Far Eastern Entomologist

Number 525: 5-12 | ISSN 1026-051X (print edition) ISSN 2713-2196 (online edition) | June 2025

https://doi.org/10.25221/fee.525.2
https://elibrary.ru/pwnhao
https://zoobank.org/References/86CE392C-AAB6-49A4-BC94-A5E901E53494

SEMANOTUS BIFASCIATUS (MOTSCHULSKY, 1875) (COLEOPTERA: CERAMBYCIDAE): A NEW DANGEROUS INVASIVE PEST OF CUPRESSACEAE IN EUROPE

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Summary. The East Asian longhorn beetle *Semanotus bifasciatus* (Motschulsky, 1875) (Coleoptera: Cerambycidae) is recorded for the first time in Europe. The species was founded in 2024 within the city of Mariupol (DPR, Russia) and has been recognized as a dangerous pest of Cupressaceae in urban environments, causing the death of large mature trees. Brief diagnostic characters, illustrations, information on geographical distribution, biology and the extent of harmful impact of *S. bifasciatus* are provided.
Key words: *Semanotus*, Cerambycidae, Cupressaceae, invasion, pest, first record, Europe.

А. И. Губин, В. В. Мартынов, Т. В. Никулина, Н. И. Булышева. *Semanotus bifasciatus* (Motschulsky, 1875) (Coleoptera: Cerambycidae): новый опасный инвазивный вредитель кипарисовых в Европе // Дальневосточный энтомолог. 2025. N 525. С. 5-12.

Резюме. Впервые для Европы указывается восточноазиатский жук-усач *Semanotus bifasciatus* (Motschulsky, 1875) (Coleoptera: Cerambycidae). Вид был обнаружен в 2024 г. на территории г. Мариуполя (ДНР, Россия) и проявил себя в качестве опасного вредителя кипарисовых в городских условиях, приводящего к гибели крупных возрастных деревьев. Приведены краткий диагноз, иллюстрации, информация по географическому распространению, биологии и вредоносности *S. bifasciatus*.

INTRODUCTION

According to contemporary systematic classifications, the genus *Semanotus* Mulsant, 1839 (Coleoptera: Cerambycidae: Cerambycinae: Callidiini) comprises 18 species distributed in the Northern Hemisphere (Monné, 2005; Hammond & Williams, 2013; Danilevsky *et al.*, 2020). The larvae of *Semanotus* are strictly woodboring and trophically associated with conifers, under the bark and in the wood of which the larvae feed. Based on their trophic specialization, species of *Semanotus* can be classified into two broad categories: species that feed and oviposit on Pinaceae (*Picea*, *Pinus*, *Cedrus*, *Abies*, *Larix* and *Pseudotsuga*) and species that feed and oviposit on Cupressaceae (*Juniperus*, *Cupressus*, *Platycladus*, *Thuja*, *Thujopsis*, *Chamaecyparis*, etc.) (Linsley & Chemsak, 1997; Hammond & Williams, 2013). Certain species of the genus pose significant threats as physiological and technical pests, including *S. undatus* (Linnaeus, 1758), *S. russicus* (Fabricius, 1777), *S. bifasciatus* (Motschulsky, 1875), *S. japonicus* (Lacordaire, 1869), *S. sinoauster* Gressitt, 1951 (Plavilstshikov, 1940; Cherepanov, 1988; Yan, 2003; Miroshnikov, 2004; Gao *et al.*, 2007; Wang, 2017; Karpun *et al.*, 2021). Given these factors, the invasion of *Semanotus* species into new territories presents a considerable ecological risk. Several such instances have been documented in the literature. In 1952, *S. japonicus* was imported from Japan to Canada (Hammond & Williams, 2013), while in 2010, *S. sinoauster* was imported from China to France (Cocquempot & Gattus, 2013), and in 2012, the same species was imported to Australia from Hong Kong (Anonymous, 2012). In all cases, beetles were transported via wood products, including furniture and wooden containers; however, none of this species established themselves in these new territories. Since the late 20th century, the penetration of *S. russicus* was noted along the Black Sea coast of the Caucasus, while the closest habitats of the species are known in Transcaucasia and, possibly, Crimea (Miroshnikov, 2004). Additionally, the introduction of *S. russicus* with Cupressaceae plants imported from the Mediterranean has been increasingly observed in Western Europe. Isolated occurrences have been documented in France and the United Kingdom (Mendel & Barclay, 2008; Allemand, 2009), and the species has successfully established populations in urban areas of the Czech Republic (Čížek, 2017). The high invasive potential of *Semanotus* species is currently of serious concern and requires intensified monitoring studies aimed at their detection.

In February 2024, fragments of a recently deceased *Thuja occidentalis* L. tree trunk exhibiting damage caused by an unidentified longhorn beetle were collected in Mariupol (DPR, Russia). Subsequent laboratory cultivation revealed that the tree had been colonized by the East Asian species *S. bifasciatus*. This finding is the first record of the species for Europe and the first documented case of successful transcontinental invasion by a species of the genus *Semanotus*.

MATERIAL AND METHODS

In February 2024, trunk fragments of a deceased 45-year-old *Th. occidentalis* tree from urban plantings in Mariupol were transported to Donetsk and stored in an unheated room. First part of the trunks was moved to the laboratory in Donetsk Botanical Garden in September, while the remaining trunks were moved at the end of December of the same year. Observations on beetle emergence continued until the end of February 2025.

The number of exit holes was recorded using standardized methods for assessing wood-boring pests (Tuzov, 2004) on five circular transects, each with a surface area of at least 7 dm². To assess the reproductive status of the females, their ovaries were examined through dissection in a physiological solution.

Photos were taken using Nikon D7200 and Nikon Z7II cameras with FTZ II mount adapter and Nikon 105mm f/2.8G IF-ED AF-S VR Micro-Nikkor lens. Mounted specimens were photographed using Carl Zeiss Stemi 2000-C microscope with Zeiss AxioCam Erc 5s camera. Photos were stacked, improved for contrast and brightness using Adobe® Photoshop®CS5 and Adobe Photoshop Lightroom Classic 2020 v9.2.1.10 software.

The material is deposited in the collection of Laboratory of Bioinvasion and Plant Protection Problems in Federal State Budgetary Scientific Institution "Donetsk botanical garden", Donetsk, DPR, Russia.

RESULTS

Semanotus bifasciatus **(Motschulsky, 1875)**
Figs 1–8

MATERIAL EXAMINED. **Russia**: Donetsk People's Republic, Mariupol city, Primorsky district, Primorsky park, 47°04'49"N, 37°31'45"E, on *Thuja occidentalis* L., galleries under the bark, 15.II.2024, leg. E.G. Mulenkova; Donetsk city, Donetsk Botanical Garden, rearing from *Thuja occidentalis* L. trunk in laboratory, 20.XI.2024–03.II.2025, 101♂, 90♀, leg. A.I. Gubin, V.V. Martynov, T.V. Nikulina.

DIAGNOSIS. (See: Cherepanov, 1988). The examined specimens correspond to the morphological descriptions provided in the literature (Motschulsky, 1875; Plavilstshikov, 1940; Cherepanov, 1988). However, considerable variation was observed in body size: males exhibited a body length ranging from 8.6 to 15.2 mm and a width of 2.5 to 4.9 mm, females measured between 9.8 and 15.2 mm in length and 3.3 to 5.0 mm in width (Fig. 1). *Semanotus bifasciatus* can be readily distinguished from the other two European species of the genus that feed on Cupressaceae by the characteristic light coloration of the apical margin of the elytra. Additionally, it is morphologically distinct from *S. russicus* due to the presence of two broad black stripes, one in the middle and another in the posterior third of the elytra. It also differs from *S. laurasii* by its comparatively narrower body, as well as by the glossy elytra, which exhibit finer and more sparsely distributed puncturation, particularly in the anterior third of their length.

DISTRIBUTION. China; Korean Peninsula; Japan; Russia: Primorsky Krai (south), DPR (Azov Lowland) (new record).

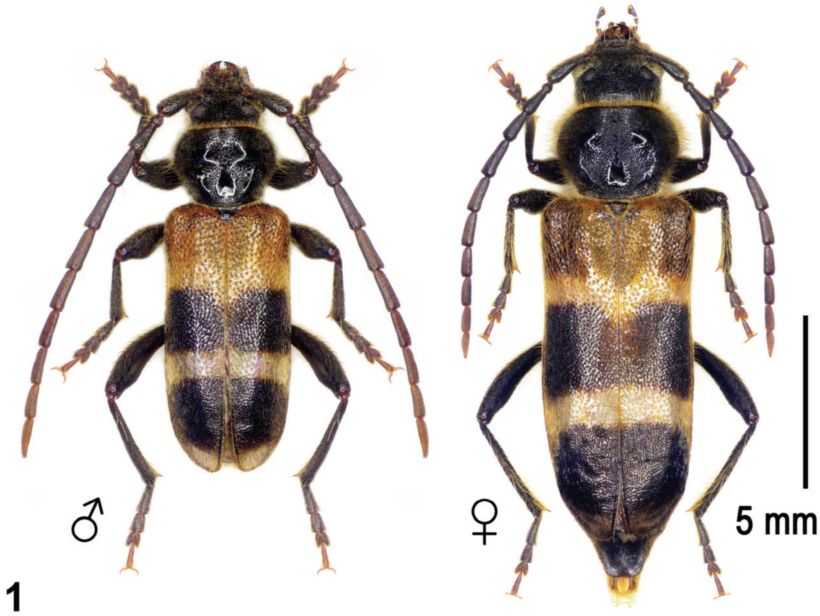


Fig. 1. *Semanotus bifasciatus* (Motschulsky, 1875), male and female, habitus.

BIOLOGY. Oligophagous, feeding on Cupressaceae: *Juniperus chinensis* L., *J. rigida* Siebold & Zucc., *Chamaecyparis obtusa* (Siebold & Zucc.) Endl., *Thujopsis dolabrata* (Thunb. ex L. f.) Siebold & Zucc., *Thuja* spp., *Cryptomeria japonica* (Thunb. ex L. f.) D. Don, *Cunninghamia lanceolata* (Lamb.) Hook. (Plavilstshikov, 1940; Cherepanov, 1988; Gao *et al.*, 2007; Iwata *et al.*, 2007). In Cis-Azov region the species has been recorded feeding on *Thuja occidentalis* L.

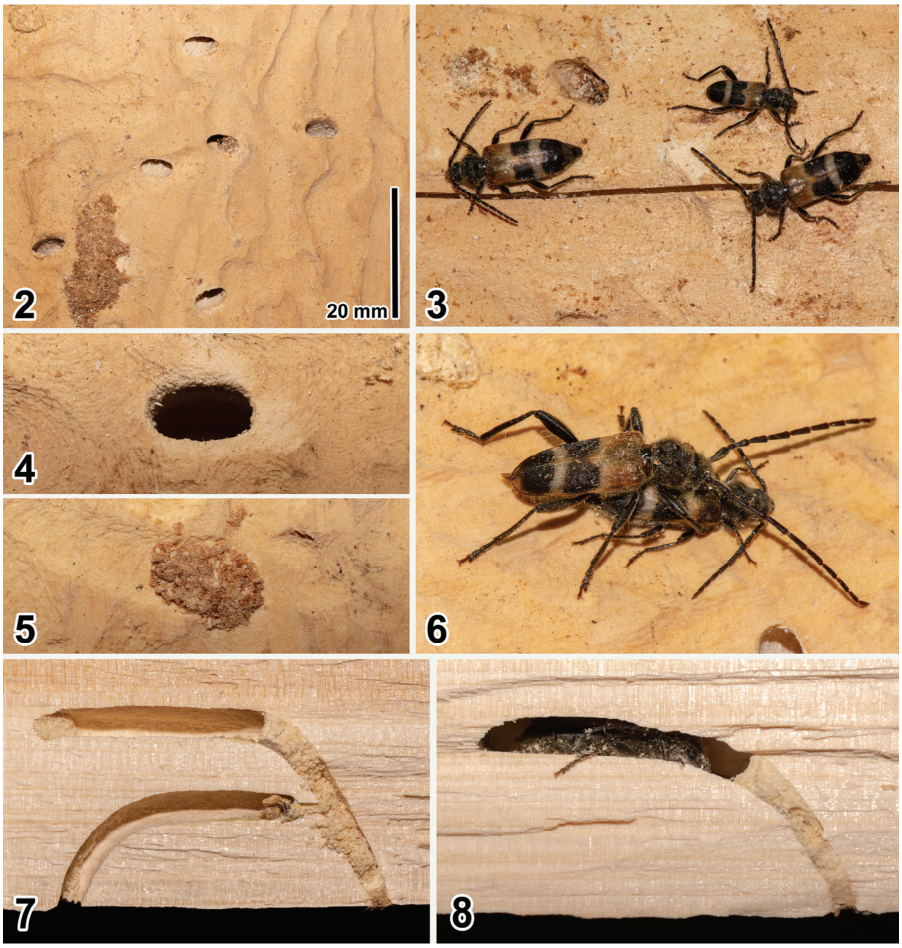
The life cycle of the species in Primorsky Krai was comprehensively studied by A.I. Cherepanov (Cherepanov, 1988), in China, South Korea, and Japan – by several other researchers (Kim & Park, 1984; Yan, 2003; Li *et al.*, 2003; Gao *et al.*, 2007; Iwata *et al.*, 2007). Generation completed in two years, in southern part of the range – one year. The beetles do not feed, active in spring and summer, exhibit a crepuscular lifestyle, can be found on trunks of windfallen or standing dying trees. In Primorsky Krai, adult flight occurs from June to August, whereas in eastern China, it takes place from late February to early May. The species colonizes trunks and thick branches, oviposit in bark crevices. Larvae feed within the cambial layer, making meandering galleries that are deeply imprinted in the sapwood and filled with fine frass. Mature larvae bore into the sapwood, where they form pupal cells at a depth of approximately 20 mm beneath the cambial layer, oriented longitudinally along trunk axis. Pupation occurs with the head toward inlet plugged with frass. Pupae appear at end of summer, beetles emerge by autumn but remain in pupal cells until the following year. In spring, the beetles break plug around inlet, push back frass, reach bark, nibble oval exit hole and emerge from wood.

The precise timing of *S. bifasciatus* invasion into the urban plantings of Mariupol remains unknown. Examination of infested trunks revealed that the cambial layer had been completely destroyed due to larval feeding, while the outer sapwood layer exhibited numerous feeding galleries filled with frass (Fig. 2). The maximum recorded width of these galleries was 12 mm. In addition to evidence of larval activity from 2023–2024, remnants of an earlier generation's development were also observed, partially overgrown with secondary xylem. Considering the species' two-year developmental cycle, these records indicate that a self-sustaining population of *S. bifasciatus* was already present in Mariupol by 2021.

The emergence of beetles from trunks brought to the laboratory in September 2024 was first recorded on November 20, indicating that exposure to low temperatures is not a prerequisite for initiating imago emergence (Fig. 3). From the trunks brought to the laboratory on December 20, emergence was observed as early as December 24, occurring just four days after placement in laboratory conditions. The emergence period was prolonged, lasting an average of 40 days. Based on these observations, it can be inferred that under the climatic conditions of Cis-Azov region, beetles emergence in natural settings should begin in early to mid-April, with emergence potentially beginning in late March during years with an early spring, and continuing until mid-May. The exit holes were oval in shape, oriented transversely or obliquely relative to the trunk axis (Fig. 4), with widths ranging from 4 to 6 mm. The density of exit holes on the accounting transects averaged 5.38 per dm^2, with values ranging from 0.7 to 8.5 per dm^2. The highest population density was recorded in the middle section of the trunk, where the diameter measured 21 cm.

Under regional conditions, *S. bifasciatus* exhibits a two years generational cycle. Beetles emergence occurred during daylight hours, with mating initiated almost immediately thereafter (Fig. 6). On the second day post-emergence, females were observed probing the surface of the trunk with their ovipositors, suggesting an attempt at oviposition. However, dissections of newly emerged females revealed the absence of mature ovaries, indicating that oviposition was not yet possible. Additionally, the beetles were observed gnawing on fresh Thuja needles placed in the insectarium, calling into question previous assertions regarding their complete aphagia.

A total of 191 beetles emerged in the laboratory between November 20, 2024, and February 3, 2025, after which emergence ceased. However, upon dissection of the trunks on February 3, several adults were found remaining inside their pupal cells, with the entrance holes sealed with frass (Figs 5, 7–8). The beetles were active, running and flying upon removal from the cells. No larvae were found in the pre-pupal stage. The pupal cells were located approximately 20 mm beneath the cambial layer within the sapwood. The emergence passages were oriented upward or downward, parallel to the trunk axis (Figs 7–8). The cells measured an average of 20–25 mm in length and 3.5 mm in height, while the frass plug sealing the entrance ranged from 14 to 25 mm in length.



Figs 2–8. *Semanotus bifasciatus* (Motschulsky, 1875) on the trunk of *Thuja occidentalis* L.: 2 – larvae galleries and exit holes in sapwood, 3 – young beetles after emerging from wood, 4 – exit hole, 5 – inlet, plugged with frass, 6 – mating, 7 – pupal cells in sapwood (lower – after beetle emerging, upper – beetle is removed, entrance to the cell plugged with frass), 8 – beetle in pupal cell.

HARMFUL IMPACT. In East Asia, *S. bifasciatus* is generally regarded as a secondary pest, primarily damaging weakened or dying trees (Iwata *et al.*, 2007). However, several studies from China and South Korea suggest that this species can also function be a significant primary pest, infesting healthy and non-stressed mature trees, particularly in urban environments (Kim & Park, 1984; Yan, 2003; Gao *et al.*, 2007). For example, in 1988, *S. bifasciatus* infested 67.3% of the surveyed Cupressaceae trees in Dalian, Liaoning Province, China. Between 2002 and 2006, the species was responsible for extensive Cupressaceae mortality in the Linyan Forest, Shandong Province, China. Additionally, in 1979, an outbreak of *S. bifasciatus* resulted in the infestation of 97% of Cupressaceae trees in Xiangshan Park, Beijing (Zhang *et al.*, 2019). Given its destructive potential, *S. bifasciatus* is currently classified as a quarantine species in several Chinese provinces due to the threat it poses to artificial forest ecosystems (Tian, 1996).

The significant damage caused by *S. bifasciatus* underscores the need for effective early detection methods and population control strategies, as discussed in the research of Chinese entomologists (Qiu, 1999; Sun, 2000; Gao *et al.*, 2007; Ma *et al.*, 2010; Wang, 2017; Li *et al.*, 2020; Jiang *et al.*, 2022). To minimize damage and prevent reinfestation, it is recommended that infested trees be promptly removed and utilized upon the first signs of pest activity. Ongoing studies are focused on biological control methods, which include the use of entomopathogenic fungi, nematodes, predatory mites, and parasitic Hymenoptera (Qiu, 1999; Sun, 2000; Ma *et al.*, 2010; Zeng *et al.*, 2024). Chemical control involves the application of systemic pesticides via trunk spraying, with the timing of treatments being crucial, as pesticides are most effective against the early larval stages of the pest (Li *et al.*, 2003; Gao *et al.*, 2007).

In Cis-Azov region, *S. bifasciatus* has proven itself to be a significant pest of Cupressaceae trees in urban areas, causing the mortality of large, mature trees. Further expansion of the species' range presents a substantial threat to urban plantings, where Cupressaceae are extensively utilized in green infrastructure. Additionally, the species poses a risk to natural plant communities, particularly to the mountain forests of Crimea and the Caucasus. It is noteworthy that *S. bifasciatus* is the third alien invasive specialized woodboring pest of Cupressaceae to penetrate Cis-Azov region in recent years. In 2010, *Phloeosinus aubei* (Perris, 1855) (Coleoptera: Curculionidae) was recorded for the first time in the region (Nikulina, 2012), followed by *Lamprodila festiva* (Linnaeus, 1767) (Coleoptera: Buprestidae) in 2020 (Gubin *et al.*, 2020). Both of these species, originating from the European-Mediterranean region, have proven themselves to be dangerous pests in local conditions. The invasion of *S. bifasciatus* further intensifies the phytopathogenic pressures on artificial coniferous plantations in the area. The continued establishment of a complex of Cupressaceae phytophagous pests raises significant concerns regarding the future use of these trees in green infrastructure projects.

ACKNOWLEDGEMENTS

We extend our gratitude to E.G. Mulenkova (Donetsk botanical garden) for her invaluable assistance in the collection of material.

The publication was financially supported by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2024-528 of 24.04.2024 on the implementation of a large-scale research project within the priority areas of scientific and technological development).

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