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The Effects of Temperature and Prey Species on the Development and Fecundity of *Platydemus manokwari* De BEAUCHAMP (Tricladida : Terricola : Rhynchodemidae)

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Abstract: The effect of temperature and prey species on the development and fecundity of the predatory flatworm *Platydemus manokwari* De BEAUCHAMP were studied to determine the most favourable laboratory rearing conditions. Developmental time and cocoon production were investigated at temperatures in a range of 12-27°C. The optimum temperature for rearing the flatworm in terms of pre-oviposition period and cocoon production was 24°C. Three types of prey species were supplied to *P. manokwari* to predict their suitability as rearing media. The terrestrial snail *Bradybaena similaris*, proved more suitable as a host than the slug *Limax marginatus*. These results confirm the feasibility of producing large nnumbers of the flatworm at 24°C on *B. similaris* for use as a biological control agent against the giant African snail *Achatina fulica* BOWDICH.

Key words: Biological control, giant African snail, flatworm

Introduction

Flatworms have been known as predators of terrestrial snails (MEAD, 1963). One species, a Rhynchodemid flatworm, *Platydemus manokwari* De BEAUCHAMP, which was first recorded from New Guinea was accidentally introduced into Guam and subsequently significantly reduced the number of giant African snails on the island. The flatworm was then introduced onto some other islands as a biological control agent against the giant African snail again with success (MUNIAPPAN *et al.*, 1986 ; MUNIAPPAN, 1987). However, no studies have been documented on the biology of the flatworm itself.

An efficient rearing method enables the release of a large number of individuals for biological control. Establishment of an efficient rearing method is also important in estimating the potential efficacy of the organism as a biological control agent.

KANEDA *et al.* (1990) reported a laboratory rearing method for the flatworm. However studies were not documented on the development of *P. manokwari* at different tempratures and on different prey species. To decide the optimal conditions for the rearing of the flatworm, effects of temperature and type of prey species on the development and fecundity of the flatworm were investigated in the present study.

Materials and Methods

The flatworms used in the present study had been bred in the laboratory following by

KANEDA *et al.* (1990). All containers used in the study reported here had no holes in the lid.

1) The effects of temperature on development and fecundity of *P. manokwari.*

Five newly hatched juveniles were placed in the plastic container (12×11×5.5 cm) with 50 g of fully water soaked sphagnum moss and a sufficient number of prey land snails *Bradybaena similaris* (FERUSSAC) to enable normal development. Experiments were carried out at 15, 18, 21, 24 and 27°C with a photoperiod of 16L-8D. Relative humidity in the container was considered to be close to 100% due to the lack of ventilation and the presence of fully water soaked sphagnum moss in the containers. Each flatworm was weighed and the number of cocoons (egg capsules) produced was counted weekly for 15 weeks. Sphagnum moss and the container were changed weekly. Two replicates were set up at each temperature.

An experiment to study the developmental period of the cocoon was also conducted using a plastic container (6 cm diameter, 3.5 cm high). This container also had no holes in the lid. Five grammes of fully water soaked sphagnum moss was included to maintain high relative humidity in the container. A newly laid cocoon (less than 24 hours old) were held in the container with sphagnum moss at 18, 21, 24 or 27°C. More than 15 replicates were set up at each temperature except at 27°C.

2) The effects of prey type on the development and fecundity of *P. manokwari.*

KANEDA *et al.* (1990) reported that *P. manokwari* could feed on various kinds of land snails. However, the quantity and species which are naturally available in any one locality is limited. An experiment was carried out to determine the optimum pey species for large scale rearing of *P. manokwari*. The effect of the type of prey species on the development and fecundity of *P. manokwari* was determined using two land snail species which were most abundant in Yokohama area. Because seasonal abundance of prey animal in a area usually fluctuate, the availability of frozen prey as food using a slug *Limax marginatus* MULLER, was also studied.

Five newly hatched juvenile flatworms and 50 g of fully water soaked sphagnum moss were placed in the plastic container at 24°C with a photoperiod of 12L-12D. Three types of prey species, a land snail, *Bradybaena similaris* ; a slug, *Limax marginatus* : and frozen slug *L. marginatus*, were supplied in sufficient quantities to enable normal development. Each flatworm was weighed and the number of produced cocoons was counted at weekly intervals for 30 weeks. The experiment was replicated three times.

Results and Discussion

1) The effects of temperature on the development and fecundity of *P. manokwari.*

Changes in the mean weight of the flatworm at all temperatures are shown in figure 1. All flatworms increased in weight and survived for the duration of the experiment at all temperatures except 12°C. No fusion was observed at any temperature during that period. At 12°C there was no change in mean weight of the flatworm up to the four week period

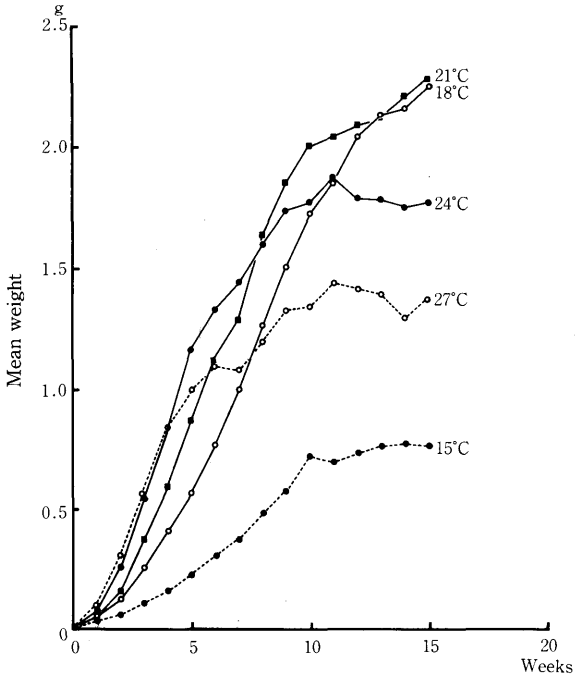

Fig. 1. Changes in mean weight of *Platydemus manokwari* at different temperatures.

after which weight reduced from 0.24 g to 0.17 g. At all other temperatures the mean weight of the flatworms increased. Developmental temperatures affected weight where the mean weight was highest at 18°C followed by 21°C, 24°C, 27°C and 15°C at 15 weeks.

Oviposition occurred at all temperatures except at 12°C and 15°C. Accordingly, the threshold temperature of the oviposition lies between 15°C and 18°C. Pre-oviposition period was shortest at 24°C (3 weeks) followed by 21°C (4 weeks), 27°C (5 weeks), 18°C (6 weeks) (Table 1). The mean weight of the flatworms which began to lay their cocoon was between 0.55 g to 0.95 g. So the flatworm became adults which were ready to start to lay their cocoon when the weight reached to 0.75 g on average. The greatest production of cocoons was achieved at 24°C where the mean number of cocoons produced per individual for the experimental period was 9.6.

The developmental threshold for the pre-oviposition period was predicted from the

Table 1. Cocoon production of *Platydemus manokwari* at different temperatures.

Temp. (°C)	n	No. of cocoon (indvidual/week)	Pre-oviposition period (week)	Mean weight at first cocoon production (g)
15	10	—	—	—
18	10	0.6	6	0.77
21	10	5.8	4	0.60
24	10	9.6	3	0.54
27	10	2.7	5	0.99

Table 2. Developmental period of cocoon of *Platydemus manokwari* at different temperatures.

Temp. (℃)	n	Developmental period (day) Mean±SD	Cocoon hatchability (%)
18	27	13.64±1.94	51.9
21	27	9.11±0.81	70.4
24	15	7.80±1.20	90.0
27	6	5.83±0.41	87.5

regression equation and calculated as 11.7°C. The equation was $Y=0.003665X-0.042958$ ($r=0.987$).

Developmental period of the cocoon at all temperatures tested are shown in Table 2. According to this data the threshold temperature for the cocoon stage was calculated as 10.0°C. The equation was $Y=0.0104X-0.1133$ ($r=0.9424$). The hatchability increased with temperature.

Accordingly, it was considered that the most favorable temperature for the rearing of the flatworms was 24°C because at that temperature, the flatworms grew faster and produced more cocoons than at any other temperature examined.

2) The effects of prey species on the development and fecundity of *P. manokwari*.

Changes in mean weight of the flatworms on three types of prey are shown in figure 2. Mean weight of the flatworms on *B. similaris* was heavier than that on *L. marginatus* the over experimental period. The mean weight of the flatworm on *L. marginatus* decreased from the tenth week but on *B. similaris* the mean weight of the flatworm increased.

Age specific fecundity and survival curves are shown in Figure 3. Successful oviposi-

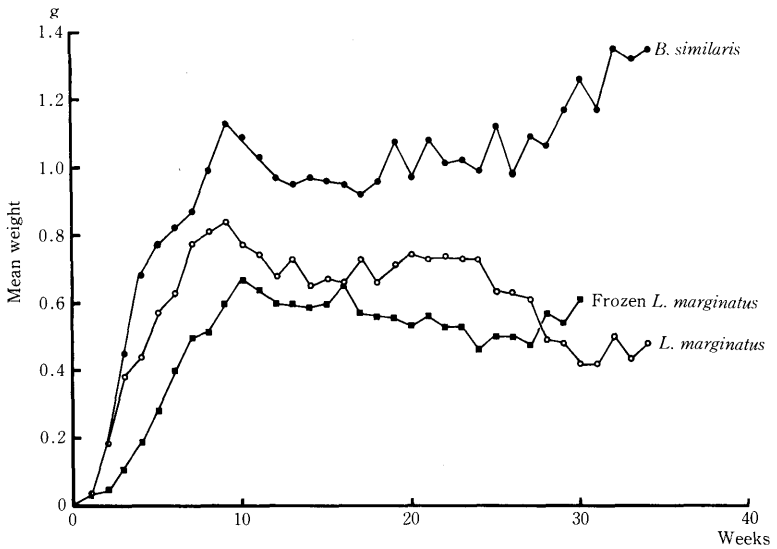

Fig. 2. Changes in mean weight of *Platydemus manokwari* on different prey species.

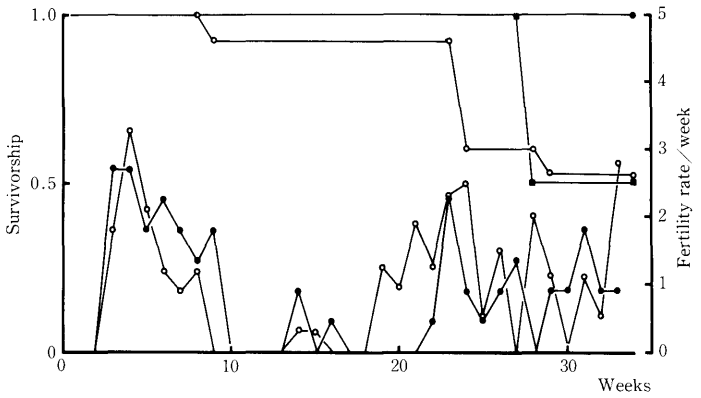

Fig. 3. Age specific fecundity and survival curves of *Platydemus manokwari* feeding on different prey species.
(●—● *B. similaris*, ○—○ *L. marginatus*, ■—■ *Frozen L. marginatus*)

tion occurred on *B. similaris* and *L. marginatus* but not on frozen *L. marginatus*. The reduction of the availability of food from the frozen prey due to decay might have resulted in insufficient intake of the nutrient. There were no differences in *P. manokwari* pre-oviposition period between *B. similaris* and *L. marginatus*.

From these results, the optimum prey for rearing *P. manokwari* in the Yokohama area is considered to be *B. similaris*. This prey provided a higher survival rate and greater cocoon production than other prey types tested.

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