Equipment and Methodology

1970. Western pine beetle pheromone trap-out.

In 1970, only a few years after the first scolytid aggregative pheromone was discovered, a robust "trap-out" experiment involving the western pine beetle (*Dendroctonus brevicomis*) was implemented near Bass Lake on the Sierra N.F., California. Hundreds of sticky traps baited with a mixture of pheromones (exo-brevicomin and frontalin) and myrcene (a pine resin monoterpene) were deployed throughout an infestation encompassing 35 square miles. At the time, I was experimenting with Douglas-fir beetle pheromones (including frontalin) in Idaho and arranged to visit the California test, during which I took the accompanying photos. I bunked at the Miami Field Base (see related Facilities item), just south of Yosemite National Park. Bill Bedard (W.D. Bedard, Jr.) was one of the researchers involved with the test and was stationed there at Miami with the Forest Service. Other researchers involved in the test were David L. Wood, Lloyd Browne, and Donald L. Dahlsten, of the University of California, Berkeley.

At the outset, I need to emphasize a couple of points. This was, I believe, the biggest such endeavor ever undertaken and it was well designed in all its technical aspects. However, for reasons that I still don't understand, it fell flat in the reporting stage. I know of no subsequent publication; this brief account is gleaned from WFIWC proceedings (1970 and 1971). I encourage surviving participants to provide me with their recollections. Why were the results not published? Here are excerpts from the cited proceedings:

"Populations of the beetle and its insect natural enemies and associates are being measured throughout the 35 sq. mile study area for four successive generations, one preceding suppression and three following. Over 250 suppression traps were erected in four one-half square mile suppression plots on an eight-chain grid. Over 100 survey traps were placed throughout the study area on a 40-chain grid. Traps were erected before spring emergence, and suppression traps were removed at end of spring flight, while the survey traps remained out for the duration of the entire flight season."

"Suppression: Four one-half-square-mile treatment areas and two one-square-mile check areas will be established. Traps will be established on 8-chain (528 ft) centers in each of the four treatment areas. At each trap, exo-brevicomin, frontalin, and myrcene will evaporate from glass vials at the rate of 10 mg/day in a 1:1:1 ratio during the spring emergence period.
Survey: Traps will be established on 40-chain centers throughout the 35-square-mile infestation area. At each trap, exo-brevicomin, frontalin, and myrcene will evaporate from glass vials at the rate of 1 mg./day in a 1:1:1 ratio throughout the entire flight season."

Bedard reported the following at the 1971 WFIWC: "The data are not completely gathered and only partially analyzed, but these preliminary results are available. We started with over 100 infested trees before the treatment. Now, two generations after suppression treatment, we have located only five infested trees. Suppression traps trapped 427,000 western pine beetles while the survey traps caught 330,000. One hundred and fifty trees were attacked adjacent to suppression traps, but only 15 or so were killed. We feel these preliminary results are very promising."

With that, I can find no further reference to this historical endeavor. -- *Malcolm Furniss*

References Cited:

Panel: Field testing attractants. Proceedings 21st WFIWC , Seattle, WA, 1970.

Panel: Bark beetle attractant tests of 1970. Proceedings 22nd WFIWC, Glenwood Springs, CO, 1971.

1970. Douglas-fir beetle attractant, Frontalin.

The attractant pheromone, frontalin was identified from the southern pine beetle, *Dendroctonus frontalis*, by Peter Vité and subsequently found to attract the Douglas-fir beetle. Such pheromones had subsequently been shown to require monoterpenes in host tree resin to promote their attractiveness. In 1970, I set up a field test to compare attractiveness of frontalin with Douglas-fir resin and its component monoterpenes. It was a robust experiment and produced an array of results (Furniss & Schmitz 1971). We tallied everything caught including 23 spp. of Scolytidae (I still use the name in historical settings), one of which was subsequently described as *Hylugops reticulatus* Wood. Also, a clerid predator,*Thanasimus undatulus* (Say), which had been rarely collected (in subsequent tests involving frontalin in northern Idaho, we caught many hundreds of this clerid).

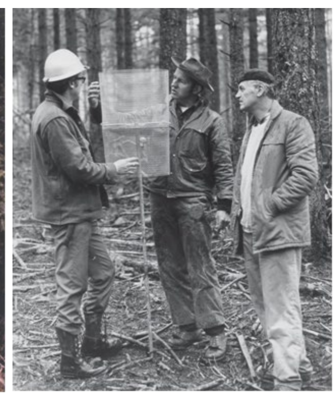
It turned out that (in presence of frontalin) alpha pinene was the most attractive monoterpene. However, stem sections containing unmated females, and raw resin caught the most (indicating that other attractants were present in them). It was stimulating during this period of discoveries of pheromones that were explaining so much about scolytid-related behavior that previous workers could only wonder about! Here was a research tool that would lead me on many trails during the next ten years, beginning with discovery of the antiaggregative effect of a pheromone, methylcyclohexene (MCH), in 1971. – *Malcolm M. Furniss*

Reference cited:

Furniss, M. M. and R. F. Schmitz. 1971. Comparative attraction of Douglas-fir beetles to frontalin and tree volatiles. USDA For. Serv. Res. Paper INT-96. 16 pp.

1971. MCH shown to be an anti-aggregative Douglas-fir beetle pheromone.





In 1971, Julius Rudinsky (1917-1980) of Oregon State University had several putative Douglas-fir beetle pheromones that he wished to have field tested. By coincidence, LeRoy Kline ... then the Oregon Dept. of Forestry forest entomologist at Salem ... had been my summer assistant while he was a graduate student of Julius. We worked out an arrangement by which I would test them in Idaho for possible differences in response compared to replicated tests by Kline and Rudinsky in Oregon. Two methods were used: 1. Various treatments applied to sticky traps to catch responding beetles, and 2. Treatments applied to live Douglas-fir. Julius did not wish to identify one of the pheromones and designated it as GLC "Peak 5." However, he characterized it as an attractant, thus I expected it to elicit Douglas fir beetle attacks when accompanying known attractants such as frontalin and alpha pinene. Well, in a sense, this turned out to be the most unbiased test imaginable...in retrospect.

The test was conducted at the Boise Basin Experimental Forest near Idaho City in spring 1971, assisted by R.F. Schmitz of my research project at Moscow. We monitored the traps daily and rotated the treatments randomly among the trap locations. We also visually examined treated live trees for tell-tale frass. Early in the test, I observed a remarkable result! The treatments involving Peak 5 were not attracting beetles; instead, it was obvious that it profoundly masked (nullified) the attraction of all previously demonstrated attractive treatments.

Also, about this time, I learned that methylcyclohexenone (MCH) had been identified from the beetle by GLC. I called Julius and announced the results that we were observing and inferred that Peak 5 was probably MCH. He confirmed that but felt that the antiaggegative (masking) effect was due to high concentration. That was never evident during subsequent research and development of MCH, but I am not sure whether he ever came to that view. To me, it seemed that it would diffuse area-wide to less concentration and at some distance it would result in trees being attacked. This never happened with MCH.

Anyway, thanks to Julius, this remarkable antiaggregative pheromone became available to me. I set out to test and develop it for managing populations of the Douglas-fir beetle, with help of cooperators, including Mark McGregor (R-1 Missoula) and Ladd Livingston (Idaho Dept. Lands, Coeur d'Alene),. -- *Malcolm Furniss*

References Cited:

Furniss, M. M., L. N. Kline, R. F. Schmitz, and J. A. Rudinsky. 1972. Tests of three pheromones to induce or disrupt aggregation of Douglas-fir beetles (Coleoptera: Scolytidae) on live trees. Ann. Entomol. Soc. Am. 65:1227-1232.

Rudinsky, J. A., M. M. Furniss, L. N. Kline, and R. F. Schmitz. 1972. Attraction and repression of Dendroctonus pseudotsugae (Coleoptera: Scolytidae) by three synthetic pheromones in traps in Oregon and Idaho. Can. Entomol. 104:815-822.

1972. Determining optimum elution rate of MCH to prevent outbreaks of Douglas-fir beetle.

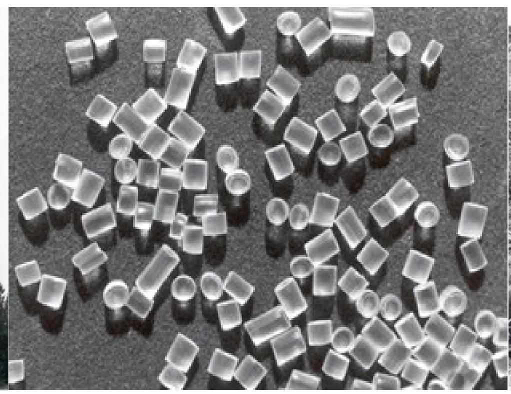
During 1971 tests, MCH repressed the attraction of the Douglas-fir beetle aggregative pheromone, frontalin. In1972, I organized a cooperative test to determine the optimum elution rate of neat MCH for preventing infestation of downed Douglas-fir (Furniss et al. 1974). Historically, "outbreaks" of the beetle in the Northwest have resulted from its population increasing in windfelled or snow-broken trees that lack host resistance. Ten treatments were replicated at locations in Idaho, Oregon and Washington. These treatments were 3 elution rates times 3 spacings around felled trees, and a control. I devised the 3 dispensers and determined elution rates in the laboratory beforehand. For the purpose of bracketing the optimum rate, I varied elution rate 1,000 fold from least to greatest, and from one dispenser per tree to dispensers placed 10-ft and 30-ft apart on plots 30- by 120-ft, encompassing each tree.

Felling the trees and setting up the plots and treatments extended from March into early April while the ground was covered with deep snow to be sure that the test was in place before beetles emerged. It was a big job requiring commitment and energy that I now can only marvel at. The gist of all this effort is that we did, indeed, bracket the optimum elution rate, which was 0.06-1.3 grams/acre per day (Furniss et al. 1974). Now, we were posed to begin the development and testing of a controlled-release formulation of MCH and thereafter an aerial application method. This would proceed over the next several years with the assistance of others including Mark McGregor of Forest Service Region 1, Missoula, who participated throughout that time. -- *Malcolm Furniss*

Reference Cited:

Furniss, M. M., G. E. Daterman, L. N. Kline, M. D. McGregor, G. C. Trostle, L. F. Pettinger, and J. A. Rudinsky. 1974. Effectiveness of the Douglas-fir beetle antiaggregating pheromone, methylcyclohexenone, at three concentrations and spacings around felled host trees. Can. Entomol. 106:381-392

1973-1981. Development and application of controlled release formulation of MCH.



After determination of the optimum elution rate of MCH in 1972, a controlled release granular formulation containing 2% MCH was developed under contract with Zoecon Corp (Young et al. 1977) and field tested in Idaho. The granules were inert dimer polyamide acid beads similar to nylon. The granules had good ballistics, not drifting, and they passed readily through the canopy. Hand application of 4 lbs of granules (containing 36 gms of MCH) per ac was effective in preventing infestation of downed Douglas-fir throughout the flight period (Furniss et al. 1977). Work then proceeded to develop an aerial application method. This spanned several years. Success came by purchasing a Simplex aerial spreader (bucket), which was adapted and calibrated to apply the desired rate by helicopter.

Next, the granules were applied by helicopter across lines of 3-ft^2 funnels to catch and weigh granules and thereby determine the height and speed of flight for the desired result (Furniss et al. 1982). There followed a final experimental field test involving replicated plots in mountainous forested areas of Latah Co., in which trees were felled to simulate windthrow (Furniss et al. 1981). Then, we waited for nature to provide wind-felled trees, which occurred in November 1981. During May 11-13, 1982, a pilot test was conducted by Forest Service Region 1 personnel (McGregor et al. 1984). That completed the long and arduous work that began with the discovery of the antiaggregative effect of MCH in 1971. -- *Malcolm Furniss*

Reference Cited:

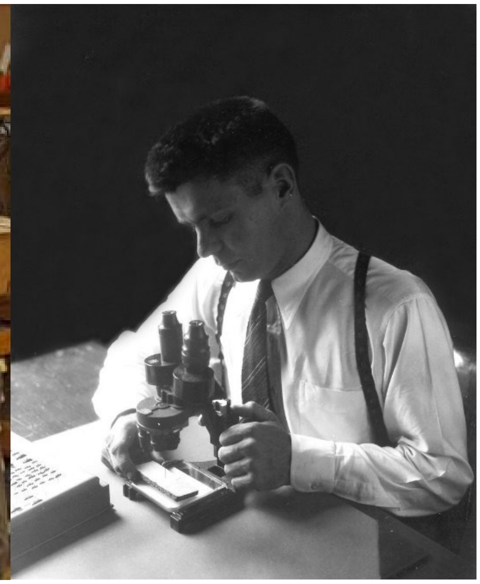
Furniss, M. M., G. P. Markin, and V. J. Hager. 1982. Aerial application of Douglas-fir beetle *antiaggregative pheromone: equipment and evaluation. USDA For. Serv. Gen. Tech. Pep. INT-137. 9 p.*

Furniss, M. M., R. W. Clausen, G. P. Markin, M. D. McGregor, and R. L. Livingston. 1981. Effectiveness of Douglas-fir beetle antiaggregative pheromone applied by helicopter. USDA For. Serv. Gen. Tech. Rep. INT-101. 9 pp.

Young, J. W., T. M. Graves, R. Curtis, and M. M. Furniss. 1977. Controlled release formulations of insect growth regulators and pheromones-evaluation methods and field test results. pp. 184-199. In Scher, H. B. (ed.) Controlled Release Pesticides. ACS Symposium Series, No. 53.

Furniss, M. M., J. W. Young, M. D. McGregor, R. L. Livingston, and D. R. Hamel. 1977. Effectiveness of controlled-release formulations of MCH for preventing Douglas-fir beetle (Coleoptera: Scolytidae) infestation in felled trees. Can. Entomol. 109:1063-1069.

McGregor, M. D., M. M. Furniss, R. D. Oakes, K. E. Gibson, and H. E. Meyer. 1984. MCH pheromone for preventing Douglas-fir beetle infestation in windthrown trees. J. Forestry 82:613-616.

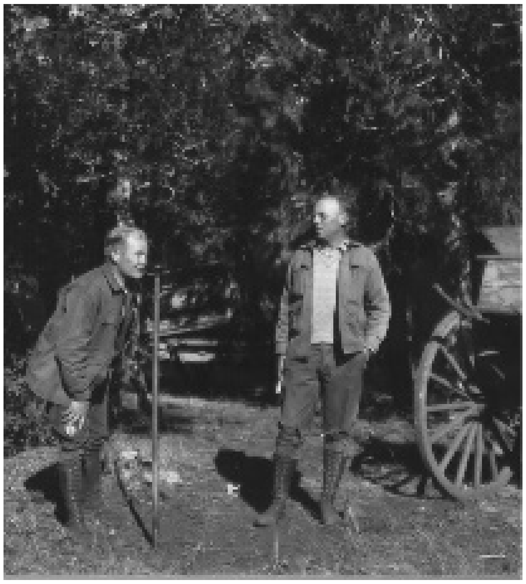


Robert L. Furniss using a binocular microscope in March 1942 (age 34) at the Portland Forest Insect Lab, Division of Forest Insect Investigations (FII), USDA, Bureau of Entomology. This style of microscope was still in use when I (MMF) came on board in 1950. In 1953, the Bureau was disbanded and personnel of FII were transferred to the Forest Service. After a time, we went from straightening-out used nails to actually having first class equipment and vehicles. In 1950, on a downgrade into Nevada City in the Sierra foothills, the brakes in my old Bureau truck failed and I just managed to stop using the emergency brake and some body English. Anyway, to complete the story ...

In 1955 I was with the Intermountain Station (INT) at Boise, still using the illustrated microscope. Division Chief, Don Parker, had just come to INT from Wash. DC. He came in while I was scrutinizing some bark beetles and was aghast. He immediately saw to it that I got a new American Optical scope! I have used this style of microscope (lower left photo) for 50 years, logging thousands of hours of discovery. Incidentally, I visited S.L. Wood, the World authority on Scolytidae taxonomy (he insists that they remain a family), and was impressed that he uses this exact model of microscope. Photo PS-575 WFIWC archives.

Camera stand constructed by J.E. Patterson for taking close-up photos of cone and seed insects being studied at Ashland, OR, 1915. Patterson had been an apprentice photographer before his employment at Ashland and later at the Palo Alto and Berkeley forest Insect Labs. This glass plate negative has been broken. Photo 2238 by J.E. Patterson, WFIWC archives. (Wickman et al. 2002, Fig. 2).

In 1927, Paul Keen flew in this Forest Service fire patrol airplane to photograph western pine beetle-killed trees on the Modoc N.F., California. Piloted by Capt. Boggs, they donned goggles and parachutes and were "off like a *Chalcophora* scared from a tree ... over the plot I unbuckled the safety belt, knelt on the seat and hung out over the side ... (Boggs) shut off the motor, turned the nose up and tilted the plane to the side and ... I clicked the camera ..." Photo no. 6515 by J.M. Miller, WFIWC archives. (Furniss & Wickman 1998, Fig.8 A)



Walter Buckhorn (left) with staff compass used during surveys of bark beetle killed trees, and his mentor F. Paul Keen. In late 1929, Keen established the Portland Forest Insect Laboratory with Buck as his assistant. Keen developed the first pine beetle susceptibility classification and published the first manual of insect enemies of western forests in 1939. His sample plots were a mile long and were surveyed with a staff compass and pacing. These plots were discontinued after the Division of Forest Insect Investigations was transferred to the Forest Service in 1953. Photo no. FPK 343, WFIWC archives. (Furniss 2000 Fig. 3)

Mountain pine beetle control, Crater Lake N.P., Oregon, 1929. Tractor pulling sleds loaded with control camp equipment and work crew. The outbreak in lodgepole pine extended from 1925-1934. Infested trees had to be felled and burned in early spring before beetles had emerged from trees and flown. At that time, deep snow was still present. Photo no. 9845 by J.E. Patterson, WFIWC archives. (Wickman et al. 2002, Fig. 7 A; Wickman 1990).

A

Ryan monoplane beneath a hopper and platform used for loading calcium arsenate dust to control a western hemlock looper outbreak in Pacific County, Washington, 1931. This was the first airplane dusting experiment attempted against a forest insect in western United States. (Photo 8768 by F.P. Keen, WFIWC archives). (Wickman et al. 2002, Fig. 8.)

Walter Buckhorn and screen cage that he designed to trap western pine beetle brood that emerged from infested ponderosa pine, Prineville, OR, May 27, 1932. Variations of this cage were used subsequently by entomologists studying other bark beetles throughout the west. Photo PS no. 125, WFIWC archives. (Furniss 2000, Fig 11).

Walter J. Buckhorn of the Portland FIL relished daredevil feats such as climbing this 250-ft-tall tree and flagging it to guide pilots in spraying insecticide to control the hemlock looper on an experimental plot in Clatsop County, OR. 10 July 1945. Note the un-sheathed double bit axe. Paul Keen recounted that Buck's safety rope slipped and was partially cut as Buck chopped-off branches. (Furniss 2000, Fig. 7) Stan Spiegle photo no. 24

In 1945, a new insecticide, DDT, was tested as an alternative to lead arsenate against the hemlock looper in Clatsop County, Oregon. Here, W.J. Buckhorn (left) and R.L. Furniss of the Portland FIL count dead loopers that dropped from treated trees. Buckhorn had climbed to the top of 250 ft trees, topped them, and marked them with white flags to mark plot corners for spray-plane pilots. Writer Stewart Holbrook described the aftermath: "Thirty minutes after spraying, dead loopers began raining down from the canopy, eventually totaling 4 million to the acre as measured on 2x3 ft. muslin trays beneath the area." Photo 22 by Stan Speigle, WFIWC archives. (Furniss 2000, Fig. 8).

Walter Buckhorn and pilot John Wear began the first systematic aerial surveys of western forest insect damage in 1947 in the Blue Mountains, Oregon, flying in this military surplus N3N open cockpit biplane. Higher performance aircraft (Cessna 195 and then a 170-B) replaced the old "oil guzzler." Wear was a former naval aviator with a forestry degree from Michigan. He also flew personnel of the Berkeley FIL, including M. Furniss, on annual damage surveys in California. Photo PS no. 786 B, WFIWC archives (Furniss 2000, Fig. 9 A).

DDT was tested against the spruce budworm on the Umatilla N.F., OR in 1948 after which millions of northwest forests were sprayed to control this defoliator. Buck marked aerial-spray plot corners with an aluminum paint bomb that was raised to the top of a tree after a projectile, having a line attached, was shot from this line gun. The gun was a .40-70 army rifle jokingly said to be left over from the Indian wars. Buck adapted the gun for this purpose and though of short stature, he was the only person who could stand the gun's kick repeatedly. (Furniss 2000, Fig. 12). WFIWC Archives.