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Biological and ecological characteristics, distribution, hosts, and potential for use in biological control of *Coniocleonus nigrosuturatus* Goeze, 1777 (Coleoptera: Curculionidae)

Coniocleonus nigrosuturatus Goeze, 1777 (Coleoptera: Curculionidae)'un biyolojik ve ekolojik özellikleri, dağılım alanları, konukçuları ve biyolojik mücadelede kullanım potansiyeli

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ABSTRACT

It has been determined that the weed *Erodium cicutarium* L., which poses a problem in pistachio production areas in Siirt province (Türkiye), can be regionally suppressed by *Coniocleonus nigrosuturatus* Goeze, 1777 (Coleoptera: Curculionidae). The primary aim of this study was determine the prevalence and density levels of *C. nigrosuturatus* in Siirt province and to identify its host weed species. For this purpose, detailed surveys were conducted in 55 pistachio orchards during 2023-2024. At the end of the study, *C. nigrosuturatus* was encountered in 11% of the orchards. Additionally, it was determined that the target insect fed only on *E. cicutarium* in the study area and completed its biological stages on this weed. A review of the literature revealed that the insect has a wide distribution in Türkiye; however detailed information regarding its host range and biological control potential is lacking. Although the primary host of the species is *E. cicutarium*, laboratory studies have reported that it could be a significant biological agent candidate for the invasive species common ragweed (*Ambrosia artemisiifolia* L.). Considering the potential of *A. artemisiifolia* to cause significant problems in Türkiye, this article compiles and summarizes relevant information and discusses the potential of the species as a biological control agent. When our survey results and related literature are considered together, it is evident that *C. nigrosuturatus* could be effective in the biological control of *E. cicutarium* and *A. artemisiifolia*; however, detailed studies are needed.

INTRODUCTION

At the intersection of three different biogeographical regions, Türkiye is home to a rich variety of flora and fauna (Seven 2020). This ecological diversity provides favorable conditions for many species, including cultivated plants, ornamental plants, endemic plants, exotic species, and pest species such as weeds, pests, disease agents, and invasive

species (Arslan et al. 2022, Atalay et al. 2014, Önen 2010, Sirri et al. 2024). This diversity is also evident in agricultural ecosystems. In fact, due to geographical, ecological, and climatic differences, there is significant variation in plant protection factors, which poses a challenge because of the diversity in applied agricultural production systems (Özer et al. 2001).

Weeds, as one of the major plant protection factors, are among the primary constraints on agricultural production due to their great diversity, including species number, population density, and intraspecific genetic, morphological, and physiological diversity, etc. (Önen 2014). In recent years, weed management has become increasingly challenging due to the rising number and spread of invasive alien species (Önen 2021). In addition to their economic and ecological impacts, the risks they pose to human/animal health, such as allergic reactions and toxicity, have made weeds and invasive alien plants a significant problem globally (Barudanović et al. 2021, Önen 2015).

On the other hand, problems arising from herbicides – such as resistance, phytotoxicity, and negative effects on the environment/human health – have been observed, especially in conventional agricultural practices. These issues have brought alternative weed control methods to the forefront (Sırrı and Özaslan 2022). Biological control has emerged as an alternative to traditional weed control methods (cultural, mechanical, physical, chemical) applied in agricultural ecosystems and/or as a complementary method within the integrated control framework (Bo et al. 2020, Monteiro and Santos 2022).

Although all living organisms capable of suppressing weed growth can be used in biological control, arthropods (such as insects, mites) and plant pathogens (such as fungi and bacteria) are more suitable and widely used (Schwarzländer et al. 2018, Winston et al. 2014). In this context, Türkiye, with its rich flora and fauna, offers important opportunities for determining the benefits of organisms that feed on weeds. Identifying potential biological control agents for weed management can significantly contribute to sustainable weed control (Arslan et al. 2022, Sırrı 2024, Sırrı and Bal 2023).

In this framework, the aim of this study was to investigate the prevalence and population density of *Coniocleonus nigrosuturatus* Goeze, 1777 (Coleoptera: Curculionidae), which is reported to be monophagous and feeds on the *Erodium cicutarium* subsp. *cicutarium* (L.) L Hér.) (Güncan and Karaca 2018), a weed problem in different geographical regions of Türkiye and in many different cultivated plants, in Siirt province and to reveal its host range. On the other hand, despite being a monophagous species, *C. nigrosuturatus* has been reported to show promising results (under laboratory conditions) in the control of the invasive weed wormwood (*Ambrosia artemisiifolia* L.) (Horváth et al. 2014). Considering that *A. artemisiifolia* can cause significant problems in Türkiye (Farooq et al. 2019, Ozaslan et al. 2016), the literature on the subject was reviewed in this article, and the potential of the species to be used as a biocontrol agent was examined in line with the results.

MATERIALS AND METHODS

Surveys were conducted in 55 pistachio orchards in Siirt center and Kurtalan districts in 2023-2024 (Figure 1). In orchards where the host plant (*E. cicutarium*) was present, a 20 × 20 m^2 area was designated for detailed examinations. All weeds within the designated area were subjected to a general screening to identify biological materials of natural agents (adults, pupae, larvae, eggs) or plants showing morphological damage (Figure 2).

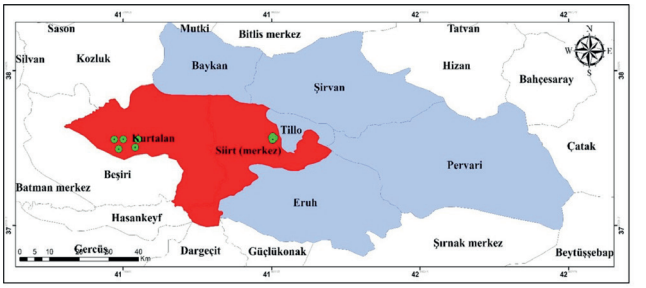

Figure 1. Surveyed areas in Siirt and locations where *C. nigrosuturatus* was detected

Figure 2. Observations from survey studies; a) host plant *E. cicutarium*, b and d) pupal period of *C. nigrosuturatus*, c and e) adult period of *C. nigrosuturatus*

During the general screening, at least 10 plants of *E. cicutarium* plants damaged by the natural agent were subjected to a detailed examination for *C. nigrosuturatus*. The screening focused on observing the morphological parts of the plant (flowers, leaves, stems, roots, and seeds)

that the insect fed on and assessing the extent of the damage caused.

Adult individuals found during the surveys were collected for identification and preserved in 70% alcohol in the laboratory. Larvae and pupae in the pre-adult stage were brought to the laboratory in special storage containers with a sufficient amount of plant material and were cultured under suitable conditions until adults emergence. Additionally, the number of plants with signs of feeding at the sampling points, the number of adults, larvae, and pupae found on them, and the coordinates of the locations were recorded using a Magellan multi-satellite Global Positioning System (explorist 710 UTM) receiver with a position accuracy of ± 5 m.

Insects were sent to the Gazi University Faculty of Science, Department of Biology laboratory for identification, which was conducted by the second author.

RESULTS AND DISCUSSION

C. nigrosuturatus was detected on the host weed *E. cicutarium* in 11% of Siirt pistachio orchards (six orchards in total) in Siirt Center and Kurtalan districts. It was determined that the target insect generally feeds on the leaves and stems of the host. Additionally, it was observed that *C. nigrosuturatus* completed its biological stages on *E. cicutarium* during different periods of observations and laboratory studies. The findings and information obtained from surveillance, laboratory studies, and a detailed literature review are summarized below.

Biological and ecological characteristics of Coniocleonus nigrosuturatus Goeze, 1777 (Coleoptera: Curculionidae)

In the literature, data on the biological and ecological characteristics of species in the genus *Coniocleonus* are quite limited. However, it is reported that *Coniocleonus* spp. prefer hot and dry habitats, as well as steppe and/or semi-desert regions (Koch 1992). Similarly, *C. nigrosuturatus* is more commonly found in sparse vegetation with a sunny and semi-arid climate (Stejskal et al. 2014).

The natural distribution of the species reportedly includes northern parts of North Africa, Asia, Western Siberia, and Europe (Meregalli and Fremuth 2013). A global distribution map of the species was created based on the records of geographical regions where *C. nigrosuturatus* has been found worldwide (GBIF 2025). The general map of the species' habitats is given in Figure 3. The global distribution map is consistent with previous data on the species' distribution and habitat (Koch 1992, Meregalli and Fremuth 2013, Stejskal et al. 2014). Similarly, due to favorable climatic conditions, the species is widespread throughout Türkiye (Figure 4).

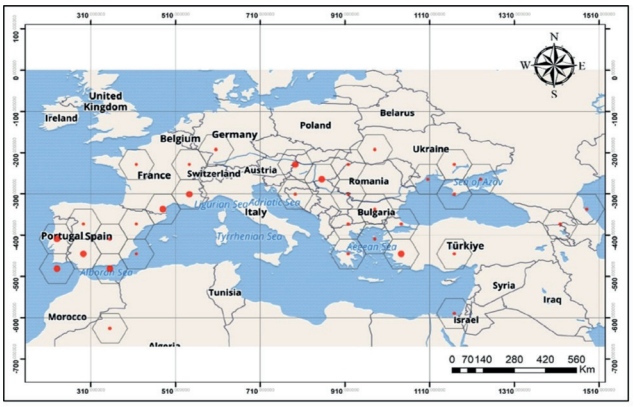

Figure 3. Global location records of *Coniocleonus nigrosuturatus* (GBIF 2025)

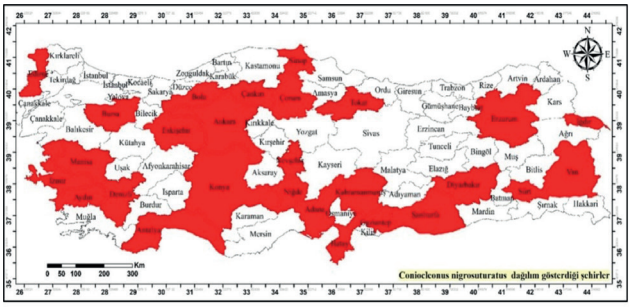

Figure 4. Location records of *Coniocleonus nigrosuturatus* in Türkiye (Gültekin 2018)

On the other hand, in Europe, *C. nigrosuturatus* is more common in the sandy, steppe, and dry meadow habitats (Koch 1992). The information about the species' habitat is consistent with our findings. Studies conducted in Siirt Center and Kurtalan districts determined that *C. nigrosuturatus* was primarily found in peanut orchards with sandy-loamy soils at elevations of 730-1000 m.

C. nigrosuturatus overwinters as pupae or adults, emerging in early spring (March) to feed and mate on host plants. Adults show peak activity between mid-April and mid-May. Larvae live in tunnels in the soil near the host plant and feed on the stem at the soil surface. Typically, only one larva is observed per plant, although up to three larvae may be present. In early July, larvae pupate in a closed soil cell, and then the adult emergence follows (Stejskal et al. 2014).

During our field studies in Siirt, the biological stages of the insect were observed to align with the findings in the literature. Larvae were encountered in the last week of April, while adult emergence was observed starting in the second

week of May. Although each plant generally hosted a single larva, some plants were found to contain two larvae.

Weed species that host Coniocleonus nigrosuturatus Goeze, 1777 (Coleoptera: Curculionidae)

Studies conducted in Siirt Center and Kurtalan districts determined that the species feeds exclusively on *E. cicutarium*. It was also observed that the species completes all its biological stages on *E. cicutarium*. Similarly, previous field and laboratory studies reported that this insect feeds only on *E. cicutarium*, classifying *C. nigrosuturatus* as a monophagous species (Stejskal et al. 2014).

However, a previous study conducted in Türkiye reported that the insect also feeds on *Anthemis* sp. (Pehlivan et al. 2005). In a survey conducted under laboratory conditions, it was concluded that the species can feed on *A. artemisiifolia* L., an invasive alien plant species that causes significant economic, ecological, and health problems in Europe. This suggests that *C. nigrosuturatus* may be a potential natural enemy of *A. artemisiifolia* (Horváth et al. 2014).

It has also been suggested that thyme species (*Thymus* spp.) host *C. nigrosuturatus* in natural ecosystems in Europe (Fremuth 1982). However, a later study definitively demonstrated that thyme species do not host *C. nigrosuturatus* (Stejskal et al. 2014). Despited this, it was concluded that detailed studies are needed to determine the full host range of the species. The results of this study, along with previous research, confirm that *E. cicutarium* is the primary host of *C. nigrosuturatus* in natural areas. For this reason, the general characteristics of the species are emphasized below. In addition, due to its importance, *A. artemisiifolia* (Horváth et al. 2014), which was controlled under laboratory conditions by *C. nigrosuturatus*, will be discussed in general terms.

Erodium cicutarium L.

This plant belongs to the *Geraniaceae* family and is an annual weed native to Europe, North Africa, and West Asia. *E. cicutarium* poses a problem in agricultural ecosystems across many geographical regions worldwide (Li et al. 2008, Snarska 2004). The importance of the common weed, which is widespread in semi-arid areas, is increasing every year in agricultural lands such as wheat, barley, chickpeas, lentils, dry beans, potatoes, sugar beet, corn, soybeans, oats, canola, mustard (Beckie et al. 2008).

Additionally, *E. cicutarium* hosts many pathogens, including viruses and fungi, as well as harmful (insect) pathogens that can harm crop and pasture plants (Francis et al. 2012). Consequently, this species is recognized as a problematic weed in various agricultural ecosystems worldwide.

In the American continent, *E. cicutarium*, an exotic species that was introduced later, can become a significant threat to agricultural ecosystems and native biodiversity when it reaches high densities (Schutzenhofer and Valone 2006).

In regions/countries where the species was later transported and spread or has the potential to spread, such as the American continent, biological control is an important alternative. In fact, it is almost the only alternative in natural ecosystems (Atay et al. 2015). Therefore, it was concluded that research on the biological characteristics of the species, the determination of its host range, and effectiveness studies are important. Studies by Beckie et al. (2008) and Francis et al. (2012) reported that the species could pose a significant risk to agricultural ecosystems as well as local biodiversity in newly introduced areas. Indeed, studies conducted in the USA found that when the density of *E. cicutarium* in agricultural areas was 20 plants/m^2, it caused an average yield loss of 10% in wheat, 18% in canola, and 25% in dry beans and peas. It was also determined that the density of *E. cicutarium* increased, yield losses due to competition increased (Blackshaw and Harker 1998). This situation further increases the importance of the subject.

As in many different geographical regions of the world, *E. cicutarium* has a wide distribution area in Türkiye and can cause problems in diverse crops, including cereals, vegetable fields, orchards, and vineyards (Eşitmez and Işık 2015, Kaya and Üremiş 2019, Önen 2023, Özer et al. 2001, Tepe 2014). In organic vineyard areas, its density along rows has been recorded as 7.2 plants/m^2 (Kaçan and Boz 2014). Since *E. cicutarium* is a native species, it is considered within the scope of general weed management in agricultural ecosystems in Türkiye. However, observations have shown that *C. nigrosuturatus* can suppress *E. cicutarium* in areas without spraying. For this reason, it has been concluded that protecting and supporting the species can contribute to weed control. In addition, the knowledge gained from detailed studies on the subject may contribute to the biological control of the species in organic farming and good agricultural practices that are becoming widespread in Türkiye (Önen 2014). Furthermore, the information obtained may be useful for managing the species in natural ecosystems.

Ambrosia artemisiifolia L.

Originating in North America, *A. artemisiifolia* (Asteraceae) is an invasive alien plant species that has spread to almost every region of the world. In addition to the economic losses it causes, the plant is considered one of the most dangerous weeds on the European continent, including Türkiye, due to its negative effects on human health (allergenic

effects) (Lommen et al. 2017, Ozaslan et al. 2016, Önen et al. 2015). Thanks to the plant's ability to adapt to different ecological conditions and its high seed-forming capacity, it is continuously spreading to new geographical regions and habitats. This makes it a model plant for understanding invasive species and a focus of scientific interest.

Although the plant invades agricultural areas with very different characteristics, it is especially common in spring-planted (summer) crops such as sunflower, corn, soybean, sugar beet, and potato where it causes significant damage (Kazinczi et al. 2012, Önen et al. 2015).

Since *A. artemisiifolia* causes problems in both agricultural ecosystems and non-agricultural areas, and because its populations affect people as a pollen source, different approaches especially biological control are necessary. For this reason, studies on the biological control of the plant are of great importance. It has been observed that even different polyphagous natural agents are being tested in Europe for the biological control of this weed (Augustinus et al. 2020, Essl et al. 2020, Igrc et al. 1995, Müller-Schärer et al. 2014, Szeôke 2012).

Therefore, the fact that *C. nigrosuturatus*, which is stated to be monophagous (Stejskal et al. 2014), has been reported to suppress *A. artemisiifolia,* one of the most dangerous invasive alien weeds worldwide, including in Türkiye, even under laboratory conditions (Horváth et al. 2014), makes studies on this subject significant. However, in our study, no evidence was found that the biological agent feeds on *A. artemisiifolia*.

Field research and literature records have revealed that *C. nigrosuturatus* is a widespread species in Türkiye. It has also been determined that the host plant of this species is the common spiny squirrel (*E. cicutarium*). However, literature findings also indicate that the insect may be polyphagous. Indeed, it is reported that the wormwood garfish (*A. artemisiifolia*) can be controlled by *C. nigrosuturatus* under laboratory conditions. It is also emphasized that the insect feeds on *Anthemis* sp. in Türkiye.

Therefore, to clarify the issue, detailed research is needed to determine the biological and ecological characteristics of *C. nigrosuturatus*, conduct studies on the reproduction of the species, and reveal its host range. Additionally, bioactivity studies under laboratory and field conditions are considered important.

Author's Contributions

Authors declare the contribution of the authors is equal.

Statement of Conflict of Interest

The authors have declared no conflict of interest.

ÖZET

Siirt ili Antep fıstığı üretim alanlarında sorun olan *Erodium cicutarium* L. yabancı otunun *Coniocleonus nigrosuturatus* Goeze, 1777 (Coleoptera: Curculionidae) tarafından bölgesel olarak baskılanabileceği belirlenmiştir. Çalışma kapsamında öncelikle Siirt ilinde *C. nigrosuturatus*'un yaygınlığı ve yoğunluk düzeylerinin belirlenmesi ve konukçu yabancı ot türlerinin teşhis edilmesi amaçlanmıştır. Bu amaçla 2023-2024 yıllarında 55 adet fıstık bahçesinde detaylı etütler yapılmıştır. Çalışma sonunda bahçelerin %11'inde *C. nigrosuturatus* ile karşılaşmıştır. Ayrıca hedef böceğin çalışma alanında sadece *E. cicutarium* ile beslendiği ve biyolojik evrelerini bu yabancı ot üzerinde geçirdiği tespit edilmiştir. Yapılan literatür çalışmaları sonunda böceğin Türkiye'de geniş bir dağılım alanına sahip olduğu görülmüştür. Ancak türün konukçu dizisi ve biyolojik mücadele potansiyeline ilişkin detaylı bilgi olmadığı saptanmıştır. Türün ana konukçusu *E. cicutarium* olmasına rağmen, laboratuvar çalışmalarında, istilacı bir tür olan pelinimsi zargan (*Ambrosia artemisiifolia* L.) için önemli bir biyolojik ajan adayı olabileceği rapor edilmiştir. Türkiye'de *A. artemisiifolia*'nın önemli sorunlara yol açma potansiyeli dikkate alındığında, makalede konu ilişkin bilgiler derlenerek özetlenmiş ve biyolojik ajan olarak türün potansiyeli tartışılmıştır. Sürvey sonuçlarımız ve konuya ilişkin ilgili literatür bir arada ele alındığında; *E. cicutarium* ve *A. artemisiifolia*'nın biyolojik mücadelesinde *C. nigrosuturatus*'un etkili olabileceğini ancak konuya ilişkin detaylı çalışmalara ihtiyaç olduğunu ortaya çıkarmıştır.

Anahtar kelimeler: *Coniocleonus nigrosuturatus,* biyoloji, ekoloji, konukçu yabancı otlar, *Erodium cicutarium,* biyolojik kontrol

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