and 1981 were compared using the Student t-test.

Larvae of insect predators were collected from fruits of nearby *Astragalus* plants and preserved in 70 percent ethanol. Additional larvae were reared into adults for identification. Other insects observed on *Astragalus* species were collected and later mounted and appropriately labeled. Specimens were identified and stored at the Oregon State University Entomology Museum.

Results

In 1980 and 1981, *A. filipes* pods were attacked by microlepidopteran larvae (*Torticidae*). Weevil larvae (*Curculionidae*) were also found in the seed pods in 1981. No attempt was made to distinguish damage caused by the two insect granivores.

In 1980, predation within *A. filipes* pods was initiated shortly after 15 May (Figure 1), and within 15 days evidence of pod entry was recorded in over 80 percent of the fruits. No further predation occurred after mid-June. In 1981, both pod development and active seed predation occurred over a longer time span.

The percent of seed crop consumed by insects decreased from 1980 to 1981 (Figure 1). Less than 7 percent of the potential seed crop survived predispersal insect predation in 1980, whereas almost 38 percent of the seed survived in 1981. Athough the numbers of damaged pods per plant increased in 1981, the total number of pods per plant increased and proportionately fewer pods were damaged (Table 1).

Green and white microlepidopteran larvae of the family *Pyralidae* were observed in *A. purshii* pods. Adult pyralid moths were not observed ovipositing, but eggs were found attached to the pericarp of the pods. Larvae bored holes through the immature pods and consumed developing

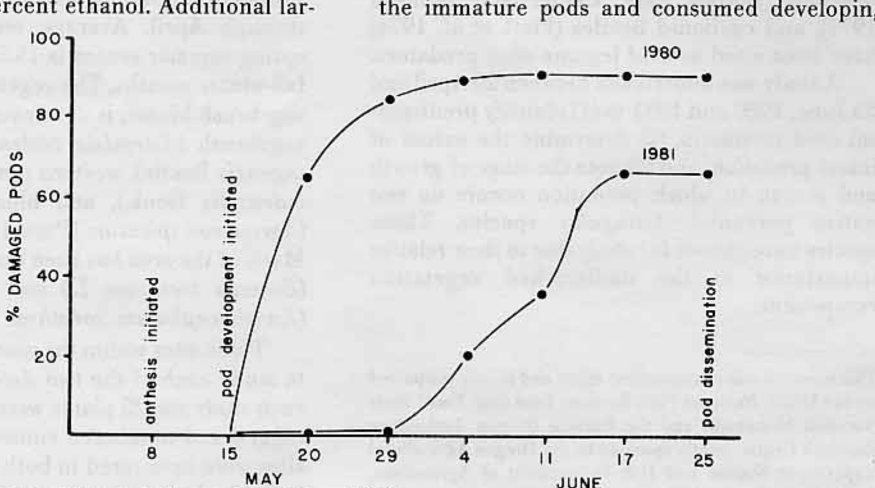

Figure 1. Percent *Astragalus filipes* pods damaged in 1980 and 1981.

Table 1. Means ± sd for plant density, seed pods per plant, number of seeds per pod, total seeds developed per m^2 and actual seeds per m^2 escaping predispersal insect predation.

	Plants/ m^2	Flower/ plant	# pods/ plant	# damaged pods/plant	# seeds/ pod	Seeds[1] produced/m^2	Seeds[2] survival/m^2
Astragalus filipes							
1980	1.33±.1	126±21	16±4.8*[3]	15±4.5*	2.0±1.1	43±12.4*	3±.9*
1981	1.33±.1	152±18.5	40±6.7	26±4.5	3.8±2.0	202±50.5	76±19
Astragalus purshii							
1980	2.0±1	27±3.2	6±.9*	3±.6*	8.0±3.8	96±35.5	45±16
1981	2.0±1	24±0.6	4±.7	.7±.3	7.4±3.7	59±23	48±19

[1](Plant/m^2)•(#pods/plant)•(#seeds/pod)
[2](Seeds produced/m^2)•(% seed survival)
[3]Means within species and plant parameter are significantly different ($p<.10$) between years.

seeds. In most pods, larvae fed on all seeds within the fruit. No pupae were found in the pods, therefore, it was assumed pupation occurred in the soil.

Astragalus purshii fruits were developing and pryalid eggs were observed by early May (Figure 2). By 12 June the number of damaged pods had peaked. Active seed predation and phenology of *A. purshii* pods was observed over the same period of time in 1980 and 1981.

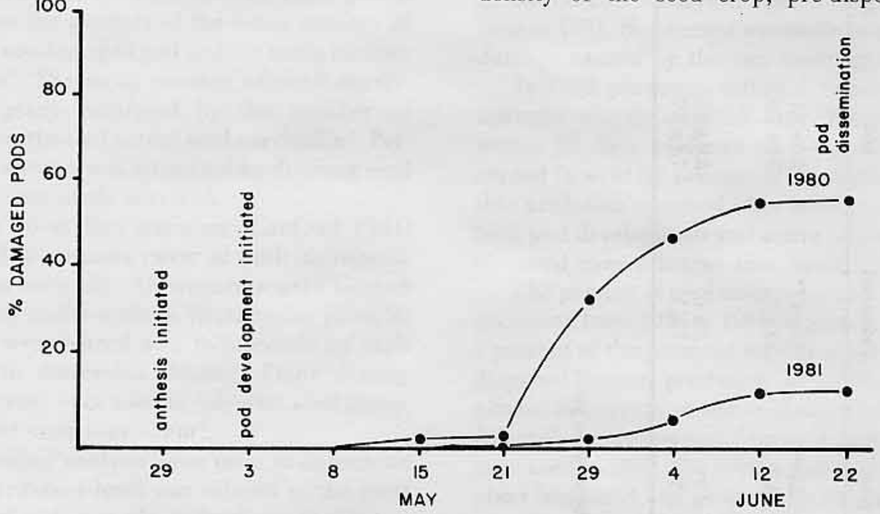

Figure 2. Percent *Astragalus purshii* pods damaged in 1980 and 1981.

Fewer seed pods of *A. purshii* were preyed upon in 1981 (Table 1). Forty-seven percent of the seed crop survived in 1980 and 82 percent in 1981. Both the total number of pods and the number of damaged pods decreased in 1981. However, the number of damaged pods showed a greater decrease. As in *A. filipes* the number of damaged pods on individual *A. purshii* plants within years increased proportionately with total number of pods per plant.

Discussion

Insect seed predators were associated with large reductions in seed crops of *A. filipes* and *A. purshii.* In both species the number of flowers per plant was not significantly different between years. However, the total number of pods on an individual plant significantly increased in *A. filipes* and decreased in *A. purshii* in 1980 and 1981, respectively. The proportion of total seed pods damaged decreased in 1981 for both species.

The impact of seed losses may vary from species to species (Crawley 1983). Both *Astragalus* are perennials not dependent on current seed production. Long-lived seed banks, repeated reproduction and mixed-age stands enable these species to persist (Cohen 1968). However, seeds are the major means of higher plant dispersal and colonization (Silvertown 1982). By reducing the density of the seed crop, pre-dispersal seed predators alter the pattern of seed dispersal. The distance in which successful natural colonization may occur is reduced (Harper 1977).

Many other factors also reduce the potential for natural colonization of native species on our western rangelands. Undisturbed stands of native communities are few and far between. Exotic species often outcompete the natives for available soil moisture (Harris 1967). Some means of artificial reseeding is necessary to enhance these native species' survival and to return these lands to optimum productivity. Due to insect seed predation, dependence on wild seed sources for revegetation efforts is probably inadequate and unreliable.

Acknowledgements

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Literature Cited

Barneby, R. C. 1964. Atlas of North American *Astragalus.* Mem. N.Y. Bot. Gard. 13.
Breedlove, D. E., and P. R. Ehrlich. 1972. Coevolution: Patterns of legume predation by a lycaenid butterfly. Oecologia 10:.99-104.
Canfield, R. H. 1941. Application of the line intercept method in the sampling of range vegetation. J. For. 39: 388-394.
Center, T. D., and C. D. Johnson. 1974. Coevolution of some seed beetles (Coleoptera: Bruchidae) and their hosts. Ecology 55:1096-1103.
Cohen, D. 1968. A general model of optimal reproduction in a randomly varying environment. Ecology 56: 219-28.
Crawley, M. 1983. Herbivory: The Dynamics of Animal-Plant Interactions. University of California Press, Berkeley.
Ehrlich, P. R., and R. H. Raven. 1964. Butterflies and plants: A study in coevolution. Evolution 18: 586-608.
Green, T. W., and I. O. Palmblad. 1975. Effects of insect seed predators on *Astragalus cibarius* and *Astragalus utahensis* (Leguminosae). Ecology 56: 1435-1440.
Harper, J. L. 1977. Population Biology of Plants. Academic Press, London.
Harris, G. 1967. Some competitive relationships between *Agropyron spicatum* and *Bromus tectorum.* Eco. Mono. 37:38-111.
Janzen, D. H. 1969. Seed eaters versus seed size, number, toxicity and dispersal. Evolution 23: 1-27.
Platt, W. J., G. R. Hill, and S. Clark. 1974. Seed production in a prairie legume (*Astragalus canadenis* L.). Oecologia 17: 55-63.
Silvertown, J. 1982. Introduction to Plant Population Ecology. Longman House, London.

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