CAPS Datasheets provide pest-specific information to support planning and completing early detection surveys.

Ips sexdentatus

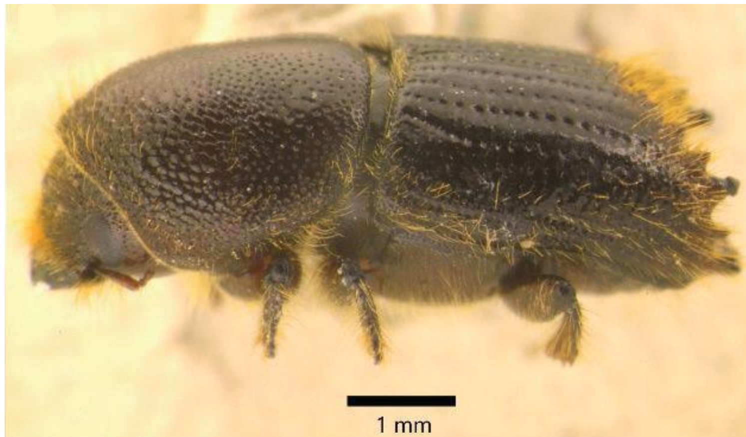

Figure 1. Adult *Ips sexdentatus* (image courtesy of Yiyi Dong and Jiri Hulcr, University of Florida EDIS 808)

Scientific Name

Ips sexdentatus (Börner, 1767)

Synonym(s):

Dermestes sexdentatus Börner, 1767
Bostrichus stenographus Duftschmid, 1825

Common Name

Six-toothed bark beetle
Pine stenographer beetle
Six-spined engraver beetle
Six-toothed Ips
Twelve-spined Ips

Type of Pest

Bark beetle

Taxonomic Position

Class: Insecta, **Order:** Coleoptera, **Family:** Curculionidae

Pest Recognition

This section describes characteristics of the organism and symptoms that will help surveyors recognize possible infestations/infections in the field, select survey sites, and collect symptomatic material. For morphological descriptions, see the Identification/Diagnostic resources on the AMPS pest page on the CAPS Resource and Collaboration website.

Pest Description

Adults: *Ips sexdentatus* is the largest beetle in the *Ips* genus (Fig. 1) (Benzel, 2015). Females and males are $^{3}/_{16}$-$^{5}/_{16}$ in. long and 2.6-2.8 times longer than wide (Fig. 2b) (Douglas et al., 2019).

Adult beetles within the *Ips* genus share many similar features, including a hairy body with fine hair on the head, surrounding the rear of the elytra (hardened outer wings), and along the sides of the body (Figs.1 and 2) (Benzel, 2015; Cavey and Passoa, 1994; Douglas et al., 2019). Body color within the genus can vary from yellow to dark brown and varies with age. Specimens collected from their galleries before maturity are usually pale (Fig. 2b), while mature specimens are typically dark (Hulcr et al., 2015).

Adult *Ips* spp. have a pill-shaped body with a rear portion that is smooth sloping and concave (also known as an elytral declivity) (Fig. 2b) and three-six spines on each lateral side. *Ips sexdentatus* has six spines with the largest spine in the fourth position (Fig. 2c), and this character differentiates the species from all other *Ips* species. A microscope is needed to see these characters (Benzel, 2015; Douglas et al., 2019).

Adults can be found underneath the tree bark, flying when swarming to new host plants, or in the ground when overwintering (Cognato, 2015; Lévieux et al., 1985).

Eggs: Eggs are pearly-white (Ciesla, 2001). They can be found in the inner bark (Cognato, 2015).

Larvae: Mature larvae are $^{3}/_{16}$-$^{5}/_{16}$ inch long, c-shaped grubs. The body is white with a distinct amber head (Fig. 3a and b) (Ciesla, 2001). They can be found in galleries in the inner bark (Cognato, 2015).

Pupae: Pupae are white and mummy-like. They show some adult features, including clearly visible wings that are folded behind the abdomen (Fig. 3c) (Ciesla, 2001). They are located in round chambers at the ends of larval galleries (Ciesla, 2011).

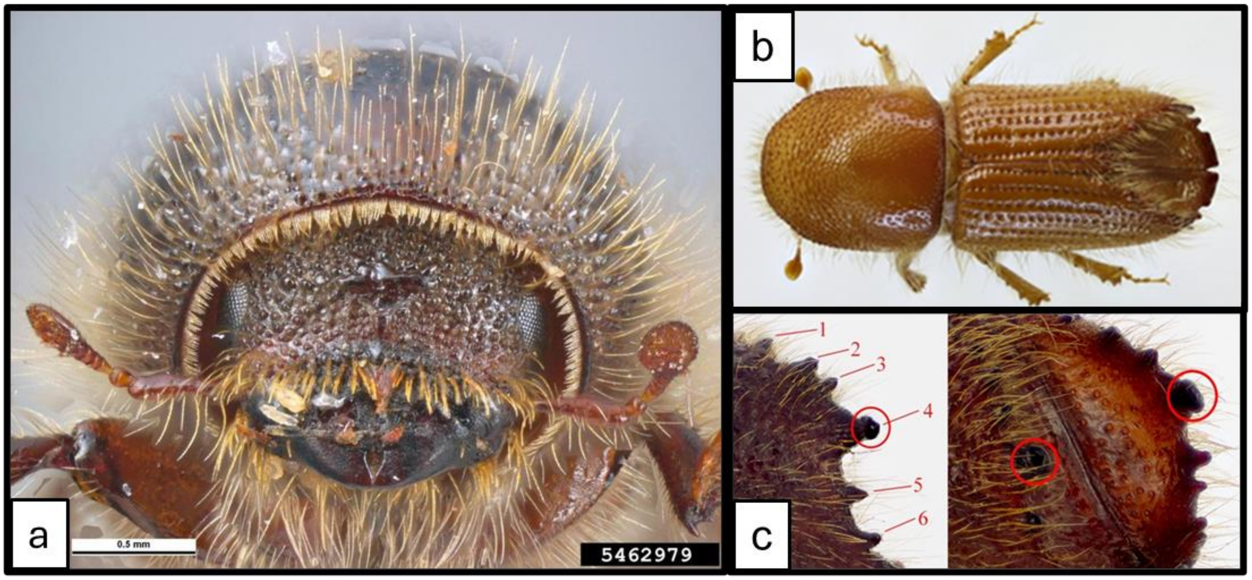

Figure 2. *Ips sexdentatus* adults: **(a)** *I. sexdentatus* head (photo by Pest and Diseases Image Library, Bugwood.org); **(b)** Adult in dorsal view (image courtesy of Douglas et al., 2019); **(c)** Apical portion of the elytral declivity showing the 4^{th} spine enlarged (photo by Joseph Benzel, Screening Aids, USDA APHIS PPQ, Bugwood.org)

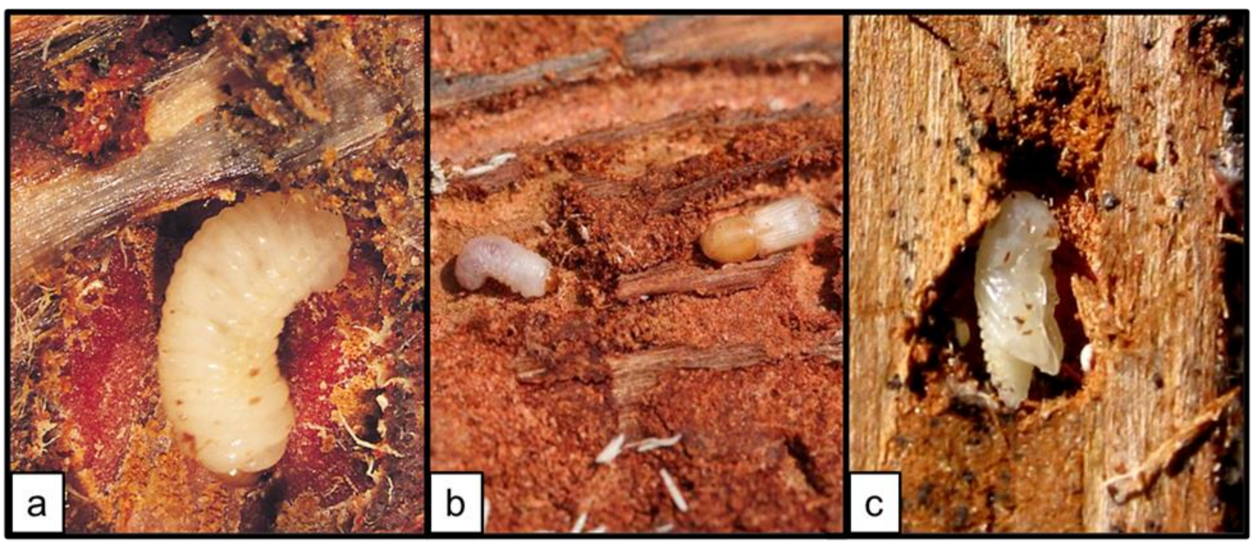

Figure 3. Immature & early adult stages of *Ips sexdentatus*. Left to right: **(a)** *I. sexdentatus* larva (photo by Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org); **(b)** larva & early adult (photo by Milan Zubrik, Forest Research Institute - Slovakia, Bugwood.org) and **(c)** pupa (photo by Vladimir Petko, V.N. Sukachev Institute of Forest SB RAS, Bugwood.org)

Signs and Symptoms

Attacked trees can show multiple signs including entrance holes, frass, sawdust, and resin coming from the holes, and symptoms such as needles turning yellow or branch dieback (Fig. 4a,b,c,d) (Dong and Hulcr, 2024).

Under the bark, mated *I. sexdentatus* females create galleries along the trunk's long axis where they will deposit their eggs; galleries are $^{3}/_{4}$ to 20 in. long and $^{1}/_{8}$-$^{3}/_{16}$ in. wide

(Fig. 5) (Chararas, 1962; Lévieux et al., 1985). Secondary galleries branching from the main gallery are characteristic of *Ips* species and often form a Y- or X-shaped pattern (Fig. 5a and b) (Ciesla, 2011). From these, larvae will burrow several small galleries perpendicular to the main gallery (Chararas, 1962).

In addition, just like nearly all *Ips* species, this bark beetle is often an inadvertent vector of ophiostomatoid fungi that leave a distinctive blue staining on the wood (Fig. 5c) (Bueno et al., 2010).

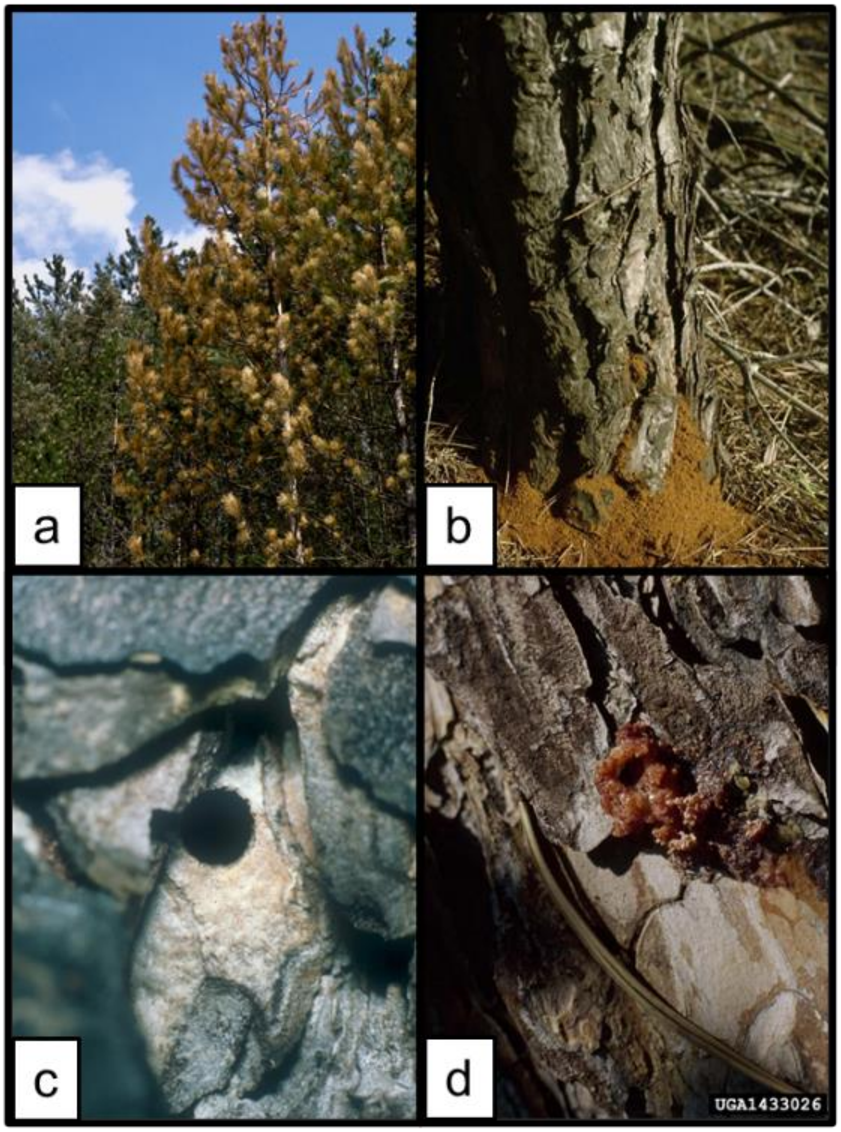

Figure 4. External signs of *I. sexdentatus* infestation: **(a)** tree branches showing yellowing (photo by Louis-Michel Nageleisen, Département de la Santé des Forêts, Bugwood.org); **(b)** larval saw dust deposition (photo by Fabio Stergulc, Università di Udine, Bugwood.org); **(c)** exit hole (photo by Maja Jurc, University of Ljubljana, Bugwood.org); and **(d)** entry hole showing resin exudate (photo by Fabio Stergulc, Università di Udine, Bugwood.org)

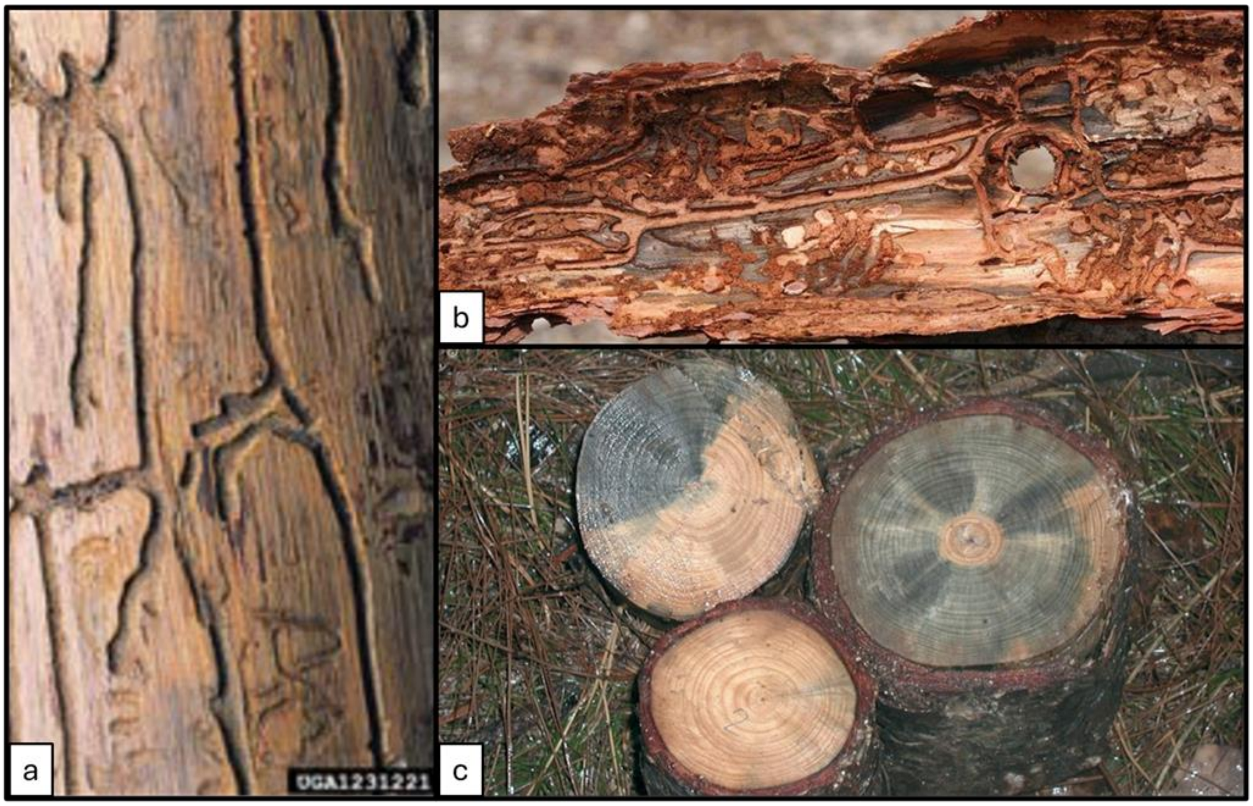

Figure 5. Signs of *Ips* spp*.,* including *I. sexdentatus*, infestation inside trees: **(a)** galleries on the trunk (photo by Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org); **(b)** galleries on the underside of the bark (photo by Milan Zubrik, Forest Research Institute- Slovakia, Bugwood.org); and **(c)** blue stain fungi in the genera *Leptographium* and *Graphium* (photo by Maja Jurc, University of Ljubljana, Bugwood.org)

Easily Mistaken Species

Several *Ips* species are present in the United States. *Ips sexdentatus* could be confused with *I. calligraphus* and *I. apache*; they are present in the United States and have *Pinus* spp. as their main host and are among the largest of *Ips* (Ciesla, 2011; Cognato, 2015; Connor and Wilkinson, 1983; Douglas et al., 2019). *Ips calligraphus* is present throughout the continental United States, while *I. apache* is only reported in Arizona (Atkinson, 2024; Douglas et al., 2019).

Both *Ips* species mentioned above have six spines at the posterior end of the elytra However, *I. sexdentatus* can be differentiated from other species because it is conspicuously larger than these two species and has the largest spine in the fourth position from the top, while the others have the largest spine in the third position (Douglas et al., 2019).

Interactive keys for *Ips* bark beetles of the world can be found in Douglas et al. (2019). Additionally, Benzel (2015) published a screening aid for *I. sexdentatus* that can help differentiate it from *I. calligraphus* and *I. apache*.

Commonly Encountered Non-targets

The approved survey method for *I. sexdentatus* is the Exotic Bark Beetle (EBB)/*Ips* lure, which includes the following blend: cis-verbenol, ipsdienol, 2-Methyl-3-buten-2-ol (MBO).

Numerous insects from multiple orders, including Diptera, Heteroptera, Hymenoptera, Odonata, Psocoptera, are attracted to the components of this pheromone blend and may be captured in traps targeting *I. sexdentatus* (El-Sayed, 2024). The most common beetles attracted include longhorn beetles, clown beetles, leaf beetles, checkered beetles, darkling beetles, click beetles, snout beetles, ambrosia beetles, and other bark beetles (El-Sayed, 2024). Of these, the Scolytinae (bark beetles) are the most morphologically similar to *I. sexdentatus.* The following bark beetles are attracted to one or more components of the lure blend and are present in the United States (Atkinson, 2024):

Carphoborus andersoni, C. intermedius, Dendroctonus brevicomis (western pine beetle), *D. frontalis* (southern pine beetle), *D. jeffreyi* (Jeffrey pine beetle), *D. ponderosae* (mountain pine beetle), *D. terebrans* (black turpentine beetle), *D. valens* (red turpentine beetle), *Hylastes porculus, Hylurgus ligniperda* (red-haired bark beetle), *Gnathotrichus materiarius, Orthotomicus erosus* (Mediterranean pine engraver beetle), *O. latidens* (smaller western pine engraver), *Phloeosinus pini, Phloeotribus piceae, Pityogenes bidentatus* (bidentated bark beetle), *P. carinulatus, P. hopkinsi* (chestnut brown bark beetle), *P. knechteli*, *Pityokteines elegans, Pityophthorus opaculus, Pseudips mexicanus* (Monterey pine engraver)*, Tomicus piniperda* (large pine shoot beetle), and *Trypodendron lineatum* (striped ambrosia beetle).

Within the *Ips* genus*,* attracted species include *I. avulsus* (small southern pine engraver), *I. bonanseai*, *I. borealis borealis, I. calligraphus* (six-spined engraver beetle), *I. confusus* (Pinyon pine beetle), *I. cribricollis, I. grandicollis* (five-spined engraver beetle), *I. integer*, *I. knausi*, *I. paraconfusus* (California fivespined ips), *I. perturbatus* (northern spruce engraver), and *I. pini* (pine engraver) (El-Sayed, 2024).

Benzel (2015) mentioned that during *I. sexdentatus* surveys in the United States the *Ips* species often captured include *I. calligraphus*, *I. plastographus*, and *I. montanus*.

Biology and Ecology

Ips sexdentatus infests mostly dead and dying trees but may colonize living trees that are stressed, or possibly even healthy (Chararas, 1962; Cognato, 2015; Fernández, 2006; Pineau et al., 2017a). They prefer to infest large trees with thick bark (Akkuzu and Guzel, 2015; Evans, 2021).

Epidemics occur following climatic disturbances or other events that stress or kill trees, such as storms, wildfires, droughts, windstorms, severe defoliation, or diseases (Bouhot et al., 1988; Davydenko et al., 2021; Etxebeste Larrañaga et al., 2013; Fernández, 2006; Lopez and Goldarazena, 2012). These disturbances create large amounts of stressed or dead wood, which serves as suitable feeding material for the beetles to breed and build up their numbers. With larger numbers, beetles can overcome the defenses of healthy trees, resulting in localized outbreaks that could last 2-3 years (Pineau et al., 2017a).

Ips sexdentatus spends most of its life underneath tree bark (Cognato, 2015). Host colonization begins when a male bores into the bark and then secretes an aggregation pheromone that attracts both males and females (Blomquist et al., 2010; Cognato, 2015). The male will mate with 2-5 females and then each female excavates her own gallery to lay eggs (Lévieux et al., 1985).

After hatching, young larvae feed inside the galleries before pupating in round chambers at the end of the larval galleries (Ciesla, 2011). After they emerge, young adults continue feeding inside the tree for approximately 12-14 days (Raffa et al., 2015; Sarikaya et al., 2012) before swarming to mate on neighboring trees, starting the next generation (Lévieux et al., 1985). The *I. sexdentatus* life cycle can take as little as 34 days but can take up to 92 days, depending on temperature and season (Chararas, 1962; Lévieux et al., 1985 citing Vallet, 1981; Sarikaya et al., 2012).

'Sister generations' or 'sister broods' have been observed where a female will fly and lay a second set of eggs in another tree after the first eggs are laid. Females lay a total of 10-60 eggs in their lifetime (Chararas, 1962; Jactel and Lieutier, 1987; Lévieux et al., 1985).

Pineau et al. (2017b) estimated the minimum and maximum developmental thresholds to be 52°F and 97°F, respectively. The optimal temperature for development was estimated to be 29°C and 517 degree-days are required for complete development. Additionally, using CLIMEX climate modeling, Pineau et al. (2017b) predicted 1 generation for most of Europe, 2-3 generations in the south of France, and 3-5 generations in the Mediterranean region, which is consistent with the observations from Chararas (1962).

Ips sexdentatus adults can overwinter under bark or, more rarely, in the ground (Chararas, 1962; Lévieux et al., 1985). The timing of swarming in the spring varies by location based on temperature and it has been observed at temperatures above 64°F (Bouhot et al., 1988; Evans, 2021; Lévieux et al., 1985).

Ips sexdentatus vectors or is associated with a broad range of fungi, including members of Ascomycota, Basidiomycota and Mucoromycotina (Davydenko et al., 2021; Evans, 2021). Some Ophiostomatoid fungi cause disease and blue staining on trees and lumber (Fig. 5c) (Davydenko et al., 2021; Kirisits, 2004). Additionally, *Fusarium circinatum,* the causal agent of pine pitch canker that is present in the United States*,* has been isolated from *I. sexdentatus*, although there is no indication that the beetle vectors the pathogen (Meinecke et al., 2022; Romon et al., 2007).

Known Hosts

Ips sexdentatus is a forest pest of several conifer species in the Pinaceae family. It attacks hosts in the *Abie*s, *Larix*, *Picea* and *Pinus* genera. *Pinus* spp. and *Picea* *orientalis* appear to be preferred hosts because they have reported outbreaks and/or economic losses (Chararas, 1962; Lévieux et al., 1985; Schönherr et al., 1983). *Ips sexdentatus* requires large trees and thick phloem for reproduction (Hulcr, 2024).

The host list below includes cultivated and wild plants that 1) are infected or infested by the pest under natural conditions, 2) are frequently described as major, primary, or preferred hosts, and 3) have primary evidence for feeding and damage documented in the literature. Plants are highlighted in bold if they are commercially produced and the pest causes economically significant damage.

Table 1. Preferred hosts of *Ips sexdentatus*.

Scientific Name	Common Name	Presence in the US*	Type/Use	References/Notes
Pinus spp.	pine	Present	Cultivated/wild	Chararas, 1962
Pinus brutia	Calabrian pine	Present	Cultivated/wild	Cebeci and Baydemir, 2019
Pinus halepensis	Aleppo pine	Present	Cultivated/wild	Agbaba and Ćelepirović, 2008
Pinus heldreichii	Bosnian pine	Present	Cultivated/wild	Zivojinovic, 1960
Pinus nigra	black pine	Present	Cultivated/wild	Özcan et al., 2018
Pinus pinaster	maritime pine	Present	Cultivated/wild	Bueno et al., 2010
Pinus pinea	Italian stone pine	Present	Cultivated/wild	Paiva et al., 1988
Pinus radiata	Monterrey pine	Present	Cultivated/wild	Cobos and Ruiz, 1990
Pinus sylvestris	Scots pine	Present	Cultivated/wild	Bouhot et al., 1988
Picea abies	Norway spruce	Present	Cultivated/wild	Nikulina et al., 2015
Picea orientalis	Oriental spruce	Absent	Wild	Cebeci and Baydemir, 2019
Pseudotsuga menziesii	Douglas-fir	Present	Cultivated/wild	Bertheau et al., 2009

*Presence in the US confirmed by NRCS, 2024

Additionally, there are several hosts mentioned in the literature without direct evidence of *I. sexdentatus* damage including *Juniperus* spp. (juniper), *Abies alba* (silver fir), *Larix sibirica* (Siberian larch), *Picea asperata* (dragon spruce), *Pinus densata* (high mountain pine), *P. tabuliformis* (Chinese pine), and *P. yunnanensis* (Yunnan pine) (Benzel, 2015; Grüne, 1979; Yin et al., 1984). These species may be hosts, but without direct evidence, we currently do not recommend them as targets for survey.

Pest Importance

Ips sexdentatus is an important secondary pest of European pine forests (Jactel and Gaillard, 1991). In its native range in southern Europe and the Mediterranean, the species is typically a secondary borer in dead and dying pines and is usually present in low numbers. Adverse environmental conditions that cause stress or mortality of pines can prompt an outbreak, which can eventually cause severe damage (Evans, 2021;

Fernández, 2006; Pineau et al., 2017a). Outbreaks can cause tree mortality, which can lead to economic losses and ecological impacts (Davydenko et al., 2021).

In southwestern France, *I. sexdentatus* is estimated to have killed 141 million cubic ft of pines covering over half a million acres after hurricane 'Klaus' in 2009 (Garric, 2012; Pineau et al., 2017b). In Spain, *I. sexdentatus* is considered the most frequent and damaging pest of *P. pinaster* in the Castilla y León region (Etxebeste Larrañaga et al., 2013; Fernández, 2006). In Turkey, *I. sexdentatus* is reported as an important bark beetle in the Anatolian black pine forests, especially in *P. nigra* (Sarikaya et al., 2012), with additional reports of outbreaks in *Picea orientalis* (Schönherr et al., 1983).

Conifers are present in all states in the United States. They are important as part of the natural forest woodlands and cultivated for Christmas trees, timber, landscaping, fuel, and other purposes (Özcan et al., 2018). Several species of pines are grown for timber, which is used in the construction and furniture industry. In 2017, 2.6 billion board feet of timber were harvested, valued at about $178 million (USDA-FS, 2019).

In addition to economic impact to the lumber industry, bark beetles can also play a role in pine forest biodiversity and nutrient cycling (Beudert et al., 2015). Although native bark beetle species often increase biodiversity, invasive wood borers may decrease biodiversity by removing tree species and their biotic interactions from the ecosystem (Herms and McCullough, 2014; Hughes et al., 2015; Przepióra et al., 2020). The specific effect of *I. sexdentatus* is difficult to predict, as its interactions with American pine species have not been studied. Previous cases of European pine-specific wood borers established in the United States have caused modest damage mostly in high-density stands as the cases of *Tomicus piniperda* (common pine shoot beetle) and *Sirex noctilio* (European woodwasp) (Fowler et al., 2015; Haavik and Foelker, 2021).

Ips sexdentatus is listed as a harmful organism in the following countries: Albania, Colombia, Vatican City, Japan, Jordan, Monaco, Morocco, San Marino, Serbia, Turkey, United Kingdom, and the European Union (USDA-PCIT, 2024). There may be trade implications if this pest becomes established in the United States.

Pathogens or Associated Organisms Vectored

Table 2. Fungi commonly associated or vectored by *I. sexdentatus* in *Pinus* spp.

Scientific Name	Phylum	Vectored /isolated	Pathogenicity	Reference
Ceratocystis montium (=Ophiostoma ips)	Ascomycota	Isolated	unknown	Evans, 2021; Kirisits, 2004
Cladosporium spp.	Ascomycota	Isolated	unknown	Davydenko et al., 2021
Ceratocystiopsis minuta	Ascomycota	Isolated	unknown	Kirisits, 2004

Entomocorticium spp.	Basidiomycota	Isolated	unknown	Davydenko et al., 2021
Graphium spp.	Ascomycota	Vectored	pathogenic	Davydenko et al., 2021
Graphium fragrans (=Pesotum fragrans)	Ascomycota	Isolated	unknown	Kirisits, 2004
Graphium pseudormiticum	Ascomycota	Isolated	unknown	Kirisits, 2004
Grosmannia penicillata	Ascomycota	Isolated	pathogenic	Davydenko et al., 2021
Hyalorhinocladiella ips (= *Ambrosiella ips*)	Ascomycota	Isolated	unknown	Kirisits, 2004
Leptographium sp.	Ascomycota	Isolated	unknown	Kirisits, 2004
Leptographium obscurum(= Ophiostoma obscurum)	Ascomycota	Isolated	unknown	Kirisits, 2004
Leptographium olivaceum	Ascomycota	Isolated	pathogenic	Davydenko et al., 2021
Leptographium sosnaicola	Ascomycota	Isolated	pathogenic	Davydenko et al., 2021
Lophiostoma clavatum (=Ophiostoma clavatum)	Ascomycota	Isolated	unknown	Kirisits, 2004
Lophiostoma japonicum (=Ophiostoma japonicum)	Ascomycota	Isolated	unknown	Kirisits, 2004
Ophiostoma ainoae	Ascomycota	Isolated	unknown	Evans, 2021; Kirisits, 2004
Ophiostoma araucariae	Ascomycota	Isolated	unknown	Kirisits, 2004
Ophiostoma bicolor	Ascomycota	Isolated	pathogenic	Davydenko et al., 2021
Ophiostoma canum	Ascomycota	Isolated	pathogenic	Davydenko et al., 2021
Ophiostoma brunneociliatum	Ascomycota	Isolated	unknown	Kirisits, 2004
Ophiostoma minus	Ascomycota	Vectored	pathogenic	Davydenko et al., 2021
Ophiostoma piceaperdum	Ascomycota	Isolated	unknown	Kirisits, 2004
Ophiostoma tingens (=*A. tingens)*	Ascomycota	Isolated	unknown	Kirisits, 2004

Pesotum piceae (=Ophiostoma piceae)	Ascomycota	Isolated	unknown	Kirisits, 2004

Some Ophiostomatoid fungi can cause disease and blue staining on trees and lumber (Fig. 5c) (Davydenko et al., 2021). Additionally, *Fusarium circinatum,* the causal agent of pitch canker, present in the United States, has been isolated from *I. sexdentatus* although there is no indication that the beetle vectors the pathogen (Meinecke et al., 2022; Romon et al., 2007).

Known Distribution

Ips sexdentatus is native to Eurasia, where it is widespread (Cognato, 2015; Douglas et al., 2019).

Table 3. Countries where *I. sexdentatus* is known to occur.

Region/Continent	Country	Reference
Asia	China	Sangyang, 1992
Asia	Kazakhstan	Mukhamadiyef et al., 2019
Asia	Russia	Kulinich and Orlinski, 1998
Asia	Thailand	Beaver and Browne, 1975
Europe	Austria	Steinwender et al., 2010
Europe	Belarus	Ramanenka et al., 2023
Europe	Bosnia and Herzegovina	Zivojinovic, 1960
Europe	Bulgaria	Takov et al., 2011
Europe	Croatia	Agbaba and Ćelepirović, 2008
Europe	Czech Republic	Knížek et al., 2022
Europe	Estonia	Voolma et al., 2004
Europe	Finland	Pulliainen, 1973
Europe	France	Pineau et al., 2017a
Europe	Germany	Kohnle et al., 1992
Europe	Greece	Faccoli et al., 2020
Europe	Georgia	Beridze et al., 2024
Europe	Hungary	Faccoli et al., 2020
Europe	Italy	Bracalini et al., 2021
Europe	Latvia	Jankevica, 2004
Europe	Lithuania	EPPO, 2024
Europe	North Macedonia	Zivojinovic, 1960
Europe	Montenegro	Zivojinovic, 1960
Europe	the Netherlands	EPPO, 2024
Europe	Norway	Bakke, 1999
Europe	Poland	Kleespies et al., 2017
Europe	Portugal	Paiva et al., 1988

Europe	Romania	Isaia et al., 2010
Europe	Russia	Voolma et al., 2004
Europe	Serbia	Zivojinovic, 1960
Europe	Slovakia	EPPO, 2024
Europe	Slovenia	Moraza et al., 2013
Europe	Spain	Fernández, 2006
Europe	Sweden	Bakke, 1999
Europe	Switzerland	EPPO, 2024
Europe	Turkey	Sarikaya et al., 2012
Europe	Ukraine	Davydenko et al., 2021
Europe	United Kingdom	Evans, 2021

EPPO (2024) reports that *I. sexdentatus* is present in Armenia, Azerbaijan, Belgium, Japan, Luxemburg, Moldova, Mongolia, Myanmar, North Korea, and South Korea, but we were unable to find direct evidence of the pest in these locations.

Pathway

Ips sexdentatus has several means for introduction and dispersal. Adults, larvae, and pupae can be spread within infested sawn timber, wooden products, or wood packing material (WPM) such as dunnage or case wood (crating) (Brockerhoff et al., 2006; Haack, 2001, 2006). In particular, WPM made from recently cut trees often have some residual bark that could disperse the beetle (Meurisse et al., 2019).

Ips sexdentatus has commonly been reported at border interceptions in the United States and New Zealand in *Pinus* from Asia and Europe (Brockerhoff et al., 2006; Haack, 2001), and in commercial *P. pinaster* timber (Lopez and Goldarazena, 2012).

Ips sexdentatus is a strong flier that can disperse rapidly over distances of several miles (Jactel, 1991; Sarikaya et al., 2012). In a mark-release-recapture experiment, the beetle has been recorded flying up to 2.5 miles within a day (Jactel, 1991). In a laboratory flight mill experiment, 50% of tested beetles could fly 12 miles and 98% could fly 3 miles within a few hours (Jactel and Gaillard, 1991).

Use the PPQ Commodity Import and Export manuals listed below to determine 1) if host plants or material are allowed to enter the United States from countries where the organism is present and 2) what phytosanitary measures (e.g., inspections, phytosanitary certificates, post entry quarantines, mandatory treatments) are in use. These manuals are updated regularly.

Agricultural Commodity Import Requirements(ACIR) manual: ACIR provides a single source to search for and retrieve entry requirements for imported commodities. https://acir.aphis.usda.gov/s/

Plants for Planting Manual: This manual is a resource for regulating imported plants or plant parts for propagation, including buds, bulbs, corms, cuttings, layers, pollen,

scions, seeds, tissue, tubers, and like structures.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf

Treatment Manual: This manual provides information about treatments applied to imported and domestic commodities to limit the movement of agricultural pests into or within the United States.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

Potential Distribution within the United States

Based on the known distribution of *Ips sexdentatus* and comparing those climates to Global Plant Hardiness Zones (Takeuchi et al., 2018), we expect that *I. sexdentatus* could establish in plant hardiness zones 1-9.

Pinus spp. and other hosts are ubiquitous throughout the continental United States, both as environmental hosts and for lumber (NRCS, 2024; USDA-FS, 2009; USDA-NASS, 2024). Cultivated species include *Pinus sylvestris* (Scots pine), *Picea abies* (Norway spruce), and *Pseudotsuga* spp. (Douglas fir) with the former being the most used (NCTA, 2024). Timber production occurs across all regions, with the main production in the northwestern states of Oregon and Washington and in the southern states of Alabama, Georgia, and Mississippi (USDA-FS, 2009).

While Christmas trees are hosts and are grown in multiple states (USDA-NASS, 2007, 2024), *I. sexdentatus* requires large trees with thick phloem for reproduction, so these production areas are not considered at risk for this beetle (Hulcr, 2024).

Outside of commercial production, *Pinus sylvestris* (Scots pine) is found growing wild in forests throughout the Midwest and Northeast (NRCS, 2024). *Pinus nigra* is found in the Mid-Atlantic, Midwest, and Northeast regions and in Mississippi and Missouri (NRCS, 2024). *Pinus pinaster* is present in North Carolina and Oregon (NRCS, 2024). *Picea abies* and *Larix decidua* are present in the Mid-Atlantic, Midwest, and Northeast regions (NRCS, 2024).

All the above-mentioned regions and states represent a suitable climate for the establishment of *I. sexdentatus* and are at risk for establishment.

Survey and Key Diagnostics

Approved Methods for Pest Surveillance*:
For the current approved methods and guidance for survey and identification, see Approved Methods for Pest Surveillance (AMPS) pest page on the CAPS Resource and Collaboration website, at https://approvedmethods.ceris.purdue.edu/.

References

Agbaba, S. N., and N. Ćelepirović. 2008. Zdravstveno stanje sumske vegetacije otoka veliki Brijun, nacionalni park Brijuni Hrvatska [Health Condition of the Forest Vegetation on the Island of Veliki Brijun, National Park Brijuni, Croatia]. Radovi Sumarskog Fakulteta Univerziteta u Sarajevu 38:35-45.

Akkuzu, E., and H. Guzel. 2015. Edge effects of pinus nigra forests on abundance and body length of *Ips sexdentatus*. Šumarski list 139(9-10):447-453.

Atkinson, T. H. 2024. Bark and ambrosia beetles of the Americas. Last accessed 04/24/2024 http://www.barkbeetles.info.

Bakke, A. 1999. High Diversity of Saproxylic Beetles in a Hemiboreal Mixed Forest Reserve in the south of Norway. Scandinavian Journal of Forest Research 14(3):199-208.

Beaver, R. A., and F. G. Browne. 1975. The Scolytidae and Platypodidae (Coleoptera) of Thailand. A checklist with biological and zoogeographical notes. Oriental Insects 9(3):283-311.

Benzel, J. 2015. Screening aid: Six-toothed Bark Beetle, *Ips sexdentatus* (Börner) USDA-APHIS-PPQ-S&T, Fort Collins, CO. 7 pp.

Beridze, M., G. Dumbadze, T. Gokturk, and R. Vasadze. 2024. Current status of bark beetles distribution and identification in Georgia-Turkey border area. African journal of biological sciences 6(11):1711-1721.

Bertheau, C., A. Salle, J.-P. Rossi, S. Bankhead-Dronnet, X. Pineau, G. Roux-Morabito, and F. Lieutier. 2009. Colonisation of native and exotic conifers by indigenous bark beetles (Coleoptera: Scolytinae) in France. Forest Ecology and Management 258(7):1619-1628.

Beudert, B., C. Bässler, S. Thorn, R. Noss, B. Schröder, H. Dieffenbach-Fries, N. Foullois, and J. Müller. 2015. Bark beetles increase biodiversity while maintaining drinking water quality. Conservation Letters 8(4):272-281.

Blomquist, G. J., R. Figueroa-Teran, M. Aw, M. Song, A. Gorzalski, N. L. Abbott, E. Chang, and C. Tittiger. 2010. Pheromone production in bark beetles. Insect Biochemistry and Molecular Biology 40:699-712.

Bouhot, L., F. Lieutier, and D. Debouzie. 1988. Spatial and temporal distribution of attacks by *Tomicus piniperda* L. and *Ips sexdentatus* Boern. (Col., Scolytidae) on *Pinus sylvestris*. Journal of Applied Entomology 106:356–371.

Bracalini, M., F. Croci, E. Ciardi, G. Mannucci, E. Papucci, G. Gestri, R. Tiberi, and T. Panzavolta. 2021. *Ips sexdentatus* mass-trapping: Mitigation of its negative effects on saproxylic beetles larger than the target. Forests 12(175):13.

Brockerhoff, E. G., J. Bain, M. Kimberley, and M. Knížek. 2006. Interception frequency of exotic bark and ambrosia beetles (Coleoptera: Scolytinae) and relationship with establishment in New Zealand and worldwide. Canadian Journal of Research 36(2):289-298.

Bueno, A., J. J. Diez, and M. M. Fernández. 2010. Ophiostomatoid fungi transported by *Ips sexdentatus* (Coleoptera; Scolytidae) in *Pinus pinaster* in NW Spain. Silva Fennica 44(3):387-397.

Cavey, J., and S. Passoa. 1994. Screening Aids for Exotic Bark Beetlesin the Northeastern United States (NA-TP-11-94). United States Department of Agriculture (USDA) Forest Service-Northeastern Area, United States. 19 pp.

Cebeci, H. H., and M. Baydemir. 2019. Bark beetles of Balikesir region in Turkey. Entomological News 128(2):109-119.

Chararas, C. 1962. Etude biologique des scolytides des conifères [Biological study of conifer bark beetles (Scolytidae)]. P. Lechevalier, Paris. 556 pp.

Ciesla, W. 2001. *Ips sexdentatus*. Forest Health Management International, United States. 7 pp.

Ciesla, W. M. 2011. Bark and Ambrosia Beetles. Pages 173-202 Forest Entomology: A Global Perspective. Blackwell.

Cobos, J., and M. Ruiz. 1990. Problemas fítosanitarios de la especie *Pinus radiata* D. Don en España, con especial referencia al País Vasco. Boletin de Sanidad Vegetal Plagas 16:37-53.

Cognato, A. I. 2015. Biology, systematics, and evolution of *Ips*. Pages 351-370 *in* F. E. Vega and R. W. Hofstetter, (eds.). Bark beetles: biology and ecology of native and invasive species. Elsevier, London, UK.

Connor, M. D., and R. C. Wilkinson. 1983. Ips bark beetles in the South. US Department of Agriculture, Forest Service Washington, District of Columbia. 8 pp.

Davydenko, K., R. Vasaitis, M. Elfstrand, D. Baturkin, V. Meshkova, and A. Menkis. 2021. Fungal communities vectored by *Ips sexdentatus* in declining *Pinus sylvestris* in Ukraine: Focus on occurrence and pathogenicity of Ophiostomatoid species. Insects 12(119):12.

Dong, Y., and J. Hulcr. 2024. Six-Toothed Bark Beetle, Six-Spined Engraver Beetle, Pine Stenographer Beetle *Ips sexdentatus* (Börner, 1767) (Insecta: Coleoptera: Curculionidae: Scolytinae) (EENY-808). The Institute of Food and Agricultural Sciences (IFAS) Extension UF. 5 pp.

Douglas, H. B., A. I. Cognato, V. Grebennikov, and K. Savard. 2019. Dichotomous and matrix-based keys to the *Ips* bark beetles of the world (Coleoptera: Curculionidae: Scolytinae). Canadian Journal of Arthropod Identification (38):234.

El-Sayed, A. M. 2024. The Pherobase: Database of Pheromones and Semiochemicals. Last accessed 04/22/2024 https://pherobase.com/.

EPPO. 2024. *Ips sexdentatus* Boern. Distribution. European and Mediterranean Plant Protection Organization. Last accessed 04/26/2024 https://gd.eppo.int/.

Etxebeste Larrañaga, I., J. L. Lencina Gutiérrez, and J. A. Pajares Alonso. 2013. Respuesta de *Ips sexdentatus* (Col.: Curculionidae, Scolytinae) y de coleópteros saproxílicos asociados a la variación en la composición feromonal. Pages 14 *in* 6to Congreso Forestal Español, Vitoria-Gasteiz, España.

Evans, H. 2021. The threat to UK conifer forests posed by *Ips* bark beetles. Forest Research, Edinburgh, UK. 38 pp.

Faccoli, M., D. Gallego, M. Branco, E. G. Brockerhoff, J. Corley, D. R. Coyle, B. P. Hurley, H. Jactel, F. Lakatos, and V. Lantschner. 2020. A first worldwide multispecies survey of invasive Mediterranean pine bark beetles (Coleoptera: Curculionidae, Scolytinae). Biological Invasions 22:1785-1799.

Fernández, M. M. 2006. Colonization of fire-damaged trees by *Ips sexdentatus* (Boerner) as related to the percentage of burnt crown. Entomologica Fennica 17(4):381-386.

Fowler, G., Y. Takeuchi, T. Vo, and L. Garrett. 2015. Pine shoot beetle, *Tomicus piniperda* (Linnaeus): Analysis of regulatory options (Rev. 01 20150219). USDA-APHIS, United States. 25 pp.

Garric, A. 2012. Tree farmers in France aim to replant Les Landes forest. The Guardain. (July 31, 2012.)

Grüne, V. S. 1979. Handbuch zur bestimmung der europaischen Borkenkäfer [Brief illustrated key to European bark beetles]. Verlag M. & H. Schaper, Hannover, Germany. 182 pp.

Haack, R. A. 2001. Intercepted Scolytidae (Coleoptera) at U.S. ports of entry: 1985–2000. Integrated Pest Management Reviews 6:253–282.

Haack, R. A. 2006. Exotic bark- and wood-boring Coleoptera in the United States: recent establishments and interceptions. Canadian Journal of Forest Research 36(2):269-288.

Haavik, L. J., and C. J. Foelker. 2021. Forest impacts, management, and monitoring of *Sirex noctilio*. USDA-Forest Service, United States. 92-98 pp.

Herms, D. A., and D. G. McCullough. 2014. Emerald ash borer invasion of North America: history, biology, ecology, impacts, and management. Annual review of entomology 59(1):13-30.

Hughes, M., J. Smith, R. Ploetz, P. Kendra, A. Mayfield, J. Hanula, J. Hulcr, L. Stelinski, S. Cameron, and J. Riggins. 2015. Recovery plan for laurel wilt on redbay and other forest species caused by *Raffaelea lauricola* and disseminated by *Xyleborus glabratus*. Plant Health Progress 16(4):173-210.

Hulcr, J. 2024. *Ips sexdentatus* host. Personal communication to R. Davila on October 31, 2024, from Jiri Hulcr (University of Florida).

Hulcr, J., T. H. Atkinson, A. I. Cognato, B. Jordal, and D. D. McKenna. 2015. Morphology, taxonomy, and phylogenetics of bark beetles. Pages 41-84 *in* F. E. Vega and R. W. Hofstetter, (eds.). Bark beetles: biology and ecology of native and invasive species. Elsevier, London, UK.

Isaia, G., A. Manea, and M. Paraschiv. 2010. Study on the effect of pheromones on the bark beetles of the Scots pine. Bulletin of the Transilvania University of Brasov Series II: Forestry Wood Industry• Agricultural Food Engineering 3(52):67-72.

Jactel, H. 1991. Dispersal and flight behaviour of *Ips sexdentatu*s (Coleoptera: Scolytidae) in pine forest. Annales des Sciences forestieres 48(4):417-428.

Jactel, H., and J. Gaillard. 1991. A preliminary study of the dispersal potential of *Ips sexdentatus* (Börner)(Col., Scolytidae) with an automatically recording flight mill. Journal of Applied Entomology 112(1-5):138-145.

Jactel, H., and F. Lieutier. 1987. Effects of attack density on fecundity of the scots pine beetle Ips sexdentatus Boern (Col.; Scolytidae) 1. Journal of Applied Entomology 104(1-5):190-204.

Jankevica, L. 2004. Ecological associations between entomopathogenic fungi and pest insects recorded in Latvia. Latvijas entomologs 41:60-65.

Kirisits, T. 2004. Fungal associates of european bark beetles with special emphasis on the ophiostomatoid fungi. Pages 181–236 *in* F. Lieutier, K. R. Day, A. Battisti, J.-C. Gregoire, and H. F. Evans, (eds.). Bark and wood boring insects in living trees in Europe, a synthesis Kluwer Academic Publishers, The Netherlands.

Kleespies, R. G., Y. W. Lim, C. Tkaczuk, M. Wrzosek, B. M. Steinwender, and R. Wegensteiner. 2017. *Metschnikowia* cf. *typographi* and other pathogens from the bark beetle *Ips sexdentatus* – Prevalence, histological and ultrastructural evidence, and molecular characterization. Journal of Invertebrate Pathology 143:69-78.

Knížek, M., J. Liška, and A. Véle. 2022. Efficacy of synthetic lures for pine bark beetle monitoring. Journal of Forest Science 68(1):19–25.

Kohnle, U., S. Densborn, D. Duhme, and J. Vité. 1992. Bark beetle attack on host logs reduced by spraying with repellents. Journal of Applied Entomology 114(1-5):83-90.

Kulinich, O. A., and P. D. Orlinski. 1998. Distribution of conifer beetles (Scolytidae, Curculionidae, Cerambycidae) and wood nematodes (*Bursaphelenchus* spp.) in European and Asian Russia. EPPO Bulletin 28:39-52.

Lévieux, J., F. Lieutier, and A. Delplanque. 1985. Les Scolytes ravageurs du Pin sylvestre [Scots pine bark beetles]. Revue forestière française 37(6):431-440.

Lopez, S., and A. Goldarazena. 2012. Flight dynamics and abundance of *Ips sexdentatus* (Coleoptera: Curculionidae: Scolytinae) in different sawmills from Northern Spain: Differences between local *Pinus radiata* (Pinales: Pinaceae) and Southern France incoming *P. pinaster* timber. Psyche: A Journal of Entomology 2012:6.

Meinecke, C., E. McCarty, T. Quesada, J. Smith, and C. Villari. 2022. Pitch Canker: A fungal disease of Southern pine forests (WSF-NR-22-62A). University of Georgia. Warnell School of Forestry and Natural Resources Outreach Publication. 6 pp.

Meurisse, N., D. Rassati, B. P. Hurley, E. G. Brockerhoff, and R. A. Haack. 2019. Common pathways by which non-native forest insects move internationally and domestically. Journal of Pest Science. 92:13-27.

Moraza, M. L., M. Fernández, and M. Jurc. 2013. Phoretic mites of the six-spined engraver beetle, *Ips sexdentatus* (Böerner, 1776) (Coleoptera, Scolytinae), on *Pinus halepensis* in Slovenia. International Journal of Acarology 39(8):597–599.

Mukhamadiyef, N. S., N. Z. Ashikbaev, and M. G. Zh. 2019. Monitoring of stem pest populations (Scolytinae) which strikes the endemic spruce shrenk in Sailiysk Alatau. News of the National academy of sciences of Republic of Kazakhstan-Series of agricultural sciences 4(52):6368.

NCTA. 2024. Tree varieties. The National Christmas Tree Association, USA. Last accessed 08/05/2024 https://realchristmastrees.org/.

Nikulina, T., M. Mandelshtam, V. Nazarenko, A. Petrov, and N. Yunako. 2015. A survey of the weevils of Ukraine. Bark and ambrosia beetles (Coleoptera: Curculionidae: Platypodinae and Scolytinae). Zootaxa 3912 (1):001–061.

NRCS. 2024. The PLANTS Database. Natural Resources Conservation Service National-USDA. Last accessed 05/07/2024 https://plants.usda.gov/home.

Özcan, G. E., K. Enez, and B. Arıcak. 2018. Effects of forest roads on *Ips sexdentatus* infestation in black pine forest. Turkish Journal of Agriculture - Food Science and Technology 6(7):828-833.

Paiva, M. R., M. F. Pessoa, and J. Vité. 1988. Reduction in the pheromone attractant response of *Orthotomicus erosus* (Woll.) and *Ips sexdentatus* Boern.(Col., Scolytidae) 1. Journal of Applied Entomology 106(1-5):198-200.

Pineau, X., M. Bourguignon, H. Jactel, F. Lieutier, and A. Sallé. 2017a. Pyrrhic victory for bark beetles: Successful standing tree colonization triggers strong intraspecific competition for offspring of *Ips sexdentatus*. Forest Ecology and Management 399:188-196.

Pineau, X., G. David, Z. Peter, A. Sallé, M. Baude, F. Lieutier, and H. Jactel. 2017b. Effect of temperature on the reproductive success, developmental rate and brood characteristics of *Ips sexdentatus* (Boern.). Agricultural and forest entomology 19(1):23-33.

Przepióra, F., J. Loch, and M. Ciach. 2020. Bark beetle infestation spots as biodiversity hotspots: Canopy gaps resulting from insect outbreaks enhance the species richness, diversity and abundance of birds breeding in coniferous forests. Forest Ecology and Management 473:118280.

Pulliainen, E. 1973. Infestation of timber by beetles on a subarctic fell in northeastern Lapland in 1972. Annales Zoologici Fennici 10(2):365-371.

Raffa, K. F., J.-C. Grégoire, and B. S. Lindgren. 2015. Natural history and ecology of bark beetles. Pages 1-40 *in* F. E. Vega and R. W. Hofstetter, (eds.). Bark beetles: biology and ecology of native and invasive species. Elsevier, London, UK.

Ramanenka, M., S. Panteleev, A. Sazonov, and L. Ivashchanka. 2023. Mycobiota of *Ips sexdentatus* (Börner, 1776)(Coleoptera, Curculionidae: Scolytinae) in Belarus. Entomological Review 103(5):545-556.

Romon, P., J. Iturrondobeitia, B. Staffan Lindgren, K. Gibson, and A. Goldarazena. 2007. Quantitative association of bark beetles with pitch canker fungus and effects of verbenone on their semiochemical communication in Monterey pine forests in Northern Spain. Environmental Entomology 36(4):743-750

Sangyang, F. 1992. The eco-geographical distribution of forest insects in China. Journal of Northeast Forest Univ. 3(2):13-22.

Sarikaya, O., M. Avci, and S. Yildirim. 2012. Flight activity and biology of *Ips sexdentatus* Boerner in Black pine (*Pinus nigra* Arnold) forests of Isparta, Turkey. Pages 597-604 *in* International Scientific Conference, Forests in the future–Sustainable use, risks and challenges, Institute of Forestry, Belgrade, Republic of Serbia. 4-5 October 2012.

Schönherr, V. J., J. P. Vite, and M. Sere. 1983. Überwachung von *Ips sexdentatus*-Populationen mit synthetischem Lockstoff [Monitoring of *Ips sexdentatus* populations with synthetic attractant]. Zeitschrift für angewandte Entomologie 95(1):51-53.

Steinwender, B., H. Krenn, and R. Wegensteiner. 2010. Different effects of the insectpathogenic fungus *Beauveria bassiana* (Deuteromycota) on the bark beetle *Ips sexdentatus* (Coleoptera: Curculionidae) and on its predator *Thanasimus formicarius* (Coleoptera: Cleridae). Journal of Plant Diseases and Protection 117(1):33-38.

Takeuchi, Y., G. Fowler, and A. S. Joseph. 2018. SAFARIS: Global plant hardiness zone development. North Carolina State University, Center for Integrated Pest

Management; United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Science and Technology, Plant Epidemiology and Risk Analysis Laboratory. Last accessed 02/01/2024 https://safaris.cipm.info/safarispestmodel/StartupServlet?phz.

Takov, D., D. Doychev, A. Linde, S. Draganova, and D. Pilarska. 2011. Pathogens of bark beetles (Coleoptera: Curculionidae) in Bulgarian forests. Phytoparasitica 39:343–352.

USDA-FS. 2009. Use of indexing to update United States annual timber harvest by state. Forest Service, United States. 30 pp.

USDA-FS. 2019. U.S. Timber production, trade, consumption, and price statistics,1965–2017. Forest Service, United States. 106 pp.

USDA-NASS. 2007. Nursery crops 2006 summary. United States Department of Agriculture, National Agriculture Statistics Service, Washington, DC. 59 pp.

USDA-NASS. 2024. Census of agriculture 2022. United States Department of Agriculture National Agriculture Statistics Service. Last accessed 05/03/2024 https://www.nass.usda.gov/AgCensus/.

USDA-PCIT. 2024. Phytosanitary Export Database (PExD): Harmful Organisms by Country and Commodity Report Format: *Ips sexdentatus*. Last accessed 04/25/2024 https://pcit.aphis.usda.gov/pcit/faces/signIn.jsfUSDA-PCIT.

Vallet, E. 1981. Etude du dépérissement du pin sylvestre en région centre et des principaux ravageurs scolytides associes: *Tomicus piniperda*, *Ips sexdentatus* et *Ips acuminatus* (Col. Scolytidae) [Study of the Scots pine decline in the central region and the main associated scolytid pests: *Tomicus piniperda*, *Ips sexdentatus* and *Ips acuminatus* (Col. Scolytidae)]. Doctoral Thesis, Université d'Orléans, Paris France. 143 pp.

Voolma, K., M. J. Mandelshtam, A. N. Shcherbakov, E. B. Yakovlev, H. Õunap, I. Süda, B. G. Popovichev, T. V. Sharapa, T. V. Galasjeva, and R. R. Khairetdinov. 2004. Distribution and spread of bark beetles (Coleoptera: Scolytidae) around the Gulf of Finland: a comparative study with notes on rare species of Estonia, Finland and North-Western Russia. Entomologica Fennica 15(4):198-210.

Yin, H.-f., F.-s. Huang, and Z.-l. Li. 1984. Zhongguo jing ji kun chong zhi [Economic insect fauna of China]. Science Press, Beijing, China. 205 pp.

Zivojinovic, S. 1960. Prilog poznavanju potkornjaka (Scolytidae) munike (*Pinus heldreichii* Christ.) i molike (*Pinus peuce* Griesbach)u Srbiji [A contribution to the knowledge of Scolytidae living on *Pinus heldreichii* Christ. and *Pinus peuce* Griesbach in Serbia]. Sumarski fakultet 57-58:21-29.

USDA-APHIS-PPQ-ST staff developed this datasheet. Cite this document as:

PPQ. 2024. Cooperative Agricultural Pest Survey (CAPS) Pest Datasheet for *Ips sexdentatus* Börner (Curculionidae): Six-toothed Bark Beetle. United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (PPQ), Raleigh, NC.

Versions

October 2014: Datasheet completed (Version 1)
December 2024 (Version 2)

- Created new **Pest Recognition** section by combining Pest Description and Damage/Signs and Symptoms
- Added **Easily Mistaken Species** section
- Added **Commonly Encountered Non-targets** section
- Updated **Biology & Ecology** section
- Updated **Known hosts** section
- Updated **Pest Importance** section with economic losses in various countries.
- Updated **Pathogens or Associated Organisms Vectored** section
- Updated **Known Distribution** section
- Updated **Pathway** section
- Updated **Potential Distribution within the United States** section
- Updated guidance for **Approved Methods** section.
- Citations from EPPO, CABI in all sections have been replaced with original sources

Reviewer

Jiri Hulcr, PhD. School of Forest, Fisheries, and Geomatics Sciences-University of Florida.