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Short communication *Agronomy*

Functional response of *Xylocoris falvipes,* a biological control agent of the flour beetle *Tribolium castaneum*

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ABSTRACT
The warehouse pirate bug *Xylocoris flavipes* is an opportunist predator of many stored product insect pests. Its functional response in relationship with variable densities of prey appears as the Holling's type II model. The predator *X. flavipes*, collected within small holder granaries in Mayo Danay division in the far North province of Cameroon, feeds on *Tribolium castaneum* (Herbst) and could perform a good biological control of this pest.

Key words: predation, functional response, *Xylocoris flavipes, Tribolium castaneum*, biological control, stored products.

INTRODUCTION

The use of living organisms to halt the invasion of pests is since long period advised as clean and environmentally friendly crop protection method [1]. The biological control of pests is a crop protection strategy interfering in the interaction among populations in an agro ecosystem in the manner to enhance the development of the auxiliary populations and in the same time reducing that of noxious one [2]. These beneficial organisms are killing factors of pests that are able to adjust their population to that of their prey. In such case the availability of the prey might influence the fluctuation of the predator. The regulation of the prey population by the predator in such case is density dependant. Prey predator systems help to ensure a natural balance both within and between populations [3].

This pest control method preserves the biodiversity and promotes the quality of the environment and that of the life. In culture, many potential pests are kept in the very low level and could not express their depredation on crop because of a permanent control made by their natural enemy. In the case the problem is solved definitely, the use of chemical pesticide is avoided. It is widely known in northern Cameroon that chemical pesticides are the popular way to control pests in stored products [4]. These chemicals used to protect stored products accumulate on them and the consumers are exposed to their residues which have potential adverse impacts on their health and accumulate in several levels of trophic chains [5].

A predator could be considered as biological control agent only if it establishes its population permanently on that of its prey. To precise this relationship between the predator and its prey, it is necessary to define the functional response model that it develops in relationship with variable densities of the prey. The functional response is the simplest approach to appreciate the impact of the predator on its prey [6]. It is also the simplest way to analyse the interaction predator – prey [7]. The functional response allows the prediction of the potential control of the predator towards its prey. Even if its model could change depending to ecological conditions, the basic model observes while analysing the predation of *X. flavipes* in variable densities of *T. castaneum* could help to predict its possibilities to control this pest.

Biological control of stored grains insect pests is not a widespread method in tropical areas in spite of the important potentialities offered by the diversity of the entomofauna. Many natural enemies, predators and parasitoids occurred naturally in stored grains. Taking into account the situation that no chemical is at the moment authorised in Cameroon for the protection of flours during storage, stored flours are attacked by *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae). In peasant granaries of the northern Cameroon, the warehouse pirate bug *Xylocoris flavipes* (Hemiptera: Anthocoridae) is frequently observed. This predator kills and sucks the hemolymph of its prey [8]. Within flours, it attacks all larval stages of *T. castaneum*. The present work intends to explore the capability of this predator to adjust its population to that of its prey.

MATERIAL AND METHODS

Larvae and adults of *X. flavipes* were isolated from peasant granaries in Kaélé and Ngaoundéré in the northern Cameroon during the dry season, in January 2005. The locality is in the sahelian region with a very long dry season lasting for more than six months. This predator was reared on larvae of *T. castaneum* in laboratory conditions (temperature: 27±3°C and 60±5% of relative humidity. These preliminary observations leaded to the fact that the development of the bug is completed after 5 instars nymphs which can be separated using their body length, the length of their wings, the amount of articles on their piercing mouthpart. Nymphs and adults are all predators and the 3rd instar larva of *T. castaneum* was chosen as the experimental prey.

1. Determination of the functional response model

The relationship between the amount of prey available and the rate of consumption of one predator is called the functional response [9]. In terms of proportion of prey consumed, 3 models of functional response are described [5]. In the type I, the predator consumes constant proportion of preys without any relationship with their densities. The type II present predators with an optimal predatory capacity, when the density of preys augments above this maximal predatory capacity, the proportion of prey consumption decreases. Finally, the type III characterized predator with low hunting capacity in case of low densities of the prey

The feeding capacities of all the nymphal stages of *X. flavipes* were observed on different densities of the prey. A single larva was reared receiving a daily diet made of 1, 2, 3, 4, 5 or 6 preys. Every 24 hours the amount of preys killed was counted, then the daily predation and prey attack percentage calculated. The tested larvae were put in starvation 24 hours before the experimentation. In all cases the experiment was replicated 4 times.

2. Potential of *Xylocoris flavipes* to control the infestation of *Tribolium castaneum*

In each of a group of 4 falcon tubes 100 adults *T. castaneum* were put on 20 g of flour during 10 days. After this delay, all the adults were removed and the infested flours divided into 2 groups. The first group was inoculated with two adults *X. flavipes* and the second was not inoculated. After 30 days, in each group the predator and prey were removed and counted.

RESULTS AND DISCUSSION

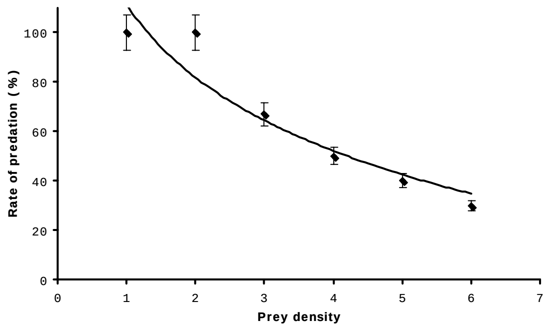
The amount of prey kill per day depended on their amount available. The percentage of prey attack by predator is maximal at low densities of prey. When the prey density increases, this attack reaches a stability which implies that the predator has a level of optimal predation capacity. In sufficient prey density, the daily predation is constant, therefore, the proportion of the prey killed decreased from the maximum to a level characterising the satiety of the predator. This rate is 30 % for the first instar nymph, 50 % for the second instar and the adult, 67 % for the third, fourth and fifth instars nymph (Figure 1). This reduction of the killing rate with the augmentation of the density of the prey allows to consider this functional response in the Holling's type II model [9]. Similar observations of this same predator on *Oryzaephilus surinamensis* (L.), *Plodia interpunctella* (Hübner) and *Rhyzopertha dominica* (F.) pointed out that the functional response was the type II [10].

This optimum killing was reached with 4, 5 or 6 preys available in the most voracious stages. The maximum amount of preys killed was 4 per day.

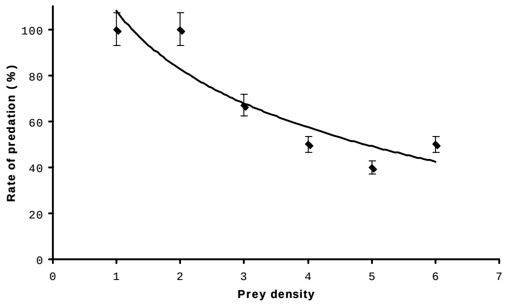
The inoculation of one pair of predator on infested flour leads to their beneficial effect in the control of the pest. Table 1 presents the amount of pest counted in any of the 2 groups observed. In the group where no inoculation was made, 189 pests were removed whereas in the group where inoculation of predator was made only 33 pests were counted. In the same time the pair of predator leads to 18 predators. The presence of predator participated to a better conservation of the flour during one month because of the reduction of the development of the pest.

Table 1: Impact of the presence of *Xylocoris flavipes* on the fluctuation of the population of *Tribolium castaneum*.

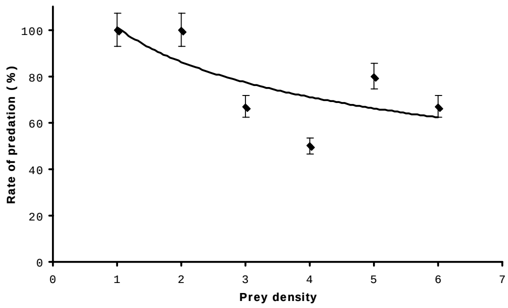
	Prey and predators		Prey alone
	Larvae and adults of *T. castaneum*	Nymphs and adults of *X. flavipes*	Larvae and adults of *T. castaneum*
Day 0	0	2	0
Day 30	33 ± 8.4	18 ± 11.9	189 ± 15.5



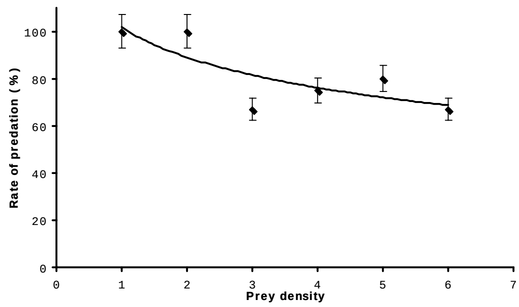
a) Nymph I



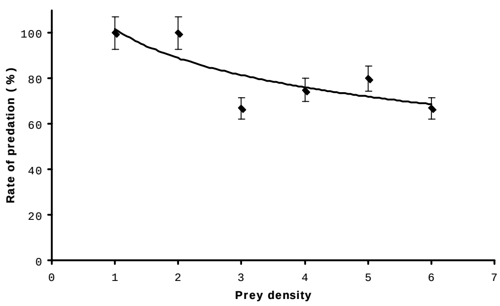
b) Nymph II



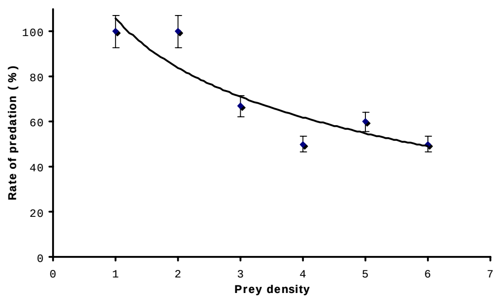
c) Nymph III



d) Nymph IV



e) Nymph V



f) Adult

Figure 1. Functional response in terms of prey consumption rate of all the predatory stages of *Xylocoris flavipes* preying upon the third instar larvae of *Tribolium castaneum*.

CONCLUSION

The predator *X. flavipes* previously pointed out as biological control agent of flour beetle is also in the northern Cameroon the main natural enemy of that pest in storage facilities. It is able to adjust its population in relationship with the density of its prey *T. castaneum*. The strategy used by this predator to link its population to the fluctuation of the prey available fits the Holling's type II model. These skills lead to a good control of its prey population. This predator is to be taken into crop protection strategies in stored products as a biological control agent of flour weevil. This could lead to the reduction in the use of chemicals in the protection of stored flour having as consequence improvement in the quality of food.

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