Volume 8
Number 4 - Winter 1975 *Number 4 - Winter 1975*

Article 9

December 1975

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ABUNDANCE OF INSECTS INHABITING THE MALE STROBILI OF RED PINE

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Southwood (1973) concluded that pollen feeding was probably the first step in the development of the phytophagous habit in insects, because pollen, compared with plant foliage, is rich in nutrients and low in secondary defense substances. Surprisingly, little is known about insects that feed mainly on pollen. For example, in a bibliography of insects that feed on reproductive structures of North American conifers (Barcia and Merkel, 1972), less than three per cent of 719 references pertained to pollen feeders. This note reports on the kinds and abundance of insects found inhabiting clusters of fresh staminate or male strobili (MS) of 60- to 65-year-old red pine trees in two seed production areas (SPAs) in northern Minnesota.

METHODS

Just before pollen dispersal in the first week of June 1969, at the Birch Hill and Portage Lake SPAs, I selected ten trees at random and stratified the crown of each tree into six cells (upper, middle, and lower levels, of both north and south sides). I counted all branches in each cell and picked one at random. Then I randomly selected the right or left side of each sample branch and collected all MS from the side for later counting and dissection in the laboratory to recover the insects in the MS. To estimate the total numbers of insects/tree, I added the branch counts and multiplied by the number of branches in that level, and then summed all levels. To determine if there were significant differences in insect and flower density associated with the various strata, I subjected the data to analyses of variance. Finally, I regressed insect densities against flower densities per branch and per tree to determine if there were significant relations between these variables.

RESULTS AND DISCUSSION

Xyelid sawflies (*Xyela* sp., probably *minor*), considered to be among the most primitive Hymenoptera, were clearly the most abundant insects in MS. Other common species were the jack pine budworm (*Choristoneura pinus* Freeman: Tortricidae), the flower moth (*Eucordylea* sp.: Gelechiidae), the cone worm (*Dioryctria disclusa* Heinrich: Pyralidae), the Zimmerman pine moth (*D. zimmermani* (Grote)), and occasional immature lacewings (Neuroptera: Hemerobiidae), plant bugs (Hemiptera: Miridae), and thrips (Thysanoptera: Thripidae). Color photos of and biological notes on most of these insects can be found in Rose and Lindquist (1973). The relative abundance of each species in both study areas is shown in the following tabulation:

(in per cent)

	Xyela sp.	*C. pinus*	*Dioryctria* spp.	*Eucordylea* sp., and other species
Birch Hill SPA	96.3	1.2	1.5	1.0
Portage Lake SPA	51.5	27.2	3.6	17.7

Mean counts ± one standard error per tree and per acre, respectively, for all species combined were 10.6 ± 2.1 and 672 ± 130 thousand at Birch Hill, and 3.7 ± 1.1 and 419 ± 126 thousand at Portage Lake.

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Insect densities/branch were least in the upper and greatest in the middle-crown (Table 1). Differences in insect density were significant ($p \leq .05$) between upper and middle-crowns but not between other levels, nor between north and south sides. MS densities were also least in the upper crown but were not different between lower and middle-crowns.

Densities of *Xyela* sp. increased as a power function of MS/branch in all levels except one (upper crown at Portage Lake) (Table 2). Densities of other species increased as a linear function of MS/branch in all but two levels. Covariance analyses revealed that the regressions for *Xyela* were significantly different among crown levels at Birch Hill but not at Portage Lake. The regressions for other species were different among all crown levels at both areas. This implies, therefore, that the differences in insect density among levels were due in most cases to other factors besides variations in MS/branch.

Differences in the mathematical relations between densities of *Xyela* and other species and MS/branch probably stem from the fact that *Xyela* sp. deposit their eggs directly in MS or expanding buds, whereas other species deposit their eggs on foliage or branches and the resulting larvae must search for MS. Little is known about the behavior of adult Xyelids except for Ebel's (1966) report that they often form large swarms around flowering pines to mate and feed.

Table 1. Mean insect densities per one-half branch in different crown levels at two seed production areas. Means followed by the same letters are not significantly ($p \leq .05$) different.

Insect species	Upper	Middle	Lower	Overall mean
BIRCH HILL				
Xyela sp.	52.1a	116.5b	73.lab	80.5
Other spp.	2.2a	4.9b	3.0ab	3.4
Ratio:				
Insects/male strobilus cluster	8.7a	5.5ab	3.3b	4.9
PORTAGE LAKE				
Xyela sp.	10.5a	30.1a	36.4a	25.7
Other spp.	4.4a	11.5b	10.3ab	8.7
Ratio:				
Insects/male strobilus cluster	2.1a	2.0a	2.2a	2.1

Table 2. Mathematical relations between the numbers of insects (Y) and male strobili (MS) per branch in different crown levels at two seed production areas.

Crown level	*Xyela* sp. log(Y) =	r^2	Other species Y =	r^2	n
BIRCH HILL					
Upper	.51 + 1.31 logMS	.71	1.39 + .19MS	n.s.*	14
Middle	.73 + .98 logMS	.74	.05 + .22MS	.40	19
Lower	.53 + .93 logMS	.65	-.50 + .15MS	.49	20
PORTAGE LAKE					
Upper	.61 + .52 logMS	n.s.*	-.51 + .75MS	.74	9
Middle	-.55 + 1.73 logMS	.74	3.58 + .25MS	n.s.*	10
Lower	-.67 + 1.69 logMS	.77	-.67 + .50MS	.93	10

*No significant regression.

The abundance of all species was highly correlated (r = .93, p = .01) with MS/tree at Birch Hill but only weakly correlated (r = .55, p = .10) at Portage Lake. Densities of MS/tree were roughly equal at both areas but Birch Hill had nearly three times as many insects/tree. Birch Hill may have had more insects in 1969 because of greater MS abundance in the preceding years. One would suspect this to be true because the Birch Hill stand was only half as dense (63 stems/acre) as the Portage Lake stand and productivity of male and female strobili/tree is known to increase with decreased tree density.

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