

WESTERN LARCH AS A HOST OF THE WESTERN
SPRUCE BUDWORM: A COMPARISON OF CAGED
LARVAE ON SUSCEPTIBLE CONIFERS ^{1/} ^{2/}

Roy C. Beckwith

USDA Forest Service, Pacific Northwest
Forest and Range Experiment Station, Range
and Wildlife Habitat Laboratory, Route 2,
Box 2315, La Grande, Oregon 97850

Caged field studies indicate that the
foliage of western larch is apparently less
suitable to western spruce budworm larval
development than the foliage of Douglas-
fir, subalpine fir, and Engelmann spruce.

Western larch, Larix occidentalis
Nutt., is sometimes listed as a major host
of the western spruce budworm,
Choristoneura occidentalis Freeman,
(Furniss and Carolin 1977). Clearly,
budworm larvae feed on larch and produce
damage (Fellin and Schmidt 1967; Schmidt
and Fellin 1973). However, numbers of eggs
on larch are usually low suggesting that
populations on this species stem partly
from incidental oviposition but mostly from
passive dispersal in the 1st and 2nd
instars (Wissenbach 1982). Also, our
observations have indicated, that although
larch may support large numbers of early
instars, few seem to survive to the pupal
stage.

Large larvae from a laboratory colony
were caged in the field on several of the
listed host species to check the relative
suitability of western larch as a host.
Data were collected on survival and pupal
weight when feeding was completed; this
note reflects the results of that study.

Methods

Two field sites in north-central
Washington were chosen to obtain four host
species representing different genera. One
site (B. S. Place) contained Douglas-
fir, Pseudotsuga menziesii var. glauca
(Beissn.) Franco, and larch; the other site
(Twisp River) contained Douglas-fir,

subalpine fir, Abies lasiocarpa (Hook.)
Nutt., and Engelmann spruce, Picea
engelmannii Parry ex Engelm. Douglas-fir
was tested on both sites to be sure there
were no major differences between sites.

At each site, five open-grown trees
per species of approximately the same
height (4-5 m) were selected for testing.
Fine-mesh nylon bags were placed around 45-
cm tips of four branches per tree about 2 m
from the ground. To monitor temperature,
one tree per species had thermocouples on
the under-surface of branches within the
nylon bags and on uncovered branches.

The nylon bags were stocked with
laboratory-reared western spruce budworm. ^{3/}
The overwintering larvae had been exposed
to cold temperatures to break diapause and
timed to reach the 5th instar at about the
same time as the field population. The
test larvae were fed a standard budworm
diet until they molted to the 5th instar,
at which time they were randomly assigned
to a specific nylon bag. Only five larvae
were placed in each bag to ensure adequate
current foliage to complete development.
All cages at one field site were fully
stocked within 2 days. Enough 5th instars
were available at the proper time to infest
five trees of Douglas-fir and Engelmann
spruce at Twisp River; subalpine fir at
Twisp River and the tree species at B. S.
Place had four trees stocked with larvae.

Budworms in bagged branches were
examined and temperatures from
thermocouples recorded at 2- to 3- day
intervals. Pupae were removed, sexed, and
weighed to the nearest milligram within 72
hours of pupation. Pupal weight and
survival were used to determine the
adequacy of each host as a food source.
Weights of naturally occurring pupae from
Douglas-fir at B. S. Place were compared
with those of pupae bagged on Douglas-fir
at that site. Weights of only those pupae
that successfully produced adults were used
in the analyses. The data were analyzed by
ANOVA; differences were tested by a
Duncan's multiple range test (1955)
incorporating Kramer's (1956) modification
for unequal sample size.

^{3/} Supplied by Dr. M. Martignoni,
Forestry Science Laboratory, Corvallis,
Oregon.

^{1/} Lepidoptera: Tortricidae.

^{2/} The research reported here was
financed in part by the Canadian/United
States Spruce Budworms Program - West.

Results

All individuals that survived to the pupal stage and emerged were pooled for each host in the analysis because survival and pupal weights were not significantly different between branches or trees.

Survival ranged from 49% on larch to 88% on Douglas-fir at Twisp River (Table 1). Survival on larch was clearly much lower than on the other species. The same pattern occurred when comparing pupal

weights from the four hosts. Male and female pupae were significantly lighter on larch than on the other species (Table 2). The heaviest males were obtained from Douglas-fir at B. S. Place; the heaviest females were also obtained from Douglas-fir at B. S. Place, but they were not significantly heavier than those on Douglas-fir at Twisp River. In general, the bagged pupae on Douglas-fir were heavier than those collected from the natural population.

Table 1. Percent survival to adults of western spruce budworm reared on various hosts in north-central Washington, 1981.

Location	Host	Number Started	Number Adults	Percent Survival
Twisp River	Douglas-fir	100	88	88
	Subalpine Fir	80	67	83
	Spruce	100	82	82
B. S. Place	Douglas-fir	80	67	83
	Larch	80	39	49

Table 2. Pupal weights of western spruce budworm reared on different hosts in north-central Washington in 1981.

Location	Host	n	Males $\bar{x}$ (mg) ^{a/}	S.E.	n	Females $\bar{x}$ (mg) ^{a/}	S.E.
Twisp River	Douglas-fir	50	90.2 b	1.70	38	121.6 ab	4.75
	Subalpine Fir	35	76.4 c	2.13	32	91.3 d	2.92
	Spruce	45	80.8 c	3.10	37	108.3 bc	4.29
B. S. Place	Douglas-fir	46	103.9 a	2.70	21	135.5 a	5.45
	Larch	17	41.5 d	2.67	22	43.2 e	3.49
	Natural	26	81.6 bc	2.43	33	104.5 cd	2.73

^{a/} Any two means by sex not having a common letter are significantly different at the .01 probability level.

Discussion

Reduced pupal weights and poor survival (49%) of western spruce budworm reared on larch may indicate that the foliage does not provide late instars with proper nutrition for normal development, or

the foliage may contain materials that produce an antibiosis in the insect. Ryan (1979) found that survival and growth of the larch casebearer, *Coleophora laricella* (Hbn.), were associated with the stage of foliage growth. Under the conditions of the 1981 experiment, the

laboratory stock may not have adapted as well to the larch foliage as to that of the other species. The report by Fellin and Schmidt (1967) of severe defoliation of larch does not mention when the damage occurred. The defoliation may have been caused by early larval feeding from high populations after spring dispersal (Beckwith and Burnell 1982). The rough bark of larch provides an excellent substrate for overwintering larvae that land on the trees during fall dispersal; large populations would thus be in place on the tree when the larvae emerge in the spring. Larch foliage breaks in the spring much earlier than Douglas-fir or true fir, thus new growth is available for early emerging larvae. The disappearance of larger larvae from larch could result from excessive predation, off-tree dispersal because of inadequate foliar nutrition, or both (Beckwith and Burnell 1982). Spur-shoot foliage apparently offers inadequate protection for large larvae. Preliminary work in 1980 also suggested that the foliage did not provide proper nutrition to produce pupae of normal size; however, larvae may still feed on the foliage as Chew (1980) found that larvae do not necessarily reject plants that fail to support larval growth in favor of those that do.

Why the natural pupae collected from Douglas-fir were significantly lighter than the caged insects on Douglas-fir is not clear. Feeding in the natural population may have been interrupted by predators, parasitoids or excessive wind movement. The experimental larvae may have been protected from these factors by the nylon mesh cages. The slightly different temperatures in the cages probably would not account for increased pupal weight; air temperatures in the cages were only 1 to 2°C higher when the cages were in the sun and equal to or slightly lower in shade. The artificial diet fed the first three instars of the test may have given them a growth advantage over the natural population. Also, the laboratory population may have larger pupae because of genetic differences.

A phytophagous insect must be able to complete its life cycle solely upon a plant species and be normal in all respects for that plant species to be considered a major host. An antibiosis response (delayed development, small size, or reduced

fecundity) would indicate that the plant is marginal as a host (Painter 1968). Foliage of western larch is apparently less suitable to budworm development than foliage of Douglas-fir, true firs, and Engelmann spruce.

Literature Cited

- Beckwith, R. C.; Burnell, D. G. Spring larval dispersal of the western spruce budworm in north-central Washington. *Environ. Entomol.* 11: 828-832; 1982.
- Chew, F. S. Food plant preferences of *Pieris caterpillars* (Lepidoptera). *Oecologia* 46: 347-353; 1980.
- Duncan, D. B. Multiple range and multiple F tests. *Biometrics* 11: 1-42; 1955.
- Fellin, D. G.; Schmidt, W. C. Spruce budworm larvae sever stems of western larch shoots in Montana. *J. For.* 65: 258-260; 1967.
- Furniss, R. L.; Carolin, V. M. Western forest insects. Misc. Publ. 1339. Washington, D.C.: U.S. Department of Agriculture, Forest Service; 1977. 654 p.
- Kramer, C. Y. Extension of multiple range tests to group means with uneven numbers of replications. *Biometrics* 12: 307-310; 1956.
- Painter, R. H. Insect resistance in crop plants. Lawrence, KA: The University Press of Kansas; 1968. 520 p.
- Ryan, R. B. The larch casebearer (Lepidoptera: Coleophoridae) and its parasites. II. The influence of different growth stages of *Larix occidentalis* foliage on casebearer development and survival. *Can. Entomol.* 111: 477-480; 1979.
- Schmidt, W. C.; Fellin, D. G. Western spruce budworm damage affects form and height growth of western larch. *Can. J. For. Res.* 3: 17-26; 1973.
- Wissenbach, M. J. Quantitative and temporal analysis of western spruce budworm damage to western larch. M.S. Thesis. Moscow, ID: University of Idaho; 1982. 71 p.