

**HOST RANGE AND BIOLOGY OF
OPHELMIMUS EUCALYPTI (GAHAN) (HYM.: EULOPHIDAE),
A PEST OF NEW ZEALAND EUCALYPTS**

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ABSTRACT

The gall wasp, *Ophelimus eucalypti* (Gahan), is a pest of New Zealand *Eucalyptus botryoides* Sm. and *Eucalyptus saligna* Sm (section *Transversaria*). The host range also includes *E. grandis* Maiden and *E. deanei* Maiden. There were no differences between female wasp-induced galls arising from *E. botryoides* or *E. saligna*. Gall mass peaks when larvae are only one third of their maximum mass. Larvae grow to fill the entire gall cavity prior to gall senescence. Maximum adult emergence from galls occurs in August and December. Adults live for about 10 days and females produce up to 350 eggs. Three species of eulophid parasitoids attack *O. eucalypti* in New Zealand.

Keywords: *Ophelimus eucalypti*, gall wasp, *Eucalyptus saligna*, *Eucalyptus botryoides*, development.

INTRODUCTION

The eulophid genus *Ophelimus* comprises approximately 50 species of microwasps which develop in galls in various species of *Eucalyptus* (Bouček 1988). *Ophelimus eucalypti* (Gahan) was described in 1922 as *Rhichnopeltella eucalypti* and was transferred to the genus *Ophelimus* by Bouček in 1988. It has not been recorded in Australia, despite being almost certainly Australian in origin. Gahan's type series was reared from galls on *Eucalyptus globulus* Labill. in Wellington, New Zealand. By 1987 *O. eucalypti* had been recorded in a number of hosts belonging to the section *Maidenaria*, subgenus *Symphyomyrtus*, including *E. globulus*, *E. nitens* (Deane & Maiden) Maiden and *E. viminalis* Labill. (Somerfield 1976). *Eucalyptus globulus* is the most susceptible eucalypt to the gall-wasp (Clark 1938) showing extensive galling on leaf midribs and branches.

In 1987, specimens identified as *O. eucalypti* by Z. Bouček (NHM, London) were reared from the valued timber trees *Eucalyptus botryoides* and *Eucalyptus saligna*. This was the first record of *O. eucalypti* from hosts in the section *Transversaria* of the subgenus *Symphyomyrtus*, and on these species wasps arise from protruding galls on leaves, and never from galls on mid-ribs or branches (McLaren 1989). This wasp has since become a serious pest of these trees (Nicholas and Hay 1990) and now occurs in all areas north of Mid Canterbury (Forest Research Forest Health Database unpublished data).

Although no morphological differences have yet been discovered between *O. eucalypti* reared from midrib and branch galls from *Maidenaria* hosts and those reared from leaf galls from *Transversaria* hosts, it is likely that these populations are different biotypes or cryptic species. Individuals used in this study were all reared from Bay of Plenty grown *E. saligna* or *E. botryoides* and will be referred to as *O. eucalypti* (*Transversaria*). We consider the distinction important in view of the possibility of future partitioning of *O. eucalypti*. This is the first record of research which aims to establish the life cycle and host range of this insect pest in New Zealand.

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MATERIALS AND METHODS

Wasp biology and gall development

Gall development data were obtained by dissecting galls of different developmental stages, a total of twenty-five from *E. saligna* and twenty-five from *E. botryoides*, from a number of different trees in Rotorua, the Bay of Plenty, in October and December 1998, and February and April 1999. Galled portions were trimmed from the host leaf with a razor blade and weighed to obtain fresh mass. Gall width (transverse axis to the leaf) was measured through a stereo-binocular microscope using an ocular micrometer. Galls were slit obliquely and the length and fresh mass of the larvae, pre-pupae or pre-emergent adults obtained.

Each morning following emergence from infested *E. saligna* leaves adult wasps were captured using an insect aspirator, identified and sexed. Wasps emerging from galls that were not *O. eucalypti* were preserved in 70 % ethanol for later determination. Individual *O. eucalypti* (n = 14 females, n = 60 males) were placed into glass vials (75 x 20 mm) along with a fibre disk (Whatman 13 mm AA) and stoppered with a plastic lid with a pin-hole. Every day one drop of either distilled water or 20 % aqueous honey solution was added to the disk to measure the effect of food source on adult longevity. All vials were checked at 24 h intervals. When female wasps died winglength was measured, the contents of the abdomen slide mounted in glycerol and the number of eggs counted to estimate total fecundity.

Observations were made of adult female *O. eucalypti* ovipositing into *E. saligna* leaves both in the field and in the laboratory by placing females onto cut branches bearing young leaves.

Host range evaluation

A number of different section *Transversaria Eucalyptus* species (as well as *E. guilfoylei* which is in the closely-related section *Tingleria*) were grown in the Forest Research nursery, Rotorua, in spring 1998 (Table 1). The plants were sown in a glasshouse, hardened off under shade cloth and then individually grown in potting mix in 4 litre plastic pails for a further three months under nursery cloth (Thermoselect[®], Lutrasil) covered cages. No insecticide or fungicide sprays were used.

A multiple-choice trial with four replicates was conducted by placing one 6 month old *Eucalyptus* of each of the ten species in a random position onto a wooden pallet on 4 March 1999. The trees and pallet were within a cylindrical steel frame cage (1.5 m height x 1.5 m diameter) which was then covered by nursery cloth. Plants were watered daily at dawn for 15 minutes with an overhead sprinkler. Between 16 and 26 March 20 female *O. eucalypti* were introduced into each of the four cages. Nine weeks later each tree was removed and each leaf assessed for the presence of protruding galls, which were dissected and their contents examined.

Statistical analysis

Regression analysis described the relationship between gall mass and gall size, and between *O. eucalypti* size and fecundity. The proportion of dissected galls containing either larvae or pre-adults was analysed according to sampling date with a chi-squared test. Non-parametric procedures were used for all other pairwise (Mann-Whitney test) and between-treatment (Kruskal-Wallis test) data comparisons.

RESULTS AND DISCUSSION

Wasp biology and gall development

Dissections of female *O. eucalypti* (*Transversaria*) galls revealed the contents (larvae versus the total of pre-pupae and pre-emergent adults) differed significantly ($\text{Chi}^2=34.1$, $\text{df}=3$, $P<0.0001$) according to sampling date. The smallest larvae were most abundant within green galls during February, while pre-pupae were most abundant within brown galls during October (Fig. 1). Together with observations (D. Kershaw, unpubl. data) that adults are most abundant in early spring (August) and again in summer (December-January), it is likely that two overlapping generations of *O. eucalypti* occur each year.

Morphometric measurements revealed no significant difference in larval development between those raised on either *E. botryoides* or *E. saligna* (Mann-

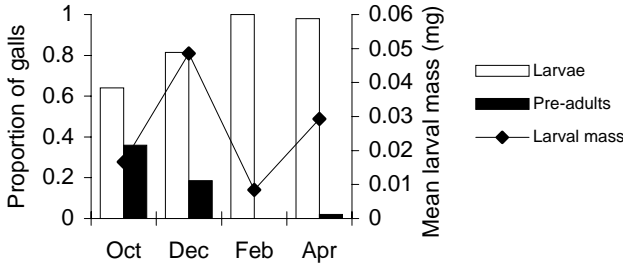


FIGURE 1: The proportion of *E. saligna* and *E. botryoides* galls containing either *O. eucalypti* larvae or pre-adults at different months of the year, and the mean fresh weight (mg) of larvae (n= 50/sampling period).

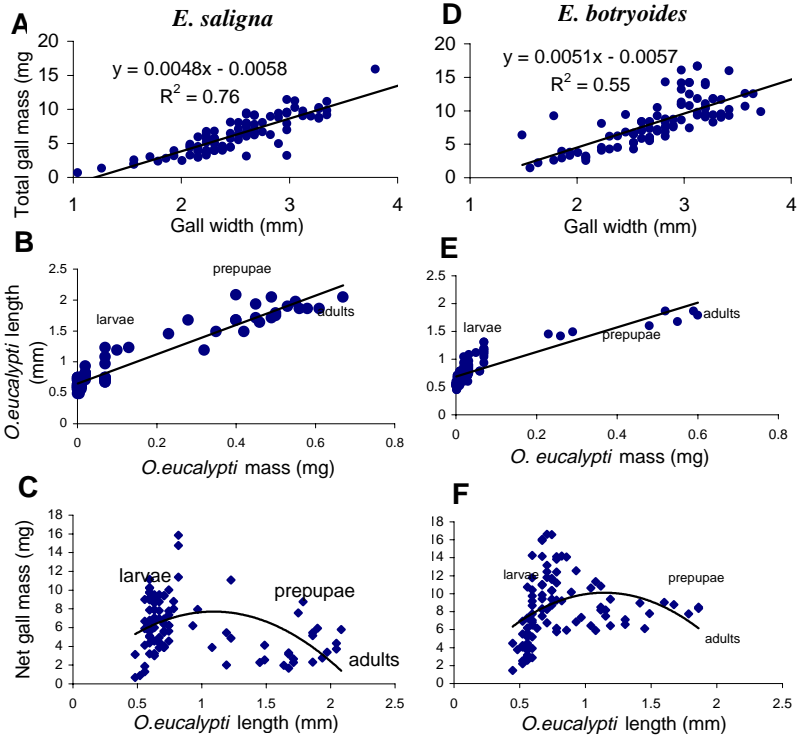


FIGURE 2: The morphometric relationships between *O. eucalypti* developmental stage and the host tissue on *E. saligna* (A-C) and *E. botryoides* (D-F). A and D: total gall fresh mass x transverse width, B and E: larva mass x larva length, C and F: gall (minus larva) fresh mass x larva length.

Whitney test, $W=9260$, $P>0.99$), confirming that both are equally suitable as hosts for *O. eucalypti*. Fresh mass of galls is positively related to gall width (Fig. 2A). The lifecycle data (Fig. 1) supports previous findings (D. Kershaw, unpubl. data) that galls take between two and three months to reach their maximum size (3–4 mm) and mass (~10 mg). During this time the gall chamber grows several times larger than the size of the inhabiting larva (larval length ~0.5 mm) (Fig. 2B). Once the larva grows to ~2 mm it occupies almost the entire gall cavity. As the mature larva turns into a non-feeding pre-pupa, gall senescence commences. Gall fresh mass decreases (4 mg) (Fig. 2C) and it changes from green to red, and then to brown. Approximately five months after oviposition the adult wasp emerges via a circular exit hole.

Oviposition by the adult female into young *Eucalyptus* foliage closely resembles that described for *O. eucalypti* (Maidenaria) (Clark 1938). Only one egg is laid at each site via either side of the leaf blade and placed midway between the leaf margin and midrib. This results in galls developing in rows along leaves. The impact of this oviposition on susceptible trees can be severe. An experimental trial (Walsh 1996) showed intense infestations of *O. eucalypti* (Transversaria) disrupt the establishment of young *E. saligna* and *E. botryoides*, and can kill older trees (Nicholas and Hay 1990) because severely galled leaves are shed from the tree. The negative impacts of *O. eucalypti* on tree health arise from defoliation as well as the exploitation of photosynthetic tissue leading to gall induction. This form of specialist phytophagy induces the redirection of nutritive materials from normal plant growth processes into gall formation (Rohfritsch 1992).

When given access to aqueous honey solution, the longevity of adult *O. eucalypti* was significantly extended from the mean lifespan of 4.8 days to a mean of 9.7 days (± 0.8) in males (Mann-Whitney test, $W=1311.5$, $P<0.0001$) and 8.2 days (± 1.3) in females ($W=55.5$, $P<0.06$). Male *O. eucalypti* did not live significantly longer than females ($W=439.0$, $P>0.5$) when both were given honey solution. Female fecundity showed a positive relationship with winglength as an indicator of body size ($y = 7.5x - 532$, $R^2 = 0.39$). Average fecundity of females ($n = 14$) at death was 155 eggs ($SE = 27$), range of 32 to 347.

TABLE 1: The susceptibility of *Eucalyptus* species to *O. eucalypti* (Transversaria) in a multiple choice assay.

Species	Seed source and supplier	No. trees infested out of four	No. (and %) total leaves infested	Mean no. of galls /infested leaf (SE)	Mean larval size in mm (SE)	
<i>E. botryoides</i>	gall free, Whangarei	97 ¹	0	0	-	-
<i>E. botryoides</i>	94/258, Orbost, Vic.	2	7 (0.55%)	10.7 (5.6)	0.60 (0.027)	
<i>E. saligna</i>	Batemans Bay, NSW	2	3	8 (0.53%)	11.7 (5.9)	0.54 (0.051)
<i>E. deanei</i>		3	1	5 (0.21%)	1.8 (0.6)	0.25 (0.034)
<i>E. robusta</i>	9/0/86/090, Tauranga	2	0	0	-	-
<i>E. punctata</i>	var. <i>punctata</i>	3	0	0	-	-
<i>E. pellita</i>	9/0/86/206	2	0	0	-	-
<i>E. longifolia</i>	J.Cox 'Elite' 1995	1	0	0	-	-
<i>E. diversicolor</i>	92022	1	0	0	-	-
<i>E. guilfoylei</i>	91006	1	0	0	-	-
Kruskal-Wallis test	(adjusted for ties)	H= 18.9, P<0.026	H= 19.2, P<0.02	H= 2.4, P>0.3	H= 10.6, P<0.007	

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During the experiments, two species of *Aprostocetus* sp. and one species of *Chrysonotomyia* sp. (Chalcidoidea: Eulophidae) were found parasitising young larvae of *O. eucalypti* (Transversaria). The impact of these parasitoids on *O. eucalypti* (Transversaria) in New Zealand has not been quantified. Parasitism may not directly benefit tree health, because the metabolically-expensive process of gall induction caused by the presence of larvae (Rohfritsch 1992) prior to parasitism, is not prevented. Voucher specimens of *O. eucalypti* (Transversaria), *O. eucalypti* (Maidenaria) and all three parasitoid species (determined by J.A. Berry) were deposited in NZAC Auckland, and NZFR Rotorua.

Host range evaluation

Three species of *Transversaria Eucalyptus*, *E. botryoides* Orbost, Vic., *E. saligna* and *E. deanei*, were susceptible to *O. eucalypti* (Table 1). These species developed protruding leaf galls which contained live larvae. The gall-free *E. botryoides* trees raised from the Whangarei seed source were all resistant to *O. eucalypti*, suggesting a genetic basis confers susceptibility to *O. eucalypti* (Transversaria). There were insufficient *E. grandis* seedlings raised to include it in experiments. *E. grandis* trees in the Bay of Plenty and Northland are also attacked by *O. eucalypti* (Transversaria) (T.M. Withers, unpublished data). Our experiments did not show that *E. robusta* Sm. is a host to *O. eucalypti* (Transversaria) as was suggested by McLaren (1989). The species of *Eucalyptus* which are hosts to *O. eucalypti* are all closely related within the section *Transversaria* of the sub-genus *Symphyomyrtus*. According to Brooker (2000) these species would all be reclassified into the section *Latoangulatae*. We were unable to induce successful galling in all replicates. Replicate three failed to result in galls on any tree. Gall induction on *E. deanei* leaves occurred in only one replicate and larvae were significantly smaller than larvae from galls of *E. botryoides* (Table 1). However there was no difference ($P>0.30$) between host species in the mean number of galls per infested leaf (Table 1).

CONCLUSION

Through host range trials and field observations we conclude that the host range of *O. eucalypti* (Transversaria) includes *E. botryoides*, *E. saligna*, *E. deanei* and *E. grandis*. Both *E. botryoides* and *E. saligna* are equally suitable hosts for larval development. Oviposition into young host leaves in early spring and summer rapidly induce the formation of protruding leaf galls containing the larval wasp. From the time gall mass peaks, larval development takes approximately another 3 months. Gall senescence and adult female wasp emergence follows. Adult female *O. eucalypti* are moderately long-lived and highly fecund. Despite the negative impacts of this widespread pest, a biological control initiative, as suggested by Walsh (1996), may now be more difficult to justify with three species of eulophid wasps already parasitising *O. eucalypti* in this country. Further research on the impacts of parasitism on this pest is warranted.

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