

Mass Rearing of *Aonidiella orientalis* (Newstead) (Hemiptera: Diaspididae) on Butternut Gramma

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ABSTRACT Oriental scale, *Aonidiella orientalis*, was successfully reared in the laboratory on butternut gramma for at least 30 generations. Males took 19.5 ± 2.7 d (mean \pm SD) from the crawler stage to adult. Females took 44.2 ± 2.4 d from the crawler stage to production of the first crawler of the subsequent generation. The scale colony is primarily used to produce parasitoids for limited release to the papaw industry.

Since 1986 oriental scale, *Aonidiella orientalis* (Newstead), has been a major and frequent pest of papaws in coastal Queensland from Yarwun (23°51' S 151°07' E) north (Elder and Smith 1994). The scale attacks the trunk and the resultant damage can kill trees. Infested fruit are unmarketable due to legal restrictions and because the scale spoils the appearance of the fruit (Elder and Smith 1994). Control of *A. orientalis* on papaws with pesticides is difficult because oil is the only registered chemical, the residue problems associated with spraying a crop which is picked twice weekly and an inability to obtain adequate spray coverage as the fruit are tightly clustered around the trunk. Another option was the control of the scale with parasitoids.

In order to test the parasitoids *Comperiella lemniscata* Compere and Annecke (Hymenoptera: Encyrtidae) and *Aphytis melinus* DeBach

(Hymenoptera: Aphelinidae) as potential scale control agents, it was first necessary to rear the scale in the laboratory and understand its development progression. The oleander scale (*Aspidiotus nerii* Bouché) has been reared in the laboratory on butternut gramma (*Cucurbita moschata* (Duchesne ex Lam.) Duchesne ex Poir.) to produce the parasitoid *Aphytis lingnanensis* Compere (Papacek and Smith 1985). The suitability of a similar method for rearing *A. orientalis* was assessed as described below.

On two occasions (1989 and 1990) crawlers (mobile first-instars) were collected from papaw fruit with a horse hair mounted on a probe and 100 were placed individually on each of six butternut grammas. The fruit was kept at 25 ± 0.5 °C and $46 \pm 4\%$ RH under continuous light provided by fluorescent tubes. Three days after the crawlers had been transferred to the grammas,

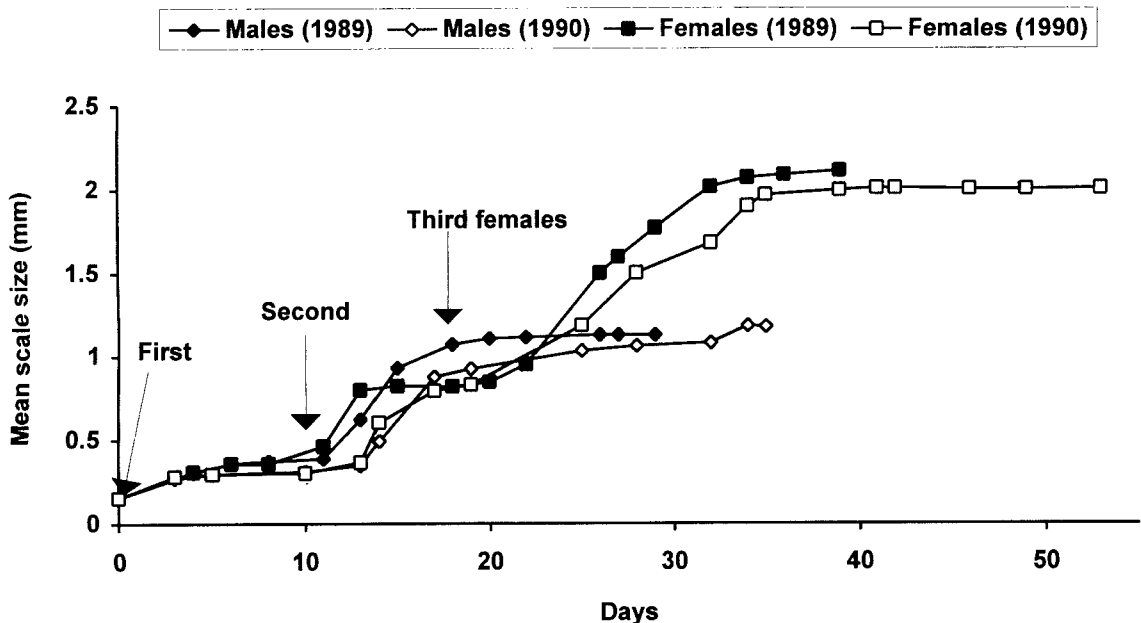


Fig. 1. Growth rates of *Aonidiella orientalis* on butternut grammas. Arrows indicate the commencement of the first and second male and female and the third-female scale enlargement phases.

10 insects on each gramma which had formed a scale (waxy covering) were numbered by marking the skin of the fruit with a pen. These insects were then examined every second or third day under a binocular microscope with a micrometer eyepiece. To determine rate of growth, records were kept of the maximum scale diameter (females and immature males) or maximum length of the scale (mature males), the appearance of pupal cases from under the edge of the scale in the case of males, and the appearance of crawlers in the case of females.

One-way analyses of variance compared the maximum size reached in each instar in each sex for the 1989 and 1990 sets of data, i.e. the level areas in Fig. 1. The two series were significantly different ($P < 0.05$) except for the second instar in the females. Accordingly, the data for the two series were plotted separately. As with other diaspidid scales (Foldi 1990; Koteja 1990), males showed two scale enlargement phases and females three including initial scale production (Fig. 1). The first and second scale enlargement phases for males and females were similar in the time to reach a specific size and the size achieved (Fig. 1).

Males took 19.5 ± 2.7 d (mean \pm SD), $n = 23$ to develop from the crawler stage to adult. Females took 44.2 ± 2.4 d, $n = 13$ from the crawler stage to production of the first crawler (1990 data only). The Yarwun district has average mean monthly temperatures of close to 25°C from November to March inclusive with April and October averaging approximately 23°C (Fitzpatrick 1965). It is probable that rate of development of the scale in the field is similar to that in this study for October to April inclusive provided the rate of development is similar on papaw. In the other major papaw growing area centred on Innisfail ($17^\circ32'S$ $146^\circ02'E$) and where *A. orientalis* is a pest, mean average temperatures are above 25°C from October to April inclusive and average 23°C in September and May (Queensland Department of Primary Industries climate database). In this northern area, the rate of development achieved in the laboratory probably would be maintained for an even longer period of the year than Yarwun.

In common with *A. aurantii* (Maskell) (Foldi 1990; Smith 1981), the male and female crawlers were mobile, females of all other stages and immature males were sessile. Adult males were

alate. The alate males emerge just prior to females commencing the third-scale enlargement phase. Females at this time have moulted to the third instar (adult) and are presumably receptive although mating was not seen. It then takes a further 25 d for the females to enlarge the scale, grow and start producing crawlers. The male:female sex ratio was 1.6 for the first series and 1.9 for the second. Sixty per cent of the transferred crawlers survived to establish a scale covering in both series. Survival from crawler with initial scale covering to adult male or third-instar female was 98% (series 1) and 95% (series 2).

The method developed by Papacek and Smith (1985) is suitable for rearing *A. orientalis* on butternut grammas over an extended number of generations. A culture has been maintained in the laboratory for 4 years (i.e. calculated as at least 30 generations) and has been used for the limited production of parasitoids and predators (Elder and Smith, unpubl. data) for release to the papaw industry. The culture has been maintained on between 100 and 200 grammas at any one time. Crawlers are transferred to the next lot of butternut grammas by light brushing with a small paint brush.

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