United States
Department of
Agriculture

Forest Service

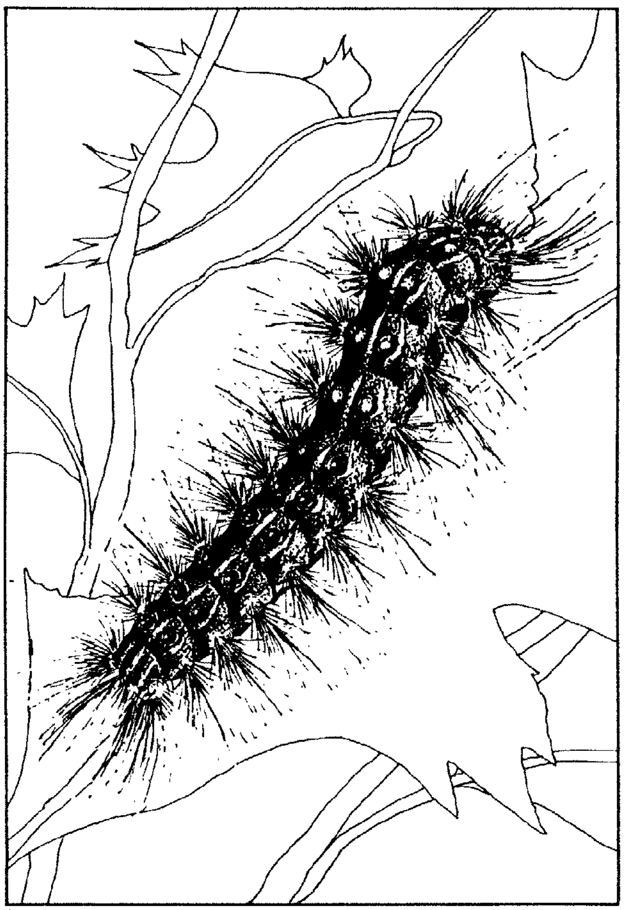
Northeastern
Station

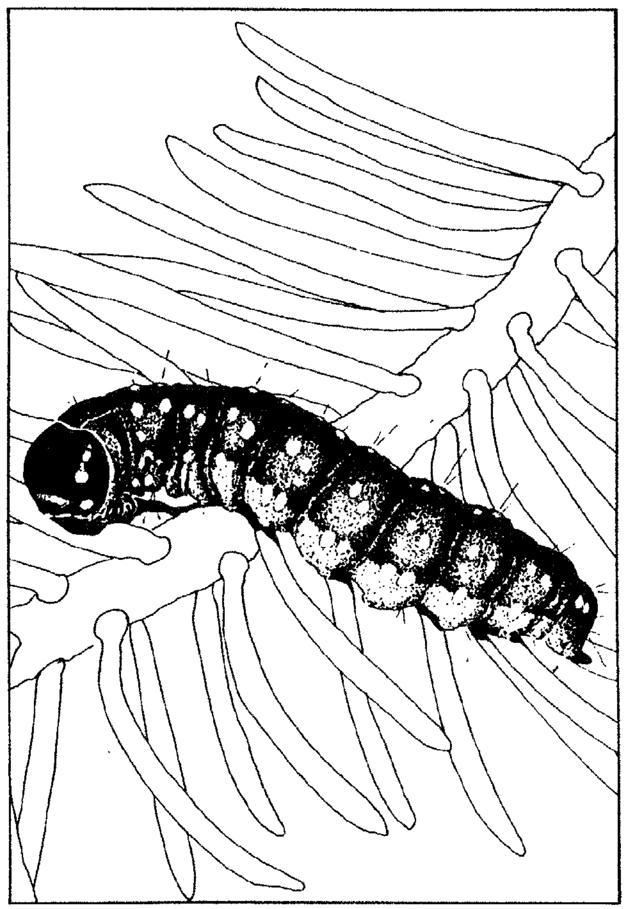
General
Technical
Report NE-85

1983

Proceedings

Forest Defoliator - Host Interactions: A Comparison between Gypsy Moth and Spruce Budworms





FOREWORD

The Canada/U.S. Spruce Budworms Program in cooperation with the Center for Biological Control of Northeastern Forest Insects and Diseases of the Northeastern Forest Experiment Station co-sponsored this Forest Defoliator-Host Interaction Workshop. This invitational workshop was limited to investigators of the spruce budworms and gypsy moth in the Forest Service, Canadian Forestry Service, and the University sector. The primary purpose of this workshop was to foster communication between researchers having a mutual interest and active research projects designed to understand the relationships between the host plant and forest defoliator feeding behavior, growth, and reproduction.

This Workshop was a follow-up to two previous meetings on host-insect interaction. In 1980, Dr. W. Mattson hosted a CANUSA-sponsored meeting at the North Central Forest Experiment Station, St. Paul, MN. This informal gathering brought together CANUSA Program investigators from the US and Canada for the purpose of sharing preliminary information and data on host-insect interactions. The second meeting took place in the fall of 1982. CANUSA(E) sponsored a Symposium on Spruce Budworm-Host Interaction at the Eastern Branch Meeting of the Entomological Society of America, Hartford, CT. The current Workshop developed from this Symposium. We found that participants were raising question concerning the similarity or differences between the spruce budworm and gypsy moth host interaction systems.

These Proceedings resulted from a three-day Workshop held in April 1983 at the Park Plaza Hotel, New Haven, CT. The structure of the Workshop allowed each participant a period for a presentation followed by lengthy discussion. These discussions were lively, friendly technical exchanges clarifying or elaborating on points raised by the speaker. Frequently, these exchanges were thought-provoking and often provided avenues for further detailed discussions and in some cases, future cooperative efforts.

The papers that make up these Proceedings were submitted at the Workshop as camera-ready copy. As a result, the participants did not have the benefit of reappraising their work in light of the discussions that followed their presentations or other ideas that developed at the Workshop.

Since the Workshop was planned late in the life of the CANUSA Program, we asked each investigator to be especially aware of the implications of these interactions on population dynamics of the insect in relation to forest management potential. When possible, we also asked that future research needs and direction be mentioned.

As technical coordinators for this Proceedings, it was our task to arrange and more effectively focus material so that papers provide a smooth transition of ideas and research activities on insect-host interactions for the spruce budworms and gypsy moth.

Lastly, we would like to acknowledge the support and confidence expressed by the following:

Denver P. Burns, Director, Northeastern Forest Experiment Station

Melvin E. McKnight, Program Leader, CANUSA

William E. Wallner, Director's Representative, Hamden, CT

August 1983 Robert L. Talerico, Broomall, PA

COVER SKETCH

Left, gypsy moth larva; right, spruce budworm larva.

PROCEEDINGS,

forest defoliator--host interactions:

A comparison between gypsy moth and spruce budworms

New Haven, Connecticut, April 5-7, 1983

Technical Coordinators:

Robert L. Talerico
Research Coordinator
CANUSA(E)
Broomall, PA 19008

Michael Montgomery
Research Entomologist
Northeastern Forest Experiment Station
Center for Biological Control of
Northeastern Forest Insects & Diseases
Hamden, CT 06514

Sponsored jointly by the
Canada/United States Spruce Budworms Program
Northeastern Forest Experiment Station

CONTENTS

Summary of Life History and Hosts of the Spruce Budworms 1
R. L. Talerico

Gypsy Moth Host Interactions: A Concept of Room and Board 5
William E. Wallner

Selection for Insect Resistance in Forest Trees 9
Donald H. DeHayes

Douglas-fir Progency Testing for Resistance to Western Spruce Budworm 15
G. I. McDonald

A Technique to Study Phenological Interactions between Douglas-Fir Buds and Emerging Second Instar Western Spruce Budworm 17
Roy F. Shepherd

Western Larch as a Host of the Western Spruce Budworm: A Comparison of Caged Larvae on Susceptible Conifers 21
Roy C. Beckwith

Spruce Budworm and Energy Metabolism 25
Thakor R. Patel

Comparisons of Elemental Profiles of the Western Spruce Budworm Reared on Three Host Foliages and Artificial Medium 33
John A. McLean, P. Laks, and T. L. Shore

Chemical Basis of Host Plant Selection by Eastern Spruce Budworm, Choristoneura fumiferana Clem. (Lepidoptera:Tortricidae) 41
P. J. Albert and S. Parisella

The Quest for Antifeedants for the Spruce Budworm (Choristoneura fumiferana (Clem.)) 45
M. D. Bentley, D. E. Leonard, and G. M. Strunz

Foliage Consumption by 6th-Instar Spruce Budworm Larvae, Choristoneura fumiferana (Clem.), Feeding on Balsam Fir and White Spruce 47
A. W. Thomas

Western Spruce Budworm Consumption - Effects of Host Species and Foliage Chemistry 49
Michael R. Wagner and Elizabeth A. Blake

Spruce Budworm (Choristoneura fumiferana) Performance in Relation to Foliar Chemistry of its Host Plants 55
William John Mattson, Scott S. Slocum, and C. Noah Koller

Leaf Quality and the Host Preferences of Gypsy Moth in the Northern Deciduous Forest 67
Martin J. Lechowicz

Changes in Tree Quality in Response to Defoliation 83
Jack C. Schultz and Ian T. Baldwin

Effect of Fertilization on Western Spruce Budworm Feeding in Young Western Larch Stands 87
Wyman C. Schmidt and David G. Fellin

Spruce Budworm Fecundity and Foliar Chemistry: Influence of Site 97
M. D. C. Schmitt, M. M. Czapowskyj, D. C. Allen, E. H. White, and M. E. Montgomery

The Influence of Herbivory on the net rate of Increase of Gypsy Moth Abundance: A Modeling Analysis 105
Harry T. Valentine

Foliage Quality and its Effect on Budworm Populations: A Modeller's Viewpoint 113
Richard A. Fleming

Characteristics of Stands Susceptible and Resistant to Gypsy Moth Defoliation 125
David R. Houston

Management Implications of Interactions between the Spruce Budworm and Spruce-Fir Stands 127
John A. Witter, Ann M. Lynch, and Bruce A. Montgomery

Biomass and Nitrogen Budgets During Larval Development of *Lymantria dispar* and *Choristoneura fumiferana*: Allometric Relationships 133
Michael E. Montgomery

Summary Remarks 141
M. E. Montgomery

CHARACTERISTICS OF STANDS SUSCEPTIBLE AND RESISTANT TO GYPSY MOTH DEFOLIATION

David R. Houston

Principal Plant Pathologist, USDA Forest Service, Northeastern Forest Experiment Station, Center for Biological Control of Northeastern Forest Insects and Diseases, 51 Mill Pond Road, Hamden, CT 06514

Site conditions strongly influence where gypsy moth defoliation will occur. In New England, where gypsy moths and forests have interacted for over a century, some forests have had a history of repeated defoliation while others have been defoliated only rarely. The often defoliated or susceptible forests characteristically grow on dry sites such as rocky ridges or deep sands. In many cases, they have been disturbed--sometimes frequently--by fire, wind, snow, or ice storms. The trees in these forests, mainly dry-site oaks, often are highly favored as food by gypsy moths, are slow growing, small, and scrubby, and have abundant structural features such as bark flaps, deep bark fissures, and holes or wounds that are used as resting sites by gypsy moths.

The open nature of susceptible forests encourages the growth of plants such as blueberry, huckleberry, bracken, sweetfern, grasses, and sedges. Leaf litter usually is shallow or lacking; on ridge stands, surface rocks or exposed ledges are common.

Resistant forests where defoliation is rare characteristically grow on relatively undisturbed sites with well-drained, deep loam soils where moisture is not limiting. They usually are well stocked and contain mixtures of species, including some that are highly preferred. Trees on these sites have good growth rates and relatively few structural features used by gypsy moths.

Understory plants in New England's resistant forests include such species as wild sarsaparilla, maple-leafed viburnum, and woodland ferns. Resistant stands have deep litter layers that are favorable habitat for many predators of gypsy moth.

It is not axiomatic that trees growing on susceptible sites are more apt to succumb to a given defoliation regimen than trees on resistant sites. Studies suggest that trees on adverse sites may be no more--indeed, may even be less vulnerable--than trees on good sites. Perhaps this reflects, at least in part, the fact that trees on poor sites represent the survivors of an exceptionally intense and continual selection process. Other relationships that are probably involved include the relative energy demands of small, slow-growing trees compared to large fast-growing ones; the amounts and conditions of substrates that support fungi and insects that attack and kill defoliation-stressed trees.

These descriptions of susceptible and resistant stands in the Northeast represent the extremes of a range of susceptibilities. It is likely that stands will be susceptible if they are on adverse sites and contain high proportions of preferred tree species with abundant refuges. It is also likely that well-stocked, mixed, fast-growing stands free of recent disturbance will be resistant, and will suffer damaging defoliation only upon disturbance or upon invasion by a large number of larvae from adjacent areas.

But stands at opposite ends of the susceptibility spectrum are not always, indeed not usually, encountered. In New England, many intermediate stands on mesic sites are changing from susceptible to resistant as their natural development is accompanied by decreases of highly preferred species and by proportionate increases of less preferred species. Intermediate stands that contain sizable proportions of highly preferred food species can be rendered more susceptible by disturbances that "open them up" and favor once again the more light-demanding food species that are preferred by the gypsy moth. Such disturbance also can reduce the impact of ground-inhabiting gypsy moth predators by removing or drying out the litter and soil habitat so important to these animals' survival and by creating above-ground protective refuges for the insect on the trees.

We often refer to susceptible stands, particularly those on ridges, as focal sites, and research and observations have indicated that gypsy moths do spread from such stands to surrounding more resistant forests. Probably susceptible stands should also be considered as focal areas for the processes that contribute to release of gypsy moth populations. Conceptually, susceptible stands that are under more or less continuous moisture stress and disturbance support the systems for population release that are expressed in more "buffered" resistant forests following periods of water shortage or disturbance.

Literature Cited

Houston, D.R., and H.T. Valentine. 1977. Comparing and predicting forest stand susceptibility to gypsy moth. Can. J. For. Res. 7:447-461.

Valentine, H.T., and D.R. Houston. 1979. A discriminant function for identifying mixed-oak stand susceptibility to gypsy moth defoliation. For. Sci. 25:468-474.

Valentine, H.T. and D.R. Houston. 1981. Stand susceptibility to gypsy moth defoliation. In: Hazard-rating systems in forest pest management: symposium proceedings. USDA FS Gen. Tech. Rep. WO-27. p. 137-144.