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HYMENOPTERAN ENTOMOPHAGES IN VEGETABLE AGROBIOCENOSES OF UZBEKISTAN

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Abstract. The present study investigated the species composition, bioecological characteristics, and trophic relationships of parasitic entomophages belonging to the order Hymenoptera in vegetable agrobiocenoses of Uzbekistan. During the research, natural enemies of the major lepidopteran pest species were identified, and their ecological significance in agrobiocenoses was evaluated. The distribution, host specialization, parasitic activity, and role of entomophages in the biological regulation of pest populations were analyzed. The conducted observations revealed the occurrence of four species from the family Trichogrammatidae (*Trichogramma evanescens, Trichogramma pintoi, Trichogramma chilonis, Trichogramma ostriniae*), seven species from the family Braconidae (*Apanteles plutellae, Apanteles telengai, Apanteles kazak, Apanteles glomeratus, Cotesia glomerata, Bracon hebetor, Cotesia melanoscela*), one species from the family Pteromalidae (*Callitula bicolor*), and two species representing the family Tachinidae (*Exorista larvarum, Gonia bimaculata*).

The obtained results demonstrated that hymenopteran parasitic entomophages play an important role in the natural regulation of pest insect populations in vegetable agrobiocenoses. In particular, *Cotesia glomerata and Bracon hebetor* were distinguished by their high biological efficiency against major lepidopteran pests. Furthermore, several parasitoid species remain insufficiently studied within the fauna of Uzbekistan, highlighting the necessity for further investigation of their bioecological characteristics. The findings of this study may serve as an important

scientific basis for improving Integrated Pest Management (IPM) systems and developing environmentally sustainable biological control strategies.

Keywords: Hymenoptera, agrobiocenosis, parasitic entomophages, biological control, species composition, Lepidoptera, Braconidae, Trichogrammatidae, Pteromalidae, Tachinidae, bioecology, Integrated Pest Management (IPM).

Annotatsiya. Mazkur tadqiqotda O‘zbekiston sabzavot agrobiotsenozlarida tarqalgan *Hymenoptera* turkumiga mansub parazit entomofaglarning tur tarkibi, bioekologik xususiyatlari va trofik munosabatlari o‘rganildi. Tadqiqotlar davomida *Lepidoptera* turkumiga mansub asosiy zararkunanda turlarning tabiiy kushandalari aniqlanib, ularning agrobiotsenozdagi ekologik ahamiyati baholandi. Entomofaglarning tarqalishi, xo‘jayin ixtisosligi, parazitlik faolligi hamda zararkunanda populyatsiyalarini biologik boshqarishdagi roli tahlil qilindi. Olib borilgan kuzatuvlar natijasida Trichogrammatidae oilasining 4 turi *(Trichogramma evanescens, Trichogramma pintoi, Trichogramma chilonis, Trichogramma ostriniae), Braconidae* oilasining 7 turi *(Apanteles plutellae, Apanteles telengai, Apanteles kazak, Apanteles glomeratus, Cotesia glomerata, Bracon hebetor, Cotesia melanoscela), Pteromalidae* oilasining 1 turi *(Callitula bicolor)* va *Tachinidae* oilasiga mansub 2 tur *(Exorista larvarum, Gonia bimaculata)* aniqlandi.

Olingan natijalar *Hymenoptera* turkumi parazit entomofaglari sabzavot agrobiotsenozlarida zararkunanda hasharotlar populyatsiyalarini tabiiy boshqarishda muhim ahamiyatga ega ekanligini ko‘rsatdi. Ayniqsa, *Cotesia glomerata* va *Bracon hebetor* turlari asosiy *Lepidoptera* zararkunanda turlariga qarshi yuqori biologik samaradorligi bilan ajralib turdi. Shuningdek, ayrim parasitoid turlarining O‘zbekiston faunasida yetarlicha o‘rganilmaganligi ularning bioekologik xususiyatlarini yanada chuqur tadqiq qilish zarurligini ko‘rsatdi. Tadqiqot natijalari integrallashgan himoya (IPM) tizimlarini takomillashtirish hamda ekologik barqaror biologik kurash strategiyalarini ishlab chiqish uchun muhim ilmiy asos bo‘lib xizmat qilishi mumkin.

Kalit so‘zlar: Hymenoptera, agrobiotsenoz, parazit entomofaglar, biologik kurash, tur tarkibi, Lepidoptera, Braconidae, Trichogrammatidae, Pteromalidae, Tachinidae, bioekologiya, integrallashgan himoya (IPM).

Аннотация. В данном исследовании изучены видовой состав, биоэкологические особенности и трофические взаимоотношения паразитических энтомофагов отряда Hymenoptera, распространённых в овощных агробиоценозах Узбекистана. В ходе исследований были выявлены естественные враги основных вредителей отряда Lepidoptera и дана оценка их экологического значения в агробиоценозах. Проанализированы

распространение энтомофагов, их кормовая специализация, паразитическая активность и роль в биологической регуляции численности вредителей. По результатам наблюдений установлено наличие 4 видов семейства Trichogrammatidae (*Trichogramma evanescens, Trichogramma pintoi, Trichogramma chilonis, Trichogramma ostriniae*), 7 видов семейства Braconidae (*Apanteles plutellae, Apanteles telengai, Apanteles kazak, Apanteles glomeratus, Cotesia glomerata, Bracon hebetor, Cotesia melanoscela*), 1 вида семейства Pteromalidae (*Callitula bicolor*) и 2 видов семейства Tachinidae (Exorista larvarum, Gonia bimaculata).

Полученные результаты показали, что паразитические энтомофаги отряда Hymenoptera играют важную роль в естественной регуляции численности вредных насекомых в овощных агробиоценозах. В частности, виды *Cotesia glomerata и Bracon hebetor* отличались высокой биологической эффективностью против основных вредителей отряда Lepidoptera. Кроме того, установлено, что некоторые виды паразитоидов остаются недостаточно изученными в фауне Узбекистана, что подчёркивает необходимость дальнейших исследований их биоэкологических особенностей. Результаты исследования могут служить важной научной основой для совершенствования систем интегрированной защиты растений (IPM) и разработки экологически безопасных стратегий биологической борьбы.

Ключевые слова: Hymenoptera, агробиоценоз, паразитические энтомофаги, биологическая борьба, видовой состав, Lepidoptera, Braconidae, Trichogrammatidae, Pteromalidae, Tachinidae, биоэкология, интегрированная защита растений (IPM).

INTRODUCTION

Parasitic and predatory entomophages belonging to the order Hymenoptera play an important ecological and biological role in agrobiocenoses and are considered one of the major natural factors regulating populations of insect pests. Representatives of this order parasitize the egg, larval, and pupal stages of numerous phytophagous insects occurring in agricultural crops, thereby maintaining pest populations below the economic injury level. In particular, hymenopteran entomophages are highly effective biological control agents against insect pests belonging to the order Lepidoptera.

In vegetable agrobiocenoses, the most common and economically important pests include cabbage butterflies (Pieris brassicae, Pieris rapae, Synchloe daplidice), moths (Plutella xylostella, Plutella maculipennis), and cutworms (*Mamestra brassicae, Agrotis segetum, Agrotis exclamationis, Autographa gamma*). These pests cause severe damage to leaves, stems, and generative organs of crops. Mass outbreaks of these

species, particularly in cruciferous crops, result in substantial yield losses and serious economic damage. The large cabbage white butterfly (*Pieris brassicae*), small cabbage white butterfly (*Pieris rapae*), and rapeseed white butterfly (*Synchloe daplidice*) are considered among the most destructive pests of cruciferous crops such as cabbage, turnip, radish, and rutabaga under the conditions of Uzbekistan. Their larvae completely defoliate plant leaves, reduce photosynthetic activity, and significantly decrease crop quality and productivity. In some years, these pests may destroy up to 60-65% of the total yield.

Currently, chemical pesticides are widely used against these pest species. However, the excessive and uncontrolled application of pesticides leads to disruption of ecological balance within agrobiocenoses. As a result, populations of beneficial entomophages decline, while pest species frequently re-establish and increase rapidly after chemical treatments. Furthermore, the prolonged use of pesticides with the same active ingredients contributes to the development of resistance in pest populations. Consequently, this leads to increased application frequency, higher pesticide doses, and greater economic costs in crop protection systems.

In recent years, considerable attention has been paid worldwide to the development of environmentally safe and sustainable agricultural systems through Integrated Pest Management (IPM) strategies. Within IPM programs, the use of parasitic and predatory entomophages represents one of the most important biological control approaches. In particular, representatives of the families Trichogrammatidae, Braconidae, Pteromalidae, and Tachinidae play a significant role in the natural regulation of lepidopteran pest populations.

Therefore, the investigation of species composition, bioecological characteristics, host–parasitoid relationships, and biological control potential of hymenopteran entomophages in agrobiocenoses is of considerable scientific and practical importance. The main objective of the present study was to determine the species composition of hymenopteran parasitic entomophages occurring in vegetable agrobiocenoses, evaluate their trophic relationships with major pest species, and assess their potential application in Integrated Pest Management systems.

MATERIALS AND METHODS

The studies were conducted during 2025 in vegetable agrobiocenoses located in the Tashkent region of the Republic of Uzbekistan. Scientific observations were carried out mainly in farmer fields and experimental plots cultivated with cruciferous, cucurbit, and other vegetable crops. The research objects included the major insect pests belonging to the order Lepidoptera and their trophically associated parasitic entomophages.

The study focused on the bioecological characteristics, natural parasitoids, and host–parasitoid relationships of economically important pest species belonging to the families Pieridae, Plutellidae, and Noctuidae. The investigations were primarily directed toward identifying parasitoid entomophages associated with the large cabbage

white butterfly (*Pieris brassicae*), small cabbage white butterfly (*Pieris rapae*), rapeseed white butterfly (*Synchloe daplidice*), diamondback moth (*Plutella xylostella, Plutella maculipennis*), and cutworm species (*Mamestra brassicae, Agrotis segetum, Agrotis exclamationis, Autographa gamma*).

Field observations were conducted using route survey methods and permanent monitoring plots. In each experimental field, 10 × 10 m sampling plots were established to determine the abundance of pest insects and entomophages. Observations were repeated every 7-10 days throughout the vegetation period. Eggs, larvae, and pupae of pest species were collected directly from host plants and transferred to laboratory conditions, where they were maintained separately until parasitoid emergence. Emerged parasitoid species were recorded and identified.

Entomophages were collected using entomological sweep nets, aspirators, pheromone traps, and manual collection methods. The collected specimens were preserved in ethanol and later identified in the laboratory based on morphological characteristics. Species identification was carried out using modern entomological atlases, taxonomic keys, and international systematic references.

Laboratory investigations were performed under the conditions of the Tashkent State Agrarian University biolaboratory. To evaluate the possibility of mass rearing promising parasitoid species, their biology, developmental duration, survival rate, and parasitism efficiency were studied. Laboratory conditions were maintained at a temperature of 25±2°C, relative humidity of 60-70%, and a photoperiod regime of 16:8 h (light:dark).

As a result of the investigations, host parasitoid relationships of major lepidopteran pests occurring in vegetable agrobiocenoses, the feeding specialization of entomophages, their distribution, and ecological significance within the biocenosis were determined. Based on the collected data, the species composition, dominant parasitoid species, and their role in the natural regulation of pest populations were evaluated.

The obtained data were statistically processed to calculate species occurrence frequency, parasitism rates, and dominance indices. Species richness and relative abundance indices were used to evaluate biological diversity. The research findings were analyzed and presented using tables and graphical diagrams.

Table 1.

Species composition of hymenopteran parasitoid entomophages distributed in vegetable agrobiocenoses.

№	Parasitoid species	Pest species	Feeding specialization
1	**Family Trichogrammatidae**	**Order Lepidoptera**	**egg**
1.1	*Trichogramma evanescens* Westv	-//-	-//-
1.2	*Trichogramma pintoi* Voeg	-//-	-//-
1.3	*Trichogramma chilonis* Ichii	-//-	-//-
1.4	*Trichogramma ostriniae* Wang	-//-	-//-
2	**Family Braconidae**	**Order Lepidoptera**	**Mature larvae and pupae**
2.1	*Apanteles plutellae* Kurd	-//-	-//-
2.2	*Apanteles telengai* Tobias	-//-	-//-
2.3	*Apanteles kazak* Tel	-//-	-//-
2.4	*Apanteles glomeratus* L	-//-	-//-
2.5	*Cotesia glomerata* L	-//-	-//-
2.6	*Bracon hebetor* Say	-//-	-//-
2.7	*Cotesia melanoscela*	-//-	-//-
3	**Family Pteromalidae**	**Order Lepidoptera**	**Mature larvae and pupae**
3.1	*Callitula bicolor* Spinola	-//-	-//-
4	**Family Tachinidae**	**Order Lepidoptera**	**Mature larvae**
4.1	*Exorista larvarum* L.	-//-	-//-
4.2	*Gonia bimaculata* Rond.	-//-	-//-

The main objective of the study was to identify parasitic entomophages associated with vegetable crop pests and to evaluate their significance in regulating pest populations under agrobiocenosis conditions. The conducted research was specifically aimed at addressing this important issue within environmentally sustainable pest management systems. In addition, international experiences and modern approaches in biological control and Integrated Pest Management (IPM) were reviewed and comparatively analyzed.

Figure 1. *Cotesia glomerata* parasitoid cocoons on a larva of the Large Cabbage White (*Pieris brassicae*).

Figure 2. Adult of the parasitoid wasp *Cotesia glomerata* L. (Hymenoptera: Braconidae) on a caterpillar of *Pieris brassicae*.

According to investigations carried out in vegetable agrobiocenoses of the Tashkent region, the majority of beneficial entomophages occurring in these ecosystems were represented by parasitic species [1;2;3;6;8]. The obtained results demonstrated that parasitoids constitute the dominant component of the entomophagous complex and play a crucial role in the natural suppression of lepidopteran pest populations. These findings confirm the ecological importance of parasitoid diversity in maintaining biological balance within agroecosystems and reducing the dependence on chemical pesticides.

According to the results of investigations conducted to determine the species composition of parasitic entomophages associated with representatives of the family Pieridae in vegetable agrobiocenoses of the Tashkent region, parasitoids belonging to four families of the order Hymenoptera were identified in cabbage agrobiocenoses. A total of 12 parasitoid species representing the families Trichogrammatidae, Braconidae, and Pteromalidae were recorded. In addition, two species belonging to the family Tachinidae of the order Diptera were also identified (Table 1).

The identified species included four species from the family Trichogrammatidae (Trichogramma evanescens, Trichogramma pintoi, Trichogramma chilonis, Trichogramma ostriniae), seven species from the family Braconidae (*Apanteles*

plutellae, Apanteles telengai, Apanteles kazak, Apanteles glomeratus, Cotesia glomerata, Bracon hebetor, Cotesia melanoscela), one species from the family Pteromalidae (*Callitula bicolor*), and two species from the family Tachinidae (Exorista larvarum and Gonia bimaculata) (Table 1).

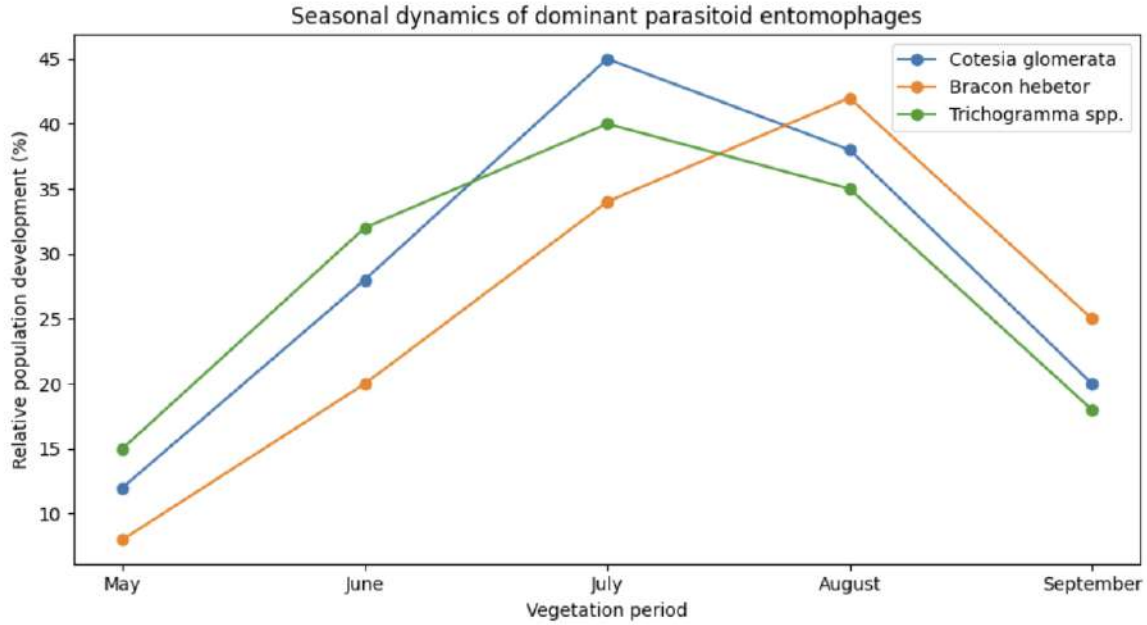

Figure 3. Seasonal population dynamics of dominant parasitoid entomophages (*Cotesia glomerata, Bracon hebetor and Trichogramma spp*.) in vegetable agrobiocenoses of the Tashkent region.

Among the identified parasitoids, one species from the family Braconidae, Cotesia glomerata L., was recorded as a new species for the southeastern fauna of Uzbekistan. Furthermore, it was revealed that the bioecological characteristics and biological control potential of this species have not yet been sufficiently investigated by local researchers [9;10;11]. The obtained results indicate the necessity for further studies on the biodiversity, ecology, and practical application of parasitoid entomophages in sustainable pest management programs.

The parasitoid entomophage *Cotesia glomerata* L., belonging to the family Braconidae, primarily parasitizes the major lepidopteran pest species Pieris brassicae, Pieris rapae, and Synchloe daplidice. This parasitoid species was found to play an important role in the natural regulation of cabbage butterfly populations in vegetable agrobiocenoses.

The development of Cotesia glomerata larvae is completed when the caterpillars of cabbage butterflies reach the fifth larval instar. After completing their development, parasitoid larvae emerge from the host body and form pupae within silken cocoons around the dead caterpillar. The cocoons of the parasitoid are characterized by a yellowish coloration. Adult parasitoids are black in color, possess antennae longer than the body, and have reddish tibiae on their legs (Figure 1).

Under laboratory conditions, the parasitoid was successfully mass-reared for up to three generations. It was observed that a single female parasitoid was capable of parasitizing approximately 40-50 host larvae during its lifespan. The biological characteristics of the species indicate its high potential for practical application in biological control programs.

The biological efficiency of laboratory-reared generations of Cotesia glomerata against the large cabbage white butterfly in cabbage agrobiocenoses was evaluated under field conditions. The obtained results demonstrated high effectiveness of the parasitoid in suppressing pest populations. Detailed data on the biological efficiency of the parasitoid are presented in Chapter 5 [1;4;5;7;9].

CONCLUSION

The conducted studies demonstrated that parasitic entomophages belonging to the order Hymenoptera possess high biodiversity in vegetable agrobiocenoses and play an important role in the natural regulation of lepidopteran pest populations. During the investigations, a total of 14 parasitoid species belonging to the families Trichogrammatidae, Braconidae, Pteromalidae, and Tachinidae were identified. Among these groups, representatives of the family Braconidae occupied a dominant position in terms of species richness and biological efficiency.

The obtained results revealed the existence of complex trophic relationships between parasitoid entomophages and insect pests. In particular, natural competition among parasitoid species for host resources was observed during different seasons and years. Such ecological interactions represent one of the key factors contributing to the maintenance of biological balance within agrobiocenoses. At the same time, the competitive relationships and dominance characteristics of parasitoid entomophages remain insufficiently studied under the conditions of Uzbekistan.

The investigations confirmed that species such as Trichogramma spp., Cotesia glomerata, and Bracon hebetor possess high biological efficiency against the major pest species occurring in vegetable crops. Mass rearing and practical application of these parasitoids under biolaboratory conditions may significantly contribute to the development and improvement of Integrated Pest Management (IPM) systems.

Furthermore, the observations demonstrated that the excessive application of chemical pesticides considerably reduces populations of beneficial entomophages and disrupts the ecological balance of agrobiocenoses. These findings emphasize the necessity of expanding environmentally safe biological control approaches in sustainable agricultural systems.

The study confirmed the important ecological and practical significance of hymenopteran parasitoids as natural entomophages in agrobiocenoses. Detailed investigations of their species composition, bioecological characteristics, and host parasitoid relationships may provide a scientific basis for improving local biological

control systems, reducing pesticide use, and promoting environmentally sustainable agricultural technologies.

Future studies will focus on the seasonal dynamics, dominance structure, climatic influences, and mass-rearing technologies of parasitoid entomophages under laboratory conditions. Such investigations will contribute to the development of scientifically based and environmentally safe biological control systems for agricultural production in Uzbekistan.

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