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Short Communication

Bark Thickness of Host Pine Trees and Female Body Size Affecting Ovipositional Success of *Sirex nitobei* Matsumura (Hymenoptera: Siricidae)

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We examined the effect of bark thickness of host trees on the ovipositional success of *Sirex nitobei* in relation to female body size by analyzing the relationships between female body-weight and ovipositor length and between bark thickness of *P. densiflora* and *P. thunbergii* trees and oviposition proportion (the proportion of eggs laid to the potential female lifetime fecundity) of the woodwasp. The ovipositor length ranged from 6 to 14 mm and was correlated positively with the fresh body-weight of females. The bark thickness of host trees had no significant correlation with the oviposition proportion of large females of more than 100 mg f.wt, whereas it was correlated negatively with that of small females of less than 100 mg f.wt. Thus, *P. densiflora,* which has thinner bark as a whole than *P. thunbergii,* may be more suitable for oviposition, especially for smaller females.

Key words: bark thickness, oviposition activity, *Pinus densiflora, Pinus thunbergii, Sirex nitobei*

Sirex nitobei is a major woodwasp species distributed all over Japan except Hokkaido, and usually attacks species of pine (Kanamitsu, 1978; Takeuchi, 1962). The females usually produce about 40-400 mature eggs depending on body size (Fukuda *et al.*, 1993). They make no less than 200 oviposition holes per female in the maximum (Fukuda and Hijii, 1996) with the ovipositors through the bark deep into the sapwood (Kanamitsu, 1978) of suppressed trees (Kobayashi *et al.*, 1978) or freshly-felled trees (Fukuda and Hijii, 1996), and then deposit eggs together with arthrospores of a symbiont fungus, *Amylostereum areolatum,* carried in a pair of small intersegmental sacs called mycangia in the body (Terashita, 1970). Therefore, it is probable that ovipositor length and bark thickness affect oviposition success. Actually, Fukuda *et al.* (1993) allowed *S. nitobei* females to oviposit on 1-m long logs of *Pinus densiflora* and *P. thunbergii* with various bark thicknesses, 1-2 days after felling, and showed that small females (< 100 mg f.wt) laid few eggs with a much lower percentage of oviposition on the logs. To clarify the effect of bark thickness, we analyzed the relationship between bark thickness and ovipositional success of *S. nitobei* in relation to female body size.

Materials and Methods

1 Relationship between female body-weight and ovipositor length

First, we analyzed the relationship between female body-weight and ovipositor length from data in Fukuda *et al.* (1993).

2 Effects of bark thickness of host pine trees on the ovipositional success

Next, we analyzed the relationship between the bark thickness of *P. densiflora* and *P. thunbergii* trees felled a few days earlier and the proportion of eggs laid to the potential female lifetime fecundity (estimated number of eggs laid /estimated number of eggs produced per female) × 100 (%) (Fukuda *et al.*, 1993). Two size groups were used: large females (≧ 100 mg f.wt), and small females (< 100 mg). Bark thickness was taken as the mean of four measurements of cross sections of each log. Moreover, we also analyzed the relationship between the body-weight of females and the proportion of oviposition on *P. densiflora* logs with a bark thickness below 1 mm, from day 4 to day 24 after felling, the period when female woodwasps exhibit the highest oviposition preference, using data from Fukuda and Hijii (1996). All these oviposition experiments were conducted in confined conditions, *i.e.* each female was placed in a clear cylindrical container and allowed to oviposit on each 1-m long log under laboratory conditions.

Results and Discussion

Ovipositor length ranges from 6 to 14 mm and is correlated positively ($r = 0.96$, $p < 0.01$) with the fresh body-weight of females at emergence (Fig. 1). No small females had ovipositors more than 10-mm long. The bark thickness of host trees was not significantly correlated ($r = 0.29$, $n = 13$, $p > 0.05$) with oviposition proportion of large females of more than 100 mg f.wt (Fig. 2). However, there was a negative correlation ($r = -0.73$, $n = 8$, $p < 0.05$) for small females. Small females of less than 100 mg f.wt laid few eggs on logs with a bark thickness over 3 mm (Fig. 2). Actually, the smallest female with a 6-mm ovipositor could not oviposit in sample logs with a bark thickness over 6 mm.

Fukuda *et al.* (1993) has shown a positive correlation between female body-weight of *S. nitobei* and oviposition proportion; the proportion tends to increase with female body size. Smaller females have shorter ovipositors (Fig. 1), and oviposition proportion tends to decline with increasing bark thickness (Fig. 2). However, on *P. densiflora* logs with a bark thickness under 1 mm there was no correlation ($r = 0.33$, $n = 16$, $p > 0.05$) between female body-weight and oviposition proportion (Fig. 3). On *P. densiflora,* there is an inflection point of bark thickness usually at 2-4 m height from the

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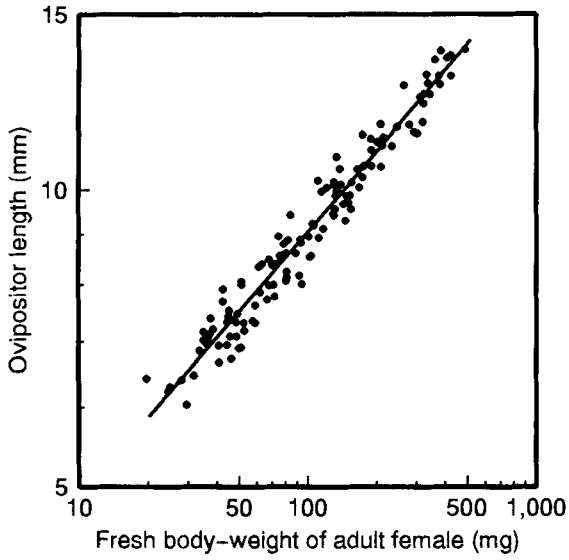

Fig. 1 Relationship between fresh body-weight of female adults of *Sirex nitobei* and ovipositor length on log-log coordinates ($r = 0.96$, $p < 0.01$).

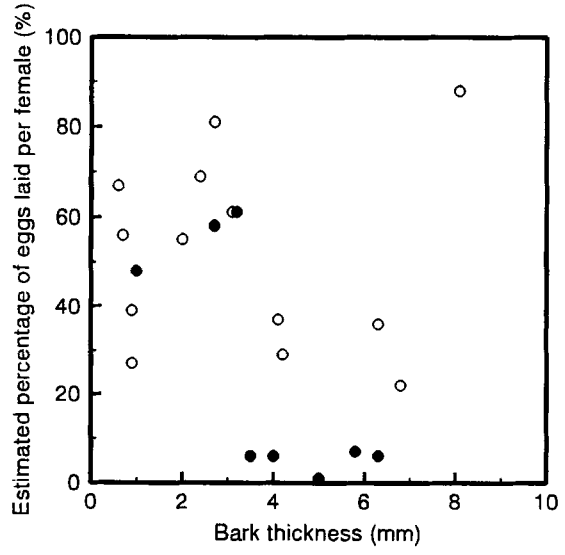

Fig. 2 Relationship between bark thickness of *Pinus densiflora* and *Pinus thunbergii* logs and estimated percentage of eggs laid per *Sirex nitobei* female to the potential fecundity (oviposition proportion). ○, large females (≧100 mg f.wt) ($r = 0.29$, $n = 13$, $p > 0.05$); ●, small females (< 100 mg f.wt) ($r = -0.73$, $n = 8$, $p < 0.05$).Percentage data were transformed to angles by arcsine transformation for correlation analysis.

ground. Trunks higher than that point have similar bark thickness (1.0–2.5 mm) and smooth surface (Yoshikawa, 1987). On *P. thunbergii*, on the other hand, there is no clear inflection point of bark thickness depending on tree height. All *P. thunbergii* trees have uneven surface, and some *P. thunbergii* trees have over a 5 mm-bark even at 7 m height (T. Urano, unpublished data). Therefore, *P. densiflora* may be more suitable for oviposition, especially by smaller females, than *P. thunbergii* with thicker bark. In fact, *P. densiflora* was attacked by *S. nitobei* more frequently than *P. thunbergii* (H.

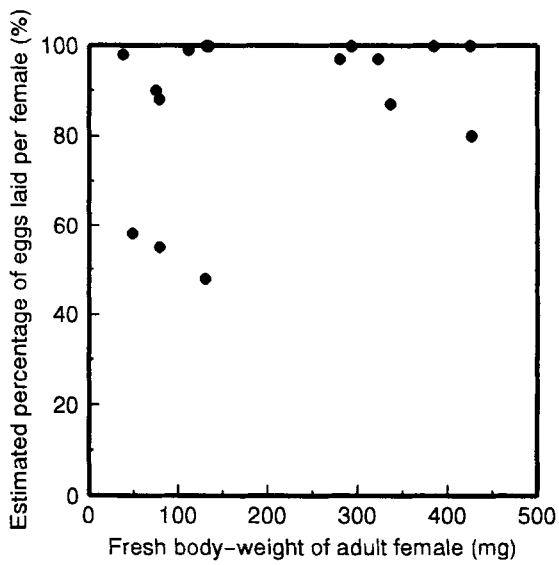

Fig. 3 Relationship between fresh body-weight of *Sirex nitobei* females and estimated percentage of eggs laid per female on *Pinus densiflora* log with bark thickness below 1 mm ($r = 0.33$, $n = 16$, $p > 0.05$). Percentage data were transformed to angles by arcsine transformation for the correlation analysis.

Fukuda, unpublished data). Madden (1971) reported that more *S. noctilio* females ovipositing on upper sections of *P. radiata* than on the thicker-barked butt sections. Effects of bark thickness of host pine trees on the ovipositional success of *S. nitobei* may be small in the field where the woodwasps can search for the most suitable position for oviposition.

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