STUDY LEVEL OF THE BIOLOGY, FAUNA, AND ECOLOGY OF COCCINELLIDS

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Abstract

Coccinellid beetles (Coccinellidae) are among the most important natural enemies of agricultural pests and play a significant role in biological plant protection systems worldwide. This article reviews the current level of knowledge on the biology, fauna, and ecology of coccinellids, with a particular focus on their use in the biological control of aphids, scale insects, and other harmful arthropods. The historical development of coccinellid research is discussed, beginning with early recommendations by Carl Linnaeus and Erasmus Darwin and highlighting the landmark introduction of *Rodolia cardinalis* against the cottony cushion scale, which marked a turning point in classical biological control. The contribution of Russian and Central Asian scientists to the study of coccinellid biology, distribution, overwintering behavior, and trophic relationships is also summarized. In addition, the article examines the limitations of chemical pest control methods, including environmental pollution, destruction of beneficial organisms, and the development of pesticide resistance among pests. Particular attention is given to the relevance of biological control in the agroecosystems of Uzbekistan, where favorable climatic conditions allow year-round crop cultivation but also promote pest outbreaks. The findings emphasize the ecological and economic importance of conserving native coccinellid species and expanding the use of biological control strategies as an environmentally safe alternative to chemical pesticides.

Introduction

Coccinellidae (ladybird beetles) play a crucial role in regulating populations of agricultural pests, particularly aphids and scale insects, through predation. Their high ecological plasticity, feeding efficiency, and adaptability have made them one of the most effective biological control agents worldwide. The study of the biology, fauna, and ecology of coccinellids is essential for developing sustainable plant protection strategies and reducing dependence on chemical pesticides. This article reviews the historical development, scientific research, and practical application of coccinellid beetles in biological pest control, with particular emphasis on their role in

Interest in coccinellids, or ladybird beetles, dates back to the great European biologist Carl Linnaeus, who recommended the use of ladybird beetles and lacewings against aphids. Erasmus Darwin also advised using ladybird beetles to cleanse

greenhouses of aphids. In England, the distribution of ladybird beetles in fields and greenhouses was proposed as a means of controlling aphid pests.

However, a turning point occurred in 1888 in California, when the ladybird beetle *Rodolia cardinalis* Muls. was introduced from Australia to combat the cottony cushion scale (*Icerya purchasi*). The exceptionally high and positive results obtained from its use on citrus plants brought about a fundamental change in the biological protection of plants.

Subsequently, the introduction of *Rodolia* beetles against the cottony cushion scale into many countries—including Egypt in 1890 and the Hawaiian Islands in the same year, as well as nearly 30 other countries—repeatedly proved that *Rodolia* ladybird beetles are highly effective natural enemies of this pest.

In Russia, the first scientific studies on the application of biological control methods against harmful insects are directly associated with the renowned Russian scientist I. I. Mechnikov. In the late 1870s and early 1880s, he identified fungal and bacterial pathogens of the grain beetle *Anisoplia austriaca* and conducted several successful experiments on the use of muscardine pathogens. I. M. Krassilshchik continued Mechnikov's work and was the first in the world to organize mass cultivation of entomopathogenic fungi.

In the former USSR, *Rodolia cardinalis* beetles were introduced from Cairo in 1931 and initially mass-reared under laboratory conditions at the Plant Protection Institute (Leningrad, now St. Petersburg). They were later released in Sukhumi and surrounding areas against the cottony cushion scale, resulting in significant suppression of the pest.

Worldwide, extensive research has been conducted on the introduction and acclimatization of *Rodolia* and other coccinellid species—such as *Lindorus lophanthae* Blaisd., *Cryptogonus orbiculus* var. *nigripennis* Wse., *Orcus chalybeus* Boisd., and *Chilocorus perniciosus* Comst.—for use against scale insects and other pests.

Numerous scientists have also conducted research on ladybird beetles. The importance of coccinellids in the biological control of plant pests has been highlighted by V. V. Yakhontov and Z. K. Adilov, who provided extensive data on their distribution and conservation of local species. Issues related to the introduction and acclimatization of coccinellids were studied by L. S. Ulyanova. The overwintering aggregation behavior of many ladybird species was investigated by V. V. Yakhontov, Z. K. Adilov, A. K. Mansurov, A. Sh. Khamroev, and Yu. Q. Babanov.

The biology, ecology, species composition, and trophic relationships of coccinellids in orchard ecosystems of Karakalpakstan were studied by S. A. Mangutova. The role of coccinellids in reducing pest populations of stone fruit trees was analyzed by Kh. H. Murotov and A. G. Davletshina. The biology of certain

ladybird species associated with apple trees in the Fergana Valley was investigated by T. Vokhidov, while A. K. Mansurov conducted an in-depth analysis of the species composition of biogeocenoses in the Jizzakh region.

From the history of biological plant protection, pest outbreaks and various diseases have long been considered global threats, causing significant damage during crop growth and storage. In some years, harmful organisms destroy 60–80% of agricultural yields and also contribute to the spread of dangerous infectious diseases among plants, animals, and humans.

Although chemical control methods are widely used against pests, insecticides and acaricides often lack selectivity and destroy beneficial organisms such as natural enemies (entomophagous insects and insectivorous birds). Moreover, many pests have developed resistance to pesticides, negatively affecting agroecosystem phytosanitary conditions and agricultural economics. Currently, 428 species of arthropods worldwide have developed resistance to various pesticide groups, of which 260 are agricultural pests.

These factors have increased interest in biological control methods, emphasizing the role of predators, parasites, and pathogens that regulate pest populations. In a broad sense, biological plant protection involves using living organisms, their metabolic products, or synthetic analogs to reduce pest damage. In a narrow sense, classical biological control refers to the use of living organisms—parasites, predators, and pathogenic microorganisms—against pests.

The Republic of Uzbekistan, due to its warm spring, summer, and autumn climate, enables year-round cultivation of many agricultural crops. However, during the summer–autumn period, arthropod pests cause significant damage to food crops, legumes, cereals, vegetables, orchards, and technical crops such as cotton and hemp. Initially, pest control in the Republic relied mainly on chemical methods, but extensive use of toxic chemicals has caused severe environmental damage, including water pollution, decline in beneficial arthropods, ecological imbalance in rural areas, and increased incidence of human diseases.

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