Life history parameters of Amphibolus venator (Klug) (Hemiptera: Reduviidae), a predator of stored-product insects

研究ノート

Life history parameters of *Amphibolus venator* (Klug) (Hemiptera: Reduviidae), a predator of stored-product insects

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Abstract

The life history parameters of *Amphibolus venator* (Klug) (Hemiptera: Reduviidae) were estimated at 25, 27.5, 30, 32.5 and 35℃. The bugs were reared on *Tribolium confusum* larvae. As the temperature increased from 25℃ to 35℃, the intrinsic rate of natural increase (r_m) increased from 0.0081 to 0.0275. This result shows that of the tested temperatures, 35℃ was the optimal temperature for population increase of *A. venator*.

Introduction

Amphibolus venator (Klug) (Hemiptera: Reduviidae) (Fig. 1) is a predator of various stored-product insects[1]. It preys on *Trogoderma granarium* Everts, *Tribolium castaneum* (Herbst), *Corcyra cephalonica* (Stainton), *Latheticus oryzae* Waterhouse and *Alphitobius diaperinus* (Panzer)[2,3]. In a warehouse trial, Pingale[2] indicated that *A. venator* effectively suppressed *Cadra cautella* (Walker) and *A. diaperinus* populations.

A. venator has frequently been found in imports of groundnuts from Africa to England[1] and also in warehouses in Thailand[4]. In Japan, *A. venator* was encountered for the first time in a rice milling facility in Okinawa Prefecture, where it acted as the major predatory natural enemy[5]. Hence, it might be expected that this assassin bug has potential as an effective biological control agent against stored-product insects.

To evaluate the possibility of use of this bug as a biological control agent, information on its biology is needed. The developmental period, egg incubation period, and adult fecundity have already been studied[6], but the intrinsic rate of natural increase has not yet been reported. This paper reports the life history parameters of *A. venator* reared on larvae of *Tribolium confusum* Jacquelin du Val.

Materials and Methods

This study is part of an earlier study completed by Nishi and Takahashi[6]; thus, the procedures and materials are only briefly described here.

Insects

A. venator were collected from a rice milling facility in Okinawa Prefecture, Japan, in 2000, and cultures were reared on larvae of *T. confusum* and *Tribolium freemani* Hinton in a constant temperature and humidity room maintained at 30℃, 70% RH and a 24L photoregime. *T. confusum* and *T. freemani* were reared on whole wheat flour in the same room as *A. venator*.

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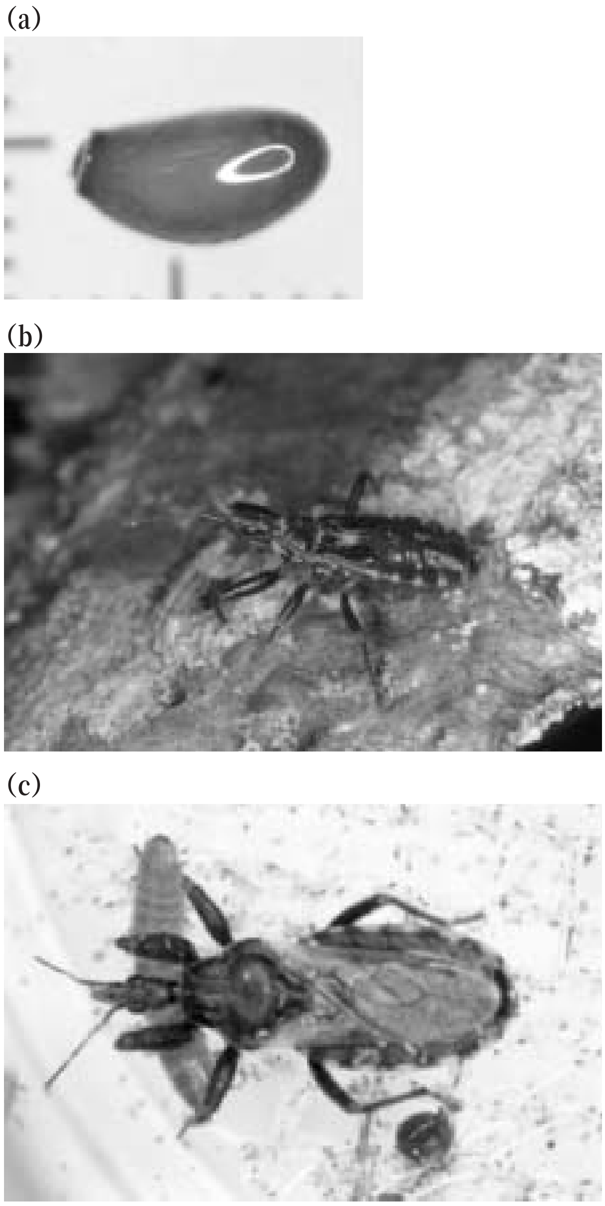

Fig. 1 Photographs of *A. venator*: (a) egg; (b) nymph in its habitat (a rice milling facility in Urasoe, Okinawa Prefecture); (c) adult attacking *Tribolium* sp. larva.

Oviposition of *A. venator*

The fecundity of *A. venator* was investigated at 25±0.5, 27.5±0.5, 30±0.5, 32.5±0.5 and 35±0.5℃, 70-75% RH and a 16L-8D photoregime. A pair of *A. venator* (0-24 h old) was placed in a plastic container (3.5 cm diameter and 2 cm height). Two late-stadium larvae of *T. confusum* were supplied as prey every day. Daily egg counts were done for each pair. The number of replications at each temperature was 24.

Egg incubation and hatchability

Egg incubation periods and percentage hatch were determined at the five constant temperatures listed above. Newly laid eggs (0-24 h old) obtained from stock cultures were used in the experiments. The eggs were placed in plastic containers (6 cm diameter and 3 cm height). Egg hatch was observed daily. The numbers of eggs tested were 55, 56, 50, 56 and 48 at 25, 27.5, 30, 32.5 and 35℃, respectively.

Developmental period of nymphal stages

Duration of nymphal stages was determined under the same experimental conditions. First-stadium nymphs (0-24 h old) were obtained from stock cultures. The nymphs were individually placed in plastic containers (3.5 cm diameter and 2 cm height). One late-stadium larva of *T. confusum* was supplied as prey daily. Observations were carried out daily for nymphal moults. The number of replications at each temperature was 24.

Life history parameters

Using the results obtained from the above experiments, the intrinsic rate of natural increase (r_m) was estimated according to the equation given by Birch[7]:

$$1 = \sum_{x=1}^{\infty} l_x \, m_x \, \mathrm{emp}(-r_m \, x),$$

where l_x is the proportion of females alive at time x of an original cohort and m_x is the mean number of female offspring produced per surviving female during the age interval x (1 day). The female sex ratio was assumed to be 0.5. The net rate of reproduction ($R_0 = \Sigma l_x \, m_x$), the mean generation time ($T = \ln R_0 / r_m$) and the finite rate of natural increase ($\lambda = \exp(r_m)$) were also calculated.

Results and Discussion

Some females laid only unfertilized eggs. This seemed to result from copulation failure, so the data on these females were excluded from calculation of life history parameters. The intrinsic rate of natural increase (r_m), the net rate of reproduction (R_0), the mean generation time (T) and the finite rate of natural increase (λ) were calculated and listed (Table 1). The r_m-value increased with increasing temperature. *Xylocoris flavipes* (Reuter) (Hemiptera: Anthocoridae) is a well-studied predator of stored-product insects. It has been reported that the r_m-value of *X. flavipes* at 35℃ is smaller than that at 30℃[8]. *A. venator* was better adapted to high tem-

Table 1. Life history parameters of *A. venator* reared on *T. confusum* larvae.

	R_0 [a]	T [b]	r_m [c]	λ [d]
25 °C	8.52	265. 06	0.0081	1.0081
27.5 °C	11.15	237. 20	0.0102	1.0102
30 °C	16.57	146. 86	0.0191	1.0193
32.5 °C	23.08	139. 67	0.0225	1.0227
35 °C	24.96	116. 82	0.0275	1.0279

[a] Net reproductive rate.
[b] Mean generation time (days).
[c] Intrinsic rate of natural increase (per day).
[d] Finite rate of natural increase (per day).

perature conditions than *X. flavipes*. The r_m-values of *A. venator* were generally smaller than those of *X. flavipes* at all tested temperatures[8)]. This mainly results from the longer developmental period of *A. venator* than of *X. flavipes*[6,8)], since the developmental periods of *A. venator* were considerably longer than those of *X. flavipes* at all temperatures (approximately 4.4-7.6 times); while the R_0-value, which represents the total number of eggs per individual, of *A. venator* at 35℃ was greater than that of *X. flavipes* at 35℃[6,8)].

The prey insects significantly influence vital phenomena such as rate of development, survival and the reproductive potential of their predators. Parajulee and Phillips[9)] showed that *L. campestris* varied its developmental period and fecundity according to its prey species. It is therefore suggested that *A. venator* may have more suitable prey for development and survival. More research on its optimal diet will be needed to develop easy methods of rearing *A. venator*.

Of the tested temperatures, the present study identifies 35℃ as being the optimal temperature for population increase of *A. venator*. Nishi et al.[10)] showed that *A. venator* killed more *T. confusum* at 30℃ than at 25℃. Because *A. venator* has a higher predatory ability and a higher population increase rate at temperatures of 30℃ or higher, this bug may be better suited for use as a biological control agent in tropical regions.

References

1) Hill, D. S., “ Pest of Stored Products and Their Control. ” Belhaven Press, London (1990).
2) Pingale, S. V., Biological control of some stored grain pests by the use of a bug predator, *Amphibolus venator* Klug. *Indian J. Ent*., 16, 300-302 (1954).
3) Haines, C. P. (ed.), “ Insects and Arachnids of Tropical Stored Products: Their Biology and Identification (A Training Manual). ” 2nd ed., Natural Resource Institute, Chatham (1991).
4) Hayashi, T., Nakamura, S., Visarathanonth, P., Uraichuen, J., Kengkanpanich, R. (eds.), “ Stored Rice Insect Pests and Their Natural Enemies in Thailand. ” JIRCAS International Agriculture Series No. 13, Funny Publishing Co. Ltd., Bangkok (2004).
5) Takahashi, K., Romero, M. V., Investigation of stored-product insect pests and their natural enemies in Okinawa-jima and Ishigaki-jima islands, Okinawa, Japan. *Jpn. J. Ent. (N.S.)*, **4**, 91-97 (2001).
6) Nishi, A., Takahashi, K., Effect of temperature on oviposition and development of *Amphibolus venator* (Klug) (Hemiptera: Reduviidae), a predator of stored product insects. *Appl. Entomol. Zool*., **37**, 415-418 (2002).
7) Birch, L. C., The intrinsic rate of natural increase of an insect population. *J. Anim. Ecol*., **17**, 15-26 (1948)
8) Arbogast, R.T., Population growth of *Xylocoris flavipes*: influence of temperature and humidity. *Environ. Entomol*., **4**, 825-831 (1975).
9) Parajulee, M. N., Phillips, T. W., Effects of prey species on development and reproduction of the predator *Lyctocoris campestris* (Heteroptera: Anthocoridae). *Environ. Entomol*., **22**, 1035-1042 (1993).
10) Nishi, A., Imamura, T., Miyanoshita, A., Morimoto, S., Takahashi, K., Visarathanonth, P., Kengkanpanich, R., Shazali, M. E. H., Sato, K., Predatory abilities of *Amphibolus venator* (Klug) (Hemiptera: Reduviidae), a predator of stored-product insect pests. *Appl. Entomol. Zool*., **39**, 321-326 (2004).

貯蔵食品害虫の捕食性天敵コメグラサシガメ（半翅目：サシガメ科）の生活史パラメーター

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コメグラサシガメ（半翅目：サシガメ科）の25，27.5，30，32.5，35℃における生活史パラメーターを算出した．カメムシはヒラタコクヌストモドキの幼虫を餌として育てられた．温度が25℃から35℃に上昇するとともに，内的自然増加率（r_m）は0.0081から0.0275へと増加した．35℃が今回の試験に用いた温度範囲では最も個体群増殖に適していることが分かった．