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The Oriental Fruit Moth (*Grapholitha Molesta* Busck.) and its Natural Enemies in the Absheron Peninsula

Abstract

Garden plants, trees and bushes suffer damages caused by lots of pests by 30-50 % every year, and sometimes by 80-90 % during the period when they grow massively. For this purpose, scientific bases for the use of perspective entomophages in the biological fight against harsh pests by studying the species composition, bioecological features of 6 species of insects, which damage garden and forest plants, and entomophages (parasites and predators), which regulate their number, have been developed in Azerbaijan. The research paper established that the oriental fruit moth infests fruit crops by 50-60 %. It was found that 22 types of parasites play a role in the regulation of abundance. Among them, macrocentrus infests oriental fruit moth larva up to 80 %, scambus up to 60 %, apanteles up to 40-50 %. The scoliidae parasite is of economic importance and can be used for biological control against the oriental fruit moth. Considering the prospects of some parasites, the bioecological features on the Absheron Peninsula have been studied.

Keywords: *pest, biology, ecology, fruit, imago, egg, larva, offspring, butterfly*

Introduction

In the economy of the Republic of Azerbaijan, fruit cultivation holds a significant place. To meet the population's demand for fruit, establishing new orchards and creating farming enterprises in this sector have become key issues based on government directives. In this context, identifying pest insects that damage fruit plants and implementing effective control measures are crucial tasks to ensure high fruit yields.

In Azerbaijan, more than 300 insect species damage fruit trees. Among them, the Oriental fruit moth is one of the most serious pests. This pest affects most stone and pome fruit plants, causing significant harm to peaches, pears, and plums, which results in a considerable decrease in fruit yields. It is widespread in the Nakhchivan Autonomous Republic, the Guba-Khachmaz region, and the Sheki-Zagatala region. Recent studies have also reported severe damage in orchards in the Absheron region, where the pest was introduced from Ordubad, affecting peach, apricot, and particularly quince varieties.

Research

The adult oriental fruit moth, or its butterfly form, has a wingspan of 12-14 mm and is brownish-gray in color. Its forewings have seven pairs of white spots shaped like claws along the leading edge and seven pairs of black spots along the trailing edge. The hindwings are brownish-gray with a bronze sheen and covered with fringed edges. Its antennae are threadlike with thin, noticeable rings. The underside of the abdomen is white, while the top is gray-brown. The eggs are oval, measuring 0.4-0.5 mm in length and 0.15 mm in width. They are initially white and turn pinkish-orange after 2-3 days. The caterpillars are whitish-milk colored in the first instar and pinkish-whitish in the 4^{th}-5^{th} instar, reaching a length of 11 mm. The pupa is oval, brown, and measures 6-8 mm in length.

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The Oriental fruit moth overwinters in the 4th or 5th instar larval stage inside a silk cocoon, located beneath the bark of tree trunks at a height of 30-40 cm above the ground. Additionally, it has been observed overwintering in fallen leaves and inside quince fruits. According to studies, larvae that have overwintered inside the cocoons transition to the pupal stage by the end of March or early April. The pupal development takes 10-12 days. Butterflies begin emerging from the pupae in the second half of April, with the flight period extending until the end of May. Newly emerged butterflies start mating on the same day they emerge. They lay eggs 14-18 hours after mating. The eggs are laid singly on the upper and lower surfaces of leaves, on shoots, and on fruit stalks. A single female butterfly can lay between 50 and 250 eggs. After 8-10 days, small larvae emerge from the eggs. They enter the young shoots of trees, where they feed for 10-25 days, reaching the 4th or 5th instar before pupating. New butterflies emerge from the pupae after 25-30 days. The development of one generation of the Oriental fruit moth takes 30-45 days. Depending on climatic conditions, the pest can produce 6-7 generations per year. According to literature, in Azerbaijan (Beybutov, 1965; Mammadov & Mamedov, 2004), particularly in the Absheron, Guba-Khachmaz, and Sheki-Zagatala regions, the pest produces 4 generations per year.

Based on calculations, the larvae of the Oriental fruit moth cause damage to quince and apricot buds ranging from 45-50 %, to early-ripening peach varieties 28-36 %, to late-ripening peach varieties 50-60 %, and to quince fruit 80-90 %.

Result. Based on multi-year research conducted in Absheron (2015-2017), it has been determined that 22 species of parasitoid wasps from the order Hymenoptera are involved in the biological control of the Oriental fruit moth. These include: Ixneumonidae – *Glypta rufoscutellata* Cress., *Pristomerus eurypthychiae* Grav., *Liotryphon punctulatus* Ratz., *Netelia fuscicornis* Holmgr., *Scambus calobata* Grav.; Braconide – *Macrocentrus ancylivorus* Roh., *Macrocentrus delicatulus* Cress, *Macrocentrus* Instabilis Mucs., *Macrocentrus collaris* Spin., *Bracon hebetor* Say., *Bracon Intercessor* Nees., *Orgilus laevigator* Nees., *Microdus rufipes* Nees., *Ascoqaster quadridentata* Wesm.; Chalcidoidae – *Brachymeria intermedia* Nees.; Tetrastichidae – *Tetrastichus* sp.; Trichoqrammatidae – *Trichoqramma minitum* Ril, *Trichoqramma Palluta* Meger., *Trichoqramma Cacoecia* March.; Larvaevoridae – *Arrhinomiya innoxia* Mg.; *Tachina praeceps* Mg.

1. *Macrocentrus ancylivorus* Roh. Parasites play a crucial role in regulating the population of the Oriental fruit moth. According to literature (Moiseyeva & Polyakova, 1970; Mammadov, 2004), this species was introduced from Canada and the USA to Russia between 1965 and 1967 and has been used in biological control against the Oriental fruit moth. In Azerbaijan, it was collected from the larval stage of the Oriental fruit moth, a significant pest of peaches and quinces, in the Ordubad and Guba regions (Mamedov, 2004).

The first generation of the *Macrocentrus* parasite infects 45-50 % of the host's larval stage in spring and 80-90 % of the 2nd and 3rd instar larvae during the summer months. Species belonging to the *Macrocentrus* genus are considered direct parasites of insects, butterflies, and flies (Mammadov, 2004).

The body of the parasite is yellowish-brown and measures 11-12 mm in length. Its antennae are longer than its body. The eggs are spindle-shaped and about 1 mm long. During development, the egg undergoes division, forming several embryos, but only one larva will develop. The larva is segmented, with a distinct head and thorax. It is light brown in color and 4-5 mm long. The parasite develops inside the host larva's body. Before completing its internal feeding, the larva moves to the upper part of the host's body and continues feeding until the host is entirely destroyed, leaving only the head capsule. After feeding is complete, the larva constructs a brown cocoon within which it pupates (Meyer, 1933-1936). The transparent cocoon allows the pupa to be clearly visible. After 5-6 days, holes are made in the front part of the cocoon, and the parasite emerges into the environment. The flight period from the pupae lasts 10-12 days. Parasites begin mating on the day they emerge from the pupae and lay eggs the following day. The eggs are placed inside the host larva's body.

In the larval stage, *Macrocentrus* overwinters inside the body of the Oriental fruit moth larvae. In early March, when the overwintering larvae emerge, the parasite's second instar larvae are

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observed inside the host larvae's body (under a microscope). The overwintering larvae of the parasite develop inside the host's body until mature individuals are formed, which coincides with the development stage of the Oriental fruit moth's first generation larvae.

Considering the high effectiveness of the *Macrocentrus* in controlling the Oriental fruit moth, it has been bred in laboratories in the USA and Canada and released into orchards (Shapiro, 1960). This has resulted in a significant reduction in the Oriental fruit moth population, with fruit infestation decreasing by 60-80 %. In our country, efforts are underway to investigate methods for mass-rearing *Macrocentrus* and its parasitoid under laboratory conditions to expand its use in controlling the pest.

2. *Scambus pomorum* Ratz. The parasite is widely distributed in Azerbaijan and is considered the primary parasitoid of the Oriental fruit moth. It was first recorded by Z. M. Mammadov (2004) in the Nakhchivan Autonomous Republic as a parasite of the apple blossom weevil. Research conducted in the Greater Caucasus region has shown that the parasite lays eggs singly on the third instar larvae of the host, with one egg per larva. After 3-4 days, larvae emerge from these eggs (Rubtsov, 1948). The parasite larvae feed on the host's body for 5-6 days before pupating. The pupal stage lasts 10-12 days, resulting in a total development time of 20-25 days.

In the imago stage, the parasite overwinters beneath the bark of trees. It emerges from hibernation in the first decade of May. In nature, it has been collected from flowering plants in clover fields and orchards. On new plum tree varieties, the pest is parasitized by 50-60 %. In the Sheki, Zagatala, and Ismailly regions, 40-45 parasites were obtained from 120 infested larvae (Aghayev & Zeynalova, 2008). It has become evident that the parasite's activity is particularly high in private gardens, where no chemical control measures are applied. According to A. I. Vorontsov (Beybutov, 1965), and Z.M.Mammadov (2004), the parasite produces two generations per year. The first generation develops on the larvae of the Oriental fruit moth, while the second generation targets caterpillars of moths that damage forest and fruit trees.

Under laboratory conditions at 22-24°C and fed with sugar syrup, the parasites live for 12-16 days, whereas they die within 3-4 days without food. The economic significance of this parasite is considerable.

3. *Apanteles laeviqatus* Ratz. *Apanteles* is a parasitoid from the Hymenoptera order, Braconidae family, and is one of the significant parasites of vegetable and fruit pests. This parasite infects the first and second instar larvae of its host. It lays 50-60 eggs per larva and can lay up to 2000 eggs during its lifetime. The larvae complete their development in the 4th and 5th instar stages (Guliyeva & Guliyev, 2007). Once the larvae have finished developing, they emerge through the host’s skin and form a yellow, cotton-like cocoon on the host’s surface. Inside this cocoon, each larva transitions to the pupal stage individually. *Apanteles* overwinters both as a pupa and as a final instar larva. The first generation of adults emerges during the second decade of April and the beginning of May. The second generation emerges in early June. Observations indicate that adults of the first generation typically parasitize 60-80 % of hawthorn moth larvae. Subsequent generations of *Apanteles* increase and proliferate by infecting the larvae of fruit pests. During the second decade of April, the parasite is rarely found in the fields due to overwintering, and the infection rate of larvae is also low (10-12 %). The parasitism rate can vary annually depending on climatic conditions and the population of the pest in the agroecosystem.

Observations in fruit farms and personal garden areas have shown that *Apanteles* produces three generations per year, with two of these generations developing on fruit pests. During late May and early June, the larvae appear on fruits and leaves about 10-12 days before the larvae emerge from their eggs. At this time, the host plants have fertilized eggs (Ismayilova, 2024). The first larvae emerging from eggs are parasitized by 40-50 %. The development of parasites completes by early June. The role of nectar-rich plants in the activity of *Apanteles* has been studied. When they feed on nectar-rich plants such as clover and dill, their reproductive capacity is high, significantly contributing to the regulation of the host population. In fruit orchards, when there is a food base for additional feeding, they are more active; without such a food base, the parasitism rate decreases. Additionally, chemical control measures against pests in orchards negatively impact their activity.

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4. ***Scolia quadripunctata* F.** Based on the materials collected from both the Guba-Khachmaz and Sheki-Zagatala regions, this parasite from the Scolidae family of the Hymenoptera order, which was first encountered in Azerbaijan, is considered one of the most important parasites in reducing host populations. Consequently, the bioecological characteristics of this species have been extensively studied. According to A. I. Vorontsov (Beybutov, 1965), species from this family are more widely distributed in tropical countries. In the former USSR, 40 species are known, with most found in Central Asia and the Caucasus. In Azerbaijan, it was first recorded by Z. M. Mammadov (2004). Based on specimens collected from soil around tree roots and from entomological traps, it was found that the parasite's flight period in nature occurs from June to July and lasts 30-35 days. In laboratory conditions, when five larvae of the beetle were placed in a 0.5-liter jar with parasites, the parasites began mating and laying eggs within 5-6 hours (Zeynalova, 2004). Female parasites congregate at the feeding sites of the host larvae, use their antennae to detect the exact location of the larvae in the soil, and then insert their ovipositor to sting and paralyze the host. The paralyzed larva remains immobile. The parasite then deposits the larva into the prepared soil nest and covers it with a secretion. After moving over the surface for a few minutes, the parasite lays one egg on the last segment of the larva's abdomen. The egg is deposited on the larva of the beetle's third instar. The egg stage lasts 3-4 days. Once hatched, the parasite larva begins feeding on the host's body contents. The larval feeding is very rapid, and the larva grows quickly. It passes through three instar stages. When the daily temperature is 26-32°C, the development of the larvae takes 10-12 days. After completing the larval stage, they pupate inside elliptical cocoons. According to V. N. Starkin (Moiseyeva & Polyakova, 1970), cocoons are typically found at a depth of 40 cm in the soil, and sometimes at 10-12 cm. Our observations indicate that cocoons were found at a depth of 5 cm in the jar with a humidity of 60 %. The pupal stage lasts 18-22 days at a temperature of 28-30°C. Initially, the parasites emerge singly, but as the temperature rises and the soil warms, the emergence rate increases. In laboratory conditions, when provided with nectar-rich plants for additional feeding, the parasites lived for 15-20 days on apricot, quince, and peach blossoms, and 10-12 days on dill and clover juice. Without additional food, they lived for only 5-6 days. They produce 3-4 generations per year.

According to V. N. Starkin (Moiseyeva & Polyakova, 1970), in the former USSR Plant Protection Institute, the multiplication of this parasite on May beetles and click beetles in special cages yielded good results.

Conclusion

The study of pest insects, particularly the Oriental fruit moth, and methods of combating them in the fruit-growing sector of Azerbaijan is crucial. Research indicates that the Oriental fruit moth is widespread in Azerbaijan and causes significant damage to orchards, leading to reduced crop yields. This pest has become a serious issue in regions such as the Nakhchivan Autonomous Republic, Guba-Khachmaz, Shaki-Zagatala, and recently in the Absheron area.

As part of biological control measures against the Oriental fruit moth, 22 species of parasitic wasps have been identified as playing a crucial role in combating this pest. Species such as *Macrocentrus ancylivorus* and *Scambus pomorum* have been noted for their high effectiveness. The mass rearing of these parasites under laboratory conditions and their application in orchards have shown positive results in reducing the pest population.

Research indicates that biological control measures against the Oriental fruit moth are not only economically viable but also beneficial for the ecosystem. Therefore, it is advisable to continue scientific research in this direction and expand the use of biological control methods in Azerbaijan.

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