# Influence of egg depth in host plants on parasitism of *Scolypopa australis* (Homoptera: Ricaniidae) by *Centrodora scolypopae* (Hymenoptera: Aphelinidae)

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## ABSTRACT

Percentage parasitism of the eggs of the passion vine hopper (*Scolypopa australis*) by *Centrodora scolypopae* varies with the host plant. The depth of the *S. australis* eggs below the surface was measured on *Pteridium aquilinum* var *esculentum, Rubus fruticosus* agg., *Berberis darwinii, Polygonum convolvulus, Coriaria arborea* and *Cyathea* sp., and related to the observed parasitism. It was found that egg depth varied between plant species, ranging from 0.30 ± .08 mm in *P. aquilinum* to 0.48 ± .01 mm in *R. fruticosus* and was inversely related to level of parasitism. Differing parts of the same plant varied in parasitism levels, with the shallow eggs on the thorns of *B. darwinii* and racemes of *C. arborea* having higher levels of parasitism than those in the stems. The average length of the *C. scolypopae* ovipositor was 0.60 ± 0.1 mm. Many eggs laid in plants with soft stems were beyond the reach of the parasite, whereas host eggs laid at shallow depths in hard plant tissues were accessible and thus were parasitised heavily.

**Keywords:** *Scolypopa australis, Centrodora scolypopae,* host plant, parasitism.

## INTRODUCTION

While investigating causes of *Scolypopa australis* (Walker) egg mortality, it was found that parasitism by *Centrodora scolypopae* (Valentine) of eggs laid in bracken *(Pteridium aquilinum* var *esculentum)* was much greater than that found in eggs laid in blackberry (*Rubus fruticosus* agg.; P<.01) (Gerard 1985). These higher levels of parasitism on bracken compared to blackberry can also be found in a survey of *S. australis* from 3 sites at which both species were sampled (Cumber 1966). The wide divergence between levels of parasitism in blackberry and bracken indicated that host plant factors played an important role in the oviposition behaviour of *C. scolypopae* females.

Plants can influence parasitism in several different ways. Olfactory responses to the host plant are common and parasites may show preferences between species. For instance, *Itoplectis conquisitor* (Hymenoptera: Ichneumonidae) is attracted to the odour of Scots pine *(Pinus sylvestris)* more than that of the Red pine *(P. resinosa)* so that the former is more heavily parasitised (Arthur 1962). Parasitism also may be influenced by physical attributes of the plant, such as surface texture in the case of *Trichogramma* (Flanders 1937). Hosts in or on differing parts of the same plant may vary in vulnerability. Females of *I. conquisitor* are unable to parasitise pupae in buds protected by needles, and parasitism was higher in small than in large buds (Arthur 1962). Carnegie (1980) considered the growth habits of host plants to be a factor causing the low levels of parasitism by *Ootetrastichus beatus* (Hymenoptera: Eulophidae) and *Oligosita numiciae* (Hymenoptera: Trichogrammatidae) in sugarcane compared to other host plants.

*Scolypopa australis* has an extremely wide range of host plants and in most cases *C. scolypopae* emerge in the vicinity of the host eggs. It seems unlikely that a specific plant odour would play a role in the attraction of the parasites. However, odours could be important in the acceptance of a host egg. Females closely investigate potential host oviposition scars with their antennae and the odour of fresh wood tufts may well influence acceptance or rejection.

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Blackberry and bracken differ in structure. Dead blackberry stems have a large soft central pith and are surrounded by a woody layer consisting of vascular tissue and an outer bark layer. The surface is relatively rough and scattered with thorns. Dead bracken stems have no central pith and are hard throughout. The surface is smooth with longitudinal ridges and planes. *Scolypopa australis* females generally oviposit in the ridges. Females lay more and larger egg batches on blackberry than bracken, probably because of the ease of ovipositing in the soft pith (Gerard 1985). It also seemed likely that the pith enabled eggs to be laid at greater depths in blackberry than occurred in bracken. If true, eggs on blackberry would have a degree of immunity in that it would make oviposition by *C. scolypopae* females more difficult.

It was decided to test the hypothesis that egg depth varied with plant species and in turn influenced parasitism levels. This paper reports on the results of this study.

## METHODS

A single 2 $m^2$ plot was selected in a gully at Rukuhia, near Hamilton, in which a study on populations of *S. australis* and *C. scolypopae* was in progress (Gerard 1985). Almost all the blackberry, bracken, barberry *(Berberis darwinii)* and black bindweed *(Polygonum convolvulus)* stems bearing oviposition scars in this site were collected in May 1983 and 1984. In the laboratory, each egg scar was opened longitudinally with a scalpel to expose the intact eggs *in situ*. The minimum distance between the stem surface and the egg was measured with the aid of an eyepiece graticule in a binocular microscope. Although the *S. australis* eggs do not hatch until October nor *C. scolypopae* emerge till January, these measurements had to be done before the end of May as both embryo and parasite development caused the egg to swell soon after. The host plant, egg depth and whether the egg was parasitised or not was recorded.

To ascertain the maximum depth to which *C. scolypopae* females could oviposit successfully, the lengths of ovipositor from just below the bulbous articulation to the tip were measured on females emerging from laboratory-maintained host eggs. Also, recently-emerged females were put in separate test tubes, each with a freshly laid egg batch on either blackberry or bracken, and the time taken to oviposit was recorded to see if this varied. Time was recorded from the commencement of drilling to the withdrawal of the ovipositor.

## RESULTS

The average length of the ovipositor was $0.60 \pm 0.1$ mm and ranged from 0.48 to 0.65 mm ($n = 21$). This does not mean the average female can oviposit in eggs 0.60 mm deep. The ovipositor must pierce the egg and also a portion of the ovipositor shaft remains above the surface even when it is embedded in the wood to the maximum limit. These 2 factors would combine to make the maximum depth of egg that an average female could successfully parasitise to be nearer 0.5 mm.

Female *C. scolypopae* took slightly longer ovipositing in bracken, averaging 18 min 14 sec (s.e. $\pm$ 154 sec $n = 22$) compared with 13 min 2 sec (s.e. $\pm$ 137 sec $n = 17$) on blackberry. This difference is most likely caused by bracken wood being harder, suggesting that difficulty in drilling was not a factor contributing to the lower levels of parasitism in blackberry. Alternatively, since no inspection was made to see if females had actually laid eggs, it is possible that some females, on blackberry in particular, may have withdrawn early after reaching maximum depth without having penetrated the host egg.

The distribution of host eggs in blackberry (Fig. 1) is deeper than on bracken, barberry and bindweed. When compared with the average length of *C. scolypopae* ovipositors, it is apparent that egg depth is an important factor in regulating levels of parasitism. Many host eggs in blackberry are beyond reach and this directly results in less parasitism, especially if eggs are laid deeper than 0.5 mm. In barberry, there are 2 peaks of egg density: That shallower than 0.3 mm, with correspondingly high parasitism, consists of eggs laid in the hard, narrow thorns whereas the other peak, mainly above 0.4 mm, and with lower parasitism, is mainly eggs laid in the softer stems. Thus within a single plant, susceptibility to parasitism varies with the plant part, depending on the depth of the eggs.

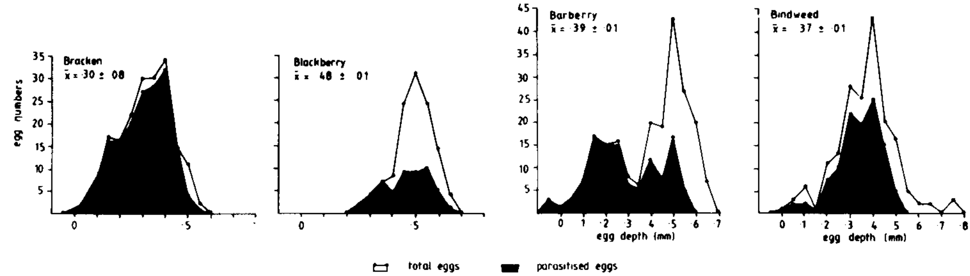


**Fig. 1:** Depth below surface of total and parasitised *S. australis* eggs in 4 plant species, Rukuhia gully site, May 1984 and 1984. ($\bar{x}$ = mean depth ± s.e.).

Egg depth sufficient to result in unsuccessful drilling would increase the likelihood of the female leaving the area, the time spent searching and the possibility of the parasite failing to deposit her full egg complement before death if she remained. This would confer a degree of immunity and reduce the rate of parasitism in the plant as a whole. Conversely, when drilling is successful, such as on bracken, the parasite may be encouraged to continue searching in the same area, resulting in a higher proportion of all eggs being parasitised. Density of host eggs/unit area was not considered a factor favouring high levels of parasitism on bracken. During the population studies on *S. australis*, it was found that *S. australis* preferred ovipositing on blackberry than on bracken, resulting in a significantly greater ratio of eggs to plant frequency for blackberry compared to bracken ($P < .01$; Gerard 1985). The high density of host eggs on blackberry would encourage the few successful parasites, i.e. those females with long ovipositors, to remain in the area and this perhaps explains the higher proportion of eggs deeper than 0.5 mm being parasitised in blackberry than in the other species.

When the percentage parasitism for each host plant is plotted against mean egg depth for the plant (from Fig. 1), a linear relationship is found ($t = 4.243$, $P \approx 0.05$) (Fig. 2). It is reasonable to look for a linear relationship over the range studied, as ovipositor length indicates zero parasitism over 0.65 mm, and superparasitism (greater than 100% parasitism) at shallow depths occurs often. For example, in 1984 39% of host eggs in bracken in the gully area were superparasitised at least once, some up to 4 times (Gerard 1985).

Although only 4 plant species in the area were assessed, the results support the hypothesis that the differing levels of parasitism observed in the plant species is influenced by the mean depth of host eggs in that plant. This conclusion was reinforced when egg batches were collected from tutu *(Coriaria arborea)* and tree fern *(Cyathea* sp.) at Karapiro. Even though from another site where the overall level of parasitism may have differed, these plant species show the same relationship between percentage parasitism and egg depth (Fig. 2). Eggs in tree fern were shallow and were heavily parasitised. Those in the flower racemes of tutu had high parasitism but the more abundant eggs in the stems were deeper and had lower levels (Fig. 3).

This interaction of egg depth and level of parasitism limits the effectiveness of *C. scolypopae* since in any bush or waste area, a proportion of the population will be resistant to attack. Of particular note is resistance of eggs in tutu. It is the high populations of *S. australis* on tutu in summer that are responsible for honey poisoning in the Coromandel and Bay of Plenty areas (Palmer-Jones *et al.* 1947).

Chemical control of either tutu or *S. australis* to prevent honey poisoning is not feasible because of the extensive distribution of both. As biological control appears the obvious alternative, these results provide important information that is relevant in the search for an exotic natural enemy. The deeply laid eggs can be regarded as an empty niche and if another egg parasite is considered, it must be one with an ovipositor longer than that of *C. scolypopae*. An alternative could be to manipulate the vegetation. The planting of

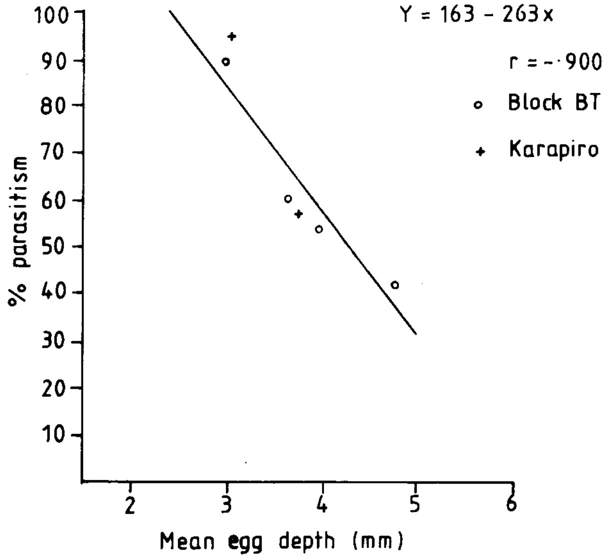


**Fig. 2:** Relationship between percentage parasitism and mean egg depth in plant species at Rukuhia and Karapiro.

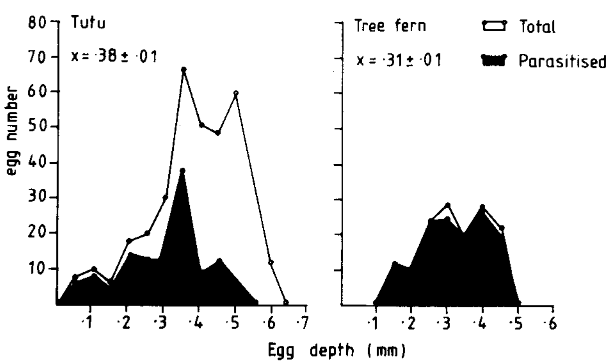


**Fig. 3:** Depth of total and parasitised *S. australis* eggs in tutu and tree fern, Karapiro, May 1984.

tree ferns or other "hard" plants or the elimination of "soft" species in areas from which *S. australis* spills over into horticultural crops could enhance the parasite populations and lessen the damage caused by *S. australis*.

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