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Predation Efficiency of the Spider *Tetragnatha squamata* (Araneae: Tetragnathidae) to Tea Leafhopper *Empoasca vitis* (Insecta: Homoptera)

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ABSTRACT

The spider, *Tetragnatha squamata* and its prey *Empoasca vitis*, the tea leafhopper, were investigated in laboratory on the prey-predator relationship. The predator spider showed a significant response to the increase of the prey. The predation effiency and the response of predator to its density were examined as well. The result of the experiments are give as questions.

Key words: predation, *Tetragnatha squamata*, spider, tea leafhopper

INTRODUCTION

It has been observed in several countries that spiders are predators of insect pests in rice fields, cotton fields and fruits orchards. These biological control experiments indicated that spider plays an important role in the suppression of serious pests in these agroecosystems.

Tea crop is one of the most important economic crops in China. Tea plantation provides a habitat for a many spider species, which may reduce tea pest populations. Nevertheless, very limited studies on this aspect have been made in China.

Predator-prey relationships constitute an important component of field population ecology, and it is of much theoretical and practical interests in the problem of how predator populations affect the populations of their prey. There are various approaches to solve this problem.

The functional responses of predators were studied in depth by Holling (1959a, 1959b, 1966) physical and biotic factors affecting functional response have been studied by various authors (Huffaker *et al.* 1963; Varley *et al.* 1973)

As pointed out by Huffaker et al. (1963), the first step in assessing the predatory efficiency is to learn how it performs as an individual that is, the way in which it searches for prey, perceives the prey and accepts or refuse given prey individuals for attack. Knowledge of the functional response of individuals is essential for a clear understanding and correct approach to modeling predator-prey interactions.

It has been observed that the spider *Tetragnatha squamata* has a great potentiality as the dominant predator of serious citrus pests in untreated orchards in China (Yan & Kim, 1994). Therefore it was important to assay its predation efficiency as a biological control agent.

MATERIALS AND METHODS

Response of the spider to prey density. Thirty adult females of *T. squamata* were reared individually in the laboratory in the presence of the adults of tea leafhoppers EMPOASCA VITIS which were taken from tea plantations. The spiders were starved for 3 days and then presented with different numbers of the tea leafhopper (5, 10, 20, 30, 40, 80) in 5 replicates, each spider was kept in an individual cage under the condition of 25 ± 1°C in temperature and 75 ± 5% in humidity. The number of the tea leafhoppers consumed by each spider was recorded 24h after the beginning of the experiment.

Response of the spider to itself density. Different density (1, 3, 5, 7) of the spiders was each kept in an individual cage and then presented with 20 the tea leafhoppers.

Influence of the temperature on predation efficiency by the spider. Under different temperature (10, 15, 20, 25, 30°C), thirty adult females of *T. squamata* were reared individually in the laboratory on 25 the tea leafhoppers.

RESULTS AND DISCUSSION

Response of T. squamata to prey. The results are summarized in Table 1 and in Fig. 1. When 5 adults of the leafhopper were given to the spider, all the prey were consumed by each spider. When the number of the tea leafhopper exceeded 40 or 50, the number consumed per spider also increased, but at every each condition the leafhoppers were invariably spared. The number of the leafhoppers consumed appeared to level off at highest densities of 80 and even more per spider.

The response curve of *T. squamata* to prey density (Fig. 1) is essentially similar to the sigmoid curve described by Yan (1991) for the response of the spider *Clubiona deletrix* O.P. Cambridge, 1885 to the density of *Drosophila*. Ans-shaped curve is characteristic of the reponses of various predators, which can be described by using Holling's disc equation: $Na = 0.5964N/(1 + 0.008356N)$

Table 1. Response of *T. squamata* to tea leafhopper *E. vitis*

Prey density	5	10	20	30	40	80
No. prey eaten by spider	3.3 ± 1.57	5.1 ± 0.67	9 ± 0.11	13.8 ± 1.08	19.2 ± 2.9	22.6 ± 3.1

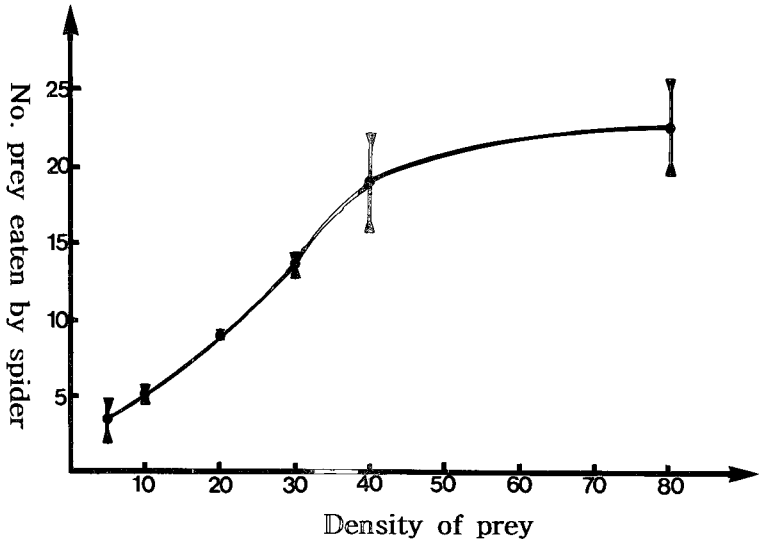

Fig. 1. Response of female adult spider (*T. squamata*) to prey *E. vitis* adult density.

Table 2. Response of the spider to itself density

Density of spiders	1	3	5	7
No. Number ofprey eaten by spider	9.2 ± 0.75	5.2 ± 0.10	2.7 ± 0.33	1.1 ± 0.251

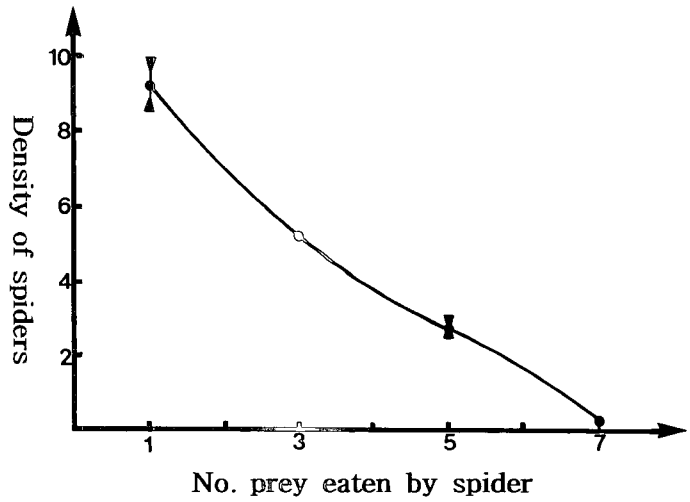

Fig. 2. Response of *T. squamata* adult to itself density.

(Holling, 1961; Huffaker *et al.* 1963).

As the density of its prey increases, the number of prey consumed by *T. squamata* increases markedly, but at a progressively reduced rate. The proportion of prey consumed declines gradually,

Table 3. Influence of mutual interference on predation rate of *T. squamata*

Density of spiders	1	3	5	7
No. Number of prey eaten	8.0 ± 0.3	16.4 ± 0.57	19.8 ± 0.45	24.8 ± 0.48
Predation rate	0.374	0.175	0.128	0.098

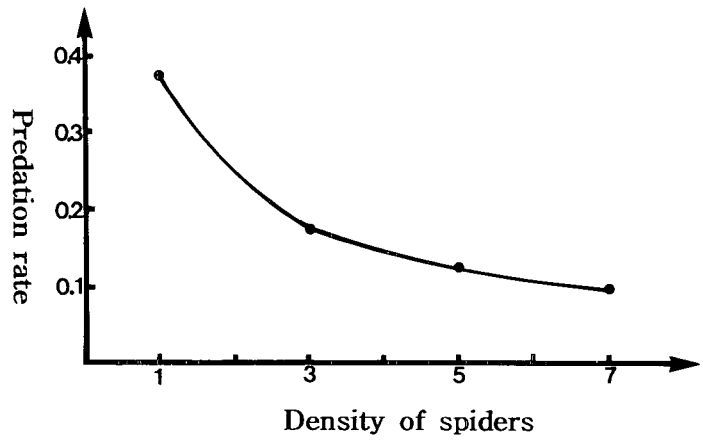

Fig. 3. Influence of mutual interference on predation rate of *T. squamata*.

Table 4. Influence of temperature on predation efficiency by *T. squamata*.

Temperature	10	15	20	25	30
No. of prey eaten	2.5 ± 0.5	6.5 ± 0.89	10.8 ± 0.74	12.0 ± 0.44	8.6 ± 1.07

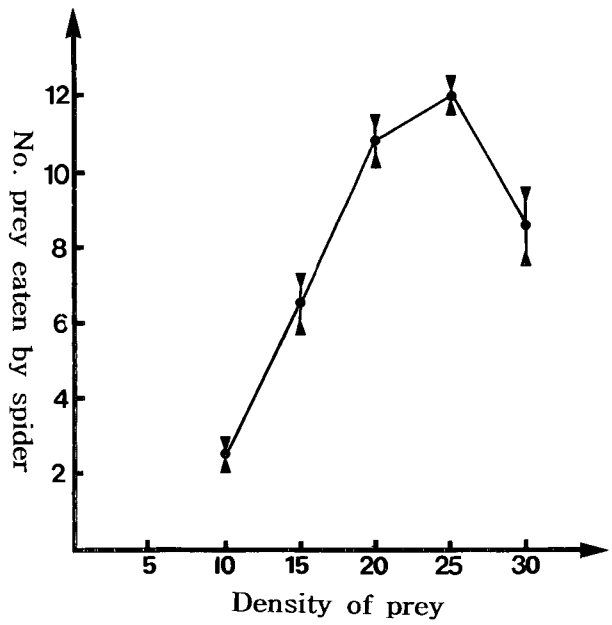

Fig. 4. Influence of temperature on predation efficiency by *T. squamata*.

as prey density increases.

Response of the spider to itself density. The experiment showed that the number of prey eaten by the spider appeared decrease while density of the spider increased(Table 2; Fig. 2). Mutual interference affected the predation efficiency of *T. squamata*. The response of the spiders to its density can be described by using Watt's equation: $A = 10.7948P^{-1.001}1$ and the predation rate is $E = 0.5986Q^{-0.6891}$(Q = a constant measuring the efficiency of utilization of prey for production by predators in Krebs, 1978, Table 3; Fig. 3).

Influence of temprature on predation efficiency by T. squamata. At 10°C, 15°C, 20°C, 25°C and 30°C, the results of laboratory observation of predation by *T. squamata* are summarized in Table 4 and in Fig. 4.

These experiments indicated that the optimum temperature for the predation efficiency is 25°C, and under 15°C and over 30°C it was decreased. The results can be described by the equation, $Na = -0.0425\ T\text{-}25^2 - 11.5674$.

The spider *T. squamata* plays an important role as a biological control agent of the tea leafhopper *E. vitis* on tea tree in China.

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Teragnatha squamata(거미 목: 갈거미 과)의 차말매미충, *Empoasca vitis* (곤충 강: 매미 목)에 대한 포식효과

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요 약

갈거미 속의 일종인 *Tetragnatha squamata*와 이의 피식자인 차말매미충, *Empoasca vitis* 사이의 포식 효율에 대하여 실험실 내에서 조사하였다. 피식자의 숫적 증가에 대하여 포식자 거미는 함수적인 반응을 보였다. 포식자가 포식자 자신의 숫적 증가와 포식 효율에 대하여서도 조사하였으며, 이 결과들은 공식으로 표시하였다.