EPPO Datasheet: *Trichoferus campestris*

Last updated: 2021-07-28

IDENTITY



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Preferred name: *Trichoferus campestris*
Authority: (Faldermann)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Cerambycidae
Other scientific names: *Callidium campestris* Faldermann, *Hesperophanes campestris* (Faldermann), *Hesperophanes flavopubescens* Kolbe, *Hesperophanes rusticus* Ganglbauer, *Stromatium turkestanicum* Heyden, *Trichoferus flavopubescens* (Kolbe), *Trichoferus rusticus* (Ganglbauer), *Trichoferus turkestanicus* (Heyden)
Common names: Chinese longhorned beetle (US), mulberry borer, mulberry longhorn beetle, velvet longhorned beetle (US)
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EPPO Categorization: A2 list
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EPPO Code: HESOCA

Notes on taxonomy and nomenclature

T. campestris has been described multiple times in various Asian countries, as well as under several generic names (*Callidium*, *Hesperophanes*, *Stromatium* and *Trichoferus*) (Lee & Lee, 2018). In much of the recent scientific literature this species has been referred to as either *H. campestris* or *T. campestris*. There are currently 8 species of *Hesperophanes* and 27 species of *Trichoferus* recognized worldwide, of which only one species of *Hesperophanes* is native to the New World (Tavakilian & Chevillotte, 2020). Grebennikov *et al*. (2010) state that the genera *Hesperophanes* and *Trichoferus* are both in need of taxonomic revision.

HOSTS

Trichoferus campestris has been recorded from more than 50 genera of woody plants, both broadleaf species as well as conifers (Iwata & Yamada, 1990; Orlinski, 2006; Lim *et al.*, 2014; CAPS, 2019; Rodman *et al*., 2020). Moreover, it can infest woody plants in a wide variety of host conditions, from live trees, to dying trees, trees that recently died and even dry wood (Iwata & Yamada, 1990; Bullas-Appleton *et al*., 2014; Rodman *et al*., 2020). The presence of bark is apparently required in all cases given that early larval development occurs just beneath the bark. In Asia, within the beetle's native range, *T. campestris* was commonly reported as a pest of *Malus* (apple), *Morus* (mulberry), and other fruit trees (Plavilstshikov, 1940; Pavlovskii & Shtakelberg, 1955; Makhnovskii, 1966; Cherepanov, 1981; Krivosheina & Tokgaev, 1985; Ler, 1996; Zhang *et al.*, 2017). In China and Japan, *T. campestris* is considered a major pest of dry wood, including logs and cut wood with bark (Iwata & Yamada, 1990; Yang, 1992). Based on the long list of known hosts, it is assumed that *T. campestris* can attack almost all woody species (Iwata & Yamada, 1990; Grebennikov *et al.*, 2010; CAPS, 2019). In addition, *T. campestris* has occasionally been reported to infest perennial grasses in Asia (Iwata & Yamada, 1990) and under laboratory conditions larvae have been reared to adults on the grain of corn and rice (Weng & Zheng 1991; Yin & Guo, 1999).

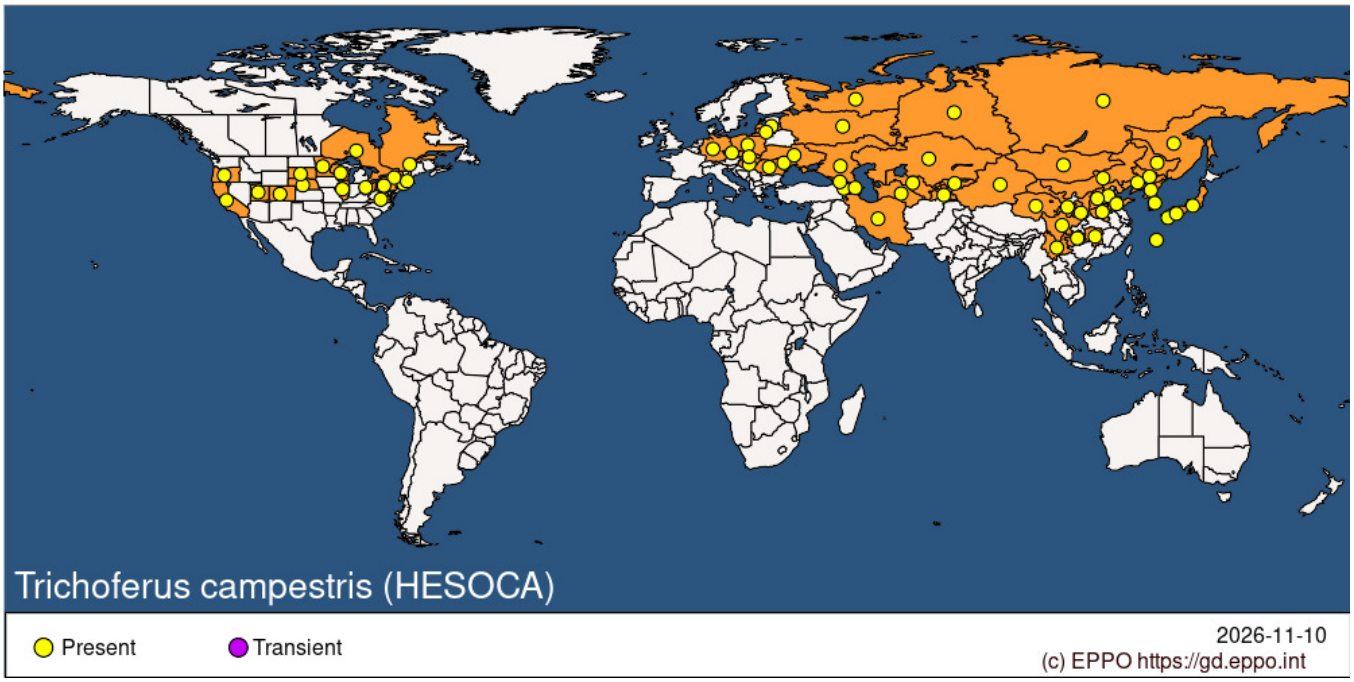
Host list: *Abies*, *Acer negundo*, *Acer platanoides*, *Acer saccharinum*, *Acer*, *Alnus maximowiczii*, *Alnus*, *Aralia elata*, *Aralia*, *Astragalus*, *Betula ermanii*, *Betula grossa*, *Betula nigra*, *Betula platyphylla*, *Betula utilis*, *Betula*, *Broussonetia papyrifera*, *Camellia japonica*, *Carpinus laxiflora*, *Carpinus*, *Carya*, *Celastrus*, *Cercidiphyllum*, *Chamaecyparis obtusa*, *Citrus*, *Cornus*, *Corylus avellana*, *Cunninghamia lanceolata*, *Diospyros*, *Elaeagnus angustifolia*, *Eleutherococcus sieboldianus*, *Eleutherococcus*, *Euonymus*, *Fagus crenata*, *Fagus*, *Fraxinus excelsior*, *Fraxinus velutina*, *Fraxinus*, *Gleditsia triacanthos*, *Gleditsia*, *Glycyrrhiza uralensis*, *Ilex latifolia*, *Ilex*, *Juglans ailanthifolia*, *Juglans nigra*, *Juglans regia*, *Juglans*, *Larix sibirica*, *Larix*, *Mallotus japonicus*, *Malus domestica*, *Malus*

, Morus bombycis, Morus, Paeonia lactiflora, Picea crassifolia, Picea obovata, Picea schrenkiana, Picea, Pinus densiflora, Pinus sibirica, Pinus, Populus, Prunus armeniaca, Prunus avium, Prunus persica, Prunus pseudocerasus , Pyrus pyrifolia var. culta, Pyrus, Quercus petraea, Quercus variabilis, Quercus, Rhus, Robinia pseudoacacia, Rubus idaeus, Salix, Scutellaria baicalensis, Sorbus alnifolia, Sorbus aucuparia, Sorbus, Styphnolobium japonicum, Syringa, Syzygium aromaticum, Syzygium, Thuja plicata, Tilia, Toxicodendron sylvestre, Toxicodendron vernicifluum , Ulmus pumila, Ulmus, Vitis vinifera, Wisteria, Zanthoxylum, Zelkova serrata, Ziziphus jujuba, Ziziphus

GEOGRAPHICAL DISTRIBUTION

T. campestris is native to East Asia (including Mongolia, Central and Northeastern China and the Korean peninsula) and is probably also native to Central Asia (including Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Eastern Russia up to the Ural Mountains) (Cherepanov, 1981; Danilevsky, 2019; Keszthelyi *et al.*, 2019). It has spread into European Russia and several eastern European countries (Dasc?lu *et al.*, 2013; Orlova-Bienkowskaja, 2017; Keszthelyi *et al.*, 2019). Its spread from east to west in Europe is likely to be occurring through both human-mediated activities as well as natural dispersal (Dasc?lu *et al.*, 2013). *T. campestris* has also become established in Canada (Grebennikov *et al.*, 2010; Bullas-Appleton *et al.*, 2014) and the United States (Krishnankutty *et al.*, 2020).

In Canada, *T. campestris* was first collected outdoors in Quebec in 2002 (Grebennikov *et al.*, 2010) and later in Ontario in 2010 (Bullas-Appleton *et al.*, 2014). In the United States, *T. campestris* was first collected outdoors in Florida in 1992, but apparently did not become established there (Pfister & Valdez, 2017). *T. campestris* was subsequently collected outdoors in Illinois in 2009 and then in Utah in 2010, and is now considered well established in both of these states (Watson *et al.*, 2016; Pfister & Valdez, 2017). As of early 2021, *T. campestris* had been collected outdoors and considered established in 14 states in the United States (PDA, 2016; Pfister & Valdez, 2017; Ball, 2019; Francese *et al.*, 2019; MNDA, 2020; Van Meter, 2019; WDATCP, 2020; CERIS, 2020; Fichtner & Wilson, 2020; Krishnankutty *et al.*, 2020; Rodman, 2020; Aitkenhead, 2021; Vlach, 2021). The current distribution is provided below.



EPPO Region: Armenia, Azerbaijan, Czechia, Georgia, Germany, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Republic of, Poland, Romania, Russian Federation (Central Russia, Eastern Siberia, Far East, Northern Russia, Southern Russia, Western Siberia), Slovakia, Ukraine, Uzbekistan
Asia: China (Gansu, Guizhou, Hebei, Heilongjiang, Henan, Hunan, Jilin, Liaoning, Neimenggu, Qinghai, Shaanxi, Shandong, Shanxi, Sichuan, Xinjiang, Yunnan), Iran, Islamic Republic of, Japan (Honshu, Kyushu, Ryukyu Archipelago, Shikoku), Kazakhstan, Korea, Democratic People's Republic of, Korea, Republic of, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, Uzbekistan
North America: Canada (Ontario, Québec), United States of America (California, Colorado, Connecticut, Illinois, Massachusetts, Minnesota, Nebraska, New York, Ohio, Oregon, Pennsylvania, South Dakota, Utah, Virginia,

Wisconsin)

BIOLOGY

T. campestris is commonly found in forests and orchards. Adults usually emerge from May to August, with peak emergence from late June to early August (Cherepanov, 1981; Spears *et al.*, 2020). In China, adults have been reported from April into November (Yin & Guo, 1999). Beetles are nocturnal: flying, mating, and laying eggs at night (Yin & Guo, 1999). Adults are attracted to lights at night (Kostin, 1973; Cherepanov, 1981). A male-produced aggregation sex pheromone has been identified and used successfully in the field (Francese *et al*., 2019; Ray *et al*., 2019). Females lay eggs on the bark of trunks and branches of woody plants (healthy, stressed or dying), as well as on the bark of cut wood (green or dry) (Cherepanov, 1981; Iwata & Yamada, 1990; Yin & Guo, 1999). Under laboratory conditions, females laid eggs singly on branches 2.5–3.0 cm in diameter (Cherepanov, 1981). Adults live for about 2-3 weeks and females lay an average of 50 eggs each (Yin & Guo, 1999). Eggs hatch in about 10 days (Yin & Guo, 1999). After hatching, the neonate larvae enter the bark and make their initial galleries between the bark and sapwood, and usually enter the wood during late larval development. Bark is apparently required during early larval development (Iwata & Yamada, 1990). Mature larvae construct galleries that measure 5–12 mm in width (Cherepanov, 1981). Larval galleries are irregular in shape, appear flattened, and often contain frass (insect excrement and boring dust) (Bullas-Appleton *et al.*, 2014). However, larvae often expel frass from their galleries as well (Yin & Guo, 1999). When larval densities are high, nearly all inner bark is consumed, which allows the outer bark to peel off. Late instar larvae usually enter the sapwood. Larvae can complete development in dry wood (Iwata & Yamada, 1990). Larvae overwinter under the bark or in pupal cells constructed in the inner bark or sapwood. Pupation usually occurs in spring or summer. In the laboratory, pupation occurs at a higher rate when mature larvae are exposed to a cold period (Nadel *et al*., 2019). The life cycle of *T. campestris* is usually completed in 1-2 years, but can take longer in dry wood (Plavilstshikov, 1940; Pavlovskii & Shtakelberg, 1955; Makhnovskii, 1966; Kostin, 1973; Cherepanov, 1981; Danilevsky & Miroshnikov, 1985; Ler, 1996; Iwata & Yamada, 1990). Larval development time often becomes protracted in wood-feeding cerambycids as the wood moisture level decreases (Haack, 2017).

DETECTION AND IDENTIFICATION

Signs and symptoms

The characteristic signs of *T. campestris* infestation are round exit holes (6-9 mm diameter) on trunks and branches, larval frass at the base of infested trees, and larval galleries under the bark or on the sapwood surface (Bullas-Appleton *et al.*, 2014; Rodman *et al.*, 2020). Common symptoms of infestation can include yellowing and thinning foliage, crown dieback, peeling bark and epicormic shoots (Bullas-Appleton *et al.*, 2014; CAPS, 2019; Rodman *et al.*, 2020).

Morphology

Egg

The eggs of *T. campestris* are white, oval, slightly elongated, 1.5 to 1.9 mm long, and 0.5 to 0.6 mm wide (Cherepanov, 1981; Rodman *et al.*, 2020).

Larva

Larvae can be identi?ed based on the morphological characters described in Cherepanov (1981), Grebennikov *et al.* (2010), Svacha & Danilevsky (1987), Jiang (1989) and Connell *et al.* (2020). Larvae are generally yellowish-white, 15 to 32 mm long when mature, with six short thoracic legs that have a trochanter present and stout setae on all segments (Grebennikov *et al.*, 2010; Connell *et al.*, 2020). The abdominal ampullae on segments I–VII are prominent and furrowed, but lack distinct tubercles and are not asperate. The head is narrow at front and retracted into the prothorax. Three large stemmata are present on each side of the head, with a row of stemmata almost as long as the diameter of antennal foramen. The antennae have 3 segments with long stout setae. The pronotum is twice as wide as long, with an orange transverse stripe broken in the middle. The scutum is prominent. The prosternum is

covered with orange hairs. Abdominal segments 4, 5 and 6 are of similar width, but are narrower than the adjoining segments 3 and 7 (Connell *et al*., 2020). A complete and illustrated description of the larva is available in Connell *et al.* (2020).

Pupa

The pupae of *T. campestris* are white, elongate, about 18 to 20 mm long, and 4 to 5 mm wide (Cherepanov, 1981; Grebennikov *et al.*, 2010). The vertex of the head and pronotum are rugose (wrinkled), and there are small spines on abdominal tergites I–VI and larger spines on abdominal tergite VII. The head has no bristles (glabrous). The antennae are curved and reach to midtibia. The pronotum is rounded in front and covered with small spines that form a transverse stripe. The spines on abdominal tergites I–VI generally form three transverse rows with 4 – 8 spines in the posterior row, 2 spines in the middle row, and 3 –5 spines in the anterior row. A detailed description of the pupa is given in Cherepanov (1981).

Adult

T. campestris adults are elongate, parallel-sided, and 10–24 mm long (Okamoto, 1927; Plavilstshikov, 1940; Cherepanov, 1981; Grebennikov *et al.*, 2010; Lee & Lee, 2018; Rodman *et al.*, 2020). The whole body, elytra and legs vary in colour from dark brown to brownish-orange, with the legs and antennae usually being lighter in colour than the body. The elytra often have a spotty appearance. Much of the head, pronotum and elytra are covered with a fine pubescence, which relates to one of the common names for this beetle: velvet longhorned beetle. The antennae are about 90% the body length in males and 70% in females (Grebennikov *et al.*, 2010). The pronotum is rounded at both ends with dense punctuation. The scutellum is rounded. The posterior margin of abdominal sternite VI (visible ventrite 4) is straight in females and notched at the middle in males (Grebennikov *et al.*, 2010). A detailed description of the adult is given in Cherepanov (1981), Danilevsky & Miroshnikov (1985), Ler (1996), Lee & Lee (2018) and Royals & Gilligan (2019).

Detection and inspection methods

Inspection methods of consignments of wood, wood products and wood packaging materials include visual inspection for larval activity (e.g. frass and larval galleries), adult exit holes, and for the presence of the different life stages of the insect. Sniffer dogs have been involved in the detection (interception) of *T. campestris* in infested wood packaging (Pennacchio *et al.*, 2016).

Monitoring methods include visual inspections of trees for the signs and symptoms typical of *T. campestris* infestation. Trapping at night with black lights (ultra-violet) or lure-baited traps is also effective. Lindgren funnel traps or cross-vane panel traps, coated with the slippery substance fluon, are often recommended. In the United States, ethanol was the recommended lure for *T. campestris* in the past, but now that a pheromone has been discovered for this beetle (Ray *et al*., 2019), the pheromone is now the lure of choice (CAPS, 2019). Many new state records for *T. campestris* have been recorded recently in the United States as a result of trapping with the pheromone lures. The best time of year to trap for *T. campestris* is during peak flight from late June to early August (Rodman *et al.*, 2020).

In the United States, *T. campestris* has been commonly trapped near wood recycling sites, pallet and dunnage yards, warehouses, and in residential and commercial landscapes where cull wood is often stored (Krishnankutty *et al.*, 2020). However, in areas where *T. campestris* is native or established, it can be trapped in both forests and orchards.

Identification of specimens is primarily done based on adult morphology. DNA barcoding can be used to confirm morphological identification of adults or to identify damaged specimens for which morphological identification is not possible, as well as for immature specimens (EPPO, 2016; Hodgetts *et al*., 2016; Wu *et al*., 2017; Connell *et al.*, 2020).

PATHWAYS FOR MOVEMENT

Natural spread of *T. campestris* is by adult flight at night. However, there have been no specific studies on the dispersal ability of *T. campestris.*

Because larvae of *T. campestris* may be hidden under bark or in wood, they can be easily transported in round wood (Iwata & Yamada, 1990), including firewood (Rodman *et al*., 2020), sawn wood (Cocquempot, 2006; Bozkurt *et al*. 2013), cut branches (Sabol *et al*., 2020), wood packaging material (Cocquempot, 2006; Pennachio *et al*., 2016; Benker, 2018), and various wood products. Several of these worldwide detections have been summarized in Pfister & Valdez (2017), Keszthelyi *et al*. (2019) and Krishnankutty *et al*. (2020). Some examples of finished wood products from which *T. campestris* has emerged include cutlery trays, rustic furniture with bark, sculptures, planters, picture frames, and decorative wood baskets and home decorations (Defra, 2015; Hodgetts, 2016; Maier, 2017; Pfister & Valdez, 2017; Krishnankutty *et al*., 2020). In the United States, for the period 1985 to 2000, *Trichoferus* (combined with *Hesperophanes*) was the fourth most commonly intercepted cerambycid genus at US ports of entry (Haack, 2006). Given this high rate of interception, it is not surprising that recent DNA evidence for established populations of *T. campestris* in the United States suggests that there were multiple introductions of this beetle that became established (Wu *et al*., 2020).

T. campestris is rather unlikely to be transported in small plants for planting, since it does not commonly attack small-diameter branches, trunks or rootstocks. Large plants of its hosts are rarely traded as live plants and therefore would be less likely to serve as a pathway for introduction. In theory, *T. campestris* could be transported in bonsai plants, which may have large diameter trunks, but no such interceptions have ever been reported to date.

PEST SIGNIFICANCE

Economic impact

Although there are reports of *T. campestris* infesting live trees in forest, orchard, and urban settings (Kostin, 1973; Krivosheina & Tokgaev, 1985, Bullas-Appleton *et al*., 2014; Rodman *et al*., 2020), there have been no reports of severe economic impact caused by this beetle in its native or introduced range. Nevertheless, infestations of live trees could result in loss of tree vigour, wood marketability due to larval galleries and exit holes, and fruit yield in the case of orchards (Makhnovskii, 1955, 1966; Kostin, 1973; Krivosheina & Tokgaev, 1985). In China, Zhang *et al*. (2017) reared eight species of cerambycids from fruit trees in various stages of decline from healthy to dead: *T. campestris* was consistently associated with dead trunks and branches, not live trees. However, given that *T. campestris* is able to develop in recently cut logs and branches (Yang, 1992; Burfitt *et al*., 2015; Sabol *et al*., 2020) as well as dry wood (Iwata & Yamada, 1990) indicates that it has the potential to be an important technical pest of wood, especially if wood is stored with bark attached. In addition, if bark is still present on wood after it is treated to ISPM 15 standards (FAO, 2019), it would be possible for *T. campestris* to infest wood after treatment.

Control

Given that this beetle appears to have a preference for stressed trees when attacking live orchard and amenity trees, managers should favour silvicultural measures that improve tree health. In settings where cull trees or cut branches are collected and stacked (Rodman *et al*., 2020; Sabol *et al*., 2020), such wood should be chipped or burned at least annually to stop *T. campestris* from completing its life cycle. In the former USSR, silvicultural and sanitary measures were applied and treatments with chemical and biological preparations were investigated (Makhnovskii, 1955). Only a few natural enemies of *T. campestris* have been reported in Asia, such as the bethylid wasp *Sclerodermus harmandi* (Lim *et al.*, 2006), the braconid wasp *Zombrus bicolor* (Zang, 1984; Cao *et al.*, 2015) and the pteromalid wasp *Solenura ania* (Cao *et al.*, 2020). It is interesting to note that the braconid *Zombrus bicolor* has become established in Italy, apparently the result of an accidental introduction (Dal Pos, 2017).

Phytosanitary risk

In its native range in Asia, *T. campestris* is considered as an occasional pest of forest and orchard trees, but often as a serious pest of logs and lumber with bark, including dry wood. *T. campestris* is likely to be able to establish throughout most of the EPPO region except at latitudes over N60° or altitudes above 2 000 m (e.g. in the Alps and the Caucasus) where the climatic conditions are probably too cold for the beetle's development (Keszthelyi *et al*., 2019). It should be noted that many other tree-infesting species of *Trichoferus* occur in the EPPO region (e.g., *T. fasciculatus*, *T. griseus*, *T. holosericeus*, *T. pallidus*), and therefore care must be taken when identifying adult beetles, as well as making certain to use taxonomic keys that contain *T. campestris* such as in Hegyessy & Kutasi

(2010). The main risk of entry to the EPPO region is in wood including wood packaging material and wood products, since the pest is able to develop in dry wood.

PHYTOSANITARY MEASURES

Wood packaging should be treated according to ISPM no. 15 (FAO, 2019). International movement of wood commodities of the host plants, especially when bark is present (given that *T. campestris* requires bark for early larval development), could serve as a pathway for *T. campestris*, but measures such as pest free area, making the wood bark free, debarking followed by heat treatment, irradiation or fumigation could be used. If bark is present, appropriate measures should be taken to prevent infestation by *T. campestris* during storage and transport. Finally, if measures are deemed necessary for plants for planting (e.g. large plants or bonsais), management options such as pest free areas or pest free production sites under complete physical isolation can be used, with plants packed in conditions preventing infestation during transport (or traded outside the period where adults are present).

In case of an outbreak removal of infested or potentially infested trees could be an effective eradication or containment measure, however, given the beetle's extensive host range such control measures could be highly disruptive to affected communities (Defra, 2015). Monitoring for the pest, especially with pheromone lures, is important to detect potential establishments early and thereby increase the chance of eradication.

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ACKNOWLEDGEMENTS

This datasheet was extensively revised and updated in 2021 by Robert A. Haack, USDA Forest Service, Northern Research Station, Lansing, MI, USA (emeritus). His valuable contribution is gratefully acknowledged.

How to cite this datasheet?

EPPO (2026) *Trichoferus campestris*. EPPO datasheets on pests recommended for regulation. Available online. https://gd.eppo.int

Datasheet history

This datasheet was first published in the EPPO Bulletin in 2009 and revised in 2021. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

EPPO (2009) *Hesperophanes campestris*. Datasheets on pests recommended for regulation. *EPPO Bulletin* **39**(1), 51-54. https://doi.org/10.1111/j.1365-2338.2009.02236.x

Co-funded by the European Union