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# Effects of founder population size on the performance of *Orius laevigatus* (Hemiptera: Anthocoridae) colonies

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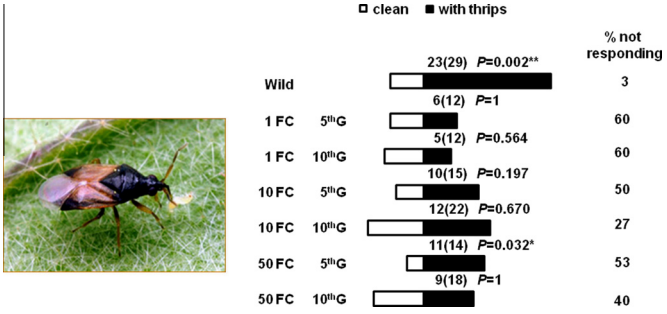
## HIGHLIGHTS

- Colonies founded by 1 founder couple perform poorly after few generations.
- *Orius laevigatus* on factitious host results in a lack of reaction to infested plants.
- 50 and even 10 founder couples can be used to start viable laboratory colonies.

## GRAPHICAL ABSTRACT

Olfactometer results: number of Orius laevigatus females walking to clean plants (left) and thrips infested plants (right) in a y-tube olfactometer; 1, 10 and 50 FC=1, 10, 50 Founder Couples; 5th and 10th Generation in captivity.

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## ABSTRACT

*Orius laevigatus* (Hemiptera: Anthocoridae) is a key predator of thrips and is mass reared in large numbers for use in biological control. The aim of this study was to evaluate the effect of founder population size on the biological and behavioral performance of *O. laevigatus* over time. Laboratory lines were started from 1, 10 and 50 founder couples from 750 adults collected in the field and their performance was evaluated at the 5th–6th and 10th–11th generations. Adaptation to the captive rearing situation occurred in the 10 and 50 founder couples lines while it failed in the 1 founder couple line. The intrinsic rate of natural increase ($r_m$) increased and the period for doubling the population ($D$) decreased over the generations in the 10 and 50 founder couples lines, while ($r_m$) decreased and ($D$) increase in the 1 founder couple line. Also, consumption of *Frankliniella occidentalis* prey was significantly lower for females from the 1 founder couple line at the 5th generation compared to females from the 10 and 50 founder couples lines. Females of laboratory lines of all founder couples did not respond to odours from thrips infested plants during the 5th and 10th generations, whereas wild females strongly reacted to these odours. We suggest that the lack of reaction to infested plant volatiles may be due to the artificial rearing method where mass reared predators do not experience an infested crop. The results showed that the 1 founder couple line differed from the 10 and 50 founder couples lines, suggesting that bottlenecking had an effect at that level. However, no difference was found between the 10 and 50 founder couples lines which suggest that these

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founder numbers can be used to start laboratory-reared *O. laevigatus* lines without a significant loss in quality of its relevant biological characteristics.



## 1. Introduction

Generalist arthropod predators are important in the regulation of pest populations, both in natural and agricultural ecosystems (Moreno et al., 2010; Bueno and van Lenteren, 2012). In protected cultivation, with high cash value crops, various species of generalist predators are successfully used for biological control of key pests (van Lenteren, 2012). Predators from the genus *Orius* (Hemiptera: Anthocoridae) are among the most commonly released species to control thrips, and are mass produced in very high numbers by various companies in many countries (Cock et al., 2010; van Lenteren, 2012). In Europe, the Palaearctic species *Orius laevigatus* (Fieber) has been widely investigated and has been commercially available for greenhouse crops since 1993 (van Lenteren, 2012). This predator is usually reared on *Ephestia kuehniella* (Zeller) (Lepidoptera: Pyralidae) eggs as a prey food source and bean pods as an oviposition substrate (Castañé and Zalom, 1994; Carvalho et al., 2011).

An approach to maintain populations of good quality during mass-rearing is to avoid the detrimental effects of inbreeding as much as possible during the first generations of a new captive population. When inbreeding may be extreme, loss of fitness is observed, such as reduction in size, fertility, or vigor (Manson et al., 1987). Inbreeding problems depend on species characteristics, but are strongly influenced by the genetic heterogeneity of the founder population. This heterogeneity largely depends on the number of founder individuals in the colony. In some species of natural enemies, large numbers of individuals can be easily collected in the field and used to start founder colonies with hundreds of individuals. Whereas, in other species, is very difficult either to collect large numbers in the field, or maintain large populations in the laboratory due to rearing difficulties. One way to measure the quality of laboratory reared predators is to evaluate their dispersal and prey-catching abilities (Nunney, 2003). In the early stages of prey finding predators often use odours associated with prey presence (prey pheromones, faeces, honeydew, etc.) or predators can use volatiles produced by plants in response to herbivore damage (Herbivore-Induced Plant Volatiles, HIPV) (Sabelis et al., 1999).

The aim of this study was to test the effect of the initial number of founder individuals on life-history characteristics, predation rate and reaction to odours produced by infected host plants by laboratory-reared *O. laevigatus* lines over a number of generations.

## 2. Materials and methods

Colonies or lines were maintained and tests performed under controlled conditions at 25 ± 1 °C, 70 ± 10% RH and 16:8 light:dark photoperiod.

### 2.1. Predator rearing

The laboratory colonies of *O. laevigatus* were started by collecting 750 adults from non-cultivated vegetation at several localities along 100 km of the coastal area of Barcelona (Spain). Insects were identified to species level using a stereomicroscope according to Riudavets (1995) and maintained in 2 l ventilated glass jars with eggs of *E. kuehniella* as prey food source, green bean pods as oviposition substrate and corrugated paper towel to provide hiding places and reduce cannibalism. Bean pods containing the first generation of predatory bug eggs from the field collected adults were taken from the jars with the adults and placed in new jars with fresh bean pods and *E. kuehniella* eggs which were replaced three times a week (Carvalho et al., 2011). Founder populations of 1, 10 and 50 *O. laevigatus* couples were formed by using the adults of the first laboratory generation; these will subsequently be referred to as the 1 FC, 10 FC and 50 FC lines, respectively. Five replicates were established for each founder population size. Each subsequent generation was initialized from 100 randomly selected adults (50 ♀♀ and 50 ♂♂) from the lines, keeping lines and replicates separated. Each line had an average of 400 adults, and the random selection was done when the whole cohort reached the adults stage and selected individuals were from mixed ages. This methodology was adapted from De Clercq et al. (1998) and viewed to stimulate inbreeding among individuals. Thus, the same approach was used for adults sampling from all formed and subsequent generations.

### 2.2. Immature development, adult life span and reproduction

Fifty eggs from each founding line and replicate were monitored daily to determine their viability and egg developmental period. To determine survival and developmental period of the nymphs, fifty newly hatched nymphs per replicate were isolated in small ventilated plastic cages (7 cm diameter × 3 cm high) with *E. kuehniella* eggs as prey, and a piece of bean pod to provide moisture. Prey were added three times a week and the bean pod was changed twice a week. Survival of the nymphs was scored daily until adult emergence, and the sex ratio of emerged adults was recorded. The average weight of females was determined by placing five newly moulted individuals inside one transparent gelatine capsule and weighed using a precision scale (0.0001 g). The weight of the gelatine capsule was subtracted from the total weight and the remainder divided by five. Twenty-five females per colony and generation were weighed. The length of the hind tibia of males and females was measured at 40× magnification. Twenty individuals were measured per line and generation. The weight of wild females ($n = 25$) and the hind tibia length of wild females and males ($n = 20$) were measured in newly moulted individuals of the first generation.

Newly emerged females and males of each replicate were allowed to mate in 2 l glass jars with *E. kuehniella* eggs and a bean pod. After four days, females were isolated in small ventilated plastic cages (7 cm diameter × 3 cm high) with a piece of bean pod and *E. kuehniella* eggs. Prey were added three times a week and the piece of bean pod was replaced twice a week. The number of eggs laid per female over a 7 days period and the longevity of females were determined. Between 7 and 23 females per replicate and treatment were used, depending on availability. Due to the limited and decreasing number of individuals produced by the 1FC line, some parameters (female weight, and female and male hind tibia length) were determined for the field population (wild), the 5th and 10th generations, and other parameters (egg and nymphal developmental time and survivorship, sex ratio, female fecundity and longevity) for the 2nd, 6th and 11th generations.

### 2.3. Response to plant volatiles

To test whether predators of the different lines of founder couples were able to find plants infested with prey, experiments were carried out using a Y-tube olfactometer. Females were offered a