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VARIATION BETWEEN CLONES OF PINUS PINASTER TO ATTACK BY THE PINE WOOLLY APHID

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Abstract:

Pinus pinaster clones growing in a Western Australian Seed Orchard varied in their ability to resist attack by pine woolly aphids. It was found that this variation was not due to distribution of the insect or environmental factors, but may be under genetic control.

INTRODUCTION

Pine woolly aphids (Pineus spp.) are considered to be a major pest among some forest species. The degree of infestation can be contributed to several factors and there is often an interaction between these factors. The infestation can be increased by off site planting resulting in unthrifty stands (Barnes et al. 1976; Tanton & Alder 1977). Barnes (1976) reports that the rapid decline of the Pinus halepensis (Mill.) population of Salisbury in 1968 resulted after the accidental introduction of Pineus pini to Zimbabwe (Rhodesia). Other pine spp. varied in their suseptability to attack. He also found that while Pinus pinaster (Ait.) suffered severe attack with a few deaths there were some immune individuals.

The family Adelgidae contains two genera, Adelges and Pineus. Their life cycle when complete is alternative with the primary host being a member of the genus Picea. When their life cycle is incomplete there is only one host and reproduction is by parthenogenesis (Carter 1971; Barnes et al. 1976). Dispersal of the adelgids as with other small insects can occur in several ways. The prevailing winds play an important role in dispersal sometimes carrying the insects several kilometres (Barnes et al. 1976; Odera 1974). Eggs are often carried by animals, or on the clothing of workers and this can result in isolated outbreaks often great distances from the main population (Barnes et al. 1976).

The distribution of the pine woolly aphids was widespread throughout the pine forests of Western Australia in 1960 (Hopkins 1960), but from earlier forestry records it appears that they may have been established as early as the mid 1940's. As no vegetative pine material had been imported to Western Australia prior to 1960, the pine woolly aphids may have been introduced as eggs on seed imported from Landes in France or Leiria in Portugal. This was the major seed source for plantation establishment.

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INTRODUCTION (Cont.)

The first trial of P.pinaster was established in Western Australia in 1896 (Harris 1957). The main strain used was from Leiria and it appears from personal observations that this strain is more resistant to attack by pine woolly aphids than strains originating from Landes or Tunisia. Infestation of Pinus spp. in Western Australia is not a serious problem with only isolated attacks on individual trees. Although these attacks are not fatal there may be some nutritional loss to the tree with a resulting loss in production.

As pine woolly aphids only attack certain individuals in the P.pinaster population, there appears to be variation between the individuals in their ability to withstand attack. The variation could be useful in future breeding programmes. This study was initiated to determine if clones used in the breeding programme varied in their ability to withstand attack by pine woolly aphids.

MATERIALS AND METHODS

The *P.pinaster* Mullaloo Seed Orchard was used for this study. It is located on the Perth coastal plain on the west side of Lake Joondalup, Latitude 31°45', Longitude 115°46', altitude 40m. The area of the seed orchard is 10.9 ha with a total of 7816 grafts, planted from 1969 to 1972 inclusive. The genetic material comprised of 98 superior clones of *P.pinaster* representing selections from Portugal and Western Australia.

The 78 clones used from this study were planted in 1969/70 in 46 randomised blocks with a total of 3,597 grafts. Spacing was in 3 metre rows aligned at a repetative 3 metre then 6 metre pattern.

A visual assessment was performed in July 1978 to assertain the presence or absence of the pine woolly aphids on each graft. No attempt was made to assess the degree of infestation or the species of *Pineus* involved.

RESULTS AND DISCUSSION

In this study 51 of the 78 clones used were affected by pine woolly aphids. The range of infestation was from 2% to 100% for individual clones with the median being 4% (fig. 1).

Figure 1

From these results it is clear that the ability of each clone to withstand attack by the pine woolly aphid varies. The experimental design allowed for complete randomisation of the clones within blocks and the distribution of the insect throughout the experimental area appeared randomised. Distribution of these insects in an area the size of the experimental plot with the close spacing between clones should have been complete. Odera (1974) reports that air born crawlers of Pineus pini have been recorded up to 60m from the host tree and those that do not land directly on another host have tremendous crawling capacity and the ability to remain alive for many days. Bearing these facts in mind it appears reasonable to assume that the variation between clones to attack is controlled from within the clones and not subject to external factors, such as the environment, experimental design, or distribution of the pest.

The ability of any pest to attack a host can depend on a number of factors (Graham 1963). Stands of forest that are unthrifty due to off site location or unsuitable silvicultural management may suffer from serious pest disorder. Often trees suffering from drought stress and subsequent reduced tugor pressure will be attacked more readily by insects (Barnes et al. 1976; Suckling et al. 1976). On a study of bark beetles Smith (1966) reports that the length of time a tree can exude resin could explain the success or failure of the beetle attack. As all the trees used in this study are in

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RESULTS AND DISCUSSION (Cont.)

good health, it appears that another mechanism is involved other than resin flow. The resin quality or chemical composition is important and Callaham (1966) suggests that the turpentine chemistry may be the key to resistance of pines to many insects. Also there is genetic variation between individuals of a species thus resulting in different turpentine chemistry, with a resulting variation to attack. This inherited factor can be passed on to the next generation and so the genetic resistance can provide the tree breeder with an important tool in forestry pest management.

Figure 2

From figure 2 it can be seen that the mean value (17%) and the median (4%) do not coinside as is the case with a normal distribution.

The majority (68%) of clones with only mild symptoms of attack lie between the mean and -1 standard deviation of the mean. The tree breader, wishing to increase the hosts resistance to attack could select clones for breeding from this area and exclude clones lying on the +ve side of the mean.

This study has shown that although the distribution of the pine woolly aphids is widespread, they prefer to attack certain individuals within a population and exclude others. As there was no limit to their distribution it appears that resistance to attack is under genetic control within each clone.

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Co-ordinates for plotting figure 1 and 2.

Figure 1

Axis											
X	0	5	15	25	35	45	55	65	75	85	95
Y	27	26	6	4	2	3	0	2	3	3	2

Figure 2

Dotted Line

Axis				
X	-3+3	-2+2	-1+1	mean
Y	$\frac{1}{2}$	5	20	30.5

Straight Line

X	-1	$-\frac{1}{2}$	mean	$+\frac{1}{2}$	+1	$+1\frac{1}{2}$	+2	$+2\frac{1}{2}$	+3
Y	0	53	30	8	4	3	$4\frac{1}{2}$	7	2

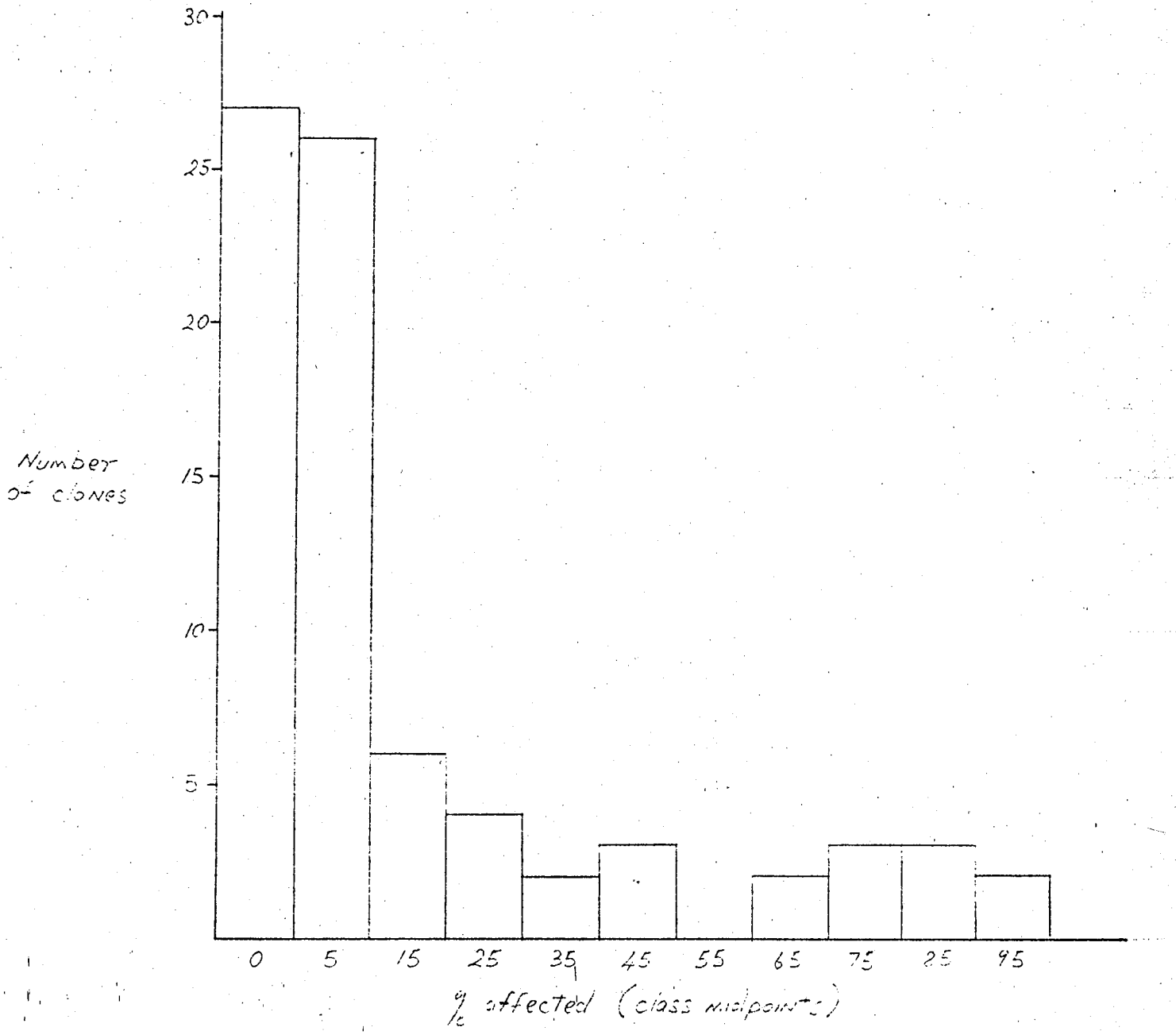

Figure 1 Number of clones of Pinus pinaster affected by pine woolly aphids.

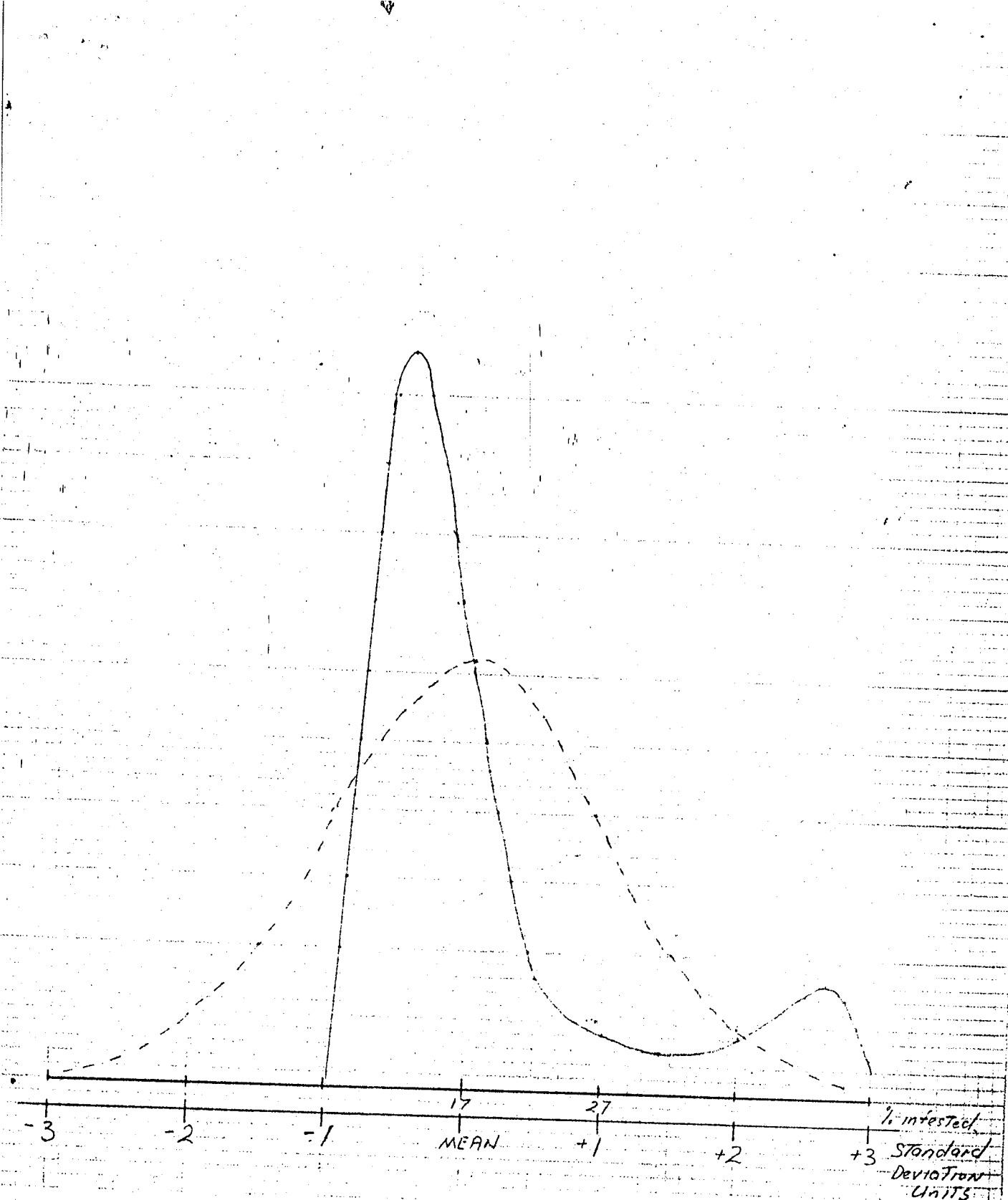

Figure 2 Comparison between the normal distribution and the actual distribution of clones infested by pine woolly aphids.