PRE-OVERWINTERING MORTALITY IN THE LARCH CASEBEARER, *COLEOPHORA LARICELLA* (LEPIDOPTERA: COLEOPHORIDAE), ON WESTERN LARCH IN NORTHERN IDAHO.[1]

M. W. Brown[2] and D. L. Kulhavy[2]

ABSTRACT

During 1976, continuous sampling of the same population cohort showed a 68% mortality in the pre-wintering larch casebearer, *Coleophora laricella*, in northern Idaho. The major mortality factors were density-independent; these were: premature needle drop caused by the needle diseases *Meria laricis* and *Hypodermella laricis* (18%); non-viable eggs (10%); and dislodgment of the eggs from the branch (10%). Other factors were: predation, desiccation, ripening and fall of the needles, intraspecific competition, loss of larvae moving between needles, and larch-willow rust.

INTRODUCTION

The larch casebearer, *Coleophora laricella* (Hübner), is the primary insect pest of western larch, *Larix occidentalis* Nutt. Originally found only in the eastern European highlands on European larch, *L. decidua* Mill., *C. laricella* is now nearly Holarctic in distribution (Schindler 1968).

Although researchers have investigated the biology and ecology of *C. laricella* (Webb 1953, Eidmann 1965, Sloan 1965), and a life table was prepared in Austria by Jagsch (1973), little is known about pre-overwintering mortality in western North America. Limited data only are available on egg mortality from predation, dislogdment and failure of the eggs to hatch (Baird 1923, Sloan 1965, Denton 1972). Predation, fungi, desiccation, autumn needle fall and intraspecific competition cause mortality during the larval mining stage (Jung 1942, Webb 1950, Sloan 1965, Jagsch 1973).

The purpose of our study was to identify the mortality factors in the egg, mining and autumn casebearing stages of the larch casebearer, in northern Idaho.

METHODS

Two sampling areas were established in sapling stands of western larch with moderate to heavy casebearer infestations. Stand 1 was located 7 km northwest of Troy, Latah County, in a *Thuja plicata/Pachistima myrsinites* habitat type (Daubenmire and Daubenmire 1968); it had 18% (stems per ha) larch and ranged from 850 to 975 m elevation. Stand 2 was located 35 km southwest of Lewiston, Nez Perce County, in an *Abies grandis/P. myrsinites* habitat type; it had 45% (stems per ha)

in larch and ranged from 1340 to 1365 m elevation.

Four circular 0.02-ha plots were located within each stand. One branch within 0.5-2.0 m of the ground was selected on each of six trees per plot. Three branches on each plot were exposed to the sun, the other three were shaded. Each sample branch consisted of 100 spur-shoots, counted from the terminal and including secondary branches, or 100 casebearer eggs, whichever came first. A barrier was erected at the end of the 100 spur shoots (or 100 eggs). The larch casebearers on these 48 branches constituted our population cohort. The branches were selected prior to oviposition to minimize sampling bias.

We sampled the same population cohort six times beginning 1 July 1976, to ascertain the degree and the cause of mortality in *C. laricella*. Counts were made on individual spur shoots to follow the development of individual casebearers. The first two samples were made biweekly, and at four-week intervals thereafter. Sampling continued until the first week of November when the larch needles had yellowed and begun to fall. By this time, nearly all the larvae had migrated to overwintering sites on the branch. Notes were made on the probable causes of mortality.

Our cohort samples differed from the samples used for other lepidopteran needle miners (Stark 1958, Jagsch 1973), in that we sampled a single cohort during the period, and thus avoided destructive sampling. Our method permitted the incorporation of more observational data and a more accurate accounting for the population decline.

Halfway through the sampling period one exposed sample branch was vandalized. Mortality of the mining and casebearing stages on the missing branch was estimated by averaging the mortality percentages from the other two exposed branches on the plot.

[2]College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho 83843.

TABLE I.   Pre-overwintering mortality factors for the larch casebearer in northern Idaho, 1976.

Age Interval x	Number alive at beginning of x l_x	Factor responsible for d_x $d_x f$	Number dying during x d_x	d_x as percent of l_x $100q_x$
Egg	3122	Non-viable		
		No-hatch	142	4.6
		Empty	116	3.7
		Abnormal	48	1.5
		Total	306	9.8
		Predation	98	3.1
		Needle Cast	176	5.6
		Needle Rust	36	1.2
		Dislodged	10	0.3
		Unknown[1]	304	9.7
			930	29.7
Mining	2192	In-transit	245	11.2
Larvae		Needle Cast	380	17.3
		Needle Rust	17	0.8
		Intraspecific Competition	55	2.5
		Needle Drop	114	5.2
		Dead	71	3.2
		Unknown[2]	222	10.1
			1104	50.3
Fall	1088	Needle Cast	19	1.8
Casebearing		Needle Drop	11	1.0
Larvae		Dislodged	6	0.6
		Dead	7	0.6
		Unknown[3]	36	3.3
			79	7.3
Entering Winter	1009	Total Mortality 2113		67.7

[1] Mostly dislodgment

[2] Mostly in-transit mortality

[3] Mostly needle drop and dislodgment

RESULTS

Approximately two-thirds (67.7%) of the cohort died between oviposition and the attainment of the overwintering stage (Table I). Nearly 30% of the eggs did not hatch for various reasons and of those that did, more than one-half of miners failed to form a case. More than 7% of those forming a case did not survive to winter. Density-dependent factors accounted for 4.9% mortality, whereas density-independent factors were responsible for 62.8% mortality (Table II).

Density-Independent Factors

Needle-cast fungi, *Meria laricis* Vuill. and *Hypodermella laricis* v. Tub., caused a decline of 18.4% in the cohort by inducing premature needle drop. *Meria laricis* was the more important. Nearly all branches were infected. Several branches, completely defoliated, had the entire resident casebearer population destroyed. Needle casts were most abundant in the lower crown.

Non-viable eggs, 9.8% of the cohort (29.7% of the eggs), were divided into three categories;

TABLE II.   Summary of pre-overwintering mortality factors acting on the larch casebearer, northern Idaho, 1976.

Factor	Stage Affected[1]		No. Killed	Percent Mortality
Density-Independent				
Needle Cast	e,m,c		575	18.4
Non-viable	e			
No-hatch		142		4.6
Empty		116		3.7
Abnormal		48		1.5
Total			306	9.8
In-transit	m		245	7.9
Needle Drop	m,c		125	4.0
Dead	m,c		78	2.5
Needle Rust	e,m		53	1.7
Dislodged	e,c		16	0.5
	e[2]		304	9.7
Unknown	m[3]		222	7.1
	c[4]		36	1.2
Density-Dependent				
Predation	e		98	3.1
Intraspecific Competition	m		55	1.8
Total	e,m,c		2113	67.7

[1]   e = egg stage, m = mining stage, c = casebearing stage

[2]   Mostly dislodgment

[3]   Mostly in-transit mortality

[4]   Mostly needle drop and dislodgment

no-hatch, empty and abnormal. No-hatch eggs had normal shape and color, but simply failed to hatch. Empty eggs were pale and translucent when first observed, apparently lacking normal contents. Abnormal eggs were either small and withered, or desiccated.

Mining and casebearing larvae still attached to the needles during autumn needle fall accounted for a 4.0% loss. Larvae in this category either failed to form a case or were attached to a needle rather than a branch for overwintering.

Larch-willow rust, caused by *Malampsora paradoxa* Diet. and Holw., caused a 1.7% mortality in the same manner as needle casts. This rust affected only the egg and early mining stages.

Some eggs and casebearing larvae were dislodged by mechanical disturbances. Much of the unknown egg mortality may have been due to dislodgment.

Miners that died while moving between needles (in-transit mortality) accounted for 7.9% of the cohort. This mortality factor, due to either dislodgment or desiccation, was estimated from mined-out needles without a larch casebearer nearby.

Larvae in their mines or cases, but not feeding between sample periods were recorded as dead. This mortality was caused by desiccation or diseases.

Density-Dependent Factors

We did not directly observe predation. Eggs placed in this category appeared healthy when first observed, but were pale and translucent at a later examination. Because of the similarity in appearance of these eggs and empty eggs, predators may have caused some of the mortality categorized as non-viable.

Intraspecific competition resulted when more than one egg hatched on the same needle. Usually only the larva located near the needle base survived. When more than one larva survived, one, or both, migrated to a fresh needle.

DISCUSSION

The high level of in-transit mortality is contrary to the findings of Webb (1953), who found little migration in the mining stage. We concluded that in-transit mortality was induced by: (1) dense aggregation of the eggs (Brown 1976), and (2) desiccation of the needles from diseases. The combined effect of these factors increased migration of the larvae which led to increased exposure and predation.

Dislodgment of eggs accounted for 0.3% of the observed mortality. However, including the unknown egg mortality, 8-10% of the cohort was lost in this manner.

The value of 3.1% predation (6.9% including eggs classified as empty) was considerably less than had been previously reported (15% by Webb 1950; 5-40% by Eidmann 1965; 22% by Sloan 1965; 16% by Denton 1972). Mites and true bugs were the most important predators, with a large red mite, *Bdella muscorum* Ewing, apparently the most important in Idaho (Denton 1972). Webb (1953) considered that predation was an important biological control factor of *C. laricella*. Predation was difficult to ascertain, but possible predators (spiders, predaceous mites, true bugs, and thrips, *Aeolothrips* sp.) were present on our sample branches.

Failure of the eggs to hatch was a major cause of mortality. Jagsch (1973) attributed egg mortality to hatching difficulties; Eidmann (1965) attributed it to disturbance in development of the embryo; or simply to infertility or non-viability. We divided egg mortality into three categories based on appearances (Table I).

Although less than one-third of our cohort survived to the over-wintering stage, the pre-overwintering period is not considered critical for population regulation. Density-independent factors were primarily responsible for the population decline, and as Nicholson (1958) and Solomon (1957) state, population regulation can only come about through the action of density-dependent mortality factors. Quednau (1967) also concluded that regulating, natural control factors do not act upon the egg stage of the larch casebearer. Following the same population cohort, as we did, allowed for a more accurate accounting of mortality, than did destructive sampling, and with less disruption to the population.

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EXAMINATION OF DOUGLAS-FIR CLONES FOR DIFFERENCES IN SUSCEPTIBILITY TO DAMAGE BY CONE AND SEED INSECTS

A. F. Hedlin and D. S. Ruth

Environment Canada
Canadian Forestry Service
Pacific Forest Research Centre
Victoria, B.C. V8Z 1M5

ABSTRACT

In 1974 and 1976, Douglas-fir cones from 51 clones and 150 clones, respectively, were collected and determinations were made of the percentage of seed damaged by the cone insects *Barbara colfaxiana*, *Contarinia oregonensis*, *C. washingtonensis* and *Megastigmus spermotrophus*. Although statistically significant differences in percentage of damaged seeds were detected among clones, these differences were not great enough to be of practical importance.