MONITORING *ESSIGELLA CALIFORNICA* POPULATIONS IN BAY OF PLENTY FORESTS

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ABSTRACT

Essigella californica (Monterey pine aphid) populations were monitored in the Bay of Plenty forests of Rotoehu and Kaingaroa over two years to determine what influence *E. californica* has on the health of *Pinus radiata*, and to identify any associated predators and parasites. Populations were sampled throughout the canopy height of forests stands at three altitudinal ranges (<300 m, 300–600 m and >600 m above sea level) and three age classes (1–10, 11–20 and 21–30 years old). Findings clearly show that although *E. californica* populations vary markedly from one year to the next, highest populations occurred in low altitude, mid-aged *P. radiata* in autumn. Even at relatively high population levels in mid-aged stands, *E. californica* did not appear to have any visible effect on tree health. The monitoring programme has shown that *E. californica* cannot be considered a pest of *P. radiata* in New Zealand.

Keywords: *Essigella californica*, *Pinus radiata*, aphid, monitoring, populations.

INTRODUCTION

Essigella californica (Hemiptera: Lachninae) is native to California, U.S.A. where its major host is *Pinus radiata* (Blackman & Eastop 1994; Sorensen 1994). Outside of the U.S.A. it has become established in France in 1989 (Turpeau & Remaudiere 1990), Spain in 1992 (Seco Fernandez & Mier Durante 1992), Australia and New Zealand in 1998 (Carver & Kent 2000) and Brazil in 2000 (de Carvalho 2000). In Australia, it has become widespread throughout southeastern states, and has been associated with major defoliation of drought stressed *P. radiata* plantations (Carver & Kent 2000). By 2000, *E. californica* had become widely distributed throughout New Zealand, but there is a lack of information regarding population trends and its influence, if any, on the health of *P. radiata*. In light of the Australian experience, it was decided to monitor *E. californica* populations at different altitudes and in different aged plantations across the Bay of Plenty region. This study was carried out in 2001–2002, in collaboration with scientists undertaking monitoring in Hawke's Bay forests (Teulon et al. 2003).

METHODS

Monitoring was conducted in the Rotoehu and Kaingaroa plantation forests, in *P. radiata* age classes: 1–10 years (young), 11–20 years (mid) and 21–30 years (old). Old age class stands were harvested in late 2001, hence their absence in 2002 monitoring. One age class stand was monitored at each of the following altitudinal ranges: <300 m (low, Rotoehu), 300–600 m (mid, Kaingaroa) and >600 m above sea level (high, Kaingaroa).

The influence of site aspect and leaf area index (L.A.I.) on aphid populations was studied in March 2002, in a young stand located in a west-facing gully in Rotoehu Forest. Sampling was undertaken twice, 14 days apart, on 40 trees growing on the northern and southern facing slopes, in the gully bottom, and on the northern ridge. L.A.I. was measured using a LI-COR LAI-2000 plant canopy analyser, which calculates L.A.I.

from radiation measurements made with a “fish-eye” optical sensor (148° field-of-view). Measurements were made below the canopy to determine canopy light interception at 2 angles, from which LAI was computed using a model of radiative transfer in vegetative canopies.

Aphid sampling was conducted once a month between October–February and every fortnight through February–May. In each stand ten trees were selected, different to those sampled on the immediate previous visit. Young trees (2 m) were sampled from the ground while canopies of older trees were accessed using a heavy-lifter parked along forest tracks, where road dust deposition in the canopy was minimal. For each tree, six beat samples were taken: two branches at the bottom, two at midway and two at the highest accessible level in the canopy, with the outer most section beaten to displace aphids into the net (50 cm diameter). Numbers of apterous and alate aphids collected for each tree were recorded. Presence of aphid predators was also recorded.

To determine *E. californica* influence on tree health, trees were scored for the level of defoliation: I (0%), II (1–25%), III (26–50%), IV (51–75%) and V (76–100%) (Kent & Carnegie 2000).

Throughout the monitoring periods, relative humidity, ambient temperature and rainfall were recorded within each altitudinal range. Multiple analyses of variance using S.A.S. was used to analyse aphid population data from trees growing in four different site aspects in Rotoehu Forest.

FIGURE 1: Mean number of *Essigella californica* collected per tree in different aged *Pinus radiata* in Rotoehu Forest (low altitude, <300 m) in (a) 2001 and (b) 2002. Error bars indicated are the SEM.

FIGURE 2: Mean number of *Esigella californica* collected per tree in different aged *Pinus radiata* in Kaingaroa Forest (mid altitude, 300–600 m) in (a) 2001 and (b) 2002. Error bars indicated are the SEM.

RESULTS

Aphid populations built up in February and March, peaked in mid April and declined to low numbers by the end of May. This trend occurred earlier in mid altitude sites (Figs 1 & 2). For both years *E. californica* was most abundant in low elevation forest stands (Figs 1 & 2) but absent above 600 m. High numbers of aphids occurred in April 2002 in mid-aged trees in Rotoehu Forest; these numbers were three to four times higher than for 2001 (Fig. 1). In heavily infested trees (counts over 500) aphids were visible on needles throughout the canopy. In both years aphid numbers were randomly distributed through tree canopies and stands but there were always more aphids in older trees than young trees (Figs 1 & 2). Alate aphids appeared in April and May, making up <5% of the population.

Irrespective of location or tree age, there was no correlation between canopy score and the number of aphids collected per tree. Canopy condition was consistent across sampling years and altitudinal range for the young and mid-aged classes, with respective mean defoliation scores being 1.3 and 1.5. Canopy condition of old stands was poorer at higher altitude sites, with mean defoliation scores being 1.5 (low), 1.6 (mid) and 2.2 (high).

Temperatures measured at the three sites during the sampling period are shown in Table 1.

TABLE 1: Mean ambient temperatures and diurnal temperature range (minimum and maximum) (°C) at three locations during 2001 and 2002.

	2001		2002	
	Mean	Min–max	Mean	Min–max
Low altitude	16.4	0.3 to 36.1	14.0	0.2 to 33.5
Mid altitude	13.3	–5.8 to 33.2	11.2	–6.0 to 29.2
High altitude	12.4	–5.3 to 32.3	10.8	–6.4 to 28.9

In the aspect study, L.A.I. was significantly different between aspects ($P<0.0001$), with highest mean values on the north facing aspect, then respectively lower for trees in bottom, south and ridge aspects. Aphid numbers were also significantly higher ($P<0.0001$) on the north facing aspect (Fig. 3), but the trend was different to the L.A.I., hence there was no correlation between aphid numbers and L.A.I. ($R^2=0.0017$). Trees at this site did not show any signs of ill health.

Generalist predators, syrphids, neuropterans and coccinellids were only present when aphid numbers were high in Rotoehu Forest in 2002. No parasitoids were found, nor were there signs of aphid parasitism or disease.

FIGURE 3: Mean number of *Esigella californica* collected per tree on *Pinus radiata* growing in different aspects in Rotoehu Forest. Error bars indicated are the SEM.

DISCUSSION

This study shows that in Bay of Plenty forests *E. californica* populations vary markedly from one year to the next, with highest numbers occurring in April in low altitude, mid-aged *P. radiata*. In comparison, Teulon et al. (2003) found that *E. californica* populations were more numerous in older trees than in mid-aged trees in low elevation forests in Hawke’s Bay. In our study *E. californica* was absent from forests above 600 m, whereas Teulon et al. (2003) found it to be fairly abundant at this elevation. The reason for the absence of *E. californica* at high altitude sites in Bay of Plenty can only be surmised. Aphids typically over-winter as sexual forms. Since sexuals of *E. californica* have never been found in New Zealand, this may explain why it is not present at high altitude sites where winter conditions are harsh. Although the site above 600 m in Kaingaroa is known to be colder than at the same altitude in Hawke’s Bay, more detailed comparison of

regional climate data and its influence on aphid populations is required to confirm the reasons for the differences in aphid populations.

Could the higher numbers of aphids observed in older trees be a reflection of sampling along track margins? Considering seasonal trends and the degree of age class differences it is doubted that there would have been a significant shift from what was observed if trees distant from track had been sampled. Higher aphid numbers in older trees indicates that either tree age, differences in foliage structure or canopy architecture are influencing aphid numbers, but this requires further investigation. The fact that Teulon et al. (2003) observed different trends in aphid numbers across age classes may have been a reflection of the different sampling techniques used, or differences in climate and geography between regions. There is a need for further studies to determine what is influencing aphid populations in different aged trees.

Although the presence of *E. californica* does not affect *P. radiata* canopy condition it may still influence tree health, as it has been shown that low homopteran densities may be beneficial to plants by mobilising nutrients, but high populations can markedly reduce plant growth and foliage development (Dixon 1971; Newbery 1980; Mills 1984; van Emden 1989; Vranjic & Gullan 1990). Since *E. californica* populations are generally low, any influence on tree growth may only be detectable through the rotation period being extended.

It is surmised that warmer temperatures in north facing sunny aspects permit aphid development to occur earlier in the year and subsequently numbers are much higher than for other aspects. But since L.A.I. (canopy density) did not correlate with aphid numbers, it is suggested that other factors, such as foliage nutrients and physiology, are influencing aphid numbers.

In conclusion, *E. californica* cannot be considered a pest of *Pinus radiata* in the Bay of Plenty at present since it did not persist at high populations or influence tree health. However, given favourable climatic conditions it does have the potential to be damaging (Carver & Kent 2000) and this information should not be ignored as there are many remaining questions about its biology in New Zealand.

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REFERENCES

- Blackman, R.L.; Eastop, V.F. 1994: Aphids on the World's Trees. An Identification and Information Guide. CAB International, Wallingford, UK. 1024 p.
- Carver, M.; Kent, D. S. 2000: *Essigella californica* (Essig) and *Eulachnus thunbergii* Wilson (Homoptera: Aphididae: Lachninae) on *Pinus* in south-eastern Australia. *Aust. J. Entomol.* 39: 62-69.
- de Carvalho, R.C.Z. 2000: First record for the California pine aphid, *Essigella* (*Essigella*) *californica* (Essig) (Homoptera: Aphididae: Lachninae), in southern Brazil. *Proc. Entomol. Soc. Wash.* 102: 757-758.
- Dixon, A.F.G. 1971: The role of aphids in wood formation. 2. The effect of the lime aphid, *Eucalipterus tiliae* L. (Aphididae), on the growth of lime, *Tilia x vulgaris* Hayne. *J. Appl. Ecol.* 8: 393-399.
- Kent, D.; Carnegie, A. 2000: Distribution of *Essigella californica* in New South Wales & ACT. In: Collett, N.G.; Simpson, J.; Schoenborn, C. ed. A review of the current status of the Monterey Pine Aphid *Essigella californica* (Essig.). Proceedings of a Workshop. Dept. Natural Resources and Environment, Heidelberg, Victoria, Australia. Pp. 22-29.
- Mills, J.N. 1984: Effects of feeding by mealybugs (*Planococcus citri*, Homoptera: Pseudococcidae) on the growth of *Colliguaya odorifera* seedlings. *Oecologia* 64: 142-144.

- Newbery, D. McC. 1980: Interactions between the coccid, *Icerya seychellarum* (Westw.) and its host tree species on Aldabra atoll. *Oecologia* 46: 171-179.
- Seco Fernandez, M.V.; Mier Durante, M.P. 1992: Presencia en Espana del pulgon verde de los pinos americanos: *Essigella* (Hom., Aphididae: Cinarinae). *Boletin de la Asociacion Espanola de Entomologia* 16: 255-256.
- Sorensen, J.T. 1994: A revision of the aphid genus *Essigella* (Homoptera: Aphididae: Lachninae): Its ecological associations with, and evolution on, Pinaceae hosts. *Pan-Pacific Entomol.* 70: 1-102.
- Teulon, D.A.J; Herman, T; Davidson, M.M. 2003: Monitoring monterey pine aphid in Hawke's Bay forests. *N.Z. Plant Prot.* 56: 39-44.
- Turpeau, E.; Remaudiere, G. 1990: Decouverte en France d'un puceron des pins Americains du genre *Essigella*. *Comptes Rendus de l'Academie Agricole de France* 76: 131-132.
- van Emden, H.F. 1989: *Pest Control*. Edward Arnold, London. 176 p.
- Vranjic, J.A; Gullan, P.J. 1990: The effect of sap-sucking herbivore, *Eriococcus coriaceus* (Homoptera: Eriococcidae), on seedling growth and architecture in *Eucalyptus blakelyi*. *Oikos* 59: 157-162.