LIFE HISTORY AND ABUNDANCE OF THE EUCALYPTUS LEAFROLLER (*STREPSICRATES MACROPETANA*)

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ABSTRACT

The *Eucalyptus* leafroller, *Strepsicrates macropetana* Meyrick, has become a pest of increasing economic importance to young eucalypt plantations in New Zealand. Damage to shoot tips, leaves, and developing flowers can potentially impact on tree form and growth. Neither *S. macropetana* life history nor abundance in the field has been well researched up until now. A laboratory study showed that larvae developed through five instars, with colour ranging from translucent green/yellow to a pink/red. A full life cycle of this species was completed within 46.2 ± 11.4 days (mean $\pm$ SD) under laboratory conditions ($20^\circ\text{C} \pm 2^\circ\text{C}$) on *Eucalyptus macarthurii*. A survey over 1998/1999 summer within the Manawatu region indicated that average leafroller occurrence was greater than five active individuals per tree on five of the fifteen *Eucalyptus* species examined. Of those five species, abundance was greater on trees without adult foliage. This insect occurred predominately within webbing about the apical shoot tips, and although rare (0.89%), up to six larvae were sometimes present within the same webbing. More detailed investigations, including the number of generations occurring per year in the field, is currently being carried out.

Keywords: Tortricidae, *Strepsicrates macropetana*, leafroller, *Eucalyptus*, life-history, abundance.

INTRODUCTION

The *Eucalyptus* leafroller, *Strepsicrates macropetana* Meyrick, originated from Australia and was first recorded in New Zealand, within the Auckland region, around 1921. This species is believed to be distributed throughout the country (Dugdale 1988). *S. macropetana* has been recorded on at least fifteen *Eucalyptus* species (Myrtaceae) in New Zealand, including *Eucalyptus botryoides*, *E. fastigata*, *E. nitens*, *E. obliqua*, *E. regnans* and *E. saligna* (Nuttall 1983).

This insect occurs primarily on juvenile foliage, but older leaves may also be attacked. *S. macropetana* larva forms the damaging life stage by feeding on the shoot tips, buds and developing flowers, which are adhered together with webbing. The insect shelters inside the resultant leaf roll, feeding on the plant tissue within, until the leaf becomes skeletonized and dies (Philips 1992).

S. macropetana inflicts damage on plantation forestry and to nursery stock and seedlings throughout New Zealand and Australia (van der Geest and Evenhuis 1991). Knowledge of pest lifecycles is vital to the development of pest management programs and to the correct identification of the different development stages. To date there has been no research carried out on the abundance and economic significance of *S. macropetana* on different plantation *Eucalyptus* species in New Zealand. This information is important for the selection of healthy tree species for plantation forestry. This paper reports on the life history and abundance of *S. macropetana* within the Manawatu and Bay of Plenty region.

METHODS

Insects

A laboratory colony of *S. macropetana* at Massey University (Entomology and IPM Laboratory), was maintained on freshly picked *Eucalyptus macarthurii* foliage at $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$, 70% R.H, and a photoperiod of L:D 18:6. The colony was derived from insects collected from a Tasman Forest Industries *E. fastigata* and *E. nitens* plantation (Kawerau, Bay of Plenty) in November 1998.

Life history

Eggs of *S. macropetana* ($n = 20$) were individually inoculated onto *E. macarthurii* leaves and placed into individual transparent containers (10.1 x 8.5 cm). Each lid was modified with a 5 x 5 cm hole, covered with Tyvec mesh (10 x 10 cm). The foliage was cut so that two medium-sized leaves remained on each stem. Each stem was inserted into a small stopper vial (5 x 2 cm) containing water, then placed inside a container. The plant material was replaced when over half had been consumed by a larva or the leaves had lost their turgidity and colour.

Whilst in the pupal stage ($n = 16$), the individuals were sexed and paired. They were placed into containers as above, also containing sheets for an oviposition substrate (paper towelling, 5 x 5 cm) and a food source (5% honey solution). The food source was dispensed by an inverted test tube (5 x 2 cm) containing a sterile dental wick and was replaced every second day. All eggs laid on the paper were transferred to individual petri dishes (9 x 9 cm).

Every second day, age-dependent variables such as development stage, colour, weight, body length, head capsule width, number of eggs laid, number of eggs hatched, and sex, were recorded. Such information was used to ascertain the duration of each development stage and an overall development time, survival rate, sex ratio and fecundity on *E. macarthurii*.

Abundance

Five field sites were established within the Manawatu and Eastern Bay of Plenty regions. The sites were chosen on the basis of appropriate *Eucalyptus* species being present and the presence of juvenile foliage. The number of trees at the chosen sites varied from over 3000 to 70. Collectively, the site incorporated fifteen *Eucalyptus* species including *E. nitens*, *E. fastigata*, *E. brookerana*, *E. macarthurii*, *E. saligna*, *E. botryoides*, *E. obliqua*, *E. regnans*, *E. agglomerata*, *E. cladocalyx*, *E. pilularis*, *E. microcorys*, *E. baxteri*, *E. muelleriana* and *E. globoidea*. Each of the sites was visited three times over the 1998/1999-summer period. This equated to a separate site being visited each week over this time.

At the first visit, each field site was divided into four separate subplots. Each replicate contained the same host species and the same number of trees so that approximately 10% of the trees present at each site were examined at each visit. Therefore, the number of trees sampled differed between sites (range of 20 to 50 trees sampled per site). Parameters recorded from each tree included date, eucalypt host species, tree size, presence of adult foliage, old and current damage estimates, leafroller development stages present, and further comments. The number of incidences where two or more leafroller were present within the same webbing was recorded and converted to a frequency.

Abundance of *S. macropetana* was determined by a scale of 1-5. This was the approximate number of leaf rolls per tree: 1 = absent (0), 2 = scarce (1-5), 3 = moderate (6-10), 4 = abundant (11-20), 5 = severe (20+). The scale gave an indication of the level of infestation without opening every leaf roll on the tree. Each tree in the sample was scanned with the naked eye on each side for old and active webbing, and ~10 leaf rolls were randomly opened to ascertain development stage present.

The data were analysed for differences in abundance according to host species with a Kruskal-Wallis one way analysis of variance. Medians were separated using a pairwise multiple comparison using the Student-Newman-Keuls Method (SNK) ($P < 0.05$).

RESULTS AND DISCUSSION

Life history

S. macropetana developed through five instars and had an overall developmental duration time of 46.2 ± 11.4 days (mean $\pm$ STD) under laboratory conditions (Fig. 1). The eggs were usually laid singly, but occasionally observed in batches of up to eight, and were laid on the underside of *Eucalyptus* leaves or paper towelling provided. The eggs ranged in colour from pale cream to brown as the 'blackhead' of the developing embryo became visible, and hatching occurred after a mean of 7.2 ± 0.5 days. Eggs were circular in shape and had an average width of 0.5 ± 0.05 mm.

FIGURE 1: Mean duration (days) of different life stages in the lifecycle of *Strepsicrates macropetana* on *Eucalyptus macarthurii* at 20°C in the laboratory.

Measurements of larvae, which were then used to separate instars, are shown in Table 1. The early instars had a rounded black head and prothoracic shield, with a translucent green/grey body. Instars three and four had a brown head and prothoracic shield; the upper terga were medium green and exhibited pinnacula set in white dots with imminent dorsal setae. The anal shield was consistently square containing a distinctive dark 'U' shape in instars four and five. Male reproductive organs i.e. testes, became visible in the fourth instar. The final instar had a distinctive body colour ranging from yellow/brown to pink/red eminent before final eclosion. Overall, the pupation rate was 80%.

The pupae were characteristically contained within a silk cocoon inside a leaf roll or against other substrate. Pupae were golden yellow in colour after final larval moult, gradually becoming darker with age. The pupa had an obrect structure, with two rows of abdominal spines visible on the dorsal surface. The male pupa had four ventral abdominal segments visible and the female had three. The male pupa had an average weight of 1.17 ± 0.3 mg, and the female 1.46 ± 0.29 mg. The male pupa had an average length of 7.55 ± 0.98 mm and the female 7.16 ± 0.56 mm. The sex ratio was 2:3 M:F and 81% of pupae resulted in successful adult emergence.

S. macropetana showed sexual dimorphism in colouration, with the male having uniform ash/grey fore-wings, and brownish grey hindwings, which contained a fringe of hairs along the edge. The female had a lighter wavy band across the costa of the forewing. The adult rested with the wings held roofwise. An average fecundity was observed at 59 eggs per female, of which 94% hatched. The overall survival rate of the leafroller on *E. macarthurii* from egg to adult was therefore 65%. Adult sexual behaviour is currently under investigation.

When compared to other tortricid leafrollers, *S. macropetana* had a very similar life history. *Strepsicrates rhothia* Meyrick, a pest of several plant species including *Eucalyptus* and guava (*Psidium littorale*) had an average development time of 44 ± 2 days (mean $\pm$ SD) (Ahmad 1972). *S. rhothia* showed a maximum fecundity of 42.5 eggs per female and had up to eight generations each year. *S. macropetana* is believed to have at least two generations each year in the field, with the adults emerging in the spring and autumn (Miller 1925). Based on developmental time, we predict that further research will reveal that *S. macropetana* may go through many more generations than this, perhaps between 6 and 8, depending on climate.

TABLE 1: Measurements of different instar *S. macropetana* larvae on *E. macarthurii*.

Instar Number	Length (mm)			Headcapsule width (mm)		
	Range	Mean	SD	Range	Mean	SD
1	0.8 - 2.2	1.6	0.3	0.15-0.20	0.18	0.02
2	1.7 - 4.6	3.2	0.9	0.15-0.46	0.30	0.09
3	3.1 - 8.9	5.9	1.4	0.25-0.89	0.59	0.16
4	7.0 -11.9	9.9	1.1	0.50-1.26	0.97	0.16
5	10.5 -14.1	12.2	0.99	1.00-1.29	1.13	0.08

Abundance

S. macropetana damage was observed on all fifteen *Eucalyptus* species examined. The abundance of damage differed significantly between the *Eucalyptus* species examined ($H= 52.5$, $df= 14$, $P< 0.0001$). A comparison of abundance between different *Eucalyptus* species showed that *E. microcorys*, *E. nitens*, *E. fastigata* and *E. saligna* were highly susceptible to feeding damage by *S. macropetana* (Fig. 2). The species least susceptible to feeding damage were *E. cladocalyx*, *E. baxteri*, *E. muelleriana*, *E. obliqua*, *E. globoidea* and *E. regnans*.

FIGURE 2: Influence of *Eucalyptus* host species on the abundance of *Strepsicrates macropetana* (scale of 1 absent to 5 severe) over one season in the Manawatu. Medians followed by the same letter are not significantly different at $P = 0.05$. Error bars represent the range of abundance on each *Eucalyptus* species.

The relationships between host species, the presence of juvenile foliage and/or climatic variation on *S. macropetana* abundance are currently under investigation.

The early larval instars typically occurred within buds, on shoot tips or between the apical junction of two leaves. Usually larva occur singly inside leaf rolls; however, two to six larvae were observed within the same webbing, at a frequency of 0.89% (n = 3430). The older larval instars tend to move away from the apical tips and further down the tree, commonly webbing together leaves. Pupa and adults have been observed inside leaf rolls or close to old larval damage.

The current research provides the foundation for further investigation into *Eucalyptus* leafroller phenology and behaviour.

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