CYCLANEUSMA (NAEMACYCLUS) NEEDLE-CAST OF PINUS RADIATA IN NEW ZEALAND

3: INCIDENCE AND SEVERITY OF THE NEEDLE-CAST

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ABSTRACT

An aerial survey of 80 000 ha of **Pinus radiata** D. Don plantations in New Zealand in 1983 showed that the needle-cast caused by **Cyclaneusma minus** (Butin) DiCosmo **et al.** was present in all forests surveyed. Stands aged between 11 and 20 years showed a considerable range of disease severity (trace to 60% crown infection) and trees with more than 20% crown infection occupied 11% of the survey area in this age-class. Stands younger than 6 years and older than 26 years of age showed very low disease severity (less than 20% of the crown infected) but in the >25-year age-class such lightly diseased trees occupied 77% of the area surveyed. The survey values were extrapolated to the entire estate of **P. radiata** and it was estimated that the annual increment loss incurred through infection by **C. minus** was of the order of 0.2% in the >25-year age-class and 3.8% in the 11–20 age-class. Over the forest estate as a whole, it equalled 2.3%.

INTRODUCTION

Needle-cast caused by *Cyclaneusma minus* occurs periodically in plantations of *Pinus radiata* throughout New Zealand. No detailed information is available on disease incidence and its impact.

Symptom expression of the disease, a yellow mottling and premature casting of the 1-year-old and older needles, occurs in spring over a period of 6 to 8 weeks. Assessment of the disease therefore has to take place during that period.

It was decided to assess severity and incidence of the disease nationwide by aerial surveys of a sample of forests during three consecutive seasons. The first aerial survey took place in September 1983. Data from that survey and provisional estimates made on the impact of the disease are reported in this paper.

METHODS

Sample Selection

Forest health records from previous years showed that the needle-cast was common throughout New Zealand. Nineteen forests were selected for the survey so as to include a wide range of sites covering the country (Table 1). The stands in each forest

TABLE 1—State forest areas (ha) aerially surveyed in 1983 for the incidence of needle-cast caused by **Cyclaneusma minus** (by age-class)

State Forest	Age-class (years)					
	1–5	6–10	11–20	21–25	>25	Total
Woodhill	78	1 150	1 140	192	171	
Glenbervie	66	693	572	78	21	
Tairua	190	674	1 391	48	163	
Pureora	264	1 111	160	36		
Kaingaroa	4 044	8 079	8 560	1 701	2 532	
Mangatu	610	1 896	2 050	102		
Ruatoria	1 286	4 260	608			
Santoft	309	516	1 234	140		
Karioi	504	747	193		32	
Gwavas	164	703	884	240	12	
Wharerata	918	805	480	122		
Patunamu	208	801	319	88	121	
Mohaka	150	924	800	38		
Golden Downs	1 021	3 906	5 417	415	178	
Mawhera	51	1 463	680			
Balmoral	963	755	520		51	
Ashley	156	1 143	826	38	10	
Herbert	82	189	280	80		
Berwick	647	3 115	2 046	239		
Total area surveyed	11 711	32 930	28 160	3 557	3 291	79 649
Percentage of national total area*	4.6	14.2	17.0	12.7	4.8	10.6

* Ages as at 31.3.81 from Elliott & Levack (1984).

were classified into five age-classes: <5 years old, 6–10 years, 11–20 years, 21–25 years, and >25 years old, and within each class a sample was selected randomly. Sample size in each age-class was chosen so as to be approximately proportional to estimates of disease prevalence based on previous assessments by Forest Health Officers. This was done to increase precision over simple random sampling.

Measurement of Disease

The terms "severity" and "incidence" of the disease are defined as follows:

Disease severity: Area or volume of plant tissue which is diseased (James 1974). In this study it is expressed as the percentage of unsuppressed green crown that showed the yellow mottling of the needles characteristic of the disease.

Disease incidence: Number of plant units which are diseased (James 1974; Horsfall & Cowling 1978). In this study the percentage of diseased trees of a given severity in a stand was estimated and from this estimate, the area occupied by those trees in that stand was calculated. Disease incidence is expressed as the percentage of the total area surveyed occupied by diseased trees.

The method of assessment of disease severity used in this survey was similar to that used in the annual national aerial survey of severity of infection by *Dothistroma pini* Hulbary (Kershaw *et al.* 1982). The survey was conducted from a Cessna 180 aircraft flying at 100 m above tree tops and at about 80 knots (150 km/h). Stands were scored by two assessors while the local Forest Health Officer helped the pilot with navigation. Stands were rated in 5% steps using a two-tier system. The first score estimated the percentage of trees in the stand that were diseased (for calculating incidence) and the second score estimated the average percentage of the green crown with disease symptoms (severity). Ground checks were made to establish possible sources of error such as foliage discoloration through suppression and magnesium deficiency. Training flights were held before the survey to "calibrate" against ground assessments and to ensure consistency between the two observers. During the training flights, before the survey, it was noted that the aerial scores of stands with high disease severity (50%) were slightly lower than ground assessment scores. This was corrected for and the accuracy of the aerial scoring of stands and the validity of its estimates are believed to be of the same order as those of the aerial assessment of *D. pini* (van der Pas, Kimberley & Kershaw 1984).

RESULTS AND DISCUSSION

The data on disease severity and incidence by age-class are summarised in Table 2 (full details are available from the author). Cyclaneusma needle-cast was present in all forests and age-classes surveyed. Disease severity was low (trace to 20%) in the 1–5 and >25-year age-classes; stands aged between 11 and 20 years had the greatest range of disease severity (trace to 60%) and 11% of the area in this age-class was occupied by trees with infection severity in excess of 20%. Disease incidence was highest in the >25-year age-class with 77% of the area surveyed being infected to some degree, but the disease severity was very low, 74% of the area showing only a trace of the disease.

Conversion of the disease incidence and severity data from the survey to an estimate of the impact of the disease on the forest estate is important in judging the magnitude

TABLE 2—Disease incidence (percentage of the area surveyed occupied by diseased trees) and disease severity (percentage of tree crown infected), listed by age-class

Disease severity (%)	Age-class				
	1–5	6–10	11–20	21–25	>25
Trace	25	1	1	9	74
1–10	7	8	6	6	2
11–20	2	6	6	9	1
21–30		2	5	2	
31–40		2	3	1	
41–50		1	2		
51–60			1		
Total	34	20	24	27	77

of the needle-cast problem in New Zealand. However, there are no established procedures for such a conversion and some arbitrary decisions had to be made. It was assumed that sample size and accuracy were adequate to estimate the impact of the disease. The disease severity and incidence figures derived from the survey sample were used to calculate the severity and incidence of the needle-cast in 1983 in the total *P. radiata* forest area by age-class. Volume reduction was estimated using the formula:

$$V = (1 - \frac{537 - 4.29D}{537}) \times 100$$

where V = volume loss (%) and D = disease severity (%). This formula was derived from the regression ($r^2 = 0.54$) of Fig. 3 in the second paper in this series (van der Pas, Slater-Hayes, Gadgil & Bulman 1984). Annual volume loss of each age-class was calculated by multiplying the area occupied by diseased trees in that age-class by the percentage loss and the periodic annual increment (PAI). A nation-wide average estimate of PAI for different age-classes was obtained from the unpublished data of J. W. Shirley. These estimates of PAI are included in Table 3 with estimates of increment loss for all age-classes and disease severity classes. It must be emphasised that this is a gross approximation which gives only an idea of the order of magnitude of a single year's impact. A source of error in the estimate is that the calculations assume that all diseased trees are grouped together and therefore do not allow for compensatory growth by healthy trees in a stand where healthy and diseased trees are mixed. Growth loss may also differ substantially from year to year since the disease occurs only periodically (Gadgil 1984). The increment loss was least in the >25-year age-class (0.2%) and highest in the age-class 11–20 years (3.8%). More stands will fall into the most vulnerable age-class of 11 to 20 years in the near future as a result of changes in age-class distribution.

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TABLE 3—Estimated area* (ha, to the nearest hundred) and annual growth loss (m^3, to the nearest 500) of **P. radiata** stands, by age-class and disease severity

Disease severity %	Age-classes (years) 1–5	6–10	11–20	21–25	>25	Loss in volume‡ (%)
	PAI† (m^3/ha/year)					
	1	5	21	34	32	
Uninfected						
Area (ha)	168 000	185 500	125 700	204 000	154 000	
Vol. lost	–	–	–	–	–	0
Trace						
Area (ha)	63 600	2 300	1 600	2 500	51 000	
Vol. lost	–	–	–	–	–	0
1–10						
Area (ha)	18 000	18 600	10 000	1 700	1 400	
Vol. lost (m^3)	1 000	4 000	8 500	2 500	2 000	
11–20						
Area (ha)	5 000	14 000	10 000	2 500	700	
Vol. lost (m^3)	500	8 500	25 000	9 000	2 500	12
21–30						
Area (ha)	–	4 600	8 300	600	–	
Vol. lost (m^3)	–	4 500	27 500	4 000	–	20
31–40						
Area (ha)	–	4 600	5 000	300	–	
Vol. lost (m^3)	–	6 500	29 500	2 500	–	28
41–50						
Area (ha)	–	2 300	3 300	–	–	36
Vol. lost (m^3)	–	6 500	29 500	2 500	–	36
51–60						
Area (ha)	–	–	1 700	–	–	
Vol. lost (m^3)	–	–	15 500	–	–	44
Total						
Area (ha)	254 600	231 900	165 600	28 000	68 500	
Vol. lost (m^3)	1 500	27 500	131 000	18 000	4 500	
Volume if total area uninfected (m^3)	254 600	1 159 500	3 477 600	952 000	2 192 000	
Volume lost (%)	0.6	2.4	3.8	1.9	0.2	

* Area figures as at 1981 from Elliott & Levack (1984)

† From unpublished data of Shirley

‡ Loss in volume (%) $= (1 - \frac{537 - 4.29D}{537}) \times 100$

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