PREDICTING OUTBREAKS OF *PSEUDO-COREMIA SUAVIS* ON DOUGLAS FIR

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ABSTRACT

This paper presents the final data from a study of endemic populations of Pseudocoremia suavis *on Douglas fir. The correlation of rainfall, during the early developmental stages of* P. suavis, *with subsequent population development is described as a predictive tool for focusing attention on high risk Douglas fir plantations.*

The indigenous pine looper *Pseudocoremia suavis* Butler (Lepidoptera: Geometridae) is the most serious defoliator of exotic forests in New Zealand. Recorded outbreaks on Douglas fir (*Pseudotsuga menziesii*) (Mirb.) Franco have been confined to Kaingaroa State Forest, where, in the last decade, three isolated, explosive population increases have been observed in the "old crop" (45- to 60-year-old) single species stands. The outbreaks, apparently developed from high, though benign, endemic populations, were shortlived and were probably terminated by viral infection.

Douglas fir represents about 7% of the total exotic forest estate, with approximately half of the national resource located in the Rotorua Conservancy. The greater proportion (12 740 ha) of the Rotorua Douglas fir is in the "old crop" (pre-1940) category (Chandler, 1974). Approximately 90% of Douglas fir plantings in other Conservancies are post 1950. To date Douglas fir defoliation has been a Rotorua problem. The Rotorua experience may benefit other forests approaching old crop status and may help in the management planning of long-term amenity plantings.

Detection and monitoring of outbreaks of *P. suavis* populations would be greatly facilitated if observations could be focused, both temporally and spatially, on forests most susceptible to epidemics. Observations, consisting of meteorological records and frass collections over eleven successive generations of *P. suavis* in Douglas fir (FRI, 1978; Kay, 1982), can provide such focusing.

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The simplest predictor of increase in insect numbers is that based on the density of the preceding generation (Klomp, 1976), assuming a constant rate of reproduction and no negating influences. There is, however, no strong relationship between the densities of the successive populations of *P. suavis* observed (Fig. 1). For seven generations recorded frass falls were about 30 g or greater, representing populations with the potential to give rise to populations exceeding a hypothetical defoliation threshold of 50 g.. In only three out of seven instances was that potential realised, *i.e.,* predictions on this basis were correct less than half of the time; one might as well have tossed a coin.

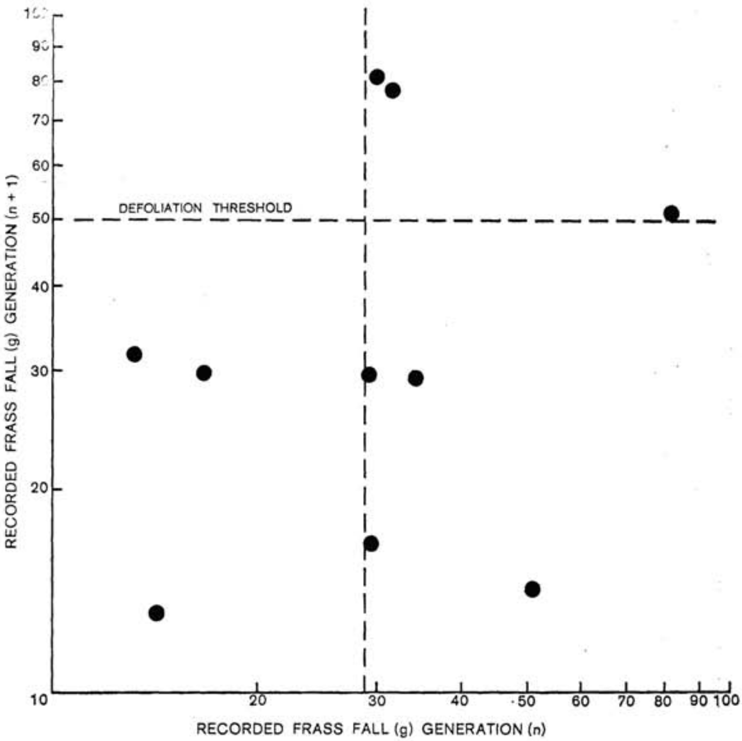

FIG. 1: *The relationship between recorded frass falls of successive* P. suavis *populations on Douglas fir. Populations producing 29 g or more frass (to the right of the dotted abscissa) had the potential to exceed a hypothetical "defoliation threshold" (dotted ordinate) of 50 g of frass—only 3 out of 7 did.*

Defoliation prediction can be based on the density of any life stage of the pest provided that major mortality factors operate prior to the stage on which the prediction is based. Alternatively, the magnitude of the mortality factor(s) may be correlated with density changes. Unfortunately, manpower and canopy sampling technology are so limited that only inadequate estimates of pre-defoliation stages of the insect are available. Furthermore, although a range of parasites has been reared from *P. suavis* (Valentine, 1967; Gauld, 1980) there are few quantitative data on parasitism, particularly for endemic populations.

It was noticed that *P. suavis* outbreaks were preceded by droughts or periods of low rainfall, and that these periods coincided with the earliest developmental stages (eggs and first larval instar) of the insect (Kay, 1982). This feature was then investigated in the observed series of endemic populations. It was found that the difference between the potential population

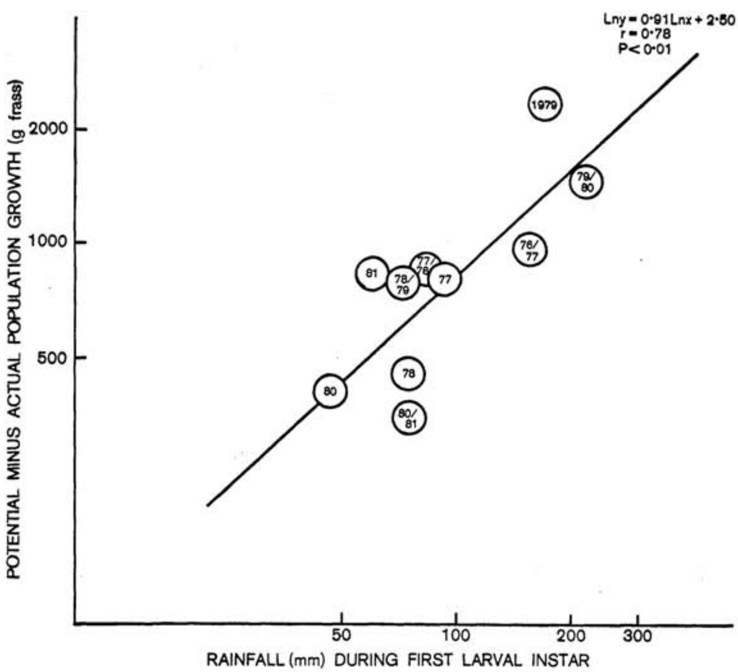

FIG. 2: *The correlation between rainfall during the first larval instar and the difference between the potential and actual population growth as measured by frass fall.*

increase, as determined from frass collections and laboratory observations of egg production, of a given generation, and the actual population density of the following generation, was significantly correlated to the rainfall during the earliest developmental stages of that following generation (Fig. 2). That is, the greater the rainfall during the critical period of the insect's life cycle the greater the mortality, or, the greater the difference between the potential and the actual population increase.

FIG. 3: *Areas where rainfall of 80 mm or less is normal for the months of October and February.*

The critical periods for the effects of rainfall are the months of October (for the early summer generation) and February (for the late summer generation). At no other stage in the insect's life cycle does rainfall show a significant correlation with population dynamics. The threshold level of precipitation, below which the population expands, is approximately 80 mm/month. Figure 3 shows those areas where 80 mm rainfall is the norm for October and February. Bearing in mind that key limiting factors may change with time and that predictions for one area do not necessarily hold for another, these low rainfall areas must be considered as high risk for old crop, poorly thinned Douglas fir. Any silvicultural practice which concentrates more foliage/stem will further promote the trees' tolerance to defoliation. The current thinking on Douglas fir silviculture—of an early first thinning to waste and a shorter rotation of about 45 years—should maintain long green crowns in production forests. Existing old crop stands and amenity plantings, however, should also be managed with this defoliator in mind.

This prediction of *P. suavis* population movements should allow Forest Health Officers and managers to concentrate their pest detection efforts on high-risk stands subject to droughts in October and February. It is not beyond the realms of credibility that long-range forecasts, based on cycle solar activity, etc. (Vines and Tomlinson, 1980; Manning, 1982), could be used to provide considerable forewarning of the population movements of *P. suavis* and that induced rainfall from cloud seeding be used as an ecologically acceptable method of pest control.

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