

ニトベキバチ(*Sirex nitobei*)の体サイズと次世代生産能力

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論 文

Fecundity of the Woodwasp, *Sirex nitobei* MATSUMURA,
in Relation to Its Body Size*

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FUKUDA, Hideshi, KAJIMURA, Hisashi and HIJII, Naoki: **Fecundity of the woodwasp, *Sirex nitobei* MATSUMURA, in relation to its body size.** J. Jpn. For. Soc. 75: 405~408, 1993 The fecundity of *Sirex nitobei* MATSUMURA (Siricidae) in relation to the body sizes of female adults was evaluated by an oviposition experiment on freshly-felled pine trees. The fresh body weight of a female adult soon after emergence was correlated positively with the total number of eggs produced by the female (the potential fecundity). Both relationships between the fresh body-weight of the female adult and the estimated proportion of eggs actually laid by the female of her potential fecundity (the proportion of oviposition) and between the maternal fresh body-weight and estimated number of eggs deposited showed significant positive correlations. The mean proportion of oviposition was estimated it about 40% at most, and not less than 25% of all emerged females with fresh body-weights under 100 mg oviposited only 10% of their potential fecundity. These findings suggest that larger female adults are more likely to contribute to the reproductive success of this woodwasp.

福田秀志・梶村 恒・肘井直樹: ニトベキバチ (*Sirex nitobei*) の体サイズと次世代生産能力 日林誌 75: 405~408, 1993 ニトベキバチのメス成虫の体サイズと次世代生産能力の関係を調べるため、新たに伐倒したアカマツ、クロマツの丸太に産卵させた。メス成虫の脱出直後の生重と産卵数の間には明瞭なべき乗関係が認められた。この関係と産卵後の残存卵数を用いて実際の産卵率、産卵数を推定し、生重との関係を調べたところ、いずれも有意な正の相関を示した。また、この強制産卵条件下での平均産卵率は約 40%と推定されたが、産卵率 10%未満の個体の割合は約 25%に達し、それらはいずれも生重 100 mg 未満であった。これらの結果より、本種の雌の繁殖成功度には体サイズが重要な要因であることが明らかにされた。

I. Introduction

Woodwasps (Siricidae) are primitive hymenopterans which have a specific feeding habit in that their larvae feed primarily on the sapwood of various coniferous and hardwood trees. In many species of woodwasps, newly-emerging females carry arthrospores of a specific fungus, *Amylostereum* spp., as a symbiont in paired small intersegmental sacs in the body. Soon after a short dispersal flight, females drill several holes through the bark deep into the sapwood of new host trees and then deposit arthrospores of the fungus and "mucus," a plausible phytotoxic secretion, together with eggs, in the holes (MORGAN, 1968; TALBOT, 1977). Discoloration and deterioration of wood tissue caused by the symbiotic fungus have often degraded the commercial value of wood.

Sirex nitobei MATSUMURA, a species of such woodwasps, attacks various coniferous species, mostly pine trees in Japan (KANAMITSU, 1978), which may be responsible for a larger part of the local mortality of pine trees than has ever been considered (KOBAYASHI *et al.*, 1978). The life cycle of *S. nitobei* usually is completed in one year. This species constructs single or multiple drills in the xylem through a single hole through the phloem when it lay eggs. When a single drill is made, only the arthrospores are deposited, whereas in multiple drills, the fungus is deposited in one drill, and a single egg is deposited in each of the other drills

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(KANAMITSU, 1978). The fecundity and proportion of eggs actually deposited, however, have not been studied sufficiently. Thus the objective of this study primarily is to clarify these aspects, which also may be related closely to the causal mechanism of damage to trees, related to the body-size parameters of the emerging adults.

II. Materials and Methods

In July 1988, several freshly-felled trees of *Pinus densiflora* SIEB. et ZUCC. were cut into 1-m long logs which were laid horizontally on the forest floor in a mixed stand of the Aichi Branch of the Tokyo University Forest in Seto City situated about 20 km east of Nagoya City (Plot I). During June and July in 1989, 20 infested-logs were selected randomly and transferred to an outdoor cage on the Nagoya University campus in Nagoya City. Other logs were cut in July 1991 from a *P. densiflora* tree infested with the woodwasp in Inabu Town situated about 70 km east of Nagoya City (Plot II). These also were transferred to the outdoor cage. During the period from mid-August to early November in 1989 for the Seto population and in 1991 for the Inabu population, we counted the numbers of new adults of *S. nitobei* emerging from the logs every few days (Seto) or every day (Inabu), and measured a few size parameters of the emerged adults; ovipositor lengths, head widths and fresh body weights. The female body weights in our study included the weights of eggs because most eggs already had matured at the time of emergence of females.

A total of 63 new female adults emerging from both populations were used for the oviposition experiment to estimate the number of eggs actually laid in the wood. After weighing, each of 21 females were placed in a clear tube-like box made of polyvinyl chloride under laboratory conditions (15~20°C) and allowed to oviposit on a 1-m long fresh log of *P. densiflora* or *P. thunbergii* PARL. from Plot I (Group 1). The fresh logs (4~10 cm in diameter and 1~8 mm in bark thickness), about 1~2 days after felling, were used randomly for the oviposition experiment. The other 42 females were not allowed to oviposit (Group 2). Among the females of Group 1, nine females were allowed to mate with males which emerged almost the same day, while the other 12 females were unmated. Soon after, female adults in both groups died, and we counted the number of mature eggs remaining in the ovaries.

III. Results and Discussion

1. Adult body sizes and longevity

On Plot I, emergence of adults continued for about two and a half months from late August to early November. By contrast, on Plot II emergence of adults was concentrated within a period of about 15 days from the beginning of emergence (Sept. 10), and thereafter very little emergence occurred.

The fresh body-weights of all new adults, within a few day after emergence, ranged from 20 to 322 mg for females and from 10 to 182 mg for males, showing a wider size range for females than for males. For each sex, the mean body sizes of adults from Plot I were significantly larger than those from Plot II (Table 1). However, sizes were larger in females than in males in each population.

Mean longevity of newly-emerged adults was about four days, which was less affected by their body sizes (Fig. 1). Oviposition usually began immediately after emergence, and no female adults ceased drilling and egg-laying on the log until they died.

Table 1. Size characteristics of emerged adults of *Sirex nitobei* (mean±S.E.)

	Seto population		Inabu population	
	♂	♀	♂	♀
Fresh body-weights (mg)	74.8±6.2** (n=44)	141.3±14.9** (n=36)	43.9±5.6 (n=25)	83.6±7.6 (n=48)
Head widths (mm)	3.0±0.1** (n=52)	3.2±0.1* (n=38)	2.5±0.1 (n=25)	2.8±0.1 (n=48)
Ovipositor lengths (mm)	—	9.7±0.3** (n=29)	—	8.2±0.2 (n=48)
Longevities (day)	—	—	4.2±0.4 (n=25)	4.1±0.2 (n=48)

Note: Significantly different from the values for the Inabu population (* $p < 0.05$, ** $p < 0.01$; t -test).

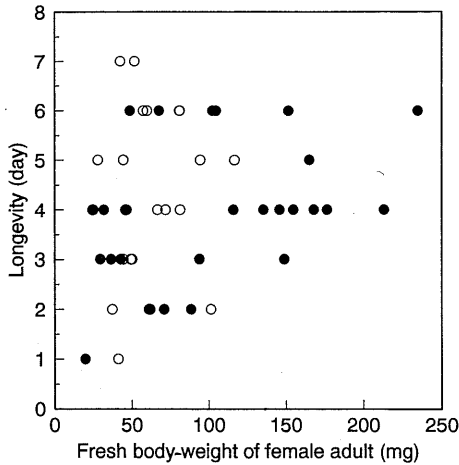


Fig. 1. Relationships between fresh body-weights and longevity of female adults

Legend: ○, Oviposited individuals ($n=28$, $r=0.36$, $p>0.05$); ●, Non-oviposited individuals ($n=20$, $r=0.09$, $p>0.05$).

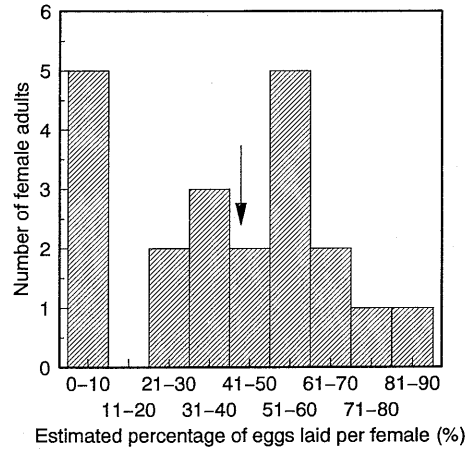


Fig. 3. Frequency distributions of estimated percentages of eggs laid by female adults to the potential fecundities (the proportions of oviposition)

Note: Arrow indicates the mean.

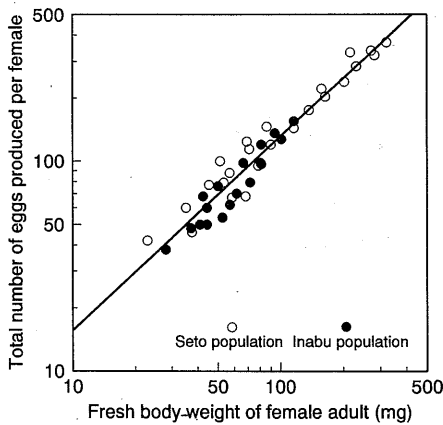


Fig. 2. Relationships between fresh body-weights of female adults and total numbers of eggs produced by female adults, potential fecundities, on log-log coordinates

Note: The regression is given by Eq.(1).

2. Fecundity and the proportion of eggs actually deposited

We first set up a least-squares regression of the total number of eggs produced per female immediately after emergence (N_p), a potential fecundity, against the fresh body-weight (W) for the female adults of Group 2. The potential fecundity of a female (N_p), varying from about 40 to 370, was correlated positively with the fresh body-weight of the female at the time of emergence (W) (Fig. 2). The relationship was given by the following equation:

$$N_p = 1.86 W^{0.92} \quad (n=42, \quad r^2=0.94, \quad p<0.01). \quad (1)$$

The potential fecundity in Group 1 was estimated by Eq. (1), and their initial body-weight was determined before oviposition. Based on these results and the number of eggs remaining in the body of a female

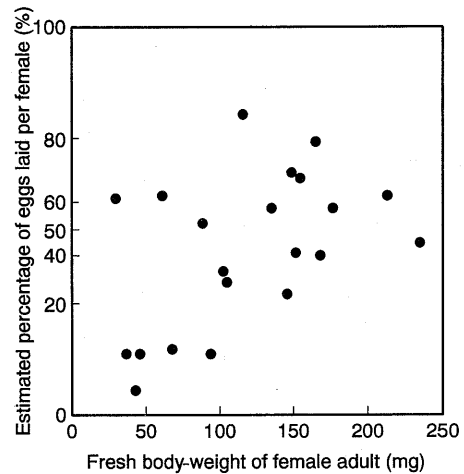


Fig. 4. Relationships between fresh body-weights of female adults and percentages of eggs laid by females to the potential fecundities (the proportions of oviposition)

Note: Percentage data are transformed to angles by arcsine transformation.

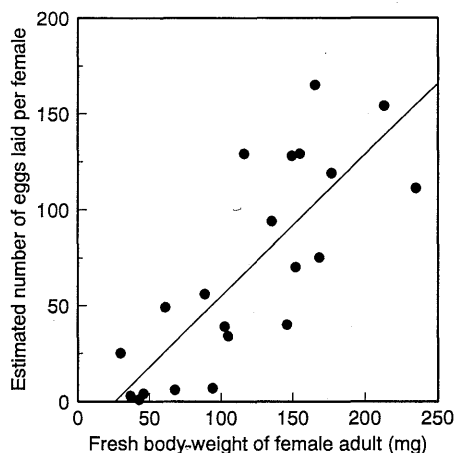


Fig. 5. Relationships between fresh body-weights of female adults and estimated numbers of eggs laid by the females.

Note: The regression is given by Eq. (4).

unmated (mean 45%; $n=12$) females (Mann-Whitney U -test, $p>0.05$), which was unlike the result of MADDEN (1974).

For *S. noctilio*, MADDEN (1974) emphasized that the oviposition activity could be affected greatly by the osmotic condition of the phloem sap, suggesting that a stimulus from the phloem sap flow is the most probable determinant in depositing eggs of the woodwasp. The small proportion of oviposition relative to the potential fecundity observed in our study may reflect the fact that the fresh logs used for the oviposition experiment were less acceptable to female adults than those expected in the field where the woodwasps can assess and choose suitable host trees.

The estimated proportion of oviposition increased with the fresh body-weight of a female ($r=0.48$, $n=21$, $p<0.05$; after arcsine transformation of percentage data (Fig. 4)). The relationship between fresh body-weight and the estimated number of eggs laid per female (N_E) was given by the following equation:

$$N_E = 0.74 W - 18.8 \quad (n=21, r^2=0.64, p<0.01), \quad (4)$$

which suggests that more successful oviposition was attained by larger female adults (Fig. 5).

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