

Ips typographus

System: Terrestrial

Kingdom	Phylum	Class	Order	Family
Animalia	Arthropoda	Insecta	Coleoptera	Scolytidae

Common name European spruce bark beetle (English), Buchdrucker (German), Grandbarkbillen (Norwegian), Le typographe de l'epicea (English), eight-toothed spruce bark beetle (English), Gran scolyte de l'epicea (French), Großer 8 - zähniger Fichtenborkenkäfer (English)

Synonym *Bostrichus octodentalis* , Paykull
Dermestes typographus , Linneaus
Ips japonicus , Niijima

Similar species

Summary *Ips typographus* the European spruce bark beetle has caused many problems in Europe and Asia. It is a pest that mostly infects damaged spruce trees, but can also damage healthy trees as well. The effects of this pest have caused a great deal of economic loss as well as ecosystem change. Populations have increased throughout Asia and Europe, and a possibility of further expansion can exist as a cause of increasing temperature change. The importance of managing this pest has been realized, and speculation exists for possible methods of controlling and preventing damage caused by this species.



[view this species on IUCN Red List](#)

Species Description

Adult *Ips typographus* beetles range from 4.2 to 5.5 mm in length. They are cylindrical and reddish or dark brown to completely black. The front of the head and the sides of the body are covered with long yellowish hairs (CFIA, 2007). The head is covered by a thoracic shield and is not visible when viewed dorsally (Eglitis, 2006). Both sexes have four spines on each side of the elytral declivity, with the third spine being the largest and capitate (CFIA, 2007). The declivity surface is dull and finely punctate (EPPO). Males have a larger head on the third spine than females do, and males have fewer hairs on the pronotum (CFIA, 2007). The pronotum is covered with asperites on the anterior half (Walker, 2009). Eggs are pearly white in color. The larvae are white, legless, 'C' shaped grubs with an amber colored head capsule. Mature larvae are about 5 mm long. The pupae are white, mummy-like, and have some adult features, including wings that are folded behind the abdomen (Eglitis, 2006). Host trees of the European spruce bark beetle include *Picea* (the main host, *Picea abies*), *Abies*, and *Larix* and *Pinus* (CFIA, 2007). Adults are strong fliers and are capable of traveling several kilometers in search of suitable host material. Newly established populations of this species may go undetected for many years due to cryptic nature, concealed activity, slow development of damage symptoms, or misdiagnosis (Eglitis, 2006). A complex system of chemical communication governs the host selection process. Male beetles find suitable hosts, probably in response to tree odors, and then initiate attacks. The males produce pheromones, which aggregate both sexes to the host material. Once the host material is fully colonized, the beetles produce anti-aggregant chemicals, which lead to cessation of further attacks. Male beetles are the principal producers of these chemicals, which are derived from host monoterpenes (Eglitis, 2006). This species possesses two important traits that are characteristic of aggressive species of bark beetles: effective aggregation pheromones and vectored mutualistic fungi that may help to overcome tree defenses (Grodzki, McManus, Knizek *et al.*, 2004). Although bark beetles are able to migrate over long distances, the majority of beetles disperse less than 500 meters (Jönsson, Harding, Bärning *et al.*, 2007).

Please follow this link to view diagnostic images of the [European spruce bark beetle *Ips typographus* \(Linnaeus\) \(Coleoptera: Curculionidae: Scolytinae: Ipini\)](#) on PaDIL (Pests and Diseases Image Library) (Walker, 2009).

Notes

Global climate change is likely to affect bark beetle dynamics among other things (Joensuu, Heliövaara & Savolainen, 2008). Both its outbreak range and its outbreak intensity are likely to increase in a warming climate (e.g., Jönsson, Harding, Bärning *et al.*, 2007, Seidl *et al.* 2009). In addition, climate change has the potential to weaken host defence mechanisms e.g. via increased drought and further facilitate attacks by *I. typographus* (e.g. Seidl *et al.* 2008)

Lifecycle Stages

The male beetle initiates a nuptial chamber. After manifold copulation with attracted females, each female gnaws a maternal gallery with egg-pockets along the sides of the gallery. Larvae from the laid eggs gnaw right-angled to the maternal galleries larval tunnels, which end in a pupal chamber. The pupae change into hairy, brown juveniles. After maturation, grub juveniles change into dark-brown, mature adults. The whole generation development from the copulation to the adult has a duration of 7-11 weeks (Kreutz, Zimmermann & Vaupel, 2004a). Adults finish maturation in the spring prior to their dispersal flight. These flights are initiated in response to air temperatures of 20 degrees celcius. The number of generations per year is dependent upon temperature. In the northern part of its range, it has one generation a year, but it can complete two generations per year further south (Eglitis, 2006). In Central European lowlands it frequently completes two generations per year and has been reported to reach three generations in recent climatically favourable years. A first generation having a high rate of reproduction means the beginning of a large second generation, which will produce many offspring flying in the next season (Faccoli & Stergulc, 2006). The lower developmental threshold for the spruce bark beetle has been computed to be 8.3 degrees celcius. With a nonlinear model, the threshold was around 6 degrees celcius. The heat sum for total development ranged from 334 degree-days to 365 degree-days (Wermelinger, 2004).

Uses

Although the European spruce bark beetle can be a very serious forest pest, it also creates new breeding material for a variety of insect species. Dead and decaying wood, including trees killed by this species, constitute a habitat for a large number of harmless species (Eriksson, Lilja & Roininen, 2006).

Habitat Description

Outbreaks of *Ips typographus* are triggered mainly by an abundance of preferred hosts (i.e. weakened or freshly dead trees of *Picea abies* above pole stage), e.g. created by heavy storm events, in combination with favorable climatic conditions. Alpine climates limit the distribution of *I. typographus*, although it does occur in the foothills and valleys of the European alps. Possibly as an effect of a warming climate, the species has recently been recorded in the subalpine vegetation belt. *I. typographus*, prefers physiologically weakened, damaged, windthrown, recently felled or overmature trees (CFIA, 2007). In wind-felled trees, with low or no resistance at all, beetles can colonize stems at lower densities and thereby avoid the strong competition that would be likely if the colonizing beetles were trying to overcome the defensive systems of healthy trees (Eriksson, Pouttu & Roininen, 2005). In spruce forests, it normally exists in low abundance. Its population fluctuation depends on presence of suitable brood material in the stands and good weather conditions during swarming (Feicht, 2004). Infestations are more severe in stands greater than 120 years old, with preference for trees between 70 and 150 years old. Stands less than 40 years old sustain very little damage (CFIA, 2007). Suitable climatic conditions and suitable host material coincide with ports of entry or major destinations (Eglitis, 2006). The European spruce bark beetle overwinters in the adult stage, generally in the duff near the tree where it developed. A few individuals remain beneath the bark during the winter, especially in the southern part of the insect's range (Eglitis, 2006).

Reproduction

The European spruce bark beetle reproduces in newly wind-felled trees (Eriksson, Pouttu & Roininen, 2005). This species has high reproductive potential (Eglitis, 2006). Males excavate a nuptial chamber and are joined by 1 to 4 females. Females construct egg galleries in the inner bark radiating outward from the nuptial chamber. Vertical egg galleries are 10 to 20 cm long and are usually three-armed, but can be two-armed or multi-branched (CFIA, 2007). Gallery length varies with gallery density, but 10-12 centimeters is an average length (Eglitis, 2006). Approximately 50 eggs are laid on each side of the egg gallery (CFIA, 2007). However, females deposit up to 80 eggs preferably on the side of the maternal gallery that least interferes with other maternal galleries (Wermelinger, 2004). Larval galleries radiate at right angles to the egg gallery and become wider as the larvae grow (CFIA, 2007). Intraspecific competition at high breeding densities affects behavior. High densities result in shorter maternal galleries and thus reduced oviposition. The optimal density is at roughly 500 maternal galleries per square meter. The sex ratio of the progeny depends on the phase of gradation. Egg production has been found to depend on temperature, with a lower temperature threshold of 11.4 degrees celcius. With nonlinear models and optimum temperature of 30.4 degrees celcius for the juvenile development and 28.9 degrees celcius for reproduction were calculated (Wermelinger, 2004). Blue-stain fungi are normally transferred with the beetle and grow into wood around the gallery. Parent females also may leave the successfully colonized host and establish another brood in other trees or logs (i.e. "sister broods"). The European spruce beetle readily infests down host material, which contains fresh cambium. Windstorms frequently provide the breeding material for subsequent outbreaks, which can kill large numbers of trees (Eglitis, 2006).

Nutrition

Ips typographus larvae feed in the inner bark up to 10 m along the stem of the host tree. This species prefers thicker-barked stems with a minimum bark thickness of 2.5 mm and an optimum thickness of 5.0 mm (CFIA, 2007).

General Impacts

Eruptive outbreaks of the European spruce bark beetle result in mass attacks of living trees and may cause tree mortality at landscape-levels (Baier, Pennerstorfer & Schopf, 2007). In fact, although this beetle species prefers damaged spruce trees, the beetles also frequently kill solitary spruce trees, for example on the edges of recently harvested clear-cuts (Eriksson, Neuvonen & Roininen, 2007). Under favorable conditions and during an high population level outbreak phase, it is able to attack healthy trees and is a primary factor causing direct tree mortality. Outbreaks can develop rapidly in spruce stands that are damaged by wind, snow, stressed by drought or air pollution (Grodzki, McManus, Knizek *et al*, 2004). During such outbreaks, the population may increase sufficiently to start an epidemic. In an epidemic situation, spruce bark beetles can overcome the resistance of healthy trees (Joensuu, Heliövaara & Savolainen, 2008). Successful bark beetle establishment is considered to occur in two successive steps. The first step is the tree's defenses are exhausted by pioneer beetles and second, final colonization of the tree occurs (Wermelinger, 2004). The damage by this species causes a decrease in value of the host affected, for instance, by lowering its market price, increasing cost of production, maintenance, or mitigation, or reducing value of property where it is located. In addition, this species may cause loss of markets (domestic or foreign) due to presence and quarantine significant status (Eglitis, 2006). Adults carry a number of associated fungi such as *Ceratocystis polonica*. This bluestain fungus is highly virulent and can kill healthy spruce trees. In addition, this fungus stains the wood with blue streaks, which reduces its commercial value (CFIA, 2007). Attacked trees die faster than would be expected by solely phloem girdling due to larval feeding. The fungi may dry the tissue and induce tracheid aspiration or vascular plugging (Wermelinger, 2004). The organism is expected to cause significant direct environmental effects, such as extensive ecological disruption. Furthermore, the killing of a large number of trees during outbreaks causes major ecological disruptions resulting in change of tree species composition to non-host trees and increased fuel for high intensity wildfires (Eglitis, 2006). Climate warming, occurring in the past decade or so, allows the bark beetle to complete life cycles at altitudes which were previously unsuitable for its development, and thus may seriously affect the protective functions of mountain forests with regard to rockfall, avalanches and soil erosion in *P. abies* dominated mountain regions (Seidl, Baier, Rammer *et al*, 2007). The spruce bark beetle is one pest that could pose significant risk to North American forests if it were introduced. The introduction of this exotic pest could result in significant changes in forest ecosystems, such as tree species conversion, deforestation of riparian communities, increased fuel loading, and loss of biodiversity (Tkacz, 2002).

Management Info

Ips typographus is absent from Australia but listed as a 'High Impact Pest Species' (Walker, 2009).

Preventative measures: Silvicultural measures such as favouring mixed stands over pure *Picea abies* stands have been reported to reduce risk for *I. typographus* attack (Netherer and Nopp-Mayer 2005). Prompt salvage or debarking of windthrown material may help to limit population growth, but may be impractical when large areas are involved (Eglitis, 2006). The only chance to stop mass propagation of the European spruce bark beetle is to transport infested wood out of the stands (Feicht, 2004).

Integrated management: Mass trapping of *Ips typographus* in combination with other measures such as removal of infested trees, have to be included in an integrated control program (Bakke, 1989). In addition, mass trapping with pheromone-baited traps or trap trees has also been successfully used to suppress beetle populations and prevent outbreak conditions (EPPO).

Chemical: Direct controls have included the use of attractant and repellent pheromones to either trap out beetles or reduce attacks on suitable host material. Insecticides have also been used in direct control, but have a number of limitations in their application (Eglitis, 2006). Work has shown that the energy reserves of this species need to be depleted before the beetles will respond to pheromones (Wermelinger, 2004). An experiment was conducted in which treatment with the *I. typographus*-associated fungus *C. polonica* enhance the capability of spruce trees to resist later beetle attacks. Thus, this experiment lends support to the hypothesis that sublethal beetle/fungus attack may trigger inducible defense mechanisms in the trees that render them more resistant to later beetle attacks (Christiansen & Krokene, 1999). In addition, experiments undergone have shown protection of spruce with anti-attractants is possible using dispensers containing a blend of verbenone and NHV. Treatments with this method decreased the probability of attack and is said to work best in conditions of clear forest edges without to-beetle-attractive wind thrown or trap trees, even in the areas with high bark beetle population (Jakus, Schlyter, Zhang *et al*, 2003).

Biological: The entomopathogenic fungus *B. bassiana* is a naturally occurring pathogen of bark beetles, especially the European spruce bark beetle. It can be used for biological control of this species in three possible ways: treatment of fallen trunks, soil treatment around spruce trees against overwintering beetles, or a combination of the fungus with the commercially available and used pheromone traps (Kreutz, Zimmermann & Vaupel, 2004a). When considering the commercial use of this fungus for biocontrol of this species of bark beetle, its efficacy at different temperatures and RH is highly relevant. In general, the optimum temperature for the growth of entomopathogenic fungi is between 20 and 30 degrees celcius, with a minimum between 0 and 10 degrees celcius and a maximum between 30 and 35 degrees celcius (Kreutz, Vaupel & Zimmermann, 2004b).

Pathway

Ips typographus is one of the most commonly detected pests traveling on solid wood packing material, even after the adoption of the 1995 regulations intended to prevent introductions of bark-associated insects (TNC, 2005). Immature stages of *Ips typographus* are subject to redistribution by human assisted means, especially via wood products (unprocessed logs or lumber, crating, pallets and dunnage containing bark strips) (Eglitis, 2006).

Principal source:

Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

Review: Rupert Seidl, Institute of Silviculture, Department of Forest and Soil Sciences, University of Natural Resources and Applied Life Sciences. Vienna Austria

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ALIEN RANGE

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 [1] KOREA, REPUBLIC OF
 [1] NETHERLANDS
 [1] SPAIN
 [1] TURKEY

BIBLIOGRAPHY

81 references found for *Ips typographus*

Management information

Akkuzu, E; Guner, S., 2008. Defoliation levels of oriental spruce by *Ips typographus* (L.) in relation to elevation and exposure. *Journal of Environmental Biology*, 29(2). MAR 2008. 223-226.

Summary: Abstract only: A study concerning the effects of elevation and exposure of the spruce forests on defoliation levels of oriental spruce (*Picea orientalis* (L.) Link.) by *Ips typographus* L. was carried out during 2005 and 2006 in Artvin-Hatila National Park, Turkey Nine spruce stands were selected at 3 zones of elevations (1000-1350 m, 1350-1700 m and 1700-2000 m) and at different aspects to assess the role of elevation and exposure in the crown defoliation level and body length of beetles. Influence of bark thickness and trunk diameter at 1.3 m on the damage caused by the pest was investigated as well. The results of the study were as follows: (1) The mean defoliation level was highest at 1700-2000 m following by 1350-1700 m and 1000-1350 m. (2) The highest defoliation levels occurred on southern slopes following by eastern and northern slopes at 1700-2000m. (3) No statistical differences were found in the mean bark thickness between tree defoliation levels 1, 2, 3 and 4.(4) Mean trunk diameters of dead trees (level4) were significantly greater than those with defoliation levels 0, 1 and 2. (5) Mean body length of *I. typographus* at upper zones was significantly higher than those at middle and lower zones.

Baier, Peter; Pennerstorfer, Josef; Schopf, Axel., 2007. PHENIPS - A comprehensive phenology model of *Ips typographus* (L.) (Col., Scolytinae) as a tool for hazard rating of bark beetle infestation. *Forest Ecology & Management*. 249(3). SEP 30 2007. 171-186.

Bakke, Alf., 1989. The Recent *Ips typographus* Outbreak in Norway: Experiences from a Control Program. *Holarctic Ecology*, Vol. 12, No. 4 (Dec., 1989), pp. 515-519

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsintroduction_surface.pdf [Accessed 28 August 2008]

[Bark and Wood Boring Beetles of the World, 2006. *Ips typographus* L., European Spruce Bark Beetle Screening Aid](#)

Summary: Available from: <http://www.barkbeetles.org/exotic/htypgrph.html> [Accessed 28 August 2008]

Borden, John H., 1989. Semiochemicals and Bark Beetle Populations: Exploitation of Natural Phenomena by Pest Management Strategists (pp. 501-510)

Borys M. Tkacz., 2002. Pest risks associated with importing wood to the United States. *Can. J. Plant Pathol.* 24: 111-116 (2002). This paper was a contribution to the Symposium entitled Importation of Wood and Wood Products - Impact on Quarantines and New Pest Introductions held during the joint meeting of the Canadian Phytopathological Society and the Pacific Division of the American Phytopathological Society, in Victoria, B.C., June 2000.

[Canadian Food Inspection Agency \(CFIA\), 2007. European Spruce Bark Beetle Coleoptera: Scolytidae *Ips typographus* \(Linnaeus\) - European spruce bark beetle](#)

Summary: Available from: <http://www.inspection.gc.ca/english/plaveg/pestrava/ipstyp/tech/ipstype.shtml>[Accessed 28 August 2008]

Christiansen, E. & Krokene, P. 1999. Can Norway spruce trees be vaccinated against attack by *Ips typographus*?. *Agricultural and Forest Entomology* 1: 185-187.

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsintroduction_surface.pdf [Accessed 28 August 2008]

[Egliitis, Andris., 2006. EXFOR Database *Ips typographus*](#)

Summary: Available from: <http://spfnic.fs.fed.us/exfor/data/pestreports.cfm?pestidval=58&langdisplay=english> [Accessed 28 August 2008]

Eriksson, Miikka; Lilja, Saara; Roininen, Heikki., 2006. Dead wood creation and restoration burning: Implications for bark beetles and beetle induced tree deaths. *Forest Ecology & Management*. 231(1-3). AUG 1 2006. 205-213.

Eriksson, Miikka; Neuvonen, Seppo; Roininen, Heikki., 2007. Retention of wind-felled trees and the risk of consequential tree mortality by the European spruce bark beetle *Ips typographus* in Finland. *Scandinavian Journal of Forest Research*. 22(6). 2007. 516-523

Eriksson, Miikka; Neuvonen, Seppo; Roininen, Heiw., 2008. *Ips typographus* (L.) attack on patches of felled trees: Wind-felled vs. cut trees and the risk of subsequent mortality. *Forest Ecology & Management*. 255(3-4). MAR 20 2008. 1336-1341

Eriksson, Miikka; Pouttu, Antti; Roininen, Heikki., 2005. The influence of windthrow area and timber characteristics on colonization of wind-felled spruces by *Ips typographus* (L.). *Forest Ecology & Management*. 216(1-3). SEP 12 2005. 105-116.

[European and Mediterranean Plant Protection Organization \(EPPO\), 2008. Distribution Maps of Quarantine Pests for Europe: *Ips typographus*](#)

Summary: Available from: <http://pqr.eppo.org/datas/IPSXTY/IPSXTY.pdf> [Accessed 28 August 2008]

[European and Mediterranean Plant Protection Organization \(EPPO\), undated. Data Sheets on Quarantine Pests: *Ips typographus* Prepared by CABI and EPPO for the EU under Contract 90/399003](#)

Summary: Available from: http://www.eppo.org/QUARANTINE/insects/Ips_typographus/IPSXTY_ds.pdf [Accessed 28 August 2008]

- Faccoli, Massimo; Stergulc, Fabio., 2008. Damage reduction and performance of mass trapping devices for forest protection against the spruce bark beetle, *Ips typographus* (Coleoptera Curculionidae Scolytinae). *Annals of Forest Science*. 65(3). MAY 2008. Article No.: 309
- Summary:** Abstract only: The spruce bark beetle, *Ips typographus*, is one of the main European forest pests, and mass trapping is probably the most common strategy applied to reduce its population density. However, the results concerning the effectiveness of this control system are often controversial, and many studies consider only the trapping performance with no attention to the damage reduction. During spring-summer 2005, a control program against *I. typographus* outbreaks was set up in NE Italy. Twenty-four spruce forests heavily infested by *I. typographus* were studied: six protected by pheromone slot-traps, six by horizontal trap-logs and six by standing trap-logs; six untreated stands were kept as controls. Trap-logs were baited with a pheromone specific to *I. typographus* and treated with insecticide. Each type of device was tested at high, medium and low density in relation to the number of trees infested during the previous year. New damage occurring in the investigated stands was later monitored for one year. Protected forests showed mean damage about 80% lower in 2005 than in 2004, with no statistical difference among traps, trap-logs or standing trap-logs. Instead, unprotected forests (controls) suffered damage to a similar extent in both years. Trapping devices showed no statistical differences among mean captures. Device densities showed similar results in damage reduction and insect trapping. The results support the hypothesis that intensive trapping performed at stand level may be useful for protecting forests against *I. typographus*, locally reducing population density and tree mortality.
- Faccoli, M.; Stergulc, F., 2004. *Ips typographus* (L.) pheromone trapping in south Alps: spring catches determine damage thresholds. *Journal of Applied Entomology*. 128(4). May 2004. 307-311.
- Faccoli, M.; Stergulc, F., 2006. A practical method for predicting the short-time trend of bivoltine populations of *Ips typographus* (L.) (Col., Scolytidae). *Journal of Applied Entomology*. 130(1). FEB 2006. 61-66.
- Feicht, Elfriede., 2004. Parasitoids of *Ips typographus* (Col., Scolytidae), their frequency and composition in uncontrolled and controlled infested spruce forest in Bavaria. *Journal of Pest Science*. 77(3). July 2004. 165-172.
- Grodzki, Wojciech; Jakus, Rastislav; Lajzova, Eva; Sitkova, Zuzana; Maczka, Tomasz; Skvarenina, Jaroslav., 2006. Effects of intensive versus no management strategies during an outbreak of the bark beetle *Ips typographus* (L.) (Col.: Curculionidae, Scolytinae) in the Tatra Mts. in Poland and Slovakia. *Annals of Forest Science*. 63(1). JAN-FEB 2006. 55-61.
- Hilsczczanski, Jacek; Gibb, Heloise; Bystrowski, Cezary., 2007. Insect natural enemies of *Ips typographus* (L.) (Coleoptera, Scolytinae) in managed and unmanaged stands of mixed lowland forest in Poland. *Journal of Pest Science*. 80(2). MAY 2007. 99-107.
- Hougaard, Evelyne & Jean-Claude Grégoire., 2001. Bark-beetle parasitoids population surveys following storm damage in spruce stands in the Vosges region (France). *Integrated Pest Management Reviews* 6: 159-162, 2001.
- [Invasive.org](http://www.invasive.org), 2008. [European spruce bark beetle Coleoptera > Curculionidae > Ips typographus \(Linnaeus\), Identification, Biology, Control and Management Resources](http://www.invasive.org).
- Summary:** Invasive.org is a joint project of The Bugwood Network, USDA Forest Service and USDA APHIS PPQ. The University of Georgia - Warnell School of Forestry and Natural Resources and College of Agricultural and Environmental Sciences - Dept. of Entomology Available from: <http://www.invasive.org/browse/subject.cfm?sub=888> [Accessed 28 August 2008]
- Jakus, R., 2001. Bark beetle (Coleoptera, Scolytidae) outbreak and system of IPM measures in an area affected by intensive forest decline connected with honey fungus (*Armillaria* sp.). *Anzeiger fuer Schaedlingskunde*. 74(2). April, 2001. 46-51.
- Jakus, R.; Schlyter, F.; Zhang, Q.-H.; Blazenc, M.; Vavercak, R.; Grodzki, W.; Brutovsky, D.; Lajzova, E.; Turcani, M.; Bengtsson, M.; Blum, Z.; Gregoire, J.-C., 2003. Overview of development of an anti-attractant based technology for spruce protection against *Ips typographus*: From past failures to future success. *Anzeiger fuer Schaedlingskunde*. 76(4). August 2003. 89-99.
- Joensuu, Johanna; Heliovaara, Kari; Savolainen, Eino., 2008. Risk of bark beetle (Coleoptera, Scolytidae) damage in a spruce forest restoration area in central Finland. *Silva Fennica*. 42(2). 2008. 233-245
- Jonasova, Magda; Matejkova, Ivona., 2007. Natural regeneration and vegetation changes in wet spruce forests after natural and artificial disturbances. *Canadian Journal of Forest Research*. 37(10). OCT 2007. 1907-1914.
- Jonsson, Anna Maria; Harding, Susanne; Barring, Lars; Ravn, Hans Peter., 2007. Impact of climate change on the population dynamics of *Ips typographus* in southern Sweden. *Agricultural & Forest Meteorology*. 146(1-2). SEP 11 2007. 70-81.
- Jurc, Maja; Perko, Marko; Dzeroski, Saso; Demsar, Damjan; Hrasovec, Boris., 2006. Spruce bark beetles (*Ips typographus*, *Pityogenes chalcographus*, Col.: Scolytidae) in the Dinaric mountain forests of Slovenia: Monitoring and modeling. *Ecological Modelling*. 194(1-3). MAR 25 2006. 219-226.
- Keller, Siegfried., 2007. List of arthropod-pathogenic mitosporic fungi from Switzerland. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*. 80(1-2). 2007. 1-5.
- Summary:** Abstract only: Nine species of mitosporic fungi (Deuteromycota, Hyphomycetes) predominantly from pest insects collected in Switzerland are listed together with their hosts and the collection sites. The findings are discussed in the context of ecology and use for microbial control.
- Kreutz, J.; Vaupel, O.; Zimmermann, G., 2004b. Efficacy of *Beauveria bassiana* (Bals.) Vuill. against the spruce bark beetle, *Ips typographus* L., in the laboratory under various conditions. *Journal of Applied Entomology*. 128(6). July 2004. 384-389.
- Kreutz, J.; Zimmermann, G.; Vaupel, O., 2004a. Horizontal transmission of the entomopathogenic fungus *Beauveria bassiana* among the spruce bark beetle, *Ips typographus* (Col., Scolytidae) in the laboratory and under field conditions. *Biocontrol Science & Technology*. 14(8). December 2004. 837-848.
- Nageleisen, Louis-Michel., 2001. Monitoring of bark and wood-boring beetles in France after the December 1999 storms. *Integrated Pest Management Reviews* 6: 159-162, 2001.
- Netherer, Sigrid; Nopp-Mayr, Ursula., 2005. Predisposition assessment systems (PAS) as supportive tools in forest management - rating of site and stand-related hazards of bark beetle infestation in the High Tatra Mountains as an example for system application and verification. *Forest Ecology & Management*. 207(1-2). MAR 7 05. 99-107.
- Netherer, S & J. Pennerstorfer., 2001. Parameters relevant for modelling the potential development of *Ips typographus* (Coleoptera: Scolytidae). *Integrated Pest Management Reviews* 6: 177-184, 2001.
- Netherer, S., Nopp-Mayer, U. 2005. Predisposition assessment systems (PAS) as supportive tools in forest management - rating of site and stand-related hazards of bark beetle infestation in the High Tatra Mountains as an example for system application and verification. *For. Ecol. Manage.* 207, 99-107
- Nils Chr. Stenseth., 1989. *Population Dynamics of Bark Beetles, with Special Reference to Ips typographus*: Preface (pp. 378-379)

Nils Chr. Stenseth, Lawrence R. Kirkendall., 1989. Population Dynamics of Bark Beetles, with Special Reference to *Ips typographus*: Introduction (pp. 382-383)

Piel, Frederic; Gilbert, Marius; De Canniere, Charles; Gregoire, Jean-Claude., 2008. Coniferous round wood imports from Russia and Baltic countries to Belgium. A pathway analysis for assessing risks of exotic pest insect introductions. *Diversity & Distributions*. 14(2). MAR 2008. 318-328

Plasil, P; Cudlin, P., 2005. Population dynamics of eight-toothed spruce bark beetle (*Ips typographus* [L.]) in the area of National Nature Reserve Praded in 1998-2001. *Journal of Forest Science (Prague)*. 51(8). AUG 2005. 359-370.

Summary: Abstract only: The paper deals with the study of bionomics and population dynamics of *Ips typographus* (L.) in the area of the Praded National Nature Reserve (NNR). Data were collected on the basis of detected feeding marks, beetles caught in traps, and also according to the frequency of occurrence or increase in the number of standing dead trees killed by the bark beetle attack in localities where sanitation felling was not performed. Finally, evaluation of the present condition of forest stand and population dynamics of *Ips typographus* was carried out. The results showed that the stands currently occur in the stage of disintegration when the role of the bark beetle is irreplaceable. Based on the research findings, the management of the bark beetle was proposed that would enable to achieve so-called regulated disintegration of natural spruce forests in the area of the Praded NNR.

Schroeder, Leif Martin., 2007. Retention or salvage logging of standing trees killed by the spruce bark beetle *Ips typographus*: Consequences for dead wood dynamics and biodiversity. *Scandinavian Journal of Forest Research*. 22(6). 2007. 524-530.

Schroeder, L.M., 2001. Tree Mortality by the Bark Beetle *Ips typographus* (L.) in storm-disturbed stands. *Integrated Pest Management Reviews*, Volume 6, Numbers 3-4 / September, 2001

[Schroeter, Hansjochen, Holger Veit, Jutta Odenthal-Kahabka., 2008. from Original article: Odenthal-Kahabka, J. \(2005\): Handreichung Sturmschadensbewältigung. Hrsg. Landesforstverwaltung Baden-Württemberg und Landesforsten Rheinland-Pfalz. Online version: Status: 12.06.2008](#)

Summary: Available from: http://www.waldwissen.net/themen/waldschutz/insekten/fva_rindenbrueter_EN [Accessed 28 August 2008]

Seidl, R., Rammer, W., Jøger, D., Lexer, M.J. 2008. Impact of bark beetle (*Ips typographus* L.) disturbance on timber production and carbon sequestration in different management strategies under climate change. *For Ecol. Manage.* 256, 209-220.

Seidl, R., Schelhaas, M.J., Lindner, M., Lexer, M.J. 2009. Modelling bark beetle disturbances in a large scale forest scenario model to assess climate change impacts and evaluate adaptive management strategies. *Reg. Environ. Change* 9, 101-119

Seidl, Rupert; Baier, Peter; Rammer, Werner; Schopf, Axel; Lexer, Manfred J., 2007. Modelling tree mortality by bark beetle infestation in Norway spruce forests. *Ecological Modelling*. 206(3-4). AUG 24 2007. 383-399.

Stephen & Gregoire., undated. Introduction and Establishment of Exotic Bark Beetles. *Papers -Exotic Forest Pests Online symposium*

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsintroduction_surface.pdf [Accessed 28 August 2008]

Sun Xiao-ling; Yang Qing-yin; Sweeney, Jonathan David; Gao Chang-qi., 2006. A review: chemical ecology of *Ips typographus* (Coleoptera, Scolytidae). *Journal of Forestry Research (Harbin)*. 17(1). MAR 2006. 65-70.

Summary: Abstract only: Chemical ecology of the spruce bark beetle *Ips typographus* (L.) was reviewed. The outbreak of *I. typographus* in central Europe triggered extensive research on chemical ecology. Males initiate host location and produce semiochemicals which attract both males and females. A successful mass attack must first overcome the resistance of the host tree. Pioneer *I. typographus* evolved to use the resin flow of host trees as kairomones in host location, and synthesized semiochemicals initially to detoxify the resin. If small bark beetle populations infest healthy trees, mass attack is prevented by host resistance. Nine monoterpene alcohols were found in male hind-guts, including cis-verbenol (cV) and 2-methyl-3-buten-2-ol (MB) which are regarded as primary aggregation pheromones, and a low proportion of Ipsdienol (Id) which increases attractiveness of cV and MB. Verbenone (Vn) and Ipsenol (Ie) are anti-aggregation pheromones, that play important roles in adjusting attack density and insect density under the bark. Non-host volatiles are repellent to *I. typographus*, so that beetles do not waste energy boring into non-host trees. The relationship between host resistance, pheromone compounds and behavior, non-host volatiles, bioassays and mass trapping are reviewed. Results of field bioassays stressed that traps baited with specific pheromones could be used as a reasonable protection measure.

[Tomiczek, C., Cech, T.L., Först, A., Hoyer-Tomiczek, U., Krehan, H., Perny, B., Steyrer, G. 2009. Forstschutzsituation in Österreich 2008. Forstschutz Aktuell 46, 3-8. ISSN 1815-5103](#)

Summary: Available from: http://bfw.ac.at/400/pdf/fsaktuell_46_1.pdf [Accessed 15 November 2009]

Turcani, M.; Hlasny, T., 2007. Spatial distribution of four spruce bark beetles in north-western Slovakia. *Journal of Forest Science (Prague)*. 53(Sp. Iss. SI). 2007. 45-52.

Turcani, M.; Nakladal, O., 2007. The results of manipulated experiments with inoculation of *Ips typographus* (L., 1758) to spruce trees under various levels of water stress. *Journal of Forest Science (Prague)*. 53(Sp. Iss. SI). 2007. 25-30.

[USDA Forest Service, undated. Invasive Pest Risk Maps, Ips typographus: Establishment Potential \(6-19-2006\)](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsestablishment_surface.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps Ips typographus: Establishment Potential Alaska 3-21-2007](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsestablishment_ak.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps, Ips typographus: Introduction Potential \(6-19-2006\)](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsintroduction_surface.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps Ips typographus: Introduction Potential Alaska 3-21-2007](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipsintro_ak.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps, Ips typographus: Susceptibility Potential \(6-19-2006\)](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipssusceptibility_surface.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps Ips typographus: Susceptibility Potential Alaska 3-21-2007](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ipssusceptibility_ak.pdf [Accessed 28 August 2008]

[USDA Forest Service, undated. Invasive Pest Risk Maps Survey Sample Areas for the United States. European Spruce Bark Beetle- Ips typographus](#)

Summary: Available from: http://www.fs.fed.us/foresthealth/technology/pdfs/ips_tesselation.pdf [Accessed 28 August 2008]

Viiri, Heli & Lieutier, Francois. 2004. Ophiostomatoid fungi associated with the spruce bark beetle, *Ips typographus*, in three areas in France. *Ann. For. Sci.* 61 (2004) 215-219.

Vite, J. P., 1989. The European struggle to control *Ips typographus* - past, present and future. *Holarctic Ecology* 12: 520-525. Copenhagen 1989

[Walker, K. 2009. European spruce bark beetle \(*Ips typographus*\) Pest and Diseases Image Library. Updated on 2/6/2009 11:58:29 AM. Available online: <http://www.padil.gov.au>](#)

Summary: Available from: <http://www.padil.gov.au/viewPestDiagnosticImages.aspx?id=163> [Accessed 28 August 2008]

Wermelinger, Beat., 2004. Ecology and management of the spruce bark beetle *Ips typographus* – a review of recent research. *Forest Ecology and Management* Volume 202, Issues 1-3, 1 December 2004, Pages 67-82

Weslien, Jan and Ake Lindelow, 1989. Trapping a local population of spruce bark beetles *Ips typographus* (L.): Population size and origin of trapped beetles. *Holarctic Ecology* 12: 511-514 Copenhagen 1989

General information

Franklin, Anne; De Canniere, Charles; Gregoire, Jean-Claude., 2004. Can sales of infested timber be used to quantify attacks by *Ips typographus* (Coleoptera, Scolytidae)? A pilot study from Belgium. *Annals of Forest Science*. 61(5). July 2004. 477-480.

[Global Biodiversity Information Facility \(GBIF\), 2008. *Ips typographus* DeGreer, 1775.](#)

Summary: Available from: <http://data.gbif.org/species/14599555/> [Accessed 15 June 2010]

Grodzki, Wojciech., 2004. Some reactions of *Ips typographus* (L.) (Col.: Scolytidae) to changing breeding conditions in a forest decline area in the Sudeten Mountains, Poland. *Journal of Pest Science*. 77(1). March 2004. 43-48.

Grodzki, Wojciech; McManus, Michael; Knizek, Milos; Meshkova, Valentina; Mihalcu, Vasile; Novotny, Julius; Turcani, Marek; Slobodyan, Yaroslav., 2004. Occurrence of spruce bark beetles in forest stands at different levels of air pollution stress. *Environmental Pollution*. 130(1). July 2004. 73-83.

Hedgren, Per Olof & Leif Martin Schroeder., 2004. Reproductive success of the spruce bark beetle *Ips typographus* (L.) and occurrence of associated species: a comparison between standing beetle-killed trees and cut trees. *Forest Ecology and Management* 203 (2004) 241-250

Hedgren, Per Olof; Schroeder, Leif Martin., 2004. Reproductive success of the spruce bark beetle *Ips typographus* (L.) and occurrence of associated species: a comparison between standing beetle-killed trees and cut trees. *Forest Ecology & Management*. 203(1-3). December 13, 2004. 241-250.

Huber, Christian., 2005. Long lasting nitrate leaching after bark beetle attack in the highlands of the Bavarian Forest National Park. *Journal of Environmental Quality*. 34(5). SEP-OCT 2005. 1772-1779.

Lakatos, F.; Kovacs., 2006. Bark beetle outbreak in the arboretum of Budafapuszta. *Novenyvedelem*. 42(1). JAN 2006. 25-30.

Summary: Abstract only: There is a large collection of exotic coniferous trees species in the arboretum of Budafapuszta (altogether 132 species). The dieback was noticed first in the old Norway spruce (*Picea abies* Karsten) stand. In 2003-2004 the damage exceeded the borders of this stand and it spread to the areas covered by other coniferous species. Because of the large number of the beetles, beyond their main host-plant, they attacked other coniferous trees, which can be found in the area. There were tree species, where mother galleries have been made, then (after the oviposition) larval galleries have been also noticed. These tree species were all perished, except of some individuals (Table 1.). On some other species larger (up to 5 cm) galleries could be seen, made by the imagines, but without any eggs laid. All these trees survived the attack (Table 2.). On several tree species only moderate attack was observed (maximum a short nuptial chamber) and all of these trees survived also (Table 3.). We found out during the field and laboratory examinations, that the main factor of the damage was *Ips typographus*, but some *Pityogenes chalcographus* were also found. According to the literature, *Picea* species (*P. abies*, *P. jezoensis*, *P. omorica*, *P. obovata*), larch species (*Larix decidua*), different *Pinus* species (*P. koraiensis*, *P. sylvestris*, *P. sibirica*, *P. strobus*), some *Abies* species (*A. alba*, *A. sibirica*), and *Pseudotsuga* species are the possible host plants of *Ips typographus*. Beyond the *Picea* and *Pinus* genera, in the arboretum *Ips typographus* also attacked the species of the genus *Abies*, *Larix*, *Pseudotsuga*, *Taxodium* and *Thuja* species, but the level of damage was lower in these stands. There was not any damage on the species of *Calocedrus*, *Cedrus*, *Cryptomeria*, *Cunninghamia*, *Juniperus*, *Metasequoia* and *Taxus* genera. The offspring-generation developed only on the main host, Norway spruce. During the evaluation it has to be considered, that the damage was on a special area, and the damage itself was also extraordinary.

Okland, Bjorn; Bjornstad, Ottar N., 2003. Synchrony and geographical variation of the spruce bark beetle (*Ips typographus*) during a non-epidemic period. *Population Ecology*. 45(3). December 2003. 213-219.

Schelhaas, Mart-Jan., Gert Jan Nabuurs And Andreas Schuck., 2003. Natural disturbances in the European forests in the 19th and 20th centuries. *Global Change Biology* (2003) 9, 1620-1633, doi: 10.1046/j.1529-8817.2003.00684.x

Schelhaas, M.J., Nabuurs, G.J., Schuck, A., 2003. Natural disturbances in the European forests in the 19th and 20th centuries. *Global Change Biology* 9, 1620-1633

Schlyter, Peter; Stjernquist, Ingrid; Barring, Lars; Jonsson, Anna Maria; Nilsson, Carin., 2006. Assessment of the impacts of climate change and weather extremes on boreal forests in northern Europe, focusing on Norway spruce. *Climate Research*. 31(1). JUN 26 2006. 75-84.

Schütt, P. Weisgerber, H., Lang, J., Roloff, A., Stimm, B., 2006. *Enzyklopädie der Holzgewerbechse*. Ecomed Biowissenschaften, Landsberg. DVD-ROM

[Steyrer, G., Krehan, H. 2009. Borkenkäfer-Kalamität 2008: Ist ein weiterer Rückgang wahrscheinlich? Forstschutz Aktuell 46, 9-15. ISSN 1815-5103](#)

Summary: Available from: http://bfw.ac.at/400/pdf/fsaktuell_46_2.pdf [Accessed 15 November 2009]

[The Nature Conservancy \(TNC\), 2005. European spruce beetle *Ips typographus* L. GIST Global Invasive Species Team](#)

Summary: Available from: <http://tncweeds.ucdavis.edu/products/gallery/ipsty1.html> [Accessed 28 August 2008]

Wichmann, Lars and Hans Peter Ravn., 2001. The spread of *Ips typographus* (L.) (Coleoptera, Scolytidae) attacks following heavy windthrow in Denmark, analysed using GIS. *Forest Ecology and Management* Volume 148, Issues 1-3, 1 July 2001, Pages 31-39



GLOBAL INVASIVE SPECIES DATABASE

FULL ACCOUNT FOR: *Ips typographus*

Xiao-ling, Sun; bin, Cheng; Chang-qj, Gao; Chang-chun, Dong; Yong-bin, Lu; Li-wen, Zhao., 2007. Research progress on ecology of *Ips typographus*. Shengtaixue Zazhi. 26(12). DEC 2007. 2089-2095.

Summary: Abstract only: *Ips typographus* is one of the most damaging bark beetles in Europe, which can attack weak spruces and aggregate in larger area via the pheromone produced by males. The aggregation pheromones can not only lead to aggregation, but also modify the density of aggregation. During the period of host orientation, both host volatiles and nonhost volatiles could be used to distinguish host or nonhost. In forest ecosystem, predators and parasitoids greatly affect the population density and behavioral ecology of *I. typographus*. This paper reviewed the research progress on the distribution and pervasion of *I. typographus*, kinds of natural enemies and their control functions, behavioral control of beetle and its natural enemies by semiochemicals, and present status of pheromone protection. Zolubas, Paulius., 2003. Spruce Bark Beetle (*Ips typographus* L.) Risk Based on Individual Tree Parameters. Proceedings: IUFRO Kanazawa 2003 Forest Insect Population Dynamics and Host Influences.

Summary: Available from: http://kamatan.uf.a.u-tokyo.ac.jp/symp/iufro2003kanazawa/proceedings/P04_Zolubas.pdf [Accessed 28 August 2008]