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RESEARCH ARTICLE

First record of *Necremnus leucarthros* (Nees, 1834) (Hymenoptera: Eulophidae) as a parasitoid of *Hypera postica* (L. Gyllenhal, 1813) in Uzbekistan

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Abstract

For the first time in Uzbekistan, the parasitoid *Necremnus leucarthros* (Nees, 1834) (Hymenoptera: Eulophidae) is recorded as a natural enemy of the alfalfa weevil *Hypera postica* (Gyllenhal), a major pest in alfalfa agroecosystems. Field studies conducted in 2024–2025 in Tashkent Region, combined with laboratory observations, revealed a high level of parasitism. Analysis of 4,580 *H. postica* cocoons showed that 46.7% were parasitized in 2024 and 54.1% in 2025. A total of 25,578 specimens of *N. leucarthros* emerged from the collected cocoons. The mean number of parasitoids per cocoon ranged between 10.3 and 11.9 individuals. Morphological characteristics of adults and larvae, as well as key aspects of the species' biology, are described, including its narrow host specialization and accelerated development (5–7 days from parasitism to adult emergence). Laboratory observations showed that females feed on host hemolymph and prefer third-instar larvae for oviposition. The increasing rate of parasitism and high survival of offspring indicate a significant role of *N. leucarthros* in the natural regulation of *H. postica* populations. These findings expand the known distribution of the species and confirm its potential as a promising biological control agent for alfalfa protection in Central Asia.

Keywords
Central Asia, alfalfa agroecosystems, alfalfa weevil, biological control, parasitism rate, laboratory experimentes

Introduction

Alfalfa is an important forage crop worldwide, with a global cultivation area of 31.5 million hectares. However, high yields are limited by many factors, among which insect pests are the most significant. The main pests of alfalfa (*Medicago sativa*) include the alfalfa weevil (*Hypera postica*), leaf miners, leafroller caterpillars, and the pea aphid (*Acyrthosiphon pisum*). These pests damage the leaves, shoots, and flowers of plants, leading to a substantial reduction in both the yield and quality of hay and seed production (Mordor Intelligence 2025).

The alfalfa weevil (*Hypera postica* (Gyllenhal, 1813) (Coleoptera: Curculionidae) is the major pest of alfalfa worldwide (Soroka et al. 2020; Herreid et al. 2024; Chennamkulangara 2025). During outbreaks, *H. postica* larvae can reduce the first cutting yield by 60–90% (Mordor Intelligence 2025). In Uzbekistan, the harmfulness of the alfalfa weevil reaches up to 65%, while the protein and lipid content in alfalfa biomass decreases by 61% and 55%, respectively (Jononova 2023).

Effective management of the alfalfa weevil must be based on an integrated pest management (IPM) system that includes agronomic, biological, and chemical approaches. Control of *H. postica* is complicated by the development of insecticide resistance, particularly to synthetic pyrethroids (Rodbell and Wanner 2021; Rodbell et al. 2024). Therefore, increasing attention has recently been given to agronomic measures (Levi-Mourao et al. 2022, 2024; Makenzie et al. 2022) and biological control methods (Çağlayan et al. 2022; Al-Nuaimy et al. 2025). Among the parasitoids that reduce *H. postica* populations, the most effective are *Bathyplectes anura* (Thomson, 1887) and *Bathyplectes curculionis* (Thomson, 1887) (Hymenoptera: Ichneumonidae), which parasitize up to 31% of *H. postica* larvae (Levi-Mourao 2021).

Representatives of the genus *Necremnus* Thomson, 1878 (Hymenoptera: Eulophidae) may serve as potential biological control agents against *H. postica*. In the Palaearctic region, the genus *Necremnus* is represented by about 20 species, which predominantly parasitize the larvae of beetles from the families Curculionidae and Chrysomelidae (Lelej 2012). Several *Necremnus* species that parasitize important pests of tomato and oilseed rape, such as *Tuta absoluta* (Lepidoptera: Gelechiidae) and *Ceutorhynchus obstrictus* (Coleoptera: Curculionidae), have been investigated as potential biological control agents (Gebiola et al. 2015; Zhang et al. 2022).

In our study, a representative of this genus – *Necremnus leucarthros* – is recorded for the first time in Uzbekistan as a parasitoid of the alfalfa leaf weevil. The hosts of *N. leucarthros* may include species from the orders Coleoptera, Diptera, and Lepidoptera (Kosheleva 2015). *N. leucarthros* is distributed in the Oriental region, North America, Europe, as well as in Turkey and Iran (Jafarlu 2021). In Europe, *N.*

leucarthros is noted as the most common parasitoid of the cereal leaf beetle *Oulema gallaeciana*, parasitizing 20–70% of the pest's cocoons (Haeselbarth 1989; Miczulski 1994; Šedivý 1995; Jeloková and Gallo 2008). However, no data on this species are available for the Central Asian republics.

The study of this species may be useful for planning biological control strategies against the alfalfa leaf weevil.

Materials and methods

The research was conducted in 2024–2025 in alfalfa agroecosystems of the Qibray and Chirchiq districts of Tashkent Region, as well as in the laboratory of the Research Institute of Plant Quarantine and Protection.

During the study, insect samples were collected from alfalfa fields during the growing season using entomological sweep nets. *Hypera postica* cocoons were collected manually from alfalfa fields. Infested crops were surveyed from the moment larvae hatched until the pest entered winter diapause. Collections were carried out from March to July, until the development of the *H. postica* generation was completed.

A portion of the collected material (larvae and cocoons) was kept under laboratory conditions in special glass jars at an air temperature of 22 ± 1 °C to observe their further development. As parasitoids emerged, the level of parasitism was determined. Cocoon dissections of *H. postica* were also performed, and the number of parasitoid larvae and pupae was counted. Observations on the development and behavior of the parasitoids were carried out under laboratory conditions. At the end of the experiments, all material was collected and preserved.

In 2024, 1,120 specimens were collected, and in 2025, 1,180 specimens of *H. postica* cocoons infected with the parasitoid *Necremnus leucarthros* were collected. The *N. leucarthros* individuals reared under laboratory conditions were also used for repeated parasitization of *H. postica* larvae. The morphology of the parasitoid adults and larvae was studied under laboratory conditions using a stereomicroscope and digital photodocumentation. The structure of the male antennae and wing venation were used for ganus-level identification. Species identification was confirmed through expert consultation and comparison with reference materials.

Results

Order: Hymenoptera

Superfamily: Chalcidoidea Latreille, 1817

Family: Eulophidae Westwood, 1829

Subfamily: Eulophinae Westwood, 1829

Genus: *Necremnus* Thomson, 1878

***Necremnus leucarthros* (Nees, 1834)**

Nees, 1834: 172 as *Eulophus leucarthros*
Forster, 1856: 86 as *Necremnus leucarthros* (Nees, 1834)

Material: Tashkent Region, Chirchik District, Saksonota, alfalfa agrocenosis, 41°24'50.8"N, 69°34'60.5"E, h–564 m, IV–VI.2024, 26 ex.; Qibray District, Bobur, alfalfa agrocenosis, 41°21'52.7"N, 69°21'13.8"E, h–490 m, IV–VI.2024, 13 ex.; Qibray District, Akhillik, alfalfa agrocenosis, 41°22'58.3"N, 69°50'51.6"E, h–490 m, IV–VI.2024, 23 ex.; Qibray District, Utkur, alfalfa agrocenosis, 41°24'19.5"N, 69°22'27.3"E, h–520 m, IV–VI.2024, 37 ex.; Qibray District, Khuzhakurgan, alfalfa agrocenosis, 41°26'14.7"N, 69°24'53.0"E, h–560 m, IV–VI.2024, 8 ex., leg. R.N. Zhononova. In addition, 25,578 specimens of *Necremnus leucarthros* were reared in the laboratory from *Hypera postica* cocoons collected at these sites.

Distribution: Oriental: India; Nearctic: North America; Palaearctic: Algeria, Armenia, Austria, Bulgaria, Czech Republic, Denmark, England, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Iran, Macedonia, Moldova, Montenegro, Mongolia, Morocco, Netherlands, Poland, Romania, Russia, Slovakia, Sweden, Switzerland, Turkey, United Kingdom (Noyes 2020, Jafarlu 2021, *Necremnus leucarthros* (nees, 1834) in GBIF Secretariat 2023).

Hosts. The hosts of *Necremnus leucarthros* may include representatives of the orders Coleoptera, Diptera, and Lepidoptera (Kosheleva 2015).

Description. The body length of females was 2.8–3.0 mm, and that of males 2.5–2.8 mm (Fig. 1A, B). The abdomen is brown with iridescent (metallic) blue or blue-green reflections. The male abdomen differs from the female in both shape and coloration. The female abdomen is pointed and metallic blue or blue-green, whereas the male abdomen is oval in shape and features a transverse patch of white or light-yellow coloration. The head and mesosoma are dark green with a coppery sheen dorsally. The antennae have a dark scape, pedicel, and flagellum; in males they are branched and resemble horns (Fig. 1C, D). The legs of *Necremnus* are rarely entirely yellow; they are usually dark brown at the apex and lighter, semi-transparent yellowish at the base. The meso- and metatibiae are typically narrowly pale at the base, with the lighter area usually somewhat wider ventrally than dorsally.

The forewing has a relatively broad speculum; the dorsal setae are positioned farther from the basal fold, and the subcubital line of setae generally consists of only a single row. The wing usually shows a slight brownish infuscation behind the stigmal vein, extending no more than half the width of the wing. Sometimes there is a broad, faint brownish area behind the marginal vein, which becomes diagonally broadened posteriorly to merge with the brownish region behind the stigmal vein.

In females, the basal yellow area is not only very short but also usually sharply and evenly delimited (Fig. 1F). Typical females also have a more finely sculptured, reticulate leathery or leathery-shingled propodeum.

Behavior under laboratory conditions. In the laboratory, newly emerged parasitoids were placed in jars in groups of 6–8 individuals, paired (♀♂), together with *H. postica* larvae of different instars (the adult parasitoids are easily distinguished by body size and antennal structure). Each jar contained 50 *H. postica* larvae, which began pupating 2–3 days after being placed inside. Adult female parasitoids fed on the host's hemolymph to obtain additional nutrients necessary for continuous oogenesis (egg production) and egg maturation. They feed on hosts of all instars but prefer 1st and 2nd instars for feeding, whereas 3rd instar larvae are preferred for oviposition. In laboratory experiments, three generations of the parasitoid were successfully obtained. The development of the parasitoid proceeds very rapidly: 5–7 days after host parasitism, adult parasitoids emerged. The maximum lifespan of adults was 10 days. Attempts to parasitize other pests (cutworms, moths) were unsuccessful, indicating the narrow host specialization of *Necremnus leucarthros*.

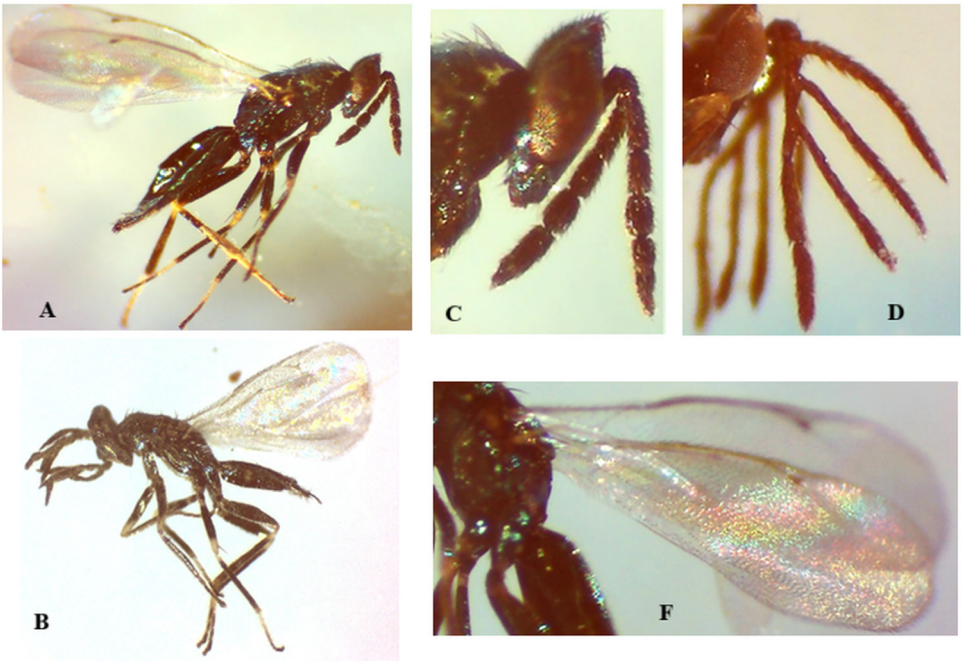

Figure 1. *Necremnus leucarthros*: **A** – adult male; **B** – adult female; **C** – head and antennae of female; **D** – head and antennae of male; **F** – female forewing.

Parasitism of *H. postica* by the parasitoid under field conditions. A total of 4,580 *H. postica* cocoons collected from alfalfa fields were analyzed in the laboratory. The data indicate a significant level of parasitism of *H. postica* cocoons by *Necremnus leucarthros* during the study period (Table 1). In 2024, the proportion of parasitized cocoons was 46.7%, whereas in 2025 it increased to 54.1%, indicating an enhancement of natural pest population control. The increase in parasitism may be attributed both to a higher abundance of the parasitoid in the agroecosystem and to favorable climatic conditions that support its successful development and survival.

The number of emerged adult parasitoids also increased, from 11,536 specimens in 2024 to 14,042 specimens in 2025. This reflects not only a higher level of parasitism but also potentially better emergence success of *N. leucarthros* offspring.

Table 1. Infestation of alfalfa leaf weevil cocoons with the parasitoid *N. leucarthros*

Year	Number of *Hypera postica* cocoons examined, specimens	Number of parasitized cocoons		Number of emerged parasitoids, specimens	Average number of parasitoids on one cocoon, specimens
		Specimens	%		
2024	2400	1120	46.7	11536	10.3
2025	2180	1180	54.1	14042	11.9

Observations of the dynamics of parasitoid emergence from the cocoon, as well as dissections of larvae and cocoons, showed that each cocoon contained 10–14 parasitoid larvae, with a maximum of 17. The larvae and pupae are very small; the larvae are yellow, while the pupae are black (Fig. 2). Inside the host cocoons, the parasitoid pupae are clustered together and connected by a white thread. The average number of parasitoids per parasitized cocoon increased from 10.3 to 11.9 specimens over the study years, which may indicate an increase in the reproductive success of the species.

Discussion

The results obtained confirm the important role of *Necremnus leucarthros* in contributing to the natural mortality of *Hypera postica* in alfalfa agroecosystems of the Tashkent Region. The observed level of parasitism of the pest cocoons (46.7% in 2024 and 54.1% in 2025) is comparable to data on *Necremnus* species parasitizing other leaf beetles in Europe, where parasitism rates can reach 20–70% (Miczulski 1994; Jeloková and Gallo 2008). The increase in the proportion of parasitized cocoons in the second year of observation suggests an enhanced population pressure of the parasitoid on the phytophage, which may be associated both with favorable agroecosystem conditions and with the accumulation of the *N. leucarthros* population in the studied ecosystem.

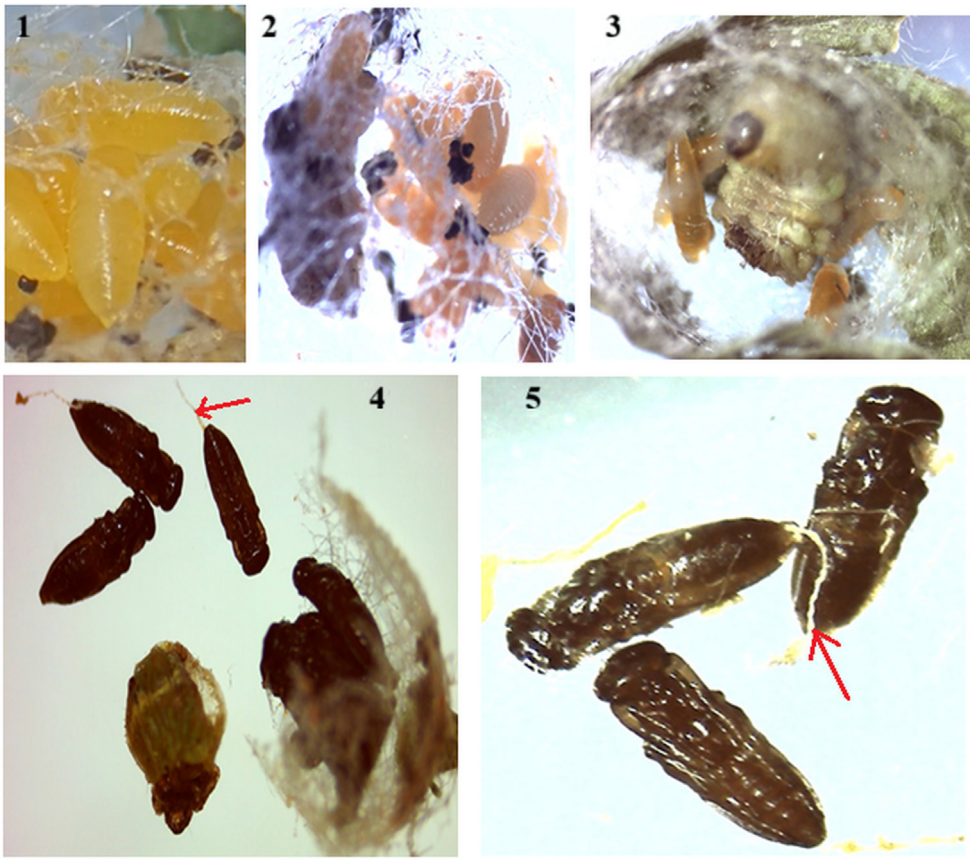

Figure 2. Larvae and pupae of *N. leucarthros*: **1**, **2**, **3** – larvae inside an *H. postica* cocoon; **4**, **5** – a cluster of pupae connected by a common thread inside the cocoon (pupae of the parasitoid within a single *H. postica* cocoon are joined together by one thread).

The increase in the total number of emerged parasitoids (from 11,536 to 14,042 specimens) and the average number of individuals developing in a single cocoon (from 10.3 to 11.9 specimens) indicates high viability and a potentially effective reproductive strategy of the species. The characteristic arrangement of pupae within the host cocoon, connected by a common thread, reflects a close spatial specialization on this type of host and is consistent with the previously described biology of the species (Kosheleva 2015). The absence of successful parasitism of other tested pest species highlights the narrow trophic specialization of *N. leucarthros*, making it a potentially safe biological control agent with minimal risk to non-target organisms.

From a practical standpoint, the presence of *N. leucarthros* in Uzbek agroecosystems is an important factor in the development of integrated alfalfa protection programs. Reducing the population of *H. postica* through natural enemies is par-

ticularly relevant given the increasing resistance of the pest to chemical insecticides (Rodbell and Wanner 2021; Rodbell et al. 2024). Incorporating *N. leucarthros* into an IPM system could complement the use of already applied parasitoids, such as *Bathyplectes* spp., providing a multi-component biotic pressure on the pest.

Nevertheless, to assess the actual effectiveness of *N. leucarthros* under field conditions, long-term observations are necessary, taking into account seasonal dynamics, the species' adaptation to agricultural practices, the influence of climatic factors, and interactions with other parasitoid species within the *H. postica* complex. Promising directions for further research include studying the combined use of *N. leucarthros* with agronomic measures, modeling population dynamics, and analyzing its potential impact on the economic thresholds of pest damage

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