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Weevils and Bark Beetles (Coleoptera, Curculionoidea) Chapter 8.2

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Abstract

We record 201 alien curculionoids established in Europe, of which 72 originate from outside Europe. Aliens *to* Europe belong to five families, but four-fifths of them are from the Curculionidae. Many families and subfamilies, including some species-rich ones, have few representatives among alien curculionoids, whereas some others are over-represented; these latter, Dryophthoridae, Cossoninae and specially Scolytinae, all contain many xylophagous species. The number of new records of alien species increases continuously, with an acceleration during the last decades. Aliens *to* Europe originate from all parts of the world, but mainly Asia; few alien curculionoids originate from Africa. Italy and France host the largest number of alien *to* Europe. The number of aliens per country decreases eastwards, but is mainly correlated with importations frequency and, secondarily, with climate. All alien curculionoids have been introduced accidentally via international shipping. Wood and seed borers are specially liable to human-mediated dispersal due to their protected habitat. Alien curculionoids mainly attack stems, and half of them are xylophagous. The majority of alien curculionoids live in human-modified habitats, but many species live in forests and other natural or semi-natural habitats. Several species are pests, among which grain feeders as *Sitophilus* spp. are the most damaging.

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Keywords
Europe, Coleoptera, Curculionoidea, Curculionidae, alien species, invasive species, xylophagy, seed feeder

8.2.1. Introduction

The superfamily Curculionoidea encompasses the weevils and the bark and ambrosia beetles; here we will use „weevils" to refer to the entire superfamily. It is the most species-rich beetle clade, with more than 60,000 described species (Oberprieler et al. 2007). Four fifths of all weevils are in the family Curculionidae. Curculionoids are distributed worldwide, everywhere vegetation is found.

This is a rather homogeneous group, its members being generally easily recognizable despite various aspects. Adults are primarily characterized by the head being produced into a rostrum (snout) to which the antennae and mouthparts are attached. The rostrum is highly variable in size and shape, varying from as long as the body to very short or absent. Larvae, generally white and C-shaped, are catepillar-like (eruciform), soft-bodied, with legs being either vestigial or (usually) absent, except in some species of the primitive family Nemonychidae.

Except for a few rare species, adults and larvae of Curculionoidea are phytophagous. Larvae are mainly endophytic or subterranean. Weevils feed on a large variety of plants, attacking all parts. Many species are important pests for agriculture or forestry.

The Macaronesian islands[1] pose a special problem. While many of their weevils are only found on single islands or groups of islands and are thus clearly endemic, other species are shared between island groups, or between Macaronesian islands and the continental Europe or North Africa. For example, a number of scolytines specialized to *Euphorbia* are shared between the Canary Islands and Madeira, or between the Canary Islands and the Mediterranean and North Africa (Table 8.2.1). Given the difficulties involved with dispersal by these tiny insects over vast expanses of salt water, we have chosen to interpret the distributions of non-endemic species as resulting from recent human transport. We are well aware that rare instances of natural dispersal do occur, at least on evolutionary time scales: after all, such natural dispersal has resulted in many instances of well documented species radiations (Emerson 2008, Juan et al. 2000). Because of the inherent uncertainty in distinguishing between recent anthropogenic spread and older natural dispersal, we classify nonendemic species of these archipelagos as *presumed* aliens (they are indicated in tables 8.2.1 & 8.2.2). Without contradictory data, we consider: 1) species known from Europe and found on a Macaronesian island as *presumed* alien *in* Europe; 2) species known from Africa (and not from Europe) and found in Macaronesia as *presumed* alien *to* Europe; 3) species from the Canary Islands which also occur further north on Madeira or the Azores as *presumed* alien

[1] We include in our coverage the Macaronesian islands associated with European countries (Madeira, the Azores, the Canary Islands); we exclude the Cape Verde Islands.

from the Canary Islands and *presumed* alien *to* Europe. *Presumed* alien are often considered below separately than others, due to the uncertainty attached to their status and the geographical and biogeographical differences between Macaronesia and Europe.

We consider that 201 alien curculionoids currently live in Europe, of which 72 species originate outside of Europe (aliens *to* Europe, Table 8.2.1; 20 *presumed* alien are included) and 129 species originate from other parts of Europe (aliens *in* Europe, Table 8.2.2; 60 *presumed* alien are included)[2]. Except where otherwise noted, our discussion of exotic curculionoids only pertains to alien *to* Europe.

8.2.2. Taxonomy and biology

The systematics of the superfamily Curculionoidea have long been controversial, in part due to the enormous number of taxa involved, in part due to extensive parallel evolution arising from the similar ecologies of unrelated clades (Alonso-Zarazaga and Lyal 1999, Oberprieler et al. 2007). We follow here the current classification of Fauna Europaea (Alonso-Zarazaga 2004), which notably considers the traditional Platypodidae and Scolytidae families as subfamilies of Curculionidae.

About 5,000 native curculionoids live in Europe, distributed among 13 families. Comparatively, the alien entomofauna is very limited with only 72 established species recorded at this time (Fig. 8.2.1). These alien species belongs to five families, all of which have native representatives.

Anthribidae. Principally present in tropical areas, these largely fungus-feeding curculionoids generally live primarily in fungus-infested wood. There is only one alien species in Europe, *Araecerus coffeae*, which is a seed feeder, an exceptional biology in this family.

Apionidae. Characterized in part by their non-geniculate antennae and endophytous larvae, these tiny curculionoids are represented in Europe by three alien species, all living on alien ornamental *Alcea* (Malvaceae).

Dryophthoridae. This family contains large weevils mainly living on woody monocotyledons. Alien dryophthorids consist of woody monocotyledons borers and seed feeders. They are particularly numerous compared with the world fauna (Fig. 8.2.1) and especially with respect to the few native species in Europe (8 aliens vs 6 natives, according to Fauna Europaea (Alonso-Zarazaga 2004)). This situation could be explained first by the few woody monocotyledons in Europe-native flora in contrast with the several woody monocotyledons introduced in Europe for ornamental or agricultural purpose. The human-mediated transport of seeds, and consequently seed feeders, is probably a further explanation.

[2] Other aliens have been recorded, but have not been taken into account here because their establishment have not been confirmed. We have also excluded some possible *presumed* aliens due to the uncertainty about their distribution.

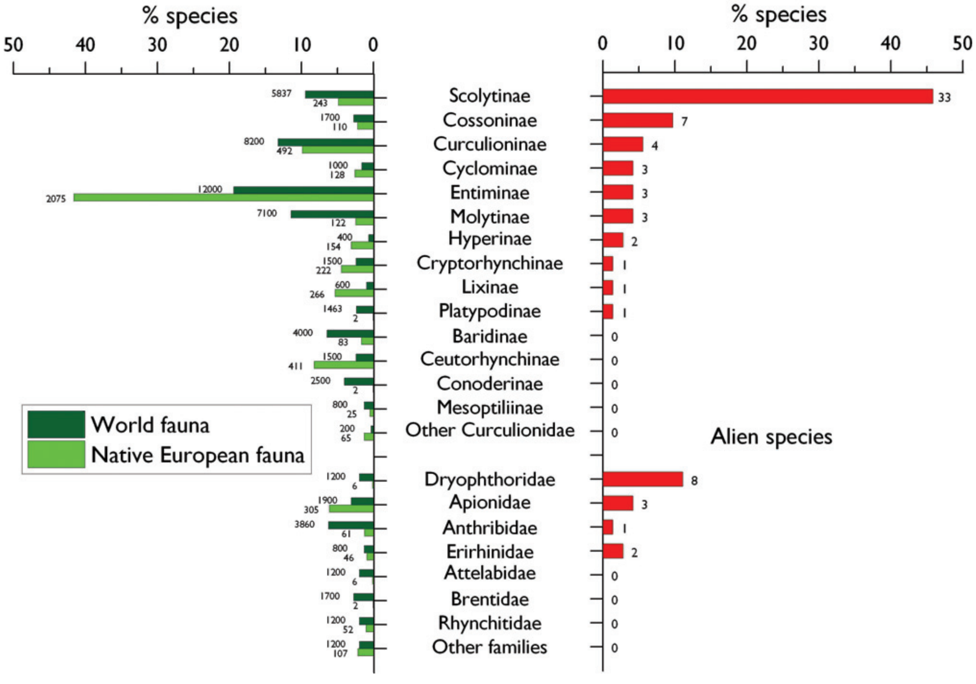

Figure 8.2.1. Taxonomic overview of Curculionoidea species alien to Europe compared to the native European fauna and to the world fauna. **Right**- Relative importance of the Curculionoidae families and subfamilies in the alien entomofauna is expressed as percentage of species in the family/ subfamily compared to the total number of alien Curculionidea in Europe. Subfamilies of Curculionidae and other families of Curculionidea are presented in a decreasing order based on the number of alien species. The number over each bar indicates the total number of alien species observed per family/ subfamily. **Left**- Relative importance of each family/ subfamily in the native European fauna of Curculionidea and in the world fauna expressed as percentage of species in the family/ subfamily compared to the total number of Curculionidea in the corresponding area. The number over each bar indicates the total number of species observed per family/ subfamily in Europe and in the world, respectively

Erirhinidae. Curculionoids of this small family mainly live on herbaceous monocotyledons, often aquatic ones. With two alien species, they are relatively well represented in Europe.

Curculionidae. This huge family encompasses more than 80% of weevils and notably includes the bark beetles and pinhole borers (Scolytinae and Platypodinae). Curculionids have a large variety of habits, but are all phytophagous. The European species are distributed in 16 subfamilies. The alien species belong to 10 subfamilies, all having native representatives. Many subfamilies, including the world's largest (Entiminae, Curculioninae and Molytinae), are under-represented among alien curculionoids compared with their world importance in the superfamily (Fig. 8.2.1). On the other hand, the subfamily Cossoninae, which mainly contains wood-boring weevils, are over-represented, but the most remarkable result is the over-representation of Scolytinae.

Scolytinae are small, cylindrical wood borers, without a rostrum or with only a very reduced one; they include some of the most important forest pests in the world. The majority are phloeophagous, breeding in the inner bark. Most others are xylo-mycetophagous, feeding on symbiotic fungi which they cultivate in tunnels in the wood (ambrosia beetles). The scolytines represent about 10% of world curculionoids but almost half of curculionoids alien *to* Europe. Alien bark beetles represent more than 12% of all bark beetle species in Europe. The over-representation of Scolytinae is related to the frequency with which they are transported in wooden packing material, pallets, and timber (Haack 2001, 2006, Brockerhoff et al. 2006). All stages of these beetles can survive long voyages well, since both adults and larvae are in tunnels under bark or in wood and not directly exposed to temperature extremes or dessication. The importance of a stable, protected microenvironment is illustrated by the high prevalence of ambrosia beetles in the Scolytinae plus Platypodinae (35%) among successful aliens *to* Europe (Table 8.2.1), compared with the prevalence of ambrosia beetles in these groups in temperate climates generally (below 20%: Kirkendall 1993). The establishment of ambrosia beetles in Europe is further facilitated by polyphagy (11/12 spp.) and inbreeding (10/12 spp.), as is generally believed to be the case for ambrosia beetles globally (Kirkendall 1993, Haack 2001).

The curculionoids alien *in* Europe are more representatives of Europe-native fauna. Scolytines (25% of aliens *in* Europe) are also over-represented compared with their importance among European curculionoids (5%), but not cossonines (3% of aliens *in* Europe). On the other hand, Entiminae (26% of alien *in* Europe, mostly *Otiorhynchus* and *Sitona*) are under-represented compared with the European fauna, but less so than among aliens *to* Europe.

8.2.3. Temporal trends

Of the five families considered in this chapter, the first information concerning an alien species in Europe was probably the description by Ratzeburg in 1837 of *Xyleborus pfeilii* based on specimens from southern Germany[8]. The curculionid *Pentarthrum huttoni* was introduced to Great Britain from New Zealand in 1854, and has subsequently become naturalized in many European countries (Table 8.2.1). Only three other introduced species were recorded in the second half of 19th century.

With the beginning of the 20th century, alien species began to be discovered more frequently, though this was limited to sporadic introductions (about 2 species per decade) confined to southern Europe – which perhaps provided more favourable climatic conditions – and along the main routes of international trade. Since the 1920s the rate of new introductions has slightly increased (Fig. 8.2.2), with a mean of nearly three species every decade, but remaining stable until middle of 1970s.

Despite the European laws regulating the trade of plant material, the number of records of new exotic species introduced to Europe has increased rapidly since 1975 and especially since 2000, reaching worrying levels with an average of more than one

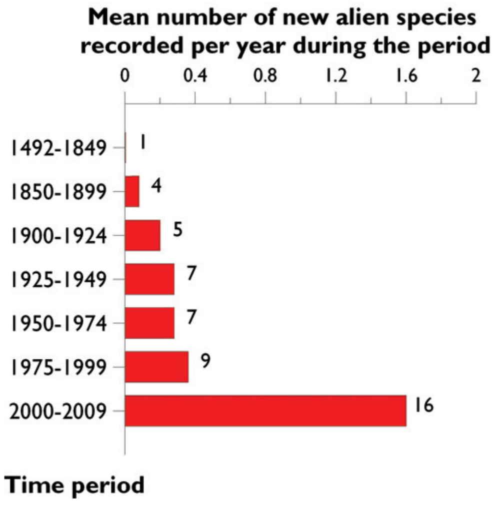

Figure 8.2.2. Temporal trend in establishment of Curculionoidea species alien *to* Europe from 1492 to 2010. *Presumed* alien species are excluded. The number besides each bar indicates the absolute number of new records during the time period. For the introduction year of each species see Table 8.2.1.

species per year (16 new species from 2000 to 2009: Table 8.2.1), and a peak of five new species per year in 2004 (8 species in 2003–2004). It is too early to say if the relatively low number of establishments observed since 2005 will be confirmed or is only due to stochastic variations. However, if the trend towards increasing rates of introduction continues unabated, in a few decades the mean number of alien species becoming established in Europe could reach several per year.

The temporal trend of alien curculionoids establishment is very similar to that observed in Europe for all alien terrestrial invertebrates (Roques et al. 2009, but see also Smith et al. 2007 for contradictory (more limited) data). On the other hand, this trend varies among weevils. Aliens from Asia follow the general trend (half of them have been recorded after 1975, a third after 2000), but the increasing of establishment rate is faster for those from North and South America (two-thirds of them have been recorded after 2000) while it is slower for those from others continents (half of them have been recorded before 1950, and none after 2000). Regarding feeding habits, all aliens follow the general trend except those with spermatophagous larvae, which show no trend. This particularity of the formers seems related to the oldness and intensity of human-mediated seed transport.

Unfortunately, for many alien species spread over large parts of Europe, data on the place and time of introduction are lacking, and generally the data on time of arrival of exotic species are very weak. Often, introduced species – especially those which are not pests – are first noticed only many years after arrival, or following subsequent and repeated introductions. As prompt communication of new findings is extremely important for the application of specific monitoring and eradication programs, the poor quality of these data is a major obstacle to aliens management.

8.2.4. Biogeographic patterns

Origin of alien species

All *presumed* aliens probably come from Africa (among which 35% from the subregion Macaronesia). These species are not included in further discussion due to uncertainty of their status and specially because their arrival modes have probably been different from other aliens due to proximity of the source region.

A probable region of origin could be specified for 51 of the 52 curculionoid species alien *to* Europe. There is one species, *Sitophilus zeamais* (Dryophthoridae), whose region of origin is uncertain (*cryptogenic*). *Cryptogenic* species are thus rare in this group compared to all alien terrestrial invertebrates (14%: Roques et al. 2009). *Sitophilus zeamais* is associated with maize crops, *Zea mays*, and feeds on maize grain stores, and it is likely that this species is American.

More than one-third (40%) of the exotic curculionoid species originate from Asia. Central and South America represents the second most important region of origin, with 19% of the species coming from this area. North America and Australasia both represent 14% of the contributing regions. Africa is a minor region of origin (6%), and the remaining species (6%) arrived from tropical or subtropical areas but the region of origin could not be precisely identified (Figure 8.2.3). This distribution is rather similar to that for all alien terrestrial invertebrates (Roques et al. 2009). The main differences are the under-representation of African aliens (6% vs. 12%) and the over-representation of South American (19% vs. 11%) and Australasian (14% vs. 7%) ones. A rather surprising result is that species originated from areas with tropical or subtropical climates all around the world represent about half of alien curculionoids.

Thirteen out of the twenty-one alien species originating from Asia are from the family Curculionidae, twelve species belonging to the subfamily Scolytinae and one species to the subfamily Cyclominae. Other families consist of Dryophthoridae (4 spp.), Apionidae (3 spp.) and Anthribidae (1 sp.). Scolytines originate from very different parts of this large continent. For example *Cyclorhipidion bodoanus* is native to Siberia and temperate northeast Asia, *Phloeosinus rudis* to Japan, and the three species of the genus *Xylosandrus* to Southeast Asia. In contrast, all the weevils of the Dryophthoridae family originate from tropical Asia. This group includes the banana root weevil *Cosmopolites sordidus*, the coconut weevil *Diocalandra frumenti*, the palm weevil *Rhynchophorus ferrugineus* and the rice weevil *Sitophilus oryzae*. The introduced apionids, *Alocentron curvirostre*, *Aspidapion validum* and *Rhopalapion longirostre*, all feed on flowers and seeds of *Alcea rosea* and other Malvaceae species (Bolu and Legalov 2008); these all originate from central Asia. Finally, the anthribid *Araecerus coffeae* originates from India.

The ten curculionoid species coming from Central and South America consist of curculionids (8 spp.) and dryophthorids (2 spp.). Curculionids originating from this region are as highly diverse taxonomically (they are distributed in six subfamilies) as in feeding habits. The native ranges of many species largely extend through the continent

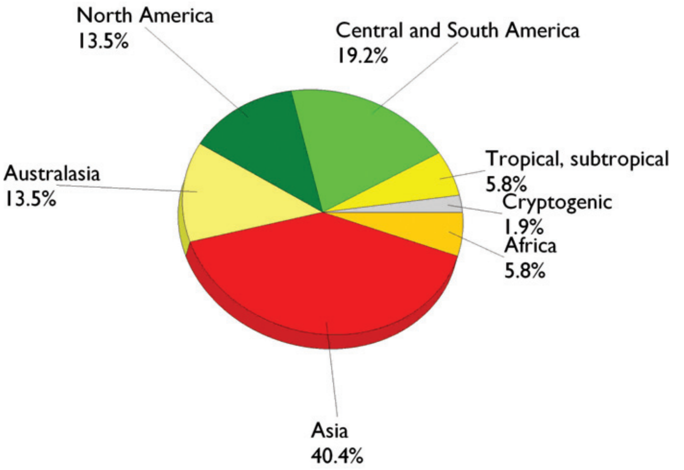

Figure 8.2.3. Origin of Curculionoidea species alien *to* Europe. *Presumed* alien species are excluded.

(including sometimes part of North America), though those of others are more narrow as for *Rhyephenes humeralis* (central Chile and neighboughring area of Argentina) and *Paradiaphorus crenatus* (Brazil).

Seven alien curculionoids are known to originate from North America. They include five species of the family Curculionidae and two of Erirhinidae. Many curculionids introduced from North America are xylophagous *sensu lato*[7], feeding on several broad-leaved or coniferous hosts. The exceptions are the ash seed weevil *Lignyodes bischoffi* and *Caulophilus oryzae*, originally from the southeastern USA, which feeds on seeds. In contrast, the two Erirhinidae species feed externally on weed roots and ferns, respectively.

Seven curculionoid species come from Australasia, all curculionids: four cossonines, two molytines and one cyclomine. Three woodboring weevils (*Pentarthrum huttoni*, *Euophryum confine* and *E. rufum*, all from Cossoninae), feeding on decaying wood, originate from New Zealand. The four other species were unintentionally introduced from Australia. All feed inside plant material (*xylophagous* or *herbiphagous*), except the Eucalyptus snout beetle, *Gonipterus scutellatus*, a defoliator of *Eucalyptus* trees originated from Southern Australia.

Only three curculionoid species are known to originate from Africa, a curculionine and two scolytines. The palm flower weevil, *Neoderelomus piriformis*, probably originates from North Africa; it feeds on but also pollinates flowers of palms like *Phoenix canariensis*. The scolytines both originate from Canary Islands; *Dactylotrypes longicollis* breeds in *Phoenix canariensis* seeds, while *Liparthrum mandibulare* is a highly polyphagous phloeophage.

Three cosmopolitan curculionoid species originate from undetermined areas of the tropical and subtropical parts of the world: the tamarind seed borer, *Sitophilus linearis* (Dryophthoridae), and the palm seed borers *Coccotrypes carpophagus* and *C. dactyliperda* (Scolytinae). As seed-feeders, they are readily distributed through commerce, which probably explain the uncertainty about their origin.

Concerning the curculionoids alien *in* Europe, nine-tens of these (114 spp. among 129, Table 8.2.2) are introduced from mainland Europe to islands (mainly the Canary Islands, the Azores, the British Isles and Madeira). They are often widespread continental species which have been introduced to islands by human transport. Other cases are mainly species of southern and western regions which were introduced into northern Europe (as *Otiorhynchus corruptor*), especially to Denmark and Sweden. However, some species have moved westwards (as *Otiorhynchus pinastri* and *Phloeotribus caucasicus*) and even southwards (*Ips duplicatus*).

Distribution of alien species in Europe

As for the other arthropod groups, alien curculionoid species are unevenly distributed throughout Europe, which may partly reflect differences in sampling intensity (Fig. 8.2.4, Table 8.2.1). In continental Europe, mainland Italy and France host the largest number of species alien *to* Europe, with 28 and 26 introduced curculionoid species, respectively. These countries are followed by continental Spain (17 spp.), Austria (15 spp.), and Germany, Switzerland and United Kingdom[3] (13 spp.). This distribution is similar as that of all alien terrestrial invertebrates (Roques et al. 2009). The number of aliens per country significantly decreases eastwards (y=12 - 0.29*longitude, R^2=0.21, $F_{1,31}$=8.08, p=0.008), but it is mainly correlated with human variables, country population (y=-1.5 + 3.7ln(population), population in million inhabitants, R^2=0.39, $F_{1,31}$=19.6, p=$1*10^{-4}$) and country importation values (y=-32 + 3.5ln(value), value 2003–2007 in million USD: The World Factbook 2009, R^2=0.53, $F_{1,29}$=32.4, p=$4*10^{-6}$)[4]. The best model integrates importations and latitude (y=-19 + 3.6ln(value) - 0.28*latitude, value in million USD, R^2=0.60, $F_{2,28}$=20.6, p=$3*10^{-6}$), indicating that alien establishment is favored by human trade and warm climate. The abundance of aliens in mainland Italy and France is not fully explained by the model (predicted values 17 and 16 alien species, respectively); it is likely related to a combination of the diversity of habitats and plants present with the favorable climate and the importance in international shipping.

Islands have a rather rich alien curculionoid fauna, especially Macaronesia: 29 (of which 14 *presumed*), 18 (8 *presumed*) and 10 (2 *presumed*) species in the Canary Islands, Madeira and the Azores, respectively. These islands are followed by Sicily (10 spp.), Corsica (8 spp.) and Malta (6 spp.). As it has been found for other alien terrestrial invertebrates (Roques et al. 2009), the number of alien curculionoids per km^2 in European islands is higher than in continental countries (on average 2.8 vs 0.17

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[3] Concerning species alien *to* Europe, United Kingdom characteristics are closer to those of continental countries than to those of other islands, so we consider it as part of continental Europe. This is likely related to its large size and population.

[4] Computations were performed without small countries where no alien curculionoid is recorded, because this absence is probably due to lack of data. Israel was also excluded due to its special location.

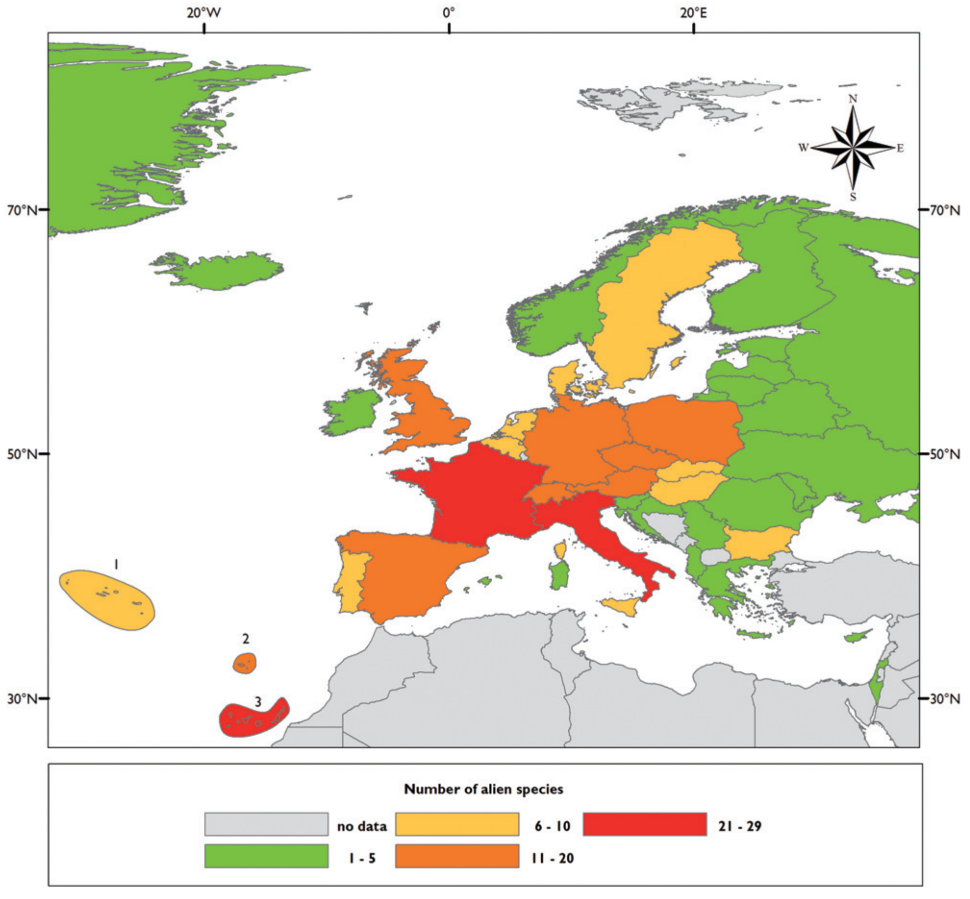

Figure 8.2.4. Comparative colonization of continental European countries and islands by Curculionoidea species alien *to* Europe. Archipelagos: **1** the Azores **2** Madeira **3** the Canary Islands.

alien/1000km^2, R^2=0.10, $F_{1,58}$=6.56, p=0.013). Aliens density is specially high in Madeira and Malta (23 and 19 alien/1000km^2, respectively), perhaps because these tiny islands are stopping places on trade routes. Islands show no global trend of alien distribution. However, cold nordic islands (Greenland, Iceland, Svalbard) host few aliens, and in Macaronesia alien number (specially *presumed* alien number) decreases when distance to continent increases.

Near half of alien curculionoid species (33 spp.) have been observed in only one country, most of them (31 spp.) in a peninsular region or on islands: Italy, Iberia, Macaronesian islands, Malta or the British Isles. Aliens introduced to such areas are less likely to move to nearby countries in comparison with aliens in other mainland regions, but Austria and Russia also host each an own alien species. As examples, *Syagrius intrudens* from Australia is encountered only in Great Britain, *Naupactus leucoloma*, from South America, is found only in the Azores, and *Paradiaphorus crenatus*, from Brazil, is known only from the Canary Islands. After the Canary Islands, Italy hosts the highest number of alien species unique to one country, eight in total, of which six are from subfamilies Scolytinae and Platypodinae. Also, the recent arrival of these species, most of them having first been discovered later than 2000, may in part explain their currently restricted distribution.

Ten alien species (14%) are limited to two countries. In almost all cases, the species are found in neighbour countries, as with the scolytine *Dryocoetes himalayensis* in France and Switzerland, and *Macrorhyncolus littoralis* in Great Britain and Ireland. One alien species, *Scyphophorus acupunctatus*, occurs in two distinct regions, Sicily and France, suggesting the possiblity of multiple introductions (this suggestion is supported by the previous interceptions of this species in different european countries: EPPO 2008).

At the other extreme, the rice weevil *Sitophilus oryzae* has been found in 34 European countries, and two other seed feeders, *Sitophilus zeamais* and *Rhopalapion longirostre*, occur in 23 and 21 countries. Their feeding habits in association with frequently transported seeds or stored products presumably explain this broad distribution. Another eleven species are found in 10 or more countries. These include several long-established species: *Xyleborus pfeilii*[8], the wood-borer *Pentarthrum huttoni*, the palm seed borer *Coccotrypes dactyliperda* and the parthenogenetic weevil *Asynonychus godmani*. However, the relatively recently introduced (1993) palm weevil *Rhynchophorus ferrugineus* is also widely distributed, occurring in most of the Mediterranean region, which attests their high dispersal capabilities (natural and human-mediated). Overall, alien weevil species are more widespread in Europe than other alien terrestrial invertebrates, with 40% of species distributed in more than two countries vs. only 22% (Roques et al. 2009).

8.2.5. Main pathways and factors contributing to successful invasions

There are two components to successful invasion, dispersal and establishment. Dispersal to new continents by phytophagous arthropods is now almost entirely due to human transport, the magnitude of which has inceased exponentially in recent decades. Plant feeding arthropods are carried in and on live plants and fruits, in wood, and as stowaways in shipments and baggage. Deliberate introductions of arthropods are less frequent, and most involve exotic organisms imported for biological control. Establishment of new arrivals depends on availability of appropriate habitats near sites of introduction, ability to compete with similar species already present, and on a reasonable tolerance for the local climate.

All exotic species of Curculionoidea have been introduced accidentally in Europe, vs. only 90% for all alien terrestrial invertebrates (Roques et al. 2009). The lack of intentional introductions of weevils could be related to their poor potential for biological control. One exotic weevil species (*Stenopelmus rufinasus*) has been used successfully for biological control of the American water fern *Azolla filicoides* in South Africa and to a less extent in the British Isles, but its first introduction in Europe was accidental (Sheppard et al. 2006, Baars and Caffery 2008).

As is the case for other regions in the world, many of Europe's alien curculionoids have presumably arrived via the shipping of wooden materials: pallets, crating, and barked or unbarked timber (Brockerhoff et al. 2006, Haack 2001, 2006). Bark and wood boring species make up half of all alien weevils (50%); these have almost certainly been introduced with wood transport and solid wood packaging materials. Logs with bark are ideal for transporting bark beetles and other weevils. However, even debarked logs can contain live wood borers such as ambrosia beetles. Although some wood-boring beetles have more restrictive requirements (e.g. high humidity and decayed wood: *Euophryum confine*, *E. rufum*, *Pentarthrum huttoni*), even these can often survive a few days or even weeks of transport. The east Asian ambrosia beetle *X. germanus* provides a typical example for entry by wood-borers. It was introduced to the USA (1932), where it was discovered in imported wine stocks in greenhouses; the species spread rapidly and has become an important nursery pest in warmer parts of eastern North America (Ranger et al. 2010). In Europe, it was first recorded after World War II, in Germany, where the species probably had been introduced with wood imported from Japan to southern Germany early in the 20th century; the present distribution area includes twelve European countries (Table 8.2.1).

Seed feeders (20%) are introduced with the seeds, which are also an excellent way for transporting insects. Several of these species are associated with agricultural products (e.g. *Caulophilus oryzae*, *Sitophilus oryzae* and *S. zeamais*), however most species feed on ornamental or forest seeds (e.g. *Rhopalapion longirostre* on *Alcea*, *Lignyodes bischoffi* on ash seeds, *Dactylotrypes longicollis* on palm seeds).

Other alien species (30%) live on or inside leaves and nonwoody stems, or in the soil. The formers can be introduced with their host plants or with host plant products (e.g. *Gonipterus scutellatus* with eucalyptus, *Listroderes costirostris* with plants such as tobacco); weevils living around roots (e.g. *Asynonychus godmani*) are transported with living plants. These feeding habits (plus root boring, which doesn't exist among aliens *to* Europe) are more frequent among *presumed* aliens *to* Europe and among aliens *in* Europe (52%); both cases result from a rather short distance transport, which likely allows survival of less protected insects (among wood boring scolytines, *phloeophagous* species are similarly much more frequent than *xylomycetophagous* species among *presumed* aliens *to* Europe and among aliens *in* Europe, contrary to what is observed among other aliens *to* Europe).

Currently, most introductions are due to international trade, but the increasing movement of fruits and plants by travelers, which is much more difficult to check, may contribute to the future diffusion of new alien species.

Newly arrived phytophages must find suitable hosts. The likelihood of success is greatly enhanced if the species is not too host specific, or if its preferred hosts are abundant. Not surprisingly, the majority of established exotic weevils in Europe are polyphagous, and the hosts of others are often widespread and abundant plants (Table 8.2.1).

Parthenogenesis and inbreeding further increase the chances for successful colonization. When an exotic species is first introduced to a new area, it faces a variety of problems associated with low density which reduce the likelihood of successful establishment and slow the rate of invasion (Tobin et al. 2007, Liebhold and Tobin 2008, Contarini et al. 2009). New populations create problems for mate finding; parthenogenetic females do not mate, and inbreeding females mate with brothers while in the natal nest, before dispersal (Jordal et al. 2001); in both cases, there is no problem of mate location and new populations can be established by single females. Very small populations (such as those in recent colonizations) may suffer from high levels of inbreeding depression (Charlesworth and Charlesworth 1987); however, regular inbreeding species such as the invasive scolytines have presumably purged their genomes of the deleterious alleles responsible for inbreeding depression (Charlesworth and Charlesworth 1987, Jordal et al. 2001, Peer and Taborsky 2005). Only a few invasive curculionoid species are parthenogenetic: *Asynonychus godmani*, *Lissorhoptrus oryzophilus*, *Listroderes costirostris* (Morrone 1993) and *Naupactus leucoloma*, whose males are unknown outside its native range (Lanteri and Marvaldi 1995). However, over half of the alien scolytines inbreed (59%, *presumed* aliens excluded), compared with less than a third of scolytines native to Europe and about a fourth of Scolytinae species worldwide (Kirkendall 1993).

8.2.6. Most invaded ecosystems and habitats

All alien curculionoid species are phytophagous, as are nearly all curculionoids worldwide. Most of the species have a cryptic way of life, at least during larval stage, feeding inside plant tissues such as stems or seeds, or living in the soil; only 9% are *leaf/stem browsers*. Stems and trunks is the major feeding niche of most alien curculionoids (65%). Most of these are bark beetles, ambrosia beetles or other wood borers (50%); *herbiphagous* (15%) comprise the remaining. Seeds are the second most important feeding niche (18%), followed by leaves (9%; some species could also attack non woody stems) and roots (6%). Last species, *Neoderelomus piriformis*, feeds on flowers, and acts as pollinator in palm trees.

By contrast, of the curculionoids alien in Europe, only 33% are wood borers, among which most are *phloeophagous* (28%). A third (30%) attack roots, especially *root browsers* as *Otiorhynchus* and *Sitona* (26%), the remaining (4%) being *root borers*. *Herbiphagous* (18%), *spermatophagous* (15%) and *leaf/stem browsers* (4%) comprise the remaining.

Near half of the alien curculionoid species established in Europe colonize urban and peri-urban habitats, primarily parks and gardens (27%) and around buildings (11%). Woodlands is also a frequent habitat for the alien curculionoids (27%), beyond natural heathlands (16%), cultivated agricultural lands (9%) and greenhouses (5%). Only three species occur in wetland habitats, one in coastal and two in inland surface water (Fig. 8.2.5). The importance of natural heathlands is in fact mainly limited to specific areas, most of the species recorded in these habitats being *presumed* aliens attacking euphorbias in Macaronesian xerophytic heathlands.

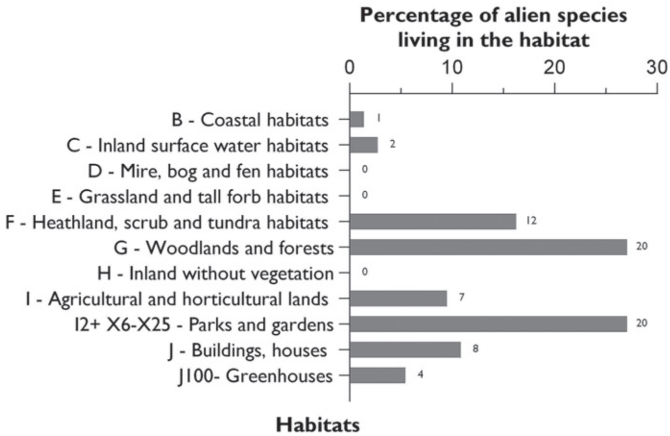

Figure 8.2.5. Main European habitats colonized by Curculionoidea species alien *to* Europe. The number besides each bar indicates the absolute number of alien curculionoids recorded per habitat. Note that a species may have colonized several habitats.

This pattern differs from the average value observed for all arthropods, where only a fourth of the species is recorded in natural or semi-natural habitats, and where agricultural lands and greenhouses contain more alien species than woodlands. That could be obviously related to the high frequency of xylophagous *sensu lato*[7] habits in alien curculionoids. Both deciduous trees, such as *Populus* sp. and *Fraxinus* sp, and conifers in the genera *Picea* and *Pinus* are colonized by several alien curculionoid species utilizing trees. *Eucalyptus* plantations are also affected by a defoliating curculionid, *Gonipterus scutellatus*, both host and weevil originating in Australia. In urban and suburban areas such as gardens and parks, other trees species, mainly exotics and in particular palm trees, are also affected by alien curculionoids.

8.2.7. Ecological and economic impact

Ecological impacts of alien insects are poorly known in general (Kenis et al. 2009), and the impacts of Curculionoidea species alien *to* Europe seem not to have been documented at all.

Their economic impact is better known, reflecting the economic importance of many of these alien species. A third of the Curculionoidea species alien *to* Europe (26 species) have a known economic impact, a much higher proportion than for native weevils, even though the latter contain numerous pests. Nevertheless, this high proportion may partly be an artefact, since pests have a higher probability of being detected.

The most damaging species are the four attacking stored products. The rice weevil *Sitophilus oryzae* and the maize weevil *S. zeamais* are among the main pests of stored grains worldwide, destroying significant amounts and incurring high pest management

Figure 8.2.6. Examples of alien curculionoids: *Gonipterus scutellatus.* Adult damage on *Eucalytus sp*. (Credit: Alain Roques).

costs[5] (Balachowsky 1963, Pimentel 1991). Larvae develop in cereal seeds and adults feed on these seeds as well as on a wide variety of stored products, products derived from cereal grains and even dried vegetables. Damages is exascerbated by incompletely dried stored products (Balachowsky 1963). In addition to their direct damage, these species facilitate attacks of grains by other pests. *Caulophilus oryzae*, a less widespread species, sporadically causes the same kind of damages, while *Araecerus coffeae* attacks grains but mainly less common products such as stored coffee and cocoa beans.

Five species attack native or introduced cultivated plants. *Listroderes costirostris* attacks a wide range of vegetables and weeds; adults can also damage foliage of fruit trees. The recently established whitefringed weevil, *Naupactus leucoloma*, is also highly polyphagous; its soil-inhabiting larvae are a serious pest of many agricultural crops. The banana root weevil, *Cosmopolites sordidus*, and *Paradiaphorus crenatus* are important pests of tropical cultures (banana and pineapple, respectively). Their economic impact is currently limited in Europe due to the limited distribution of their hosts in this area and a rather low aggressiveness in its climate, but it could increase later in the future according to the global warming. The last species is the rice water weevil, *Lissorhoptrus oryzophilus*. Recently introduced in Europe, it is a major pest of rice, but also attacks indigenous *Carex*.

Eight species damage different ornamental plants and trees, mainly introduced tropical or subtropical species. The palm weevil *Rhynchophorus ferrugineus* is a dangerous pest of palms which has rapidly colonized the Mediterannean basin. On the Canary Islands, palms are also attacked by the lesser coconut weevil *Diocalandra frumenti*. Even if damage are mainly esthetic, they are worrying because this insect princi-

[5] Damages are also due to the grain weevil *S. granarius*, probably alien too, but not taken into account here because it has been established in Europe at least since Antiquity.

Figure 8.2.7. Examples of alien curculionoids: *Rhynchophorus ferrugineus*. Female, larvae and damage (Credit: Juan Antonio Ávalos, Universidad Politécnica de Valencia).

pally attacks *Phoenix canariensis*, an endemic palm which is emblematic of the Canary Islands where it is widely used for landscaping and is a major element of coastal landscape. *Asynonychus godmani* attacks roots of a large variety of ornamental shrubs and fruit trees, native or introduced. Others species are monophagous or oligophagous on introduced hosts: the tamarind seed borer *Sitophilus linearis* on *Tamarindus indica*, *Demyrsus meleoides* on cycadophyts, *Scyphophorus acupunctatus* on Agavaceae species, *Phloeotribus liminaris* on *Prunus serotina*, *Phloeosinus rudis* on Cupressaceae species.

Five species have an impact on forests or related habitats. Three attack live exotic or native trees. The Eucalyptus snout beetle *Gonipterus scutellatus* is an important pest of *Eucalyptus* everywhere it has been introduced (see factsheet 14.12). This defoliator causes severe damage and wood loss, particularly on *E. globulus*, the major cultivated *Eucalyptus* species in southern Europe. *Rhyephenes humeralis* attack another introduced tree, *Pinus radiata*, but causes less damage. *Megaplatypus mutatus* is one of the few platypodine beetles which breeds in live trees; it is highly polyphagous, but in Europe it has thus far only been found to damage *Populus* plantations in Italy (Alfaro et al. 2007). The two other species depreciate wood stock. *Gnathotrichus materiarius* is a common pest of a large variety of conifer wood, and *Xylosandrus germanus* sporadically attacks mainly broadleaf wood.

Pentarthrum huttoni and the two *Euophryum* species live in rotting wood, so their economic impact is generally low, though they do attack wood of historically signifi-

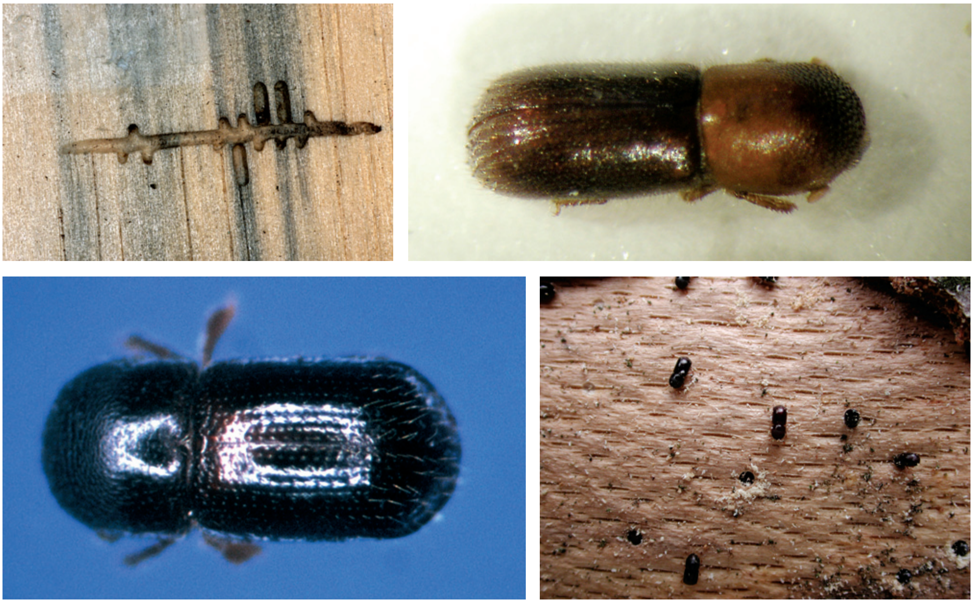

Figure 8.2.8. Examples of alien curculionoids: Scolytinae. Top left: *Gnathotrichus materiarius*: gallery in wood (Credit: Louis-Michel Nageleisen). Top right: *Cyclorhipidion bodoanus*: femelle (Credit: Louis-Michel Nageleisen). Bottom: *Xylosandrus germanus* (Blandford 1894): female (Credit: Daniel Adam), adults and gallery holes on wood (Credit: Louis-Michel Nageleisen).

cant artefacts or buildings. Finally, as opposed to all previous species, the introduced frond-feeding weevil *Stenopelmus rufinasus* has a positive impact due to its hability to control the invasive red water fern *Azolla filiculoides*.

8.2.8. Conclusion

The superfamily Curculionoidea is well represented among alien species now established in Europe. Alien weevils show specific characteristics comparing both native and world ones, which seem result from a selection of species having high capabilities to human-mediated dispersal and establishment in a new habitat. Thus, they have often cryptic habits, as seed boring or wood and plant boring, leading to over-representation of bark and ambrosia beetles and other xylophagous *sensu lato*[7] species; alien weevils are consequently more numerous in natural areas than other terrestrial invertebrate aliens. Seed feeders are the major alien pests. Alien species are mainly originated from Asia, which is related to the importance of trade with this continent, and many of them come from different tropical or subtropical areas.

The more worrying observation is the fast increase in the invasion rate during last decades, as noticed for all terrestrial invertebrate aliens. Without appropriate control, the invasive pressure will probably continue to increase in the future, further threatening European people and ecosystems, more especially as global warming may allow the naturalization of more tropical and subtropical species accidentally introduced into Europe and particularly the Mediterranean.

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Table 8.2.1. Characteristics of the Curculionoidea species alien *to* Europe. Asterisks indicate *presumed* aliens. Feeding habits and hosts are those of larvae, which are generally the more damaging stage[6]. Country codes abbreviations refer to ISO 3166, with extensions (see Appendix I); main Atlantic and Mediterranean islands are treated separately as special „countries". **N/A** data non available. Status: **A** alien *to* Europe **C** *cryptogenic*. Feeding habits: abbreviations between brackets specify the feeding habits; **her** *herbiphagous* (larvae bore and feed inside non woody tissue of plant stems or leaves; stem includes branches, twigs, collar, bulb and rootstock) **lbw** *leaf/stem browser* (larvae externally feed on leaves or stems, as most caterpillars; early stages could be miner) **phl** *phloeophagous* (larvae bore and feed inside tree inner bark) **rbo** *root borer* (larvae bore and feed inside roots) **rbw** *root browser* (subterranean larvae externally feed on roots; early stages could be root miner) **spe** *spermatophagous* (larvae bore and feed inside reproductive organs, generally seeds) **xmp** *xylomycetophagous* (larvae live in galleries bored by females inside wood and mainly feed on wood-decaying symbiotic fungi) **xyl** *xylophagous* (larvae bore and feed inside wood, including woody materials such as palm stems)[7]. Native range: the field contains standardized range; if useful, native range could be specified between brackets. 1st record in Europe: date and countries of first known specimen, or first publication. Habitat: habitats in invaded countries; abbreviations refer to EUNIS (see Appendix II). Hosts: recorded hosts in invaded countries, and, between brackets, host breath in native range; host breath in native range is given as *monophagous*, *oligophagous* or *polyphagous* (abbreviated as **mp**, **op** and **pp**), depending if the species normally attacks hosts in one genera, one family or more; **hpp**: *highly polyphagous*.

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Anthribidae								
Araecerus coffeae (Fabricius 1801)	A	phyto-phagous (spe)	Asia-Tropical	1951, DE	AT, BG, DE, FR, GB, IL, IT, MT, PL	J1	stored products (pp: *Coffea*, *Camellia sinensis*, stored products)	Essl and Rabitsch (2002), Mphuru (1974), Obretenchev et al. (1990), Sebelin (1951)
Apionidae								
Alocentron (*Alocentron*) *curvirostre* (Gyllenhal 1833)	A	phyto-phagous (spe)	Asia-Temperate	1904, BG	AT, BG, CH, CZ, HU, IT-SIC, MD, PL, RO, RS, SI, SK	I2, FA, FB	*Alcea rosae* (op: Malvaceae)	Essl and Rabitsch (2002), Joakimow (1904), Wittenberg (2005)
Aspidapion (*Aspidapion*) *validum* (Germar 1817)	A	phyto-phagous (spe)	Asia-Temperate	1960, BG	AT, BG, CH, CZ, DE, FR, HR, HU, IT, MD, PL, PT, RO, SK, UA	I2, FA, FB	*Alcea rosae* (op: Malvaceae)	Abbazzi et al. (1994), Angelov (1960), Essl and Rabitsch (2002), Wittenberg (2005)

6 Platypodines and scolytines adults generally feed as larvae, as do adults of many other species with *spermatophagous* or xylophagous *sensu lato*[7] larvae. Otherwise adults generally feed externally on leaf and stem regardless of the larval habits. Adults are often more polyphagous than larvae, except platypodines and scolytines.

7 We use the term xylophagous *sensu lato* to gather species with *phloeophagous*, *xylomycetophagous* and *xylophagous* larvae.

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Rhopalapion longirostre (Olivier 1807)	A	phyto-phagous (spe)	Asia-Temperate	1875, RO	AT, BG, CH, CY, CZ, ES, FR, FR-COR, DE, GR, GR-NEG, HR, HU, IT, MD, NL, PL, RO, RS, SK, UA	I2	*Alcea rosae* (op: Malvaceae)	Abbazzi et al. (1994), Ehret (1983), Essl and Rabitsch (2002), Kozłowski and Knutelski (2003), Markovich (1909), Mazur (2002), Perrin (1984), Perrin (1995), Wittenberg (2005)
Curculionidae								
Cossoninae								
Amaurorhinus (Amaurorhinus) monizianus (Wollaston 1860)*	A	phyto-phagous	Africa (ES-CAN)	N/A	PT-AZO, PT-MAD	B	N/A (*Suaeda*, *Salsola*)	Base de dados da biodiversidade dos Açores, Oromí and García (1995)
Caulophilus oryzae (Gyllenhal 1838)	A	phyto-phagous (spe)	North America	1982, PT-MAD	ES-CAN, GB, PT-MAD	J1	grain, stored products (pp: grain, *Persea* seed)	Izquierdo et al. (2004), Morris (2002), O'Brien and Wibmer (1982)
Euophryum confine (Broun 1880)	A	phyto-phagous (xyl)	Australasia	1937, GB	AD, AT, CZ, ES, ES-BAL, FR, GB, HU, PT, SE	J1, I2	decaying wood (pp: decaying wood)	Essl and Rabitsch (2002), Hill et al. (2005), Menet (1998)
Euophryum rufum (Broun 1880)	A	phyto-phagous (xyl)	Australasia	1934, GB	CH, DK, ES, GB, IE, SE	J1, I2	decaying wood (pp: decaying wood)	Hill et al. (2005), O'Connor (1977)
Macrorhyncolus littoralis (Broun 1880)	A	phyto-phagous (xyl)	Australasia	1987, GB	GB, IE	B2	driftwood (pp: decaying wood)	Morris (2002), Telfer (2007), Welch (1990)
Pentarthrum huttoni Wollaston 1854	A	phyto-phagous (xyl)	Australasia	1854, GB	AT, BE, CH, DE, DK, ES, FR, GB, IE, IT, NL, PL, RU, SK	J1	decaying wood (pp: decaying wood)	Abbazzi and Osella (1992), Bruge (1994), Buck (1948), Dieckmann (1983), Halmschlager et al. (2007), Hoffmann (1954), Rasmussen (1976), Stachowiak and Wanat (2001), Strejček (1993), Wittenberg (2005)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Pentatemnus arenarius Wollaston 1861*	A	phyto-phagous	Africa (North)	N/A	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Cryptorhynchinae								
Rhyephenes humeralis (Guérin-Méneville 1830)	A	phyto-phagous (phl)	C & S America	2003, ES	ES	G1, G5, X11	*Pinus radiata* (pp: broadleaf trees)	Alonso-Zarazaga and Goldarazena (2005)
Curculioninae								
Lignyodes (*Lignyodes*) *bischoffi* (Blatchley 1916)	A	phyto-phagous (spe)	North America	2001, PL	AT, PL	G, I2	*Fraxinus* (op: *Fraxinus*, *Syringa*)	Essl and Rabitsch (2002), Freude et al. (1983), Gosik et al. (2001)
Neoderelomus piriformis (Hoffmann 1938)	A	phyto-phagous (spe)	Africa (North)	1992, IT, IT-SIC	ES, ES-CAN, FR, IL, IT, IT-SIC, PT-MAD	I2	*Phoenix canariensis* (*Phoenix*)	Abbazzi and Osella (1992), Alonso-Zarazaga and Lyal (1999), Friedman (2006), Machado and Oromí (2000), Piry and Gompel (2002)
Tychius (Tychius) antoinei Hustache 1932*	A	phyto-phagous	Africa (North)	N/A	ES-CAN	N/A	N/A (Fabaceae)	Machado and Oromí (2000)
Tychius (Tychius) depauperatus Wollaston 1864*	A	phyto-phagous	Africa (North)	N/A	ES-CAN	N/A	N/A (Fabaceae)	Machado and Oromí (2000)
Cyclominae								
Asperogronops inaequalis (Boheman 1842)	A	phyto-phagous (lbw)	Asia-Temperate	1946, SE	DE, DK, FI, FR, GB, LT, LV, NL, SE	I2	*Atriplex* (op: Chenopodiaceae)	Meregalli (2004)
Gonipterus scutellatus Gyllenhal 1833	A	phyto-phagous (lbw)	Australasia	1975, IT	ES, ES-CAN, FR, FR-COR, IT, PT	I2, G2	*Eucalyptus* (mp: *Eucalyptus*)	Abbazzi and Osella (1992), Arzone (1976), Carrillo (1999), Machado and Oromí (2000), Mansilla (1992), Mansilla and Pérez Otero (1996), Neid (2003), Paiva (1996), Rabasse and Perrin (1979), Sampò (1976)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Listroderes costirostris Schoenherr 1826	A	phytophagous (lbw)	C & S America	1950, ES-CAN	ES-BAL, ES-CAN, FR, IL, PT	I, J100	N/A (hpp: vegetables, weeds)	Balachowsky (1963), Friedman (2009), Germain et al. (2008a), Machado and Oromí (2000), Moncoutier (1982)
Entiminae								
Asynonychus godmani Crotch 1867	A	phytophagous (rbw)	C & S America	1908, IT	DK, ES, ES-BAL, ES-CAN, FR, IT, IT-SAR, IT-SIC, MT, PT, PT-AZO, PT-MAD, SE	I	N/A (pp: *Rosa*, ornamentals, fruit trees)	Hoffmann (1950), Machado and Oromí (2000), Solari and Solari (1908), Stüben (2003)
Naupactus leucoloma Boheman 1840	A	phytophagous (rbw)	C & S America	2003, PT-AZO	PT-AZO	I, G	N/A (hpp: Fabaceae, vegetables, *Zea mays*)	Borges et al. (2005)
Sitona (Sitona) latipennis Gyllenhal 1834*	A	phytophagous (rbw)	Africa (PT-MAD)	N/A	ES-CAN	N/A	*Foeniculum* (N/A)	García (2003), Machado and Oromí (2000)
Hyperinae								
Donus (Donus) fallax (Capiomont 1868)*	A	phytophagous (lbw)	Africa (North)	N/A	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Donus (Antidonus) isabellinus (Boheman 1834)*	A	phytophagous (lbw)	Africa (North)	N/A	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Lixinae								
Pycnodactylopsis (Louwia) tomentosa (Fåhraeus 1842)*	A	phytophagous	Africa (North)	N/A	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Molytinae								
Demyrsus meleoides Pascoe 1872	A	phytophagous (xyl)	Australasia	1974, IT	IT	I2	Cycadales (op: Cycadales)	Covassi (1974)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Styphloderes (Parastyphloderes) lindbergi Roudier 1963*	A	phyto-phagous	Africa (ES-CAN)	N/A	PT-MAD	N/A	N/A (N/A)	Oromí and García (1995)
Syagrius intrudens Waterhouse 1903	A	phyto-phagous (her)	Australasia	1998, GB	GB	J100	Pteridopsida (op: Pteridopsida)	Hackett (1998), Hill et al. (2005)
Platypodinae								
Megaplatypus mutatus (Chapuis 1865)	A	phyto-phagous (xmp)	C & S America	2000, IT	IT	G1, I2	*Populus* (pp: broadleaf trees)	Tremblay et al. (2000)
Scolytinae								
Ambrosiodmus rubricollis Eichhoff 1875	A	phyto-phagous (xmp)	Asia	2008, IT	IT	G	*Aesculus hippocastanum*, *Prunus persica* (pp: broadleaf trees)	Faccoli et al. (2009)
Aphanarthrum affine Wollaston 1860*	A	phyto-phagous (her)	Africa	1860, ES-CAN	ES-CAN	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1972)
Aphanarthrum bicinctum Wollaston 1860*	A	phyto-phagous (her)	Africa	1860, ES-CAN	ES-CAN	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1972)
Aphanarthrum bicolor Wollaston 1860*	A	phyto-phagous (her)	Africa (ES-CAN)	1972, PT-MAD	PT-MAD	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1972)
Aphanarthrum mairei Peyerimhoff 1923*	A	phyto-phagous (her)	Africa	1928, ES-CAN	ES-CAN	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1980)
Aphanarthrum piscatorium Wollaston 1860*	A	phyto-phagous (her)	Africa (ES-CAN)	1972, PT-MAD	PT-MAD	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1972)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Cisurgus wollastonii (Eichhoff 1878)*	A	phyto-phagous (her)	Africa	1860, ES-CAN	ES-CAN	F8	*Euphorbia* (mp: *Euphorbia*)	Schedl (1946)
Coccotrypes carpophagus (Hornung 1842)	A	phyto-phagous (spe)	Tropical, subtropical	N/A	ES-CAN, PT-AZO, PT-MAD	I2	*Phoenix*, *Washingtonia*, Arecaceae, *Dracaena* (pp: Arecaceae, woody seeds)	Bright (1987), Kirkendall per. obs.
Coccotrypes dactyliperda (Fabricius 1801)	A	phyto-phagous (spe)	Tropical, subtropical	1884, IT	ES-CAN, FR, FR-COR, HU, IT, IT-SAR, IT-SIC, MT, PT-MAD	I2	*Phoenix*, *Chamaerops umilis*, Arecaceae (pp: Arecaceae, woody seeds)	Kirkendall and Faccoli (2010), Schedl (1963), Schedl et al. (1959), Targioni Tozzetti (1884)
Coleobothrus alluaudi (Peyerimhoff 1923)*	A	phyto-phagous (her)	Africa	1928, ES-CAN	ES-CAN	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1980)
Cyclorhipidion bodoanus (Reitter 1913)	A	phyto-phagous (xmp)	Asia	1960, FR	BE, CH, DE, FR, IT, NL	G1	*Quercus* (op: Fagaceae)	Audisio et al. (2008), Bouget and Noblecourt (2005), Kirkendall and Faccoli (2010), Schott (2004), Schott and Callot (1994)
Dactylotrypes longicollis (Wollaston 1864)	A	phyto-phagous (spe)	Africa (ES-CAN)	1949, FR-COR	ES, FR, FR-COR, HR, IT, IT-SIC, PT-MAD	I2	*Phoenix canariensis*, Arecaceae, *Dracaena draco* (op: Arecaceae, Dracaenaceae)	Balachowsky (1949), Lombardero and Novoa (1994), Sampò and Olmi (1975), Whitehead et al. (2000)
Dryocoetes himalayensis Strohmeyer 1908	A	phyto-phagous (phl)	Asia-Temperate	2004, FR	CH, FR	G	N/A (pp: *Juglans regia*, *Pyrus lanata*)	Knížek (2004)
Gnathotrichus materiarius (Fitch 1858)	A	phyto-phagous (xmp)	North America	1933, FR	BE, CH, CZ, DE, ES, FI, FR, IT, NL, SE	G	*Picea*, *Pinus* (pp: conifers)	Balachowsky (1949), Faccoli (1998), Kirkendall and Faccoli (2010), Valkama et al. (1997), Wittenberg (2005)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Hypocryphalus scabricollis (Eichhoff 1878)	A	phyto-phagous (phl)	Asia	1991, MT	MT	I2	*Ficus* (pp)	Mifsud and Knížek (2009)
Hypothenemus crudiae (Panzer 1791)	A	phyto-phagous (phl)	C & S America (+ North Am.)	N/A	PT-AZO	G1	N/A (hpp)	Base de dados da biodiversidade dos Açores
Hypothenemus eruditus Westwood 1836	A	phyto-phagous (phl, spe)	C & S America (+ North Am.)	1924, IT-SIC	ES, ES-CAN, FR, FR-COR, IL, IT, IT-SIC, MT, PT-AZO, PT-MAD	J1	N/A (hpp)	Balachowsky (1949), Machado and Oromí (2000), Noblecourt (2004), Pfeffer (1995), Ragusa (1924), Roll et al. (2007)
Liparthrum artemisiae Wollaston 1854*	A	phyto-phagous (phl)	Africa (ES-CAN)	N/A	PT-MAD	F5	*Artemisia* (mp: *Artemisia*)	Schedl (1963)
Liparthrum bituberculatum Wollaston 1854*	A	phyto-phagous (phl)	Africa (North)	N/A	ES-CAN, PT-MAD	G1	*Laurus* (mp: *Laurus*)	Israelson (1990)
Liparthrum curtum Wollaston 1854*	A	phyto-phagous (phl)	Africa (ES-CAN)	N/A	PT-AZO, PT-MAD	G1	*Castanea*, *Ficus* (pp: Euphorbiaceae, Moraceae, Fabaceae, Fagaceae)	Israelson (1990)
Liparthrum inarmatum Wollaston 1860*	A	phyto-phagous (her)	Africa	N/A	ES-CAN, PT-MAD	F8	*Euphorbia* (mp: *Euphorbia*)	Israelson (1990)
Liparthrum mandibulare Wollaston 1854	A	phyto-phagous (phl)	Africa (ES-CAN)	N/A	ES, GB, PT-MAD	G1	*Alnus*, *Betula*, *Castanea*, *Euphorbia*, *Erica*, *Quercus*, *Rubus* (hpp)	Israelson (1990), Lombardero and Novoa (1993)
Monarthrum mali (Fitch 1855)	A	phyto-phagous (xmp)	North America	2007, IT	IT	G	N/A (pp: broadleaf trees)	Kirkendall et al. (2008)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Phloeosinus rudis Blandford 1894	A	phyto-phagous (phl)	Asia	1940, FR	FR, NL	FA, G5	*Thuja*, *Chamaecyparis*, *Juniperus chinensis*, Cupressaceae (op: Cupressaceae)	Balachowsky (1949), Moraal (2009)
Phloeotribus liminaris (Harris 1852)	A	phyto-phagous (phl)	North America	2004, IT	IT	I2	*Prunus serotina* (mp: *Prunus*)	Pennacchio et al. (2004)
Polygraphus proximus Blandford 1894	A	phyto-phagous (phl)	Asia	2000, RU	RU	G3	*Abies* (mp: *Abies*)	Chilahsayeva (2008), Mandelshtam and Popovichev (2000)
Xyleborinus attenuatus Wood & Bright 1992	A	phyto-phagous (xmp)	Asia	1987, AT, CZ	AT, CH, CZ, DE, ES, HU, NL, PL, RU, SE, SK, UA	G1	*Alnus*, *Betula*, *Salix*, *Tilia*, *Quercus*, *Corylus*, broadleaf trees (pp: broadleaf trees)	Essl and Rabitsch (2002), Kirkendall and Faccoli (2010)
Xyleborus affinis Eichhoff 1868	A	phyto-phagous (xmp)	C & S America (+ North Am.)	2006, AT	AT	I	*Dracaena* (pp: broadleaf trees)	Holzer (2007)
Xyleborus atratus Eichhoff 1875	A	phyto-phagous (xmp)	Asia	2007, IT	IT	G	N/A: *Quercus*? (pp: broadleaf trees)	Faccoli (2008)
Xyleborus pfeilii (Ratzeburg 1837)[8]	A	phyto-phagous (xmp)	Asia	1837, DE	AT, BG, CH, CZ, DE, ES, FR, HR, HU, IT, PL, SI, SK, UA	G	*Alnus*, *Betula*, *Populus* (pp: broadleaf trees)	Kirkendall and Faccoli (2010), Ratzeburg (1837)
Xylosandrus crassiusculus (Motschulsky 1866)	A	phyto-phagous (xmp)	Asia	2003, IT	IT	G2, J100	*Ceratonia siliqua* (pp: broadleaf trees, *Pinus*)	Pennacchio et al. (2003)

8 *Xyleborus pfeilii* was until recently treated as native to Europe, but is now thought to be introduced (Kirkendall and Faccoli 2010).

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Xylosandrus germanus (Blandford 1894)	A	phyto-phagous (xmp)	Asia	1950, DE	AT, BE, CH, CZ, DE, FR, HU, IT, NL, PL, RU, SI	G	*Fagus*, *Castanea*, *Buxus*, *Ficus*, *Carpinus*, *Quercus*, *Juglans*, *Picea*, *Pinus* (pp: broadleaf trees, conifers)	Henin and Versteirt (2004), Kirkendall and Faccoli (2010)
Xylosandrus morigerus (Blandford 1894)	A	phyto-phagous (xmp)	Asia	1916, AT, CZ, FR, GB	AT, CZ, FR, GB, IT	J100	greenhouse orchids as *Dendrobium* (pp: broadleaf trees)	Kirkendall and Faccoli (2010), Reitter (1916)
Dryophthoridae								
Cosmopolites sordidus (Germar 1824)	A	phyto-phagous (xyl)	Asia-Tropical	2004, ES-CAN	ES-CAN, PT-AZO, PT-MAD	I	N/A (op: *Musa*, *Ensete*)	Machado and Oromí (2000)
Diocalandra frumenti (Fabricius 1801)	A	phyto-phagous (xyl)	Asia-Tropical	1998, ES-CAN	ES-CAN	I2	*Phoenix*, Arecaceae (op: Arecaceae)	Gonzales et al. (2002), Machado and Oromí (2000), Salomone Suárez et al. (2000)
Paradiaphorus crenatus (Billberg 1820)	A	phyto-phagous (xyl)	C & S America	2004, ES-CAN	ES-CAN	I1	N/A (*Ananas*)	Machado and Oromí (2000)
Rhynchophorus ferrugineus (Olivier 1790)	A	phyto-phagous (xyl)	Asia-Tropical	1993, ES	CY, ES, ES-CAN, FR, FR-COR, GR, GR-CRE, GR-SEG, IL, IT, IT-SAR, IT-SIC	X24, I2	Arecaceae (op: Arecaceae)	Barranco et al. (1996), Bitton and Nakache (2000), EPPO (2006), FREDON-Corse (2007), Kehat (1999), Kontodimas et al. (2006), MAPA (2006), Sacchetti et al. (2005)
Scyphophorus acupunctatus Gyllenhal 1838	A	phyto-phagous (her)	C & S America	2006, IT-SIC	FR, IT-SIC	I2	*Agave* (pp: Agavaceae, Dracaenaceae)	Germain et al. (2008b), Longo (2007)

Family / *subfamily* Species	**Status**	**Feeding habits**	**Native range**	**1st record in Europe**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Sitophilus linearis (Herbst 1797)	A	phyto-phagous (spe)	Tropical, subtropical	1954, FR-COR	AL, AT, ES-CAN, FR, FR-COR, IT, PL	J1	*Tamarindus indica* (mp: *Tamarindus indica*)	Abbazzi et al. (1994), Essl and Rabitsch (2002), Hoffmann (1954), Machado and Oromí (2000), Tomov et al. (2009)
Sitophilus oryzae (Linnaeus 1763)	A	phyto-phagous (spe)	Asia-Tropical	1896, SE	AL, AT, BG, BY, CH, CY, CZ, DE, DK, EE, ES, ES-CAN, FI, FR, FR-COR, GB, GL, HR, HU, IS, IT, IT-SAR, IT-SIC, LT, LV, MT, NL, NO, PL, PT, PT-AZO, RO, SE, UA	J1	grain (op: cereal grain)	Abbazzi et al. (1994), Balachowsky (1963), Essl and Rabitsch (2002), Hoffmann (1954), Joakimow (1904), Machado and Oromí (2000), Silfverberg (2004a), Silfverberg (2004b), Teodorescu et al. (2006), Tomov et al. (2009), Wittenberg (2005)
Sitophilus zeamais Motschulsky 1855	C	phyto-phagous (spe)	*Cryptogenic*	1927, DE	AD, AL, AT, BE, BG, CH, CZ, DE, DK, EE, ES-CAN, FI, FR, GB, IT, IT-SAR, IT-SIC, PL, PT, PT-AZO, PT-MAD, RU, SE	J1	grain (op: cereal grain)	Balachowsky (1963), Dal Monte (1972), Essl and Rabitsch (2002), Haghebaert (1991), Lundberg (1995), Machado and Oromí (2000), Obretenchev et al. (1990), Tomov et al. (2009), Wittenberg (2005)
Erirhinidae								
Lissorhoptrus oryzophilus Kuschel 1952	A	phyto-phagous (rbw)	North America	2004, IT	IT	I1	*Oryza*, *Carex* (pp: Gramineae, Cyperaceae)	Caldara et al. (2004)
Stenopelmus rufinasus Gyllenhal 1835	A	phyto-phagous (lbw)	North America	1900, FR	BE, DE, ES, FR, GB, IE, IT, NL	C1, C2	*Azolla* (mp: *Azolla*)	Baars and Caffery (2008), Dana and Viva (2006), Fernandez Carrillo et al. (2005), Hill et al. (2005), Janson (1921)

Table 8.2.2. Characteristics of the Curculionoidea species alien *in* Europe. See Table 8.2.1 legend. Native range: „Mediterranean“ refers to southern Europe, North Africa and western Asia; „West Mediterranean“ refers to southern Europe and North Africa.

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Anthribidae						
Bruchela rufipes (Olivier 1790)	phytophagous (spe)	Europe	GB	I2	N/A (mp: *Reseda lutea*)	Hill et al. (2005), Morris (1990)
Apionidae						
Aspidapion (Aspidapion) radiolus (Marsham 1802)*	phytophagous (her)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO	N/A	N/A (op: Malvaceae)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Catapion pubescens (W. Kirby 1811)*	phytophagous (her)	Europe, Mediterranean	ES-CAN	N/A	N/A (mp: *Trifolium*)	Machado and Oromí (2000)
Eutrichapion (Cnemapion) vorax (Herbst 1797)*	phytophagous	Europe, West Mediterranean	ES-CAN	N/A	N/A (op: Fabaceae)	Machado and Oromí (2000)
Holotrichapion (Holotrichapion) ononis (W. Kirby 1808)*	phytophagous (spe)	Europe, Mediterranean, Asia	ES-CAN	N/A	N/A (mp: *Ononis*)	Machado and Oromí (2000)
Ischnopterapion (Ischnopterapion) plumbeomicans (Rosenhauer 1856)*	phytophagous (spe)	Mediterranean	ES-CAN	N/A	N/A (mp: *Lotus*)	Machado and Oromí (2000)
Ischnopterapion (Chlorapion) virens (Herbst 1797)*	phytophagous (her)	Europe, Mediterranean, Asia	ES-CAN	N/A	N/A (mp: *Trifolium*)	Machado and Oromí (2000)
Ixapion variegatum (Wencker 1864)	phytophagous (her)	Europe	GB	I2, H5	*Viscum album* (mp: *Viscum album*)	Duff (2008), Foster et al. (2001)
Kalcapion semivittatum (Gyllenhal 1833)*	phytophagous (her)	Europe, Mediterranean	ES-CAN, PT-AZO	N/A	N/A (mp: *Mercurialis*)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Brachyceridae						
Brachycerus plicatus Gyllenhal 1833*	phytophagous (her?)	Mediterranean	ES-CAN	N/A	N/A (op: Liliaceae?)	Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Curculionidae						
Bagoinae						
Bagous exilis Jacquelin du Val 1854*	phytophagous	West Mediterranean	ES-CAN	B	N/A (coastal shrubs: *Frankenia*, Chenopodiaceae)	Machado and Oromí (2000)
Baridinae						
Melaleucus sellatus (Boheman 1844)*	phytophagous	West Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Melanobaris quadraticollis (Boheman 1836)*	phytophagous (her)	West Mediterranean	ES-CAN	I, J	N/A (op: Cruciferae)	Machado and Oromí (2000)
Ceutorhynchinae						
Ceutorhynchus assimilis (Paykull 1800)	phytophagous (spe)	Europe, West Mediterranean	PT-AZO	I, J	N/A (op: *Brassica*, Cruciferae)	Borges et al. (2005)
Micrelus ferrugatus (Perris 1847)*	phytophagous (spe)	West Mediterranean	ES-CAN	E	N/A (mp: *Erica*)	Machado and Oromí (2000)
Mogulones geographicus (Goeze 1777)	phytophagous (rbo)	Europe, West Mediterranean	PT-AZO	I, G	*Echium* (mp: *Echium*)	Borges et al. (2005)
Rhinoncus pericarpius (Linnaeus 1758)	phytophagous (rbo)	Europe, West Mediterranean, Asia	FÖ	E, I	N/A (mp: *Rumex*)	N/A
Cossoninae						
Brachytemnus porcatus (Germar 1824)	phytophagous (xyl)	Europe, West Mediterranean	PT-AZO	I2	N/A (op: Pinaceae)	Borges et al. (2005)
Pselactus spadix (Herbst 1795)	phytophagous (xyl)	Europe	PT-AZO	B, E	marine driftwood (pp: decaying wood)	Stüben (2003)
Pseudophloeophagus aeneopiceus (Boheman 1845)*	phytophagous (xyl)	Europe	PT-AZO	N/A	N/A (pp: decaying wood)	Base de dados da biodiversidade dos Açores
Rhopalomesites tardyi (Curtis 1825)	phytophagous (xyl)	Europe	PT-AZO	G	N/A (pp: dead wood)	Borges et al. (2005)
Cryptorhynchinae						
Dichromacalles (Dichromacalles) dromedarius (Boheman 1844)*	phytophagous (her?)	West Mediterranean	ES-CAN, PT-AZO	N/A	N/A (op: Compositae)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Curculioninae						
Mecinus circulatus (Marsham 1802)*	phytophagous (her)	Europe, Mediterranean	ES-CAN	I, J	N/A (mp: *Plantago*)	Machado and Oromí (2000)
Mecinus longiusculus Boheman 1845*	phytophagous (her)	West Mediterranean	ES-CAN	I, J	N/A (op: Scrophulariaceae)	Machado and Oromí (2000)
Mecinus pascuorum (Gyllenhal 1813)	phytophagous (spe)	Europe, Mediterranean	ES-CAN, PT-AZO	I, J	*Plantago* (mp: *Plantago*)	Borges et al. (2005), Machado and Oromí (2000)
Pachytychius aridicola (Wollaston 1864)*	phytophagous (spe)	Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Philernus farinosus Gyllenhal 1835*	phytophagous	Europe, Asia	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Sibinia (Dichotychius) albosquamosa Pic 1904*	phytophagous (spe?)	Mediterranean	ES-CAN	N/A	*Limonium* (N/A)	Machado and Oromí (2000)
Sibinia (Dichotychius) planiuscula (Desbrochers 1873)*	phytophagous (spe?)	Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Sibinia (Sibinia) primita (Herbst 1795)*	phytophagous (spe)	Europe, West Mediterranean	ES-CAN	N/A	N/A (pp: Caryophyllaceae, Plumbaginaceae, Thymelaeaceae)	Machado and Oromí (2000)
Smicronyx albosquamosus Wollaston 1854*	phytophagous (her?)	West Mediterranean	ES-CAN, PT-MAD	N/A	N/A (N/A)	Hoffmann (1958), Machado and Oromí (2000)
Smicronyx brevicornis Solari 1952*	phytophagous (her)	West Mediterranean	ES-CAN	N/A	N/A (mp: *Cuscuta*)	Machado and Oromí (2000)
Tychius (*Tychius*) *cuprifer* (Panzer 1799)	phytophagous (spe)	Europe, Mediterranean	PT-AZO	I1	N/A (mp: *Trifolium*)	Borges et al. (2005), Stüben (2003)
Tychius (*Tychius*) *picirostris* (Fabricius 1787)	phytophagous (spe)	Europe, Mediterranean, Asia	PT-AZO	I1, E	N/A (mp: *Trifolium*)	Borges et al. (2005)
Tychius (Tychius) stephensi Schonherr 1836*	phytophagous (spe)	Europe, Mediterranean, Asia	ES-CAN	N/A	N/A (mp: *Trifolium*)	Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Tychius (Tychius) striatulus Gyllenhal 1836*	phytophagous (spe)	Mediterranean	ES-CAN	N/A	N/A (mp: *Ononis*)	Machado and Oromí (2000)
Cyclominae						
Gronops fasciatus Kuster 1851*	phytophagous	Mediterranean	ES-CAN	N/A	Opuntia (N/A)	Machado and Oromí (2000)
Entiminae						
Barynotus squamosus Germar 1824	phytophagous	Europe	FÖ	G	N/A (N/A)	N/A
Barypeithes (*Exomias*) *pellucidus* (Boheman 1834)	phytophagous (rbw?)	Europe	IS	I	*Medicago* (mp: *Medicago*)	Ólafsson (1991)
Cathormiocerus (*Cathormiocerus*) *curvipes* (Wollaston 1854)	phytophagous	Europe	PT-AZO	F5	*Pittosporum*? (N/A)	Stüben (2003)
Otiorhynchus (*Otiorhynchus*) *apenninus* Stierlin 1883	phytophagous (rbw)	Europe (Alps)	DK, GB, MT, NL, SE	I2	N/A (pp: *Acer*, *Camelia*, *Prunus*, *Rhododendron*)	Heijerman et al. (2003), Hill et al. (2005), Runge (2008)
Otiorhynchus (*Otiorhynchus*) *armadillo* (Rossi 1792)	phytophagous (rbw)	Europe (central)	GB, SE	I2, J4	N/A (*Alnus*)	Borisch (1997), Hill et al. (2005)
Otiorhynchus (*Nehrodistus*) *armatus* Boheman 1843	phytophagous (rbw)	Europe (southern)	SE	J100	*Fragaria*, *Vitis*, *Carduus*, *Rumex* (N/A)	Borisch (1997), Silfverberg (2004a), Silfverberg (2004b)
Otiorhynchus (*Otiorhynchus*) *aurifer* Boheman 1843	phytophagous (rbw)	Mediterranean	DK	N/A	N/A (N/A)	Runge (2008)
Otiorhynchus (*Pocodalemes*) *crataegi* Germar 1824	phytophagous (rbw)	Europe, Mediterranean	GB	I2	N/A (*Cyclamen*)	Hill et al. (2005)
Otiorhynchus (*Nehrodistus*) *corruptor* (Host 1789)	phytophagous (rbw)	Europe (southern)	DE, DK, FR, GB	I	*Pyrus*? (N/A)	Barclay (2001), Lucht (1985), Palm (1996), Valladares and Cocquempot (2008)
Otiorhynchus (*Arammichnus*) *cribricollis* Gyllenhal 1834	phytophagous (rbw)	West Mediterranean	ES-CAN, PT-AZO	I, J	N/A (mp: *Artemisia*)	Borges et al. (2005), Machado and Oromí (2000), Stüben (2003)
Otiorhynchus (*Arammichnus*) *dieckmanni* Magnano 1979	phytophagous (rbw)	Europe (western)	DK, SE	G, I2	N/A (N/A)	Borisch (1997), Runge (2008), Silfverberg (2004a), Silfverberg (2004b)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Otiorhynchus (*Padilehus*) *pinastri* (Herbst 1795)	phytophagous (rbw)	Europe (eastern)	CH	J	*Vincetoxicum* (N/A)	Germann (2004)
Otiorhynchus (Zustalestus) rugosostriatus (Goeze 1777)*	phytophagous (rbw)	Europe, West Mediterranean	PT-AZO	N/A	N/A (pp: *Rumex*, *Dactylis*, *Trifolium*...)	Base de dados da biodiversidade dos Açores
Otiorhynchus (*Metopiorrhynchus*) *singularis* (Linnaeus 1767)	phytophagous (rbw)	Europe	FÖ, IS	I2	N/A (N/A)	Ólafsson (1991)
Otiorhynchus (*Dorymerus*) *sulcatus* (Fabricius 1775)	phytophagous (rbw)	Europe	PT-AZO	F5	*Pittosporum*? (pp: *Vitis*...)	Borges et al. (2005), Stüben (2003)
Philopedon plagiatum (Schaller 1783)	phytophagous (rbw?)	Europe, West Mediterranean	PT-AZO	I,G	N/A (*Ammophila*)	Borges et al. (2005)
Psallidium (*Psallidium*) *maxillosum* (Fabricius 1792)	phytophagous	Europe (southcentral, southeastern)	SE	I1	N/A (N/A)	Lundberg (2006)
Rhytideres (Rhytideres) plicatus (Olivier 1790)*	phytophagous (rbw)	Mediterranean	ES-CAN	N/A	N/A (pp: Resedaceae, Cruciferae)	Machado and Oromí (2000)
Sitona (Charagmus) cachectus Gyllenhal 1834*	phytophagous (rbw)	West Mediterranean	ES-CAN	N/A	N/A (mp: *Astragalus*)	Machado and Oromí (2000)
Sitona (*Sitona*) *cinnamomeus* Allard 1863	phytophagous (rbw)	Mediterranean	PT-AZO	I, G	N/A (op: *Lotus*, *Trifolium*, Fabaceae)	Borges et al. (2005)
Sitona (*Sitona*) *discoideus* Gyllenhal 1834	phytophagous (rbw)	Mediterranean	ES-CAN, PT-AZO	I, G	N/A (mp: *Medicago*)	Borges et al. (2005), Machado and Oromí (2000)
Sitona (Charagmus) gressorius (Fabricius 1792)*	phytophagous (rbw)	Mediterranean, Asia	ES-CAN, PT-AZO	N/A	N/A (mp: *Lupinus*)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Sitona (*Sitona*) *lepidus* Gyllenhal 1834	phytophagous (rbw)	Europe, Mediterranean	PT-AZO	I, J	N/A (op: *Lotus*, *Trifolium*, Fabaceae)	Borges et al. (2005)
Sitona (Sitona) lineatus (Linnaeus 1758)*	phytophagous (rbw)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO	I, J	N/A (op: Fabaceae)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Sitona (Sitona) macularius (Marsham 1802)*	phytophagous (rbw)	Europe, Mediterranean, Asia	ES-CAN	I, J	N/A (mp: *Trifolium*)	Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Sitona (Sitona) ocellatus Kuster 1849*	phytophagous (rbw)	Mediterranean	ES-CAN	N/A	N/A (Fabaceae?)	Machado and Oromí (2000)
Sitona (*Sitona*) *puberulus* Reitter 1903	phytophagous (rbw)	Mediterranean	ES-CAN, PT-AZO, PT-MAD	I, J	N/A (mp: *Lotus*)	Borges et al. (2005), Hoffmann (1950), Machado and Oromí (2000), Stüben (2003)
Sitona (*Sitona*) *puncticollis* Stephens 1831	phytophagous (rbw)	Europe, Mediterranean, Asia	FÖ, PT-AZO	I	N/A (op: *Trifolium*, *Melilotus*?)	Borges et al. (2005)
Sitona (Charagmus) variegatus Fåhraeus 1840*	phytophagous (rbw)	West Mediterranean	ES-CAN	N/A	N/A (mp: *Astragalus*)	Machado and Oromí (2000)
Strophosoma (*Strophosoma*) *melanogrammum melanogrammum* (Forster 1771)	phytophagous (rbw?)	Europe	PT-AZO	G, I2	N/A (pp: *Rumex*, *Aira*...)	Borges et al. (2005)
Trachyphloeus (Trachyphloeus) angustisetulus Hansen 1915*	phytophagous (rbw?)	Europe	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Trachyphloeus (Trachyphloeus) laticollis Boheman 1843*	phytophagous (rbw?)	Mediterranean	ES-CAN	N/A	*Mercurialis*, *Bidens* (N/A)	Machado and Oromí (2000)
Trachyphloeus (Trachyphloeus) spinimanus Germar 1824*	phytophagous (rbw)	Europe, Asia	ES-CAN	N/A	N/A (mp: *Cynodon*)	Machado and Oromí (2000)
Hyperinae						
Coniatus (Coniatus) tamarisci (Fabricius 1787)*	phytophagous	Mediterranean	ES-CAN	N/A	N/A (mp: *Tamarix*)	Machado and Oromí (2000)
Donus (*Antidonus*) *lunatus* (Wollaston 1854)*	phytophagous (lbw)	Europe, Mediterranean, Asia	ES-CAN	E	N/A (op: Geraniaceae)	Machado and Oromí (2000)
Hypera (Hypera) melancholica (Fabricius 1792)*	phytophagous (lbw)	Europe, Mediterranean, Asia	ES-CAN	I, J	N/A (op: *Medicago*, *Trifolium*)	Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Hypera (Hypera) nigrirostris (Fabricius 1775)*	phytophagous (lbw)	Europe, Mediterranean, Asia	ES-CAN	E, J	N/A (op: *Ononis*, *Trifolium*)	Machado and Oromí (2000)
Hypera (Hypera) ononidis (Chevrolat 1863)*	phytophagous (lbw)	Europe, West Mediterranean	ES-CAN	E	N/A (mp: *Ononis*)	Machado and Oromí (2000)
Hypera (*Hypera*) *postica* (Gyllenhal 1813)	phytophagous (lbw)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO	I, J	N/A (op: Fabaceae)	Borges et al. (2005), Machado and Oromí (2000)
Lixinae						
Coniocleonus excoriatus (Gyllenhal 1834)*	phytophagous	Europe, Mediterranean	ES-CAN, PT-AZO	N/A	N/A (N/A)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Coniocleonus variolosus (Wollaston 1864)*	phytophagous	West Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Conorhynchus (Pycnodactylus) brevirostris (Gyllenhal 1834)*	phytophagous (rbo)	Mediterranean, Africa	ES-CAN	B	N/A (op: Chenopodiaceae)	Machado and Oromí (2000)
Conorhynchus (Pycnodactylus) conicirostris (Olivier 1807)*	phytophagous	Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Lixus (Compsolixus) anguinus (Linnaeus 1767)*	phytophagous (her)	West Mediterranean	ES-CAN	E?	N/A (op: *Cheiranthus*, *Sinapis*)	Machado and Oromí (2000)
Lixus (Eulixus) brevirostris Boheman 1835*	phytophagous (her)	West Mediterranean	ES-CAN	N/A	N/A (mp: *Atriplex*)	Machado and Oromí (2000)
Lixus (Epimeces) filiformis (Fabricius 1781)*	phytophagous (her)	Europe, Mediterranean	ES-CAN	I, J	N/A (mp: *Carduus*)	Machado and Oromí (2000)
Lixus (Compsolixus) juncii Boheman 1835*	phytophagous (her)	Mediterranean, Asia	ES-CAN	N/A	N/A (op: Chenopodiaceae)	Machado and Oromí (2000)
Lixus (Dilixellus) linearis Olivier 1807*	phytophagous (her)	Europe, Mediterranean	ES-CAN	I, J	N/A (mp: *Rumex*)	Machado and Oromí (2000)
Lixus (Dilixellus) pulverulentus (Scopoli 1763)*	phytophagous (her)	Europe, Asia, North Africa	ES-CAN	N/A	N/A (op: Malvaceae, Fabaceae)	Machado and Oromí (2000)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Rhinocyllus conicus (Froelich 1792)	phytophagous (spe)	Europe, Mediterranean	LT, LV, SE	E, I	N/A (op: *Carduus*, *Cirsium*, *Galactites*, *Cynara*...)	Gillerfors (1988), Lundberg (2006)
Mesoptiliinae						
Magdalis (*Magdalis*) *memnonia* (Gyllenhal 1837)	phytophagous (her)	Europe, Mediterranean, Asia	GB	G3	*Pinus* (mp: *Pinus*)	Hill et al. (2005)
Molytinae						
Anisorhynchus hespericus Desbrochers 1875*	phytophagous	Europe (southwestern)	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Ita crassirostris Tournier 1878*	phytophagous	Europe (southern)	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Liparus (*Liparus*) *glabrirostris* Küster 1849	phytophagous	Europe (Alps)	DK	G	N/A (mp: *Heracleum*)	Hansen (1996)
Pissodes (Pissodes) castaneus (De Geer 1775)*	phytophagous (phl)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO	G	N/A (mp: *Pinus*)	Base de dados da biodiversidade dos Açores, Machado and Oromí (2000)
Scolytinae						
Chaetoptelius vestitus (Mulsant & Rey 1860)*	phytophagous (phl)	Mediterranean, Asia	ES-CAN	G1, I2	*Laurus* (pp: *Pistacia*, *Cotinus*, *Olea*, *Smilax*)	Schedl et al. (1959)
Crypturgus subcribrosus Eggers 1933	phytophagous (phl)	Europe (central, eastern)	GB	G3	*Picea* (op: *Pinus*, *Abies*, *Picea*)	Alexander (2002)
Dendroctonus micans (Kugelann 1794)	phytophagous (phl)	Europe, Asia	GB	G3	*Picea* (mp: *Picea*)	Alexander (2002), Hill et al. (2005)
Dryocoetes villosus (Fabricius 1792)*	phytophagous (phl)	Europe, West Mediterranean	ES-CAN, PT-MAD	G1	*Laurus* (pp: *Laurus*, *Alnus*)	Schedl (1963), Schedl et al. (1959)
Hylastes angustatus (Herbst 1793)	phytophagous (phl)	Europe (southern, central), Asia	GB	G3	*Pinus* (mp: *Pinus*)	Alexander (2002)
Hylastes ater (Paykull 1800)	phytophagous (phl)	Europe, Asia	GB, PT-AZO	G3, I2	*Pinus* (mp: *Pinus*)	Alexander (2002), Bright (1987)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Hylastes attenuatus Erichson 1836	phytophagous (phl)	Europe, Mediterranean, Asia	GB, PT-AZO, PT-MAD	G3	*Pinus* (mp: *Pinus*)	Alexander (2002), Bright (1987), Mandelshtam et al. (2006)
Hylastes cunicularius Erichson 1836	phytophagous (phl)	Europe, Asia	GB	G3	*Picea* (mp: *Picea*)	Alexander (2002)
Hylastes linearis Erichson 1836*	phytophagous (phl)	Europe, West Mediterranean	ES-CAN, PT-MAD	G3	*Pinus* (mp: *Pinus*)	Schedl (1963), Schedl et al. (1959)
Hylastinus obscurus (Marsham 1802)*	phytophagous (phl, rbo)	Europe, West Mediterranean	ES-CAN, PT-MAD	F5, F7	*Cytisus*, *Laurus*, *Castanea* (op: *Trifolium*, Fabaceae);	Schedl (1963), Schedl et al. (1959)
Hylurgops palliatus (Gyllenhal 1813)	phytophagous (phl)	Europe, Mediterranean, Asia	GB	G3	N/A (op: Pinaceae)	Alexander (2002)
Hylurgus ligniperda (Fabricius 1787)*	phytophagous (phl)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO, PT-MAD	G3	*Pinus* (mp: *Pinus*)	Bright (1987), Schedl (1963), Schedl et al. (1959)
Hypoborus ficus Erichson 1836*	phytophagous (phl)	Europe, West Mediterranean	ES-CAN, PT-AZO, PT-MAD	I2	*Echium*, *Ficus* (mp: *Ficus*)	Bright (1987), Schedl (1963), Schedl et al. (1959)
Ips cembrae (Heer 1836)	phytophagous (phl)	Europe (central)	DK, GB, NL	G3	*Larix* (op: *Larix*, *Pinus cembra*)	EPPO (2005), Hill et al. (2005), Stauffer et al. (2001)
Ips duplicatus (Sahlberg 1836)	phytophagous (phl)	Europe (northeastern, Russia)	AT, BE, SK	G3	*Picea abies* (mp: *Picea*)	Essl and Rabitsch (2002), OPIE (2002), Piel et al. (2006)
Orthotomicus erosus (Wollaston 1857)*	phytophagous (phl)	Europe, Mediterranean, Asia	PT-MAD	G3	*Pinus* (mp: *Pinus*)	Schedl (1963)
Phloeosinus armatus Reitter 1887	phytophagous (phl)	Mediterranean (eastern)	IT	FA, G5	*Cupressus* (op: Cupressaceae)	Covassi (1991)
Phloeosinus aubei (Perris 1855)[9]	phytophagous (phl)	Europe, West Mediterranean	ES-CAN, NL	G3	*Juniperus* (op: Cupressaceae)	Moraal (2006), Oromí and García (1995)

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Phloeosinus thujae (Perris 1855)	phytophagous (phl)	Europe, West Mediterranean	ES-CAN, GB	FA, G5	*Juniperus* (op: Cupressaceae)	Alexander (2002), Machado and Oromí (2000)
Phloeotribus caucasicus Reitter 1891	phytophagous (phl)	Europe (eastern), Asia	AT, CZ, FR	FA, G5	*Fraxinus* (mp: *Fraxinus*)	Bouget and Noblecourt (2005), Essl and Rabitsch (2002), Schott and Callot (1994)
Phloeotribus cristatus (Fauvel 1889)*	phytophagous (phl)	West Mediterranean	ES-CAN	F5, F7	N/A: Fabaceae? (op: Fabaceae)	Machado and Oromí (2000)
Phloeotribus rhododactylus (Marsham 1802)*	phytophagous (phl)	Europe, West Mediterranean	PT-MAD	F5, F7	*Cytisus* (op: Fabaceae)	Schedl (1963)
Phloeotribus scarabaeoides (Bernard 1788)*	phytophagous (phl)	Europe, West Mediterranean	ES-CAN	I2	N/A: Oleaceae? (op: Oleaceae)	Machado and Oromí (2000)
Pityophthorus traegardhi Spessivtseff 1921	phytophagous (phl)	Europe (northern), Asia	AT	G3	*Picea* (mp: *Picea*)	Holzschuh (1994)
Polygraphus poligraphus (Linnaeus 1758)	phytophagous (phl)	Europe (central, northern, eastern)	GB	G3	N/A (op: Pinaceae)	Alexander (2002)
Pteleobius kraatzii (Eichhoff 1864)*	phytophagous (phl)	Europe, West Mediterranean	ES-CAN	I2, G1, G5, FA	N/A: *Ulmus*? (mp: *Ulmus*)	Pfeffer (1995)
Scolytus amygdali Guérin-Méneville 1847*	phytophagous (phl)	Europe, Mediterranean, Asia	ES-CAN	I2	*Prunus* (op: Rosaceae trees)	Israelson (1969)
Scolytus laevis Chapuis 1869	phytophagous (phl)	Europe	GB	G1, G5, I2	*Ulmus* (mp: *Ulmus*)	Hill et al. (2005)
Scolytus pygmaeus (Fabricius 1787)	phytophagous (phl)	Europe	GB	G1, I2, FA, FB	*Ulmus* (mp: *Ulmus*)	Hill et al. (2005)
Scolytus rugulosus (Muller 1818)*	phytophagous (phl)	Europe, Mediterranean, Asia	PT-AZO	I2	N/A (op: Rosaceae trees)	Bright (1987)

[9] This species was incorrectly reported from the Canary Islands (Oromí and García 1995) as *P. gillerforsi* Bright, an Azores endemic. Specimens so identified have been examined by Kirkendall, and they belong to the common Mediterranean species *P. aubei*.

Family / *subfamily* Species	**Feeding habits**	**Native range**	**Invaded countries**	**Habitat**	**Hosts**	**References**
Tomicus destruens (Wollaston 1865)[10]	phytophagous (phl)	Europe, Asia	PT-MAD	G3, I2	*Pinus* (mp: *Pinus*)	Schedl (1963)
Xyleborinus saxesenii (Ratzeburg 1837)[11]	phytophagous (xmp)	Europe, Mediterranean, Asia	ES-CAN, PT-AZO, PT-MAD	I2	*Laurus*, *Pinus*, *Castanea* (pp: broadleaves, conifers)	Bright (1987), Schedl et al. (1959)
Dryophthoridae						
Sphenophorus meridionalis Gyllenhal 1838	phytophagous (rbo?)	West Mediterranean	ES-CAN	E6	N/A (N/A)	Machado and Oromí (2000)
Erirhinidae						
Procas armillatus (Fabricius 1801)*	phytophagous	Europe, Mediterranean	ES-CAN	N/A	N/A (N/A)	Machado and Oromí (2000)
Nanophyidae						
Dieckmanniellus nitidulus (Gyllenhal 1838)*	phytophagous (her)	Europe, Mediterranean	ES-CAN	N/A	N/A (mp: *Lythrum*)	Machado and Oromí (2000)
Nanodiscus transversus (Aube 1850)	phytophagous (spe)	West Mediterranean	ES-CAN	N/A	N/A (op: *Juniperus*, *Cupressus*)	Machado and Oromí (2000)
Nemonychidae						
Cimberis attelaboides (Fabricius 1787)	phytophagous (spe)	Europe, Mediterranean, Asia	GB	G3	*Pinus sylvestris* (mp: *Pinus sylvestris*)	Duff (2008)

[10] Early records from Madeira refer to *T. piniperda*, but specimens collected by Kirkendall in 1999 are *T. destruens*; as the two species had been mixed up for a long time we think all records correspond to *T. destruens*

[11] This species has been improperly recorded in the Canary Islands as *Xyleborus xylographus*. *Xyleborus xylographus* (Say 1826), an oak specialist from the eastern United States, does not occur in any recent collections from the archipelago (or elsewhere in Europe), whereas *X. saxesenii* does (Kirkendall, unpublished data). The presence of *X. xylographus* on all Canary Islands species lists (Schedl et al. 1959, Oromi and Garcia 1995, Machado and Oromi 2000, Izquierdo et al. 2004), and the absence of *X. saxesenii*, seems to stem from an early mistaken treatment of *X. saxesenii* as a junior synonym of *X. xylographus* (Schedl 1970). To verify this, Kirkendall located one specimen recently determined as *X. Xylographus* (Oromi and Garcia 1995), and confirmed that it is *X. saxesenii*.