THE BIOLOGY AND ECOLOGY OF CALIFORNIA RED SCALE, *Aonidiella aurantii* (Mask.) (Hemiptera:Diaspididae), AND ITS NATURAL ENEMY, *Aphytis melinus* DeBach (Hymenoptera:Aphelinidae).

by

Zhao Jing-wei

B. Ag. Sc. (Entomology),

M. Ag. Sc. (Fujian Agricultural College, China)

A thesis submitted for the degree of Doctor of Philosophy in the Faculty of Agricultural Science to the University of Adelaide.

Department of Entomology,

Waite Agricultural Research Institute,

The University of Adelaide.

August, 1987

TABLE OF CONTENTS

Page.

SUMMARY

Studies of biology of California red scale, Aonidiella aurantii (Mask.), and its natural enemy, Aphytis melinus DeBach, were conducted at the Waite Agricultural Research Institute (W.A.R.I.), South Australia.

Field and laboratory experiments showed that survival and reproductive ability of female wasps of A. melinus are functions of a carbohydrate source, i.e., honey or flower-nectar. By contrast, host-feeding of female wasps has little effect on survival time and reproductive ability. The host-feeding can cause only little mortality of red scale of growing stages if the wasps have no access to a carbohydrate source.

A patchy population of red scale was constructed to test the searching efficiency of one-day-old female wasps of A. melinus. This population comprised several densities of red scale; different numbers of host citrus fruits were used to maintain the same total number of red scale in each of the densities. Results showed that wasps gave a "frequency response" instead of the classical Holling's functional response: the mortality of red scale was not aggregated in high densities of host scales. The wasps' searching efficiency varied greatly with the availability of carbohydrate.

Field and laboratory experiments tested the influence of extreme temperature on the mortality of red scale. Mortality was influenced not only by the values of the extremes but also by their durations. Similar results were obtained for pupae of A. melinus at 45°C.

Orchard experiments were conducted to measure the temperature 1 mm. above and 5 mm. under the skin of lemons in the sunlight. In summer, scales in the sunlight on lemons could experience a temperature 15°C higher than ambient (in a Stevenson Screen). Also in the orchard, cohorts of red scales were exposed to the sun in summer to measure the effect of extreme temperatures in the sunlight on mortality. The drop-off rate of a cohort in relation to extreme temperatures was also measured. The drop-off rate was not a function of extreme temperatures but a function of the duration after the cohort had been started.

From May 1984 to March 1986, the population dynamics of red scales on lemons were studied in the W.A.R.I. orchard. Samples were taken with an interval of about 95 day-degrees, greater than 12°C. After overwintering, the population of red scale started to grow in early November (mid spring) and stopped in late March (late summer) of the following year. A mathematical analysis indicated a threshold growth of the red scale population occurred at the mean of about 18.5°C for an observation period with 95 day-degrees greater than 12°C. The positive trend of the growth of the population during this period was not reversed by the extremely high temperatures in summer. The daily minima below 8.5°C could cause a significant mortality of red scale (young stages). The parasitoid, A. melinus, showed a poor ability to regulate the population of red scale.

Also detected or measured were (1) the influence of methods of transferring crawlers on the mortality of red scale, (2) the identification of stages of the development of A. melinus at 25°C and 75% R.H., and (3) the growth of Phacelia sp. at constant temperatures.

For field experiments, a special microscope system was constructed.