in toxicity. The rats had to remain at the modified ambient temperature (under the influence of the stressor) after the venom was injected. For example, whether they were in the low ambient temperature previous to injection (group 1A) or whether they were placed in the low ambient temperature after injection (group 2) did not seem to be important. But those animals that were removed from the stressor after injection (group 1B) did not experience a significant increase in toxicity; in fact, some appeared to be more refractory to the venom (especially at 2°C). "Exposure to cold is followed by an increased production of certain hormones such as corticotropin, corticoids, thyroid hormone and epinephrine" (*5*). Since epinephrine is rapidly inactivated in the body (*6*) the reaction of those animals removed from the influence of the stressor would certainly suggest that this hormone could be involved in the increase in toxicity. This reasoning is supported by the results obtained when epinephrine was injected in varying doses after venenation of the test animals. This apparent synergism of epinephrine with both venoms is further substantiated by the reciprocal test in which the LD_{50} of epinephrine was reduced from the normal 7.07 mg/kg (4.3 to 11.5) to 2.98 mg/kg (2.1 to 4.2) by scorpion venom and to 1.49 mg/kg (0.88 to 2.53) by rattlesnake venom.

The increase in refractoriness to scorpion venom and rattlesnake venom by those animals in group 1B (Table 1) further supports the role of stress, especially at the 2°C. With the destruction of the epinephrine, the synergistic action of this hormone and the venom is discontinued. Now the organism's systemic defense (counter shock) comes into play, and a resistance to the venom action seems to occur. The action of this mechanism is not clearly understood (*7*), but the therapeutic implications are interesting. At the other temperatures (13°C and 35° to 38°C) the initial stress was apparently not as great and the resulting counter shock was of lower degree. At 35° to 38°C for scorpion venom and at both 13°C and 35° to 38°C for rattlesnake venom, it is possible that sufficient residual epinephrine prevented the LD_{50} from going above normal levels.

Although some of the results with rattlesnake venom (Table 2) do not show statistical significance, the decrease in the LD_{50}'s with the increase in stimulus is sufficient to establish significance. Also, the results obtained with epinephrine add to the weight of this conclusion.

Changes in venom toxicity seem to occur when the recipient rats are subjected to changes in ambient temperature. Whether the change is an increase or a decrease in temperature does not seem to be important; the greater the temperature change the greater the change in toxicity. Epinephrine also increased the toxicity of these two venoms in rats. Since this hormone is released under conditions of stress, the mechanism causing the increase in toxicity of these venoms during stress seems to be, at least in part, a result of the synergism between the venoms and epinephrine.

"It is now definitely established that nervous stressors (pain, emotions) are particularly conducive to the development of the somatic manifestations of the stress syndrome, so that stress can be both cause and be caused by mental reactions" (*8*) and epinephrine is a concomitant product of stress regardless of the source. This evidence, plus the evidence provided by the present research, should call for a reevaluation of certain recommended therapeutic practices for the treatment of snake venenation. Thus, practices increasing the pain and the complete immobilizing of the patient would not provide the optimum therapeutic environment. In fact, pain and emotional stressors could be the cause of a continuous production of epinephrine.

Table 2. Effect of epinephrine on venom toxicity.

Injection	LD_{50} and 95-percent confidence interval (mg/kg)	
	Scorpion	Rattlesnake
Venom only	1.00 (0.88–1.14)	15 (10–22)
Venom plus 2.0 mg/kg epinephrine in one dose 20 min after venom	0.94 (0.79–1.12)	14 (10–20)
Venom plus ½ LD_{50} epinephrine (3.54 mg/kg) in one dose 20 min after venom	0.67 (0.56–0.79)	9 (8–11)
Venom plus ½ LD_{50} epinephrine (3.54 mg/kg) in four equal doses, the first 20 min after venom, other three at 10-min intervals	0.44 (0.36–0.55)	6 (5–7)

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Dendroctonus pseudotsugae: A Hypothesis Regarding Its Primary Attractant

Abstract. *The Douglas-fir beetle is attracted to α-pinene but repelled by β-pinene. Attacks on standing trees are related to the content of α- or β-pinene in the tree; this correlation suggests that volatile oils may be the stimuli initially attracting the insect to the Douglas fir.*

The Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins) exhibits positive and negative motor responses to selected volatile oils of Douglas fir [*Pseudotsuga menziezii* (Mirb.) Franco], and these motor responses vary with the composition and concentration of the volatile oils. Perhaps it is of greater importance that in standing trees the composition and concentration of the volatile oils attractive to the insect can be related to the parts of the trees attacked.

The attractiveness of selected volatile oils was tested by placing five beetles and a given oil in a closed-system olfactometer (*1*). The position of the beetles in relation to the oil was recorded every 5 minutes for 1 hour, with an arbitrary scale of attractiveness based on concentric circles, 2.5 cm apart, and rated 5 to 1 from the location of the oil. The beetles showed a highly significant preference for α-pinene only. There was no significant difference between the control (no oil) and dipentene, α-terpineol, geraniol, or β-pinene.

However, the behavior of the beetles in response to β-pinene suggested that this oil may be a repellent and that the concentration of the oil may be a contributing factor. Beetles approached α-pinene but did not come directly over the oil, whereas β-pinene often produced a stupor which increased the apparent attractiveness index. The repellency of α- and β-pinene was tested by placing a visible light stimulus beyond the olfactometer holding the volatile oils; the concentration of the oils was determined by diluting the oil to be tested with low-melting paraffin. Five beetles in a given olfactometer were observed every 5 minutes for 1 hour.

The beetles were not repelled by 10 percent concentrations of either α- or β-pinene; they exhibited a photopositive motor response. A mixture of equal parts of these two volatile oils had some repellent property; β-pinene alone was extremely repellent, the difference being highly significant.

The volatile oils from Douglas fir, summarized by Kurth (*2*), include α- and β-pinene, limonene, geraniol, α-terpineol, and camphene. Results of analysis, by gas chromatography, of a sample of turpentine isolated from Douglas fir by steam distillation indicate that many more compounds are present, but they have not been identified (Fig. 1).

The terpene content varies with the age of the tree and the anatomical part from which the terpene is isolated. In a sample of resin, composition of the volatile oils also varies markedly between the liquid and vapor phases (Fig. 2, *a* and *b*). The differences between a liquid and the vapor in equilibrium with this liquid can be expressed by the ratio of α- to β-pinene. In the oils from the inner bark on a 40-year-old Douglas fir this ratio varies from 1.1 to 10.0 between the liquid and vapor samples, while the vapor sample from oils of the inner bark of a 15-year-old tree has a ratio of 2.0. In oils from the leaves the liquid and vapor ratios range from 0.4 to 0.6, and in oils from a pitch blister on a 15-year-old tree they range from 0.6 to 0.8. In order to be sure that the vapor coming off specific parts of the tree is an olfactory stimulant, the vapor must be sampled directly; data on the composition of liquid resin have little utility in insect-attractant studies. Our analysis of the volatile oils was made with a Perkin-Elmer instrument, model 811; polypropylene glycol columns were used.

We therefore propose that Douglas-fir beetles initially locate the host tree in response to olfactory stimuli produced by the tree's volatile oils.

How the beetles locate a tree is

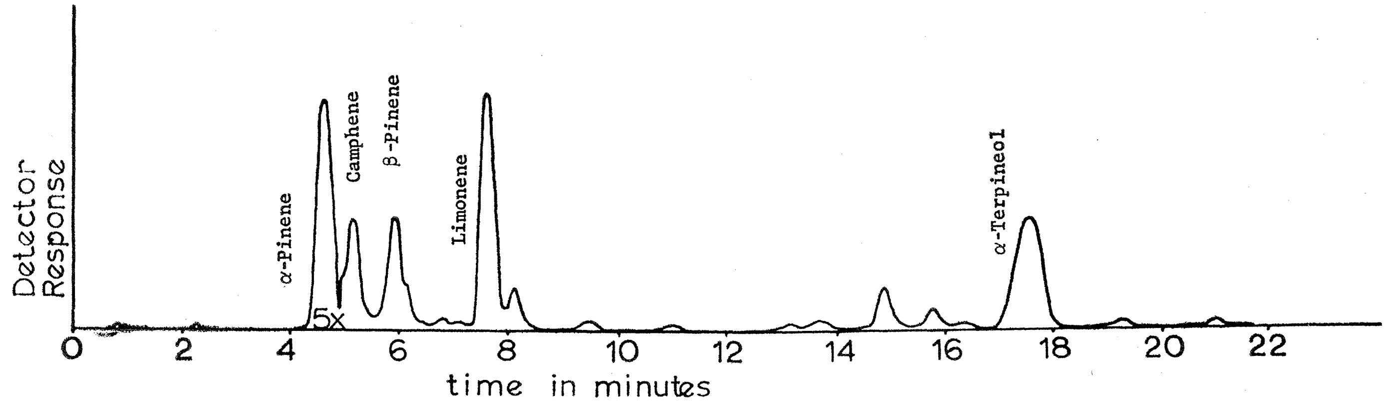

Fig. 1. A chromatogram of steam-distilled turpentine from Douglas fir (liquid sample).

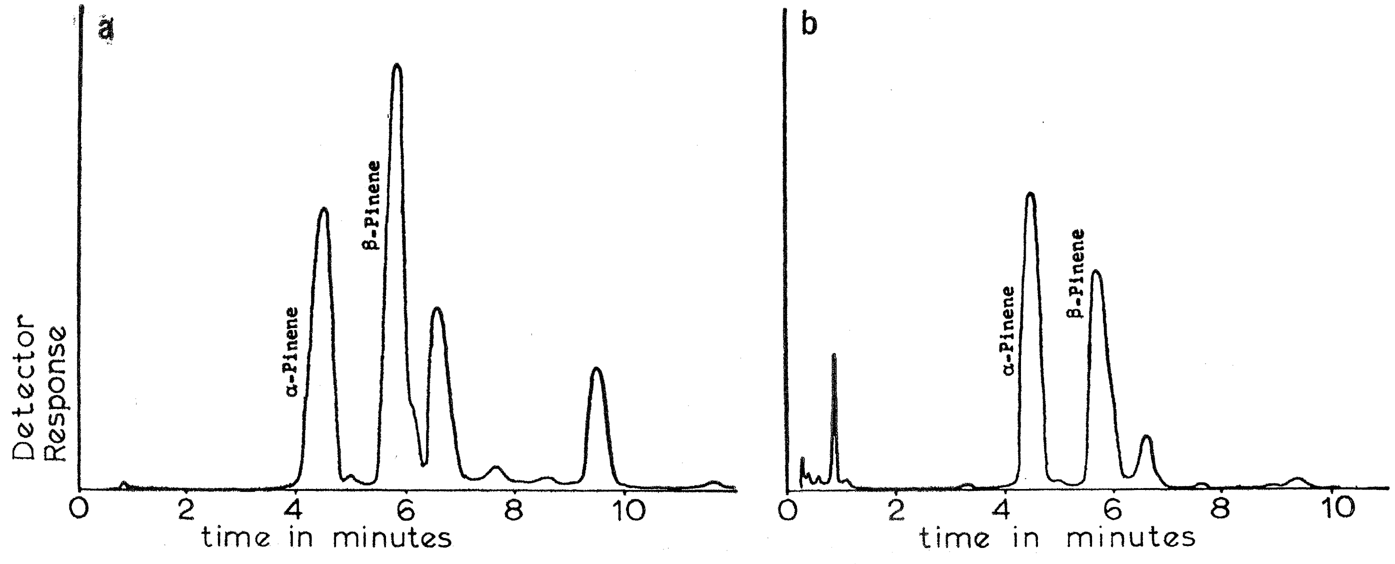

Fig. 2. Chromatograms of resin from pitch blister of a 15-year-old Douglas fir. (*a*) Liquid sample; (*b*) vapor sample.

debatable. Some forest entomologists believe that the initial attack is a random process—when one beetle is successful, a secondary sexual attractant is produced that lures in more beetles (*3*)—but other forest entomologists believe that the beetles are initially attracted to the trees (*4, 5*). Directed responses of the Douglas-fir beetle to freshly killed trees have been reported (*4, 5*), and the stimuli creating this response are most likely olfactory. Visual response is not involved, as beetles can be lured into nonhost species adjacent to the preferred host species (*5*).

Our tests indicate that the ratios and concentrations of the volatile oils of Douglas fir influence the motor response of the Douglas-fir beetle; α-pinene attracts the insect, whereas β-pinene may repel it. This insect usually feeds within the inner bark of mature Douglas-fir trees, which is low in β-pinene and high in α-pinene. The beetle usually does not attack the crown, the bark on young trees, or the area around wounds of mature trees. These parts of the Douglas fir and the wound areas are relatively high in β-pinene, a suspected repellent.

The possible mechanism whereby a tree releases volatile oils may be associated with the tree's water regime. Trees transpiring normally may emit from the needles oils that are repellent to the beetle (low ratio of α- to β-pinene). When the coolant properties of transpiration fail, the absorption of radiant energy may permit rapid volatilization of attractive concentrations of oils (high ratio of α- to β-pinene) from the main stem. The functioning of stomata and lenticels would also be contributing factors.

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Microsaccades and the Velocity-Amplitude Relationship for Saccadic Eye Movements

Abstract. *The maximum velocities of microsaccades (flicks) are an increasing function of amplitude of movement. Measured velocities fall on the extrapolation of the curve of maximum velocity versus amplitude for voluntary saccades and involuntary corrective saccades. Hence all these movements are produced by a common physiological system, or the characteristics of the movements are determined by a single dynamically limiting element.*

It has been known for some time that the velocity of a saccadic eye movement is a nonlinearly increasing function of its amplitude (*1–3*). This relationship is one of the nonlinearities encountered in a study of the versional eye-movement system as a servomechanism (*3*). Westheimer (*1*) has studied the relationship of maximum velocity to amplitude for voluntary saccades ranging from 2 to 30 degrees. His curve shows a curvilinear relationship over the entire range, with a tendency to saturation for larger amplitudes. Gurevich (*4*), in studying average velocity, found a similar relationship, although his velocities are naturally much lower than Westheimer's. Gurevich also found that average velocity measurements for any given size movement were fairly constant under the following conditions: horizontal, diagonal, or vertical move-

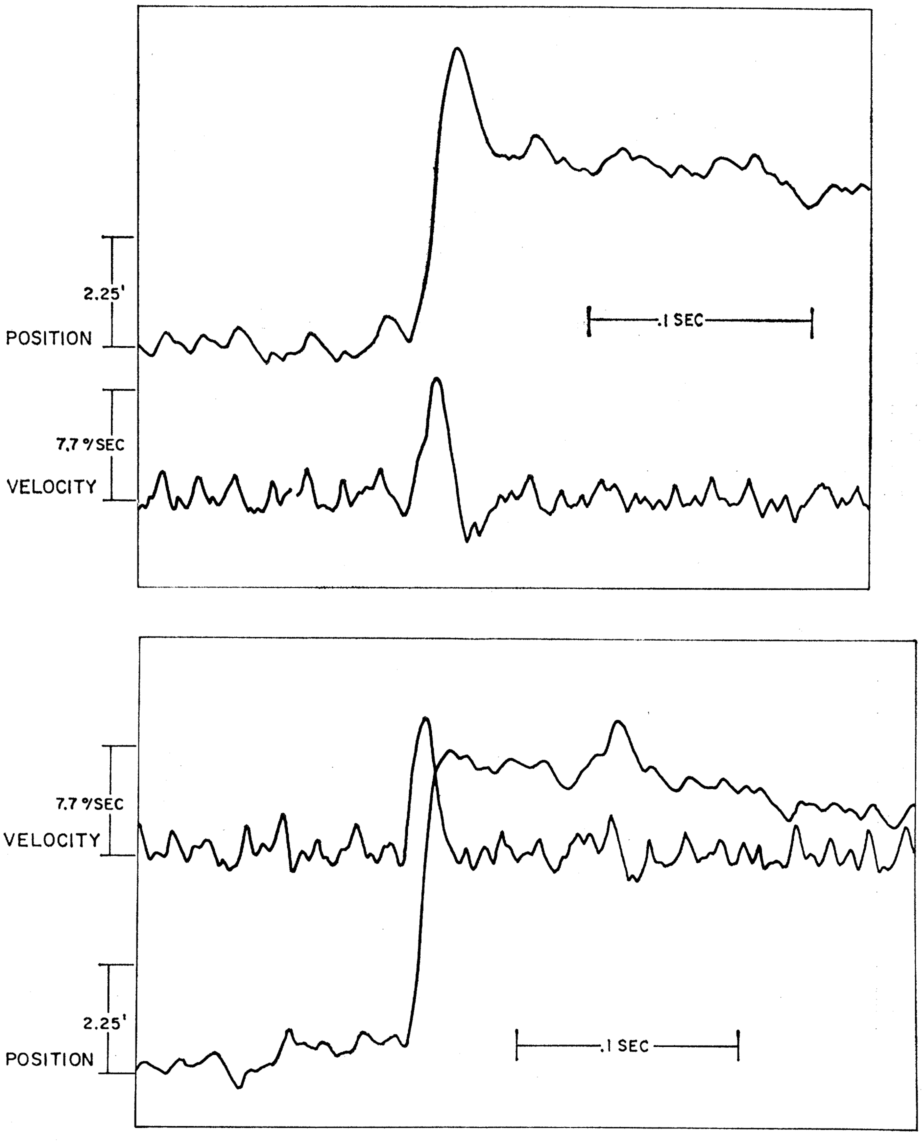

Fig. 1. Two typical microsaccades and their velocity traces. Although both movements are about the same size, only one has overshoot.