

Preparedness in biological control of priority biosecurity threats

European spruce bark beetle, *Ips typographus* (L.)

Introduction

The European spruce bark beetle, or eight-toothed bark beetle (*Ips typographus* (L.)) is a Eurasian species, widespread from East Asia to Western Europe (EPPO 2022). It is the most serious pest of coniferous forests in Europe, where its primary host tree is Norway spruce, *Picea abies*, Europe's most economically valuable forest tree species (Wermelinger 2004). It attacks mostly stressed and injured trees but, when populations are high, e.g. after a storm, it also attacks and kill healthy host trees. Besides spruce species (*Picea* spp.), it can occasionally colonise other conifer species such as firs (*Abies* spp.), Douglas fir (*Pseudotsuga menziesii*), larches (*Larix* spp.) and pines (*Pinus* spp.). It is present in almost all European countries, with the exception of Portugal, Spain, Sardinia Island (Italy) and Ireland. It has recently been found at several sites in Great Britain, where it is the target of eradication programmes (EPPO, 2022).

History of classical biological control against *Ips typographus*

No classical biological control programme has been conducted against *Ips typographus*, mostly because it never invaded new continents. In the recent history, plantations of *P. abies* outside of the natural range of the tree in continental Europe were quickly invaded by *Ips typographus* and its cohort of natural enemies. If the eradication of recently found populations in Great Britain fails, some natural enemies that are not yet present in the British Isles could be introduced. *Ips typographus* was already intercepted several times in North America (EPPO 2022) and if it was introduced in this continent, it could have devastating effects on spruce stands and, thus generate interest for a classical biocontrol programme.

Most promising natural enemies

The natural enemies of *I. typographus* are numerous and well-known. Kenis et al. (2004) listed 36 parasitoids and 67 predators recorded from *I. typographus* in Europe only, even though the authors argue that several are doubtful records. Wegensteiner (2004) reviewed the pathogens of *I. typographus* and other bark beetles in Europe. Although natural enemies of bark beetles are often considered as being of low importance in their population dynamics, studies based on exclusion cages (e.g. Weslien 1992) showed that parasitoids and predators can reduce broods of *I. typographus* by as much as 83%. However, all predators and most parasitoids and pathogens of *I. typographus* are polyphagous and cannot be used in classical biological control programmes. Exceptions are parasitoids of adult beetles (Kenis et al. 2004), and some pathogens such as a virus (Wegensteiner 2004). Some larval parasitoids are oligophagous and specific to a few bark beetle species living in spruce (Kenis et al. 2004). The natural enemies showing some degree of specificity and able to cause high mortality in *I. typographus* populations are listed here:

Four parasitoids of adult beetles are commonly found in *I. typographus* adults (Kenis et al. 2004), the pteromalid *Tomicobia seitneri* (Ruschka) and the braconids *Rhopalophorus clavicornis* (Wesmael), *Cosmophorus klugi* Ratzeburg and *Cosmophorus regius* Niezabitowski. The fecundity of the parasitised beetle is reduced but not totally suppressed and, therefore, the exact impact of adult parasitoids on *I. typographus* populations is unclear. They are all occasionally reported from other bark beetles, but most records are on *I. typographus*. Their specificity is most probably due

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to the fact that females locate adult beetles using their aggregative pheromones. The most studied species, and possibly the most specific (Noyes 2019), is the pteromalid *Tomicobia seitneri* (Ruschka). In Italy, parasitism rates of *I. typographus* adults vary between 20 and 100% (Faccoli 2000). This species should be given priority for classical biological control against in the UK or elsewhere. The three braconids are less well known and are also worth studying. However, *R. clavicornis* has already been found in the UK (Yu et al. 2016) and the host range of the two *Cosmophorus* spp. is unclear and is likely to be broader than that of the two other species.

The braconid *Coeloides bostrichorum* Giraud is, among all larval parasitoids of *Ips typographus*, the most suitable candidate for classical biological control. It is among the most abundant species on this host and probably the most specific because it is confined to large bark beetle species on spruce, in particular but not only *I. typographus* (Kenis et al. 2004). Thus, introducing this parasitoid in areas where spruce species are non-native (e.g. UK) would most probably have limited consequences for the native fauna.

Other natural enemies

Among all predators of *I. typographus*, the clerid beetle *Thanasimus formicarius* (L.) is the most studied species and probably the most efficient (Kenis et al. 2004; Akkuzu et al., 2009). It can be mass cultured for augmentative releases. However, it preys on a whole range of bark beetles and, thus, it is probably not suitable for introduction into other continents.

Ips typographus larvae and adults are attacked by many pathogens (Wegensteiner 2004; Wegensteiner et al. 2015), but their impact and specificity require further investigations. Some pathogens such as the fungus *Beauveria bassiana*, are very common but are not at all specific. The pathogens that appear the most specific, such as *Ips typographus* entomopoxvirus (ItEPV), are not considered very important. The disease typically develops only in mature bark beetles. Although there are records of infection rates of the virus in populations of beetles, information about virus-induced mortality is controversial. Although the prevalence of the virus in the natural population is generally low, exceptions were documented. The abundance of ItEPV found in *I. typographus* population in one Austrian site reached as high as 21.3 % (Haidler et al. 2003).

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