K. Graham

PROCEEDINGS
of the Third Annual
WESTERN FOREST INSECT WORK CONFERENCE

Portland, Oregon
November 26-28, 1951

(For Information Of Conference Members Only,
Not For Publication)

Contents




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## of the Third Annual
## WESTERN FOREST INSECT WORK CONFERENCE[1/]

Portland, Oregon
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The Conference was called to order at 9:00 a.m. by Chairman Hector A. Richmond in Room 524, U. S. Court House, Sixth and Main Streets, Portland, Oregon. The 50 delegates present were welcomed by Chairman Richmond and Mr. Robert L. Furniss, in charge of the local arrangements, following which each delegate was introduced. A roster of those attending the Conference is appended.

### OPENING BUSINESS SESSION
(Monday, November 26, 9:15 a.m.)

All officers of the Conference were present including Chairman Richmond, Secretary-Treasurer Philip C. Johnson and three Councillors: Leslie W. Orr, George R. Hopping, and Robert L. Furniss.

Secretarial and treasury reports were read by the Secretary-Treasurer and approved by the delegates.

Chairman Richmond appointed a committee composed of A. J. Jaenicke and George R. Hopping to prepare and report upon a slate of Conference officers for 1952, the report to be made at the closing business session on Wednesday afternoon.

A program committee for the 1952 Conference was proposed by the Chairman and favored by the delegates in informal discussion. Mr. Jack W. Bongberg was appointed chairman of such a committee by Chairman Richmond.

The program of the 1951 Conference was briefly described by the Chairman.

The Chairman asked the Secretary-Treasurer to report on the procedures of preparing the Proceedings of the 1950 Conference in Fort Collins, Colorado. Following a brief description of the procedure by the Secretary-Treasurer, the Chairman requested expressions from the delegates as to the value of the Proceedings. Expressions of approval of the form and content of the Proceedings were made by Messrs. Chamberlin, Jaenicke, and Keen. Dr. Beal suggested a wider distribution. The consensus was that the Proceedings should be continued and the Chairman so ruled. Mr. Hopping suggested mechanical recording of the Conference from which the Proceedings could be made. Mr. Furniss outlined the problems connected with such service and indicated that the expense was too great to justify its use for the present. Data filed with Secretary-Treasurer.

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1/ Compiled by Philip C. Johnson, Secretary-Treasurer

Chairman Richmond outlined proposed changes to the Constitution (Article III) pertaining to membership qualifications. Mr. Keen asked for and received details of these qualifications, then suggested broadening them to permit a more unrestricted attendance. Mr. L. W. Orr cited as reasons for not doing so the danger of outside interests, particularly commercial concerns, using confidential information for their own use.

Mr. Furniss outlined possibilities for an informal evening session of the current Conference involving dinner, movies, and slides; also that similar arrangements at future Conferences be made 1 year in advance. Show of hands favored arrangements for a dinner meeting November 27 at a local restaurant which was subsequently held.

## OPENING PROGRAM SESSION
(Monday, November 26, 9:50 a.m.)

### Current Forest Insect Research Programs
(Hector A. Richmond, Moderator)

#### Eastern Slope Canadian Rockies (Hopping)

Major research effort by the Dominion Forest Insect Laboratory at Calgary, Alberta, is on the lodgepole pine needleminer: (1) working out of population sampling techniques and (2) affect of general and microclimate on the insect. Good insect to work with because many disturbing factors are absent. Population accessible and stable. Insect very resistant to winter air temperatures, sometimes as low as -60° F. Thorough investigation being made of relationship of weather and major outbreaks of all forest insects in this region.

#### Interior British Columbia (Mathers)

Major research effort of Dominion Forest Insect Laboratory at Vernon (sub-laboratory of Victoria, B. C., laboratory) concerned with the spruce bark beetle and the spruce budworm. Methods of silvicultural control are being sought for the beetle. Also being studied are ecological factors thought to be contributing to a 2-year budworm life cycle at higher elevations and a 1-year cycle at lower elevations. 2-year cycle infestations now running concurrently with spruce bark beetle infestations.

#### Coastal British Columbia (Thomson)

Investigative work by the Dominion Forest Insect Laboratory at Victoria concerned with effects of flooding large areas of spruce and pine upon bark beetle infestations. Present huge industrial expansion calls for extensive flooding of uncleared forest areas for water storage. Other studies include (1) chemical control of the mountain pine beetle, (2) control of same insect by silviculture on forest management, and (3) detailed analyses of past hemlock looper outbreaks as the basis for determining stand susceptibility and methods of control by forest management.

Northern Rocky Mountains, U. S. (Evenden)

Major research effort at U.S.D.A. Forest Insect Laboratory, Coeur-d'Alene, Idaho: (1) spruce budworm, where, if, and when to control using methods developed in Oregon 1949-51; (2) testing of bark penetrating insecticides for Douglas-fir beetle in Douglas-fir and mountain pine beetle in western white pine and lodgepole pine; (3) indirect control of mountain pine beetle in western white pine and western pine beetle in ponderosa pine by sanitation-salvage logging; (4) methods of improving bark beetle and defoliator insect surveys.

Central Rocky Mountains (Wygant)

Research work at the U.S.D.A. Forest Insect Laboratory at Fort Collins, Colorado, now includes studies of (1) chemical sprays to control the Engelmann spruce bark beetle, ethylene dibromide emulsions and, for residual effects, EDB-oil solutions; (2) biology of the Engelmann spruce beetle in relation to nematodes as a controlling factor in beetle outbreaks; (3) vigor strains of the spruce beetle; (4) use of trap logs in Engelmann spruce beetle control; (5) improvements of bark beetle surveys and infestation sampling techniques; and (6) the biology of Dendroctonus convexifrons in southeastern New Mexico.

Intermountain Region (L. W. Orr)

U.S.D.A. Forest Insect Laboratory at Ogden, Utah, established July 1949, is at present concerned only with insect surveys and not research. Research is needed in this region on (1) relationship of ponderosa pine needle blight, now very serious, and bark beetles in southern Idaho; (2) relationship of limb rust on ponderosa pine and development of Black Hills beetle outbreaks; (3) biology of a mealybug now prevalent on Engelmann spruce in eastern Utah; (4) prevalence of lodgepole needleminer outbreaks in southern Idaho (now furnishing parasites for study by Canadians under MacLeod, here present); (5) occurrence of increasing white pine butterfly activity in southern Idaho; and (6) reasons for failure of Douglas-fir tussock moth caterpillars to mature in epidemic reported in 1950 southwestern Idaho fir stands harvested in 1870's for mine timbers.

Oregon-Washington Region (Furniss)

Current research studies by the U.S.D.A. Forest Insect Laboratory, Portland, Oregon include: (1) western pine beetle control by sanitation-salvage control, in cooperation with U.S.D.A. Forest Insect Laboratory, Berkeley, California; (2) long-term western pine beetle outbreak trends, also in cooperation with Berkeley laboratory; (3) Douglas-fir beetle losses in Douglas-fir stands in Coos Bay area, Oregon, in cooperation with Weyerhaeuser Timber Company (heavy current DFB losses, also heavy DF losses from disease, fire, and wind, first disclosed by recent Weyerhaeuser timber cruises); (4) biology and habits of the Douglas-fir beetle in interior Douglas-fir forests; (5) area bark beetle hazard zonation in ponderosa pine stands (primarily application of indices of hazard developed at Berkeley laboratory rather than original research); (6) forest insect aerial survey technique improvements, particularly refinements in aerial sketch. mapping of defoliator outbreaks, aerial strip viewing, and the application of aerial photographs in dense Douglas-fir and hemlock stands and in more open ponderosa pine stands. Current research problems with no work being done include (1) cooperation with Canadians in studies of the hemlock looper, blackheaded budworm, and hemlock sawfly in British Columbia and southeastern Alaska, (2) Buprestis in wood products, (3) spruce budworm biology and control methods, (4) Pseudohylesinus in silver fir in Washington (severe outbreak now in Olympic Peninsula), (5) Sitka spruce weevil in plantations, (6) carpenter ants in forest plantations, and (7) biology habits, and control of Dendroctonus obesus and D. borealis in Sitka spruce in Alaska.

California (Keen)

Current investigative work by the Berkeley laboratory includes the following: (1) selection of high risk trees by the western pine beetle in ponderosa pine forests (study extended to west side of Sierra Nevada mountains and to the Coast Range in 1951), (2) effectiveness of sanitation-salvage logging in preventing western pine beetle damage in interior ponderosa pine forests, (3) control methods for mountain pine beetle in sugar pine forests comprising 50-year old heavily stocked site I and II stands (present infestation taking out whole stands; present study on control methods in cooperation with Blister Rust Control pathologists), (4) Ips in second-growth pine stands, (5) testing of chemical control methods for southern California bark beetle outbreaks in heavily used recreational forests (methods developed at Fort Collins laboratory), (6) resistance of hybrid pines to insect attack (cross-bred Jeffrey-Coulter pines at Institute of Forest Genetics, Placerville, California, showing resistance to Cylindrocopturus eatoni, pine reproduction weevil, which has practically wiped out extensive pine plantations in northern California, (7) improvements in insect survey methods.

University of British Columbia (Graham)

Research efforts in cooperation with Dominion forest insect laboratories include studies in (1) lodgepole pine needleminer in lodgepole pine and (2) spruce weevil in Sitka spruce. The needleminer is a serious threat to lodgepole pine forests needed along the eastern slope of the Rockies for their watershed value. An analysis is being made of Sitka spruce weevil plots to determine the role of the weevil in planted and natural plantations. Weevil activity has seriously limited spruce plantation establishment. Some weevil populations have levelled off after 4 or 5 years. Weevil damage consists of malformation of trees and loss in increment. No evidence of decline in present infestations. Genetic strains of spruce show hopeful promise of natural control.

The State College of Washington (Sinkover)

Only minor research carried on. Work largely concerned with forest entomology service courses for entomology and forestry majors.

University of Idaho (Barr)

Same conditions as at W.S.C. above.

Montana State University (Chapman)

Forest entomology service coursework major activity. Hope for work on forest insect problems on 20,000 university experimental forest. Effort being made to get forestry and zoology students to appreciate forest insect problems.

Oregon State College (Chamberlin)

Considerable research on forest insect problems allowed at one time, but present heavy teaching loads limit this now. Extra curricular research work includes (1) completion of manuscripts on (a) forest insect problems in Oregon for Oregon State Board of Forestry, and (b) history of forest entomology in Oregon, (2) mountain mahogany beetle in southeastern Oregon (plant valued for stock grazing), (3) Pseudohylesinus nebulosis followed by the Douglas-fir beetle in parks and woodlots (owners anxious for control, methods being developed in 1952), (4) attacks by a sawfly on 20-25 year old ponderosa pine trees bordering highway US-99 (population now affected by a disease, infestation concurrent with one of an Aegerid moth now being controlled by digging out the caterpillars).

Weyerhaeuser Timber Company, Coos Bay Operation (Lauterbach)

Large company-owned sawmill recently completed at Coos Bay, Oregon is depending upon a continuous supply of timber for the next 80 years. Timber cruises of Douglas-fir forests by the company are showing excessive tree mortality -- groups of dead trees covering as much as 10 acres -- largely from the fungus Poria weirii and insects (mostly the Douglas-fir beetle). More insect-caused mortality in 1951 than in past 5 years together. Loss in 1951 averaged 800-900 board feet of Douglas-fir per acre. Present studies by company aimed at (1) developing methods to salvage or prevent loss, (2) developing strip cruising methods to measure loss, and (3) determining causes of the abnormal tree mortality. The company is also concerned with spruce budworm outbreaks in its holdings in other parts of Oregon.

Weyerhaeuser Timber Company, Klamath Operation (T. J. Orr, Jr.)

Company is cooperating with the U.S.D.A. forest insect laboratories at Berkeley, California and Portland, Oregon in testing indirect methods of western pine beetle control and in securing data for use of the laboratories in improving the individual tree beetle risk ratings.

Oregon State Department of Forestry (Woods)

The Department is cooperating with the U.S.D.A. forest insect laboratory at Portland on studies of spruce budworm biology and control and on the surveying of budworm and bark beetle outbreaks on State-and privately-owned forest lands in the State. Also cooperating with Oregon State College on the preparation of a publication on forest insects in Oregon.

Dominion Biological Control Investigations Laboratory (MacLeod)

The laboratory at Vancouver, British Columbia, is conducting research on biological control problems on forest and agricultural insect pests. Some of the more important problems include the transfer of larch sawfly parasites from western to eastern Canada, spruce budworm parasites from British Columbia to eastern Canada, Douglas-fir tussock moth parasites from Idaho and western Canada to the East.

Discussion

(Chamberlin) I would like to hear more details of the carpenter ant problem.

(Furniss) Studies now being conducted to assess damage and distribution. Problem important on roots of conifers in western Oregon and Washington. Four years of plot records support contention that ant problem may be important in marginal plantations.

(L. W. Orr) Are ants eating roots?

(Furniss) Yes. This causes girdling. Root aphids feed on roots and root crowns.

(L. W. Orr) Similar problem in ponderosa pine plantations in Utah -- aphids found on root crowns with ants on the trees. Trees become stunted.

(Furniss) Ant damage spotty. Most damaged plantations were those where logging slash had been burned and large chunks or logs were left to become food for ants.

(Beal) Aphids on roots abundant on pines in southern U.S. Tree damage characteristics (short needles and reddening) progress from top down.

(Hall) What about the Sitka spruce weevil?

(Graham) Life history studies show 75-175 eggs per terminal shoot laid in the spring, Larvae work downward in cambial region to 1st node during 1st season. Loss of terminal leader produces multiple leaders from side branches. Result: bushy appearance and sometimes no leader.

(Hall) Any chemical control?

(Graham) No.

(Hall) Good control obtained for pine reproduction weevil, Cylindrocopturus eatoni in California by applying aerial sprays of DDT-oil solution in spring at a cost of $1.25 - $1.50 per acre. Spring spraying timed for peak weevil emergence.

(Graham) Methods might apply to Sitka spruce weevil though Canadian studies concerned with natural control and hazard zonation of spruce areas.

(Callahan) Is weevil concerned with tree vigor?

(Graham) Weevil thrives on better spruce sites and where growth rate is greater. Seems that the more effort exerted by trees to overcome weevil attacks through production of multiple terminals, the more do weevil attacks occur.

(Callahan) Summer moisture appears to curb C. eatoni attacks in California. No weevil damage in nurseries sprinkled during the summer.

(Chamberlin) Sitka spruce weevil ever work in laterals?

(Graham) No.

(Struble) What lodgepole pine needleminer population sampling methods are employed in Canada?

(Hopping) Determine the number of trees per population level. Population level varies in trees in different elevations. Population studies are related to climate studies at Calgary.

(Furniss) A problem of mutual interest to U.S. and Canadian workers is the blackheaded budworm outbreaks in Washington and British Columbia. No extensive timber loss in Washington or Alaska, but heavy losses in British Columbia. What factors cause this difference?

(Graham) Difficult to predict. May be due to presence of secondary insects, possibly roundheaded or flatheaded borers.

(Keen) Did flatheaded borers follow the budworm?

(Richmond) Don't know, but budworm infestations died out soon after finding the borers in the trees.

(Kinghorn) Tetropium is important in fog belt forests in furthering tree mortality from hemlock looper by drying the cambium. Heavily defoliated trees put out new foliage during the following summer but added no radial increment. Trees thus "sitting ducks" for so-called primary insect attacks. Did any tree mortality occur in Oregon from hemlock sawfly outbreak?

(Furniss) None over 50,000 acres infested.

(Richmond) Surveys show blackheaded budworm all along British Columbia coast. In previous hemlock looper outbreaks, all were preceded by a build-up of blackheaded budworm populations. The present indications are therefore pointing to an expected looper outbreak.

(Furniss) What is the northernmost looper record?

(Richmond) Kipsumgallum Lake in central B. C. Infestations of the Engelmann spruce beetle are now very heavy in northern B. C.

SECOND PROGRAM SESSION
(Monday, November 26, 1:30 p.m.)

Spruce Budworm Problem
(Robert L. Furniss, Moderator)

Furniss gave a brief description of the experimental aerial spray control program for spruce budworm in Oregon and Washington during the last 3 years. A total of 2,250,000 acres were sprayed.

(Woods) Planning of that part of the 1952 budworm control project to be undertaken by the State of Oregon is under way. Aerial surveys are being made to determine the size of aircraft, location of airstrips, and amount of insecticide. Magnitude of the over-all project is being determined from aerial photos. Aerial mosaics of each area to be treated are being prepared commercially to determine the net acreage of timber to be sprayed. The boundaries of spray units are located on the aerial photos, scale 1 inch = 1 mile, to provide for proper distribution of insecticide over entire project area. From these, maps are prepared. Ground location of each spray unit is identified from air by contractors' chief pilots.

Organization: Administrative units used to subdivide control effort over project area. Unit supervisor directs "base bosses" who, in turn, supervise each air strip operation, check distribution of spray, and maintain records of DDT used and of weather. Contractor's representatives are responsible for operation of aircraft and for spraying. Forest insect laboratory entomologists are set up to check results of the spray and Civil Aeronautics Administration officials to check airplane safety features and operation.

State of Oregon bids for the 1952 budworm project are now ready, the specifications having been established by the insect laboratory. The transportation and storage of the DDT insecticide has already been contracted. One-third of the total amount of DDT solution to be used will be stored at the airstrips. Airplane re-fueling procedure will follow that used in the Douglas-fir tussock moth control project in northern Idaho in 1947. Airstrips are to be oiled, a very necessary item for dense traffic use.

Bids for flying (spraying) are very competitive. The specifications of the number and type of aircraft to be used are included in the invitations to bid put out by the State. The invitations also specify safety installations, pilot experience, and provisions for enforcing provisions of the contract.

State check pilots are provided for to observe and inspect the work of the spray pilots, and to shut down the spraying operations when weather conditions make flying unsafe or cause uneven distribution of the spray. Commercial airfields are used wherever possible, but it is important to have airfields or specially constructed airstrips so that ferrying distances do not exceed 12 miles for small planes and 40 miles for larger ones. Entire spraying operation will be joined by State-owned and operated radio communications system. Insect laboratory entomologists determine when and where to spray.

Contractors' chief pilots are educated as to the proper spray pattern desired so as to avoid flying accidents (especially those caused by up hill flying), poor budworm mortality, and agricultural crop damage (insurance against chemical damage to crops will be required of contractors in 1952). Inspection by the State in cooperation with the CAA will be made of contractors' airplanes to check flights, leaking equipment, proper calibration of spray distribution. Aerial photos are given to each spray pilot showing the spray block he is responsible for and indicating, on the photo, the number of gallons of DDT allotted for that block.

Spray planes averaged 4 minutes each for reloading DDT tanks or for re-fueling. Pilots were checked in 1951 by entomologists using glass plates to intercept spray particles. Missed areas are sprayed immediately. 450 h.p. Stearmans, and BT-13's were the types of planes most commonly used in 1951. Spray runs of not more than 5 or 6 miles proved most efficient. Pilots forget location of spray strips in longer runs. Flying height of from 75 to 250 feet above tree tops gave best spray results in '51. Budworm mortality in 1951 was better than 90 percent, not as good as in 1950 because of change in DDT formulation. Cost of spraying in 1951, 85 cents to $1.05 per acre.

(Chamberlin) 1951 cost higher than in 1950?

(Woods) About 1/2 cent.

(L. W. Orr) Did solvent in spray damage auto finishes?

(Woods) GA-10 solvent pitted paint on automobiles.

(Whiteside) Pilot fatalities, 2 in 1951, were on non-state part of project.

(Johnson) Tussock moth spray pilots in Idaho in 1947 found little use for aerial photos as an aid in flying. Most couldn't read them, they were too busy flying and too low to the ground to use them while flying, and they soon became soaked with insecticide. How did pilots use them on the '51 Oregon project?

(Woods) Photos studied by pilots before and after flights.

(Jaenicke) The U. S. Forest Service part of the 1951 budworm spray project was essentially the same as that described above for the State of Oregon. The 1947 northern Idaho tussock moth project was used as the pattern for procedures. The Bureau of Entomology and Plant Quarantine, through its Portland forest insect laboratory, is an essential agency in planning the technical phases of an operation of this kind. Flying safety is of much concern now in planning for the 1952 program. Accident picture since 1947 is as follows:

| | | | |
|---|---|---|---|
| 1947 | Idaho tussock moth, | some accidents, | no deaths |
| 1949 | Ore.-Wash. spruce budworm, | some accidents, | no deaths |
| 1950 | " " " " , | " " | , 7 deaths |
| 1951 | " " " " , | " " | , 2 deaths |

The spraying height is the primary basis for the current safety program. Flying over tree tops, height is not too important. Condition of the aircraft and weather is more important.

(Beal) The accidents on the Oregon-Washington spruce budworm projects are known to many. The 1950 fatalities nearly closed the project. There was considerable pressure on the Bureau of Entomology and Plant Quarantine to determine the maximum allowable spray application height above the tree tops. Tests were conducted last year at the Beltsville, Maryland, forest insect laboratory and indicated (1) no more loss of spray at a 200-foot flying altitude than at a 50-foot altitude, (2) a farther spray drift at 200 feet, but (3) a more uniform spray distribution at 200 feet. At 500 feet, using a Stearman plane, there was no spray intercepted on the ground.

(Woods) Where is the spray limit between 200 and 500 feet altitude?

(Beal) Spraying at 300 feet altitude gave no spray on the ground. Multiple spray swaths are responsible for better budworm control in the West than in the East. 200-foot spray height O.K.

(Hall) Any tests to increase spray droplet size at greater altitudes?

(Beal) Finest droplet sizes not always best.

(Wear) Can spraying greater amounts of DDT/acre allow greater flying altitudes or greater spray deposit?

(Beal) Spraying 1 pound DDT/acre actually results in deposits ranging from 0 to 2 pounds/acre. Good deposit results due to swath overlays.

(L. W. Orr) Good results due to small droplets?

(Beal) Small droplets drift away.

(Massey) Droplet size calculated at plane or on ground?

(Beal) At plane nozzle orifice.

(Furniss) Any tests to indicate spraying at 500 feet above ground O.K.?

(Beal) No tests made.

(Furniss) Ken Wright will now tell us of some of the spruce budworm research being done in Oregon.

(Wright) Very little was known about budworm biology and habits in Oregon up to 1940. The present epidemics rose rapidly and warranted control. First research in control methods was begun in 1948. Additional research in 1949 was undertaken in eastern Oregon to (1) determine effect of spray against pre-hibernation larvae (no satisfactory mortality achieved), (2) test the toxic effects of Toxaphene, and benzene hexachloride, and (3) test spray distribution by helicopter vs. fixed wing aircraft. In 1950, tests were run to test reduced DDT dosages/acre. The 1950 control project used 3/4-pound of DDT/acre (results unsatisfactory). The 1952 control project returned to 1 pound/acre.

No biological research on the budworm in Oregon until 1950; objectives then were to investigate budworm and parasite populations on sprayed and unsprayed areas. On unsprayed areas natural control factors were studied; also infestation status ranging through increasing, static, and decreasing forms. Parasitism varied greatly, enough to control the budworm in some areas, not effective in others. Factors of stand age, vigor, and site believed to be responsible for heavy infestations in some areas and not in others. Habits of the budworm are not too well known in the Pacific Northwest. A 2-year life cycle believed to exist at high elevations in eastern Oregon. Sampling the overwintering population was done as part of pre-spraying programs as an indication of subsequent feeding population. Conflicting results made this measure not too indicative.

Tests on sprayed areas were made to check effectiveness of treatment on both budworm and parasite populations. Budworm showed better than 95 percent mortality in all tests 1949 through 1951. Post-spraying parasitism was 25-30 percent on untreated areas, 60-70 percent on treated areas.

(Chamberlin) What was the average percentage of parasitism on untreated areas?

(Wright) It varied. Averaged 70-80 percent in eastern Oregon and 40 percent in western Oregon.

(Struble) Any disease or virus?

(Wright) Some preliminary evidence was later disproved.

(Bongberg) Did poor control cause a rapid post-spraying budworm population?

(Wright) Yes.

(Richmond) Against what larval instar was spraying done?

(Wright) Fifth.

(Keen) If 99 percent of the budworm population was killed by the spray, weren't the parasites also killed?

(Wright) The percentage of parasitism in the surviving brood was much greater.

(Massey) Are parasites specific and native to the budworm? (Answer, Yes.)

(Richmond) How was the overwintering budworm population sampled?

(Wright) Douglas-fir limb samples with roughened bark were collected from numerous localities during the winter and placed in rearing. At room temperatures the minute instar larvae emerged from the hibernacula into collecting vials for counting.

(Hopping) What sampling unit was used?

(Wright) Square foot of bark surface and, on permanently located plots, 15-inch branch terminals.

(Hall) Any check areas for budworm populations? (Yes.)

(L. W. Orr) Any laboratory spray tests?

(Wright) No. Canadian tests indicate small larvae to be more susceptible to spray than large larvae.

(Keen) Why was no control achieved by spraying pre-hibernating larvae?

(Furniss) Despite ideal timing of the spraying, no control resulted.

(Keen) Perhaps the spray was not reaching the larvae. (Answer: Maybe.)

(Richmond) Were all infested areas sprayed?

(Wright) Adjacent blocks were left unsprayed. Drift of budworm population back into sprayed blocks is occurring at the rate of 1/4 mile/year.

(Richmond) What will happen to infestation on unsprayed areas?

(Wright) Don't know. They will be studied for possible break in the infestation.

(Chamberlin) Won't residual effect of DDT be effective during the first year after spraying? (Answer, don't know.)

(Barr) Is the spruce budworm native to this region?

(Wright) Yes. Budworm was recorded in southern Oregin in 1915. Probably always been present, sometimes in epidemic status.

(Graham) Is the 2-year cycle budworm in Oregon on spruce or fir?

(Wright) First found on alpine fir in eastern Oregon in 1950 at elevations of 5,000 feet or over.

(Furniss) We will now hear reports on the status of spruce budworm infestations, research, and control in various western North American areas. First, Mr. Hopping, Alberta.

(Hopping) No serious budworm problem along the eastern slope of the Rockies in Alberta. Populations have fluctuated for 30 years in alpine fir, white and Engelmann spruces at high elevations; never enough to kill trees. No research until last 3-4 years. Parasitism very low, not associated with budworm declines. Declining infestations in 1950 due to lack of eggs. No control planned.

(Chamberlin) Any bark beetle follow-up in budworm areas? (No.)

(Mathers) In B. C., budworm first recorded in 1909 on east coast Vancouver Island. In 1922-23 it was recorded on Douglas-fir in the south interior section of the Province, in 1924 in the central interior in balsam-spruce forests. It is more common now in the latter area. Many budworm populations and infestations have been discovered as the Province becomes more and more accessible; many found from aerial observers. A 2-year life cycle prevails in the interior spruce-balsam type; a 1-year cycle in Douglas-fir in both coastal and interior areas. In the former, flight years occur on even-numbered years.

Research in 1951 was done on the 2-year cycle form to study the forest stand, flora, and soils for comparison with measurements of the abundance of mature larvae in 1953. Tests under way to transfer 1-year cycle populations into areas normally supporting 2-year cycle populations, and vice versa, and between low and high elevations to determine any environmental-caused changes in habits. Length of life cycle appears now to depend upon source and habits of parent stock.

(Gruba) What percentage of foliage is fed upon during the first year of 2-year cycle populations?

(Mathers) Budworm presence is not too evident then; mostly found mining needles and buds. They enter a diapause by July or early August during the 3rd or 4th instar.

(Gruba) Is spraying effective during the 1st year of a 2-year cycle budworm population?

(Mathers) Not known, no control attempted during this period. No tree killing has resulted from budworm infestations, though tree suppression has been noted. Dryocetes confusus followed budworm infestations in some areas in 1950.

(Furniss) We will now hear from the northern Rocky Mountain region. Mr. Denton reporting.

(Denton) This region ranks second to Oregon and Washington in the extent and severity of current spruce budworm infestations. The budworm was first recorded in Idaho in 1922, annually since then; on the Helena National Forest outbreaks have been recorded every year since 1923. Present budworm outbreaks in the region cover 1.8 million acres, 90 percent in Douglas-fir type, 80 percent in Montana. No control to date due to marginal values of many infested stands and general approval of the experimental control plan in Oregon and Washington.

Research objectives aimed at the improvement of budworm survey techniques to enable entomologists to determine where, when, and if control is necessary. General belief now that many budworm infestations are not in need of applied control measures because of the liklihood of natural control before host tree damage becomes intolerable. Present studies concerned with (1) determination of overwintering budworm populations, (2) their relationship to the size of subsequent actively feeding populations, and (3) the amount of defoliation caused by different population levels over varying periods of time.

(Hopping) When were the overwintering samples taken?

(Denton) Three times between April 1 and May 30. May samples gave the best results in rearing.

(Hopping) All work with 1-year cycle budworm? (Yes.)

(Graham) Any evidence of spring larval migration? Evidence in eastern Canada shows considerable wind-borne movement of larvae after hibernation is broken.

(Denton) No work done on this phase.

(Buckhorn) From what part of the tree was the greatest population reared?

(Denton) About breast high on the bole in areas of heavy infestation.

(Johnson) Size of trees sampled?

(Denton) Tree sizes in the Rockies run smaller than Douglas-fir in Oregon and Washington. Heaviest damage from budworm in dense, even-aged, pole or sapling stands, or reproduction.

(Buckhorn) Was sampling on different parts of the trees comparable?

(Denton) Heavier overwintering populations were found in the roughened bark of the lower bole. Limbs were smoother than those in Oregon because of the smaller average tree size and, consequently, contained fewer hibernacula.

(Furniss) And now, the budworm problem in the Central Rocky Mountains. Dr. Wygant reporting.

(Wygant) Spruce budworm infestations in Douglas-fir standsin parts of Colorado have subsided since the 1944-45 epidemic. In South Dakota the ponderosa pine form of the budworm declined from epidemic to endemic status in 1 year. Budworm infestations in New Mexico seem to move from area to area with no damage. Little damage in the region from budworm except in one 5,000-acre tract of white fir which was successfully treated in 1950 by aerial spraying. No budworm research being done. Tree mortality in Douglas-fir budworm-infested stands has occurred from follow-up infestations of the Douglas-fir beetle. Most outbreaks of the beetle were stopped by excessive winter brood mortality in 1950-51.

Defoliatir a B?

(Lindsten) What controlled the budworm naturally?

(Wygant) Heavy moth flights were reported near Pueblo, Colorado in 1945-46, but no eggs were found. In 1945, severe late spring freeze killed new Douglas-fir growth back 1 inch and effected 80 percent budworm mortality. The central Rockies is a desirable region for budworm research because of localized outbreaks and short duration of outbreaks.

(Struble) Any record of budworm-caused tree mortality?

(Wygant) Yes, but no estimate of how much.

(Hopping) Any mass moth flight records? (No.)

(Furniss) Mr. L. W. Orr will report on the budworm in the Intermountain Region (Utah, southern Idaho, southwestern Wyoming, eastern Nevada, western Colorado, and northern Arizona).

(L. W. Orr) First record of budworm outbreaks were from the Salmon River country in Idaho in 1922. Since then there has been lots of defoliation but little tree killing from periodic outbreaks. Douglas-fir and Abies most common hosts, but Engelmann spruce is a host at the Grand Canyon in Arizona. No control has been attempted because of low host tree values. No research.

(Furniss) Mr. Keen will report on budworm in California.

(Keen) No budworm problem in region except in the Warner Mountains in the extreme northeastern part of California. Outbreaks reported there in 1921-22 and again in 1950-51, apparently coinciding with outbreaks in other parts of the Pacific Northwest; northern Rocky Mountains, and western Canada.

(Furniss) Spruce budworm was found in every Douglas-fir or Abies stand in Oregon and Washington during 1951 except those in the Olympic Peninsula. No new dead tree areas were found in the 1951 survey. Of 2,578,000 acres infested by the budworm in Oregon and Washington in 1951, 927,000 acres were sprayed. Areas not sprayed in 1951 included 1,569,000 acres of light epidemics (no trees dying), and 82,000 acres of heavy epidemics (trees dying). The 1951 survey indicated that the aerial spraying operations of 1949, 1950, and 1951, in which a total of 2,130,865 acres was sprayed, had a marked effect in reducing the areas of budworm infestation and in preventing wholesale killing of valuable forest resources. On most of the 1,650,600 acres of epidemic budworm infestations remaining, the situation is generally favorable. On most units the trees can withstand from 2 to 3 years of additional defoliation. Control planning now is somewhat of a gamble on how long the epidemic will run. The 1951 cooperative budworm accomplishments include: (1) completion of the aerial survey covering most of the 49 million acres of forested lands was done in 202.3 hours of flying time, (2) 399 mandays were expended by 123 individuals participating in the ground survey, (3) 3,474 sample plots were examined in lightly infested areas for the presence or absence of budworm.

Canadians are studying the effects of disease on budworm control and, in the East, of silvicultural methods. Latter study would be difficult in the West because of the much younger tree age classes infested.

(Chamberlin) Has changing to pure spruce in the East affected budworm populations?

(Beal) Pure black spruce stands in the East are resistant to budworm attack.

(Graham) Silviculturists may object to growing pure spruce because of increasing soil infertility under spruce forests as found by European foresters.

(Furniss) Control of budworm by forest management practices would be difficult in the West because of varying host type conditions.

(        ) When should control of budworm infestations be considered?

(Furniss) Spraying program was not approved for Oregon-Washington areas until excessive tree killing appeared imminent the next feeding season. This policy based upon lack of previous experience and of definite cyclic tendencies of budworm infestations in these areas. Land-managing agencies decided not to gamble, but to spray.

(Denton) Won't spraying have to be continued once it is begun?

(Furniss) Yes, to some extent. Re-infestation would be imminent in some cases. Land-managing agencies in western Oregon chose to continue spraying to protect benefits of previous work.

(Keen) Isn't trend of budworm in 1952 returning to status of outbreaks in 1947? (Yes, good liklihood.)

(Kinghorn) Do timber values influence the priority of spraying in Oregon? (Yes; example, western Oregon.)

(Denton) Budworm spraying priority is very high in fir stands managed for Christmas trees in Montana. Even one year of defoliation or partial defoliation would be disastrous and would keep trees off the market for 3 to 4 years if no further defoliation occurred.

(Richmond) Budworm control in Christmas tree stands would have many aspects of fruit orchard spraying: killing of parasites, increase in scale insects, etc.

(Furniss) Will Dr. Beal tell us of some of the results of the budworm control tests at the Beltsville, Maryland, forest insect laboratory?

(Beal) Tests are moved into the field each summer: New York, Quebec, Maine. Recent studies have been concerned with minimum dosages, degree of spray atomization, and timing of sprays. Data from 10-acre plots with 25-acre barriers. Spray particle sizes tested were (1) fine, 80 microns; (2) medium, 150 microns; and (3) coarse, 300 microns. Medium-sized particles proved best. DDT at 1 pound/acre gave better results than lighter dosages. Spray applications against older larval instars more effective. Eastern test results indicate less budworm mortality from spraying than that attained on the large-scale Western spray jobs.

## THIRD PROGRAM SESSION
(Tuesday, November 27, 9:00 a.m.)

Chairman Richmond introduced Dr. Avery S. Hoyt, Chief, U. S. Bureau of Entomology and Plant Quarantine, Washington, D. C., and Mr. Warren V. Benedict, Regional Director (of the Bureau), Western Region, Berkeley, California.

### Ecology of Bark Beetle Outbreaks
(Dr. Calvin L. Massey, Moderator)

(Hall) Studies in northern California started in 1939 by the Berkeley forest insect laboratory show relationships between the bark beetle hazard ratings of various ponderosa pine stands and certain climatic factors. Seasonal precipitation was significant, that between April and June especially so. Seasonal amounts totalled 19.4 inches in low hazard stands, 15.0 inches in very high hazard stands. Average April - June air temperatures were 56.6° F. on low hazard areas, 62.9° F. on very high hazard areas. Available soil moisture was significant, phloem moisture showed some significance. It was found that individual ponderosa pine trees may be more resistant to attacks of the western pine beetle in the spring and less so in the summer. In D. brevicomis brood production, the Risk IV trees (most susceptible to attack) of the ponderosa pine risk rating system contained 7-10 as much per square foot of bark surface as Risk I (least susceptible) trees.

Ips confusus cannot kill pole-sized ponderosa pine trees during its first summer generation. Maintains itself then in slash or tops of larger green trees. Habit may be associated with phloem moisture which, in late summer, averages 250 percent at the lower bole, 150 percent in the midbole, and 125 percent in the top. I. confusus apparently prefers less phloem moisture, hence its top-killing habit or late summer attacks on green trees. Ips outbreaks are associated with deficient spring precipitation. 3½ to 4 Ips generations per year in study area.

(Struble) Low air temperatures during Ips development lengthens the development period and increases brood mortality. Excess phloem moisture limits brood development.

(Callahan) Any relationship between amount of precipitation and percentage of phloem moisture?

(Struble) Yes. Trees on better sites have greater phloem moisture. Concerning the habits of I. confusus, adults emerge from slash in midsummer to attack ponderosa pine reproduction for feeding purposes. Attacks average 500/square foot of bark surface. Population in reproduction often completely wiped out by woodpeckers. Broods developing in slash do not mature because of fungi development in phloem robbing larvae of food.

(Chamberlin) Attacks on reproduction an attempt to raise brood? What tree diameters?

(Struble) No brood is attempted, attacks for adult feeding only. Trees average 4-6 inches in diameter.

(Richmond) What is the relationship between I. confusus and D. brevicomis?

(Struble) Top-killing Ips attacks often precede mid- and lower-bole D. brevicomis attacks, the topkilling apparently serving to attract the latter. Ips can kill ponderosa pine trees up to 24 inches d.b.h. Ips also often attacks trees following initial basal attacks by D. brevicomis.

(Hall) In Lake County, California, D. brevicomis attacks followed initial Ips topkilling attacks in 194 of 200 trees examined in 1948. Trees were Ips topkilled only in the spring and later in the summer were attacked by Ips and D. brevicomis.

(L. W. Orr) What effects does slash disposal have on Ips?

(Struble) In one study in central California unlopped slash attracted most I. confusus attacks. Handpiled slash prevented successful brood development.

(T. J. Orr) Slash composed of 2-3 tree tops/acre created no I. oregoni problem. This Ips controlled in slash by (1) hot logging, (2) keeping logs away from reserve trees, and (3) piling of slash along roads because of State law.

(Struble) Lopping tops keeps phloem moisture high in bole sections thus deterring I. confusus attacks or brood development.

(Whiteside) Oregon studies indicate that slash laid down certain times during the year prevents the buildup of I. oregoni. Could this effect be nullified by certain climatic behavior?

(Hall) Probably so. Ips population buildup largely affected by sporadic cutting from April through June.

(Struble) No I. confusus activity has been observed above 4,500 feet in elevation in California.

(Buckhorn) I. oregoni activity observed above 5,000 feet in elevation in Oregon.

(L. W. Orr) Kaibab Plateau in Arizona (elev. 7000-8000 feet) had Ips outbreaks in 1951.

(Hopping) A study of the relationship of climatic cycles and bark beetle activity was carried on between 1920 and 1935 in Alberta. There are no important bark beetle infestations now during the present wet climatic cycle.

(Beal) Are bark beetle outbreaks in Canada related to dry periods?

(Hopping) Yes. Largest bark beetle outbreak in British Columbia occurred during the period 1920-35 coincident with a drouth.

(Beal) Studies of the Black Hills beetle and Douglas-fir beetle in Colorado showed that 9 out of 13 outbreaks built up during periods of precipitation deficiency and subsided when precipitation returned to normal or above. Not conclusive, for no one factor such as precipitation alone governs fluctuations in beetle activity. In Texas, for instance, the current widespread epidemic of southern pine beetle came during a period of abnormally heavy precipitation -- almost tantamount to surface flooding. Cyclic tendencies of bark beetle outbreaks are apparent in many cases regardless of the presence or absence of supposedly regulatory factors. An example, Dendroctonus terrebrans, normally confining its attacks to stumps of southern pines, killed more green pine timber in the southeastern U. S. than all other bark beetles combined.

(Hopping) We can't stretch the knowledge of one insect species too far. It may prove to be another strain in some other locality and exhibit different habits.

(Massey) Extended drouth in New Mexico may be associated with many dead larvae of Dendroctonus convexifrons now being found.

(Callahan) Tree vigor is indicated, but we have no real knowledge of what attracts bark beetles to certain trees. Oleoresin content and pitch exudation pressure may be contributing factors. Ips cannot attack where pitch flow is abundant. Studies now at Berkeley of resin production and its effect on the position of bark beetle attacks in trees.

(Struble) Any evidence of the effects of climate on the Pseudohylesinus outbreak near Mt. Baker, Washington?

(Coulter) This outbreak not definitely associated with climate. Insects apparently acting in a secondary capacity with P. granulatus in base of tree, P. grandis and P. furniss in upper bole. Root rot, Armillaria mellea, present in most infested trees prior to beetle attack. Root rot & BB.

(Wright) Studies to determine the cause of excessive Douglas-fir mortality in coastal Oregon caused by the Douglas-fir beetle show correlation between rainfall (70 inches, normal annual) and tree growth. Normally dry summers lower the vigor of the trees. Late summer rainfall affects tree growth the following year.

(Richmond) Canadian aluminum interests determined northern British Columbia to have best available hydro-electric development site in world for planned large-scale aluminum reduction plant. To develop power, an immense area of spruce-balsam-lodgepole pine forests will be flooded to a maximum depth of 285 feet in 5 years. Entomologists are interested in the prospects of bark beetle infestations developing in the flooded timber, none of which will be cut. Plots are being installed to study beetle-caused tree mortality abundance annually as the water increases in depth. Trap trees will be used to study possible fluctuation of beetle population density at specific points in the affected area.

(Hall) All trees were cleared from the reservoir site behind Shasta Dam, California, prior to flooding. The only bark beetle-killed trees were those along the edge of the reservoir's high water level.

(Johnson) A number of large 1951-killed ponderosa pine trees were examined on the Kootenai National Forest, Montana and all were found to be flooded by beaver dams to depths of 2 to 3 feet. No bark beetle attacks were observed in the basal portion of the trees. flooding & No BB.

Flooding & no BB.

(Wygant) Flooding of Engelmann spruce in Colorado by beaver dams resulted in soured cambium and no bark beetle attacks.

(Struble) Flooding of ponderosa pine trees at Bass Lake, California, a reservoir, attracted some Dendroctonus brevicomis and D. valens attacks in the bases of the trees, but no brood developed.

(Callahan) In laboratory studies, bark beetles did not attack trees with excessive phloem moisture.

(Evenden) Ecology plays an important part in outbreaks of the mountain pine beetle in Idaho's western white pine forests. The forest type is a temporary one following fires, consequently it is even-aged. Stands begin with 12,000-14,000 stems/acre and end with 40-50 stems/acre at maturity. Most white pine stands are subjected to partial cuttings to prevent excessive Ribes plant germination and consequent blister rust infection, sunscald, windthrow, and pine beetle outbreaks. Between 80 and 180 years of age, the average annual stand increment equals the average annual stand mortality from the pine beetle. Many mature white pine forests have lost 75 percent of the original stand volume in the past 2 or 3 decades.

(Richmond) Do you consider the Douglas-fir beetle to be the No. 1 forest pest in the northern Rockies?

(Evenden) Yes. Recently increasing fir values have made it the problem it is today.

(Richmond) Any experience in managing interior Douglas-fir stands?

(Evenden) Douglas-fir management will be practiced on a large scale when interference from the fir beetle is assured.

(Kinghorn) Douglas-fir beetle knowledge also lacking in British Columbia. Some fir beetle outbreaks are associated with logging operations aimed at the utilization of peeler logs only.

Mountain pine beetle infestations in lodgepole pine in eastern British Columbia are being studied in relation to soil and tree crown conditions. In some areas pine beetle brood survives to a height of only 5 to 10 feet with attacks above but no brood. In others, there is successful brood development up to 50-60 feet on the boles. Most pine beetle outbreaks develop in place.

(Evenden) Douglas-fir is not a climax type in the interior regions. No scattered Douglas-fir beetle infestations in thrifty stands, but stand susceptibility doesn't mean much during epidemics.

(Thomson) The economy of the interior forests has changed since World War II, with less valued tree species now more widely used. Some marking systems still are responsible for considerable bark beetle losses. Blowdowns causing additional beetle losses to timber. A study is now under way to evaluate slash and windthrows as a source of Engelmann spruce beetle populations in spruce forests. Large diameter spruce appears to be more frequently attacked.

(Wygant) Surveys in Colorado show that (1) the Engelmann spruce beetle often selects the largest trees in the stands, (2) that the stands attacked are pre-dominantly even-aged and overmature, (3) that the average diameter of infested spruce trees declines 4 inches/year in prolonged outbreaks, (4) Black Hills Beetle outbreaks develop in dominant and co-dominant trees in 2nd growth ponderosa pine, and (5) current Engelmann spruce beetle outbreak is associated with abnormally good precipitation and tree ring growth.

FOURTH PROGRAM SESSION
(Tuesday, November 27, 1:30 p.m.)

No formal program was scheduled for this session so that Conference delegates could attend the Pest Control Committee meeting of the Western Forestry and Conservation Association. Approximately 35 Conference delegates chose to continue the Conference with an informal program with Dr. Kenneth Graham as moderator.

(Struble) Mountain pine beetle epidemics occurred in 1951 on approximately 15,000 acres of 2nd growth sugar pine. Stands average 300+ stems/acre with trees ranging from 6 to 24 inches in diameter. Dense stocking may be contributing to outbreak.

(Chamberlin) What do you think of Hopkins host selection principle in this case?

(Struble) D. monticolae prefers sugar pine; broods were bred in sugar pine, emerged, and attacked sugar pine despite intermingling ponderosa pine trees.

(Callahan) Possible to get emerging bark beetles to attack trap logs of different host species but not different living host tree species except when caged.

(Chamberlin) Early tests by Keen showed sugar pine reared D. breviconis dying after being placed on caged ponderosa pine.

(Hopping) Dendroctonus monticolae attacks spruce occasionally.

(Massey) Engelmann spruce beetle bred in Engelmann spruce attacks lodgepole pine readily when this host occurs in mixture with spruce. No brood is produced in the attacked lodgepole pine trees except in infrequent cases where the infested trees have been injured by porcupines. Engelmann spruce beetles attacking lodgepole pine do not hibernate in the duff as they do when attacking E. spruce trees.

(Terrell) Earliest attacks in some E. spruce beetle infested areas in Colorado were in lodgepole pine first, taking 6 percent of the pine stand, while few attacks occurred in E. spruce.

(Graham) An infestation near Princeton, B. C. in 1933 began from D. breviconis attacks and ended with D. monticolae attacks; young and old trees attacked indiscriminately by both insects.

(Terrell) No selective traits by the Engelmann spruce beetle as to vigor or class of tree attacked except large diameter trees attacked first.

(Massey) Engelmann spruce cannot be cut selectively even if for beetle control because of danger of windthrowing of reserve trees.

(Chamberlin) Any evidence of prior E. spruce beetle outbreaks in Colorado?

(Massey) Yes. Sudworth in 1909 and Edmonston in 1912 pointed out previous outbreaks; apparently occurring in 50-75 year cycles.

Flooding & BB

(Chamberlin) First attempt to control bark beetles in western U.S. was in the Blue Mountains, Oregon, in 1913-14. Control then was against *D. brevicomis* and *D. monticolae* in ponderosa pine. Many beaver dam-flooded trees were not attacked in the control area.

Needle cast & BB

(Callahan) Bark beetle attacks now occurring in ponderosa pine trees infected by the needle blight *Hypodermella deformans*. Similarly infected trees at Lake Tahoe were not attacked.

(Washburn) Needle blight infected ponderosa pine trees in the Boise National Forest, Idaho were readily attacked in 1950 and 1951 by *D. brevicomis* and *D. monticolae*; either by one or both species. The needle blight, or cast, produces tree crown characteristics akin to those of high risk trees of the ponderosa pine risk rating system.

(Johnson) Similarly blighted trees in eastern Oregon have not been attacked by bark beetles, probably due to high moisture content of phloem.

Root Rot & BB

(Chamberlin) 80 percent of Douglas-fir trees in the Coos Bay area of Oregon suffer root rot infection and Douglas-fir populations are increasing in the general area.

Windfall & BB

(Wright) Heavy Douglas-fir beetle populations emerging from 1949-windfelled trees are now attacking green trees. Beetle-killed green fir timber averaged 1,000 b.m./acre in 1951 in the Coos Bay area, while beetle-killed and windthrown timber together averaged 3,000 b.m./acre. Is buildup of Douglas-fir beetle infestations in the northern Rockies associated with windthrow?

Defoliation & BB

(Terrell) Yes, also considerable from logging slash. On large outbreak in Cody Canyon, Yellowstone National Park, in 1931 developed in spruce budworm defoliated trees. Total of 12,000 trees 6-8 inches d.b.h. treated.

(Lauterbach) One solution to the problem at Coos Bay would be the substitution of Douglas-fir for root rot resistant tree species, such as hemlock, redwood, Port Orford cedar. Salvage of present fir mortality calls for the development of an adequate forest road system.

(Callahan) DeLeon pointed out an interesting root fungus-bark beetle relationship in southern California in 1940. Apparently affected by periodic wet and dry climatic cycles. Wet cycles increased Coulter and Jeffrey pine tree mortality from *Fomes annosus* root infections; dry cycles increased mortality from *Melanophila* and *Dendroctonus valens* attacks.

(Massey) General infesting of Engelmann spruce windfalls by the E. spruce beetle is the generally accepted cause of the present widespread beetle outbreaks in Colorado. However, since 1949 many spruce windfall areas in Colorado have not produced abnormally heavy E. spruce beetle populations. This indicates other factors must need be combined with presence of windfalls to produce abnormally heavy beetle populations.

(Chamberlin) Any studies to indicate vigor strains of E. spruce beetle? (Yes.)

(Hopping) What beetle populations must be present to produce heavy infestations in windfall areas?

(Terrell) A 2-day examination in 1951 of a 600-acre 1949 Engelmann spruce blowdown in Montana showed only 2 E. spruce beetle egg galleries.

(Denton) Examinations of many 100 percent 1949 blowdown areas in Montana in 1951 indicated bark beetles were attracted to fringe of the blowdowns and not to their centers. Might indicate that normal endemic beetle populations are insufficient to fully infest all material in a blowdown.

(Gibson) Use of bark penetrating insecticides to kill bark beetle broods has rapidly increased since the first inconclusive tests in California in 1932. Subsequent tests in Idaho developed effective oil solutions containing toxic agents. Most successful and widely used is ODB (orthodichlorobenzene)-oil solution (1 part ODB, 5 parts Diesel or light fuel oil). Brood mortality occurs through fumigant action of ODB. It is sprayed on the outer bark surface of standing or felled infested trees or on logs until the solution begins to run. Hand or machine sprayers or ordinary garden sprinkling cans can be used, the latter on downed material. More recently ethylene dibromide solutions and emulsions have been developed and used as bark penetrating insecticides for bark beetle control. The emulsions have not proved quite as effective as the EDB oil solutions.

(Hopping) Does temperature affect penetration?

(Gibson) No. ODB placed during the winter does not kill beetle broods immediately, but brood mortality eventually occurs with the advent of warm weather the following spring.

(Massey) Adding surface active agent (wetting agent) to an emulsion or solution will increase its penetration into the bark.

(Struble) Any bad effects of EDB on man?

(Massey) Colorado studies in 1951 to determine this not yet completed. U.S. Public Health Service has asked all users of chlorinated benzenes (ODB) to cease using it because of its toxicity to man. Use of ODB by the U.S. forest insect laboratories has given no ill effects to persons after 10-12 years use on bark beetle control jobs.

(Washburn) Human toxic re-action occurred in connection with the use of EDB in controlling a western pine beetle outbreak in ponderosa pine on the Payette National Forest, Idaho, in 1951. Symptoms: Legs swollen from contact with EDB-saturated clothing, one case; two other slight skin burns reported from same cause.

(Massey) Most fumigants are irritating to skin through contact, not by fumigating action. Some persons more susceptible to toxic reaction than others.

(Chamberlin) Any cost advantage in using EDB over ODB?

(Massey) EDB, 35 cents/ pound; ODB, 9 cents/pound. Takes 8 pounds ODB or $1\frac{1}{2}$-3 pounds EDB for comparable control results. Wetting agents used with EDB are costly, however.

(Gibson) Preliminary tests with EDB solutions and emulsions indicate successful penetration in Douglas-fir bark up to 3 inches; solutions slightly better.

(Struble) Any EDB used on ponderosa pine bark?

(Massey) Yes, solutions and emulsions against Black Hills beetle. Also by Ogden laboratory against western pine beetle.

(Denton) Will ODB sprays kill green cambium?

(Massey) Yes, in case of Engelmann spruce beetle in E. spruce in Colorado. Not known whether the oil carrier or the ODB itself did the cambium killing.

(Barr) EDB emulsions kill cambium? (Not known.)

(Massey) Tests in Colorado with fluorescent compounds in spray material and "black light" illumination show insecticide penetration concentrated under bark fissures and bark beetle entrance holes.

(Chamberlin) Any Ips in EDB-treated ponderosa pine in Idaho?

(Washburn) Yes, many attacked after spray treatment. Some mortality, but not definitely attributed to EDB.

(Kinghorn) Laboratory tests with Ips in lodgepole pine showed good control of adults but not so with larvae when using EDB (1 pound to 5 gallons of mix), ODB, DDT, Chlordane emulsions.

(Terrell) Were examinations made too soon after treatment? Lethal action of ODB often very slow. (Probably so).

(Massey) Sounds like dosages were too light.

(Struble) How soon can control effect be determined?

(Massey) With emulsions in laboratory, after 2 weeks. Depends upon weather in the field; sooner if warm, later if cold. EDB emulsions, to be effective, must act against the beetle broods within 2 hours.

after application. Consequently, very cold weather during application limits penetration and fumigant action and may nullify control results. May have to limit use of EDB emulsions to summer months.

(Terrell) Type of water affect the potency of emulsions?

(Massey) Hard or soft water, no difference. Wetting agents always help.

(Kinghorn) Any trouble mixing emulsions in the field? (No.)

(Hopping) Will EDB or ODB affect borers? (Don't know.)

(Massey) Use of EDB solution, at a saving over ODB solution of 5 cents/gallon, would have saved the Colorado Engelmann spruce beetle control project $50,000 if the EDB solutions had been developed in time to have been used.

(Terrell) What are the mixed weight comparisons between emulsions and oil solutions?

(Massey) EDB emulsion equals the weight of corresponding amount of water, but is heavier than oil solution. Oil solutions easier to spray on standing trees than emulsions.

(Question) Can trees with wet bark be sprayed to secure effective control?

(Massey) Yes, with ODB oil solution, not with emulsions.

(Callahan) Can green tree trunks be sprayed to prevent bark beetle attack?

(Massey) Yes, with 2 percent DDT emulsion.

(Chamberlin) Same emulsion is also used in East to prevent elm bark beetle attacks. Residual effect lasts for 2 years.

## FIFTH PROGRAM SESSION
(Wednesday, November 28, 9:00 a.m.)

### Forest Insect Surveys
(Jack W. Bongberg, Moderator)

Bongberg opened the session with a brief outline of the importance of surveys in western forest entomology. Richmond called upon to discuss Canadian insect surveys.

(Richmond) (Aims of surveys in Canada and the present status). Canadian surveys are principally a large-scale ecological study aiming to obtain an overall survey of all insects in the forest to build up information on abundance, life history, and natural factors. In 1952, an insect disease survey was incorporated into the insect survey proper. Disease technicians from the new Sault Ste. Marie disease laboratory handle laboratory and field phases of the work. Forest insect rangers, year-round employees, operate in geographical districts under the supervision of technical foresters. Ranger collections are made by forest types and other subdivisions.

(Beal) How is forest tree disease information worked into the insect survey?

(Richmond) Rangers work under the direction of pathologists. Additional characteristics of the insect survey: (1) Forester in charge of surveys cooperates on research programs, but his main job is the survey, (2) surveys not especially concentrated in large epidemic areas, (3) any additional surveys needed in epidemic areas are handled by special research crews.

(Buckhorn) Is sampling carried to all geographic locations?

(Richmond) Survey attempts to sample all forest types in each district.

(Hall) How are bark beetle infestations sampled?

(Mathers) Rangers record location of outbreaks. Insects are collected and identified in field. The number of red-tops and green trees.

(Richmond) British Columbia is very difficult to survey. Coastal forests are dense, extensive, and with very few roads. A shoreline of 1,000 miles is covered by boat in 2 years.

(Wear) What percentage of timber type is covered?

(Richmond) About 50 percent.

(Struble) Any aerial surveys conducted in B. C.?

(Richmond) Yes, in connection with spruce budworm infestations.

(Bongberg) What appropriations are made by the Dominion for forest insects? (About $1,000,000).

(Richmond) About 50 percent of British Columbia allotment is for surveys.

(L. W. Orr) Is it possible to use indicator insect species to forewarn increases in abundance of major insect species?

(Richmond) Yes. Recent hemlock looper outbreaks on Vancouver Island were preceded by increases in black-headed budworm populations. Past records indicate the latter species appears immediately before looper outbreaks. Surveys this year indicate a tremendous looper infestation may be brewing despite a lack of loopers in present samples. More defoliator infestation cycles are needed to definitely prove this association.

(L. W. Orr) Do rangers send all collected insect material in to laboratories for identification?

(Richmond) Yes. A total of 6,500 collections were received at the Victoria and Vernon laboratories in 1951. Rangers can identify about 2/3 of the collections correctly.

(Question) What is the purpose of rearing out the insect material collected in the surveys?

(Richmond) To identify species, determine the life histories, and study the parasite-disease complex.

(Beal) (U.S. aims and status) Forest Pest Control Act provides surveys other than insects: white pine pole blight in Idaho, oak wilt in Arkansas, newly introduced larch canker in the northeastern U.S., mistletoe surveys in southwestern U.S. The forest insect surveys in the U.S. are not comparable to those of the Canadians, more a measure of specific outbreaks. Bureau of Entomology and Plant Quarantine personnel is inadequate to cover all forested areas, hence the aim of the U.S. surveys is to educate and obtain the assistance of many survey cooperators. Funds now available for new survey headquarters to fill in some of the gaps in the present coverage (Texas, New Mexico, Alaska). A plan of forest insect survey activities was outlined by a study committee at the special forest insect survey school operated at Fort Collins, Colorado, early in 1951 by Division of Forest Insect Investigations of the Bureau of Entomology and Plant Quarantine. The plan, with some slight modifications is being considered as a guide for the Division's 11 forest insect field laboratories throughout the U.S. Briefly, it stresses the responsibilities of the laboratories in carrying out provisions of the Forest Pest Control Act relating to insect outbreaks. Three major types of forest insect surveys are defined and recommended for use by all laboratories: (1) detection, (2) reconnaissance, and (3) appraisal surveys.

(Chamberlin) The monthly insect pest survey report of the Bureau, prepared by the Insect Survey and Information office in Washington, D. C. should include more forest insect information. Could be very useful to schools. Oregon State College is now getting monthly information for this survey report.

(Beal) Items submitted by forest insect laboratories admittedly is sporadic, depending largely upon the enthusiasm of the workers at the laboratories.

(Lauterbach) Could a disease survey be incorporated with forest insect surveys?

(Beal) Yes, but pathologists for this work are probably not available now.

(Terrell) Many extra duties have been added to the work of the forest insect survey crews at times thus making it difficult to gain adequate coverage of large areas in the survey program.

(Buckhorn) On recent forest insect aerial surveys efforts have been made to map fungus diseased areas such as white pine blister rust, larch blight, fir needle cast, and pine needle cast. The causal agent in each case has been determined from subsequent ground checks.

(Furniss) Many areas of fungus infection are relatively easy to detect. There are many opportunities to incorporate pathologists on our insect surveys, but too many non-entomological objectives seriously interfere with the insect survey objectives.

(Richmond) If large outbreaks develop, entomologists may often be embarrassed by a lack of information during its buildup. North end of Vancouver Island is being covered by the lumbering industry using approved survey methods to make certain no outbreaks get out of hand before being detected. All information is submitted to the Victoria laboratory. In B. C. it is almost impossible to be sure insect outbreaks are not present.

(Evenden) The problem of detecting outbreaks in their early stages presents a problem. Shall the entomologist recommend control of a few trees or acres at a high per unit cost or wait until more trees or acres can be treated at a lesser per unit cost?

(Furniss) Possible solution to this might be (1) to apply control when the outbreak is on the verge of causing economic damage or (2) while the outbreak is still in the small tree group stage (for bark beetles) or small area stage (defoliators). The timing of many of our control recommendations actually is based upon economic considerations though we recognize the primary entomological basis for them.

(Evenden) (Integration of Canadian - U.S. surveys). Integration of the Canadian and U.S. surveys has not been highly developed because of the primary difference in objectives. The Canadians conduct true insect surveys, the Americans insect damage surveys. The Canadians a year-to-year survey by areas regardless of outbreaks. The Americans are apt to modify their annual surveys to follow current outbreaks. The Canadians have their bi-monthly printed reports which, incidentally, are most helpful to the Americans. No such reporting procedure in the States. The need is great for more interchange of knowledge and information between the two countries. The first step might be an American publication similar to the Canadian bi-monthly insect report.

(Beal) The Division is making a start in this direction with a mimeographed economic survey report of nationwide forest insect conditions. This appears once a year for the present.

(Chamberlin) Why not resurrect the old insect newsletter which the Division used to publish? The colleges and universities are definitely in need of the information it contained. The forest industry would also welcome the information.

(Beal) There is indeed a lack of information being made available to the colleges concerning the work of the Division. The holding up of information for publication may be one of the reasons.

(Chamberlin) Oregon State College has received much good information from the Bureau's forest insect laboratories, information which has helped in the teaching of forest entomology. This Conference could facilitate the interchange of slides, motion pictures, work specimens, etc., between the insect laboratories and the schools as an aid in teaching. In this respect, the Conference could well afford to devote one session of the 1952 meeting to the teaching of forest entomology in the colleges and universities.

## Forest Insect Survey Research

(Whiteside) A large series of 640- and 320-acre sample plots have been the basis of bark beetle surveys in Oregon and Washington, some going back to 1920 in Oregon. Plots cruised annually for a measure of insect-caused tree mortality, but information on the types of trees killed led to the development of the Keen susceptibility classification. 10-acre plots now used in cutover lands to measure tree mortality following various cutting methods. Data from these plots has sometimes suggested changes in management plans and timber marking rules. Other uses for the 320-acre plots: insect area hazard zonation, studies of the relationship of bug loss to stand composition, density, and growth, and volume tables for insect-killed trees.

(Furniss) Defoliator surveys are usually made to show when and where to begin control and when to terminate it. There are reduced opportunities for research data in the present makeup of defoliator surveys, but they do help detect new problems (larch budworm), aid in evaluating old problems to justify new research, and record the rise and fall of infestations for correlation with natural factors.

(Jaenicke) Referring again to the 320-acre plots used for years in the Oregon bark beetle surveys, it is fortunate that from the beginning the Forest Service administration, principally E. E. Carter who headed Timber Management for many years, approved the inclusion of certain measurements of research value from the Bureau's survey plots. As a result, these measurements became the foundation of many cutting practices in Forest Service Region 6 (Oregon-Washington). Until recently, Forest Service timber sales aimed at 80 percent cut in ponderosa pine. The present lighter cutting policy stems from some of the information obtained from the plots. Much good knowledge of forest insect problems has been gained by Department of Interior (Bureau of Land Management, Indian Service) and State and private foresters taking part in the plot surveys.

(Whiteside) Without the help of the Forest Service, principally through Mr. Jaenicke, the plot survey system could not have been maintained in recent years. Men who in the past were part of the plot survey crews are now among the best insect survey cooperators in the region.

(Thomson) (Discussing the research value of the Canadian forest insect surveys). Previous to 1949 survey information from outside cooperators was of little research value. Since then survey methods have been developed to yield pertinent data for easy use in interpreting the status of infestations for control needs. The data also yield information of research value: (1) distribution of insect species, (2) host trees, (3) parasite relationships, and (4) biotic factors including such things as forest type, stand formation, age, composition, exposure, slope, elevation, aspect, and history.

Another survey research problem is the method of quantatively sampling spruce budworm, loopers, and other defoliators. Defoliator insect hazard has been indicated since 1937 and high hazard areas are set up in cutting priorities. Difficult, however, to pinpoint every outbreak and to note insect concentration and frequency of occurrence.

(Beal) Are logging operations flexible enough to move into an outbreak quick enough to effect control?

(Richmond) Depends upon the location and nature of nearby operations.

(Johnson) Any indices except past outbreak history used for defoliator hazard? (No.)

(Barr) Are the insect specimens obtained from the survey kept?

(Thomson) Yes. They are reared for identification, for evidence of disease or parasites, and placed in Dominion or laboratory collections.

(Massey) No provisions for sampling bark beetle parasites under this method? (No, being developed now.)

(Terrell) Western white pine vigor classification, soon to be published, has much of its basis from information obtained during bark beetle surveys in Idaho.

(Hall) Ponderosa pine risk rating system developed from surveys?

(Bongberg) Yes, developed as refinements of Person's, Keen's Dunning's, and Pearson's work on tree vigor and insect host selection.

(Wygant) (What research is needed in surveys). Primary objective of insect surveys is not always on a number of infested trees per unit basis. There is often a need for qualitative data to predict trend changes, populations, etc. Research needed now in better ways of sampling populations. May need 2 surveys, a fall and spring survey to indicate last minute changes before control. Much information of this sort does not fall within the scope of present Forest Pest Control Act surveys.

(Beal) Surveys were a distinct Bureau function until the adoption of the pest act. Some criticism has come from the outside that pest act survey funds were being used for research. Education is needed to show the positive tie between research and surveys.

(Johnson) Little research value is obtained from sporadic surveys. Greatest research contributions have come from survey systems employing more or less permanent samples.

(Bongberg) The 1952 forest insect survey in California abandoned permanent samples. The data coming from survey cooperators was sufficient to point out active infestations, but no data of research benefit were secured.

SIXTH PROGRAM SESSION
(Wednesday, November 28, 1:30 p.m.)

Forest Insect Surveys (con.)

(Hall) (Ground plot sampling for bark beetle control). Ground sampling methods depend upon the infestation habits of the bark beetles being surveyed. The intensity of sampling (size or number of plots) increases as the size of the sampling universe decreases. Estimates of the average amount of beetle-caused tree mortality are good for national forests in their entirety, but not so good for small units within the forests. Estimates are therefore expressed along with a standard error (estimate plus or minus so much). Western pine beetle surveys in California at one time used 320-acre sample plots. In 1938 some were subdivided into smaller units for statistical analysis. In general, estimates of the number of trees or volume per acre killed by beetles increased in accuracy as the size of the plots diminished until a plot size of 5 acres was reached. As a practical example, the sampling of a 200,000-acre tract to obtain estimates of beetle-caused tree mortality could be done with 70 five-acre plots at an accuracy of ± 15 percent at the 95 percent level. Against this would have to be considered such things as travel time between plots, cruising time on the plots. The larger 320-acre plots often contain non-uniformities in stand structures and hence are not truly representative when not stratified for sampling. Smaller plots usually are more uniform in stand make-up. Long, narrow plots are more reliable samples than square-shaped plots.

(Terrell) The 1951 surveys in the northern Rocky Mountains utilized statistical procedures decided upon at the Division forest insect survey school at Fort Collins in January. Using long chain-wide strips for sampling units, satisfactory results were obtained where epidemic bark beetle conditions prevailed. Estimates of the number of trees currently attacked were within 25 percent plus or minus using 5 percent strip coverage on areas larger than 2,000 acres. Where the infestation was light the plus or minus variation often reached 100 percent.

(Wygant) Engelmann spruce beetle surveys in Colorado employ 1/10-acre plots every 2 chains on a true grid strip system of sampling to get the estimated number of currently infested trees in any area. Fred Knight's work (Entomologist, Fort Collins laboratory-P.C.J.) indicated variations in intensity of sampling for different infestation and stand conditions. In 1951 a test Black Hills beetle survey was run in which every infested tree was mapped in place on a number of areas varying in size from 100 to 400 acres. Various kinds and intensities of sampling were tried to determine the most effective method. Sampling light infestations is a problem, but not too important.

(Washburn) Statistical procedures recommended at the Fort Collins school were used in 1951 for Black Hills beetle surveys in ponderosa pine in Utah. On one 50,000 acres, every infested tree was located on aerial photographs for sampling tests. Fifth-acre line plots were used to estimate the number of ponderosa pine trees currently infested by the western pine beetle on the Boise National Forest in 1951. The number estimated by this means checked out very well in terms of trees treated in subsequent beetle control operations.

(Mathers) (Ground plot sampling for defoliators). More permanent sampling plots probably are needed to determine the statistical accuracy of defoliator insect surveys. Canadian insect rangers cover too large an area to enable them to get to the same plots at the same corresponding time each year. Many zero (no insects) samples of defoliator insect populations are obtained when using tree branches as samples. Technique of sampling now used consists of beating 3 trees on to collecting mats at each sample location. Improved beating techniques have been developed for this job. Sampling is on a forest type basis, not so much on an area basis.

(Wright) Sampling spruce budworm populations in Oregon is done by means of series of 10 marked sampling stations on compass lines. Four 15-inch twigs are taken at each station for budworm population counts before aerial spraying. Process is repeated after spraying and the population decrease expressed as a percentage. Sampling described is for determination of control effect. Sampling for research needs is essentially the same but more intensified. On control jobs the aim of sampling is for quantitative data; on research projects it is for qualitative data.

(Thomson) Are the research benefits from bark beetle survey plots similarly realized from budworm plots?

(Wright) Permanent budworm sampling stations are to be used mostly for parasite studies. They will be maintained after the present epidemic conditions cease.

(Denton) One of the difficulties in sampling budworm feeding-stage larval populations in the northern Rockies is the difference in insect development encountered in relatively small differences in elevation. Has this been experienced in Oregon?

(Wright) Yes, it is a big problem. Studies by the Oregon State Board of Forestry show that a wide range in the time of sampling is necessary to overcome this. Best to wait until the maximum feeding population is fully developed before sampling.

(Denton) Budworm sampling in the spring of 1951 in Montana called for stratification to meet varying progress of larval development even within comparatively small drainages.

(Whiteside) On the Oregon control job, sampling at given stations was made daily. This might overcome the (above) objections.

(Kinghorn) Would phenological observations have helped the Montana sampling?

(Denton) There was insufficient time to make them.

(Beal) The Maine budworm sampling poses no problem from an elevational standpoint - country flat. Good systematic aerial surveys have been made to record degree of foliage damage, followed by subsequent ground examinations. The ground points are used for larval counts, later for egg mass counts. Egg mass counts have proven a reliable indication of budworm activity the following season. Survey methods work well because of good cooperation. Beginning in 1944 many plots, 1x2 chains, have been used in the New England states to find out what kinds of trees are damaged or killed by the budworm. However, low budworm populations since then have limited progress of the study.

(L. W. Orr) When low populations prevail estimates needed for accurate trend determinations can only be made at great cost.

(Buckhorn) (Aerial sampling techniques). Aerial surveys have been widely used in Oregon and Washington since the appearance of large defoliator insect outbreaks. Some of the early aerial surveys include those for the hemlock looper in western Oregon (Keen and Beal, 1931) (Furniss, 1945) and in Alaska (Furniss, 1946), the Douglas-fir tussock moth in northeastern Oregon, 8,000,000 acres, in 1947. On the latter survey the tussock moth was found on only 70,000 acres and spruce budworm on 700,000 acres. The budworm outbreak in Oregon and Washington has been surveyed from the air each year since then.

In 1949, the Oregon aerial survey program aimed to map all insect outbreaks. In 1951 the aerial survey utilized 220 hours of flying time in Oregon and Washington. Several observer and aircraft combinations have been studied. The best - helicopters. A Cessna 170 plane is operated by the Portland laboratory for aerial survey work. Two observers are best, one for each side of the flight line. Flight lines 6 miles apart on grid and contour systems, are used.

Preparations to fly include assembling of forest type and cultural maps, preferably to a scale of 1/4 inch to the mile. Maps sufficient for a full day's flying should be used. U. S. Forest Service maps excellent for detail, especially those based upon aerial surveys. Maps used on sheet of Masonite 15x17 inches. Predetermined flight lines may be marked on map, but these not essential. Reference points, especially forest fire lookout stations, should be located on map for flight reference. Map orientation is maintained by tracking plane's progress on map at all times, a "must" over unfamiliar areas. Top of map is kept northward while tracking. Tracking also valuable for subsequent plotting of flight location, and to indicate where unflown areas exist. In mapping large infestations from air use as many topographic and cultural features as possible; either those on the ground or on observer's map. Dot or circle small infestations.

Time morning and afternoon flights so that canyon bottoms are sunlighted. Teamwork between pilot and observers is absolutely essential for good aerial insect surveys.

Flight fatigue is slight on short flights. Long flying day regarded as 5-6 hours. Fatigue increased by atmospheric haze and smoke or rough air; all increase difficulty of mapping and note keeping. Eye strain considerable on long flights, makes note transcription in evening difficult. Poor weather conditions in one area may be entirely localized, making moving of survey to different areas necessary day by day.

Timing of aerial surveys dependent upon most visible stages of infestations to be examined and upon optimum flying and air visibility conditions. Observer must be able to identify infested tree species and, if possible, the insect responsible for the infestation. Symptoms of non-insect tree damage should also be noted (fungus, porcupines, winter drying, cone crops, flooding, burns, snowbreak, genetic off-color of tree foliage, bears).

Tussock moth infestations are the easiest to detect because of the early tree top damage. Spruce budworm infesting young under-storied trees may often go undetected from the air until the infestation reaches epidemic proportions. Hemlock looper damage is first visible in lower tree crowns and so is not visible from the air until infestation becomes epidemic. The limits of bark beetle infestations are often indistinct from the air because of general widespread distribution of infested trees even during endemic infestations. Average flying altitude: for defoliators, 500-800 feet above tree tops; for bark beetles, 1,500 feet. Air speed, about 100-110 m.p.h. (cruising speed of Cessna 170). Ground check follows aerial surveys where the areas are accessible.

(Denton) Is there any tendency to overemphasize the size of small infestations when observed from the air? (No.)

(Richmond) Is this an annual survey? (Yes.)

(Beal) Its features are desirable enough to warrant permanency.

(Furniss) The above procedures are highly specialized. The need is great for considerable training of new personnel for this work.

(Buckhorn) Sketch mapping of infestation adequately outlines its limits but provides little quantitative or qualitative data. Quantitative information obtained from the air must be under control. Special equipment, such as a strip viewer, must be used for quantitative data obtained from the air. The viewer is mounted on the floor of the plane and, by means of a rectangular opening, allows a vertical view of a determined area of ground, which, due to the forward motion of the plane, is converted into a strip. The evident strip width is governed by the altitude of the plane and a shutter adjustment on the viewer. The viewer is equipped with color filters to enhance the discernibility of "red-top" trees.

The aerial strip viewer was used in California during the spring of 1950 to determine whether bark beetle-killed trees viewed on the strip could be "dated". The year of killing was successfully ascertained for 39 percent of the 1948-killed trees and for 85 percent of the 1949-killed trees.

(Wear) (Aerial photographic sampling). Aerial photos have a definite limitation, chiefly in their scale, when used for forest insect survey work. Their use for the detection of defoliator outbreaks is not feasible because of the large-scale over-all area coverage needed (photo scale 1:2,500). Other reasons are:

1.) It is physically impossible to have region-wide aerial photography completed each year when the damage is most apparent, because

a.) To detect light defoliation photography should not extend more than a month (possibly 6 weeks with no rains or strong winds) after maximum defoliation.

b.) When comparing the low altitudes of 500 to 1,000 feet above the tree tops to see light epidemic damage obviously extremely large scale photos (1:1,000 to 1:2,500) are necessary.

c.) Difficulties involved with such large scale are

aa.) Couldn't cover a large area in number of days available for good photography

bb.) Each time the scale of the photos is doubled, the number of photos of a given area quadruples; also it is difficult to prepare maps with so many photographic prints.

cc.) Actual photography

1.) Turbulence at low altitude - tip and tilt.

2.) Side lap - hard to get proper check points.

3.) Over lap - camera recycling may not be complete.

4.) Exposure - slow plane needed to offset image movement, thus requiring more flying time.

2.) Annual large scale aerial photography would require a large outlay of money and labor of many competent forest entomological interpreters to complete the initial detection survey in time to follow up with reconnaissance or appraisal surveys (mostly on the ground) before the evidence of light defoliation had disappeared.

3.) Costs, based upon 1,000 square miles of continuous timber area, gently rolling to moderately steep:

| Scale | Cost/sq. mile | Cost/acre |
|---|---|---|
| 1:20,000 | $ 5.00 | .8 cents |
| 1:18,000 (level terrain) | 4.25 | .7 " |
| 1:12,000 | 9.00 | 1.4 " |
| 1:6,000 | 20.00 | 3.1 " |
| 1:6,000 | 12.00 | 1.9 " |
| 1:2,500 | 45.00 | 7.0 " |

Additional cost of preparing maps, interpreting photos, minimum of ground checking would be 4 cents/acre for scale 1:2,500. This would bring total cost to 11 cents/acre or $70.40/square mile, or $70,400 for 1,000 square miles.

The average cost of the annual 49 million acre sketch-mapping aerial survey in Oregon (described by Buckhorn), including salaries, airplane cost @ $13.00/hour, ground checking cost @ 10 cents/mile, per diem travel @ $6.00/day, is about $12,300 (.25 cent/acre or 16 cents/square mile, or $160/1,000 squre miles).

Aerial photos are not satisfactory to depict the current bark beetle-killed trees because of the normal lag in foliage discoloration following their attack. Trees killed in any given year are easily discernible in aerial photos as early as the spring following their attack, in a few tree species as early the same fall. Film and filter combinations used to depict current bark beetle losses in ponderosa pine show that (1) infra-red film, with any filter, is least desirable, (2) panchromatic film with yellow, orange, and light red filters are very good, and (3) color film is as good if not better than the best panchromatic film-filter combination.

Advantages of aerial photographs in forest insect survey work are: (1) permanent visual record of tree mortality, (2) high accuracy tree mortality data, and (3) savings in time, manpower, and cost over ground methods.

(Bongberg) Cannot aerial photos be used for drain surveys (BF&PQ term for forest insect surveys primarily used to record periodic timber drain (loss in inventory) from insect activity, P.C.J.) on permanent ground sample plots to record the year-to-year loss?

(Wear) Probably feasible for bark beetle infestations on a strip or block plot basis if present study of filter-film combinations proves successful. The advantage of the photos in this case would be their use as a permanent record.

(Wygant) Are costs available for black-and-white and for color aerial photos?

(Wear) For black-and-white, yes. No large scale use of color photos yet upon which to base comparable costs.

(Bongberg) The same detail accuracy can be obtained in many cases with black-and-white film as with color film. Color film must be examined on a light table, a disadvantage. Probable cost differential between black and white film and color film is not important when considering an over-all aerial photographic project. One advantage of color film may be its ability to detect losses in the chlorophyll of infested tree foliage too slight for the human eye to detect.

(Wear) The large scale aerial photos deemed best for forest entomologists are difficult to obtain because of the closeness of the ground and the speed of the plane, air turbulence, and tilting of the plane and camera.

(Bongberg) In one instance small scale (1:15,000) photos made by a lumber company in northern California showed the presence of Douglas-fir beetle-killed trees plainly enough and in such quantity that logging operations were shifted to salvage the loss.

(Beal) Have you here in the West considered the use of the operation recorder now used quite successfully in the eastern U.S.?

(Buckhorn) It has been found difficult to adequately delineate many infestation boundaries and, hence, to record them on the recorder. Also, the operation recorder doesn't lend itself too readily to the many host and insect species encountered on many single flights in the West.

## FINAL BUSINESS SESSION
(Wednesday, November 28, 4 p.m.)

(Chairman Richmond) We will hear the report of the nominating committee (Jaenicke, Hopping).

(Jaenicke) The nomination committee nominates the incumbent Chairman and Secretary-Treasurer for an additional term in office during 1952. The Committee further nominates Mr. Mathers as a Councilor replacing Mr. Hopping whose 3-year term has expired.

(Richmond) Are there any nominations from the floor?

(Hall) I move that the nominations be closed and that the Secretary be instructed to cast an unanimous ballot for those nominated. (Seconded by Chamberlin).

Motion carried.

(Richmond) Mr. Bongberg, will you report for the 1952 program committee?

(Bongberg) The committee (Wright, Kinghorn, Thomson, L. W. Orr, and Bongberg, Chairman) met this noon and the following suggestions are offered for the program of the 1952 Conference: (1) one day be set aside for division of Conference delegates by subject groups, (2) one session be devoted to problems associated with the teaching of forest entomology in colleges and universities, (3) that the theme of the '52 Conference be "the development of adequate forest insect control plans, (4) that the '52 Conference be held in Victoria, British Columbia, in conjunction with the annual meeting of the Western Forestry and Conservation Association, and (5) that, if a 3-day Conference is held, it be held one day either on a Saturday or Sunday in order to avoid a conflict with the WF&C meeting. We would appreciate your comments now and during the coming months.

(Chamberlin) I would like to suggest that work specimens be brought from specific geographic locations and a few hours be made available at the Conference for their examination and for an exchange of information concerning them.

(Jaenicke) Direct insect control is still very common, but indirect control is increasing in use and possibilities. The latter needs more attention from this Conference.

(Chamberlin) Educational institutions should be contacted to assure attendance of teachers at the 1952 Conference.

(Furniss) Perhaps future Conferences should be planned to cover fewer topics in more detail.

(Beal) The scheduling of the Conferences in conjunction with other forestry or entomological meetings might allow more men to attend the Conference and result in a saving of travel funds where attendance at the Conference and the other meeting was contemplated.

(Richmond) I would now like to have an expression of the delegates as to the possible selection of Victoria as the location of the 1952 Conference. (Show of hands, majority favored Victoria. Victoria selected). Before adjourning, I would like to admonish you to assist the program committee in any way possible. The committee's task is large and I am sure they would welcome your ideas and help. Now, as we close the 1951 Conference I would like to express the appreciation of all the officers and members to Mr. Furniss and his staff for their untiring effort in arranging the many details of the present Conference, to those of you who came from distant places, and to all who participated so generously in the Conference program. May we all meet together again in Victoria next year! I hereby declare the 1951 Conference adjourned.

(Conference adjourned at 4:45 p.m.)

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Mimeographing done by:
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ATTENDANCE ROSTER
THIRD ANNUAL
WESTERN FOREST INSECT WORK CONFERENCE
Portland, Oregon
November 26-28, 1951

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