

STUDIES ON THE BEHAVIOUR OF THE LARVAE OF *Plutella xylostella* (LINNAEUS)
(LEPIDOPTERA: PLUTELLIDAE), A WORLD PEST OF CRUCIFEROUS CROPS.
NORMAL AND 'SPACING' BEHAVIOUR¹

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Resumen

Las larvas recién emergidas de Plutella xylostella (L.) construyen galerías de manera que nunca llegan a encontrarse unas con otras, reduciendo la probabilidad de competencia por alimento, espacio y riesgo de ser encontrados por enemigos naturales. Los experimentos realizados se llevaron a cabo bajo condiciones controladas a $20 \pm 1^\circ\text{C}$, 16 h luz/día y a una humedad relativa entre 44-52%, en cajas plásticas transparentes de forma circular. En cada caja se colocó discos (2.5 cm diámetro) de hojas de repollo en forma vertical, sobre una capa de arena silverada que sirvió de sostén.

El movimiento de las larvas se observó desde que emergieron hasta que finalizaron la construcción del capullo, considerándose tanto el movimiento de larvas emergiendo de huevos separados o en grupos. Las observaciones del primer instar se realizaron desde la eclosión hasta el primer lugar de alimentación y después del primer sitio de abastecimiento.

Cada larva se arrastra y realiza movimientos "sensitivos" con su cabeza por varios minutos hasta que se ve estimulada por otras larvas inicia su autoalimentación. Las larvas provenientes de huevos individuales tienden a padecer de hambre pero carecen de estímulo de otras larvas. Después de la primera muda las larvas se alimentan sobre la hoja y no en galerías, separándose unas de otras al detectar cambios en la calidad del sustrato, colgándose de los hilos de seda que producen, por movimientos compulsivos fuertes, etc. Su distribución induce a una dispersión de áreas sobrepobladas, evitando así una sobre explotación del alimento disponible. En casos de baja densidad de población, la búsqueda de las larvas aumenta la probabilidad de encuentros entre larvas, con el consecuente estímulo para alimentarse.

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Introduction

P*lutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae) is a very common pest of cruciferous crops, with a wide distribution around the world. Although *P. xylostella* lays many eggs on a leaf either singly or in groups, the larvae rarely form aggregations as happens with some other pests of crucifers (i.e. *Pieris aripa* Boisduval, *Pieris brassicae* (L.), *Mamestra brassicae* (L.)). In normal field conditions, even at high densities, the larvae, especially the last

Studies on the Ecology and Behaviour of *P. xylostella* L. Cannibalism Induced by Starvation¹

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ABSTRACT

Experiments were designed in order to observe and record the behavior of the larvae of the diamondback moth, *Plutella xylostella* L. (Lepidoptera: Plutellidae) under starvation by depriving them of food, after being previously well-fed. When the larvae of the diamondback moth are subjected to starvation, some physiological and behavioral changes occur. The changes in behavior may be drastic. The larvae become aggressive and irritable, disturbed by any nearby movement. The individual larva normally reacts to the disturbance by moving away and, if another touches it, both larvae crawl away in different directions. In some extreme cases of starvation, the larvae may acquire cannibalistic tendencies; if a weakened larva is found by a stronger one, the normal biting associated with their encounter encourages the stronger larvae to feed on the weak one. Despite the vigorous movement of the attacked larva, the aggressor continues to bite. The attacked larva does not cease to struggle in an unsuccessful effort to escape from the continuous biting of the aggressor larva, and every time the attacked larva struggled, the aggressor became more aggressive and made very rapid attacks in the form of a series of bites all over the abdomen, biting any part of the abdomen that it grasped. Next morning, there was nothing left of the attacked larva, not even the head capsule. This cannibalistic behavior has apparently not been reported before in the diamondback moth, and is very rare in Lepidoptera.

INTRODUCTION

The diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) is an important pest of cruciferous crops throughout the world, as shown by Salinas (1, 3, 4). Many papers have been published on the chemical and biological control of this pest, but very few on its ecology and behavior.

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RESUMEN

Se diseñaron experimentos para observar y registrar el comportamiento de las larvas de la polilla del repollo, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) bajo inanición, después de haber sido bien alimentadas. Cuando las larvas de la polilla del repollo son sometidas a inanición, les ocurren algunos cambios fisiológicos y de comportamiento. Los cambios de comportamiento pueden ser drásticos. Las larvas se vuelven agresivas e irritables, perturbándose por cualquier movimiento cercano. La larva individual reacciona normalmente a la perturbación moviéndose y alejándose, y si otra larva la toca, ambas se alejan en diferentes direcciones. En algunos casos extremos de inanición, las larvas adquirirían tendencias canibalísticas; y si una larva debilitada se encuentra con otra más fuerte, el comportamiento cambia y la más fuerte se alimenta de la débil. En el experimento, a pesar de los movimientos fuertes de la larva "atacada", la "agresora" continuó mordiéndola. La "atacada" no dejó de forcejear en un esfuerzo inútil por escapar de las mordeduras continuas de la "agresora", y cada vez que la otra forcejeaba la "agresora" se mostraba más agresiva y atacaba muy rápido con una serie de mordeduras en cualquier parte del abdomen. Al día siguiente no quedaron restos de la larva "atacada", ni siquiera la cápsula craneal.

MATERIALS AND METHODS

Experiments were designed in order to observe and record the behavior of the larvae under starvation by depriving them of food after they had previously been well fed.

The experiments were carried out in controlled environment rooms at 20 ± 1 °C, 16 h of light per day and 44% - 52% relative humidity. The cages, the leaf discs and the set-up of the experiments were similar to those previously described (2, 5).

RESULTS

When the larvae of the diamondback moth are subjected to starvation, some physiological and behavioral changes occur. The changes in physiology will not be discussed. Behavioral changes may be drastic.

The larvae become aggressive and irritable, being disturbed by the slightest nearby movement. The individual larva normally reacts to the disturbance by moving away and, if another touches it, both larvae crawl away in different directions. When the contact is strong, they perform rapid twitching movements of the thorax and/or abdomen. In some cases, the twitching movements are made so rapidly that the larva is displaced from its initial location. In extreme cases of starvation, the larvae may acquire cannibalistic tendencies; if a weakened larva is found by a stronger one, the normal biting associated with their encounter changes into the stronger larvae feeding on the weak one. Such cannibalistic behavior has apparently not been reported before, and description of it follows:

A third-instar larva from a group of starved larvae was moulting into a fourth-instar on the cage wall. Probably due to starvation conditions, the cuticle of the last abdominal segment did not separate from the newly moulted larva, sticking it to the exuvia which in turn adhered to the cage wall. As the larva struggled to get free, another fourth-instar larva arrived and started to bite the penultimate abdominal segment of the stuck larva. Despite the very strong movement of the attacked larva, the aggressor continued to bite until it made a hole on the dorsal part of the abdominal segment, through which the haemolymph began to flow out.

The attacked larva did not cease to struggle in its unsuccessful effort to escape the continuous biting of the aggressor, which was feeding on the released fluid (Fig. 1). After the haemolymph, a semi-liquid green material, probably part of the gut contents, emerged. The process had now taken 30 minutes. The aggressor larva stopped for one minute, and then moved to the frontal part of the attacked larva, where it started to bite the thorax and abdomen. At this stage, the following change of behavior was observed in the aggressor: every time the attacked larva struggled, the aggressor became more aggressive, making very rapid attacks in the form of a series of bites all over the abdomen; by this time, 45 minutes had passed.

Once the aggressor had eaten most of the flowing green material from the body of the attacked larva, it started to eat the right pleura of the fourth-abdominal segment. The attacked larva ceased struggling, only moving the anterior part of the body. The aggressor



Fig. 1. Cannibalism induced by starvation in *Plutella xylostella*.

then feed on the thorax. One hour after the attack started, the aggressor was eating the thorax and trying unsuccessfully to bite the head capsule of the prey. Then the aggressor moved again to the abdomen and made a hole on the ventral side of the last abdominal segment. It continued eating for 30 minutes more, then stopped. The attacked larva, now almost empty of body contents, was motionless. Five minutes later the aggressor started to eat again at the last abdominal segment of the attacked larva, and in about five minutes it ate all the cuticle of that segment, including the prolegs. Then, 105 minutes from the beginning of the attack, the aggressor started to eat and rest, during alternating periods of 3 to 5 minutes. Next morning (it was not observed during the night) the attacked larva was totally eaten, including the head capsule.

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