and/or fertile than females in the same treatments that remained refractory.

Remating also had a significant impact on spruce budworm reproduction. Females initially mated with males on YF had a significant increase in both fecundity and longevity following remating. A similar, but less pronounced pattern was seen for females whose first mate was an OF or AD male.

The observed differences due to male quality could not be explained by the size of the spermatophore produced. For example, the reproductive performance of females mated with either OF or AD males was similar, but the size of the spermatophore produced by the OF individuals was half that of AD males. This suggests that the quality, rather that the quantity of the ejaculate is important in influencing female reproduction. These results are discussed in relation to the possible role of ambient pheromone titers as a cue for the initiation of migratory flight in the spruce budworm.

Nosema fumiferanae infection in field-collected, adult spruce budworm, *Choristoneura fumiferana*

E. Eveleigh, C. Lucarotti and T. Royama

Canadian Forest Service - Maritimes Region, Fredericton, New Brunswick

Spruce budworm moths were collected daily from 1983 to 1987 in a balsam fir - white spruce stand near Fredericton, New Brunswick after adult eclosion at the end of June to mid-July. This period covered part of the outbreak (1983-85) and the decline (1986-87) of a spruce budworm population cycle. Male and female moths were examined for *Nosema fumiferanae* spores. Adult eclosion occurred between the end of June and mid-July. The percent of male and female moths with *Nosema* infections progressively increased towards the end of the eclosion period. A greater percentage of male moths had *Nosema* infections than did the females throughout the eclosion period. Non-migrating moths (at the time of capture) were, on average, more severely infected than moths that were dispersing. Percent *Nosema* infection was positively correlated with moth density. The use of trap catches to determine *Nosema* infection levels in spruce budworm moths is discussed.

Needle survival in young, spaced balsam fir

R. Fleming[1] and H. Piene[2]

[1]Canadian Forest Service - Forest Pest Management Institute, Sault Ste. Marie, Ontario
[2]Canadian Forest Service - Maritimes Region, Fredericton, New Brunswick

Year-to-year changes in foliar biomass are particularly important in research relating defoliation by forest insects to changes in volume growth. But since observations of foliage loss cannot distinguish insect-caused losses from those due to the natural senescence of aging foliage, independent estimates of the latter are required to estimate the former.

We report on part of a larger study relating spruce budworm-caused defoliation to growth loss in 25 - 35 year-old balsam fir [Abies balsamea (L.) Mill.] on the Cape Breton Highlands, Nova Scotia. Detailed data of needle survivorship were collected from 1976 to 1984 on each sample tree in two protected plots, and the Weibull model (see Fleming & Piene 1992, For. Sci. 38: 287-304) was used as the basis for period (or time-specific) and cohort analyses of needle survivorship.

Survival rates were inferred from the age structure of the needle populations at specific points in time for the period of analysis, indicating a trend of increasing needle survivorship over time. The age-specific survival rates decreased with needle age throughout the crown, and needle populations experienced distinct stages of needle-fall as they aged. Differences between trees and between the crown levels of the whorls sampled were of little additional value in explaining needle survivorship.

The cohort analysis, which involved following sets of needles initiated concurrently (i.e., a cohort) over time and recording the proportion surviving at different ages, confirmed the results of the time-specific analysis. However, fitting the Weibull model to individual cohorts often left over half of the variation in needle survivorship unexplained. Much of this unexplained variation was due to large year-to-year variability. Neither year of observation nor crown level were of much predictive value.

These year-to-year fluctuations restrict our capacity for predicting age-specific rates of needle fall. The Weibull model may describe future needle age distributions well, but large variations in the parameter values can be expected caused by weather-caused fluctuations, long term cycles, or trends in needle-fall.