bi-monthly research notes

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ENTOMOLOGY

Sex Attraction in the Eastern Hemlock Looper.—The eastern hemlock looper [*Lambdina fiscellaria fiscellaria* (Guenée)] is an important pest of balsam fir forests in Newfoundland and its cyclic outbreaks have caused extensive tree mortality. Between outbreaks looper numbers decrease to such a low, endemic level that it is very difficult to measure population levels. Sex pheromones are potentially useful in population density surveys and in monitoring the effectiveness of control programs (Jacobson, M., Insect sex attractants. Wiley, New York. 1965). Accordingly, the presence of a sex pheromone in the eastern hemlock looper was investigated.

Sixteen masonite board traps, measuring 2 x 2 ft, coated with Tanglefoot (The Tanglefoot Company, Grand Falls, Michigan) were secured to trees within a balsam fir stand infested by the hemlock looper. A small screen cage, measuring 3 x 1 x 0.5 inches, designed to hold bait, was wired to the center of each board. The 16 traps were divided into four equal groups; the first was baited with six, 1- to 3-day old virgin males; the second with six, 1- to 3-day old virgin females; the third with a piece of cotton soaked in benzene; and the fourth with a piece of cotton impregnated with a "slush" of benzene in which abdomen tips of six 1- to 3-day old virgin females were crushed. Adults were obtained from field collected pupæ that were sexed and reared separately. All cages contained a piece of cotton soaked in 5% sugar solution. The experiment began on September 11 when both sexes of the adults were present in the field. Moths caught in each trap were counted, sexed and removed on September 17 and the traps were replenished, and checked again on October 15. For comparison traps baited with virgin males were used as a check on those baited with virgin females, and the benzene baited traps on those with abdomen tips of virgin females crushed in benzene (ATVF). Statistical analysis was done by using a chi^2 test on the proportion of the sexes caught.

Traps baited with virgin females and with ATVF caught more adults than their respective controls (Table 1).

Traps with virgin females caught, on the average, 2.3 times as many adults as the control. There was a highly significant difference in the male to female ratio between traps with virgin females and with virgin males (chi^2 = 43, d.f. = 1; $P<0.001$).

TABLE 1

Number and sex of eastern hemlock looper adults caught in baited traps between September 11 and October 15, 1969

Trap Groups With	Sex	Moth Trapped Total	No per trap Min	Max	Avg	Sex Ratio (male:female)
Virgin males	Male	265	6	95	66.3	1.6:1.0
	Female	165	4	69	41.3	
Virgin females	Male	707	17	340	176.8	2.6:1.0
	Female	277	10	82	69.3	
Benzene	Male	202	10	68	50.5	1.5:1.0
	Female	135	5	41	33.8	
ATVF[a]	Male	1,046	24	347	261.0	3.5:1.0
	Female	299	11	82	74.8	

[a] Abdomen tips of virgin females crushed in benzene.

The male to female ratio among pupæ in the field just prior to emergence was 1.1:1.0 (n = 1632).

Traps with ATVF caught 4.0 times as many adults as their respective controls. The difference in the sex ratio between these two groups of adults was also significant (chi^2 = 177; d.f. = 1; $P<0.001$).

The highest number of moths was caught by traps baited with ATVF. The higher attractancy of these traps over those baited with virgin females is possibly caused by synergism between the solvent and the attractant. Increased attractancy as a result of synergism has been noted before (Borden, Silverstein and Brownlee. Can. Entomol. 100:597-603. 1968).

The sex ratio among the adults caught by traps baited with virgin males and with benzene are virtually the same; 1.6:1.0 and 1.5:1.0 respectively. However, they differ from the 1.1:1.0 (n=1632) ratio determined from pupal collections. This difference is probably caused by the flight behavior of the adults; male moths are more active than the gravid, heavier females.

The fact that the male to female ratio of the adults caught by traps baited with virgin females and ATVF was significantly greater than those of their respective controls gives evidence that further studies on isolation, identification and synthesis of the sex pheromone of this economically important pest, appear warranted. The result of these studies may provide a valuable tool for detection surveys, and also in the forecasting and in the evaluation of success of control measures.—Imre S. Otvos, Newfoundland Forest Research Centre, St. John's, Nfld.

Juvenile Hormone-Like Activity of Thujic Acid, an Extractive of Western Red Cedar.—Western red cedar [*Thuja plicata* Donn] has long been suspected of having insecticidal properties. Experiments at the University of Massachusetts (1955) showed the toxicity of methyl thujate to larvæ of black carpet beetles, furniture carpet beetles and case-making moths. (Barton and MacDonald, Can. Forest. Serv. Pub. No. 1023, revised 1971). Also, the use of cedar shavings as litter to control mites in poultry and in colonies of mice (Hansen, New Wood-Use Series, Circ. 20, Univ. Wash., 1952) further indicates the insecticidal activity of western red cedar extractives. In a current study of neutral cedar extractives, methyl thujate as well as other components from cedar wood have been tested for juvenile hormone-like activity. The results with one of these, thujic acid, is now reported.

Thujic acid (Fig. 1) is present in western red cedar heartwood in amounts of 0.08% of the moisture-free wood. It is a steam-distillable acid and unlike its methyl ester, which is mainly responsible for cedar's fragrant odor, has no smell. Because of its natural transformation into the isomeric p-isopropyl benzoic acid (cumic acid — Barton and MacDonald, Bi-mon. Res. Notes 27:41-42, 1971) in moist cedar wood, cumic acid will also be tested for hormone activity later.

Juvenile hormone (JH)-like activity of thujic acid was tested in a preliminary experiment using *Tenebrio* bioassay as described by Bowers and Thompson (Science 142:1469-1470, 1963). A 50/50 (w/w) mixture of thujic acid and peanut oil was injected into ten fresh *Tenebrio molitor* pupæ in the amount of 1.0 µl/pupa. Injected pupæ, along with ten controls, were maintained at 22C. At this temperature, controls emerged into normal adults in 8 days. Injected insects, however, exhibited various kinds of deformities. They were unable to shed the pupal cuticle which broke at various places. Legs became partially mobile, but the broken pupal cuticle stuck to the pupal-adult intermediate with its trachea still lodged in the spiracles of the new cuticle. This was always accompanied by the retention of pupal wings, similar to the observations of Wellington and Lawko (J. Invertebr. Pathol. 14:287-288, 1969) and Zeikus and Steinhaus (J. Invertebr. Pathol.