2.1 Adelges piceae (RATZEBURG), Balsam Woolly Adelgid (Hem., Adelgidae)

Syn.: Dreyfusia piceae (RATZEBURG)

Adelges piceae is considered by some authors to be native to the Caucasus region and introduced into Europe in the 18th century (Clausen 1978), while others consider it native to Europe but alien in Sweden and the UK (Roy and Migeon 2010). The species has further been introduced into North America and Chile (CABI 2007).

Adelges piceae colonizes Abies alba and other congeneric species. It attacks all epigean parts of the plants (i.e. trunk, exposed roots, branches and twigs). When heavily colonized, sap sucking by A. piceae and sooty mould fungi growing on honeydew often leads to the decline or death of trees. In Europe, A. piceae is only rarely harmful, but it has become a serious pest on many of the indigenous species of Abies in North America.

Chemical control of A. piceae is difficult as females are effectively protected by the copious wax wool covering their bodies. Insecticides sprayed from the air over forest stands were ineffective in some experiments. Ground applications of insecticide to protect Christmas trees, seed orchards and highly valued trees in parks and gardens can be effective in reducing pest population levels, but are extremely costly.

Other effective attempts to control A. piceae include harvesting Abies spp. from an infested area to protect the uninfested nearby stands, shortening of the rotation age of Abies spp., or conversion to non-susceptible or less susceptible Abies species or to other tree species (CABI 2007).

Several predatory species are reported to attack A. piceae (CABI 2007).

2.1.1 Laricobius erichsonii ROSENHAUER (Col., Derodontidae)

Laricobius erichsonii is a predatory beetle native to central Europe (Clausen 1978). Adult L. erichsonii and later instars feed primarily on adult Adelgidae, but also on eggs. Early instars feed on eggs (Hammond and Barham 1982). This species is associated mainly with A. piceae but feeds also on other Adelgidae, i.e. Adelges cooleyi, Adelges nordmannianae, Pineus pineoides and Pinus strobi (Hammond and Barham 1982). Laricobius erichsonii
has been introduced as a biological control agent for *A. piceae* and other *Adelges* spp. into Canada, Pakistan and the USA (BIOCAT 2005). In Europe, *L. erichsonii* is recorded from Belgium, Denmark, Germany, the Netherlands, Sweden, the UK, the Alps and the Carpathian Mountains (Hammond and Barham 1982).

In 1972, 1800 *L. erichsonii* from Germany (Black Forest) were introduced into the UK on an acute, not further specified *Adelges* infestation on *A. alba* (Hammond and Barham 1982). No evidence has been found that the species has become established as a result of this introduction. *Laricobius erichsonii* has, however, been reported since 1971 in other parts of the UK, presumably as a result of natural spread from localities on the coast of Belgium or the Netherlands, where it has been established for some time (Hammond and Barham 1982).

### 2.1.2 Scymnus impexus Mulsant (Col., Coccinellidae)

*Scymnus impexus* is a predatory beetle native throughout central and southern Europe (Clausen 1978). It is associated mainly with *A. piceae* and has often been observed to cause sharp reductions in the aphid infestations in its native distribution range (Clausen 1978). *Scymnus impexus* has been introduced against *A. piceae* into Canada and the USA (BIOCAT 2005). It has also been introduced into Pakistan against an unspecified *Adelges* species, but failed to establish there (BIOCAT 2005).

Specimens collected in southern Germany (Black Forest) were introduced into Sweden in 1968 to fight *A. piceae* (and another Adelgidae, *A. nordmannianae*). At two sites, 7000 and 12,000 specimens were released, respectively (Greathead 1976). *Scymnus impexus* established and initially responded with a parallel increase to its host population increase (Greathead 1976); however, no information on its long-term impact has been found.

In 1972, 10,000 *S. impexus* originating from southern Germany (Black Forest) were introduced into the UK, against both *A. piceae* and *A. nordmannianae* (Greathead 1976). However, the species failed to establish permanently (Duff 2008).

### 2.2 Diaspidiotus perniciosus (Comstock), San José Scale (Hem., Diaspididae)

See Section 1.18.

### 2.2.1 Encarsia fasciata (Malenotti) (Hym., Aphelinidae)

Syn.: *Prosaptiella fasciata* Malenotti

*Encarsia fasciata* is native to Italy (Clausen 1978). Known hosts include 11 genera in the family Diaspididae (Noyes 2016). It was also introduced into Peru to control *Selenaspidus articulatus* (BIOCAT 2005). In Europe, the species is reported from Austria, France, Germany, Greece, Hungary, Italy, Montenegro, Serbia, Spain, Switzerland and the former USSR (CABI 2007).
In 1951, *E. fasciata* together with *Encarsia perniciosi* (Section 1.18.2) was imported to France to develop mass-rearing techniques (Greathead 1976). In 1958, it was reimported and released. No information on its success as a biocontrol agent was found.

In 1956, *E. fasciata* was received and mass reared in Germany (Clausen 1978). Up to 1958, 4 million individuals had been released (Clausen 1978). No information on its success as a biocontrol agent was found.

### 2.3 *Dociostaurus maroccanus* (Thunberg), Moroccan Locust (Ort., Acrididae)

*Dociostaurus maroccanus* is a locust native to northern Africa, southern and eastern Europe, and western and central Asia. It swarms and migrates, but not over long distances (CABI 2007). Today, *D. maroccanus* is recorded from several countries in Europe, i.e. Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, France, Greece, Hungary, Italy, Former Yugoslav Republic of Macedonia, Romania and Spain (CABI 2007). While some countries are part of the native range of this species, it might have been introduced in others. For instance, it is unclear whether *D. maroccanus* is indigenous to the Carpathian Basin, and its appearance in Hungary approximately 100 years ago might have been the result of introduction from the Mediterranean region (CABI 2007).

*Dociostaurus maroccanus* is a highly polyphagous species, recorded from approximately 70 hosts (CABI 2007). This species prefers grass, but also frequently attacks deciduous trees, especially young oaks, feeding mainly on leaves and stems. *Dociostaurus maroccanus* can damage almost all agricultural crops, and major hosts recorded include *Avena* (oat), *Glycine max* (soybean), *Hordeum* (barley), *Panicum miliaceum* (millet), *Secale cereale* (rye), *Triticum* (wheat) and *Zea mays* (maize) (CABI 2007). Local outbreaks in Europe have been observed in Bulgaria, Hungary and Spain (CABI 2007).

Chemical insecticides can provide control of locust and grasshopper outbreaks in general; however, the widespread use of chemicals and their associated detrimental effects on the environment, combined with the hazard they represent to users and livestock, remains a major drawback to continued reliance on their use (CABI 2007).

Control measures also include destroying egg masses, digging trenches to trap nymphs, using hopper dozers (wheeled screens) that cause locusts to fall into troughs containing water and kerosene and using poison (CABI 2007).

The entomopathogenic control agent *Metarhizium anisopliae* var. *acridum* has received considerable attention since the early 2000s as a viable biopesticide alternative to chemicals for locust control (CABI 2007).

Natural enemies recorded on *D. maroccanus* include eight parasitoid species from four genera (including many *Blaesoxipha* species (Sarcophagidae, Diptera)), five pathogen and 16 predator species from nine genera (CABI 2007). Birds and reptiles also prey on on *D. maroccanus*.

#### 2.3.1 *Cytherea obscura* Fabricius (Dip., Bombyliidae)

*Cytherea obscura* is native to the Palaearctic region (Evenhuis and Greathead 1999). No information on its host range was found.
Cytherea obscura originating from mainland Italy was introduced into Sardinia in 1946 and released in six locations. An estimated 14,000 individuals including both imported C. obscura and Systoechus ctenopterus (Section 2.3.3) were released. The species established (CABI 2007), but control of D. maroccanus was achieved mainly by Mylabris variabilis (Section 2.3.2).

2.3.2 Mylabris variabilis (Pallas) (Col., Meloidae)

Mylabris variabilis is a predatory beetle recorded from Bulgaria, Iran, Italy, Spain and Turkey (Nikbakhtzadeh 2002; CABI 2007). Species in the subfamily Mylabrini feed on the eggs of grasshoppers.

In 1946, M. variabilis was introduced from mainland Italy to Sardinia, where 21,000 were released in 22 localities (Greathead 1976). The species has spread over most of the island. The impact of M. variabilis is considered to be partly responsible for the fact that no serious outbreaks of D. maroccanus have been observed in Sardinia since (Greathead 1976). Between 1957 and 1959, 2000 specimens of M. variabilis were released in Corsica, France, from where complete control of the pest has been reported (OPIE 1986; Malausa et al. 2008).

2.3.3 Systoechus ctenopterus (Mikan) (Dip., Bombyliidae)

Syn.: Systoechus sulphureus (Mikan)

Systoechus ctenopterus is native to the Palaearctic region (Evenhuis and Greathead 1999). No information on its host range was available.

In 1946, S. ctenopterus originating from mainland Italy was introduced to Sardinia and released in six locations. An estimated 14,000 individuals including both imported Systoechus sulphureus and C. obscura (Section 2.3.1) were released; however, the species failed to establish (CABI 2007).

2.4 Dialeurodes citri (Ashmead), Citrus Whitefly (Hem., Aleyrodidae)

See Section 1.17.

2.4.1 Encarsia tricolor Forster (Hym., Aphelinidae)

Encarsia tricolor is an endoparasitoid native to Europe (Huang et al. 2009). Known hosts include nine other Aleyrodidae species in different genera, but it is also reported to be hyperparasitic on four Aphelinidae, Encarsia formosa, Encarsia inaron, Encarsia lutea and Encarsia pergandiella and the Eulophidae Euderomphale chelidonii (Noyes 2002; Huang et al. 2009). In Europe, E. tricolor is recorded from Belgium, Bosnia and Herzegovina, Croatia, the Czech Republic, France, Germany, Greece, Hungary, Italy, Former Yugoslav Republic of Macedonia, Montenegro, Serbia, Spain, Switzerland and the UK (Noyes 2002; CABI 2007).
In 1950, some 10,000 Encarsia spp., including E. tricolor from Belgium and Switzerland, were introduced into France (Greathead 1976); no information on its success as a biocontrol agent was found.

2.5 Ips sexdentatus (Boerner), Six-toothed Bark Beetle (Col., Scolytidae)

*Ips sexdentatus* is native to Eurasia (CABI 2007). So far, it has not been introduced to areas outside its native range, but trade will maintain a high potential for *I. sexdentatus* to become established outside its native range (CABI 2007). In fact, it has been intercepted in North America (CABI 2007). In Europe, it is currently recorded from all countries except Albania, Cyprus, Iceland, Liechtenstein and Malta (CABI 2007). In Denmark, the species has been intercepted, but has not established (CABI 2007).

*Ips sexdentatus* attacks conifers; major hosts include *Pinus sylvestris* and *Pinus taiwanensis* (Taiwan pine) (CABI 2007). It is also recorded from other *Pinus* species, as well as from *Abies nordmanniana* (Nordmann fir) and occasionally from *Larix* species (EPPO/CABI 1997; CABI 2007). *Ips sexdentatus* is of no significance as a pest in northern and central Europe, where it breeds only in fresh logs or in weakened or dying trees. It has, however, caused the death of *P. sylvestris* and *P. radiata* suffering from drought stress in central and southern France, northern Spain and Portugal, often in association with other pests (EPPO/CABI 1997). As the adults construct the egg galleries in the phloem under the outer bark, they defecate spores of blue stain fungi (*Ophiostoma brunneo-ciliatum* Math.). These spores germinate and the fungal hyphae grow throughout the outer sapwood, thereby blocking the movement of water from the roots to the needles. Thus, the tree is weakened by dehydration, which increases the beetles’ ability to colonize a living host and ultimately cause tree death (CABI 2007). During outbreaks, large economic losses occur due to the death of trees. For instance, approximately 1 million *Picea orientalis* trees were lost in Turkey due to sporadic *I. sexdentatus* infestations (CABI 2007).

The most effective control measure is to remove infested trees before the new generation of adult beetles emerge (EPPO/CABI 1997). Unhealthy and wind-thrown trees, as well as slash, should be removed quickly and processed. Beetle-infested material should be cut, piled and burned. Semiochemicals are used to monitor *I. sexdentatus* populations (CABI 2007).

Many insect, mite and nematode species either consume or parasitize *Ips* spp. Natural enemies recorded on *I. sexdentatus* include 12 parasitoid species from nine genera and five predator species (CABI 2007).

2.5.1 Aulonium ruficorne (Olivier) (Col., Zopheridae)

*Aulonium ruficorne* is a predatory beetle native to Europe (Greathead 1976). It is reported as a natural enemy of Scolytidae. Besides *I. purchasi*, the species is recorded from two other Scolytidae, *Orthotomicus erosus* and *Pityogenes calcicaratus* (CABI 2007). *Aulonium ruficorne* has been introduced into South Africa to control *O. erosus*
In Europe, *A. ruficorne* has presumably been introduced accidentally to the UK on imported pit props from France made from maritime pine and has since established in southern UK (Greathead 1976).

In 1948, an intentional introduction of *A. ruficorne* from France was made into the UK (Greathead 1976). No information on its success as a biocontrol agent was found.

### 2.5.2 Hypophloeus fraxini KUGELANN (Olivier) (Col., Tenebrionidae)

**Syn.:** *Corticeus fraxini* KUGELANN

*Hypophloeus fraxini* is a predatory beetle native to Europe (Greathead 1976). It is also recorded as a natural enemy of another Scolytidae, *Hylurgops palliatus* (CABI 2007). The species has presumably been introduced accidentally to the UK on imported pit props from France (see above) and is now established in southern UK (Greathead 1976).

In 1948, an intentional introduction of *H. fraxini* was made from France into the UK (Greathead 1976). No information on the success of *H. fraxini* as a biocontrol agent was found.

### 2.5.3 Platysoma oblongum (FABRICIUS) (Col., Histeridae)

*Platysoma oblongum* is a predatory beetle native to Europe (Greathead 1976). The species is reported as a natural enemy of Scolytidae; besides *I. sexdentatus*, the species is also recorded from *O. erosus* and *Hylurgus ligniperda* (CABI 2007). *Platysoma oblongum* has been introduced against *O. erosus* into South Africa (BIOCAT 2005).

In 1948, *P. oblongum* was introduced from France into the UK (Greathead 1976). No information on its success as a biocontrol agent was found.

### 2.5.4 Tomicobia seitneri (RUSCHKA) (Hym., Pteromalidae)

*Tomicobia seitneri* is an adult parasitoid native to Eurasia (CABI 2007). It is also recorded from other species in the genus *Ips*, i.e., *I. amitinus*, *I. duplicatus*, *I. subelongatus* and *I. typographus* (CABI 2007). The importance of *T. seitneri* on *Ips* populations is difficult to estimate; it has been observed that females can lay eggs despite being parasitized by this pteromalid (Feicht 2003).

In 1948, *T. seitneri* from Germany was introduced into the UK (Greathead 1976). No information on its success as a biocontrol agent was found.

### 2.6 Liriomyza trifolii (BURGESS IN COMSTOCK), American Serpentine Leafminer (Dip., Agromyzidae)

*Liriomyza trifolii* originates from the Americas (Scheffer and Lewis 2006) and has been introduced into several countries in Africa, Asia, Europe, Central and South America and Oceania. It is now a major pest of the Asteraceae worldwide (CABI 2007).
In Europe, \textit{L. trifolii} is recorded from Austria, Belgium, Croatia, Cyprus, France, Greece, Italy, Malta, Montenegro, the Netherlands, Norway, Portugal, Romania, Serbia, Slovenia, Spain and Switzerland. It has been present formerly in Bulgaria, the Czech Republic, Denmark, Finland, Germany, Hungary, Ireland, Poland, Sweden and the UK, but is today recorded as eradicated from these countries (CABI 2007).

\textit{Liriomyza trifolii} is a polyphagous species recorded from 28 plant families (CABI 2007). The species attacks a wide range of ornamental and vegetable crops, including \textit{Allium} spp. (garlic, onions, leek), beans (e.g. \textit{G. max}, \textit{Pisum sativum}, \textit{Phaseolus}), celery, Chinese cabbage (\textit{Brassica rapa} subsp. \textit{chinensis}), chrysanthemums (\textit{Dendranthenum} spp.), clover, \textit{Gerbera}, lettuces, lucerne, potatoes and tomatoes. In particular, it is considered a pest on chrysanthemums (CABI 2007). \textit{Liriomyza trifolii} attacks leaves (CABI 2007); larval mining reduces the photosynthetic ability of plants and severely infested leaves may fall, exposing plant stems to wind action and causing flower buds and developing fruit to scald (CABI 2007). In young plants and seedlings, \textit{L. trifolii} mining can cause considerable delay in plant development, occasionally leading to plant loss (CABI 2007). The species may further act as vectors for diseases (CABI 2007). \textit{Liriomyza trifolii} is mainly a pest of crops grown under glass, but it can also cause damage to these crops grown in the open in the warmer parts of the EPPO region (CABI 2007).

Some insecticides, particularly pyrethroids, are effective, but some individual strains of \textit{L. trifolii} have become resistant to most insecticides, making control difficult (CABI 2007). Storage of plants at 0°C for 1–2 weeks after the eggs of \textit{L. trifolii} hatch should kill the larvae. Gamma irradiation of eggs and first larval stages at doses of 40–50 Gy provided effective control (CABI 2007).

Foliar applications of the entomophagous nematode \textit{Steinernema carpocapsae} reduced adult development of \textit{L. trifolii} significantly. Biological control programmes using parasitoids have been attempted worldwide (BIOCAT 2005). Natural enemies recorded on \textit{L. trifolii} include 47 parasitoids from 18 genera, two predators and five pathogen species.

\textbf{2.6.1 \textit{Diglyphus isaea} (WALKER) (Hym., Eulophidae)}

\textit{Diglyphus isaea} is an ectoparasitoid of leafminers native to the Palearctic (Eurasia) (Minkenberg 1989). The known host range includes 11 Agromyzidae species, but also three Lepidoptera species, i.e. \textit{Pieris rapae} (Pieridae), \textit{Plutella xylostella} (Plutellidae) and \textit{Stigmella malella} (Nepticulidae), and the hemipteran \textit{Lipaphis erysimi} (Aphididae) (CABI 2007). Besides Europe, \textit{D. isaea} has also been introduced against \textit{L. trifolii} into Canada and against another Agromyzidae, \textit{Agromyza frontella}, into Hawaii (BIOCAT 2005). In Europe, \textit{D. isaea} is recorded from Austria, Belgium, the Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, the Netherlands, Malta, Poland, Spain, Sweden, the UK and former Yugoslavia (Serbia and Montenegro) (Noyes 2002).

In 1994, \textit{D. isaea} was introduced into Malta and more than 80% parasitism was recorded (Mišud 1997). No information on the origin of the introduced
parasitoids was found; since at that time *D. isaea* was already being used as a biological control agent in Europe, it was assumed that the specimens were introduced from Continental Europe.

### 2.6.2 *Dacnusa sibirica* Telega (Hym., Braconidae)

**Syn.:** *Pachysema sibirica* (Telega)

*Pachysema sibirica* is an ectoparasitoid of leafminers native to northern Eurasia (McPartland *et al.* 2000). The known host range includes at least 12 Agromyzidae species from four genera (Yu *et al.* 2005), including leafminers such as the Agromyzidae *Liriomyza bryoniae* (Kaltenbach), *Liriomyza huidobrensis*, *L. trifoli*, *Chromatomyia horticola* and *Chromatomyia syngenesiae* (Hardy) (CABI 2007). In Europe, *P. sibirica* is recorded from Austria, Belgium, Bulgaria, Denmark, France, Germany, Hungary, Ireland, Italy, Lithuania, the Netherlands, Poland, Portugal, Spain, Sweden, the UK and former Yugoslavia (Yu *et al.* 2005; CABI 2007). As a biocontrol agent it only works as a preventative measure, since it reproduces too slowly to stop even moderate infestations (McPartland *et al.* 2000).

In 1979, *P. sibirica* was introduced into Malta (Mifsud 1997). In 1994, it was again introduced, together with *D. isaea* (Section 2.6.1), but it proved to be less effective than the latter (Mifsud 1997). No information on the origin of the introduced parasitoids was found; since at that time *D. sibirica* was already being used as a biological control agent in Europe, it was assumed that the specimens were introduced from Continental Europe.

### 2.7 *Prays oleae* (Bernard), Olive Kernel Borer (Lep., Yponomeutidae)

See Section 1.46.

### 2.7.1 *Chelonus elaephiilus* (Silvestri) (Hym., Braconidae)

*Chelonus elaephiilus* is an endoparasitoid that is thought to occur in most Mediterranean countries (Greathead 1976), although it is only recorded officially from Hungary, Italy, Portugal, Spain and former Yugoslavia (Yu *et al.* 2005). Known hosts also include five other Lepidoptera species from four families (*Coleophora hemerobiella* (Coleophoridae), *Ochromolopis staionellus* (Epermeniidae), *Palumbina guerinii* (Gelechidae), *Pempelia turtreella* and *Ephestia kuehniella* (Pyralidae)) (BIOCAT 2005; Yu *et al.* 2005).

In 1968, 1117 and 300 adult *C. elaephiilus* from France were released at two sites in Greece (Greathead 1976). Between 1970 and 1972, an additional 6000 adults, also from France, were released (Greathead 1976). According to Greathead (1976), the species established and 26% parasitism was recorded 1 year after release at one of the 1968 release sites.
2.7.2 *Trichogramma embryophagum* (HARTIG) (Hym., Trichogrammatidae)

**Syn.: Trichogramma telengai Sorokina**

*Trichogramma embryophagum* is an egg parasitoid native to Eurasia (CABI 2007). The species has been recorded from at least 24 Lepidoptera species, including Geometridae, Tortricidae, Pyralidae and Saturniidae (CABI 2007). It has been introduced as a biocontrol agent against *Cydia pomonella* into India (BIOCAT 2005). In Europe, it is recorded today from Bulgaria, the Czech Republic, France, Germany, Italy, Montenegro, Poland, Portugal, Romania, Serbia, the Slovak Republic and the former USSR (CABI 2007).

During 1982/83, *T. embryophagum* from former Yugoslavia was released in Greece, together with other *Trichogramma* species, but only low parasitism rates were achieved (Stavraki 1985).

2.8 *Rhyacionia buoliana* (DENIS AND SCHIFFERMÜLLER), European Pine Shoot Moth (Lep., Tortricidae)

See Section 1.49.

2.8.1 *Baryscapus turionum* (HARTIG) (Hym., Eulophidae)

**Syn.: Tetristichus turionum** (HARTIG)

*Baryscapus turionum* is an endoparasitoid native to Europe (CABI 2007). It is recorded from four Lepidoptera species, and as a hyperparasite from one Diptera (*Actia nudibasis*, Tachinidae) and one Hymenoptera species (*Copidosoma geniculatum* (Encyrtidae); Noyes 2002). *Baryscapus turionum* has also been introduced into Canada and the USA as a biocontrol agent against *R. buoliana* (BIOCAT 2005).

Between 1936 and 1937, *B. turionum* originating from Austria was introduced into the UK, where it established. The species was released simultaneously with *C. geniculatum* (Section 2.8.2). *Rhyacionia buoliana* populations collapsed due to parasitism, which presumably was due to *B. turionum* since *C. geniculatum* was a parasitoid of *Exoteleia dedecella* and not of *R. buoliana* (Greathead 1976).

2.8.2 *Copidosoma geniculatum* (DALMAN) (Hym., Encyrtidae)

*Copidosoma geniculatum* is native to Europe (CABI 2007). The species is also recorded from *Choristoneura fumiferana* (Tortricidae) and *Exoteleia* and *Gelechia* species (Gelechiidae) (Noyes 2002). *Copidosoma geniculatum* has also been introduced into Canada and the USA as a biocontrol agent against *R. buoliana* (BIOCAT 2005).
Between 1936 and 1937, 3000 and 4400 individuals of *C. geniculatum* originating from Austria were released in the UK at two sites, respectively (Greathead 1976). The species was released simultaneously with *B. turionum* (Section 2.8.1). *Copidosoma geniculatum* was not recovered on *R. buoliana* and presumably did not attack the species (Greathead 1976).

### 2.9 **Scolytus scolytus** (Fabricius), Large European Elm Bark Beetle (Col., Scolytidae)

*Scolytus scolytus* is native to parts of Europe and Asia (CABI 2007). In Europe, *S. scolytus* is present in central, eastern and southern Europe and is recorded from all countries but Cyprus, Estonia, Finland, Iceland, Latvia, Former Yugoslav Republic of Macedonia, Malta and Norway (CABI 2007).

*Scolytus scolytus* lives on several elm (*Ulmus*) species. It has also been reported on *Populus nigra*, but very rarely (CABI 2007). The larvae develop in stems. Only old elms have barks thick enough to allow *S. scolytus* colonization. In the 20th century, Dutch elm disease, which was vectored by elm bark beetles (including *S. scolytus*), caused the disappearance of elms in almost all European towns.

Insecticides can be applied to kill the beetles when they arrive to feed or breed in elm trees. Both contact insecticides and systemic insecticides can be used.

To prevent and minimize *Scolytus* outbreaks, population density can be reduced by the elimination of trees already infested or suitable for colonization.

Many organisms are associated with elm bark beetles but only a limited group appears to act as predators or pathogens/parasites. The most important enemies are woodpeckers and wasps. Overall, natural enemies of *S. scolytus* include ten parasitoid species from nine genera, four predator species from three genera and five pathogen species (CABI 2007).

#### 2.9.1 **Dendrosoter protuberans** (Nees) (Hym., Braconidae)

*Dendrosoter protuberans* is an ectoparasitoid native to Europe (Manojlovic et al. 2003). Known hosts include other Scolytidae, i.e. *Scolytus multistriatus*, *Scolytus pygmaeus*, *Scolytus ensifer*, and *Pteleobius kraatzii* (Manojlovic et al. 2003).

In 1971, *D. protuberans* was introduced from Austria into the UK (Greathead 1976). No information on its establishment or impact as a biocontrol agent was found.