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Thermal requirements and phenology of the *Eucalyptus* snout beetle *Gonipterus scutellatus* Gyllenhal

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Abstract: Laboratory experiments and field surveys were carried out to study the thermal requirements and phenology of the Eucalyptus snout beetle *Gonipterus scutellatus* (Curculionidae) and its parasitoid, *Anaphes nitens* (Mymaridae). Developmental times were recorded for *G. scutellatus* life stages: egg to first instar larva, first instar to pre-pupal larva, prepupae to adults and the complete life cycle. Experiments were performed in temperature-controlled chambers maintained at 10, 15, 20, 25 and 30°C with a photoperiod of 11 : 13 h of light : darkness and 50–60% RH. To calculate the minimum threshold temperature of the parasitoid, parasitized egg capsules were kept under similar conditions. During 1998 and 1999 we studied the phenology and the day-degree (DD) accumulation of *G. scutellatus* and its parasitoid in plots of *Eucalyptus* globulus at six different sites in NW Spain. Every 2 weeks, the numbers of snout beetle adults and egg capsules were counted in each plot. The rate of parasitism was estimated by collecting 90 egg capsules from each plot on each sampling date. We recorded the temperatures in each plot to test whether differences in temperature alone could account for the phenology of this snout beetle. To complete a full life cycle from egg to adult, the weevil required a mean of 1119.83 ± 20.59 DD above a base temperature of 6.11°C. The parasitoid had a base temperature of 5.09°C and needed 318.16 DD to complete a life cycle. Our model indicated that three generations of snout beetle could develop each year, corresponding to peaks of snout beetle numbers in the field in March–April, June–July and November. In some years only one generation of *G. scutellatus* was recorded due probably to the effectiveness of the parasitoid. Differences in numbers of adults and egg capsule were recorded between neighbouring 'coastal plots' and between neighbouring 'inland plots'. Hence, climate alone does not appear to explain the phenology of *G. scutellatus*.

Key words: *Anaphes nitens*, *Eucalyptus globulus*, day-degree, developmental thresholds, host–parasitoid interactions, pest management

1 Introduction

Predicting the timing of particular stages in the life cycle of pest insects is important in studies of their population dynamics and for forecasting pest insect attacks in cultivated crops (Nylin, 2001). The development of ectotherm organisms occurs within a narrow range of temperatures, and this has a profound effect on all aspects of their development. Physiological time (PhT) is the amount of heat required over time for an insect to complete a full life cycle or simply to complete one specific stage of development (Taylor, 1981). A day-degree (DD) is the amount of heat that accumulates above a specific base temperature during each 24-h period (Baskerville and Emin, 1968). This work provides the first detailed analysis of the thermal requirements and phenology of the *Eucalyptus* snout beetle *Gonipterus scutellatus* Gyllenhal (Col., Curculionidae) and one of its natural enemies, the parasitoid *Anaphes nitens* Girault (Hym., Mymaridae). This snout beetle is of Australasian origin and feeds specifically on *Eucalyptus*. Both the snout beetle adults and larvae eat the leaves, buds and shoots of the *Eucalyptus* trees, which retards tree growth and contorts and eventually kills branches of trees that are heavily infested (Tooke, 1955). Female snout beetles lay their hard brown egg capsules on shoots and young leaves. The egg capsules, composed mainly of faeces, contain about eight eggs. The neonate larvae emerge after 7–10 days and the pass through four instars. The first instars feed on the surface of the leaves, whereas the later instars consume the entire leaf blade. This snout beetle and its parasitoid, *A. nitens*, have been studied since the start of the 20th century primarily because of a combination of the high pest status of the snout beetle and the good possibility of controlling it with the above parasitoid (Marelli, 1928; Tooke, 1955; Arzone and Vidano, 1978; Mansilla, 1992; Cordero Rivera et al., 1999; Hanks et al., 2000).

The *Eucalyptus* snout beetle was introduced accidentally into Galicia, NW Spain in 1991. The egg parasitoid