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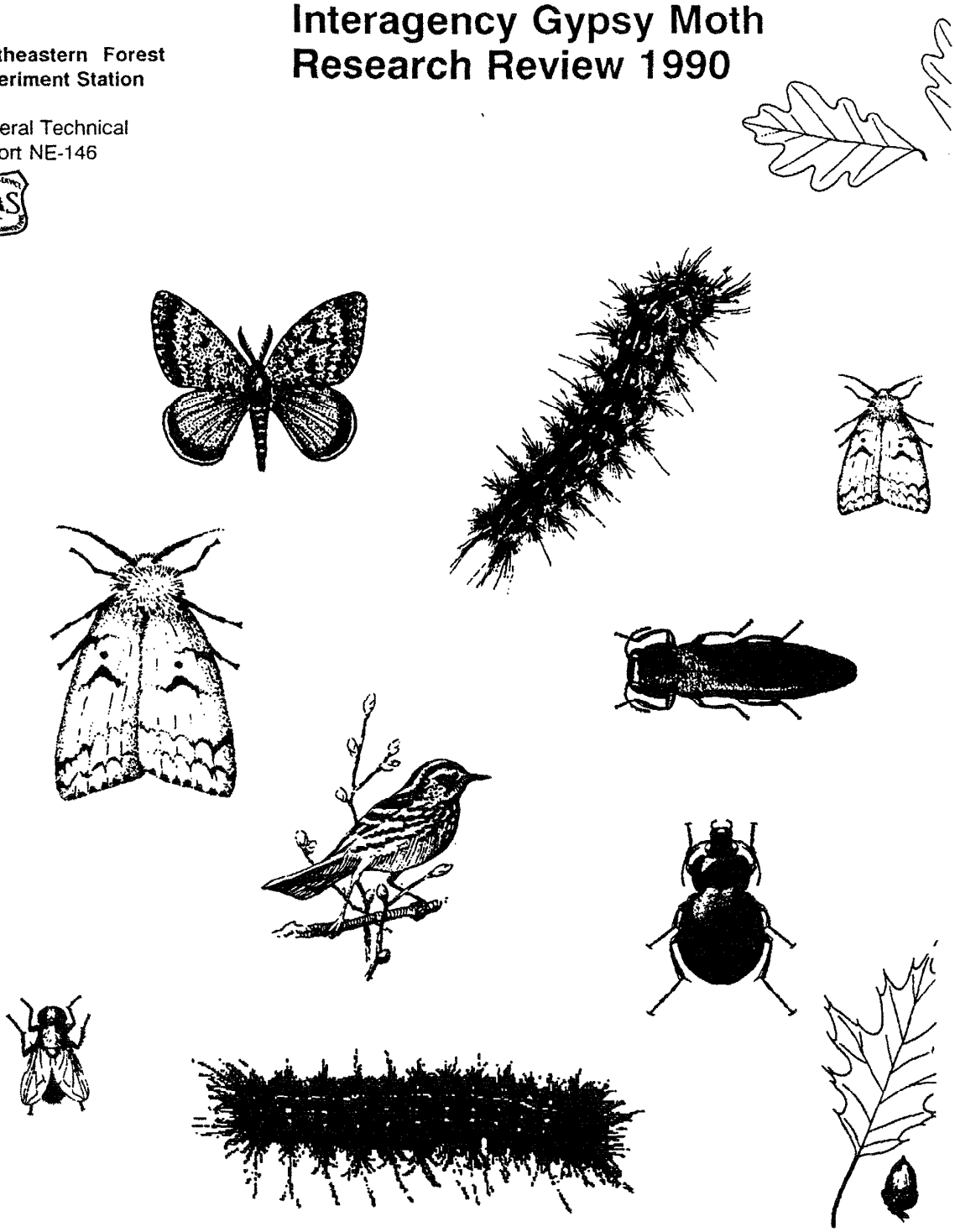

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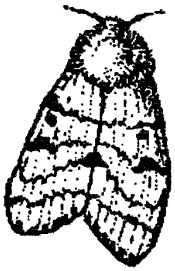

January 22-25, 1990
East Windsor, CT

Edited by
Kurt W. Gottschalk, Mark J. Twery, and Shirley I. Smith

Sponsored by:

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Forest Service State and Private Forestry

Agricultural Research Service

Animal and Plant Health Inspection Service

Cooperative State Research Service

FOREWORD

In July of 1989 representatives of Forest Service-Research (FS-R), Animal and Plant Health Inspection Service (APHIS), and Agricultural Research Service (ARS) began regular meetings to discuss opportunities for improving cooperation among the agencies conducting research on gypsy moth. Representatives from the Cooperative State Research Service (CSRS) and Forest Service-State & Private Forestry (FS-S&PF) were added over the next few months. The group is known as the USDA Gypsy Moth Research and Development Coordinating Group and has the following objectives:

a. To monitor the progress of Service programs and any breakthroughs which may influence USDA policies;

b. To keep the Services and the Gypsy Moth Working Group appraised of progress in research and methods development;

c. To identify research and methods development issues and concerns;

d. To set priorities;

e. To maximize use of current resources as well as to provide appropriate rationale to justify increased resources.

The Coordinating Group resolved at its initial meeting that a combined interagency review of gypsy moth research and development activities would add immeasurably to better communication as well as provide a comprehensive overview of ongoing research. Members of the Coordinating Group also agreed that a proceedings should be published following the meeting.

These proceedings document the efforts of many individuals: those who made the meeting possible, those who made presentations, and those who compiled and edited the proceedings. But more than that, the proceedings illustrate the depth and breadth of studies being supported by the agencies and it is satisfying, indeed, that all of this can be accomplished in a cooperative spirit.

USDA Gypsy Moth Research and Development Coordinating Group
R. Bram, ARS
C. Schwalbe, APHIS
R. Riley, CSRS
T. Hofacker, FS-S&PF
M. McFadden, FS-R, Chairperson

USDA Interagency Gypsy Moth Research Review
January 22-25, 1990
Ramada Inn
East Windsor, Connecticut

CONTENTS

INTRODUCTORY SESSION.....Moderator: Ralph Bram

Invited Papers:

M.E. Montgomery –
Variation in the suitability of tree species for the gypsy moth.....1

J.S. Elkinton, J.P. Burand, K.D. Murray, and S.A. Woods –
Epizootiology of gypsy moth nuclear polyhedrosis virus 14

M.J. Twery –
Effects of defoliation by gypsy moth 27

POPULATION DYNAMICS.....Moderator: Kurt Gottschalk

Invited Paper:

W.E. Wallner, C.G. Jones, J.S. Elkinton, and B.L. Parker –
Sampling low-density gypsy moth populations 40

Abstracts:

A.E. Hajek and J.S. Elkinton –
Entomophaga maimaiga panzootic in Northeastern gypsy moth populations 45

R.M. Weseloh –
General and specific gypsy moth predators 46

J.S. Elkinton, H.R. Smith, and A.M. Liebhold –
Impact of small mammal predators on gypsy moth 46

J.A. Witter, M.E. Montgomery, C.A. Chilcote, and J.L. Stoyenoff –
The effects of tree species and site conditions on gypsy moth survival and growth in Michigan..... 47

C.W. Berisford and M.E. Montgomery –
Performance of gypsy moth larvae on hosts from the Deep South: Survival, development and host preferences..... 48

K.W. Thorpe, R.L. Ridgway, and R.E. Webb –
Development of appropriate methodologies for sampling gypsy moth populations in moderately-sized urban parks and other wooded public lands..... 48

M.R. Carter, F.W. Ravlin, and M.L. McManus –
Leading edge gypsy moth population dynamics..... 49

A.M. Liebhold and J.S. Elkinton –
Analysis of spatial density dependence in gypsy moth mortality 50

BIOTECHNOLOGY ..... Moderator: William Yendol

Abstracts:

K.S. Shields and T. Butt –
Gypsy moth larval defense mechanisms against pathogenic microorganisms 51

J.M. Slavicek and N. Hayes-Plazolles –
Temporal analysis and spatial mapping of *Lymantria dispar* nuclear polyhedrosis virus transcripts and *in vitro* translation products 52

S.T. Hiremath, M. Fikes, and A. Ichida –
Construction of a transfer vector for a clonal isolate of LDNPV 53

J.M. Slavicek, C. Lanner-Herrera, N. Hayes-Plazolles, M.E. Kelly, and M. Fikes –
Replication and inclusion body characteristics of two *Lymantria dispar* nuclear polyhedrosis virus plaque variants 54

E.M. Dougherty, D. Guzo, K.S. Shields, D.E. Lynn, and S.K. Braun –
Autographa californica nuclear polyhedrosis virus replication in non-permissive *Lymantria dispar* cell lines 55

K.S. Shields and E.M. Dougherty –
Response of gypsy moth larvae to homologous and heterologous nuclear polyhedrosis virus 56

J.P. Burand, S.T. Keating, and J.S. Elkinton
Detection of *Lymantria dispar* nuclear polyhedrosis virus in infected larvae using a DNA hybridization assay 57

H.A. Wood and Yu Zailin –
Genetically engineered baculovirus pesticides and their environmental safety..... 57

GYPSES SESSION..... Moderator: Sheila Andrus

Abstracts:

G.A. Elmes, C.B. Yuill, and T.L. Millette –
Knowledge-based geographic information systems on the Macintosh computer: A component of the GypsES project..... 58

J.A. Logan, L.P. Schaub, and F.W. Ravlin –
Phenology prediction component of GypsES..... 59

M.C. Saunders and M.A. Foster –
The treatment implementation advisor: A component of the GypsES project 61

L.P. Schaub, F.W. Ravlin, J.A. Logan, and S.J. Fleischer –
Monitoring components of GypsES 62

M.J. Twery and G.A. Elmes –
Hazard rating for gypsy moth on a Macintosh computer: A component of the GypsES system 63

MICROBIAL CONTROL ..... Moderator: Richard Ridgway

Invited Paper:

M.L. McManus –
Microbial pesticides 64

Abstracts:

L.S. Bauer, M.L. McManus, and J.V. Maddox –
Interactions between nuclear polyhedrosis virus and *Nosema* sp. infecting gypsy moth 76

R. E. Webb, M. Shapiro, J. D. Podgwaite, D. D. Cohen, and R. L. Ridgway –
Evaluation of the Abington isolate of the gypsy moth nuclear polyhedrosis virus against a formulation of Gypchek® in small field plots 77

J. D. Podgwaite –
Gypchek® use pattern realities 78

N.R. Dubois –
Current research efforts with *Bacillus thuringiensis* 78

D.R. Miller, W.E. Yendol, M.L. McManus, D.E. Anderson, and K. Mierzejewski –
Summary of the Blackmo 88 spray experiment 79

R.E. Webb, K.W. Thorpe, and R.L. Ridgway –
Gypsy moth management program for moderately sized urban parks and other wooded public lands 79

J. Rosovsky, B.L. Parker, and L. Curtis –
Vermont management in focal areas 80

J.V. Maddox, M. Jeffords, M.L. McManus, and R.E. Webb –
Summary of experimental releases of exotic microsporidia: Conclusions and recommendations 81

GYPSY MOTH BIOLOGY ..... Moderator: David Leonard

Abstracts:

J.M. Giebultowicz, A.K. Raina, and K.W. Thorpe –
Regulation of disparlure titer in gypsy moth females: Effects of mating and senescence 81

A.P. Valaitis and J. Jolliff –
Isolation and characterization of juvenile hormone esterase from gypsy moth (*Lymantria dispar*) 82

D.R. Gray, J.A. Logan, and F.W. Ravlin –
Using respiration rates of single eggs to determine pre-diapause development rates..... 83

J. Werren and T. O'Dell –
Use of molecular probes to detect parasites in gypsy moth 84

V.C. Mastro and A. Pellegrini-Toole –
The backcross sterility technique 85

J.A. Tanner and C.P. Schwalbe –
Outcrossing colonies of the Otis New Jersey gypsy moth strain and its effect on progeny development 86

R.W. Hansen –
Pupal abnormalities among laboratory-reared gypsy moths..... 87

P.W. Schaefer –
Variation in gypsy moth, with comparisons to other *Lymantria* spp..... 88

MONITORING / MODELING ..... Moderator: Max McFadden

Invited Papers:

F.W. Ravlin, S.J. Fleischer, M.R. Carter, E.A. Roberts, and M.L. McManus –
A monitoring system for gypsy moth management 89

J.J. Colbert –
History of research on modelling gypsy moth population ecology..... 98

Abstracts:

B. A. Leonhardt, V.C. Mastro, C.P. Schwalbe, and R.L. Ridgway –
Pheromone dispenser formulations for use in gypsy moth management programs.....111

J.S. Elkinton and M.L. McManus –
Development of a pheromone-baited trap to monitor gypsy moth populations 111

S.J. Fleischer, E.A. Roberts, F. William Ravlin, and R.C. Reardon –
Monitoring and mapping gypsy moth data in AIPM: The process and problems of implementation.....112

A.M. Liebhold, J. Halverson, G.A. Elmes, and J. Hutchinson –
Landscape ecology of gypsy moth in the Northeastern U.S.....113

J.A. Logan and D.R. Gray –
Modeling gypsy moth seasonality.....114

J.M. Russo, J.G.W. Kelly, and A.M. Liebhold –
Mesoscale landscape model of gypsy moth phenology.....115

J.J. Colbert and Xu Rumei –
Behavior of the gypsy moth life system model and development of synoptic model formulations.....116

IMPACTS ..... Moderator: Robert Wolfe

Invited Paper:

R.R. Hicks, Jr. –
Hazard rating forest stands for gypsy moth 117

Abstracts:

C.G. Jones –
What causes the patterns of gypsy moth defoliation? 127

M.J. Twery and P.M. Wargo –
Development of a sampling system for *Armillaria* rhizomorphs in mixed oak stands: a progress report 128

R.C. Whitmore and R.D. Greer –
Short term effects of gypsy moth defoliation on nongame birds 129

D. Samuel and R. Silvester –
The effects of gypsy moth infestation on gray squirrel habitat and populations 130

S.M. Brock, S. Hollenhorst, and W. Freimund –
Effects of gypsy moth infestation on aesthetic preferences and behavior intentions 131

K.W. Gottschalk –
Using silviculture to minimize gypsy moth impacts 132

R.D. Greer and R.C. Whitmore –
The effects of gypsy moth-oriented silvicultural treatments on vertebrate predator communities 133

CLOSING COMMENTS ..... USDA Gypsy Moth Co-ordinators

POSTER PRESENTATIONS:

Abstracts:

D. E. Anderson, D. R. Miller, and W. E. Wallner –
Demonstration of the gypsy moth energy budget microclimate model 134

D.E. Anderson, D.R. Miller, Y.S. Wang, W.E. Yendol, and M.L. McManus –
Micrometeorological measurements during the Blackmo 88 spray trials 135

J.P. Burand, H. Horton, J.S. Elkinton –
Detection of latent nuclear polyhedrosis virus in the gypsy moth 135

J. J. Colbert and G.E. Racin –
Gypsy moth life system model 136

J.R. Deans –
Modified lignin sulfonate formulation for the photo protection of GMNPV 137

B. Duan, K. Mierzejewski, and W.G. Yendol –
Statistical comparison of AGDISP prediction with Mission III data 138

R.W. Fuester –
A multiple regression model for parasitization of gypsy moths by the introduced larval parasite *Cotesia melanoscelus* (Hymenoptera: Braconidae) 139

K.W. Gottschalk –
Does previous stand management influence gypsy moth-related mortality? 140

K.W. Gottschalk –
Gypsy moth impacts on oak acorn production 141

R.R. Hicks, Jr., D.E. Fosbroke, S. Kosuri, and C.B. Yuill –
The West Virginia University Forest hazard rating study: the hazards of hazard rating 142

J.B. McGraw and K.W. Gottschalk –
Interactive effects of defoliation and low resource levels on photosynthesis, growth, and gypsy moth larval response to red oak seedlings 143

M.E. Montgomery –
Predicting defoliation with egg mass counts and a "helper" variable 144

J.M. Slavicek and N. Hayes-Plazolles –
Identification, cloning, and expression analysis of three putative *Lymantria dispar* nuclear polyhedrosis virus immediate early genes 145

H.R. Smith –
Understanding predation: implications toward forest management 146

M.J. Twery –
Changes in vertical distribution of wood production in hardwoods defoliated by gypsy moth 147

C.R. Vossbrinck, M. Baker, J.V. Maddox, M.R. Jeffords, and B.A. Debrunner-Vossbrinck –
Using ribosomal RNA technology for classifying microsporidia 148

Y.S. Wang, J.Welles, D.R. Miller, D.E. Anderson, G. Heisler, and M.L. McManus –
Architecture of the Black Moshannon forest canopy measured by hemispherical photographs and a Li-Cor LAI-2000 sensor 149

W.G. Yendol, K. Mierzejewski, D.R. Miller, D.E. Anderson, M.L. McManus, R.C. Reardon, and W. McLane –
Aerial application of *Bacillus thuringiensis* to an oak forest: deposit analysis and predictions with FSCBG 150

LIST OF ATTENDEES 151

DEMONSTRATION OF THE GYPSY MOTH ENERGY BUDGET MICROCLIMATE MODEL

D. E. Anderson[1], D. R. Miller[1] and W. E. Wallner[2]
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ABSTRACT

The use of a "User friendly" version of "GMMICRO" model to quantify the local environment and resulting core temperature of GM larvae under different conditions of canopy defoliation, different forest sites, and different weather conditions was demonstrated.

The model is a steady-state, one dimensional, numerical simulation of hardwood forest canopy and sub-canopy microclimate which was developed to examine some insect-host-environment interactions. The microclimate sub-model calculates radiation, leaf and air temperatures, and vapor pressure profiles. Soil and litter temperatures are calculated by the force-restore method. Caterpillar temperatures at each layer and for two contrasting resting positions are calculated with a four term energy budget equation. As the canopy undergoes defoliation by the insect, the model calculates the projected changes in microclimate.

In the PC version demonstrated here, the user can easily input various sites (slope, aspect, latitude), forest canopies, weather conditions, insect instars and time of the day. Therefore, comparisons of various conditions can be made and the effects of changes in these variables on the microclimate and larvae temperature at various locations in the forest from the top of the canopy to beneath the litter can be quantified.

The model can similarly be used to examine the physical environment of predators and parasites. Researchers in these areas are encouraged to try using the model.

The authors will give it, with instructions and help, to anyone interested in using it. It currently requires an IBM 286 PC or compatible to run the user friendly menu version. It can be made available as uncompiled Fortran77 code for use on the DG system or other mainframes.

MICROMETEOROLOGICAL MEASUREMENTS DURING THE BLACKMO 88 SPRAY TRIALS

D. E. Anderson[1], D. R. Miller[1], Y. S. Wang[1], W. E. Yendol[2], and M. L. McManus[3]
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ABSTRACT

Instrumentation was arrayed on a 120 foot tower to detail the local atmospheric conditions during the Blackmo 88 spray experiment. Measurements were continuous for 30 minute periods encompassing each spray pass. Vertical profiles of wind, temperature, humidity, heat and momentum flux, radiation and three component turbulence intensity were measured during each run. In addition, simultaneous upper air wind temperature were measured from the nearby mid-state airport with an acoustic radar operated by the Meteorology department of PSU. In all, 9 hours (18 runs) of data were taken over a period of 3 days, and a very high quality, complete data set was obtained for use in analyzing the deposition patterns.

The mean 30 minute profiles of temperature and wind from the various times of day show completely different thermal stability regimes during various times of day. The turbulence measurements during each run demonstrate that minute-to-minute changes in turbulence, solar heating, leaf wetness and local atmospheric stability are severe enough to cause wide disparities in the patterns of spray drift and deposition. The upper air measurements show that the most preferred times for aerial spraying, early morning and late evening, are periods of rapid stability transitions in the lower atmosphere and, therefore, uncertainty in drift patterns in spite of the low wind speeds at these times.

The data is now being used to correlate spray deposition patterns to local atmospheric conditions and to test the FSCBG model.

DETECTION OF LATENT NUCLEAR POLYHEDROSIS VIRUS IN THE GYPSY MOTH

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ABSTRACT

It is unclear if and precisely at what level the nuclear polyhedrosis virus (NPV) of the gypsy moth persists in its' insect host. DNA hybridization, the method currently used for the detection of persistent viral infections, can only detect 100 to 1,000 copies of the viral genome per cell. It is likely that viral genomes persist in insects at levels far below this. Using polymerase chain reactior (PCR), we have developed a method for the detection of viral DNA at a level of one copy of the viral genome per 100 cells. This assay holds considerable promise for determining if the gypsy moth virus persists in insects since it is very sensitive, highly specific for gypsy moth viral DNA and can be used for DNA samples extracted from a single embryo.

GYPSY MOTH LIFE SYSTEM MODEL

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ABSTRACT

The model is composed of four major subsystems that are driven by weather. The stand subsystem incorporates the effects of damage by the gypsy moth into annual tree diameter and height growth as well as tree mortality. These calculations are driven by ambient temperature accumulated for a year. The gypsy moth, predator/parasite, and pathogen subsystems are driven by the difference between daily minimum and maximum temperatures that are accumulated into 30 degree-day steps (step size can be altered by the user). Rain can also decrease gypsy moth development rates. Weather data can be introduced or stochastic weather generation requested. The gypsy moth subsystem follows the growth of the nominal insect in each cohort, density of insects, and larval movement between strata. The predator and parasite subsystem follows several natural enemy guilds and species that have been determined to be significant mortality agents of the gypsy moth; feedback is provided for some of these populations as gypsy moth is their food source. The pathogen subsystem follows naturally occurring nucleopoly-hedrosis virus (NPV), and introductions of both NPV and *Bacillus thuringiensis* (Bt) as insecticides. This subsystem models distribution of NPV in the environment and in infected gypsy moth.

The spatial scope of the model is a single forest stand. No spatial coordinates of trees are needed but the model does use vertical stratification of the tree canopies. The stand is partitioned by tree species and diameter class for calculation of tree growth and mortality and for calculations of foliage biomass for use in the gypsy moth portion of the model. Stand variables are updated once each year; these updates include stand management prescriptions imposed by the user.

Foliage, gypsy moth, and natural enemies are followed on a finer time scale within each year. After sufficient degree-day accumulation, foliage begins to grow and gypsy moth eggs begin to hatch. As long as the current generation of gypsy moth exists, each accumulated 30 degree-days produces another simulation step. Following the completion of an insect-generation cycle, annual summary accounts and links to the stand model are completed for a year, and another year produces another generation. These routines operate on a spatial scale that aggregates among the diameter classes for each tree species present. Four strata are distinguished: (1) overstory trees, (2) understory trees, (3) boles of overstory trees, and (4) a shrub and ground layer.

Four input data files are required and three others are optional. These provide the users with maximum flexibility in controlling the model. There are a number of table and plain ASCII text files that can be generated; the latter are designed for use as input to graphic packages or for use in statistical analyses.

MODIFIED LIGNIN SULFONATE FORMULATION FOR THE PHOTO PROTECTION OF GMNPV

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ABSTRACT

Many potentially useful insecticides and herbicides undergo relatively rapid degradation on exposure to sunlight. This research studied the formulation and behavior of a novel water-soluble carrier which was designed to form thin surface layers over leaves and stalks. This formulation contained a modified lignin sulfonate, photoreactive cross-linking agents and GMNPV. The research demonstrated that this formulation is converted by sunlight into a crosslinked film which is both water-insoluble and protects GMNPV from UV light. Bioassay studies demonstrated that this approach is as effective as the Forest Service formulation used for GYPCHEK. However, the modified lignin sulfonate formulation contain approximately one-fifth as many PIBs to achieve the same LD_{50}. Future tests will be performed in bogs to evaluate efficacy under damp conditions.

This research was funded by the National Science Foundation, Grant Number ISI-8860565.

STATISTICAL COMPARISONS OF AGDISP PREDICTION WITH MISSION III DATA

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ABSTRACT

Statistical comparison of AGDISP prediction were made against data obtained during aerial spray field trials ("Mission III") conducted in March 1987 at the APHIS Facility, Moore Air Base, Edinburg, Texas, by the NEFAAT group (Northeast Forest Aerial Application Technology). Seven out of twenty one runs were observed and predicted means (O and P), mean bias error (d) standard deviation of the difference (σ_d), root mean square error of the difference (RMSE), and average absolute gross error of the difference ($|d|$), index of agreement (r), variance comparison (Var), fraction of positive residuals (f_p) and average relative error (RE=RMSE/O) of prediction.

Also, the test of the sensitivity of AGDISP to its input parameters was done in this study. AGDISP was first run by using parameters that were designated as the "typical condition". The meteorological parameters were obtained by averaging each variable over twenty one runs, those for aircraft, such as aircraft weight, flight height and speed, were average values in the field trials, and nozzle configuration and a droplet spectrum were the same as used during field trials.

Then, AGDISP was run for several test cases and the same statistical parameters as mentioned above were calculated using predictions for these cases and the "typical condition".

The results of our studies indicate the following:

1. Without applying the catch efficiency to measure data, the average relative errors of AGDISP prediction over the seven runs was 70% and 80% for number and volume deposition, respectively. The ranges of errors for the individual runs were from 32% to 158% for droplet number density and from 43% to 208% for volume density. For the measurement data corrected for collection efficiency of 0.7, these mean errors were 83% and 81% for droplet number and volume density, respectively.
2. When a sensitivity study was conducted with AGDISP, with variations in flight height within 30% of the normal height of 15.5 m, predictions by AGDISP varied by 61% and 27% for droplet number and volume density, respectively.
3. For application under wet or dry spray conditions, AGDISP predicted variations in volume deposition within 82% of that for typical condition. With light winds (<1 m/s), differences in deposition predicted by AGDISP were within 42% of "typical condition" for droplet number density and zero for volume. While with strong wind (about 7 m/s), these values are 20% and 36%.
4. When half the number of nozzles fitted to the aircraft were modelled, or no vertical offset was included in the input parameters, AGDISP outputs varied by up to 10% in volume deposition and up to 5% in droplet number density when compared to runs made under the actual configuration. With 10 nozzles or uniform distribution along the spray boom, variations in deposition were within 38% of typical values.
5. Variations in AGDISP output with a four size droplet spectrum as input parameters were within 6% and 18% of that obtained with an eight size spectrum for droplet volume and number density, respectively. With a single size spectrum, predicted variations in droplet volume and number density were 73% and 104% of that with the eight spectrum.

A MULTIPLE REGRESSION MODEL FOR PARASITIZATION OF GYPSY MOTHS BY THE INTRODUCED LARVAL PARASITE *COTESIA MELANOSCELUS* (HYMENOPTERA: BRACONIDAE)

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ABSTRACT

Cotesia melanoscelus (Ratzeburg) is a bivoltine, solitary, endoparasite of larvae of the gypsy moth, *Lymantria dispar* (L.). Imported from Europe after the turn of the century, it readily became established and now occurs throughout the generally infested area. Rates of parasitization are highly variable, particularly during the second (overwintering) parasite generation when females attack third and fourth instars of the gypsy moth. Detailed observations on parasitization of gypsy moths by this species were made in yellow pine-hardwood stands at Belleplain State Forest on the coastal plain of southern New Jersey during 1982-1989. Each year of the study, *C. melanoscelus* was the dominant larval parasite of *L. dispar*.

Multiple regression analysis of 10 variables monitored over the 8-year period indicated that temperature, host density, abundance of overwintering cocoons (formed the previous year), and basal area of oaks within the stand were the most important factors affecting rates of parasitization by this braconid during its second generation. When rates of parasitization were plotted against mean temperatures during the period from May 1 to June 15 (includes the attack period of adults emerging from overwintered cocoons, development of the first parasite generation, and the attack period of adults emerging from first generation cocoons), a second-order regression gave a rather good fit ($r = 0.568$), suggesting that the gypsy moth is favored at moderate temperatures, but that the parasite is favored at low or high temperatures. Second generation parasitism was positively correlated ($r = 0.408$) with the parasite to host ratio, that is, the previous year's parasite cocoon counts divided by the present year's gypsy moth larval counts. Parasitization was negatively correlated ($r = -0.267$) with the basal area of oaks in the stand, a variable considered to serve as an index of the area to be searched by the parasites. The multiple regression model obtained by using these three variables as predictors accounted for 51% of the variation in rates of parasitization by second brood *C. melanoscelus*.

DOES PREVIOUS STAND MANAGEMENT INFLUENCE GYPSY MOTH-RELATED MORTALITY?

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ABSTRACT

Oak-hickory forest stands were sampled for tree mortality using a series of temporary plots. Stands were classified by gypsy moth defoliation and by thinning treatment timing. Uncut, undefoliated stands had a 12.1 percent mortality (sq. ft. basal area/acre), while thinned, undefoliated stands had mortality rates of 3.6 to 7.2 percent. Defoliated, uncut stands ranged from 17.6 to 55.7 percent mortality depending on defoliation intensity and frequency, while thinned, defoliated stands had mortality rates ranging from 10.2 to 51.7 percent. Significant differences in mortality occurred between thinning treatments in undefoliated stands. Defoliated stands, due to high variability, showed few significant differences due to thinning. Thinning of forest stands does accomplish its goal of reducing mortality in undefoliated stands, however, the effect is not present when stands are defoliated. Defoliation causes increased mortality in larger size stems while maintaining mortality rates of small stems.

GYPSY MOTH IMPACTS ON OAK ACORN PRODUCTION

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ABSTRACT

Gypsy moth outbreaks can have drastic effects on many forest resources and uses. Because gypsy moth prefers oak foliage, oak stands are the most susceptible to defoliation and resultant damage. The value of oak mast for many wildlife species is high. The high carbohydrate content of acorns provides the energy necessary for winter survival. Loss of mast crops due to direct and indirect effects of gypsy moth defoliation may result in large-scale reductions in wildlife habitat and food sources.

Direct defoliation effects during years of moderate and heavy defoliation can come from three sources: direct consumption of flowers, abortion of immature acorns due to low carbohydrate supply, and lack of flower bud initiation. These effects are generally short-lived, having residual effects for only 1 or 2 years after defoliation ends. Information available to date suggests that abortion of immature acorns is the most significant of these three effects. It is possible to go for 2 to 5 years in succession with complete failures of acorn production.

Longer term indirect effects of outbreaks result from: crown dieback and poor vigor, mortality of oaks and hickories, and shifts in species composition of current and regenerated stands. These effects can reduce viable seed for regeneration and wildlife food. Crown dieback can turn productive acorn producers into nonproducers. Trees may take as long as 10 years to recover their full vigor. Mortality of mast producers in stands is distributed across a wide range from low to moderate to heavy. Estimates of the impact of mortality on stand-level acorn production show that considerable mortality (>60 percent of the basal area) must occur before significant reductions in acorn production occur. This result is due to mortality occurring primarily in intermediate and suppressed trees that are not heavy producers. This thinning from below may even stimulate production by residual trees. Many stands that were predominantly oak before defoliation and mortality occurred have regenerated to red maple and black birch. This shift in composition results in a long-term reduction in mast production in these areas.

THE WEST VIRGINIA UNIVERSITY FOREST HAZARD RATING STUDY: THE HAZARDS OF HAZARD RATING

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ABSTRACT

The West Virginia University (WVU) Forest is a 7,600-acre tract located along the leading edge of gypsy moth infestation. The hazard rating study at the WVU Forest serves three objectives. First, hazard rating is being used to determine the extent and distribution of damage that can be expected when gypsy moth defoliation occurs. Second, susceptibility and vulnerability equations currently available in the literature are being tested. Finally, through the use of computer technologies such as geographic information systems (GIS), the project demonstrates how to streamline the hazard rating process by applying surrogate variables (e.g. aspect and slope position) for prediction variables that are expensive to measure (e.g. species composition and site index).

Two of the 23 compartments at the WVU Forest were chosen for an in-depth stand analysis. Data were collected on a 1-chain grid to delineate stands. More complete data (including variables used in published hazard rating systems) were collected on a subsample of plots and analyzed using the Silviculture of Allegheny Hardwoods (SILVAH) software. Stand maps were developed and these were compared to stand maps made in the 1950's. The data from the SILVAH plots were used to compute gypsy moth hazard using several susceptibility and vulnerability equations.

The display shows the result of applying these hazard rating equations to six stands in the Fire Tower Block at the WVU Forest. We expect that the high proportion of oak (>75% of the basal area) makes stands 1-3 highly susceptible and vulnerable to gypsy moth. We also expect stands 5 & 6 to be relatively immune to defoliation because of their low proportion of oak (<25%). The three susceptibility equations that we used classified all 6 stands as probably resistant to defoliation. The two vulnerability rating systems developed by Gansner and Herrick predict 5% stem loss in all six stands. The vulnerability equation developed by Crow predicts higher mortality in stands 1, 5, & 6 (>29% basal area loss) than in stand 2 & 3 (20%). Though defoliation has not occurred, we still expect the highest damage to occur in stands 1-3.

Differences in the conditions of stands used to develop these models and those at the WVU Forest seem to account for the unexpected predictions. We are currently building new equations using data from the Appalachian Plateau and are expanding the testing of published models at the WVU Forest. For more information on gypsy moth hazard rating see the paper by Hicks in this proceedings.

INTERACTIVE EFFECTS OF DEFOLIATION AND LOW RESOURCE LEVELS ON PHOTOSYNTHESIS, GROWTH, AND GYPSY MOTH LARVAL RESPONSE TO RED OAK SEEDLINGS

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ABSTRACT

The potential for defoliation of oak seedlings by gypsy moth is quite high. We were interested in examining the interactions between various natural stresses and resulting gypsy moth feeding preferences and the results of defoliation stress on the growth and photosynthetic responses of the oak seedlings. A factorial greenhouse experiment was carried out with northern red oak (*Quercus rubra* L.) seedlings. The seedlings were grown under one of eight conditions: high or low light, high or low nutrients, and high or low water in a split-block design with shade cloth over half of the blocks. After two months of growth under these conditions, one-half of the seedlings were completely defoliated manually. This foliage was fed to fourth instar gypsy moth larvae in a preference test with leaf discs from each of the eight treatments in a petri dish. At the end of three months, photosynthetic parameters were measured on a subsample of the seedlings. After four months, trees were harvested, separated into stems, roots, and leaves, leaf area measured, and dry weights obtained. Seedling mortality was also compared for the defoliation treatments.

Photosynthetic quantum yields were similar for plants in all treatments. Light compensation point was significantly higher and dark respiration rate significantly greater for plants grown in high light than for plants grown in low light, an expected acclimation pattern. there were no significant interactions with defoliation. However, there was a significant defoliation x water interaction for maximum net photosynthesis, such that defoliation increased photosynthetic rate when drought stress was present (compensatory photosynthesis), but not when water was plentiful.

Defoliated plants had a 32.6 percent mortality rate; significantly higher than that of undefoliated plants (1.3 percent). Dry weights and leaf areas ere significantly reduced by most of the factors. Two-way interactions of stresses with defoliation were significant and in most cases positive, in the sense that defoliation had a lesser effect in depressing growth in the presence of stress than when resources were abundant. There were no significant effects on root:shoot ratio. There were differences in gypsy moth larval leaf consumption/preference due to stress factors. Foliage grown under high light was preferred over foliage produced under shade stress.

The number and magnitude of interactions among stresses imposed in this study were unexpectedly high. Stresses interacted to affect photosynthetic properties, leaf characteristics, and growth. Defoliation x stress interactions on tree responses to defoliation were pronounced.

PREDICTING DEFOLIATION BY THE GYPSY MOTH USING EGG MASS COUNTS AND A *HELPER* VARIABLE

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ABSTRACT

Traditionally, counts of egg masses have been used to predict defoliation by the gypsy moth. Regardless of the method and precision used to obtain the counts, estimates of egg mass density alone often do not provide satisfactory predictions of defoliation. Although defoliation levels greater than 50% are seldom observed if egg mass densities are less than 600 per hectare (250/acre), data from Melrose Highlands and the Intensive Plot System (IPS), as well as recent data from New Jersey and Pennsylvania, reveal that egg mass densities above this "threshold" result in damaging defoliation in less than 50% of the observations.

The accuracy of defoliation predictions can be greatly helped by including measures of the habitat and quality of the population in the predictive function. Using data from the IPS, several measures of habitat, i.e., site index, stand basal area, % oak in the site, and soil moisture class, improved predictions. An index of soil moisture (scores of 1-4) obtained from SCS maps was most helpful. Measures of population quality that were helpful included fecundity, vertical location of the egg mass, and incidence of viral infection in larvae emerged from an egg mass.

Instead of providing complex models that need to be solved to obtain a prediction of defoliation level, the models were used to construct an isogram of 60% predicted defoliation for each soil class across a range of egg mass densities and population quality. The example given shows that >60% defoliation occurred in only 9 of the 38 cases where egg mass density was above 250 EM/acre (dashed line). The isogram shows how using egg mass location in conjunction with density can greatly increase accuracy of defoliation predictions; it correctly classified 34 of the 38 cases where density was above 250 egg masses/acre. This illustrates how the accuracy of gypsy moth defoliation predictions can be improved when information on habitat and population quality is used along with estimates of population density.

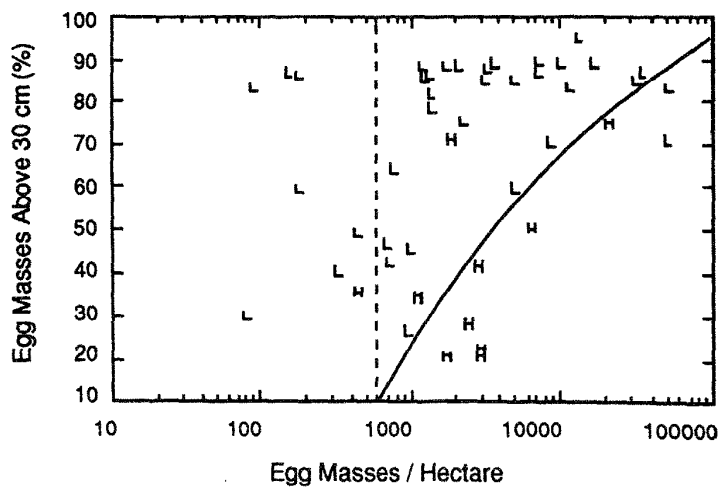

Figure 1. Actual observations of < 60% (L) and > 60% (H) defoliation on a dry site. The dashed line is a typical suppression-action threshold and the solid line is the prediction of 60% defoliation for dry sites.

IDENTIFICATION, CLONING, AND EXPRESSION ANALYSIS OF THREE PUTATIVE *LYMANTRIA DISPAR* NUCLEAR POLYHEDROSIS VIRUS IMMEDIATE EARLY GENES

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ABSTRACT

Viral immediate early gene products are usually regulatory proteins that control expression of other viral genes at the transcriptional level or are proteins that are part of the viral DNA replication complex. The identification and functional characterization of the immediate early gene products of *Lymantria dispar* nuclear polyhedrosis virus (LdNPV) will further our understanding of viral pathogenesis at the molecular level and may yield insights into a molecular means of enhancing viral potency. In addition, the transcriptional promoters of these genes can be used to drive the expression of foreign genes inserted into the viral genome.

Lymantria dispar nuclear polyhedrosis virus (LdNPV) early transcripts were identified through northern analysis. RNAs isolated from 652Y cells, infected with clonal isolate 5-6 (CI 5-6), 2 and 7 hours postinfection were probed with LdNPV genomic fragments from a cosmid library. Fifteen viral transcripts were detected: three were chosen for further study. A cDNA library was constructed (in lambda gt11) from poly A+ RNA isolated from 652Y cells 7 hours after infection with CI 5-6, and probed with LdNPV genomic fragments containing the coding sequences for the three genes of interest. Several positive plaques for each gene were identified and used for further study.

The clone lambda LdIE-I contains a cDNA of 880 bp and is derived from a transcript of approximately 950 bases in length. This gene, designated IE-I, is initially expressed 4 hours postinfection (p.i.), and is synthesized throughout infection at near steady state levels. At least three other distinct viral transcripts were identified that contain IE-I sequences. The approximate genomic location of the IE-I gene is from 6.0 to 6.7 map units. In addition, IE-I contains sequences with limited homology to the *Autographa californica* NPV gene IE-N. The clone lambda LdIE-G1 contains a cDNA of 750 bp that is derived from a gene (termed IE-G1) that codes for a transcript of approximately 750 bases in length. IE-G1 is expressed primarily from 2 to 10 hours p.i. (the transcript is detectable after a 1 hour adsorption period), and maps to the genomic area between 9.3 and 13.7 map units. The clone lambda LdIE-G2 contains a cDNA of 1950 bp that is derived from a gene (termed IE-G2) that codes for a transcript of approximately 2050 bases in length that maps to the genomic region between 9.3 and 13.7 map units. IE-G2 is expressed primarily from 4 to 10 hours p.i., and is first detected 2 hours p.i. In addition, at least 4 other viral transcripts overlap the IE-G2 gene.

UNDERSTANDING PREDATION: IMPLICATIONS TOWARD FOREST MANAGEMENT

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ABSTRACT

It is generally accepted that when gypsy moths rest in the litter survival is low due to predation by ground-foraging generalist predators and that predation can maintain these populations indefinitely. Forest Service research on predators of gypsy moth continues to focus on population dynamics, the mechanisms of predation and forest management implications.

It has been shown that abundance and diversity of small mammals differed considerably among forest stands that varied in potential susceptibility to defoliation by gypsy moth. In particular, stands most susceptible to defoliation had fewer small mammals and, hence, it is hypothesized that predators at these sites had a reduced effect on gypsy moth populations. At Bryant Mountain in Vermont, year to year differences in survivorship of gypsy moth pupae were strongly influenced by predator density particularly *Peromyscus leucopus*. It was also shown that within year differences in survivorship of pupae (when comparative *Peromyscus* densities in both the susceptible and resistant stands were similar) resulted from differences in the vertical stratification of cover which affects the foraging behavior of small mammals and the increased availability of more palatable alternative foods, especially low bush blueberry (*Vaccinium* spp.), which significantly reduces the consumption of arthropods in the diets of small mammals. The interrelationships between predator density, type and spatial distribution of cover and availability of alternative foods offer a number of forest management implications. Forest and wildlife managers should focus more attention on the habitat requirements of small mammals, particularly those that are ground foraging generalists, to insure their impact in maintaining innocuous gypsy moth populations.

Recent visits to the Soviet Union to study gypsy moth predator-prey interrelationships have provided (1) important information regarding the convergent evolution of ecological equivalents to vertebrate predators of the gypsy moth in the U.S., and (2) a better understanding of the role of predators in Soviet forest protection. Species studied included *Apodemus sylvaticus*, *A. flavicollis*, *Clethrionomys glareolus*, and *Dryomys nitedula*.

The objectives in researching the relationship between predator impact potential and forest management implications are twofold. First, to ascertain the possibility and feasibility of habitat manipulation which could enhance the magnitude of predation and, second, to provide sufficient information which would enable forest managers to avoid inadvertent detrimental consequences that would reduce or possibly eliminate predator community impact as a result of applied selected forest management practices thereby encouraging management practices that are compatible with maintaining natural predator communities. Long-term studies, which are designed to access abundance and habitat relationships of small mammal communities on a localized scale, are still needed to give additional insight into the importance of small mammals to the population dynamics of gypsy moth and also to determine their role in future management scenarios which would reduce the susceptibility of northeastern deciduous forests to defoliation by gypsy moth. Specific management implications derived from these and subsequent studies focusing on predator-prey relationships will allow: (1) more accurate classification of forest stand susceptibility; (2) more reliable gypsy moth population forecasting; (3) the development of useful life system models; (4)

more effective integrated pest management; and (5) the evaluation of silvicultural practices on predator-prey interactions and stand susceptibility to defoliation.

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CHANGES IN VERTICAL DISTRIBUTION OF XYLEM PRODUCTION IN HARDWOODS DEFOLIATED BY GYPSY MOTH

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ABSTRACT

Trees distribute the production of xylem through the bole in an unequal manner. Defoliating insects such as the gypsy moth (*Lymantria dispar*) affect the balance of that distribution. Historical defoliation data were combined with detailed stem analysis of 49 mixed oaks (*Quercus rubra, Q. alba, Q. prinus, Q. coccinea, Q. velutina*) and associated species, including red maple (*Acer rubrum*), in southern New England. The cross-sectional area of an annual ring within the branch-free bole was normally greater toward the base despite a greater ring width at the base of the crown. In years of very poor growth due to defoliation or other causes, the cross-sectional area approached uniformity through the branch-free bole. Partial rings and missing rings were evident in the understory red maple, but never in the oaks, despite growth rings as small as 0.1 mm.

In some oak species growth was reduced overall by as much as 50% in years of defoliation, and a continued effect was observed for three years after a defoliation. Assuming one two-year defoliation episode each decade, volume growth of surviving trees was reduced 9.7% overall. Increased growth in neighboring, non-defoliated trees was significant in the year of defoliation and again three years afterward. Compensatory growth in the year following defoliation was found only in red maple. A redistribution upward was detectable in all defoliated trees, but did not affect the overall form of the bole, due to the cumulative nature of stem taper.

USING RIBOSOMAL RNA TECHNOLOGY FOR CLASSIFYING MICROSPORIDIA

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ABSTRACT

The microsporidia are an obligately parasitic group of protists with a number of unusual cytological and molecular characteristics. They have no mitochondria, their nuclear division is primitive, their ribosomes and ribosomal RNA's are reportedly of prokaryotic size, and their large ribosomal subunit contains no 5.8S rRNA. There are about 87 microsporidian genera that are based primarily on spore shape, numbers of nuclei in the spore, nature of the sporophorous vesicle, and several ultrastructural characteristics of the spores and vegetative stages. Because they have few other morphological characters it is difficult to develop phylogenetic relationships and identify specific isolates of microsporidia.

Molecular sequencing methods have been useful in establishing the phylogenetic relationships of higher taxa, including Microsporida. These same sequencing methods are currently being used to develop a phylogeny of microsporidian genera and to identify specific microsporidian species. Portions of the 23S and 16S rRNA have been sequenced for all five species of microsporidia isolated from the gypsy moth.

The sequences of the gypsy moth microsporidia were compared and a phylogenic tree developed by the use of parsimony analysis. Based on these results, we can distinguish all of the five species of gypsy moth microsporidia and we believe that rRNA sequences can be used for identifying most other species of microsporidia. The use of rRNA has great promise in the development of probes for species specific identifications because of the high copy number of ribosomes in cells.

We currently need relatively large quantities of pure microsporidian spores in order to obtain rRNA sequences, but the use of newly developed techniques (PCR) to amplify specific rRNA genes or pieces of DNA should greatly reduce the quantify of spores needed for restriction enzyme analysis.

ARCHITECTURE OF THE BLACK MOSHANNON FOREST CANOPY MEASURED BY HEMISPHERICAL PHOTOGRAPHS AND A LI-COR LAI-2000 SENSOR

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ABSTRACT

Non-destructive measurements of light penetration were made at 10 heights in the canopy on twelve different sites in the PA oak forest where the Blackmo 88 spray-micrometeorological experiment was conducted. Vertical profiles of Leaf Area Index, LAI, were calculated from these measurements, and the data were used to define the spatial variability of the forest canopy density.

Two different sensors were used for the light measurements, a remotely controlled camera with a 180 degree hemispherical lens (polar projection) and a LI-COR LAI-2000 radiation sensor. The paper presented the physics and mathematical theoretical background for these measurements. The two sensors generally performed similarly with some differences near the top of the canopy.

The average leaf area index in this stand during the spray experiment was 3.72 square meters of leaf area per square meter of ground. This was reduced to 3.02, a 19% reduction, during partial defoliation in 1989. Spatially, the canopy was quite variable. The standard deviation of the leaf area density over the 12 measurement locations was approximately 70% of the mean (3.02).

This experiment demonstrated a relatively simple non-destructive sampling technique to measure leaf area distributions in mature forest stands. The realistic use of model simulations for spray operations or insect-host interactions will require the documentation of the leaf area distribution characteristics of a large range of forest types and stand densities. The sensors and techniques used here are dependable, accurate and inexpensive ways to accomplish this.

AERIAL APPLICATION OF *BACILLUS THURINGIENSIS* TO AN OAK FOREST: DEPOSIT ANALYSIS AND PREDICTIONS WITH FSCBG

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ABSTRACT NOT RECEIVED

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Eight invited papers and 68 abstracts of volunteer presentations on gypsy moth biology, ecology, impacts, and management presented at the U. S. Department of Agriculture Interagency Gypsy Moth Research Review.

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