



United States
Department of
Agriculture

PROCEEDINGS

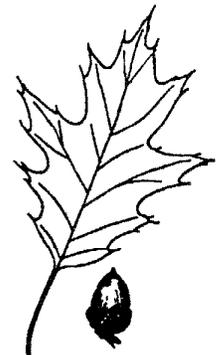
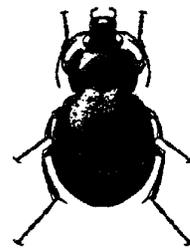
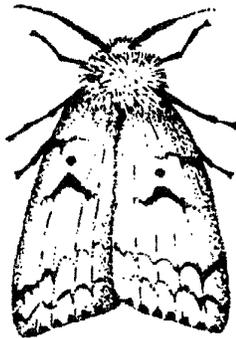
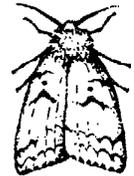
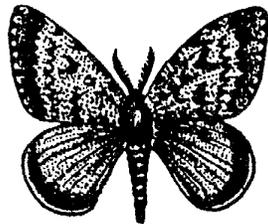
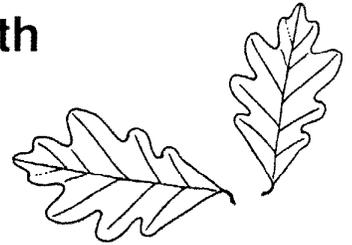
Forest Service

Northeastern Forest
Experiment Station

General Technical
Report NE-146



U.S. Department of Agriculture Interagency Gypsy Moth Research Review 1990



Most of the papers and abstracts were submitted on floppy disk and were edited to achieve a uniform format and type face. Each contributor is responsible for the accuracy and style of his or her own paper. Statements of the contributors from outside the U. S. Department of Agriculture may not necessarily reflect the policy of the Department.

The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U. S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

Remarks about pesticides appear in some technical papers contained in these proceedings. Publication of these statements does not constitute endorsement or recommendation of them by the conference sponsors, nor does it imply that uses discussed have been registered. Use of most pesticides is regulated by State and Federal Law. Applicable regulations must be obtained from the appropriate regulatory agencies.

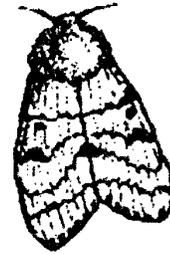
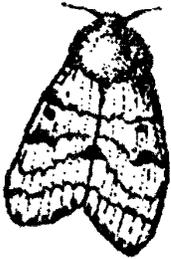
CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish and other wildlife – if they are not handled and applied properly. Use all pesticides selectively and carefully. Follow recommended practices given on the label for use and disposal of pesticides and pesticide containers.

Layout and cover design by Mark J. Twery, Morgantown, WV.

Northeastern Forest Experiment Station
5 Radnor Corporate Center
100 Matsonford Road, Suite 200
P.O. Box 6775
Radnor, Pennsylvania 19087

January 1991

Proceedings
U.S. Department of Agriculture
Interagency Gypsy Moth Research Review
1990



January 22-25, 1990
East Windsor, CT

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

Sponsored by:

Forest Service Research

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 apprised 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 – <i>Entomophaga maimaiga</i> 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 <i>Lymantria dispar</i> nuclear polyhedrosis virus transcripts and <i>in vitro</i> 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 <i>Lymantria dispar</i> nuclear polyhedrosis virus plaque variants	54
E.M. Dougherty, D. Guzo, K.S. Shields, D.E. Lynn, and S.K. Braun – <i>Autographa californica</i> nuclear polyhedrosis virus replication in non-permissive <i>Lymantria dispar</i> 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 <i>Lymantria dispar</i> 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 <i>Nosema</i> 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 <i>Bacillus thuringiensis</i>	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

GYPSE 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 (<i>Lymantria dispar</i>)	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 <i>Lymantria</i> 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

IMPACTSModerator: 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 <i>Cotesia melanoscelus</i> (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 <i>Lymantria dispar</i> 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 <i>Bacillus thuringiensis</i> to an oak forest: deposit analysis and predictions with FSCBG	150
LIST OF ATTENDEES.....	151

ISOLATION AND CHARACTERIZATION OF JUVENILE HORMONE ESTERASE
FROM GYPSY MOTH (*LYMANTRIA DISPAR*).

Algimantas P. Valaitis and Joan Jolliff
USDA Forest Service, Northeastern Forest Experiment Station,
359 Main Road, Delaware, OH 43015

ABSTRACT

Insect metamorphosis is under precise hormonal control. During the last larval stadium, the degradation of juvenile hormone by juvenile hormone esterase (JHE) is essential for the initiation of pupation. Therefore, we have targeted this system for disruption with a strategy to produce a recombinant gypsy moth virus which expresses JHE. In order to clone and insert the JHE gene into the virus, purification of the enzyme, amino acid sequence information, and polyclonal antibody were needed.

Developmental analysis of JHE activity revealed a single major peak during the last larval stadium and another peak of JHE 3-5 days after pupation. JHE was purified from larval and pupal hemolymph by classical procedures. The specific activity of the purified enzyme approached 1000 units/mg. Gypsy moth JHE was found to have an apparent size of 62 kilodaltons, was insensitive to diisopropylphosphofluoridate, and was activated by polyethylene glycol. Partially purified enzyme displayed two closely-spaced bands on SDS PAGE. Polyclonal antiserum raised against the larval enzyme also reacted with the pupal JHE. This antiserum did not cross-react with hemolymph JHE from other Lepidoptera by western blot analysis. Two forms of JHE, JHE-A and JHE-B, were isolated by reverse-phase HPLC. Both appeared similar in size, had very similar amino acid compositions, were indistinguishable by HPLC tryptic peptide mapping, and had an identical N-terminal amino acid sequence. Since JHE-A and JHE-B are structurally very similar, these two forms may reflect minor differences in post-translational modification of the gypsy moth enzyme. Whether these forms differ with respect to their function remains to be determined.

Comparison of the gypsy moth enzyme with that from other Lepidoptera showed that they were antigenically distinct. In addition, the N-terminal and peptide amino acid sequences revealed marked differences in the structures of JHE from different Lepidoptera. Whether these enzymes also differ in their properties remains to be determined.

USING RESPIRATION RATES OF SINGLE EGGS TO DETERMINE GYPSY MOTH PRE-DIAPAUSE DEVELOPMENTAL RATES

D.R. Gray, J.A. Logan, and F.W. Ravlin
Department of Entomology, VPI & SU, Blacksburg, VA 24061

ABSTRACT

Gypsy moth (*Lymantria dispar* L.) egg phenology has been described as being comprised of three phases: pre-diapause morphological development, diapause, and post-diapause morphological development. Despite a large amount of published information on the temperature-time requirements of egg hatch there exists no robust model of the process(es) involved. This may be largely due to an inability to distinguish the phases of development (Rubstov 1938¹, Lyons and Lysyk 1988²). This inability has necessitated that the observed (dependent) variable in egg phenology studies be the temperature and duration of the final incubation period leading to egg hatch, despite the fact that treatments may have been applied to eggs in a diapause, pre-diapause, or post-diapause phase. Respiration rate has previously been unusable as a distinguishing characteristic due to the requirement of using hundreds of eggs in each measurement. This has prevented accurate estimation of temperature-time requirements for each phase, and obscured variability within the population.

This paper proposes a three phase model to describe gypsy moth egg phenology, and presents a novel technique for determining the temperature requirements of the pre-diapause phase, and preliminary estimates of population variability in those requirements.

Respiration rates of individual gypsy moth eggs were determined under temperature conditions ranging from 4°C to 38°C using an infrared gas analyzer. Among individuals of equal physiological age, temperature had a significant effect on respiration rate. Among individuals reared at constant temperatures, respiration rate was observed to increase with time and then decline rapidly to a steady rate of approximately 50% of each maximum. This rapid decline was interpreted as the completion of pre-diapause development.

A non-linear development rate curve was fit to the inverse of the median development time for each temperature. Population variability in pre-diapause temperature requirements was described by a three parameter Weibull function fit to the normalized development times.

This technique has the important ability to distinguish developmental phases on the basis of an accepted physiological parameter. Using appropriately designed experiments, this technique can be used to determine the uniqueness or commonality of the phases, the relationships between developmental phases, and the developmental rates of each unique phase.

¹ Rev. Appl. Entomol. A.27:313-314.

² Proceedings. Lymantriidae: A comparison of features of new and old world tussock moths. USDA Gen. Tech. Rep. NE-123.

USE OF MOLECULAR PROBES TO DETECT PARASITES AND RETROTRANSPOSONS IN GYPSY MOTHS

John H. Werren¹ and Thomas O'Dell²

¹Department of Biology, University of Rochester, Rochester, NY 14627

²USDA Forest Service, Northeastern Forest Experiment Station,
51 Mill Pond Rd., Hamden, CT 06514

ABSTRACT

Retrotransposon screen: Gypsy moth families containing straggling and nonstraggling individuals were divided into categories of straggling, medium, and nonstraggling individuals, from which DNA was extracted. Four families were tested by southern hybridization and probing with ribosomal sequences designed to detect R1 and R2 retrotransposon insertions. Results showed no differences between stragglers and nonstragglers in the proportion of insertions in their ribosomal genes. The average proportion of insertions was 30%.

An initial screen from one family indicated that an amplification of ribosomal genes had occurred among stragglers; however, this was not observed in the other three families. It can be concluded that variable expression of R1 and R2 retrotransposons is not a likely cause of straggling in Gypsy Moths. Experiments were performed to test the effectiveness of the *Compsilura* total genomic probe for detecting parasitization in gypsy moths by that fly parasitoid. For one experiment, 3rd instar and 4th instar larvae were exposed to *Compsilura* females until stung. These were then shipped (1-2 days) to the Werren laboratory. Samples were divided into three groups. One was frozen immediately at -70 C, the second group developed on media for one day (25 C) prior to freezing, and the third group developed for two days. These were then individually homogenized and probed using radionucleotide labelled *Compsilura* total genomic DNA. Forty individuals were used in each group. Approximately 73% of third instar larvae yielded parasites and approximately 78% of 4th instar larvae yielded parasites. Most of these produced 1 parasite per larva, although multiple parasites did emerge in a few cases.

DNA probing results closely match rearing results for larvae which had fed for 1-2 days post stinging. However, there was a significant drop-off in detection of parasites in 3-4 day post stung larvae. There are two possible explanations for this drop-off. First, parasite larvae may be growing less rapidly than the gypsy moth larvae, resulting in a "dilution" of the parasite DNA below the level of sensitivity of the particular probe. A second explanation may be that shipping of samples caused some lethality of parasites within the hosts, and that decreasing detection with time represents degradation of parasite DNA.

So far, results are very promising that a simple molecular probe can be used to detect parasitization of gypsy moths. However, issues relating to sensitivity of the technique for detecting parasitization need to be resolved.

THE BACKCROSS STERILITY TECHNIQUE

V.C. Mastro and A. Pellegrini-Toole
USDA-APHIS, Science & Technology,
Otis Methods Development Center, Otis ANGB, MA 02542

ABSTRACT

The sterile insect technique (SIT) and the induced inherited (F_1) sterility technique have been investigated for a number of lepidopterous pests, including the gypsy moths. Another technique, backcross sterility, which could potentially prove as or more useful for control of pest species has been developed for the control of only one lepidopteran species, *Heliothis virescens*. This genetic technique has several theoretical advantages over both SIT and the F_1 sterility techniques. In contrast to F_1 sterility, backcross sterility can persist indefinitely once introduced into a population. Because fertile females are continuously backcrossed to target males, the strain becomes increasingly genetically similar to the target species. The backcross strain should also be behaviorally similar to the target species and there are no radiation-induced effects on competitiveness.

Because of these potential benefits, approximately a year and a half ago we initiated a project to screen for backcross sterility with the gypsy moth and other closely-related lymantriid species. The first species we selected was *Lymantria obfuscata*, a species from India. To date we have hybridized *L. dispar* and *L. obfuscata* and are in the process of making the appropriate backcrosses. At this time, it is too early to determine the outcome of these particular crosses. We plan to continue to screen additional *Lymantria* species to determine if backcross sterility can be developed and applied as a technique for use in the management of gypsy moth populations.

OUTCROSSING COLONIES OF THE OTIS NEW JERSEY GYPSY MOTH STRAIN
AND ITS EFFECT ON PROGENY DEVELOPMENT

John Allen Tanner and Charles P. Schwalbe
USDA-APHIS, Otis Methods Development Center, Bldg. 1398, Otis ANGB, MA 02542

ABSTRACT

The Otis New Jersey gypsy moth (*Lymantria dispar* L.) strain is considered the "white rat" of gypsy moth research. This strain has been laboratory reared for 34 generations. It currently consist of 35 subcolonies or cohorts that have been genetically isolated from one another for several generations. Usually, larvae that hatch at the same time develop synchronously; however, in recent years this strain has been plagued by periods of asynchronous larval growth (straggling) and other performance abnormalities. These abnormalities are now collectively called *Abnormal Performance Syndrome* (APS).

It was hypothesized that APS may be caused by the intense inbreeding within subcolonies. During 1989, the Otis Rearing Facility made outcrosses between subcolonies placed into cold storage in adjacent weeks. The progeny from the outcrossed lines were compared to those of the pure bred lines to determine if outcrossing had any influence on the incidence of APS and/or survival in the G₁ generation.

APS was not detected in either the outcross or pure lines and therefore we could not determine if outcrossing would have had any effect on the incidence of APS in the G₁ generation. Parents used to produce these crosses had a high incidence of APS, indicating that APS is probably not caused by genetic factors but by environmental, nutritional and/or microbial factors that affect the parental generation but are not expressed until the G₁ generation, or affect the G₁ eggs shortly after they are deposited.

Outcrossing did not have any influence on survival of G₁ generation insects. Both the outcross and pure lines had greater than 90% pupation and adult emergence. This high survival rate also indicates that APS was not present in the G₁ generation.

PUPAL ABNORMALITIES AMONG LABORATORY-REARED GYPSY MOTHS

Richard W. Hansen

USDA-APHIS, Otis Methods Development Center, Otis ANGB, MA 02542

ABSTRACT

Gypsy moth cohorts from 10 near-wild strains (one to six previous generations in culture), six wild strains (field-collected egg masses), and the standard "New Jersey" lab strain (34th and 35th generation in culture) were reared on Otis wheat germ-based artificial diet, in a constant environment. Rearings were begun with newly-hatched first instars; pupae were later collected daily, sexed, and weighed. Pupal lengths and maximum body widths were measured for some lab strain females. Collected pupae were classified as morphologically "normal" or as possessing at least one of seven types of morphological abnormalities, then reared individually to adult eclosion.

Less than 25% of near-wild, wild, and lab strain female pupae were classified as normal. "Banding" was the most common female abnormality; banded pupae possessed a light-colored, poorly-sclerotized cuticular band located ventrally between thorax and abdomen. Pupal abnormalities were infrequent among male pupae of all strains; most (>85%) were classified as normal. For both sexes, frequencies of occurrence for various pupal abnormalities varied little among strains.

Banded female pupae were significantly heavier, longer, and wider than normal female pupae. Normal pupae tended to experience longer larval stages, though mean larval development times for banded and normal pupae were not significantly different.

Pupal deformity patterns for lab-reared females were compared to those for feral and lab-strain females reared on oak foliage or artificial diet in an outdoor insectary. Most foliage-reared female pupae were normal; less than 5% exhibited banding compared to 70% or more of the lab-reared females. Diet-fed female pupae reared outdoors exhibited intermediate banding levels. Foliage-reared pupae were smaller, averaging ca. 1.22 g in weight, while lab-reared female pupae exhibited mean weights greater than 2.25 g. Thus, the occurrence of banding among female pupae appears associated with the larger sizes and, perhaps, more rapid development connected with artificial diet and laboratory rearing conditions. However, a direct abnormality-inducing role for the artificial diet or its constituents remains a possibility.

Banded female pupae successfully eclosed adults as frequently as normal pupae; only females with "gross abnormalities" yielded adult less successfully. Male pupae exhibiting morphological abnormalities produced adults less often than normal pupae. However, these reduced male eclosion rates are likely to have a minor impact, if any, because of the infrequent occurrence of malformed males.

Ongoing and future experiments will further quantify the impacts of pupal deformities on adult eclosion and egg mass production rates in the mass-rearing operation, and will address specific mechanism(s) responsible for the occurrence of pupal abnormalities.

VARIATION IN GYPSY MOTH, WITH COMPARISONS TO OTHER *LYMANTRIA* SPP.

Paul W. Schaefer

USDA, ARS, Beneficial Insects Research Laboratory (BIRL)
501 S. Chapel St., Newark, Delaware 19713

ABSTRACT

Specimens of gypsy moth, *Lymantria dispar* (L.) *sensu lato* were displayed in museum trays. Many specimens were quarantine laboratory reared during the 1989 season to provide samples (wing venation, frozen adults, prepupal haemolymph, larval feeding behavior, egg mass hair color, head capsule coloration and larval development) for various studies. Material reared was from HOKkaido, HONshu, and KYUshu, JAPAN; BEIjing, CHINA; Sibenik, YUGOSLAVIA; Queen Annes, MARYLAND (QAMD); and our standard BIRL culture. All (except HON) were individually reared (60 specimens each) in the first rearing using prepared diet. Varying numbers of additional specimens were reared on diet or *Betula* leaves in multiple larval containers. All were examined daily.

Specimens were used first to satisfy the various study needs. Remaining specimens were frozen and subsequently mounted. Reared adults illustrate the intraspecific variation present in *L. dispar sensu lato*. Most striking was the HON strain with very dark brown males and females with a dark wash to the general color and unusual large size in both. Maximum male forewing length was 32 mm in HON compared to only 23 mm in QAMD. Maximum female wing length was 43, 41, 38, 32, 32, 29, and NA mm in HON, KYU, HOK, BEI, YUG, BIRL and QAMD respectively (flight impossible in the latter three). Ability for flight was demonstrated in gravid females for HON, HOK and BEI but not in YUG. Morphological comparisons between these two functionally polymorphic forms illustrated the degree of wing reduction in the non-flying forms. HON pupae weighed nearly twice as much as the representative North American forms since maximum female pupal weight was 5.43 g for HON but only 2.47 g in QAMD. Maximum egg production in the three largest HON females was 1550, 1482, and 1375 eggs while the maximum was 1028 eggs per QAMD female. Two black-backed larval mutants appeared in YUG samples. In summary, size (expressed either as forewing length, pupal weight or female egg production), body color, and female flight capability clearly differed among the samples reared. As we will repeat these rearings in 1990, and we intend to incorporate several Russian samples, we expect to see even more evidence of intraspecific variation in gypsy moth.

Specimens of congeneric species, *mathura* Moore, *monacha* L., and *sakaguchi* Matsumaura (all from Japan) and *atemeles* Collenette (Thailand) were displayed to illustrate the similarities of these species to *dispar*. These permitted a comparison of the differences between intraspecific and interspecific variation.