species of the genus *Scolothrips* are predators of mites on many plants. Unfortunately, these predatory thrips were few in the gardens surveyed.

Thrips tabaci LINDEMANN is known as a cosmopolitan species and has also been recorded from Southeast Asia (DAMMERMAN, 1929; HILL, 1983). Although this polyphagous thrips is a worldwide important pest of onion, it has frequently been recorded from other vegetables such as watermelon, muskmelon, cucumber and eggplant in Japan (MIYAZAKI and KUDO, 1988). However, *T. tabaci* was never found during our surveys.

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Rearing of the Predatory Stink Bug, *Eocanthecona furcellata* (WOLFF) (Heteroptera: Pentatomidae), on Frozen Larvae of *Spodoptera litura* (FABRICIUS) (Lepidoptera: Noctuidae)¹

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A predatory stink bug, *Eocanthecona furcellata*

(WOLFF) predating on the larvae of Lepidoptera, Coleoptera and Heteroptera, is distributed in Southeast Asia and the Okinawan region of Japan (PRASAD et al., 1983; JAKHMOLA, 1983; CHU, 1975). We found this bug was able to feed on frozen larvae of various noctuid species.

The purposes of the present study were to develop an adequate rearing method for *E. furcellata* and to determine its developmental parameters when rearing the bugs on the frozen larvae of *Spodoptera litura* (FABRICIUS) in the laboratory. This will provide a basis for further research focusing on its characteristics and its potential as a pest control agent in IPM (integrated pest management) strategies.

MATERIALS AND METHODS

Eocanthecona furcellata was provided by Mr. M. TAKAI of the Kochi Prefectural Institute of Agri-

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Table 1. Development and survival of the nymphs of *Eocanthecona furcellata* reared on live or frozen larvae of *Spodoptera litura*

Stage	Development period ^a (d)	
	Live prey (N=48)	Frozen prey (N=48)
1st instar	4.3±0.1	4.3±0.1
2nd instar	4.4±0.1	4.3±0.1
3rd instar	3.3±0.2 (0.813)	3.8±0.2 (0.854)
4th instar	3.7±0.3 (0.771)	3.6±0.2 (0.854)
5th instar	6.1±0.4 (0.750)	6.5±0.3 (0.813)
Total	21.8±0.2 (0.750)	22.5±0.2 (0.729)

^a Values indicate mean±S.E. Values in the parentheses are survival rates from the second instar.

Only the difference in the third instar was significant by *t*-test at $p<0.05$.

cultural Science, Japan. The insects were originally collected on October 3, 1989, on Ishigaki Island, Okinawa Prefecture, Japan.

Plastic Petri dishes (9 cm dia.×1.5 cm ht.) and plastic boxes (8 cm dia.×4.5 cm ht.) were used. The lid of the plastic box had vent-holes covered with fine mesh screen. The cultures were maintained on live larvae of *Spodoptera litura* and *Spodoptera exigua* (HÜBNER) at 26°C with a 16L-8D cycle.

Developmental periods, survival rates of the nymphal stage and longevity and reproduction rates of adults were determined under the same conditions; water and live or frozen fourth to sixth *S. litura* instars, were provided every three or four days. *S. litura* larvae were reared on an artificial diet (WAKAMURA, 1988). Live *S. litura* larvae were frozen at -30°C, and stored in the same condition for less than 1 y.

Four egg masses laid by different *E. furcellata* females were grouped by stage (egg stage to the second instar) on sheets of absorbent paper in separate Petri dishes. Only water was provided to first instars. Second instar nymphs were divided into two groups of twelve bugs and transferred to plastic rearing boxes (8 cm dia.×5 cm depth): separate groups were reared on live and frozen *S. litura* larvae. Each bug was weighed before feeding every three or four days and numbers of live and dead bugs at each instar were recorded. Emergent bugs were paired with one female and one male within the same group, which resulted in three or four pairs for each. The numbers of eggs laid and hatched were counted every three or four days until the bugs' death.

RESULTS AND DISCUSSION

Developmental periods and survival rates are reported in Table 1. No significant difference was observed between the developmental periods of nymphs reared on the live and frozen larvae (*t*-test: $p>0.05$), except in the third instar. The Developmental period of third instars reared on the frozen larvae was slightly longer than that of instars reared on live prey ($p<0.05$). The reason for this was not clear. No significant difference was observed in the survival rates.

Body weights and longevities of adult bugs are shown in Table 2. Adult bugs, both male and female, reared on frozen prey were significantly smaller than those reared on live prey ($p<0.01$). Adult longevity was not significantly different between groups reared on the two foods ($p>0.05$). Maximum longevities were 314 and 299 d after adult emergence when reared on live and frozen larvae, respectively.

Reproduction of *E. furcellata* is also summarized in Table 2. Egg masses per female, total eggs per female and eggs per egg mass were not significantly different, although there was significant difference in hatching rate ($p<0.05$). Eggs hatched 7.5 ± 0.1 d (mean±S.E.) after oviposition.

Although the adults reared on frozen larvae were generally smaller than those feeding on live larvae, reproductive rates were not significantly different. This indicates that frozen larvae are suitable diets for *E. furcellata* rearing.

CHU (1975) reported that handling about 40,000 eggs and rearing 4,000 nymphs of *E. furcellata* required 8 h. This does not include prey-rearing

Table 2. Reproduction of *Eocanthecona furcellata* reared on live and frozen larvae of *Spodoptera litura*

	Mean±S.E. (min.-max.)		<i>t</i> -test ^a
	Live (12 pairs)	Frozen (15 pairs)	
Adult weight (mg) ♂	71.1± 0.3 (48-103)	61.3± 0.3 (43- 81)	**
♀	151.6± 1.1 (64-216)	123.7± 0.9 (63-197)	**
Adult longevity (d)	98.5± 12.7 (0-314)	93.0± 14.2 (0-299)	—
No. of egg masses per ♀	11.4± 3.0 (0- 27)	15.3± 2.8 (0- 39)	—
Egg mass size	44.5± 2.1 (4-117)	41.1± 1.4 (4- 96)	—
No. of total eggs per ♀	507.3±139.5 (0-1353)	628.8±110.2 (0-1320)	—
Hatched eggs (%)	73.8± 3.2 (0- 98.6)	83.0± 2.2 (0- 98.9)	*

^a —: $p>0.05$, *: $p<0.05$, **: $p<0.01$.

operations. ADIDHARMA (1986) reported that *Podisus sagittus* (L.) were successfully reared on artificial diets. However, DE CLERCQ et al. (1988) reported that artificial diet was insufficient to rear *Podisus sagitta* (FAB). They also reported that frozen larvae were suitable for rearing only in cases of shortages of live prey or emergencies. However, our results suggest that frozen larvae may be a good diet for continuous rearing of predatory stink bugs.

In a separate observation, we noted that some *E. furcellata* bugs were destroyed by *S. litura* larvae, when the bugs remained dormant for a few days before and a few hours after moulting. An additional merit of using frozen prey is to avoid such losses of the beneficial predators.

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