

METHODS FOR DETERMINING MIGRATORY ACTIVITY AND FINDING ABILITY OF *Perillus bioculatus*

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Summary. The analysis of the regularities of larval migration activity of different age groups and the finding ability of *Perillus bioculatus* imago using specially constructed devices. It was found that with age and size, the speed of insect movement increases. The general seeking ability and its level by chemotaxis were determined. It is shown that the specific seeking ability proved to be more effective; its level, compared to the general value of this indicator, was 10 % higher and accounted for 26 % per day.

Keywords: predatory bug, *Perillus*, colorado potato beetle, potato farming, migration activity, search ability, chemotaxis.

Introduction

The annual loss of potato yields due to damage by one of the most dangerous pests of Solanaceae, the Colorado potato beetle (*Leptinotarsa decemlineata* Say, 1824), can range from 25 to 50%. First of all, its harmfulness is increased due to the high resistance to the use of insecticides of chemical origin of any class [1, 2, 3, 4]. This resistance was first discovered in the beetle in 1952 against DDT [1].

Huge amounts of money are spent every year to protect potatoes from this pest. In addition, the use of a large number of chemical pesticides increases the chemical pollution in the ecosystem and, as a result, can have a toxic effect on the human body [5, 6]. Therefore, research related to the use of environmentally friendly biological methods of protecting potatoes from the Colorado potato beetle, especially in farms working on organic farming principles, is relevant both in theory and practice.

One of the most effective means of biological control of the Colorado potato beetle population is the use of entomophages - its natural enemies. In particular, one of the most promising natural entomophages is the predatory bug from the family Pentatomidae (scale insects) (*Perillus bioculatus* Fabr., 1775). This predator is oligophagous and can prey on larvae from several species of insects, but prefers the *Colorado potato beetle* in its diet [7]. Practical use of *P. bioculatus* in most areas of the current range of the *Colorado potato beetle* is possible through mass releases of the entomophage at the beginning of the egg-laying period. For the widespread use of mass production of perilla, it is necessary to develop an industrial technology for its mass breeding. Currently, this species has become acclimatised in southern Ukraine, which provides great opportunities for creating conditions for its reproduction in natural conditions of horizontal and vertical introduction of the predator, and therefore the development of its breeding technology is very important.

The successful introduction of *P. bioculatus* into agroecosystems, especially in greenhouses, requires the use of adult insects with high biological parameters, one of the most important being their migratory activity and seeking ability. These indicators are closely related to the predatory qualities of insects at the adult stage, and therefore are of significant importance in the selection of biomaterial for use in agroecosystems. That is why the purpose of the presented research was to develop methods for studying the migration activity and search ability of *P. bioculatus*.

Materials and methods

An unoptimised population of the bug *P. bioculatus* was used as a study material. To study the migratory activity and search ability of insects, special devices developed at the Engineering and Technological Institute "Biotekhnika" of the National Academy of Sciences of Ukraine were used.

Results and discussions

The migration activity of *P. bioculatus* was determined using the developed experimental field (Fig. 1), which is a sheet of white paper 1200 mm × 1200 mm in size with seven concentric circles drawn in pencil. The sheet is attached to a carton board to provide a flat surface with a radius of 10 mm (1 circle) to 610 mm (seventh circle). To determine the direction of movement, the device is divided into 4 sectors – A, Б, B, Г. The presence of the rings allows us to determine the distance from the release point that the larva travels over a certain period of time.

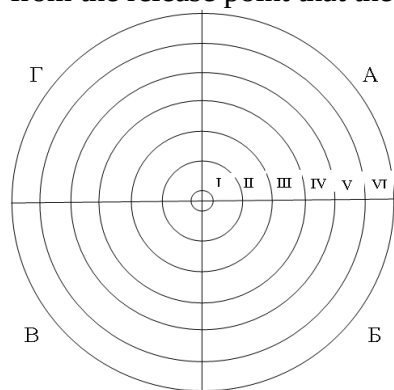


Figure 1. Experimental field for determining the migration activity of *P. bioculatus* larvae

The experiments used the “black box” method, i.e., the location of insects was determined after a certain period of time, despite the change in the direction of their movement during this period.

The migration activity of second and third instar larvae was determined. For this purpose, 10 larvae of the same age and taken from the same cage were placed in the central circle and after 30 seconds the number of larvae at different distances from the place of their release was counted. It was determined that the south-north direction does not significantly affect the movement of larvae. As a result of the experiment, it was noted that with increasing age and size, the speed of movement of insects increases. Thus, 35 % of the larvae of the third age group covered a distance of more than 500 mm in 30 seconds (Fig. 2). 60% of the larvae of the 2nd age group covered a distance of more than 300 mm during this period (Fig. 3).

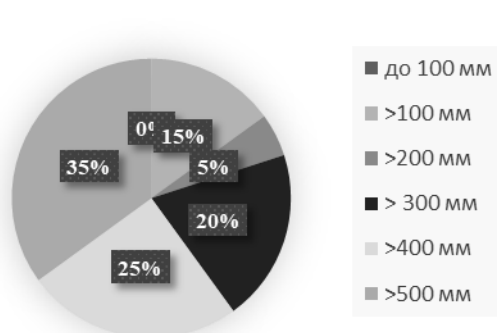


Figure 2. Migration activity of larvae *P. bioculatus* age 3

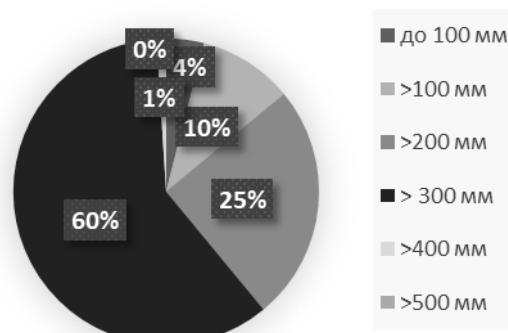


Figure 3. Migration activity of larvae *P. bioculatus* age 2

The predator's seeking ability is based primarily on the phenomenon of chemotaxis. There is evidence that a bug can not visually identify a victim at a distance of more than 5 cm. In looking for prey, it reacts to chemicals released by plants damaged by the larvae of the Colorado potato beetle [8].

To determine the search activity of imago, a special device was created, which is a 500 ml rounded transparent plastic container with six transparent flexible tubes with an inner diameter of 8 mm, which open at opposite ends into 260 ml receiver containers with different types of feed for the phytophagous: 1) control - without feed, 2) larvae of the *Colorado potato beetle* with potato leaves,

3) larvae of the *Colorado potato beetle*, 4) *Colorado potato beetle* imago with potato leaves, 5) imago of the *Colorado potato beetle*, 6) flour moth (*Ephestia kuehniella*) larvae (Fig.4, 5).

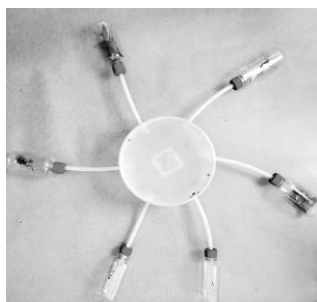


Figure 4. Equipment for determining the search ability of adults *P. bioculatus*

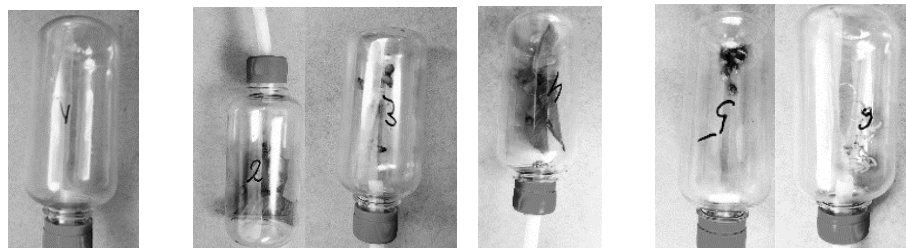


Figure 5. Receiving tanks with different types of feed

Thirty imago *P. bioculatus* were placed in a distillation tank. After a day, the number of bugs that got into the receiving containers was counted. In this experiment, 21 and 27% of predators were found in containers with imago and larvae of the Colorado potato beetle with the addition of potatoes, respectively. In the containers with pests without potatoes and in the control variant, the indicators did not differ significantly - 10 and 12 % (Fig. 6).

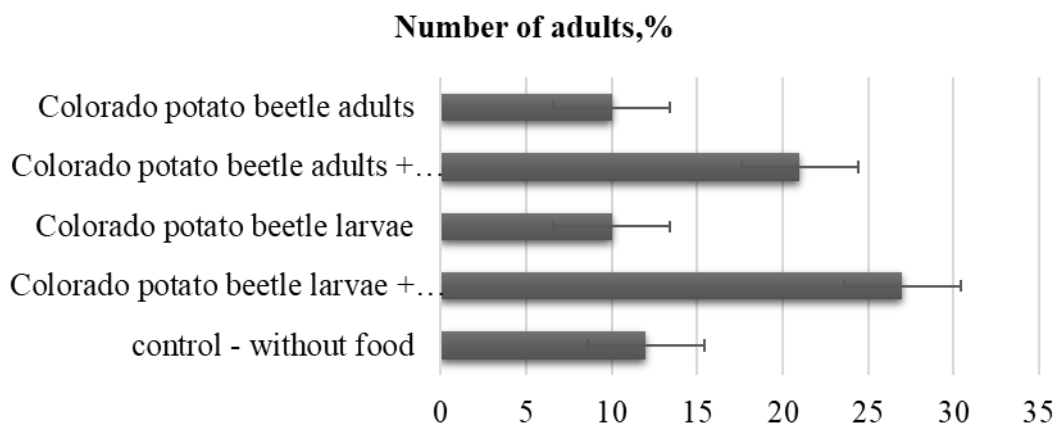


Figure 6. Study of the search ability of adults *Perillus bioculatus*

As a result of the experiment, the general and specific (by chemotaxis to potato leaves damaged by a pest) seeking ability of the non-optimised population was established, which in the first case was about 16 % per day, and in the second case was significantly higher and reached 26 % per day.

Conclusions

Using the devices created by the Research Department of Industrial Entomology of ITI 'Biotechnics', the peculiarities of the search ability of imago and the migratory activity of larvae in different age groups of *Perillus bioculatus* were investigated. The experiments revealed a direct correlation between the growth of larval weight and age and their movement speed. Thus, during the same period of time (30 seconds), the majority of larvae of the 3rd generation (35 %) covered a distance of more than 500 mm, while in the second age group, the vast majority of individuals (60 %) were able to cover a distance of only 300 mm. The study of the seeking ability of the predator showed that the phenomenon of chemotaxis (specific seeking ability) plays a significant role in increasing the efficiency of this indicator - in seeking prey, it reacts to chemicals released by plants damaged by the larvae of the Colorado potato beetle. In the studies presented here, specific seeking ability significantly outperformed general seeking ability by a difference of 10%.

Using the devices created by the Research Department of Industrial Entomology of ITI 'Biotechnics', the peculiarities of the search ability of imago and the migratory activity of larvae in different age groups of *Perillus bioculatus* were investigated.

References

1. Almady S., Khelifi M., Beaudoin M.P. Control of the Colorado Potato Beetle, *Leptinotarsa decemlineata* (Say), Using Predator Insects Released by a Mechanical Prototype. Journal of Environmental Science and Engineering. Volume 1, Number 11, November 2012. PP 1279 – 1287.
2. Rinkevich F. D., Cathy Su., Lazo T. A., Hawthorne D.J., Tingey W.M., Naimov S., Scott J.G. Multiple evolutionary origins of knockdown resistance (kdr) in pyrethroid-resistant Colorado potato beetle, *Leptinotarsa decemlineata*. Pesticide Biochemistry and Physiology. 2012. 104. P.192–200.
3. Wegorek P. Insecticide resistance management strategy for Colorado potato beetle (*Leptinotarsa decemlineata* Say) in Poland. *Resistant Pest Management Newsletter*. 2002. 11(2). P. 22–30.
4. Alyokhin A., Dively G., Patterson M., Castaldo C., Rogers D., Mahoney M., Wollam J. Resistance and cross-resistance to imidacloprid and thiamethoxam in the Colorado potato beetle *Leptinotarsa decemlineata*. *Pest Manag Sci*. 2007, 63(1) P. 32–41.
5. Coudron T. A., Kim Y. Life History and Cost Analysis for Continuous Rearing of *Perillus bioculatus* (Heteroptera: Pentatomidae) on aophtogenous Artificial Diet. *Journal of Economic Entomology*. 2004 Vol. 97, No. 3. P. 807-812.
6. Adams T.S., Filipi P.A., Shu-Xia Yi. Effect of age, diet, diapause and juvenile hormone on oogenesis and the amount of vitellogenin and vitellin in the twospotted stink bug, *Perillus bioculatus* (Heteroptera: pentatomidae) *Journal of Insect Physiology*. 2002. 48. P. 477–486
7. Babenko A.S., Shternshis M.V., Andreeva I.V., Tomilova O.G., Korobov V.A. Entomophage in plant protection. Novosibirsk. 2001. 205 p. (in Russian)
8. Van Loon J.J.A, De Vos E.W., Dicke M. Orientation behaviour of the predatory hemipteran *Perillus bioculatus* to plant and prey odours. *Entomologia Experimentalis et Applicata*. 2000.96. P. 51–58.