-- MINUTES --

NINETEENTH ANNUAL
SOUTHERN FOREST INSECT WORK CONFERENCE

Arlington, Virginia
August 12 - 15, 1974

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<table>
<thead>
<tr>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORKSHOP: Planning and Administering a Pest Control Project</td>
<td>38</td>
</tr>
<tr>
<td>Bill Hoffard, Moderator</td>
<td></td>
</tr>
<tr>
<td>WORKSHOP: Pheromones of Forest Pests</td>
<td>39</td>
</tr>
<tr>
<td>C. W. Fatzinger, Moderator</td>
<td></td>
</tr>
<tr>
<td>BUSINESS MEETING</td>
<td>42</td>
</tr>
<tr>
<td>REGISTRANTS</td>
<td>45</td>
</tr>
</tbody>
</table>
KEYNOTE ADDRESS TO THE
SOUTHERN FOREST INSECT WORK CONFERENCE
BY
R. K. SMITH, USFS,
STATE & PRIVATE FORESTRY
WASHINGTON, D. C.

It is good to be here today and to make a few comments regarding the present operation of forest pest control and project some future needs, or the task we believe we should be doing to accomplish our assigned mission and the direction indicated for progressive action.

You are all well aware of the tremendous losses currently being inflicted on the South's pine resource by the southern pine beetle. Nationwide, a number of other forest pests including the gypsy moth, spruce budworm, Douglas fir tussock moth, and mountain pine beetle are also causing heavy losses, some equally as damaging as the southern pine beetle. Losses occurring to merchantable timber and the impact on forest stands in every geographic region of the country have been at record levels for several years.

We are equipped today with better tools and strategies for employment against destructive outbreaks than at any other time in the past. Yet, the current losses serve to demonstrate that many things are yet to be learned about managing forest pests before insect and disease losses can be kept within tolerable levels.

Because the current losses have affected, directly and indirectly, a large segment of the American people, the public's attention and concern have been aroused regarding insect and disease problems. Some of this concern has been voiced in the form of public discontent over the adverse impacts of insect and disease suppression projects which, some believe, may have seriously impaired the quality of the country's forests. We believe that the net effect of the public's new interest has been beneficial. Many have expressed concern over the unnecessary volume of the Nation's timber--already in short supply--that is now being destroyed or for the other social and economic problems being caused by the high levels of insect infestations and disease infections. This support may eventually assist us in accomplishing objectives and reaching goals in forest pest management and environmental quality more quickly.

At the same time, the solutions to problems are becoming more difficult to achieve and will continue to become increasingly complex because of environmental considerations. We must be responsive to the environmental impact associated with our programs and projects and the programs of others and must broaden our responsibilities to include all aspects of environmental quality as it affects the health and vitality of forest stands. We can no longer restrict our considerations and activities to the narrow field of forest insect and disease suppression. We must give attention to the total forest stand ecology and environment as it relates to reducing losses.

It is clear that new program thrusts are needed to supplement and supplant current programs and projects in forest pest control. To provide emphasized direction and assistance in this endeavor, we have recently divided our Washington Office responsibilities among four technical areas--program planning and analysis, forest entomology, forest pathology, and environmental quality evaluation. In the remainder of my talk, I would like to make several comments regarding each of these technical areas with particular reference to areas where improvements can be made. As these new program thrusts are emphasized by States, industry, Areas, and Regions,
on a nationwide basis, the new orientation will need to provide assurance that the needed funds and personnel expertise is available.

Through program planning and analysis, we are placing a much greater emphasis on evaluating the performance of ongoing and past programs and projects in order that we may better establish future priorities and courses of action. Programs and projects must be critically analyzed to determine the extent that stated objectives are satisfied or whether future endeavors should be modified or curtailed. This effort requires the collection, storage, and analysis of more detailed program data and technical information which can be retrieved to support and justify alternative courses of action.

In addition to providing the essential data on which management decisions can be made, better program analysis will enable us to justify the funds necessary for financing work in insect and disease suppression and environmental quality enhancement on a priority basis. As you know, the competition for Federal program and project dollars is increasing and the problem is enlarged by the need to reduce Federal spending at a time when the cost of doing business has increased sharply due to inflationary factors and new environmental considerations.

The justification for Federal funds must be more carefully considered and prepared. As entomologists and pathologists, we too often talk among ourselves concerning the importance of insect and disease problems. This became abundantly clear to us in our recent request for a supplemental appropriation. The President's Office of Management and Budget was not particularly impressed by general information that 60 million acres of southern pines were infested by the southern pine beetle and that a large volume of timber was dying. Neither were they impressed by general information that many livelihoods were tied directly to the forest resource of the South or similar arguments that we usually advance when discussing such matters. What did impress them were the specific benefits that could be derived from the expenditure of alternative amounts of Federal dollars. In other words, the benefit-cost evaluation associated with the southern pine beetle projects. We must never forget that every Federal dollar which is appropriated for forest insects and diseases is one less dollar available for medical research, mass transit, flood relief assistance, or similar needs and must compete with those needs. I am sure some of the same competition prevails when authorizations are considered by legislative bodies.

At the moment our benefit-cost evaluations often lack the preciseness that is needed. To continue to be successful in obtaining funds, both State and Federal, these evaluations and the associated data must be adequate and must be more finely honed. We must be in a position to point out what impacts are specifically associated with forest pests or pollutants when no corrective action is taken. And we must be able to quantify the benefits that will accrue to the American people under alternative levels of spending for forest pest management and environmental quality evaluation activities.

We need to begin to integrate our survey and evaluation information with data from all forest resources to determine the total impact. Too often in the past we have worked on the premise that all insect and disease outbreaks that cause tree mortality are detrimental and must be controlled. Perhaps in most instances this has been true, but the effect of the outbreak on wildlife may have been a positive factor that we often did not recognize.

Many survey and evaluation methods still urgently need to be developed or refined. We are continuing to develop the needed impact information on about 10 insect and disease pests throughout the country and this probably needs to be expanded to 20 or more. A large void exists in our current knowledge on the impact
of forest pests. It is mandatory that this void be spanned to provide for the fullest and most effective utilization of available manpower and funds on a priority basis.

We must strengthen our linkage with research and work in close harmony in developing the best methods and techniques available. Also, however, we do have a responsibility to employ the technology that is now available to produce data that have a satisfactory level of confidence.

In those areas where we do not have all the information that we would like to have on impacts, it is often still necessary to continue our suppression programs. It is the policy of the Department of Agriculture to practice and encourage the use of those means of effective pest control which provide the least potential hazard to man, his animals, wildlife, and other components of the natural environment. In such an integrated effort, generally no single method of pest control will be effective. We must have and use a variety of suppression techniques selecting the proper method or combination of methods for each situation. Our activities have often involved an integrated control approach that employs a combination of methods to suppress a pest population. It involves maximum reliance on natural controls along with a combination of techniques for direct suppression. When you utilize these integrated systems with good silvicultural practices, which are standard operating procedures in many situations, one sees a real, viable integrated suppression system at work. This enables us to obtain our objective of more efficient pest control with minimum adverse effects at an economical cost. This approach gives major promise for future programs.

As research is consumated, we in forest pest control have a major job in implementation of the results. One of the best examples of this activity is the pilot project. When a new technique is produced or refinements in old techniques are needed and they are worthwhile, our job is to find out if they will work operationally. We have a big job in this area and all signs point to it as becoming bigger and more important. I encourage you to determine your real needs and do what is necessary to get new systems into operational use.

As we examine future needs, we realize our total detection and surveillance systems need major improvements. Early detection and prompt action can produce dramatic results with some of our major insects and pests. Outbreaks should not get started without the pest manager knowing about them. As a minimum goal, we should cut outbreak discovery time in half. It is readily apparent that there is an urgent necessity for implementing new or improved detection and evaluation techniques. Survey data used in direct suppression decisions are coming under close scrutiny. Some environmental groups have challenged the use of some pesticides. The question in some areas has become—why do anything at all? They say show me that you have a problem in quantitative terms. Your survey data must be good, it must be accurate, and it must define the problem. This is really what we all want from our survey data and what we must strive for. Much can be done to improve our capabilities in this area by staffing with personnel with backgrounds in statistics, biometeorology, sampling design, economics, program planning, and perhaps other disciplines. Area, State, and Federal field offices will need to maintain adequate training effort to assure that their current personnel receive additional training as needed and that vacancies are filled with individuals having the expertise and the new skills that will be required. We have a big job in research implementation; specialized training will aid in the transfer of this new technology as it develops.

In an effort to cope with environmental problems related to and associated with many forest pest control programs and projects, we established an Environmental Quality Evaluation (EQE) Group in the Washington Office this year. This group is responsible for collecting, coordinating, and providing the information required
to evaluate the Forest Service's position on questions from our own people as well as outside groups concerning environmental pollutants including pesticides and air pollution. In order to provide a position or response to questions, we must base our information on the most current and reliable work that is underway. Many times this information originates with you folks in the field who are most aware of the local situation.

Specific areas in which the EQE group will be working are:

1. Providing input to the Environmental Protection Agency (EPA) in the development of FIFRA regulations and interpretations of these regulations.

2. Compiling a data bank of all registrations of pesticides which may be used in forestry.

3. Providing assistance in the development of certified applicator programs such as help in the writing of legislation, writing of training materials, and coordination between Federal, State, and private entities to enable this legislation to meet our responsibilities and needs in this area.

4. Providing assistance in the securing of registration of minor and specialty use registrations. Coordinating with State, USDA, and commercial interests to most efficiently work with EPA in securing registration.

We are hopeful that similar responsibilities to these will be recognized and provided for in our field organizations.

Classification of pesticides will probably put most of the chemicals used in forestry into the "restricted use" category. This will require that pest control people undergo a program of training, testing, and certification before some materials can either be recommended or used. Training and certification programs will probably be a field responsibility with input from our Washington Office. This work will need to be completed by October of 1976. This leaves us little time to develop training programs, certify pest control people and get on with the work.

Another area involving pesticide use that will have an impact on pest control activities is the "specialty" materials for small uses in small areas. This may ultimately require that we become producers and be registered as manufacturers of pesticides. Where pesticides are required in small quantities for selected geographical areas, we may have to develop other alternatives or change our management objectives. This also may not be realistic, but we need to look at all the alternatives available to insure that we comply with the intent of the law.

We have, for the past year, been developing an information system for computerization of pesticide-use information. We are at the point in this work where only the data need to be introduced into the system. This system hopefully can be tapped by each major field unit and will provide up-to-date information about registration, use patterns, environmental constraints, safety, etc., to our pesticide users. This information can then be relayed to cooperating State and Federal field units as well as universities and private industry.

Pesticide-use activities require very close coordination with our cooperators throughout the pest management work area. This is not a job that can be handled by a few people in the Washington Office; it's everyone's responsibility, and it's one of the largest and most complicated jobs we have had in a long time.
Another major task that will increase in importance in the future is monitoring or evaluating air pollution impacts. This is at best difficult. We have few professionals that have an adequate background to thoroughly evaluate air pollutants. However, we should take advantage of the expertise we do have on board now plus that which is available outside our organizations and develop the knowledge we need to do a complete job of pest control. This may require sending personnel back to school, or providing specialized cooperative training sessions, or by contracting outside services to broaden our levels of expertise to do our air pollution work.

Despite the fact that becoming involved in evaluating the consequences of air pollutants may have political or legal aspects, we must get with the job of getting this information in our biological evaluation reports. The Federal Government, and probably most State organizations as well, have a direct responsibility to evaluate the consequences of all factors having in impact on trees and related vegetation in the forest environment. Air pollutants, regardless of what form they occur in, that damage or destroy our forest resources, should be evaluated at the same extent and intensity as bark beetles or defoliators, or a forest disease.

In detection and monitoring surveys, we need to use all the tools available including remote sensing technology. Before we can fully implement programs for evaluating the impacts of forest insects and diseases through remote sensing, we need to develop good sampling methods and work out problems with resolution, timing--both seasonal as well as time of day, and interpretation. Our best use of remote sensing techniques at this time would be for evaluation work rather than detection.

The use of remote sensing methodology has the potential of reducing time involved in surveys and achieve coverage of large areas at a relatively small cost with an improvement in the accuracy level.

In summary, the future looks bright but it will require a dedicated and committed group of people to reach our objective. To implement new or improved survey techniques, develop and implement new or improved control systems, to do the job of environmental quality evaluation related to pesticides, and to develop the information needed on the social and economic impacts of forest pests is a big job. It is a real challenge. We will have to strengthen our linkage with research organizations to span voids in information. But I'm sure that good efforts will be made and that you will meet the challenge in your usual progressive way.

Again, I appreciate the opportunity to be with you today and look forward to working with you in the future on some difficult problems.
Comments by John Kegg
New Jersey Department of Agriculture

The total acreage treated in the 1974 gypsy moth control program amounted
to a little more than 63,000.

Last year 47,500 acres were treated. The cost of the program was shared by
the local government, the State Department of Agriculture and the U.S. Forest Service.

Leaf feeding damage by the gypsy moth occurred on an estimated 28,102 acres.
This acreage represents a substantial decrease from the 258,425 acres defoliated
by this pest last year.

Surveys to determine timber losses in unprotected gypsy moth defoliated forests
were conducted during 1974 in the Sourland and Kittatinny mountains.

Stumpage value lost (using a value of $60/thousand board feet) on plots where
two consecutive severe defoliations occurred varied from $33 to $437 per acre.
Stumpage values lost from one year to severe defoliation ranged between $15 and
$76 per acre. The check plot, a highly susceptible oak forest, was protected with
aerial spraying and showed no measurable board foot losses.

As the data show, the board foot value losses vary considerably from site to
site.

The Gypsy Moth Research & Development Program

James L. Bean
U.S. Forest Service
Hamden, Connecticut

A brief review of the proposed expanded gypsy moth program was presented. At
this date, the package was still under review by the Department and the Office of
Management and Budget. It was expected that the program as presented would be
favorably acted upon.

The main thrust of the gypsy moth R&D Program at the Hamden Laboratory was on
the development of the safety data required for the registration of the virus (FPV).
Some efficacy data will also be generated from the current field studies.

Studies on the parasites of the gypsy moth, specifically Blepharipa scutellata,
continued this season. A system for sampling adult tachinids was developed and will
be published at an early date. A radiographic method of examining gypsy moth pupae
and tachinid puparia was developed and used extensively in our research efforts.
An improved egg mass sampling procedure will be field tested this fall. The suburban
site, and larval dispersal studies were covered briefly and R&D plans for CY 1975
were outlined. Some of the benefits of the Hamden research efforts on the gypsy moth
to the Southeastern Area were explored.

1/ Package accepted by OMB on Oct. 74 and funding of first year's expanded research
program began in early Nov. 1974.
Gypsy Moth Status in Pennsylvania

James O. Nichols
Div. of Forest Pest Mgt.
Middletown, Pa.

Pennsylvania's program to combat the gypsy moth consists of three principal program areas:

1. Suppression projects that are organized into a cooperative effort between the county, state, and federal governments. Generally speaking, spraying is restricted to those areas considered to be of high-use or high-value and is primarily aimed at alleviating the public nuisance problem. Areas considered for treatment include: forested parks, recreational areas, forested communities or rural residential areas, special-use sites, and areas surrounding public water supply reservoirs. This program is voluntary on the part of property owners. Selection of proposed treatment areas, based on established guidelines, is done at the local level; the state then evaluates these areas through a biological evaluation to determine the need for treatment and conducts the spraying operation. Counties contribute 25% of the spraying costs, state--25%, and the federal government--50%. The State also performs all of the preliminary aerial survey detection work.

2. The production of exotic parasites is performed at the State's new $500,000 laboratory located at the Harrisburg International Airport. The establishment of natural enemies from native overseas habitats is considered to be the only realistic long-term approach to alleviating the overall forest impact of the gypsy moth. The main objective is to establish populations of various insect parasites and predators throughout the distribution of the gypsy moth population in the Commonwealth. We believe that these efforts will assist in maintaining gypsy moth populations at a level where their impact on the forest and urban eco-systems can be tolerated, both economically and ecologically. There is no intent to inundate areas with parasites or predators in order to prevent tree defoliation. The program's purpose is to "naturalize" the gypsy moth as soon as possible, to promote quicker natural collapses of outbreaks and to try to maintain residual infestations after collapses at non-damaging levels. In other words, we will try to increase the role of parasites and predators in pest management and integrated control systems.

3. Evaluation of parasites released into numerous established study plots will determine the efficacy of these biological agents. Those which fail to become established or which perform poorly will be dropped from the program after a reasonable evaluation period. This program will also deal with other biological weapons or methods which may become available through research, including such things as parasitic dissemination of virus materials.
WORKSHOP: SEED AND CONE INSECTS
JOHN D. WALSTAD, MODERATOR
WEYERHAEUSER COMPANY
HOT SPRING, ARKANSAS

The Economic Impact of Cone and Seed Insects

Robert J. Weir

First-generation forest tree seed orchards of southern pines have reached advanced stages of development and are now nearing their full productive potential. The value of genetically improved orchard seed is enormous, yet efficient seed production is not without difficulty. Currently, seed orchard pests, particularly cone and seed insects, are considered to be the most serious problem confronting applied improvement programs in the South.

The value of genetically improved seed is very high when expressed in terms of the present worth of the additional wood volume available at harvest (see table and assumptions). With such high value seed it is imperative that seed orchard losses be minimized. In the case of seed and cone insects, an effective and registered chemical control method is urgently needed.

Data from control studies in 14 loblolly pine seed orchards, conducted throughout the Southeast in 1973, show an annual loss of 20 to 30 percent of the second-year cone crop to be common. The value of seed destroyed by these insects can range from $230,000 to $350,000 for an average size improvement program (50-acre seed orchard). Considering the 6 to 7 thousand acres of producing orchards in the South, annual losses may approach 30 to 45 million dollars. Indeed, insect control measures are most urgently needed.

Present Value of Improved Seed
(as prepared by H. D. Smith,
Liaison Economist,
N. C. State University
Cooperative Tree Improvement Program)

<table>
<thead>
<tr>
<th>Amount</th>
<th>First-Generation Seed Value</th>
<th>Second-Generation Seed Value</th>
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<tr>
<td>One lb. of improved seed</td>
<td>$591</td>
<td>$1,057</td>
</tr>
<tr>
<td>One year's production</td>
<td></td>
<td></td>
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<tr>
<td>from a 50-acre orchard (2,000 lbs.)</td>
<td>$1,182,000</td>
<td>$2,114,000</td>
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Assumptions:
1. Interest Rate                              | 8%                         | 10%                          |
2. Genetic Gain                                | 15%                        | 35%                          |
3. Productivity of land base                  | 1.5 cords/A/Yr.           | 2 Cords/A/Yr.               |
4. Acres Regenerated                          |                            |                              |
| w/1 lb. of seed                              | 16                         | 16                           |
5. Seed Yield per Orchard Acre                | 40 lbs.                    | 40 lbs.                      |
6. Rotation Length                            | 25 yrs.                    | 25 yrs.                      |
7. Stumpage Value of Wood                     | $40/Cord                   | $40/Cord                     |

(25 years in future)
Southern Seed Orchard Pest Committee

Loyd R. Drake
U.S. Forest Service
Alexandria, La.

One of the most important problems confronting seed orchard managers today is the unavailability of registered pesticides for use in controlling seed orchard insects. This problem was recently compounded by certain restrictions being placed on them by the passage of the Federal Environmental Pesticides Control Act of 1972. These problems led to the formation of the Southern Seed Orchard Pest Committee in November 1973.

The Committee has nine members—one representing each of the three southern tree improvement cooperatives, one representing university research, one representing states not participating in a cooperative, one representing TVA and one representing each of the three arms of the Forest Service. The primary objective is to collect efficacy and phytotoxicity data through the coordinated testing of pesticides for seed orchard insect control. These tests, using standardized work plans, are distributed throughout the South, and involve a sufficient number of hosts and insect species to gain South-wide registration.

Just how does the Committee work? The Committee meets, as necessary, to determine on a priority basis what the greatest needs are, and appoints ad hoc committee chairman to get the job done. The ad hoc chairman in turn selects individuals of his choice from throughout the South with expertise in the various aspects of chemical testing to serve on his committee. It is this committee's responsibility to write study plans, acquire pesticides for testing, coordinate the testing effort among various cooperators through the steering committee members, arrange for collection and analysis of data, report results, and furnish data to the pesticide company for presentation to EPA.

When a particular effort is completed, the ad hoc committee is dissolved and others are formed as the need arises.

This year's effort involves the testing of Guthion and Furadan to control coneworms. There are 10 orchards participating in the Furadan test, and two participating in the Guthion test. Test areas range from Virginia to east Texas.

We are quite pleased with the progress this Committee has made and with the cooperative spirit that has been demonstrated among its members and among the people they represent. We feel that the Committee has a sizable job ahead not only in testing of pesticides, but possibly in other areas of seed orchard pest management where coordinated problem solving efforts are needed, such as operational pesticide application methods and pest detection and evaluation survey techniques.

1/ Chairman, Southern Seed Orchard Pest Committee.
Dr. Thomas Payne was scheduled to moderate this workshop session. When it became impossible for Tom to attend the work conference, Lewis Edson, currently a postdoctorate fellow with Dr. Payne’s group, filled in. Previously Dr. Payne had called on Dr. Fred Stephen, assistant professor of forest entomology at the University of Arkansas and Dr. Franklin Lewis, with the Northeast Forest Insect and Disease Laboratory, Hamden, Connecticut, and Dr. Wayne Berisford, University of Georgia, requesting their participation in the workshop.

Dr. Stephens began the semi-formal workshop presentations by showing slides and discussing the work Dr. Donald Dahlsten, UCB concerning his research on avian predators of forest insects. This work was conducted in northern California and was undertaken with the objectives of quantifying the effectiveness of avian predators as well as evaluating certain practices designed to augment avian predators population buildup in the forest environment. Dr. Stephen discussed the background for this study and how such studies undertaken in Europe have yielded beneficial results. The European efforts have been focused primarily on the augmentation of bird populations by providing artificial nesting sites and the successes have been primarily with lepidopterous defoliators.

Dr. Dahlsten's studies have dealt primarily with hole (cavity) nesting birds such as chickadees and nuthatches which periodically occur in large numbers in association with various defoliating insect species, such as the Douglas fir tussock moth and lodgepole needle miner. Among the biological parameters investigated in these studies were general habits, longevity, nature of pair bonding, diet, reproductive potential. Such techniques as photographic telemetry and banding were utilized to obtain information. The primary variable investigated was that of the impact of nesting site availability on population size in a given area. Logging practices in California advocate the removal of snags. The long range impact of such a practice on cavity nesting bird populations is significant.

In one study conducted in a young pine plantation in which artificial nest boxes were provided, little impact on the avian population was recorded. However, in a natural forest situation where artificial nest boxes constructed of cement and sawdust mortar were provided a substantial increase in nesting and consequent increase in reproductive potential was realized over control areas. Several unforeseen problems using this technique became apparent, including competition for nests, both among two different species and between birds and tree squirrels. The territorial nature of certain bird species would also be a limiting factor in population augmentation attempts of this type. The species techniques tested in these studies showed promise, particularly as they would apply to intensively managed forests and particularly against defoliating species of forest insect pests.
Pathogens
Dr. Franklin Lewis
Northeast Forest Insect and Disease Laboratory
Hamden, Connecticut

Bacillus Thuringensis is currently the most widely used microbial agent--it is fully registered. Other microbials which are currently under investigation include viruses, fungi, and rickettsia. Rickettsia have been used with some success in Europe. The biggest problem in the U.S. remains that of registering such agents.

Certain other problems must be addressed if microbial agents are to be utilized in large-scale pest management programs:

1. Most microbials must be directly ingested by populations of forest pests before their effects are manifested. Consequently their effectiveness would be limited to foliage-feeding insect groups (i.e. they would not likely be effective against wood borers).

2. Often there is a delay period between the inoculation of microbials and actual population regulation. If the pest species continues to feed heavily during this period intolerable losses may not be prevented.

3. New microbials must meet registration requirements before being fit into any sort of pest management scheme. This also means public acceptance. Safety and efficacy requirements must be established.

4. Assuming registerability, the microbial must then be produced in large quantities and marketed. The difficulties of these phases cannot be minimized.

5. The problems associated with vectoring must be investigated. Such techniques as parasite vectoring, egg mass spotting, and aerial application are considered among others.

Among the general topics discussed in the workshop were the following:

1. Gordon Moore mentioned the possibility of augmenting the expression of certain biological control agents through silvicultural manipulations. The winter mortality of southern pine beetle to certain fungal species being a case in point.

2. Recent studies on gypsy moth have indicated that white footed mouse populations can be augmented through artificial feeding. When mouse populations were artificially maintained at these higher levels in treatment plots, greater gypsy moth control was achieved over controls. The fact that bird and mice predator studies remain low-level priority has limited this type of research endeavor.

3. The virtually uninvestigated impact of ants, spiders and nematodes as biological control agents was discussed briefly. Formica Rufa was mentioned as a predator of the southern pine beetle.
The Role of Parasites in Bark Beetle Pest Management Programs

C. W. Berisford
University of Georgia

The present knowledge concerning hymenopterous parasites of southern bark beetles is probably not sufficient to make a substantial contribution to bark beetle pest management programs. Pest Management implies that substantial and detailed information if available on the whole insect and plant complex associated with the pest insect. In most instances detailed information on southern bark beetle parasites is not available.

I shall attempt to briefly review the current status of bark beetle parasite research here as I know it. Most of the parasites have been identified but many common parasites of southern pine beetle and some other southern bark beetles have only recently been confirmed by rearing directly from the host. Rates of parasitism may be extremely variable, from almost none to nearly 100%, in adjacent trees. The reasons for this are unknown.

Parasitism is generally higher in tops of trees and some parasitic species which oviposit through the bark may be largely restricted to the upper bole.

It appears that trees may exhibit some attraction for parasites which is independent of the number of species of beetles attacking them. Also, different pine species may be differentially attractive to some parasitic species.

Some parasites are known to accept a wide range of hosts but it is not known if they have preferences if they have a choice among two or more host species at the same time. For example this author has reared Coeloides pissodis Ashmead from the southern pine beetle, four Ips spp., white pine weevil, deodar weevil, and the Eastern juniper bark beetle, but I do not know if C. pissodis exhibits strong preferences. Some other parasites appear to accept only one or two hosts.

Many workers suspect that there is a relationship between host density and effectiveness of different parasite species, but good quantitative data are not yet available.

The sequence of arrival and departure of several bark beetle parasites in relation to their hosts is known but without additional data on parasite biology, this information cannot yet be put to practical use.

For the majority of southern pine beetle parasites, we have little or no information regarding fecundity, numbers of generations, life cycle lengths, diapause, etc. It appears that we have reached a point where each bit of information asks more questions than it answers. Many more such questions must be asked and answered before we can make any real contribution to a system of pest management.
Use of Pitch Tube Density as a Possible Indicator and Predictor of Various Southern Pine Beetle Population Parameters

Evan Nebeker
Mississippi State University
Mississippi State, Mississippi

Abstract

Initial research has begun on: (1) development of sampling strategies and estimations, (2) quantitative population biology (population dynamics), (3) the measurement of intraspecific competition, and (4) development of pest management strategies and tactics for the southern pine beetle.

Preliminary data analyzed, using simple linear regression, was presented concerning: (1) total number of pitch tubes vs. height, (2) cumulative number of pitch tubes vs. height, (3) mean gallery length/100 cm² vs. mean number of pitch tubes/100 cm², and (4) mean distance to nearest pitch tube vs. mean number of pitch tubes/100 cm².

Sample unit sizes (45 cm², 66 cm², 100 cm², and 153 cm²) were examined to determine which was best for estimating the total number of pitch tubes on various trees. Conclusion--does not matter what sample size you use but the percent of the infested area sampled and the manner in which the samples were selected were important.

Inter Specific Competition Between
Monochamus titillator and Dendroctonus frontalis

Robert N. Coulson
Texas A&M Univ.
College Station, Texas

Adil M. Mayyazi
Texas A&M Univ.
College Station, Texas

Fred P. Hain
North Carolina State Univ.
Raleigh, N. C.

Abstract

The process of inter-specific competition between D. frontalis and M. titillator was hypothesized to exist as a result of foraging by M. titillator in the sub-cortical region of loblolly pines attacked by D. frontalis. The existence of the interaction was demonstrated experimentally, 1st by defining the distribution
of *D. frontalis* parent and progeny adults in samples of bark in which *M. titillator* foraging was both present and absent and then by comparing the observed density of *D. frontalis* inside the foraged area, SPB₁ in A₁, with the expected density E(SPΒ₁) if no foraging were present. The observed and expected values were demonstrated to come from different distributions which substantiated the existence of the interaction.

The specifications for developing mathematical models to express the process of inter-specific competition between the two insects were next investigated and found to include consideration of the extent and distribution of *M. titillator* foraging over the entire bole of the tree and *D. frontalis* density in the infested portion of the tree bole. The form of the data used in the model development was appraised from the standpoint of providing the most realistic account of the process under consideration and the results of the use of unmanipulated data were compared with 2 separate types of manipulations commonly employed in the analysis of bark beetle populations.

A series of non-linear mathematic models based on unmanipulated data were developed which ultimately provide the expression of mortality resulting to *D. frontalis* as a result of *M. titillator* foraging as well as a survivorship model. These models include a definition of the following components: the relationship between the density of *D. frontalis* in the area foraged by *M. titillator* [E(SPΒ₁)] and S.H./I.B.H., the difference between (SPΒ₁) and E(SPΒ₁) = Δ(SPΒ₁) and S.H./I.B.H., the relationship between the area foraged by *M. titillator* A₁ and S.H./I.B.H., the relationship between SPΒ₁ and A₁, which is the mortality expression, and the related expression of survivorship.

The Incidence of *Fomes annosus* Found in Loblolly Pine Attacked by *Dendroctonus frontalis*

J. M. Skelly, D. W. Powers
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

C. L. Morris
Virginia Division of Forestry
Charlottesville, Virginia

Abstract

The incidence of *Fomes annosus* in thinned and non-thinned stands of loblolly pine has been under investigation for many years. Previous reports indicate that infection level varies from 2.8% to 33% of the trees within a plantation. Variation of incidence levels reported depends upon the sample intensity and methods used to identify the fungus within any given root system. Entire tree root system excavation by the use of bulldozers alleviates errors in sampling procedures and subsequent evaluation of root systems by isolation for *F. annosus* increases the accuracy of determining infection levels. A continuing study that has been conducted, until recently, in thinned loblolly pine plantations, using entire tree root system excavation, has not yielded less than 52% infection and the maximum incidence of *F. annosus* found was 100%. Evaluation of primary root infection indicated that 24 percent of the 225 trees examined had over 20 percent of their root systems infected. These data were obtained from 10 plots, each containing 25 trees, and the plots were scattered throughout the coastal plain and Piedmont sections of Virginia. The high incidence and associated severity of infection by *F. annosus* indicated that the fungus may play a role in predisposing trees to attack by bark beetles.
such as *D. frontalis* or *D. terebrans*.

A preliminary evaluation of the level of incidence of *F. annosus* found associated with pockets of attack by *Dendroctonus frontalis* in thinned and non-thinned stands of loblolly pine was initiated in June of 1974. To date, 25 trees have been examined in each of one thinned and one non-thinned plantation. In addition, 3 plots containing both bark beetles and *F. annosus* have been located, but evaluations are not yet completed. The level of incidence of *F. annosus* in the thinned stand was 96 percent. Roots of trees in the thinned stand were severely infected with 13 of the 25 trees samples having over 20% of the primary roots exhibiting advanced stages of decay. The range of infection, when present, was 5 to 71 percent of the primary roots and 6 to 67 percent of the secondary roots. The level of incidence of *F. annosus* in the non-thinned stand was 88 percent of the 25 trees examined. Infection was located in numerous fine feeder roots and subsequent evaluation of the impact of this type of infection is being conducted.

These high levels of infection of both primary and secondary roots of most trees examined in the bark beetle and non-bark beetle attacked stands indicate that the importance of this type of possible predisposing association needs to be carefully evaluated.

Tagging Teneral Southern Pine Beetles With Radioactive Compounds

Gordon E. Moore and James F. Taylor
Southeastern Forest Experiment Station
Research Triangle Park, N. C.

Abstract

A promising method has been developed to determine the fate of adult southern pine beetles that emerge from infested trees, particularly those that are cut down but not sprayed with insecticides. Infested parts of the tree are coated with a 5% glycerin solution of radioactive phosphorus (32p).

In laboratory and enclosed field studies emerging beetles picked up and retained sufficient radiation to detect from the pitch tubes and the beetles themselves in freshly infested bolts. The test insects and pitch tubes were placed in toluene, triton-x-butyl PDB cocktail, and counts were made with a Beckman LS-100 liquid scintillation counter. The method is currently being tested for application under normal field conditions.

PBAP - A Computer Program to Calculate the Potential Benefits of Insect Management Programs

William A. Leuschner
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Blacksburg, Virginia

Abstract

The financial criterion for entering a management program is that the potential benefits of that program exceed the potential costs. The prevention of timber

1/ The work reported herein was funded in part by a National Science Foundation project entitled "The Principles, Strategies, and Tactics of Pest Population Regulation and Control in Major Crop Ecosystems." NSF GB 34718.
mortality and the prevention of a lower valued stand following an infestation are two potential benefits of insect control. A computer program has been written by John F. Snyder and William A. Leuschner to calculate these benefits which occur in any one year. The program requires inputs such as d.b.h. distribution of the attacked trees; number of attacked trees; stumpage prices; and estimated cash flows for the original and subsequent stand, and a summary of potential benefits from prevented mortality, reduced growth, and lower valued subsequent stands. This is the first phase of the program's development and additional work is anticipated.

Evaluating the Operational Effectiveness of Southern Pine Beetle Control Methods

Ronald F. Billings
Texas Forest Service
Lufkin, Texas

Abstract

One of the more pressing problems confronting Pest Management groups (both state and federal) is to develop thorough and realistic methods of evaluating the effectiveness of various control techniques for the southern pine beetle. Historically, the primary and often sole basis for measuring efficacy has been the percent brood reduction in treated versus untreated trees. Although important, this represents only one aspect of a total evaluation.

At least two general criteria are recognized as essential for fully evaluating promising bark beetle control techniques; (1) effect of the control tactic on reducing the attack potential of the bark beetle population and (2) effect of the control tactic on reducing timber losses. I suggest that university and federal research-oriented groups are in the best position to ascertain the former (biological impact) while state and federal pest management groups can contribute substantial information on the latter (economic impact). Accordingly, a thorough analysis of control effectiveness can best be achieved by means of a multi-organizational approach.

Effect on Attack Potential

The impact of the control tactic on the attack potential of the bark beetle population can be documented by measuring (1) brood reduction in treated versus untreated trees and (2) ultimate fate of that proportion of the bark beetle brood which survives to disperse from treated trees (e.g. extent of dispersal losses). Identification of the causal factors contributing to reduced brood survival or increased dispersal losses also should be an important research objective.

Effect on Reducing Timber Losses

If the control tactic in question is being applied under operational conditions, then survey records can be used for monitoring the effectiveness in reducing timber losses. Effectiveness can be measured by comparing ultimate spot growth in treated versus untreated spots of similar description over a similar time period. Accordingly, cost:benefit ratios which incorporate data on resources protected can be calculated to ascertain the advantage of applying the control versus no control.

A final aspect which has been largely ignored in the past is the influence of control treatment on new spot proliferation. Obviously, if disruption of spot infestations by a given control tactic induces surviving beetles to initiate one or more new spots in adjacent uninfested stands, the control effort may be aggravating
rather than alleviating the pest problem. In recognition of this possibility, the Texas Forest Service recently initiated a computer analysis of survey and control records aimed at quantitatively describing the extent of spot proliferation associated with various control tactics (salvage, fell only, fell and top, other) and no control (inactive and active spots). This analysis was facilitated by the establishment in March, 1973 of the Texas Forest Service Operations Informational System (described in detail by Herbert A. Pase III in a later workshop). This system utilizes electronic data processes to record and tabulate SPB survey and control records. As a result, survey data is stored on IBM punch cards in a form appropriate for post-seasonal computer analysis.

For purposes of the spot proliferation study, a computer program was developed which essentially compares the date of detection or control and the grid location of every spot detected during a given calendar year in east Texas with those of every other spot on record. Spots occurring within a specified time period after control (60 days) and within a specified area (605 acres) surrounding the spot being analyzed were considered as proliferation and accumulated by control treatment, season, spot size and geographical area. Mean values were subjected to statistical analysis (binomial distribution "z" test) to detect significant differences.

Preliminary results of the analysis of 1973 survey records were presented and their implications discussed. Significant differences in spot proliferation were observed based on type of control treatment. Furthermore, the extent of spot proliferation was correlated with spot size, season and geographical area. Results of the analysis of 1973 records will be compared with those for 1974 in order to confirm apparent relationships.

Hopefully, this type of analysis will contribute substantially to a complete evaluation of the operational effectiveness of the variety of presently available or proposed control tactics for the southern pine beetle.
Nantucket Pine Tip Moth Research in Arkansas

J. D. Walstad
Weyerhaeuser Company
Hot Springs, Ark.

Control of the Nantucket pine tip moth looms as a significant challenge for increasing the productivity of southern pine plantations. Research is underway at Weyerhaeuser Company's Southern Forestry Research Center at Hot Springs, Arkansas, to determine the impact of this insect on tree growth and to develop methods for reducing its damage. Previously, surveys in Arkansas and Oklahoma indicate that Coastal Plain sites are more heavily attacked than upland sites and that mechanically site-prepared areas (sheared, piled, and burned) suffer more damage than chemically prepared areas (aerial-sprayed or injected and burned). Chemical site preparation on upland areas and the use of insecticides such as Guthion in Coastal Plain areas appear to be feasible techniques for reducing tip moth damage.

Rearing and Mating Successive Generations of the Nantucket Pine Tip Moth From Artificial Diet

James A. Richmond
U.S. Forest Service
Research Triangle Park, N. C.

Three generations of the Nantucket pine tip moth were successively reared on a meridic diet. The percentage survival to adult was 60, 56, and 60 for generations 1, 2, and 3, respectively. Pupation occurred in about 25 days with a slight decrease from 43 to 34 days noted for adult emergence of succeeding generations. Although mating was obtained, a decline in the production of fertile eggs caused a lower moth yield in succeeding generations.
Preliminary Results of a Field Test of Insecticides to Prevent Damage by Reproduction Weevils

John C. Nord, Thomas H. Flavell, and William D. Pepper

Two experiments were installed in southeastern North Carolina in 1973 to test various insecticidal treatments for control of pales and pitch-eating weevils on loblolly pine seedlings. One study was installed in early February on Federal Paper Board land near Bolton, N.C. and the other in late March on Weyerhaeuser Co. land near Burgaw, N.C. The treatments and the results as of late June are given in Tables 1 and 2.

Table 1.—Percent weevil-caused mortality of loblolly pine seedlings by June 26 (5 months post planting) in a field test of insecticides—Bolton, N. C., 1974.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>MEAN PCT WEEVIL-CAUSED MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IMIDAN w.p. b/ 4% a.i. c/ + Plantgard -- Top Dip</td>
<td>0.4 a</td>
</tr>
<tr>
<td>2. IMIDAN w.p. 2% a.i. + Nu-Film 17 -- Top Dip</td>
<td>1.9 a</td>
</tr>
<tr>
<td>3. IMIDAN w.p. 2% a.i. -- Top Dip</td>
<td>2.3 ab</td>
</tr>
<tr>
<td>4. IMIDAN 2S (microencapsulated) 2% a.i. -- Top Dip</td>
<td>3.1 abc</td>
</tr>
<tr>
<td>5. DURSBN (M-3633) e.c. d/ 4% a.i. + Plantgard -- Top Dip</td>
<td>4.2 abc</td>
</tr>
<tr>
<td>6. DURSBN (M-3865) e.c. 4% a.i. -- Top Dip</td>
<td>4.4 abcd</td>
</tr>
<tr>
<td>7. DURSBN e.c. 4% a.i. + Plantgard - Nursery Spray</td>
<td>5.9 abcde</td>
</tr>
<tr>
<td>8. IMIDAN w.p. 2% a.i. + Plantgard -- Top Dip</td>
<td>7.0 cde</td>
</tr>
<tr>
<td>9. DURSBN (M-3633) e.c. 2% a.i. + Plantgard -- Top Dip</td>
<td>7.4 bcde</td>
</tr>
<tr>
<td>10. RABON w.p. 4% a.i. + Plantgard -- Top Dip</td>
<td>7.8 bcde</td>
</tr>
<tr>
<td>11. DURSBN (M-3633) e.c. 4% a.i. -- Top Dip</td>
<td>8.0 abcde</td>
</tr>
<tr>
<td>12. RABON w.p. 4% a.i. -- Top Dip</td>
<td>8.5 cde</td>
</tr>
<tr>
<td>13. DURSBN (M-3865) e.c. 2% a.i. -- Top Dip</td>
<td>9.6 bcde</td>
</tr>
<tr>
<td>14. DURSBN (M-3633) e.c. 2% a.i. -- Top Dip</td>
<td>12.2 de</td>
</tr>
<tr>
<td>15. DURSBN e.c. 4% a.i. -- Nursery Spray</td>
<td>15.0 e</td>
</tr>
<tr>
<td>16. CONTROL</td>
<td>53.8 f</td>
</tr>
</tbody>
</table>

a/ Any two means not having a letter in common are significantly different at the 5% level. Chemical treatment means based on 14 20-seedling replicates and control mean on 42 20-seedling replicates.

b/ Wetable powder c/ Active ingredient d/ Emulsifiable concentrate

Study conducted by the SE Forest Exp. Sta., in cooperation with Forest Pest Management, SE Area, S&PF, U. S. Forest Service; N. C. Forest Service; Federal Paper Board Co., Inc.; and the Weyerhaeuser Co.

Research Entomologist, Supervisory Entomologist, and Biometrician, respectively
Table 2.—Percent weevil-caused mortality of loblolly pine seedlings by June 25 (3 months post planting) in a field test of insecticides—Burgaw, N. C., 1974.

<table>
<thead>
<tr>
<th>TREATMENT</th>
<th>WEEVIL-CAUSED MORTALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FURADAN 10G 0.2gm (a.i.)/seedling -- Planting Hole</td>
<td>0.8 a</td>
</tr>
<tr>
<td>2. FURADAN 10G 0.4gm (a.i.)/seedling -- Planting Hole</td>
<td>1.5 a</td>
</tr>
<tr>
<td>3. FURADAN 10G 0.1gm (a.i.)/seedling -- Planting Hole</td>
<td>2.8 a</td>
</tr>
<tr>
<td>4. FURADAN 10G 1.0gm (a.i.)/seedling -- Surface Treatment</td>
<td>3.6 a</td>
</tr>
<tr>
<td>5. FURADAN 10G 0.5gm (a.i.)/seedling -- Surface Treatment</td>
<td>3.6 a</td>
</tr>
<tr>
<td>6. IMIDAN w.p. 4% a.i. + Plantgard -- Top Dip</td>
<td>6.7 ab</td>
</tr>
<tr>
<td>7. IMIDAN w.p. 4% a.i. -- Top Dip</td>
<td>12.1 bc</td>
</tr>
<tr>
<td>8. DURBAN (M-3865) e.c. 4% a.i. -- Top Dip</td>
<td>18.0 cd</td>
</tr>
<tr>
<td>9. DURBAN (M-3633) e.c. 4% a.i. + Plantgard -- Top Dip</td>
<td>19.6 d</td>
</tr>
<tr>
<td>10. FURADAN (flowable) 1% a.i. -- Clay -- Root Dip</td>
<td>21.3 cd</td>
</tr>
<tr>
<td>11. DURBAN (M-3633) e.c. 4% a.i. -- Top Dip</td>
<td>28.7 de</td>
</tr>
<tr>
<td>12. DURBAN 10G 1.0gm (a.i.)/seedling -- Surface Treatment</td>
<td>33.9 e</td>
</tr>
<tr>
<td>13. DURBAN 10G 0.5gm (a.i.)/seedling -- Surface Treatment</td>
<td>38.5 ef</td>
</tr>
<tr>
<td>14. DURBAN (M-3633) e.c. 3% a.i. -- Nursery Spray</td>
<td>40.3 ef</td>
</tr>
<tr>
<td>15. CONTROL</td>
<td>49.1 f</td>
</tr>
</tbody>
</table>

\( ^a/ \) Any two means not having a letter in common are significantly different at the 5% level. Chemical treatment means based on 14 20-seedling replicates and control mean on 42 20-seedling replicates.

Extenders such as Plantgard and Nu-Film 17 were tested to determine their value in extending the residual activity of the insecticide. Also tested was a formulation of Dursban, M-3865, with an extender added and a micro-encapsulated (slow release) formulation of Imidan. Several methods of application were tested: (1) top dip to the root collar, (2) root dip, (3) nursery spray, (4) granular application around the base of the seedling in a 6-inch diameter circle with light soil cover, and (5) granular application in the planting hole.

Both study areas were formerly covered with dense stands of pine which were harvested in the late summer and fall of 1973. Trap bolts indicated high weevil populations in both areas.

A generalized randomized complete-block design was used in both experiments. There are a total of 14 20-seedling repetitions/chemical treatment and 42 repetitions/control in each experiment.
At the SFIWC we did not have a formal presentation by any one but we had a general free-for-all discussion on the state of knowledge in the following general areas.

1. What is the potential for enhancing pathogens of insect pests that remain within host tissue most of the time?

2. Considering our present state of knowledge of pathogens of southern forest insects, what areas of research seem feasible or desirable?

3. Of what importance are microbes in the maintenance of pest populations? Some information is available on termites and soft rot fungi, but what information do we have on other insects?

Since we did not take notes or have a formal presentation, I can't give you much in the way of what was actually said. Some of the people who took part in the discussions were Frank Lewis, George Allen, Bob Wilkinson, Gordon Moore, Joe Mauldin, Bob Thatcher and others.
WORKSHOP: RADIOGRAPHY OF FOREST INSECTS
ROBERT N. COULSON, MODERATOR
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS

Radiography in Forest Entomology

Ralph Woodruff
Industrial and Scientific X-Ray Systems
Hewlett Packard Corp.

Radiographic Technique

Abstract

The application of radiographic techniques to forest entomological problems parallels the more common industrial uses. Modern instrumentation permits the use of x-rays to produce radiographs of high quality without extensive training in radiation physics. A cursory knowledge of the following subject areas is however important to a basic understanding of radiographic technique: Geometric principles, factors governing exposure, radiographic screens, scattered radiation, arithmetic of exposure, and film types.

Radiographing Standing Timber For Decay and Insects

John A. Beaton
Northeastern Forest Experiment Station

Abstract

The ability to radiograph trees under forest conditions has proven successful. A mobile X-Ray unit has been developed to transverse forest terrain, and many specialized techniques have been incorporated from industrial radiography. Sample radiographs show insects, insect damage, decay, and metal inclusions in trees up to 13 inches.

Applications of Radiography in Forest Entomology

Robert N. Coulson
Texas A&M University

Abstract

Radiography permits the remote sensing of insect inclusions in various types of wood, and bark samples. Illustrations of several different applications of radiography in forest entomology were presented including bark beetles, wood boring insects and seed insects. Comparisons of the resolution of various film types including Kodak AA, M, T, R, RR were made.
WORKSHOP: TERMITES AND WOOD DESTROYING BEETLES IN THE HOME
R. SMYTHE
U.S. FOREST SERVICE
GULFPORT, MISSISSIPPI

Wood-Destroying Beetles
Lonnie H. Williams
U.S. Forest Service
Gulfport, Mississippi

Time is limited, so I'll not thoroughly cover the material given in the series of articles about wood-destroying beetles published last year in Pest Control magazine. Reprints of these articles and other bulletins have been distributed for your study.

Today I'd like to emphasize why the proper selection of control measures based on beetle identification is important to you and the pest control industry. At the 1973 National Pest Control Association Meeting in Denver, a public education program about the pest control industry was initiated. By now you are aware that this program is an attempt to change the public's image of pest control operators. I'll explain the relationship between the public's image of PCOs and wood-destroying beetles.

Although PCOs and most of their customers have some familiarity with termites and their damage, attacks of beetles are poorly understood by both PCOs and their customers. Beetle identifications and biologies are ignored when selecting control measures. I believe most of you, upon seeing small round or oval holes in the wood, are guilty of saying, "powder-post beetle damage. Control these beetles with spray treatments or fumigate." As professional pest control men, you can and should give better performance. Why? One good reason is because faulty beetle treatments are much more easily detected than faulty termite treatments. Faulty termite treatments are difficult to detect because termites' attacks may not occur for years after treatment. Chemical analyses may be necessary to show insufficient insecticide was applied. Construction faults that may invite termite attack may not be corrected but the customer may not know that they should be corrected. Even then attack may not occur for years.

How do beetles differ? First, let's contrast the biologies of subterranean termites and beetles. As you know, termites live in colonies in the soil, and termites travel from the soil to wood to attack it. Beetles live individually and spend most of their life feeding within wood. Beetles infest wood by adults laying eggs on or in it. The beetle's young or larvae damage wood by tunneling through it, feeding for periods ranging from a few months to 10 or more years. These larvae pupate and change to adults within the wood. These new adults chew small circular or oval exit or emergence holes through the wood surface. Beetles never swarm but outdoors they do have definite emergence seasons or periods when most adults emerge, mate, and lay eggs. Termite damage is often severe but often isolated in a few boards or small areas. Termites can and do damage any cellulosic material. Beetle damage is often widespread in many boards. But many of the different beetles are restricted to certain kinds of woods. Briefly, the difference is that the beetles or damage is already there. Beetle treatments are not preventative treatments although subsequent attacks may be prevented.
It is important to make identifications and determine the activity of beetle infestations because some beetles cause damage in wood when it is dead or dying trees, or drying logs and lumber. These beetles cannot infest wood that is dry. Imagine the impression the homeowner has of the pest control industry when he learns he has paid $2,000 for fumigating beetles incapable of reinfesting the dry wood in his home. In another house the owner may pay $5,000 for fumigating beetles capable of attacking only hardwoods when most hardwood products in the home have to be replaced anyway because they are severely damaged. That is why identifications are necessary before prescribing control measures.

Information in the series of articles in Pest Control is sufficient for making identifications to family, and for distinguishing damage done by beetles incapable of reinfesting seasoned wood. Thus, you can avoid applying unnecessary controls for beetles that can't reinfest dry wood and you can select proper control measures for those pests of seasoned wood that do need controlling. Obviously, then, if we intend to make distinctive identifications and consider beetle biologies as a partial basis for selecting control measures, we must use distinctive names. We should dispense with the term "powder-post beetles" anyway because it is not a very suitable term. Why? Because beetles in the family Lyctidae have the common name true powder-post beetles.

Lyctid beetles have been more widely studied and loose usage of the term powder-post beetles just causes known biological information about all the beetles to be confused. None of the beetles commonly found damaging seasoned wood have very good common names. For example, the most common beetle damaging structures in the Southeastern United States, Xyletinus peltatus (Harris), a member of the family Anobiidae, does not have a common name. Other wood infesting beetles either have no common names or their names are inappropriate. Therefore, I've suggested names for referring to the most important beetles that damage wood products--the ones capable of reinfesting seasoned wood.

The acronym ALBOW aids in remembering these names. Remember this acronym by thinking of sore elbows in a crawl space. The A remains you of the suggested name--anobiids; L is to remind you of the suggested name--lyctids; B--bostrychids; O--old house borers, the major pest of seasoned wood in the family Cerambycidae; and W--weevils. Certain weevils in the subfamily Cossoninae may damage seasoned wood. They really are relatively minor pests.

If proper control measures are to be selected according to typical biological habits, we need to know certain information such as beetle identification, wood identification, and the habits of the beetles represented by ALBOW.

I won't cover the subject of wood identification, but the only identification needed is to distinguish between hardwoods and softwoods. References in the pest control series should give you this information. It's been my experience that the training of most PCOs has not included a basic knowledge about wood--how it is formed, how to identify wood, and the appropriate terminology. If you are controlling pests that damage wood, then this knowledge is needed. When identifying beetles, we are really just identifying the damage that they cause because the adult beetles are seldom found and the larvae are hard to identify. Thus, it seems as though you have only a few exit holes and some powder on which to base your identification. There are other characteristics.

The acronym TOW-A-TOP is to help you to remember these characteristics: The TOW stands for the type of wood attacked--softwoods or hardwoods. The A is to remind you of the age of the wood attacked--old wood, under this definition, is wood that more than 10 years has elapsed since it was felled from a tree. The anobiids are usually found in old softwoods and hardwoods; lyctids and bostrychids
in new hardwoods; old house borers in new softwoods; and weevils in old softwoods and hardwoods. The TOP is to remind you of the type of products damaged. The anobiids are usually found in floor joists, subfloorsing or lumber; although, they may damage almost any wooden article in a widespread infestation. The lycids are usually found in hardwood millwork, furniture, flooring, or paneling in new homes. Bostrychids are often brought in the homes in firewood or they may occur in the hardwood flooring and paneling in new homes. The old house borers are usually in the softwood structural timbers of new homes or else in new lumber.

Now let's review the available control measures for these beetles. These include: temperature regulation, wood moisture content regulation, toxic chemicals, surface films, oxygen depletion, mechanical removal, and quarantine regulations. You should recognize that some of these control measures are rarely used but they have been tried. Others are control measures only in the sense that they help prevent beetle attack. Some of these control measures are more effective against some beetles than others. Many of these control measures are not applied by PCOs but they are important in preventing beetle damage. I think those of you in structural pest control should be using an integrated control approach for beetles infesting wood in structures. In other words, there may be more than just one or two control measures available for your use.

You are most likely to be using toxic chemicals--chlorinated hydrocarbon insecticides. Really preservatives are not very effective against beetles and they aren't recommended because brush treatments of beetle-infested wood won't prevent the emergence of adult beetles. Brush treatments are lacking long term effectiveness. The only way preservatives are effective are when they are applied as pressure treatments. The two common fumigants for beetle control are methyl bromide or sulfuryl fluoride. Current USDA recommendations for wood surface spray treatments are 2 percent chlordane or 1/2 percent lindane in oil carriers. I know that these USDA recommendations are at odds with current industry practices and I know that there is an EPA approved label for water emulsion formulations of chlordane for beetle control. Test data on the effectiveness of water emulsions for beetle control is limited. Therefore, we feel that more information is needed about their effectiveness. We are planning tests to obtain such information now.

Let's look at several examples of beetle damage, discuss how biological habits can be used in identification, how to apply the acronyms ALBOW and TOW-A-TOP when considering the identifications, and the recommendation of control measures, and relate these practices to the image of the pest control industry. With beetle infestations, one of the first things you must do is determine whether an infestation is active or not. The primary means of doing so is by the presence of fresh powder on the damaged wood. For anobiids it will be drifting down the sides of floor joists or there will be piles of frass beneath the damaged wood. Old damage would have many exit holes but no powder. Probably the beetles have already left the wood or they have previously been controlled.

Suppose you inspect a house for beetle treatment and learn that the house is about 20 years old with a crawl space. You note that the street in front of the house is much higher than the lot. You crawl in the crawl space and you notice that it is very wet, there is evidence of standing water. You look for damage, you notice that there is some old powder and a lot of exit holes but there doesn't seem to be very much fresh damage. You go inside and you see that there is damage in the footboard of the bed. You note that the bed is made of hardwood, the wood in the crawl space was softwood, you look a little further and you note that there is damage in the headboard. Again, it is a hardwood but it is a different one. You look at the dresser mirror frame and you see that there is damage there too. Now what beetle does this damage suggest? Remembering the acronyms ALBOW and TOW-A-TOP--the house is about 20 years old, there is damage in both softwoods and hardwoods,
the frass has lemon shaped pellets in it, and feels gritty; these are all characteristics of the anobiids.

How would we control this infestation? The suggestion for immediate control would be fumigation. But maybe the owners don't want to pay for this. You noted that the road was higher than the lot and when it rained that the water overflowed the lot and flowed toward the house. One of the things that you could do would be to install drainage tile which would direct the water away from the house. Then apply a moisture barrier in the crawl space—a polyethylene plastic film. And, of course, you should spray all of the bare wood surfaces with insecticides. But this still wouldn't control the beetles in the furniture. You may have to place them in a van type truck and fumigate them, or possibly treat all the bare wood and exit holes with insecticides.

We noted wood moisture content regulation earlier. This control measure in most cases is not applied by you but it is primarily directed toward anobiids. We can be thankful that almost half of our homes in the Southeast have central air conditioning and central heating, both of which tend to dry out the moisture in the wood which reduces the likelihood of anobiid beetle attacks occurring since anobiids are very dependent on moisture. Our homes have better ventilation than many of the homes in foreign countries where these beetles are a real problem. We can reduce the WMC in homes with soil cover applications in the crawl spaces. Surface films also reduce the moisture content.

With beetle identifications, there are obviously sources of confusion. The damage of anobiids and ambrosia beetles, bark beetles, or lyctids could be confused. Lyctid and bostrychid damage could be confused. Old house borer and miscellaneous round or flat headed borers could be confused. And weevils and anobiid damage could be confused. I'd like to show you some examples of damage to help you remember damage characteristics when you are inspecting homes. If you see some damage or holes like this in the wood, note that there is a dark stain on the walls of the galleries; there are a lot of branched tunnels; there is no powder present; and some of the holes in the wood are at an angle. These are all key characteristics of the ambrosia beetles. The holes appear to enter the wood at an angle because the beetles attack the wood while it is dying trees or drying logs. When it is sawn up the saw cuts these tunnels diagonally and thus causes the holes to appear to be at an angle to the wood surface. Ambrosia beetles can't reinfest dry wood and there is no need to apply control, yet, I've inspected many houses supposedly given powder-post beetle treatment where the only damage present was that of ambrosia beetles.

I don't have any damage pictures for these beetles but a few characteristics for bark beetle damage would be that there are strips of wane or bark present on the wood, tunnels underneath this bark would score both the bark and the wood, there would be some powder the same color as the bark in these tunnels and damage wouldn't be widespread.

I recall inspecting one house in Mississippi that had been given a beetle treatment with this type of damage. The owner was a widow and she had a termite service contract on her house. A year or two after the termite treatment, the PCO was making an annual inspection and he told her that she had beetles and that she had better get the house treated or it might fall down. Alarmed, she borrowed the $250 to have the treatment done. When we inspected the house we could just find a couple of floor joists that had damage with these characteristics. These beetles attack dying trees and they can't infest dry wood so there was no need for the treatment. Imagine what a few treatments like this can do for the image of the pest control industry.
New homes often have damage within 10 years after building. Often damage is found in hardwood flooring, trim, or molding, or else in window and door units. Examination of powder reveals it feels like talcum powder. The damage is always in new homes, in large pored hardwoods like ash, oak, pecan, hickory, or imported hardwoods. How do we control these beetles? If the wood hasn't been installed in the homes yet, often kiln drying can be used. Really, attempts at temperature regulation are just extremes of heat or cold. For most articles it is achieved by kiln drying but for smaller articles, infrared radiation, microwave radiation, conventional oven, or even the opposite extreme, freezing can be used. Many times with lyctid infestations in window and door units or in the flooring, only one or two units or a couple of boards are infested. Often the most effective means of control is simply to remove and replace the units with sound new ones.

Surface films have done much to reduce the damage by lyctids. Lyctids used to be a real problem but because of better kiln drying facilities in hardwood industries, faster movement of articles, and the use of water repellent sealers or other finishes after machining, which seal up the pores of the wood, the lyctids are unable to attack the wood. The importance of the lyctid problem is changing because many of our hardwood products are being imported from other countries now where dry kilns are not available. The wood is often air-dried and stored for long periods. Lyctid beetles have ample opportunity to attack the wood and often infested materials escape detection by port quarantine officials because no outward damage is visible.

Suppose you examine a bamboo machette handle from Asia. To determine whether it was lyctids or bostrychids requires examination of the powder. The powder of bostrychids is coarser than lyctids and the holes average somewhat larger than lyctids. This infestation could be controlled by placing it in an oven, dipping or brushing insecticides on it, freezing, etc. There are a number of ways of controlling infestations in small articles.

If some large oval holes are found in another house, you must determine whether it is old house borers or some other long-horned borer. If you want to be sure whether you are treating a pest that can reinfect seasoned wood or a pest of dead or dying trees, you dig out some of the frass and you find that it is coarse fibrous frass, it is not tightly packed powder. This should tell you that it is any one of a number of miscellaneous long-horned borers. If the frass was tightly packed, it would tell you that it was old house borers and maybe a fumigation treatment would be necessary if the damage was widespread.

How many of you are aware of what will be our greatest wood-destroying beetle problem in the very near future? Or why this problem is occurring? Or that it is largely preventable?

A typical example of our future problem is wood-destroying beetles in imported wood products. Why is it occurring? Because our nation's supply of hardwood lumber is insufficient to meet the demand. Manufacturers of window and door units, trims and moldings, and furniture are searching for supplies of cheaper raw material. Woods such as white pine and ponderosa pine are being replaced by banak. Many different foreign woods are being used for furniture. Examples would be guatamb, ramin, and samba. Also, composition board, pressboard, etc. overlaid with veneers has become common in the furniture industry. Beetle infestations are most prevalent in banak used for windows, doors, trims, moldings, and in various other woods imported as furniture stock. Occasionally problems occur in plywood. Only about 10 percent of the imported wood arrives in log form; primarily these logs are high-quality veneer stock. This situation is a result of economics. It is cheaper to utilize foreign labor for the initial manufacturing processes, and of course, removal of waste products reduces shipping charges. Also, semi-manufactured products can be
containerized for easier handling.

The world's supply of hardwoods is primarily in southeast Asia, Africa, and Central and South America. Most of our hardwood imports come from Asia and the Americas; most of Africa's exports go to Europe. In general, very few beetle infestations occur in luan plywood or mahogany imports from Asia and Africa.

Many foreign woods are being introduced into world markets. Some of these are low grade and some are very susceptible to beetle attacks.

So, what is the problem? Logging, drying, manufacturing, and transportation practices in the countries supplying these hardwoods are not so sophisticated as in the United States. Most of the logs are floated downriver and stockpiled for sawing. The upper portions of less dense logs of species such as banak suffer severe ambrosia beetle attacks. Dry kilns are seldom available and the lumber is usually air-dried. Transit time from felling to importation in the United States can be 6 months or even years. Thus, beetles have ample opportunity to infest many of these woods and they are doing so. So?

The United States has quarantine inspections and infested shipments will be detected and controlled. Right? Not necessarily! The wood may contain eggs or larvae and no damages (exit holes) are visible on the surface so the infestation passes through undetected. Inspectors may find a whole shipload of lumber infested by very damaging pests of seasoned wood like the old house borer or Lyctus brunnaus; yet no controls would be applied because these beetles are already established in our country.

I don't intend to cast any unfavorable impressions on the Animal and Plant Health Inspection Service (APHIS). APHIS quarantine inspectors do a remarkable job under very unfavorable conditions and they have a tremendous workload. What I am trying to do is shed some light on the problem of introducing beetle pests or spreading of beetle infestations which occurs through the importation and movement of foreign woods in our country. I think it would be informative if we examine our country's import policies and quarantine inspection problems. This subject should be one that some of you have firsthand knowledge of and one that the Armed Forces Pest Control Board can be very influential in solving.

Is a permit required for the importation of wood into our country? Or, in other words, is wood subject to import regulations? No. Wood is not a regulated item. This does not mean that our quarantine personnel do not inspect shipments of imported woods, for they do. What it does mean is that foreign exporters do not have to meet any specific regulations regarding shipment of wood into our country. Is this bad or good? How can our policies be changed? Should they be changed? The answers to these questions are not simple. Answers cannot be easily given without first considering the problems of the quarantine personnel, port operations, shippers, importers, foreign exporters, and the effects any changes may have on commerce. Let us use the port of New Orleans for an example. Twenty APHIS inspectors must inspect annually over 100 million tons of cargo passing through 25 miles of wharf and warehouse facilities. Envision miles upon miles of covered docks or warehouses bustling with people, lift trucks, cars, trailer trucks, etc. in the stifling heat of summer to the damp cold winds of winter, the exhaust fumes of vehicles, and piles upon piles of an endless variety of commodities from many countries of the world. These are the conditions in which these inspectors work, often on nights, weekends, and holidays. Cargo continues to become more and more containerized or packaged and more and more difficult to inspect properly. Searches are made for over 700 wood-inhabiting insects as well as 150 species of snails, various nematodes, etc. Infested shipments are held until decisions are made to control the pests or release the shipment. All fumigations are inspected for proper procedures and concentrations.
Obviously, cargo, inspections, and conditions vary from port to port. Control costs are borne by the shipper. Thus, variations in port inspections gain the ire of shippers. Thorough inspections of various infested commodities and required control operations can literally "stall" a port or cause shippers to import through a different port, thus gaining the ire of port authorities. Control costs for infested shipments can cause the cost of all shipments to be increased to meet these costs. Thus "profits" are substantial for uninfested shipments. In addition, LASH and Seabee barge systems are expanding operations. With these systems, a barge is loaded with some commodity in a country, then the fully loaded barge is loaded on the mother ship, brought to the United States, unloaded and towed upriver to Oklahoma City, Kansas City, St. Paul, Pittsburg or some other inland city before it is ever opened or inspected. The potential for pest introduction is obvious.

In short, the problem is complex. It is largely an administrative problem, requiring the establishment of good communications between interested parties. There are also facets of these problems that would require considerable research effort. These research problems include compilation of reference materials on many, many insects and foreign woods. APHIS personnel, primarily through the efforts of one very capable and dedicated man, have compiled a list of about 676 insects intercepted in wood products. Many, if not most, of these insects have not been studied. If anything is known about these pests, the information is either old, in a foreign language, or inadequate, i.e., virtually inaccessible. We in the Forest Service, or personnel in other agencies, are not prepared to assess the importance of all these pests or make decisions on the need for control.

Many foreign woods have trade names or common names which vary with the country of origin. One trade name may include a number of different species with varying susceptibility to beetle attack. A compilation of commercially important woods by scientific name, trade names, countries of origin, known pests, etc., would be very helpful.

The effectiveness of microwave radiation in the sterilization of wood in ports, wholesale or retail lumberyards, and homes needs to be fully investigated.

These are some of the future problems with wood-destroying beetles. I could describe dozens of infestations in imported products I have encountered in the last 3 years which indicate the future is now. How do we go about solving these problems? I welcome your comments and questions.
Biology of Termites
Joe K. Mauldin

What are Termites?

Termites belong to the order Isoptera (Iso. meaning equal and -tera meaning wings). Isoptera and Hymenoptera are the two orders containing social insects. However, termites are really more closely related to roaches, but we'll not get into that today.

There are about 2,200 known termite species in the world, 55 of which are found in the United States. Few of these are economically damaging to man's possessions.

Colonizing Flight

Termite flights are not mating flights. Males and females fly, lose their wings at a preexisting basal suture, and by chance a male and female find each other. In tandem (male behind female) they seek a nest site such as a piece of wood, under which they seal themselves, mate (3 to 7 days after flight), and thus begin a new colony. The males continue to live and fertilize the female throughout life.

Termites usually remain hidden in wood or soil but periodically swarming tubes 2 to 8 inches long, or perhaps longer under certain conditions, are constructed. Workers and soldiers guard the emergence holes before, during, and after the flight.

Major flights usually occur in the spring or fall and with some species certain meteorological conditions must be met before flight will occur. Eastern Reticulitermes species have their main flight in the spring (February to May) and Western Reticulitermes have their main flight in the fall, usually the first sunny day after a rain. The flight may cease if the area become shaded or if ants attempt to enter the emergence holes.

From a control standpoint, sporadic flights are often encountered in areas where man has modified the environment so that conditions required for flight exist only in a small area. For example, hosing out a garage or an overflowing bathtub may trigger a flight in colonies close by.

The synchronous or simultaneous swarming of termites is one of the rhythmic activities of termite colonies which is not well understood. The stimulus or stimuli are unknown but probably a combination of successive factors are responsible. How precise are these clues? Simultaneous swarming occurs from many colonies over a large area (even from state to state).

Some additional comments concerning flight are as follows: (1) winged adults never return to the parent colony after flight, (2) some adults never leave the colony and a portion of these lose their wings and are accepted in the colony, but not as functional reproductives, and (3) the alates may comprise from 2 to 43 percent of the individuals in a colony.
Colony Founding and Growth

Little is known about how the paired dealates select a nest site. In dry-wood termites it is thought that nest site selection is done visually (a building, fence post, dead tree, etc.). In other termites, site selection is thought to be thigmotrophic. That is, any stone, log, or chip of wood will suffice.

Egg-laying is very slow at first. For example, R. flavipes lays 6 to 12 eggs in the first 30 to 60 days after pairing and 60 to 90 days later a somewhat larger batch is laid. If all goes well, a new colony may produce alates in 3 years and the colony is large enough to be damaging after 5 years. The parents must feed the young termites until the third instar is reached, then intestinal protozoa are passed from the parents to the young. The young workers then begin to feed the parents, other young termites, and soldiers, and do so for life. The protozoa are lost at each molt and must be reacquired from their brothers. The workers may live from 1 to 10 years and the reproductives from 3 to 30 years. The number of soldiers in a colony depends on the termite species, i.e., in Reticulitermes, soldiers account for about 10 percent. The soldiers cannot feed themselves and must be fed by workers.

Early in colony life eggs are laid by the primary queen. Later, supplementary reproductives may develop from workers or nymphs. These supplementary reproductives are not as prolific as the primary queen but 40 to 250 may be in one colony so in combination they lay more eggs than the primary queen. The functional supplementary reproductives cannot feed and are fed by the workers.

Feeding Behavior

Termites may literally damage wood, say in the floor of your home, until someone, maybe you, falls through the floor. Aside from the fact that this incident will cost someone a lot of money, several questions come to mind. How did the termite get to the floor? Did the termite choose between the floor wood and other wood? Why and how does a termite eat wood?

Termites can damage an incredible variety of items, i.e., tin cans, elephant tusks, billiard, golf, or croquet balls, etc. However, these items are damaged, but not used as food by termites. The damage results when termites burrow through the items, when the items are corroded by their body moisture or secretions, or when moist earth is packed against the item.

Let's get back to your floor and discuss the three questions somewhat further.

A. How did the termites find the wood in your floor? Random search? Directed search? Perhaps a few examples would help us.

(1) This slide shows tunnels built by Reticulitermes flavipes on a tree to Sheboygan, Wisconsin. The tunnels lead only to a dead limb.

(2) Some species of termites in Africa will wrap up a tree with runways. Are they searching for dead branches?

(3) An Australian species of Coptotermes built a 135-foot long gallery which varied in depth from 7 to 28 inches. Each time the gallery was deepened it was to avoid gravel. Finally it branched and one branch went straight up to 2-1/2 inches deep to enter a root of an
eaten-out stump. Did scouts find the root and lay a chemical trail for his brothers to follow? Obviously, termites are quite capable of finding available food supplies. When their food supply is a dead tree or stump there is no problem, but when our homes or other woody possessions serve as food, then there is quite a serious problem. As long as it's food, the termite doesn't care.

We really don't understand exactly how the termites found your floor.

B. How about why they chose the floor and not some other wood—the walls, for example? This can be very tricky and complex and we will look at a few of the problems.

Termites have been known to build runways across some wood to attack another kind of wood. Everyone knows that some woods are eaten—others aren't, but is it really that clear cut? For example:

(1) Over 200 species of wood are listed in the literature as being resistant to termites and North American woods have not been studied.

(2) Railroad sleepers in Australia which lasted 50 years were transferred to South Africa and were ruined in 2 years. Different termites—different climate.

(3) Bald cypress is thought to be resistant to termites, but in Florida Incisitermes snyderi specializes in attacking cypress snags and poles.

(4) Redwood also has a reputation for being termite resistant, but in California some termites prefer it.

(5) Sapwood is more readily attacked than heartwood and in this day of fast growing trees, pines at least, the heartwood doesn't have time to form the components necessary for termite resistance.

(6) If wood is decayed, its susceptibility to termites may be changed. Decayed wood may be repellent, favorable, or toxic to termites.

(7) Termites will eat the most preferred woods if they are available, but if steak isn't available, they'll eat hamburger.

C. How do termites eat wood?

Termites, individually, do not eat much wood, but in combination, several thousand termites can destroy considerable quantities of wood.

The presence of protozoa in the hindgut of termites has been known for over 100 years and the symbiotic relationship has been known for over 50 years and we still don't know the exact physiological relationship between the termites and their protozoa. We do know that without the protozoa the termites die and that one important thing the protozoa do is digest cellulose. We are in the process of studying this symbiotic association to determine what physiological role various species of protozoa play in the association.
Two problems associated with studying this symbiotic association are as follows: (1) the major protozoa have not yet been cultured in vitro and (2) some of the protozoa may not be contributing to the general welfare and thus may be just going along for the ride. Because the protozoa cannot be cultured in vitro, we are selectively eliminating the protozoa and then running metabolic studies to determine how well the abnormally faunated termites can function. Through the use of $^{14}$C-cellulose we have shown that Coptotermes formosanus cannot survive or synthesize normal levels of lipids with one species of protozoa eliminated. Protein synthesis does seem to be affected as much as lipid synthesis. But why worry about such studies? It is known that any life process which depends on more than one organism is a fragile relationship—if one is killed the other also dies. We are trying to interrupt the biochemical processes in this fragile association between termites and their protozoa.

Environmental Influences

A. Moisture—This subject is very much misunderstood. First, let's discuss the moisture content of wood. Wood is hygroscopic and thus absorbs water. The moisture content of wood depends on the season, where the wood is, and whether the house is centrally heated and air-conditioned. If the air around wood is wet, the wood soon will be and if the air is dry, the wood will be, also. Subterranean termites tested in the laboratory eat maximally on wood at 40 to 200 percent moisture content. The upper level is just short of soaking wet. However, some subterranean termites can attack wood with a moisture content as low as 13 to 15 percent and drywoods as low as 10 to 12 percent.

Perhaps several reminders are in order at this point:

(1) What WMC termites need to establish an attack and what they need to maintain an attack are two different stories and should not be confused.

(a) Termite colonies can maintain an attack although they will not prosper, in very dry wood, especially if it is a big, well-established and thus sealed-in colony.

(b) Without a source of moisture subterranean termites cannot initiate an attack.

(c) Wood can be very dry and termite galleries over the wood very moist because the termites keep them that way.

(2) What is the source of water for termites? Termites do not have to be in contact with the soil—faulty plumbing, drains, leaky roofs, or clogged gutters and downspouts will serve the purpose.

(3) The relative humidity of the air is relatively unimportant. Subterranean termites carry moisture by capillary action of the soil and they can descend to the water table. Drywood termites get their moisture from the wood.

B. Temperature—The main problem with discussing the influence of temperature on termites is that termites are not exposed to the same temperature we are. The temperature in the center of mounds of some Australian termite was 15 to 190 F. higher than in the center of unoccupied mounds. Colonies of Reticulitermes really
change position in soil and wood, depending on the temperature. In winter the entire colony is below the frost line.

That about temperature extremes?

Cold—Some termites have been found frozen to the point of rattling like peas but when thawed they were fine. However, a temperature of close to 32°C limits movement and survival of termites. Cold temperatures may depopulate a colony by confining them deep in the soil below adequate food sources.

Heat—R. flavipes, 86°F will slowly (over weeks) kill them; 97°F will kill them after 4 to 5 days.

C. formosanus, 91°F will slowly kill them.

Thus, termites can control, at least to some extent, their own temperature and humidity because of their social behavior.
The southern pine beetle has been a chronic pest problem in east Texas for the past fifteen years and the Texas Forest Service has the legal responsibility of monitoring the outbreak. In the past, infestation records were recorded by hand in large ledger books maintained in the District and industry field offices. Not only was this record keeping method time consuming, but very little data retrieval on short notice was possible—there was just too much information through which to sort.

With the cooperation of the larger timber industries and the National Forests in Texas, the TFS initiated the SPB Operations Informational System in March 1973 to facilitate statewide survey and control operations. A computer program was developed to handle all pertinent spot information.

All records concerning beetle spots are placed on computer punch cards as soon as they are received from field offices. On a single spot at least three different input reports may be received. These include: (1) a flight report following an aerial detection survey; (2) a ground check report that provides more accurate information after ground examination; and (3) a control report indicating how and when a spot was controlled.

Computer printouts providing up-to-date spot information are then sent to the various field offices at weekly or bi-weekly intervals during the active beetle season. Operational summaries are sent to the administrative units of field offices to keep supervisors abreast of pest activity and control status on their lands.

The printouts received by the field offices contain lists of spots to be ground checked and lists of spots to be controlled. Once a spot is reported controlled or inactive it no longer appears on the printouts and provides a visual incentive for field personnel to reduce the number of spots requiring ground check or control action.

Other computer programs have been written to provide periodic summary information from the field data. These include:

1. A state-wide summary of six different levels of spot activity (highly active through inactive) by four spot size ranges (1-25, 26-50, 51-100, 101+). Spot size and spot activity are based on the number of active trees at the time of ground check.

2. A state-wide summary of six control techniques for four spot size ranges. Control strategies most commonly used in Texas are salvage, fell only, and fell and top. The spot sizes (based on number of active trees at time of control) are the same as in 1 above.
3. A list summarizing the SPB status in each TFS grid block (Ca. 18,000 acres) within the entire infestation area. Information includes total spots detected, total active trees, total spots controlled and total spots inactive.

One, two and three above are used by the Pest Control Section for writing statewide infestation status reports.

4. A list of spots that have been reported controlled or inactive since the last run of the operational report. These can be used to update flight maps and are sent to TFS field offices.

5. A complete listing of all spot information in the data bank for all or part of any cooperator or TFS administrative unit. These dump reports are not run regularly, but only when requested (by a particular company or TFS administrative unit).

6. A printout of SPB killed timber for sale indicating the number of active trees by size-class categories (pulpwood, small sawlog and large sawlog). This is sent to wood dealers in the vicinity of the spot to encourage salvage.

7. A summary of timber volumes killed by SPB categorized by salvaged or not salvaged pulpwood and sawtimber, total number of merchantable and non-merchantable trees killed, and number of infested acres. The volume of timber lost for any single company, county, administrative unit, etc. can be summarized as well as state-wide losses.
WORKSHOP: USE OF SYNTHETIC PHEROMONES AS A TOOL IN BARK BEETLE RESEARCH
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ABSTRACT

The recent isolation, identification and synthesis of a number of bark beetle pheromones has created great interest in application of these chemical messengers in control programs. Another, perhaps equally important, use of synthetic pheromones, however, appears to have been largely overlooked. Namely, the use of synthetic pheromones to facilitate research on bark beetle host selection and attack behavior.

Among the various ways in which pheromones can be used to elucidate aspects of bark beetle behavior are:

1. To concentrate flying beetles using standardized pheromone-baited traps as a means of monitoring diurnal and seasonal flight patterns of bark beetle and certain predators. Also, the vertical and horizontal distribution of in-flight populations can be measured with similar techniques.

2. To create sustained and renewable sources of attraction for study of bark beetle response and landing patterns about an attractive center.

3. To test the hypotheses of random versus non-random initial attack.

4. To ascertain the relative attractiveness of synthetic host volatiles active in the mass aggregation phenomenon. Host volatiles which appear inactive when bioassayed alone can be effectively tested in combination with equal amounts of synthetic pheromones.

5. To demonstrate that susceptible (stressed) host trees release host volatiles which, in turn, stimulate bark beetles to initiate boring activities.

6. To induce attacks on trees in pre-selected locations as a means of studying host susceptibility, attack patterns within and between trees.

To illustrate the various methods in which pheromones can aid bark beetle host selection studies, examples of the author's recent research utilizing synthetic trans-verbenol with the mountain pine beetle in eastern Washington were presented and discussed. In conclusion, the use of synthetic pheromones in future research on southern pine beetle was encouraged.
Pest Management Plans for Hardwood Insect Pests

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Pest management of hardwood insects in its infancy. Cottonwood nurseries and plantations are the only southern hardwood management areas where insect management is seriously considered at the present time.

Carbofuran (Furadan\textsuperscript{R}) granules have been recently registered for control of the cottonwood leaf beetle, the cottonwood twig borer, and the cottonwood clear-wing borer in cottonwood nurseries and plantations. Chlorpyrifos (Dursban\textsuperscript{R}) is being tested at the Southern Hardwood lab., Stoneville, Mississippi, as an alternate control for the cottonwood leaf beetle.

With these control tools and the present biological knowledge we have about cottonwood insect pests, their predators (in particular, the 12-spotted lady beetle) and parasites we should be able to develop a workable, integrated pest management plan for cottonwood nurseries and plantations. Both Mississippi Forestry Commission and Crown-Zellerbach are looking into this possibility now.

New Methods Available for Controlling Pales Weevil

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For several years the pales weevil has hampered pine regeneration efforts by Weyerhaeuser Company in the Arkansas/Oklahoma region. Between 40-90% seedling mortality occurred whenever areas were planted immediately following logging. With the loss of DDT and Aldrin as legitimate protective treatments, field screening of new candidate insecticides was begun in 1971. Based on this work, the Environmental Protection Agency has recently registered Furadan\textsuperscript{R} for protecting individual pine seedlings from weevil attack. Furadan can either be used as a 1% ai clay slurry root dip, or applied as granules during or after planting at rates up to 1.0 g ai per seedeing. These treatments work best if planting is delayed until March. During the 1973-74 planting season, Weyerhaeuser Company foresters utilized these treatments safely and effectively on an operational scale.
Sex Pheromones of Tip Moths--Their Use as Research Tools

C. W. Berisford
University of Georgia

Tip moth sex pheromones may be very useful as aids in studies involving life histories or behavior. In several studies using pheromones as the primary investigative tools (Berisford and Brady, 1972; 1973; Berisford, 1974), we have shown that the Nantucket pine tip moth, Rhyacionia frustrana (Comstock), and the pitch pine tip moth R. rigidana (Fernald) can coexist in the same trees and even the same shoots due to different activity periods. Pheromones were also found to be effective species isolating mechanisms (Berisford, 1973).

Tip moth pheromones may be put to use in control attempts when synthetics are developed by attempting to inhibit R. frustrana, which is by far the most common southern species, with R. rigidana pheromones. We have shown strong R. frustrana inhibition with ratios as low as 1 female equivalent of crude R. rigidana extract or 50 R. frustrana equivalents (Berisford, et al., 1974).

Pheromones may also be useful for aid in timing of insecticide applications. Field populations may easily be monitored by untrained personnel by using pheromone-baited traps to determine when adult emergence begins. Careful monitoring may allow the use of short residual insecticides and thereby reduce the effect on non-target organisms.

References


Carpenterworm Sex Pheromone Studies

J. D. Solomon
U.S. Forest Service
Stoneville, Ms

and

R. L. Doolittle
USDA Attractants Laboratory
Gainesville, Florida

Based on chemical and electroantennogram studies together with bioassays, a synthetic sex attractant for the carpenterworm was discovered in 1971. Recent studies have centered around the synthetic compound to establish the best trap design, optimum concentration, isomer ratio, and keepers to extend the duration of attractancy. Of several trap designs tested, a 1-gal. cylinder mounted on a small piece of hardboard and coated with a sticky compound proved to be the best trap design. Traps baited with 250-500 micrograms of the attractant have shown the greatest activity. Combination of two isomers of the attractant appears to enhance the activity especially of low concentrations. A new "keeper", sustane-6, combined with the attractant greatly extends the duration of attractancy. Based on field tests, the synthetic attractant appears to be competitive with virgin female moths in attractancy. Based on these promising results, a small-scale control study utilizing the synthetic attractant was initiated in 1974.

Dioryctria abietella Sex Pheromone Studies

Carl W. Fatzinger
U.S. Forest Service
Olustee, Florida

Results of studies on the mating behavior and sex pheromone of Dioryctria abietella (Denis & Schiffermuller) was discussed. Periods during which the sex pheromone is released by female moths, and periods during which the male moths are responsive to the pheromone, follow a circadian rhythm. The duration of male responsiveness to the pheromone is about twice as long as the period of female release. This extended period of responsiveness might be exploited under field conditions by eliminating competition between synthetic and natural pheromone sources, e.g., by releasing synthetics during periods of male responsiveness that are not synchronized with periods of female release of the pheromone. Female production and release of the pheromone, as well as male responsiveness to the pheromone, are inhibited by light.
Dioryctria amatella Moth/Host-Attractant Trapping Study

E. P. Merkel and Carl W. Fatzinger
U.S. Forest Service
Olustee, Florida

In late September 1972 at Olustee, Florida, six male Dioryctria amatella moths were caught in 8 sticky traps baited with virgin females, and one female was caught in four traps baited with fresh-cut sections of southern fusiform rust galls taken from infected slash pines. The results of this preliminary test led to a larger exploratory field study in 1973.

A total of 66 cylindrical sticky traps were operated continuously from 16 April through 2 November 1973 in a slash pine clonal plantation (tree spacing: 20' x 20'). One-third of the traps were baited with two virgin D. amatella moths per trap with the objective of trapping males. Another one-third of the traps were baited with sections of fusiform rust galls, hopefully to attract gravid females. The remaining traps, serving as checks, contained neither virgin females nor galls. Fresh-cut gall sections and new virgin females were added to the traps at weekly intervals throughout the trapping period. Only three male D. amatella moths were trapped, in each of three separate female-baited traps, on 19 October.

The results of these preliminary field studies and laboratory studies of sex pheromone production and mating behavior only indicate that sex and/or host attractants may find potential use in an integrated control scheme for Dioryctria moths but much further in-depth research is needed.
BUSINESS MEETING

Mr. John Graham presided as chairman for the meeting in the absence of Chairman Bill Echols.

At a preliminary business session, a nominating committee consisting of Loyd Drake, Charlie Chellman, and Ken Knauer was appointed to present nominations for a new counselor. Also a resolutions committee was appointed consisting of Jack Heikkenen, Coleman Doggett, and Ed Merkel. Copies of a Directory of Conference Membership were distributed.

Bob Thatcher and Keith Shea briefly brought the group up to date on the Pine Bark Beetle Research and Development Program. A Program Document has been prepared and a program manager will soon be appointed. The program is set up for a 5-year period and outlines a strict time commitment for obtaining results. Program organization and costs were also discussed.

Bob Wilkinson, Chairman of Committee to Re-work Southern Pine Beetle Slide Set, showed a series of slides that had been selected for inclusion in the slide set.

Mike Remion, Chairman of Committee on Losses Caused by Forest Insects, passed out copies of the committee report. Several problems in collecting the data were discussed. Reporting forms will be re-worked for next year's data collections.

The Common Names Committee proposed the following four names for consideration:

1. Southern pine engraver  Ips grandicollis (Eichooff.)
2. Half winged geometer  Phigalia titea (Cramer)
3. Virginia pine sawfly  Neodiprion pratti pratti (Dyer)
4. Subtropical pine tip moth  Rhyacionia subtropica Miller

All four proposals received the necessary 75% approval of the membership and will be submitted to the ESA's Common Names Committee for consideration.


Allen Miller, Chairman of the "Ethical Awards" Committee, presented the award for 1974 to Joe Cook.

The Nominating Committee presented the names of Jack Walstad and Rich Goyer for Counselor. Jack Walstad was elected to a 3-year term as Counselor.

Three options for selecting future meeting sites were discussed: (1) meet at a central location (Atlanta), (2) alternate central meeting site (Atlanta and New Orleans), (3) select site from invitations (old way). A show of hands favored the third option, i.e. select site from invitations (old way). Invitations extended for the next meeting included Little Rock, Ark., Baton Rouge, La., and Louisville, Ky. By a show of hands, Baton Rouge, La., was selected for the 1975 meeting.

In the past, the Program Chairman has been selected by the Conference Chairman.
A motion was made by Bob Coulson that the Program Chairman be elected by the membership at the final business session. Motion was defeated.

Jack Heikkenen moved that a committee be formed to investigate the feasibility of setting up an international film library. Motion carried.

The question of need for a Conference Vice Chairman was raised. A motion was made that the senior Counselor serve as Acting Chairman in the absence of the elected Chairman. Motion carried.

Ed Merkel suggested that copies of the Conference Guidelines be made available at next year's meeting.

Appreciation was extended to all who helped make the meeting a success.

Acting Chairman, John Graham, adjourned the Conference until August 1975.
Treasurer's Report

Balance 11-23-73 $585.03

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Balance August 1, 1974 $306.91

Respectfully submitted,

Garland N. Mason, Sec.-Treas.
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