SETTLING-SITE SELECTION AND SURVIVAL OF TWO SCALE INSECTS, CEROPLASTES RUBENS AND C. CERIFERUS, ON CITRUS TREES

Takao ITIOKA and Tamiji INOUE

Laboratory of Entomology, Faculty of Agriculture, Kyoto University, Kyoto 606, Japan

SUMMARY

We studied settling-site selection and the resulting survival of two sessile scale insects, Ceroplastes rubens and C. ceriferus, in the citrus tree, Citrus unshiu, in central Japan.

C. rubens preferred 0-year-old twigs most as a settling-site; the density of nymphs settling on 0-year-old twigs was significantly higher than those on ≥1-year-old twigs, and few nymphs settled on ≥3-year-old twigs. The mean survival rates from settling until reproduction in the next year were significantly higher on more preferred twigs than on less preferred ones. In C. ceriferus, nymphs significantly preferred 1- and 2-year-old twigs to 0- and ≥3-year-old ones, and the mean survival rates on the more preferred 1- and 2-year-old twigs were significantly higher than those on less preferred ≥3-year-old twigs. However, the survival rate on less preferred 0-year-old twigs was slightly higher than those on 1- and 2-year-old ones. Thus, in both species of scale, it was the preferred twigs which were more profitable sites for survival after settling, except for less preferred 0-year-old twigs for C. ceriferus.

In both scale species, most mortality was due to growth cessation, which is believed to be related to the twig quality as a food source. Predators and parasitoids were minor mortality factors.

Both species showed constant survival rates until the density of settled nymphs exceeded double the “upper-limit” density, whereupon they decreased drastically.

Nymphs of C. rubens settling on twigs of high scale density showed a spacing-out distribution, those of C. ceriferus did not. In C. rubens, an increase in preference for originally less profitable twigs at the later stage of the settling season was observed, but not in C. ceriferus. Accordingly, individuals of C. rubens showed a stronger tendency to avoid conspecifics than did C. ceriferus.

Although nymphs of the two scales clearly preferred more profitable sites, their settling-site selection did not agree with the predictions from the ideal free distribution theory (Fretwell and Lucas, 1970). The discrepancies were (1) frequent settling on

---

1 Contributions to the ecological studies of scale insects. 2.
2 Present address: Center for Ecological Research, Kyoto University, Shimosakamoto 4-1-23, Otsu 520-01, Japan.
less profitable sites at the early stage of the settling season, (2) insufficient utilization of
the most profitable twigs, and (3) virtually 100% mortality on overcrowded twigs
under conditions where unoccupied profitable twigs still remained. These
discrepancies are thought due to the limited dispersal time of nymphs.

KEY WORDS: scale insects, Coccidae, Homoptera, habitat selection, plant-herbivore interaction

INTRODUCTION

This paper considers the settling-site selection of scale insects within individual
plants that might have parts of different habitat qualities, determined by chemical,
physical, morphological and nutritional features of plant tissues. Sessile scale insects
are unusual in that they have only one brief opportunity to settle during the life cycle.
For such insects, the ideal free distribution theory (Fretwell and Lucas, 1970) predicts,
(1) preference for more profitable sites during the early settling season (as a
population) and use of less profitable sites later in the season, and (2) a resulting equal
individual fitness over sites at the end of a settling season, due to a relatively higher
density-dependent decrease of fitness in the originally more profitable sites. However,
an alternative model (Ward, 1987) of optimal habitat selection in time-limited
dispersers predicts that due to the limitation of time more dispersers would settle on
less profitable sites than would be predicted by the ideal free distribution. We here
examine these possibilities in two citrus scale insects.

The two studied species of scale insect, Ceroplastes rubens and C. ceriferus, often
coexist on individual citrus trees. They have an extremely limited dispersal ability
such that they can move only during several hours after hatching. After settling they
are unable to move again, in contrast to several other scale insects which can relocate
repeatedly (Ohgushi, 1969). In this study, we measured the fitness of individual
scales immediately after settling in terms of the survival rate from settling to the start of
reproduction in the next year.

MATERIALS AND METHODS

Study Site

This study was performed at a citrus (Citrus unshiu Marc.) orchard (ca. 1 ha with
1000 trees) in Shimotsu-cho, Kaisoh-gun, Wakayama Prefecture (34°06'04"N,
135°12'27"E, 300 m A. S. L.). The orchard was founded in 1973 and practically all
citrus trees present are almost 20-year-old full grown individuals. Prior to 1986 the
only method of pest control implemented was spraying with petroleum oil every other
year in winter. This insecticide is effective only for the arrowhead scale, Unaspis
yanonensis, but not for the two Ceroplastes scales (Ohgushi, 1969).