

# Inventory of terrestrial alien arthropod predators and parasites established in Europe

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**Abstract** There are currently 1590 terrestrial arthropod species identified as alien to Europe. Of these, 513 are predators or parasites. The largest group is the insects (409 species), followed by spiders (47 species), myriapods (34 species) and mites (23 species). The species within these alien groupings are extremely diverse, as highlighted by the large number of families represented (115 families). The majority (66.1%) of alien arthropod predator and parasite species arrived unintentionally, but at least 174 (33.9%) have been introduced intentionally, mainly for biological control purposes. Assessment of the major invasion pathways is difficult due to the lack of comprehensive information but it is likely that the majority of predatory or parasitic alien arthropods arrive through leading-edge dispersal or as contaminants and stowaways. The number of new species arriving in Europe has progressively increased since 1500, with the increase in global trade over the last century accelerating this rate of increase. Only a small number of alien predatory and parasitic arthropods in Europe have been shown to

cause either an ecological or economical impact, yet knowledge is severely limited by a paucity of data.

**Keywords** Invasive alien species · Arthropod · Predator · Parasitoid · Parasite · Spatial and temporal distribution patterns

## Introduction

The Delivering Alien Invasive Species Inventory for Europe (DAISIE) project provides an outstanding resource for synthesising trends in biological invasions in Europe (DAISIE 2009; Hulme and Roy 2010; Roques et al. 2010). The infrastructure of DAISIE was achieved through a consortium of researchers from 19 institutions and 15 countries across Europe resulting in 182 individual contributors of data. DAISIE comprises an inventory, distribution maps (on a country-scale) and accounts for a selection of alien species across Europe. The DAISIE inventory, The European Alien Species Database (<http://www.europe-aliens.org/>), was compiled from national and regional lists of alien fungi, bryophytes, vascular plants, invertebrates, fish, amphibians, reptiles, birds and mammals. The alien terrestrial invertebrates proved to be a major challenge because there were no checklists available for this group even though invertebrates comprise the largest proportion of alien animals (Nentwig and Josefsson 2010) and are one of the taxonomic groups with the most species causing impacts (mainly economical) in

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Europe (Hulme and Roy 2010). Here we review the DAISIE inventory, using its recent update of alien arthropods by Roques et al. (2010), to provide a review of the established (self-sustaining populations in the wild) alien arthropod predators and parasites (mostly parasitoids).

### Alien arthropod predators and parasites

Alien arthropod predators and parasites are a particularly interesting group to consider because they generally have a positive impact on the economy or environment (through introduction as biological control agents for the control of pest insects) but, in a few cases, can also have negative impacts (through interference with other beneficial insects). There are many examples of predators and parasitoids providing cost-effective biological control particularly in glasshouse systems (van Lenteren 2007; De Clercq et al. 2011). However, there are a few examples of a biological control agent becoming a pest and threatening non-target organisms (Kenis and Branco 2010). The harlequin ladybird, *Harmonia axyridis* Pallas (Coleoptera: Coccinellidae) is one such example (Roy and Wajnberg 2008). The release of generalist predators, such as *H. axyridis*, is extremely risky and can impact on ecosystem services and processes through trophic cascades (Kenis and Branco 2010).

There are currently 1590 terrestrial arthropod species identified as alien to Europe (Roques 2010). Of these, 513 are predators or parasites, mainly parasitoids but also some mites (Table 1). The largest group is the insects (409 species constituting 79.7%), followed by spiders (47 species constituting 9.2%, data from Nentwig and Kobelt 2010), myriapods (34 species constituting 6.6%, data from Stoev et al. 2010) and mites (23 species constituting 4.5%, data from Navajas et al. 2010) as the next most speciose groups. The taxonomy of species within these alien groupings is extremely diverse, as highlighted by the large number of families represented (115 families). However, only 24 families have five or more species. The richest families with respect to alien insect species all belong to the Hymenoptera: Aphelinidae, Encyrtidae, Formicidae and Eulophidae (Fig. 1a). Furthermore, Hymenoptera constitute the largest proportion of the alien insects (Fig. 1b, 259 species constituting 63.3%, data from Rasplus et al. 2010)

followed by Coleoptera (Fig. 1b, 62 species constituting 15.2%, data from Denux and Zagatti 2010; Roy and Migeon 2010). The six additional insect orders comprise less than 35 alien species each (Fig. 2, data from Kenis and Roques 2010; Rabitsch 2010a; Rasplus and Roques 2010; Reynaud 2010; Skuhrová et al. 2010).

### Invasion pathways

The majority (86%) of alien arthropods in Europe arrived unintentionally but 14% were deliberately introduced, mainly as biological control agents (Rabitsch 2010b). It is, therefore, not surprising that the proportion of alien predators and parasites introduced intentionally is higher than for other functional groups. At least 174 (33.9%) predatory and parasitic species have been introduced intentionally, mainly for biological control purposes, whilst 339 (66.1%) other species arrived accidentally (Fig. 2). Roques et al. (2009) reported the number of intentional introductions as only 131 alien terrestrial invertebrate species. However, the analysis presented here is based on a major update to the DAISIE inventory, undertaken to account for the underestimation of hymenopteran parasitoids released as biological control agents but which subsequently established within Europe (Roques 2010; Rasplus et al. 2010).

#### Species introduced intentionally as biological control agents

The majority of predator and parasitoid species have arrived into Europe unintentionally but intentional introduction through the release of exotic (=alien) biological control agents is undoubtedly an important invasion pathway for many arthropod species into Europe. The definitive pathways involved are diverse and in some cases difficult to monitor (Rabitsch 2010b).

There is considerable variation between families in the proportion of alien predator and parasite species that have been intentionally introduced within Europe. So, for example, a very high proportion (approximately 90%) of alien parasitoids in the family Aphelinidae found in Europe have been intentionally introduced (Fig. 1b; from Rasplus et al. 2010). This family comprises a diverse range

**Table 1** List of the alien species of parasitoids and predators established in Europe until 2008, modes of introduction (U = Unintentional; I = Intentional), status (A = Alien; C = Cryptogenic), date of first record on the continent, and number of invaded countries and major European islands (including oceanic islands)

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Epidermoptes bilobatus</i> Rivolta, 1876	Acari	Astigmata	Epidermoptidae	U	A	1948	1
<i>Listrophorus americanus</i> Radford, 1944	Acari	Astigmata	Listrophoridae	U	A	1955	1
<i>Listrophorus dozieri</i> Redford, 1994	Acari	Astigmata	Listrophoridae	U	A	2004	1
<i>Listrophorus faini</i> Dubinina, 1972	Acari	Astigmata	Listrophoridae	U	A	2004	1
<i>Listrophorus validus</i> Banks, 1910	Acari	Astigmata	Listrophoridae	U	A	2004	1
<i>Mycoptes ondatrae</i> Lukoschus & Rouwet, 1968	Acari	Astigmata	Mycopidae	U	A	2004	1
<i>Dermatophagoidea evansi</i> Fain, Hughes et Johnston, 1967	Acari	Astigmata	Pyroglyphidae	U	A	Unknown	4
<i>Amblyomma exornatum</i> Koch, 1844	Acari	Ixodida	Ixodidae	U	A	2004	1
<i>Amblyomma latum</i> Koch, 1844	Acari	Ixodida	Ixodidae	U	A	2004	1
<i>Dermacentor variabilis</i> (Say, 1821)	Acari	Ixodida	Ixodidae	U	A	Unknown	1
<i>Hyalomma aegyptium</i> (L., 1758)	Acari	Ixodida	Ixodidae	U	A	1911	14
<i>Hyalomma anatolicum</i> Koch 1844	Acari	Ixodida	Ixodidae	U	A	1929	1
<i>Hyalomma dromedarii</i> Koch 1844	Acari	Ixodida	Ixodidae	U	A	1929	2
<i>Hyalomma excavatum</i> Pomerantsev 1946	Acari	Ixodida	Ixodidae	U	A	1940	7
<i>Hyalomma truncatum</i> Koch 1844	Acari	Ixodida	Ixodidae	U	A	1956	1
<i>Rhipicephalus rossicus</i> Yakimov & Kolyakimova, 1911	Acari	Ixodida	Ixodidae	U	A	1965	1
<i>Laelaps echidninus</i> Berlese, 1887	Acari	Mesostigmata	Laelapidae	U	A	1955	1
<i>Ondatraelaps multispinosus</i> (Banks, 1909)	Acari	Mesostigmata	Laelapidae	U	A	1955	1
<i>Ornithonyssus bacoti</i> (Hirst, 1913)	Acari	Mesostigmata	Macronyssidae	U	A	1952	1
<i>Ornithonyssus bursa</i> (Berlese)	Acari	Mesostigmata	Macronyssidae	U	A	1948	2
<i>Amblyseius (Neoseiulus) californicus</i> (McGregor 1954)	Acari	Mesostigmata	Phytoseiidae	I	A	1991	4
<i>Phytoseiulus persimilis</i> Athias-Henriot 1957	Acari	Mesostigmata	Phytoseiidae	I	A	1974	7
<i>Varroa destructor</i> Anderson & Trueman, 2000	Acari	Mesostigmata	Varroidae	U	A	1964	24
<i>Amaurobius similis</i> (Blackwall 1861)	Aranea	Aranea	Amaurobiidae	U	A	1915	16
<i>Clubiona facilis</i> O. P.-Cambridge 1910	Aranea	Aranea	Clubionidae	U	A	1932	1
<i>Cicurina japonica</i> (Simon 1886)	Aranea	Aranea	Dictynidae	U	A	1990	3
<i>Dysdera aculeata</i> Kroneberg 1875	Aranea	Aranea	Dysderidae	U	A	1988	1
<i>Seothyra perelegans</i> Simon 1906	Aranea	Aranea	Eresidae	U	A	1906	1
<i>Sosticus loricatus</i> (L. Koch 1866)	Aranea	Aranea	Gnaphosidae	U	A	1879	19
<i>Zelotes puritanus</i> Chamberlin 1922	Aranea	Aranea	Gnaphosidae	U	A	1966	10

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Erigone autumnalis</i> Emerton 1882	Aranea	Aranea	Linyphiidae	U	A	1990	2
<i>Mermessus denticulatus</i> (Banks, 1898)	Aranea	Aranea	Linyphiidae	U	A	1995	5
<i>Mermessus trilobatus</i> (Emerton 1882)	Aranea	Aranea	Linyphiidae	U	A	1980	6
<i>Ostearius melanopygius</i> (O. P.-Cambridge 1879)	Aranea	Aranea	Linyphiidae	U	A	1906	18
<i>Diblenma domisthorpei</i> O. P.-Cambridge 1908	Aranea	Aranea	Oonopidae	U	A	1914	1
<i>Ischnothyreus lymphaseus</i> Simon 1893	Aranea	Aranea	Oonopidae	U	A	2005	1
<i>Ischnothyreus velox</i> Jackson 1908	Aranea	Aranea	Oonopidae	U	A	2003	3
<i>Triaeris stenaspis</i> Simon 1891	Aranea	Aranea	Oonopidae	U	A	1896	5
<i>Artema atlanta</i> Walckenaer 1837	Aranea	Aranea	Pholcidae	U	A	2001	3
<i>Crossopriza lyoni</i> (Blackwall 1867)	Aranea	Aranea	Pholcidae	U	A	2004	1
<i>Micropholcus fauroti</i> (Simon 1887)	Aranea	Aranea	Pholcidae	U	A	2001	2
<i>Pholcus opiltonoides</i> (Schrank 1781)	Aranea	Aranea	Pholcidae	U	A	1859	24
<i>Pholcus phalangioides</i> (Fuesslin 1775)	Aranea	Aranea	Pholcidae	U	A	1857	33
<i>Smeringopus pallidus</i> (Blackwall 1858)	Aranea	Aranea	Pholcidae	U	A	2004	1
<i>Spermophora senoculata</i> (Dugès 1836)	Aranea	Aranea	Pholcidae	U	A	1976	15
<i>Zimiris doriai</i> Simon 1882	Aranea	Aranea	Prodidomidae	U	A	2005	1
<i>Hasarius adamsoni</i> (Audouin 1826)	Aranea	Aranea	Salticidae	U	A	1901	13
<i>Menemerus bivittatus</i> (Dufour 1831)	Aranea	Aranea	Salticidae	U	A	1831	6
<i>Panyssinus nicholsoni</i> (O. P.-Cambridge 1899)	Aranea	Aranea	Salticidae	U	A	2005	1
<i>Plexippus paykullii</i> (Audouin 1826)	Aranea	Aranea	Salticidae	U	A	1819	6
<i>Scytodes venusta</i> (Thorell 1890)	Aranea	Aranea	Scytodidae	U	A	2004	1
<i>Loxosceles laeta</i> (Nicolet 1849)	Aranea	Aranea	Sicariidae	U	A	1963	2
<i>Loxosceles rufescens</i> (Dufour 1820)	Aranea	Aranea	Sicariidae	U	A	1820	8
<i>Barylestis scutatus</i> (Pocock 1903)	Aranea	Aranea	Sparassidae	U	A	1961	1
<i>Barylestis variatus</i> (Pocock 1899)	Aranea	Aranea	Sparassidae	U	A	1961	2
<i>Heteropoda venatoria</i> (Linnaeus 1767)	Aranea	Aranea	Sparassidae	U	A	1960	8
<i>Olios sanctivincentii</i> (Simon 1897)	Aranea	Aranea	Sparassidae	U	A	1961	2
<i>Tychicus longipes</i> (Walckenaer 1837)	Aranea	Aranea	Sparassidae	U	A	1837	1
<i>Tetragatha shoshone</i> (Levi 1981)	Aranea	Aranea	Tetragnathidae	U	A	1992	7
<i>Achaearanea acorensis</i> (Berland 1932)	Aranea	Aranea	Theridiidae	U	A	2002	1
<i>Achaearanea tabulata</i> Levi 1980	Aranea	Aranea	Theridiidae	U	A	1991	7

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Achaearanea tepidariorum</i> (C.L. Koch 1841)	Aranea	Aranea	Theridiidae	U	A	1867	30
<i>Achaearanea veniculata</i> (Urquhart 1885)	Aranea	Aranea	Theridiidae	U	A	1885	2
<i>Chryso spiniventris</i> (O. P.-Cambridge 1869)	Aranea	Aranea	Theridiidae	U	A	1949	1
<i>Coleosoma floridanum</i> Banks 1900	Aranea	Aranea	Theridiidae	U	A	1981	6
<i>Latrodectus hasselti</i> Thorell 1870	Aranea	Aranea	Theridiidae	U	A	2001	2
<i>Nesticodes rufipes</i> (Lucas 1846)	Aranea	Aranea	Theridiidae	U	A	1996	6
<i>Steatoda grossa</i> (C.L. Koch 1838)	Aranea	Aranea	Theridiidae	U	A	1850	31
<i>Steatoda triangulosa</i> (Walckenaer 1802)	Aranea	Aranea	Theridiidae	U	A	1852	24
<i>Bassaniana versicolor</i> Keyserling 1880	Aranea	Aranea	Thomisidae	U	A	1932	1
<i>Arenophilus peregrinus</i> Jones, 1989	Chilopoda	Geophilomorpha	Geophilidae	U	C	1986	1
<i>Nothogeophilus turki</i> Lewis, Jones & Keay, 1988	Chilopoda	Geophilomorpha	Geophilidae	U	C	1985	1
<i>Mecistocephalus guildingii</i> Newport, 1843	Chilopoda	Geophilomorpha	Mecistocephalidae	U	A	1895	4
<i>Mecistocephalus maxillaris</i> (Gervais, 1837)	Chilopoda	Geophilomorpha	Mecistocephalidae	U	C	1837	3
<i>Tygarrip javanicus</i> Atems, 1929	Chilopoda	Geophilomorpha	Mecistocephalidae	U	A	1975	2
<i>Orphnaeus brevilabiatus</i> (Newport, 1845)	Chilopoda	Geophilomorpha	Oryidae	U	A	1800–1900	1
<i>Nyctunguis persimilis</i> Attems, 1932	Chilopoda	Geophilomorpha	Schendylidae	U	C	1996	1
<i>Ghilaroviella</i> cf. <i>valiachmedovi</i> Zaleskaja, 1975	Chilopoda	Lithobiomorpha	Henicopidae	U	A	2004	1
<i>Lamyctes</i> ( <i>Lamyctes</i> ) <i>coeculus</i> (Brölemann, 1889)	Chilopoda	Lithobiomorpha	Henicopidae	U	A	1889	7
<i>Lamyctes</i> ( <i>Lamyctes</i> ) <i>emarginatus</i> (Newport, 1844)	Chilopoda	Lithobiomorpha	Henicopidae	U	A	1868	26
<i>Lamyctes</i> ( <i>Metalamyctes</i> ) <i>albipes</i> (Pocock, 1895)	Chilopoda	Lithobiomorpha	Henicopidae	U	C	1988	1
<i>Rhodobius lagoi</i> Silvestri, 1933	Chilopoda	Lithobiomorpha	Henicopidae	U	C	1933	1
<i>Cryptops doriae</i> Pocock, 1891	Chilopoda	Scolopendromorpha	Cryptopidae	U	A	2007	1
<i>Scolopendra gigantea</i> Linnaeus, 1758	Chilopoda	Scolopendromorpha	Scolopendridae	U	A	2005	1
<i>Scolopendra morsitans</i> Linnaeus, 1758	Chilopoda	Scolopendromorpha	Scolopendridae	U	A	1902	1
<i>Scolopendra subspinipes</i> Leach, 1815	Chilopoda	Scolopendromorpha	Scolopendridae	U	A	1902	1
<i>Chondrodesmus</i> cf. <i>riparius</i> Carl, 1914	Diplopoda	Polydesmida	Chelodesmidae	U	A	2000	4
<i>Cylindrodesmus hirsutus</i> Pocock, 1889	Diplopoda	Polydesmida	Haplodesmidae	U	A	1950–1985	6
<i>Prosopodesmus panporus</i> Blower & Rundle, 1980	Diplopoda	Polydesmida	Haplodesmidae	U	A	1975	1
<i>Amphitomeus attensis</i> (Schubart, 1934)	Diplopoda	Polydesmida	Oniscodesmidae	U	A	1930	9
<i>Asiomorpha coarctata</i> (De Saussure, 1860)	Diplopoda	Polydesmida	Paradoxosomatidae	U	A	1906	1
<i>Chondromorpha kelaarti</i> (Humbert, 1865)	Diplopoda	Polydesmida	Paradoxosomatidae	U	A	1902	1

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Oxidus gracilis</i> (C.L. Koch, 1847)	Diplopoda	Polydesmida	Paradoxosomatidae	U	A	1879	36
<i>Cynedesmus formicola</i> (Cook, 1896)	Diplopoda	Polydesmida	Pyrgodesmidae	U	C	1896	3
<i>Poratia digitata</i> (Porat, 1889)	Diplopoda	Polydesmida	Pyrgodesmidae	U	A	1889	9
<i>Poratia oblitterata</i> (Kraus, 1960)	Diplopoda	Polydesmida	Pyrgodesmidae	U	A	1995–2000	3
<i>Napocodesmus endogeus</i> Ceuca, 1974	Diplopoda	Polydesmida	Trichopolydesmidae	U	C	1969	1
<i>Eurygyrus ochraceus</i> C.L. Koch, 1847	Diplopoda	Callipodida	Schizopetalidae	U	A	1925	2
<i>Polyxenus fasciculatus</i> Say, 1821	Diplopoda	Polyxenida	Polyxenidae	U	A	1961	2
<i>Rhinotus purpureus</i> (Pocock, 1894)	Diplopoda	Polyzonida	Siphonotidae	U	A	1986	1
<i>Laemosstenus complanatus</i> (Dejean, 1828)	Insecta	Coleoptera	Carabidae	U	A	Unknown	6
<i>Leistus nubivagus</i> Wollaston, 1864	Insecta	Coleoptera	Carabidae	U	A	Unknown	1
<i>Plochionus pallens</i> (Fabricius, 1775)	Insecta	Coleoptera	Carabidae	U	A	2000	6
<i>Pterostichus caspius</i> (Ménétriés, 1832)	Insecta	Coleoptera	Carabidae	U	A	1980	2
<i>Somotrichus unifasciatus</i> (Dejean, 1831)	Insecta	Coleoptera	Carabidae	U	A	Unknown	2
<i>Trechicus nigriceps</i> (Dejean, 1831)	Insecta	Coleoptera	Carabidae	U	A	1902	30
<i>Necrobia ruficollis</i> (Fabricius 1775)	Insecta	Coleoptera	Cleridae	U	C	1976	10
<i>Necrobia rufipes</i> (De Geer 1775)	Insecta	Coleoptera	Cleridae	U	A	1935	12
<i>Necrobia violacea</i> (Linnaeus 1758)	Insecta	Coleoptera	Cleridae	U	C	1976	8
<i>Opetiopalpus scutellaris</i> (Panzer 1797)	Insecta	Coleoptera	Cleridae	U	A	Unknown	5
<i>Paratillus carus</i> (Newman, 1840)	Insecta	Coleoptera	Cleridae	U	A	1933	2
<i>Tarsostenus univittatus</i> (Rossi, 1792)	Insecta	Coleoptera	Cleridae	U	C	1990	3
<i>Thaneroclerus buqueti</i> (Lefebvre, 1835)	Insecta	Coleoptera	Cleridae	U	A	1963	4
<i>Chilocorus kawanae</i> Silvestri, 1909	Insecta	Coleoptera	Coccinellidae	I	A	1989	2
<i>Chilocorus nigritus</i> (Fabricius, 1798)	Insecta	Coleoptera	Coccinellidae	I	A	1994	3
<i>Cryptolaemus montrouzieri</i> Mulsant, 1853	Insecta	Coleoptera	Coccinellidae	I	A	1908	15
<i>Harmonia axyridis</i> (Pallas, 1773)	Insecta	Coleoptera	Coccinellidae	I	A	1991	31
<i>Hippodamia convergens</i> Guerin-Meneville, 1842	Insecta	Coleoptera	Coccinellidae	I	A	1992	5
<i>Hyperaspis pantherina</i> Fürsch, 1975	Insecta	Coleoptera	Coccinellidae	I	A	2002	1
<i>Nephus reunioni</i> Fürsch, 1974	Insecta	Coleoptera	Coccinellidae	I	A	1983	6
<i>Rhyzobius forestieri</i> (Mulsant, 1853)	Insecta	Coleoptera	Coccinellidae	I	A	1982	4
<i>Rhyzobius lophanthae</i> (Blaisdell, 1892)	Insecta	Coleoptera	Coccinellidae	I	A	1908	16
<i>Rodolia cardinalis</i> (Mulsant, 1850)	Insecta	Coleoptera	Coccinellidae	I	A	1888	21

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Serangium parcesetosum</i> Sicaud, 1929	Insecta	Coleoptera	Coccinellidae	I	A	1986	2
<i>Aglyptinus agathidioides</i> Blair 1930	Insecta	Coleoptera	Cybocephalidae	U	A	1912	2
<i>Cybocephalus nipponicus</i> Endrody-Younga, 1971	Insecta	Coleoptera	Cybocephalidae	I	A	2002	1
<i>Thaumaglossa rufocapillata</i> Redtenbacher, 1867	Insecta	Coleoptera	Dermestidae	U	A	Unknown	2
<i>Megadytes costalis</i> Fabricius, 1775	Insecta	Coleoptera	Dytiscidae	U	A	Unknown	1
<i>Carcinops pumilio</i> (Erichson, 1834)	Insecta	Coleoptera	Histeridae	U	C	1995	7
<i>Carcinops troglodytes</i> (Paykull, 1811)	Insecta	Coleoptera	Histeridae	U	A	Unknown	1
<i>Chalcionellus decemstriatus</i> Reichardt, 1932	Insecta	Coleoptera	Histeridae	U	A	Unknown	1
<i>Diplostix mayeti</i> (Marseul, 1870)	Insecta	Coleoptera	Histeridae	U	A	Unknown	1
<i>Hister bipunctatus</i> Paykull, 1811	Insecta	Coleoptera	Histeridae	U	A	1974	3
<i>Hypocaccus brasiliensis</i> (Paykull, 1811)	Insecta	Coleoptera	Histeridae	U	C	Unknown	2
<i>Cercyon laminatus</i> Sharp, 1873	Insecta	Coleoptera	Hydrophilidae	U	A	1950	16
<i>Cercyon nigriceps</i> (Marsham, 1802)	Insecta	Coleoptera	Hydrophilidae	U	A	Unknown	2
<i>Cryptopleurum subtile</i> Sharp, 1884	Insecta	Coleoptera	Hydrophilidae	U	A	1950	15
<i>Dactylosternum abdominale</i> (Fabricius, 1792)	Insecta	Coleoptera	Hydrophilidae	U	A	Unknown	10
<i>Catogenus rufus</i> (Fabricius, 1798)	Insecta	Coleoptera	Passandridae	U	A	2007	1
<i>Ripidius pectinicornis</i> Thunberg, 1806	Insecta	Coleoptera	Ripiphoridae	I	A	Unknown	4
<i>Acrotoma pseudotenera</i> (Cameron, 1933)	Insecta	Coleoptera	Staphylinidae	U	A	1988	7
<i>Adota maritima</i> Mannerheim, 1843	Insecta	Coleoptera	Staphylinidae	U	A	Unknown	1
<i>Aleochara puberula</i> Klug, 1833	Insecta	Coleoptera	Staphylinidae	U	C	Unknown	2
<i>Anonylus nitidifrons</i> (Wollaston, 1871)	Insecta	Coleoptera	Staphylinidae	U	C	Unknown	2
<i>Atheta dilatipennis</i> (Motschulsky, 1858)	Insecta	Coleoptera	Staphylinidae	U	A	1995	4
<i>Atheta mucronata</i> (Kraatz, 1859)	Insecta	Coleoptera	Staphylinidae	U	A	2002	2
<i>Bisnius palmi</i> (Smetana, 1955)	Insecta	Coleoptera	Staphylinidae	U	A	Unknown	4
<i>Bisnius parvus</i> (Sharp, 1874)	Insecta	Coleoptera	Staphylinidae	U	A	1950	12
<i>Bohemellina flavipennis</i> (Cameron, 1921)	Insecta	Coleoptera	Staphylinidae	U	C	1941	9
<i>Carpelimus bilineatus</i> Stephens, 1834	Insecta	Coleoptera	Staphylinidae	U	C	2005	1
<i>Carpelimus corticinus</i> (Gravenhorst, 1806)	Insecta	Coleoptera	Staphylinidae	U	C	2005	1
<i>Carpelimus gracilis</i> (Mannerheim, 1830)	Insecta	Coleoptera	Staphylinidae	U	C	2005	1
<i>Carpelimus pusillus</i> (Gravenhorst, 1802)	Insecta	Coleoptera	Staphylinidae	U	C	2005	1
<i>Citea silphoides</i> (Linnaeus, 1767)	Insecta	Coleoptera	Staphylinidae	U	C	2005	2

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Leptoplectes remyi</i> (Jeannel, 1961)	Insecta	Coleoptera	Staphylinidae	U	A	Unknown	1
<i>Lithocharis nigriceps</i> (Kraatz, 1859)	Insecta	Coleoptera	Staphylinidae	U	A	1912	22
<i>Myrmecopora brevipes</i> Butler, 1909	Insecta	Coleoptera	Staphylinidae	U	C	Unknown	3
<i>Philonthus rectangulus</i> Sharp, 1874	Insecta	Coleoptera	Staphylinidae	U	A	1920	36
<i>Philonthus spinipes</i> Sharp, 1874	Insecta	Coleoptera	Staphylinidae	U	A	1980	10
<i>Teropalpus unicolor</i> (Sharp, 1900)	Insecta	Coleoptera	Staphylinidae	U	A	Unknown	1
<i>Alphitobius diaperinus</i> (Panzer, 1797)	Insecta	Coleoptera	Tenebrionidae	U	A	1921	17
<i>Tenebroides maroccanus</i> Reitter 1884	Insecta	Coleoptera	Trogossitidae	U	A	2005	1
<i>Euborellia stali</i> (Dohm, 1864)	Insecta	Dermaptera	Anisolabididae	U	A	2002	1
<i>Nala lividipes</i> (Dufour, 1828)	Insecta	Dermaptera	Labiduridae	U	A	1915	8
<i>Braula schmitzi</i> Orosi Pal, 1939	Insecta	Diptera	Braulidae	U	C	1998	7
<i>Chrysomya albiceps</i> (Wiedemann, 1819)	Insecta	Diptera	Calliphoridae	U	C	1927	12
<i>Dicrodiplosis pseudococci</i> (Felt, 1914)	Insecta	Diptera	Cecidomyiidae	U	A	1914	2
<i>Epidiplosis filifera</i> (Nijveldt, 1965)	Insecta	Diptera	Cecidomyiidae	U	A	1965	4
<i>Felitia acarisuga</i> (Vallot, 1827)	Insecta	Diptera	Cecidomyiidae	I	C	1827	21
<i>Lestodiplosis aonidiellae</i> Harris, 1968	Insecta	Diptera	Cecidomyiidae	U	A	1999	1
<i>Aedes albopictus</i> (Skuse, 1894)	Insecta	Diptera	Culicidae	U	A	1979	13
<i>Aedes japonicus</i> (Theobald, 1901)	Insecta	Diptera	Culicidae	U	A	2000	4
<i>Culex deserticola</i> Kirkpatrick, 1925	Insecta	Diptera	Culicidae	U	A	1993	1
<i>Culex tritaeniorhynchus</i> Giles, 1901	Insecta	Diptera	Culicidae	U	A	1987	2
<i>Culex vishnui</i> (Theobald, 1901)	Insecta	Diptera	Culicidae	U	A	1987	1
<i>Ochleroratus atropalpus</i> (Coquillett, 1902)	Insecta	Diptera	Culicidae	U	A	1996	1
<i>Ochleroratus subdiversus</i> (Martini, 1926)	Insecta	Diptera	Culicidae	U	A	1987	1
<i>Micropygus vagans</i> Parent, 1933	Insecta	Diptera	Dolichopodidae	U	A	1970	2
<i>Elephantinosoma chnumi</i> Becker, 1903	Insecta	Diptera	Ephydridae	U	A	2003	1
<i>Placopsidella phaenota</i> Mathis, 1986	Insecta	Diptera	Ephydridae	U	A	2003	1
<i>Psilopa fratella</i> (Becker, 1903)	Insecta	Diptera	Ephydridae	U	A	2002	2
<i>Crataerina melbae</i> (Rondani, 1879)	Insecta	Diptera	Hippoboscidae	U	A	1990	5
<i>Desmometopa microps</i> Lamb, 1914	Insecta	Diptera	Milichiidae	U	A	Unknown	3
<i>Hydrotaea aenescens</i> (Wiedemann, 1830)	Insecta	Diptera	Muscidae	I	A	1964	15
<i>Hermelia illucens</i> (Linnaeus, 1758)	Insecta	Diptera	Stratiomyidae	I	A	1936	8



Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Blepharipa schineri</i> (Mesnil, 1939)	Insecta	Diptera	Tachinidae	U	C	Unknown	5
<i>Catharosia pygmaea</i> (Fallén, 1815)	Insecta	Diptera	Tachinidae	U	C	Unknown	4
<i>Clytionya continua</i> (Panzer, 1789)	Insecta	Diptera	Tachinidae	U	C	Unknown	2
<i>Leucostoma edentata</i> Kluger, 1978	Insecta	Diptera	Tachinidae	U	A	1995	1
<i>Phasia barbifrons</i> (Girschner, 1887)	Insecta	Diptera	Tachinidae	U	C	2001	1
<i>Sturmia bella</i> (Meigen, 1824)	Insecta	Diptera	Tachinidae	U	C	Unknown	2
<i>Trichopoda pennipes</i> (Fabricius, 1781)	Insecta	Diptera	Tachinidae	U	A	1989	5
<i>Zeuxia zejana</i> Kolomiets, 1971	Insecta	Diptera	Tachinidae	U	A	1995	1
<i>Amphiareus constrictus</i> (Stål, 1860)	Insecta	Hemiptera	Anthocoridae	U	C	2007	1
<i>Amphiareus obscuriceps</i> (Poppius, 1909)	Insecta	Hemiptera	Anthocoridae	U	A	1987	12
<i>Buchananiella continua</i> (White, 1880)	Insecta	Hemiptera	Anthocoridae	U	C	1880	10
<i>Lycotocoris campestris</i> (Fabricius, 1794)	Insecta	Hemiptera	Anthocoridae	U	C	Unknown	41
<i>Trichocortixa verticalis</i> (Fieber, 1851)	Insecta	Hemiptera	Corixidae	U	A	1997	2
<i>Fulvius borgei</i> Chérot, J. Ribes & Gorczyca, 2006	Insecta	Hemiptera	Miridae	U	A	2003	1
<i>Nesidiocoris tenuis</i> (Reuter, 1895)	Insecta	Hemiptera	Miridae	U	C	Unknown	9
<i>Tupiocoris rhododendri</i> (Dolling, 1972)	Insecta	Hemiptera	Miridae	U	A	1971	4
<i>Perillus bioculatus</i> (Fabricius, 1775)	Insecta	Hemiptera	Pentatomidae	I	A	1992	2
<i>Empicoris rubromaculatus</i> (Blackburn, 1889)	Insecta	Hemiptera	Reduviidae	U	C	Unknown	11
<i>Ploiaria chilensis</i> (Philippi, 1862)	Insecta	Hemiptera	Reduviidae	U	C	Unknown	6
<i>Pentacora sphacelata</i> (Uhler, 1877)	Insecta	Hemiptera	Saldidae	U	A	1953	3
<i>Ablerus chionaspidis</i> (Howard, 1914)	Insecta	Hymenoptera	Aphelinidae	I	A	1972	5
<i>Ablerus clistocampae</i> (Ashmead, 1894)	Insecta	Hymenoptera	Aphelinidae	I	A	1953	2
<i>Ablerus perspicuosus</i> Girault, 1916	Insecta	Hymenoptera	Aphelinidae	I	A	1972	5
<i>Aphelinus mali</i> (Haldeman, 1851)	Insecta	Hymenoptera	Aphelinidae	I	A	1921	20
<i>Aphelinus semiflavus</i> Howard, 1908	Insecta	Hymenoptera	Aphelinidae	I	A	1953	4
<i>Aphytis abnormis</i> (Howard, 1881)	Insecta	Hymenoptera	Aphelinidae	I	A	1953	4
<i>Aphytis acrenulatus</i> DeBach & Rosen, 1976	Insecta	Hymenoptera	Aphelinidae	I	A	1994	1
<i>Aphytis chilensis</i> Howard, 1900	Insecta	Hymenoptera	Aphelinidae	I	A	1910	6
<i>Aphytis coheni</i> DeBach, 1960	Insecta	Hymenoptera	Aphelinidae	I	A	1959	3
<i>Aphytis diaspidis</i> (Howard, 1881)	Insecta	Hymenoptera	Aphelinidae	I	A	1952	9
<i>Aphytis holoxanthus</i> DeBach, 1960	Insecta	Hymenoptera	Aphelinidae	I	A	1959	8

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Aphytis lepidosaphes</i> Compere, 1955	Insecta	Hymenoptera	Aphelinidae	I	A	1961	8
<i>Aphytis lingnanensis</i> Compere, 1955	Insecta	Hymenoptera	Aphelinidae	I	A	1966	6
<i>Aphytis melinus</i> DeBach, 1959	Insecta	Hymenoptera	Aphelinidae	I	A	1966	13
<i>Aphytis mytilaspidis</i> (Le Baron, 1870)	Insecta	Hymenoptera	Aphelinidae	I	A	1837	23
<i>Aphytis yanomensis</i> DeBach & Rosen, 1982	Insecta	Hymenoptera	Aphelinidae	I	A	1986	2
<i>Cales noacki</i> Howard, 1907	Insecta	Hymenoptera	Aphelinidae	I	A	1970	10
<i>Centrodora speciosissima</i> (Girault, 1911)	Insecta	Hymenoptera	Aphelinidae	U	A	1943	5
<i>Coccobius fulvus</i> (Compere & Annecke, 1961)	Insecta	Hymenoptera	Aphelinidae	I	A	1986	1
<i>Coccophagoides murfeldtae</i> (Howard, 1894)	Insecta	Hymenoptera	Aphelinidae	I	A	1962	1
<i>Coccophagoides utilis</i> Doutt, 1966	Insecta	Hymenoptera	Aphelinidae	I	A	1975	1
<i>Coccophagus bivittatus</i> Compere, 1931	Insecta	Hymenoptera	Aphelinidae	I	A	1960	2
<i>Coccophagus capensis</i> Compere, 1931	Insecta	Hymenoptera	Aphelinidae	I	A	1962	2
<i>Coccophagus ceroplastae</i> (Howard, 1895)	Insecta	Hymenoptera	Aphelinidae	I	A	1975	2
<i>Coccophagus cowperi</i> Girault, 1917	Insecta	Hymenoptera	Aphelinidae	I	A	1963	3
<i>Coccophagus flavoscutellum</i> Ashmead, 1881	Insecta	Hymenoptera	Aphelinidae	I	A	1962	1
<i>Coccophagus gossypariae</i> Gahan, 1927	Insecta	Hymenoptera	Aphelinidae	I	A	1990	2
<i>Coccophagus gumeyi</i> Compere, 1929	Insecta	Hymenoptera	Aphelinidae	I	A	1973	1
<i>Coccophagus matsuyamensis</i> Ishihara, 1977	Insecta	Hymenoptera	Aphelinidae	I	A	1979	2
<i>Coccophagus saissetiae</i> (Annecke & Mynhardt, 1979)	Insecta	Hymenoptera	Aphelinidae	I	A	1978	2
<i>Coccophagus scutellaris</i> (Dalman, 1825)	Insecta	Hymenoptera	Aphelinidae	I	C	1826	9
<i>Coccophagus silvestrii</i> Compere, 1931	Insecta	Hymenoptera	Aphelinidae	U	A	1972	2
<i>Coccophagus varius</i> (Silvestri, 1915)	Insecta	Hymenoptera	Aphelinidae	I	A	1983	2
<i>Encarsia acandaleyrodii</i> Hayat, 1976	Insecta	Hymenoptera	Aphelinidae	I	A	1999	1
<i>Encarsia aurantii</i> (Howard, 1894)	Insecta	Hymenoptera	Aphelinidae	I	A	1941	6
<i>Encarsia azimi</i> Hayat, 1986	Insecta	Hymenoptera	Aphelinidae	I	A	2001	4
<i>Encarsia berlessei</i> (Howard, 1906)	Insecta	Hymenoptera	Aphelinidae	I	A	1906	17
<i>Encarsia citrina</i> (Craw, 1891)	Insecta	Hymenoptera	Aphelinidae	I	C	1915	5
<i>Encarsia diaspidicola</i> (Silvestri, 1909)	Insecta	Hymenoptera	Aphelinidae	I	A	1962	1
<i>Encarsia fasciata</i> (Malenotti, 1917)	Insecta	Hymenoptera	Aphelinidae	I	C	1917	6
<i>Encarsia formosa</i> (Gahan, 1924)	Insecta	Hymenoptera	Aphelinidae	I	A	1964	30
<i>Encarsia guadeloupae</i> Viggiani, 1987	Insecta	Hymenoptera	Aphelinidae	I	A	2000	1

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Encarsia herudoni</i> (Girault, 1935)	Insecta	Hymenoptera	Aphelinidae	I	A	1987	5
<i>Encarsia hispida</i> De Santis, 1948	Insecta	Hymenoptera	Aphelinidae	I	A	1992	5
<i>Encarsia inquirenda</i> (Silvestri, 1930)	Insecta	Hymenoptera	Aphelinidae	I	A	1979	3
<i>Encarsia lahorensis</i> (Howard, 1911)	Insecta	Hymenoptera	Aphelinidae	I	A	1973	8
<i>Encarsia lounsburyi</i> (Berlese & Paoli, 1916)	Insecta	Hymenoptera	Aphelinidae	I	A	1922	13
<i>Encarsia meritotia</i> Gahan, 1927	Insecta	Hymenoptera	Aphelinidae	I	A	1990	2
<i>Encarsia pergandiella</i> Howard, 1907	Insecta	Hymenoptera	Aphelinidae	I	A	1978	4
<i>Encarsia perniciosi</i> (Tower, 1913)	Insecta	Hymenoptera	Aphelinidae	I	A	1946	17
<i>Encarsia porteri</i> (Mercet, 1928)	Insecta	Hymenoptera	Aphelinidae	I	A	1993	1
<i>Encarsia protransvena</i> Viggiani, 1985	Insecta	Hymenoptera	Aphelinidae	I	A	1998	2
<i>Encarsia sophia</i> (Girault & Dodd, 1915)	Insecta	Hymenoptera	Aphelinidae	I	A	1992	5
<i>Eretmocerus californicus</i> Howard, 1895	Insecta	Hymenoptera	Aphelinidae	I	A	1987	6
<i>Eretmocerus corni</i> Haldeman, 1850	Insecta	Hymenoptera	Aphelinidae	U	A	1963	2
<i>Eretmocerus debachi</i> Rose & Rosen, 1992	Insecta	Hymenoptera	Aphelinidae	I	A	1991	4
<i>Eretmocerus eremicus</i> Rose & Zolnerowich, 1997	Insecta	Hymenoptera	Aphelinidae	I	A	1994	18
<i>Eretmocerus haldemani</i> Howard, 1908	Insecta	Hymenoptera	Aphelinidae	I	A	1968	2
<i>Eretmocerus paulistus</i> Hempel, 1904	Insecta	Hymenoptera	Aphelinidae	I	A	1970	2
<i>Marietta carnesi</i> (Howard, 1910)	Insecta	Hymenoptera	Aphelinidae	U	A	1987	2
<i>Pteroptrix chinensis</i> (Howard, 1907)	Insecta	Hymenoptera	Aphelinidae	I	A	1974	2
<i>Pteroptrix orientalis</i> (Silvestri, 1909)	Insecta	Hymenoptera	Aphelinidae	I	A	1909	1
<i>Pteroptrix smithi</i> (Compere 1953)	Insecta	Hymenoptera	Aphelinidae	I	A	1968	2
<i>Cephalonomia waterstoni</i> Gahan, 1931	Insecta	Hymenoptera	Bethylidae	U	C	Unknown	1
<i>Holepyris sylvanidis</i> (Brèthes, 1913)	Insecta	Hymenoptera	Bethylidae	U	C	Unknown	1
<i>Laelius utilis</i> Cockerell, 1920	Insecta	Hymenoptera	Bethylidae	U	A	Unknown	1
<i>Plastanoxus laevis</i> (Ashmead, 1893)	Insecta	Hymenoptera	Bethylidae	U	A	Unknown	4
<i>Aphidius colemani</i> Viereck, 1912	Insecta	Hymenoptera	Braconidae	I	A	1965	26
<i>Aphidius smithi</i> Sharma & Subba Rao, 1959	Insecta	Hymenoptera	Braconidae	U	A	1960	26
<i>Cotesia hyphantriae</i> (Riley, 1887)	Insecta	Hymenoptera	Braconidae	U	A	1953	1
<i>Cotesia marginiventris</i> (Cresson, 1865)	Insecta	Hymenoptera	Braconidae	I	A	1993	5
<i>Diachasma morpho fullawayi</i> (Silvestri, 1912)	Insecta	Hymenoptera	Braconidae	I	A	Unknown	1
<i>Diachasma morpho tryoni</i> (Cameron, 1911)	Insecta	Hymenoptera	Braconidae	I	A	1932	3

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Heterospilus cephi</i> Rohwer, 1925	Insecta	Hymenoptera	Braconidae	I	A	Unknown	1
<i>Hymenochaonia delicata</i> (Cresson 1872)	Insecta	Hymenoptera	Braconidae	U	A	1933	2
<i>Lysiphlebus testaceipes</i> (Cresson, 1880)	Insecta	Hymenoptera	Braconidae	I	C	1965	9
<i>Macrocentrus ancylivorus</i> (Rohwer, 1923)	Insecta	Hymenoptera	Braconidae	I	A	1930	2
<i>Microgaster pantographae</i> Muesebeck, 1922	Insecta	Hymenoptera	Braconidae	U	A	Unknown	1
<i>Opius dimidiatus</i> Ashmead, 1889	Insecta	Hymenoptera	Braconidae	I	A	Unknown	1
<i>Pauesia cedrobii</i> Stary & Leclant 1977	Insecta	Hymenoptera	Braconidae	I	A	1987	2
<i>Pauesia unilachni</i> (Gahan, 1927)	Insecta	Hymenoptera	Braconidae	U	A	1930	2
<i>Perilitus vitatae</i> (Muesebeck, 1936)	Insecta	Hymenoptera	Braconidae	U	A	Unknown	1
<i>Psytaltia concolor</i> (Szépligeti, 1910)	Insecta	Hymenoptera	Braconidae	I	A	1914	3
<i>Aphanogmus bicolor</i> Ashmead, 1893	Insecta	Hymenoptera	Ceraphronidae	U	A	Unknown	8
<i>Dirhinus giffardii</i> Silvestri, 1913	Insecta	Hymenoptera	Chalcididae	I	A	1912	3
<i>Neodryinus typhlocybae</i> (Ashmead, 1893)	Insecta	Hymenoptera	Dryinidae	I	A	1994	4
<i>Adelencyrtus aulacaspidis</i> (Brèthes, 1914)	Insecta	Hymenoptera	Encyrtidae	U	A	1930	13
<i>Aenasius flandersi</i> Kerrich, 1967	Insecta	Hymenoptera	Encyrtidae	I	A	1999	1
<i>Ageniaspis citricola</i> Logvinovskaya, 1983	Insecta	Hymenoptera	Encyrtidae	I	A	1966	8
<i>Aloencyrtus saissetiae</i> (Compere, 1939)	Insecta	Hymenoptera	Encyrtidae	I	A	1987	1
<i>Anagyrrus agraensis</i> Saraswat, 1975	Insecta	Hymenoptera	Encyrtidae	I	A	1987	1
<i>Anagyrrus fusciventris</i> (Girault, 1915)	Insecta	Hymenoptera	Encyrtidae	I	A	1983	8
<i>Anagyrrus sawadai</i> Ishii, 1928	Insecta	Hymenoptera	Encyrtidae	U	A	1996	1
<i>Anagyrrus subflaviceps</i> (Girault, 1915)	Insecta	Hymenoptera	Encyrtidae	I	A	1994	3
<i>Anicetus annulatus</i> Timberlake, 1919	Insecta	Hymenoptera	Encyrtidae	U	A	1977	2
<i>Anicetus ceroplastis</i> Ishii, 1928	Insecta	Hymenoptera	Encyrtidae	I	A	1989	1
<i>Anthemus hilli</i> Dodd, 1917	Insecta	Hymenoptera	Encyrtidae	I	A	1954	1
<i>Avetianella longoi</i> Siscaro, 1992	Insecta	Hymenoptera	Encyrtidae	I	A	1990	3
<i>Bothriophryne fuscicornis</i> Compere, 1939	Insecta	Hymenoptera	Encyrtidae	U	A	1972	3
<i>Clausenia purpurea</i> Ishii, 1923	Insecta	Hymenoptera	Encyrtidae	U	A	1974	2
<i>Coccidencyrus malloi</i> Blanchard, 1964	Insecta	Hymenoptera	Encyrtidae	I	A	1999	2
<i>Coccidoxenoides perminutus</i> Girault, 1915	Insecta	Hymenoptera	Encyrtidae	I	A	1956	4
<i>Comperia merceti</i> (Compere, 1938)	Insecta	Hymenoptera	Encyrtidae	U	A	1988	2
<i>Comperiella bifasciata</i> Howard, 1906	Insecta	Hymenoptera	Encyrtidae	I	A	1990	14

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Comperiella lemniscata</i> Compere & Annecke, 1961	Insecta	Hymenoptera	Encyrtidae	I	A	1989	3
<i>Copidosoma floridanum</i> (Ashmead, 1900)	Insecta	Hymenoptera	Encyrtidae	I	A	1920	17
<i>Copidosoma koehleri</i> Blanchard, 1940	Insecta	Hymenoptera	Encyrtidae	I	A	1994	4
<i>Diversinervus cervantesi</i> (Girault, 1933)	Insecta	Hymenoptera	Encyrtidae	U	A	1982	1
<i>Diversinervus elegans</i> Silvestri, 1915	Insecta	Hymenoptera	Encyrtidae	I	A	1977	5
<i>Encyrtus fuscus</i> (Howard, 1881)	Insecta	Hymenoptera	Encyrtidae	U	A	1901	1
<i>Encyrtus infelix</i> (Embleton, 1902)	Insecta	Hymenoptera	Encyrtidae	I	A	1901	8
<i>Leptomastix dactylopii</i> Howard, 1885	Insecta	Hymenoptera	Encyrtidae	I	A	1959	24
<i>Metaphycus angustifrons</i> Compere, 1957	Insecta	Hymenoptera	Encyrtidae	I	A	1988	1
<i>Metaphycus annekei</i> Guerrieri & Noyes, 2000	Insecta	Hymenoptera	Encyrtidae	I	A	1973	7
<i>Metaphycus flavus</i> (Howard, 1881)	Insecta	Hymenoptera	Encyrtidae	U	A	1915	9
<i>Metaphycus galbus</i> Annecke, 1964	Insecta	Hymenoptera	Encyrtidae	I	A	1993	1
<i>Metaphycus helvolus</i> (Compere, 1926)	Insecta	Hymenoptera	Encyrtidae	I	A	1978	14
<i>Metaphycus invisus</i> Compere, 1940	Insecta	Hymenoptera	Encyrtidae	I	A	1987	3
<i>Metaphycus lounsburyi</i> (Howard, 1898)	Insecta	Hymenoptera	Encyrtidae	I	A	1973	9
<i>Metaphycus luteolus</i> (Timberlake, 1916)	Insecta	Hymenoptera	Encyrtidae	I	A	1989	3
<i>Metaphycus maculipennis</i> (Timberlake, 1916)	Insecta	Hymenoptera	Encyrtidae	I	A	1988	6
<i>Metaphycus orientalis</i> (Compere, 1924)	Insecta	Hymenoptera	Encyrtidae	I	A	1989	1
<i>Metaphycus stanleyi</i> Compere, 1940	Insecta	Hymenoptera	Encyrtidae	I	A	1960	5
<i>Metaphycus swirskii</i> Annecke & Mynhardt, 1979	Insecta	Hymenoptera	Encyrtidae	I	A	1976	7
<i>Microterys clauseni</i> Compere, 1926	Insecta	Hymenoptera	Encyrtidae	I	A	1987	1
<i>Microterys nitneri</i> (Motschulsky, 1859)	Insecta	Hymenoptera	Encyrtidae	I	A	1989	2
<i>Microterys speciosus</i> Ishii, 1923	Insecta	Hymenoptera	Encyrtidae	I	A	1987	1
<i>Neodusmetia sangwani</i> (Subba Rao, 1957)	Insecta	Hymenoptera	Encyrtidae	I	A	1974	1
<i>Ooencyrtus kawanae</i> (Howard, 1910)	Insecta	Hymenoptera	Encyrtidae	I	A	1932	17
<i>Plagiomerus diaspidis</i> Crawford, 1910	Insecta	Hymenoptera	Encyrtidae	U	A	1994	4
<i>Prochilonerus pulchellus</i> Silvestri, 1915	Insecta	Hymenoptera	Encyrtidae	I	A	1972	2
<i>Pseudaphycus angelicus</i> (Howard, 1898)	Insecta	Hymenoptera	Encyrtidae	I	A	1964	2
<i>Pseudaphycus malinus</i> Gahan, 1946	Insecta	Hymenoptera	Encyrtidae	I	A	1998	2
<i>Pseudectroma signatum</i> (Prinsloo, 1982)	Insecta	Hymenoptera	Encyrtidae	I	A	1986	1
<i>Psyllaephagus pilosus</i> Noyes, 1988	Insecta	Hymenoptera	Encyrtidae	I	A	2006	5

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Rhopus nigroclavatus</i> (Ashmead, 1902)	Insecta	Hymenoptera	Encyrtidae	U	A	1978	1
<i>Tachinaephagus zealandicus</i> Ashmead, 1904	Insecta	Hymenoptera	Encyrtidae	I	A	2002	4
<i>Tetracnemoidea brevicornis</i> (Girault, 1915)	Insecta	Hymenoptera	Encyrtidae	U	A	1987	2
<i>Tetracnemoidea peregrina</i> (Compere, 1939)	Insecta	Hymenoptera	Encyrtidae	U	A	1994	5
<i>Tineophoctonus armatus</i> (Ashmead, 1888)	Insecta	Hymenoptera	Encyrtidae	U	A	1963	2
<i>Zarhopalus sheldoni</i> Ashmead, 1900	Insecta	Hymenoptera	Encyrtidae	I	A	1945	1
<i>Aceratoneuromyia indica</i> (Silvestri, 1910)	Insecta	Hymenoptera	Eulophidae	I	A	1974	2
<i>Aprostocetus ceroplastae</i> (Girault, 1916)	Insecta	Hymenoptera	Eulophidae	U	A	1962	4
<i>Aprostocetus diplosidis</i> Crawford, 1907	Insecta	Hymenoptera	Eulophidae	U	A	1964	1
<i>Aprostocetus microcosmus</i> (Girault, 1917)	Insecta	Hymenoptera	Eulophidae	U	A	1977	1
<i>Aprostocetus sicarius</i> (Silvestri, 1915)	Insecta	Hymenoptera	Eulophidae	I	A	1962	2
<i>Astichus trifasciatiipennis</i> (Girault, 1913)	Insecta	Hymenoptera	Eulophidae	U	A	1989	1
<i>Ceranus americanus</i> (Girault, 1917)	Insecta	Hymenoptera	Eulophidae	I	A	1994	1
<i>Ceranus russelli</i> (Crawford, 1911)	Insecta	Hymenoptera	Eulophidae	I	A	1954	1
<i>Chaenotetrastichus semiflavus</i> (Girault, 1917)	Insecta	Hymenoptera	Eulophidae	U	A	1995	1
<i>Chouioia cunea</i> Yang, 1989	Insecta	Hymenoptera	Eulophidae	U	A	1990	1
<i>Chrysocharis ainsliei</i> Crawford, 1912	Insecta	Hymenoptera	Eulophidae	U	A	1984	2
<i>Chrysocharis oscinidis</i> Ashmead, 1888	Insecta	Hymenoptera	Eulophidae	I	A	1984	2
<i>Cirrospilus ingenuus</i> Gahan, 1932	Insecta	Hymenoptera	Eulophidae	I	A	1994	5
<i>Citrostichus phylloclonistoides</i> (Narayanan, 1960)	Insecta	Hymenoptera	Eulophidae	I	A	1995	7
<i>Closterocerus cinctipennis</i> Ashmead, 1888	Insecta	Hymenoptera	Eulophidae	I	A	1971	1
<i>Diglyphus begini</i> (Ashmead, 1904)	Insecta	Hymenoptera	Eulophidae	U	A	1988	2
<i>Edovum puttleri</i> Grissell, 1981	Insecta	Hymenoptera	Eulophidae	U	A	1985	2
<i>Elachertus cidariae</i> (Ashmead, 1898)	Insecta	Hymenoptera	Eulophidae	U	A	1962	1
<i>Euderus cavasolae</i> (Silvestri, 1914)	Insecta	Hymenoptera	Eulophidae	I	A	1954	1
<i>Galeopsomyia fausta</i> LaSalle, 1997	Insecta	Hymenoptera	Eulophidae	I	A	1999	1
<i>Goetheana shakepearei</i> Girault, 1920	Insecta	Hymenoptera	Eulophidae	I	A	1992	1
<i>Hyssopus thymus</i> Girault, 1916	Insecta	Hymenoptera	Eulophidae	I	A	1970	1
<i>Pediobius phyllotretae</i> (Riley, 1884)	Insecta	Hymenoptera	Eulophidae	U	A	1944	3
<i>Semitelacher petiolata</i> (Girault, 1915)	Insecta	Hymenoptera	Eulophidae	I	A	1995	8
<i>Tetrastichomyia clisiocampae</i> (Ashmead, 1894)	Insecta	Hymenoptera	Eulophidae	U	A	1966	1

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Thripobius javae</i> (Girault, 1917)	Insecta	Hymenoptera	Eulophidae	I	A	1995	8
<i>Anastatus japonicus</i> Ashmead, 1904	Insecta	Hymenoptera	Eupelmidae	I	A	1920	4
<i>Anastatus tenuipes</i> Bolivar & Pielain, 1925	Insecta	Hymenoptera	Eupelmidae	U	A	1999	1
<i>Eupelmus afer</i> Silvestri, 1914	Insecta	Hymenoptera	Eupelmidae	I	A	1974	1
<i>Eupelmus australiensis</i> (Girault, 1913)	Insecta	Hymenoptera	Eupelmidae	U	A	1964	4
<i>Eupelmus longicarpus</i> Girault, 1915	Insecta	Hymenoptera	Eupelmidae	U	A	1987	1
<i>Aganaspis daci</i> (Weld, 1951)	Insecta	Hymenoptera	Figitidae	U	A	1970	2
<i>Brachymyrmex heeri</i> Forel, 1874	Insecta	Hymenoptera	Formicidae	U	A	1874	4
<i>Cardiocondyla emeryi</i> Forel, 1881	Insecta	Hymenoptera	Formicidae	U	A	1894	2
<i>Cardiocondyla mauritanica</i> Forel, 1890	Insecta	Hymenoptera	Formicidae	U	A	1981	7
<i>Cardiocondyla obscurior</i> (Wheeler, 1929)	Insecta	Hymenoptera	Formicidae	U	A	1930	2
<i>Cardiocondyla wroughtoni</i> (Forel, 1890)	Insecta	Hymenoptera	Formicidae	U	A	1982	1
<i>Crematogaster brevispinosa</i> Mayr, 1870	Insecta	Hymenoptera	Formicidae	U	A	1935	1
<i>Hypoponera ergatandria</i> (Forel, 1893)	Insecta	Hymenoptera	Formicidae	U	A	1952	2
<i>Hypoponera punctatissima</i> (Roger, 1859)	Insecta	Hymenoptera	Formicidae	U	A	1847	31
<i>Lasius neglectus</i> Van Loon, Boomsma & Andrasfalvy, 1990	Insecta	Hymenoptera	Formicidae	U	A	1973	10
<i>Lasius turcicus</i> Sanctichi, 1921	Insecta	Hymenoptera	Formicidae	U	A	1970	15
<i>Linepithema humile</i> (Mayer, 1868)	Insecta	Hymenoptera	Formicidae	U	A	1847	17
<i>Linepithema leucomelas</i> Emery, 1894	Insecta	Hymenoptera	Formicidae	U	A	1955	1
<i>Monomorium andrei</i> Saunders, 1890	Insecta	Hymenoptera	Formicidae	U	A	1924	2
<i>Monomorium destructor</i> (Jerdon, 1851)	Insecta	Hymenoptera	Formicidae	U	A	1892	3
<i>Monomorium floricola</i> (Jerdon, 1851)	Insecta	Hymenoptera	Formicidae	U	A	1982	1
<i>Monomorium pharaonis</i> (Linnaeus, 1758)	Insecta	Hymenoptera	Formicidae	U	A	1892	23
<i>Monomorium salomonis</i> (Linnaeus, 1758)	Insecta	Hymenoptera	Formicidae	U	A	1881	8
<i>Pachycondyla darwini</i> Forel, 1893	Insecta	Hymenoptera	Formicidae	U	A	Unknown	1
<i>Paratrechina bourbonica</i> (Forel, 1886)	Insecta	Hymenoptera	Formicidae	U	A	Unknown	1
<i>Paratrechina flavipes</i> (Smith, 1874)	Insecta	Hymenoptera	Formicidae	U	A	1952	2
<i>Paratrechina jaegerskjoeldi</i> (Mayr, 1904)	Insecta	Hymenoptera	Formicidae	U	A	1989	4
<i>Paratrechina longicomis</i> (Latreille, 1802)	Insecta	Hymenoptera	Formicidae	U	A	1847	13
<i>Paratrechina vividula</i> (Nylander, 1846)	Insecta	Hymenoptera	Formicidae	U	C	1881	11
<i>Pheldole bilimeki</i> Mayr 1870	Insecta	Hymenoptera	Formicidae	U	A	1952	5

Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Pheidole guineensis</i> (Fabricius, 1793)	Insecta	Hymenoptera	Formicidae	U	A	1883	2
<i>Pheidole megacephala</i> (Fabricius, 1793)	Insecta	Hymenoptera	Formicidae	U	A	1847	14
<i>Pheidole noda</i> (Smith, 1874)	Insecta	Hymenoptera	Formicidae	U	A	2003	1
<i>Pheidole teneriffana</i> Forel, 1893	Insecta	Hymenoptera	Formicidae	U	A	1893	8
<i>Plagiotelepis alluaudi</i> (Emery, 1894)	Insecta	Hymenoptera	Formicidae	U	A	1915	4
<i>Plagiotelepis exigua</i> Forel, 1894	Insecta	Hymenoptera	Formicidae	U	A	1952	1
<i>Plagiotelepis obscuriscapa</i> Santschi, 1923	Insecta	Hymenoptera	Formicidae	U	A	Unknown	2
<i>Pyramica membranifera</i> (Emery, 1869)	Insecta	Hymenoptera	Formicidae	U	A	1889	1
<i>Strumigenys lewisi</i> Cameron, 1886	Insecta	Hymenoptera	Formicidae	U	A	1996	1
<i>Strumigenys rogeri</i> Emery, 1890	Insecta	Hymenoptera	Formicidae	U	A	Unknown	2
<i>Strumigenys sivestrii</i> Emery, 1906	Insecta	Hymenoptera	Formicidae	U	A	1889	1
<i>Tapinoma melanocephalum</i> (Fabricius, 1793)	Insecta	Hymenoptera	Formicidae	U	A	1984	6
<i>Technomyrmex detorquens</i> (Walker, 1859)	Insecta	Hymenoptera	Formicidae	U	A	1937	3
<i>Tennothorax longispinosus</i> Roger, 1863	Insecta	Hymenoptera	Formicidae	U	A	Unknown	1
<i>Tetranorium bicarinatum</i> (Nylander, 1846)	Insecta	Hymenoptera	Formicidae	U	A	2003	4
<i>Tetranorium insolens</i> (Smith, 1861)	Insecta	Hymenoptera	Formicidae	U	A	Unknown	4
<i>Tetranorium lanuginosum</i> Mayr, 1870	Insecta	Hymenoptera	Formicidae	U	A	Unknown	2
<i>Tetranorium similimum</i> (Smith, 1851)	Insecta	Hymenoptera	Formicidae	U	A	Unknown	9
<i>Auberteterus alternicoloratus</i> (Cushman, 1929)	Insecta	Hymenoptera	Ichneumonidae	U	A	Unknown	2
<i>Cryptus luctuosus</i> Cresson, 1864	Insecta	Hymenoptera	Ichneumonidae	U	A	Unknown	3
<i>Cteniscus dorsalis</i> Cresson, 1864	Insecta	Hymenoptera	Ichneumonidae	U	A	Unknown	2
<i>Delomerista novita</i> (Cresson, 1870)	Insecta	Hymenoptera	Ichneumonidae	U	A	Unknown	8
<i>Ephialtes spatulatus</i> (Townes, 1960)	Insecta	Hymenoptera	Ichneumonidae	U	A	Unknown	4
<i>Itopectis conquistator</i> (Say, 1835)	Insecta	Hymenoptera	Ichneumonidae	I	A	Unknown	1
<i>Anaphes nitens</i> (Girault, 1928)	Insecta	Hymenoptera	Mymaridae	I	A	1977	4
<i>Polynema stritaticorne</i> Girault, 1911	Insecta	Hymenoptera	Mymaridae	I	A	1966	1
<i>Steffanolampus salicetum</i> (Steffan, 1952)	Insecta	Hymenoptera	Perilampidae	U	A	1876	1
<i>Amitus fuscipennis</i> MacGown & Nebeker, 1978	Insecta	Hymenoptera	Platygastridae	I	A	1980	1
<i>Amitus spiniferus</i> (Brèthes, 1914)	Insecta	Hymenoptera	Platygastridae	I	A	1971	4
<i>Anisopteromalus calandrae</i> (Howard, 1881)	Insecta	Hymenoptera	Pteromalidae	I	C	1911	17
<i>Halticoptera daci</i> Silvestri, 1914	Insecta	Hymenoptera	Pteromalidae	I	A	1957	1



Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Mesopolobus modestus</i> (Silvestri, 1914)	Insecta	Hymenoptera	Pteromalidae	I	A	1974	1
<i>Mesopolobus pinus</i> Hussey, 1960	Insecta	Hymenoptera	Pteromalidae	U	A	1953	7
<i>Mesopolobus spermatrophus</i> Husey, 1960	Insecta	Hymenoptera	Pteromalidae	U	A	1952	10
<i>Monoksia dorsiplana</i> Bouček, 1991	Insecta	Hymenoptera	Pteromalidae	U	A	1980	1
<i>Moranila californica</i> (Howard, 1881)	Insecta	Hymenoptera	Pteromalidae	U	A	1973	8
<i>Muscidifurax raptor</i> Girault & Sanders, 1910	Insecta	Hymenoptera	Pteromalidae	I	A	1954	6
<i>Paracarotomus cephalotes</i> Ashmead, 1894	Insecta	Hymenoptera	Pteromalidae	U	A	1976	4
<i>Spalangia cameroni</i> , Perkins 1910	Insecta	Hymenoptera	Pteromalidae	I	A	1969	9
<i>Theocolax elegans</i> (Westwood, 1874)	Insecta	Hymenoptera	Pteromalidae	I	C	1957	4
<i>Urolepis rufipes</i> (Ashmead, 1896)	Insecta	Hymenoptera	Pteromalidae	I	A	1989	3
<i>Duta tenuicornis</i> (Dodd, 1920)	Insecta	Hymenoptera	Scelionidae	U	A	1989	2
<i>Gryon leptocorisae</i> (Howard, 1885)	Insecta	Hymenoptera	Scelionidae	U	A	Unknown	3
<i>Telenomus busseolae</i> Gahan, 1922	Insecta	Hymenoptera	Scelionidae	U	A	Unknown	1
<i>Chartocerus niger</i> (Ashmead, 1900)	Insecta	Hymenoptera	Signiphoridae	U	A	Unknown	3
<i>Isodonita mexicana</i> (Saussure, 1867)	Insecta	Hymenoptera	Sphecidae	U	A	1960	9
<i>Sceliphron cementarium</i> (Drury, 1773)	Insecta	Hymenoptera	Sphecidae	U	A	1945	12
<i>Sceliphron curvatum</i> (Smith, 1870)	Insecta	Hymenoptera	Sphecidae	U	A	1979	17
<i>Sceliphron deforme</i> (Smith, 1856)	Insecta	Hymenoptera	Sphecidae	U	A	1998	2
<i>Eridontomerus isosomatis</i> (Riley, 1882)	Insecta	Hymenoptera	Torymidae	I	A	1912	4
<i>Megaphragma mymaripenne</i> Timberlake, 1924	Insecta	Hymenoptera	Trichogrammatidae	I	A	1995	2
<i>Oligosita distincta</i> (Silvestri, 1915)	Insecta	Hymenoptera	Trichogrammatidae	I	A	1939	2
<i>Oligosita sanguinea</i> (Girault, 1911)	Insecta	Hymenoptera	Trichogrammatidae	I	A	1949	1
<i>Trichogramma achaeae</i> Nagaraja & Nagarkatti, 1970	Insecta	Hymenoptera	Trichogrammatidae	I	A	1987	1
<i>Trichogramma chilonis</i> Ishii, 1941	Insecta	Hymenoptera	Trichogrammatidae	I	A	1985	2
<i>Trichogramma dendrolimi</i> Matsumura, 1926	Insecta	Hymenoptera	Trichogrammatidae	I	A	1978	15
<i>Trichogramma minutum</i> Riley, 1871	Insecta	Hymenoptera	Trichogrammatidae	I	C	1957	7
<i>Trichogramma perkinsi</i> Girault, 1912	Insecta	Hymenoptera	Trichogrammatidae	I	A	1984	1
<i>Trichogramma pretiosum</i> Riley, 1879	Insecta	Hymenoptera	Trichogrammatidae	I	C	1975	3
<i>Uscana johnstoni</i> (Waterston, 1926)	Insecta	Hymenoptera	Trichogrammatidae	I	A	1970	1
<i>Uscana semifumipennis</i> Girault, 1911	Insecta	Hymenoptera	Trichogrammatidae	I	A	1963	1
<i>Vespa velutina nigrithorax</i> du Buysson, 1905	Insecta	Hymenoptera	Vespidae	U	A	2004	1

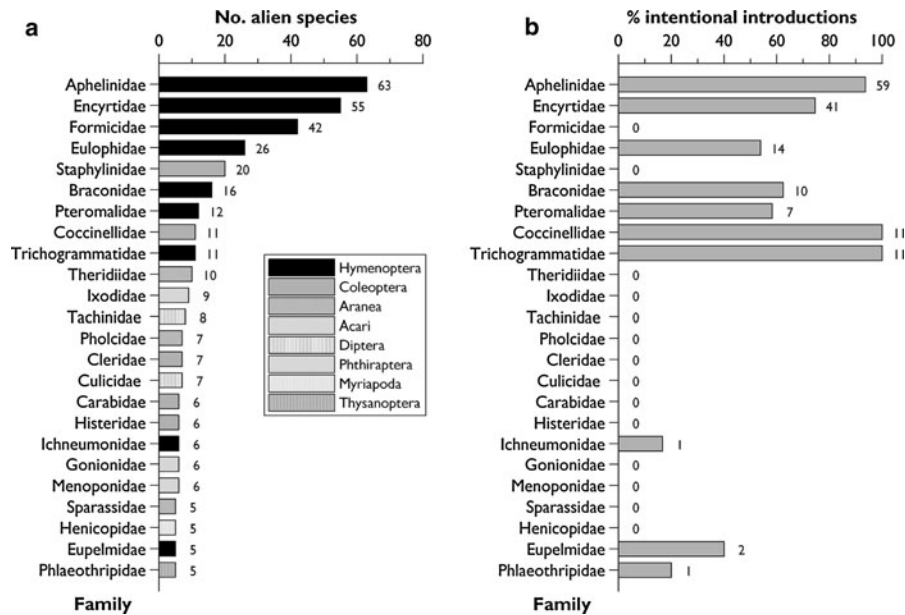
Table 1 continued

Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Bovicola (Bovicola) ovis</i> (Schrank, 1781)	Insecta	Phthiraptera	Bovicoliidae	U	C	1916	13
<i>Enderleinellus longiceps</i> Kellogg & Ferris, 1915	Insecta	Phthiraptera	Enderleinellidae	U	A	1979	1
<i>Enderleinellus tamiensis</i> Fahrenholz, 1916	Insecta	Phthiraptera	Enderleinellidae	U	A	1916	2
<i>Gliricicola porcelli</i> (Schrank 1781)	Insecta	Phthiraptera	Gliricicolidae	U	A	1781	12
<i>Pitufuquenia coypus</i> Marelli 1932	Insecta	Phthiraptera	Gliricicolidae	U	A	1932	5
<i>Stenocrotaphus gigas</i> (Taschenberg 1879)	Insecta	Phthiraptera	Gonioididae	U	A	1924	8
<i>Chelopistes meleagridis</i> (Linnaeus, 1758)	Insecta	Phthiraptera	Gonioididae	U	A	1877	11
<i>Goniocotes gallinae</i> (De Geer 1778)	Insecta	Phthiraptera	Gonioididae	U	C	1880	11
<i>Goniocotes rectangularis</i> Nitzsch, 1818	Insecta	Phthiraptera	Gonioididae	U	C	1818	3
<i>Goniodes pavonis</i> (Linnaeus, 1758)	Insecta	Phthiraptera	Gonioididae	U	C	1892	8
<i>Zlotorzycykella colchici</i> (Denny, 1842)	Insecta	Phthiraptera	Gonioididae	U	A	1977	7
<i>Gyropus ovalis</i> Burmeister, 1838	Insecta	Phthiraptera	Gyropidae	U	A	1838	11
<i>Hoplopleura sciuricola</i> Ferris, 1921	Insecta	Phthiraptera	Hoplopeuridae	U	A	1976	2
<i>Linognathus stenopsis</i> (Burmeister, 1838)	Insecta	Phthiraptera	Linognathidae	U	C	1838	7
<i>Solenopotes munitacus</i> Thompson, 1938	Insecta	Phthiraptera	Linognathidae	U	A	1983	1
<i>Eomenacanthus stramineus</i> (Nitzsch 1818)	Insecta	Phthiraptera	Menoponidae	U	C	1818	9
<i>Hohorstiella gigantea lata</i> (Piaget 1880)	Insecta	Phthiraptera	Menoponidae	U	C	1880	9
<i>Menopon gallinae</i> (L. 1758)	Insecta	Phthiraptera	Menoponidae	U	C	1781	13
<i>Myrsidea quadrifasciata</i> (Piaget, 1880)	Insecta	Phthiraptera	Menoponidae	U	A	1880	6
<i>Neocolpocephalum turbinatum</i> (Denny 1842)	Insecta	Phthiraptera	Menoponidae	U	C	1842	10
<i>Uchida phasiani</i> (Modrzejewska & Zlotorzycyka, 1977)	Insecta	Phthiraptera	Menoponidae	U	A	1998	3
<i>Cuclotogaster heterographa</i> (Nitzsch in Giebel 1866)	Insecta	Phthiraptera	Philopteridae	U	C	1876	12
<i>Lagopoeus colchicus</i> Emerson, 1949	Insecta	Phthiraptera	Philopteridae	U	A	1989	4
<i>Lipeurus maculosus</i> Clay, 1938	Insecta	Phthiraptera	Philopteridae	U	A	1938	8
<i>Reticulipeurus polytrapezius</i> (Burmeister 1838)	Insecta	Phthiraptera	Philopteridae	U	A	1880	4
<i>Haemodipsus lyriocephalus</i> (Burmeister, 1839)	Insecta	Phthiraptera	Philopteridae	U	C	1880	4
<i>Polyplax spinulosa</i> (Burmeister, 1839)	Insecta	Phthiraptera	Polyplacidae	U	C	1839	10
<i>Trichodectes (Stachytella) octomaculatus</i> Paine 1912	Insecta	Phthiraptera	Polyplacidae	U	A	1839	9
<i>Trichodectes (Trichodectes) canis</i> (De Geer 1778)	Insecta	Phthiraptera	Trichodectidae	U	A	Unknown	4
<i>Trimenopon hispidum</i> Burmeister, 1838	Insecta	Phthiraptera	Trichodectidae	U	C	1880	8
<i>Callopsylla (Geminopsylla) gemina</i> (Toff, 1946)	Insecta	Phthiraptera	Trimenoponidae	U	A	1966	7
	Insecta	Siphonaptera	Ceratophyllidae	U	A	1985	1

**Table 1** continued

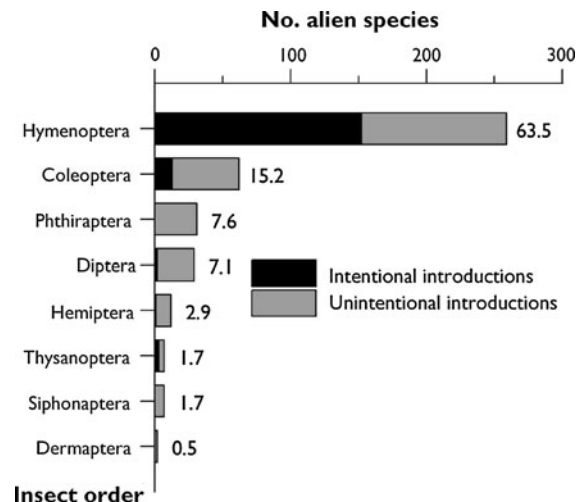
Species	Phylum	Order	Family	Introduction	Status	Date	No. countries invaded
<i>Leptopsylla (Leptopsylla) segnis</i> (Schönherr, 1811)	Insecta	Siphonaptera	Ceratophyllidae	U	C	1811	44
<i>Nosopsyllus (Nosopsyllus) fasciatus</i> (Bosc d'Antic, 1800)	Insecta	Siphonaptera	Ceratophyllidae	U	A	1900	30
<i>Orchopeas howardi</i> Baker 1895	Insecta	Siphonaptera	Ceratophyllidae	U	A	1800	2
<i>Euhoplopsyllus glacialis affinis</i> (Baker, 1904)	Insecta	Siphonaptera	Pulicidae	U	A	1977	2
<i>Xenopsylla brasiliensis</i> (Baker, 1904)	Insecta	Siphonaptera	Pulicidae	U	A	1942	2
<i>Xenopsylla cheopis cheopis</i> (Rothschild, 1903)	Insecta	Siphonaptera	Pulicidae	U	A	1904	17
<i>Franklinothrips megalops</i> (Trybom, 1912)	Insecta	Thysanoptera	Aeolothripidae	I	A	Unknown	3
<i>Franklinothrips vespiformis</i> (Crawford, 1909)	Insecta	Thysanoptera	Aeolothripidae	I	A	Unknown	9
<i>Aleurodothrips fasciapennis</i> (Franklin, 1908)	Insecta	Thysanoptera	Phlaeothripidae	U	C	1908	2
<i>Karnyothrips americanus</i> (Hood, 1912)	Insecta	Thysanoptera	Phlaeothripidae	U	A	1974	1
<i>Karnyothrips flavipes</i> (Jones, 1912)	Insecta	Thysanoptera	Phlaeothripidae	U	A	1919	5
<i>Karnyothrips melaleucus</i> (Bagnall, 1911)	Insecta	Thysanoptera	Phlaeothripidae	I	A	1911	6
<i>Podothrips semiflavus</i> Hood, 1913	Insecta	Thysanoptera	Phlaeothripidae	U	A	1964	1
<i>Allopauropus pseudomilloitamus</i> Remy & Balland, 1958	Pauropoda	Tetramerocerata	Pauropodidae	U	A	1958	2
<i>Hanseniella caldaria</i> (Hansen, 1903)	Symphyla	Symphylomorpha	Scutigerellidae	U	A	1903	5
<i>Hanseniella oligomacrochaeta</i> Scheller, 2002	Symphyla	Symphylomorpha	Scutigerellidae	U	C	2000	1
<i>Hanseniella orientalis</i> (Hansen, 1903)	Symphyla	Symphylomorpha	Scutigerellidae	U	A	2000	1

Introduction: U unintentional; I intentional. Status: A Alien, C Cryptogenic (Source DAISIE)



**Fig. 1** **a** Number of alien predator and parasite species within the 24 arthropod families which are represented by five or more alien parasites and predators in Europe (including major islands). **b** Proportion of the alien predator and parasite species within each family intentionally introduced to Europe

(including major islands). Number above the bar = total number of species. Data from Denux and Zagatti (2010), Kenis and Roques (2010), Navajas et al. (2010), Nentwig and Kobelt (2010), Rabitsch (2010b), Reynaud (2010), Roy and Migeon (2010), Skuhrová et al. (2010), Stoev et al. (2010)



**Fig. 2** Number of alien parasite and predator species intentionally and accidentally introduced to Europe (including major islands) per insect order. Number above bars = percentage of parasite and predator species within the order from the total number of alien parasites and predators (409 spp.). Data from Denux and Zagatti (2010), Kenis and Roques (2010), Rabitsch (2010b), Rasplus and Roques (2010), Reynaud (2010), Roy and Migeon (2010), Skuhrová et al. (2010)

of small parasitic wasps which have been widely used in biological control. *Encarsia formosa* Gahan (Hymenoptera: Aphelinidae) is a well known example. It was extensively introduced to control the glasshouse whitefly *Trialeurodes vaporariorum* (Westwood) (Homoptera: Aleyrodidae) (Vet et al. 1980; van Lenteren et al. 1996; De Clercq et al. 2011) and now established in the wild (Roques et al. 2009). The Coccinellidae is another family for which the majority of alien species (predatory ladybirds) have been intentionally introduced as biological control agents (Roy and Migeon 2010). Similarly the Trichogrammatidae, small chalcid parasitic wasps, comprise a group widely used in biological control strategies (Smith 1996). In contrast, there are 42 species of alien Formicidae (ants) in Europe and none are considered to have been introduced intentionally but are likely to have arrived as contaminants and stowaways (Rabitsch 2011).

Species introduced unintentionally as contaminants and stowaways

Escape from captivity is a common pathway for many alien species, including arthropods. Arthropods

are rarely domesticated but insects used for biological control in contained environments, such as glasshouses and open fields are an important source of alien introductions into Europe. The harlequin ladybird, *H. axyridis*, was introduced into glasshouses as a biological control agent of aphids but subsequently escaped into the wider countryside and spread dramatically across Europe (Majerus et al. 2006; Roy et al. 2006; Roy and Wajnberg 2008; Roy and Roy 2010; De Clercq and Bale 2011; Evans et al. 2011a).

Many alien arthropods have arrived in Europe as contaminants or stowaways with plants (including fruit and vegetables), stored products or timber (Rabitsch 2010b). However, the majority of these are herbivorous insects. Honeybee imports are responsible for the introduction of a number of infamous parasites including the tracheal mite, *Acarapis woodi* (Rennie) (Trombidiformes: Tarsonemidae), and *Varroa destructor* Anderson & Trueman (Parasitiformes: Varroidae) (Coffey 2007). Hymenoptera have a history of introduction as stowaways (Rabitsch 2010b). The oriental mud dauber, *Sceliphron curvatum* Smith (Hymenoptera: Sphecidae), arrived with air cargo from Asia into Austria. This predatory species feeds paralysed spiders to its larvae within distinctive mud nests (Schmid-Egger 2004; Rabitsch 2010b).

Alien ants are among the most invasive species globally (Holway et al. 2002; Rabitsch 2011). Colonies are transported in the soil with ornamental plants or, indeed, other plant material or anything that provides shelter (Rabitsch 2010b). The expression “tramp ants” is derived from this reliance on human-mediated transport (Hölldobler and Wilson 1990; Passera 1994). The Argentine ant, *Linepithema humile* (Mayr) (Hymenoptera: Formicidae), arrived as a stowaway in Madeira and mainland Portugal in the nineteenth century (Rabitsch 2010b). *Linepithema humile* routinely move their nests and colonise potted plants and refuse. This can facilitate dispersal through subsequent human movement of the material (Rabitsch 2011). Furthermore, *L. humile* can be transported as small nest fragments on land vehicles and in sea freight. Only one queen and ten workers are required for colony establishment (Suarez et al. 2001).

#### Invasion corridors

Transport routes can provide pathways for the movement of alien species. *Harmonia axyridis* has been

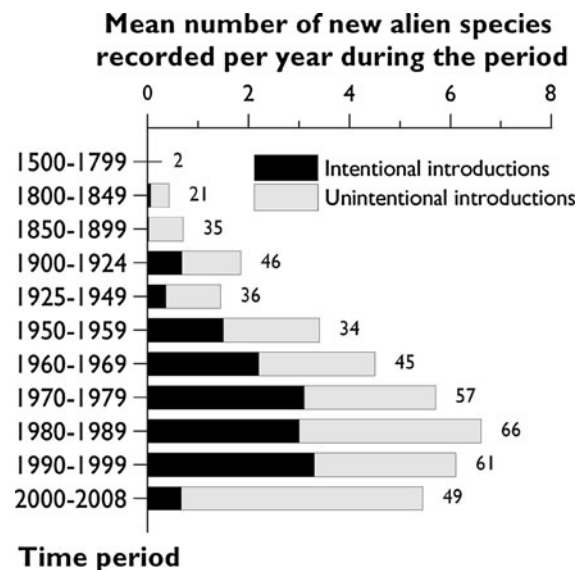
found on trains, cars and boats and these mechanisms have undoubtedly contributed to the dramatic spread of this species across Europe (Roy et al. 2006; Brown et al. 2008a). A number of other species are likely to have benefited from global transport networks but it is difficult to separate the role of the network from contaminant and stowaway pathways (Roques et al. 2009; Rabitsch 2010b). For example, the alien mosquito *Aedes albopictus* Skuse (Diptera: Culicidae) is reported to be transported by ship and aircraft traffic (Tatem et al. 2006) but is also commonly implicated as stowaways, for example in second-hand tyres and with plants (Roques et al. 2009).

#### Leading-edge dispersal following intentional and unintentional introduction

Alien species can arrive in a new region from a donor region, where it is also alien, unaided. This is termed “leading-edge dispersal” (Rabitsch 2010b; Lawson Handley et al. 2011). The majority of alien arthropod species in Europe are thought to have followed a classic invasion route: introduction, establishment and spread. However, acclimatization, whereby abiotic and biotic barriers to survival and reproduction are overcome, is a fundamental process that alien species have to achieve prior to establishment (Richardson et al. 2000). The spread into neighbouring countries is unsurprising once a species has acclimated and established in one new region. Again *H. axyridis* provides a well-studied example of a species that has undergone leading edge dispersal which has resulted in its spread across much of Europe within two decades (Brown et al. 2008a; Brown et al. 2011b; Lawson Handley et al. 2011). Another example of a species that has spread rapidly through leading edge dispersal is the fast spreading *Platygaaster robiniae* Buhl & Duso (Hymenoptera: Platygasteridae), a parasitoid of the black locust gall midge, *Obolodiplosis robiniae* (Haldeman) (Diptera: Cecidomyiidae). This parasitoid was accidentally introduced from North America to Europe along with its host. *Obolodiplosis robiniae* was first found in Italy in 2003. It rapidly colonized most of Europe within five years. However, the parasitoid was only detected in 2005, again in Italy, but it quickly followed the host expansion. In 2008, the host midge and the parasitoid appeared simultaneously in Switzerland and Montenegro (Glavendekić et al. 2010).

## Temporal trends

Many of the alien arthropods in Europe are often not discovered until they are established and spreading primarily because of the difficulties in determining their introduction pathways (Roques 2010). Therefore, it is difficult to determine the precise date of arrival for many alien species. However, the DAISIE inventory has the date of first record for 89.4% of the 1590 alien arthropods (Roques 2010). The proportion of alien arthropod predators and parasites for which there is a date of first record is similarly high (88.1%). The number of new arrivals has been progressively increasing since 1500, with the rate accelerating during the last 100 years (Fig. 3). However, the 1980s appear to represent a peak: 66 alien arthropod predators and parasites were recorded from 1980 to 1989. Although the total number of alien arthropods recorded each year is still increasing (with approximately 20 new species recorded in the period 2000–2008) this is mainly attributed to phytophagous species rather than predators and parasites (Roques 2010). The observed decrease in number of alien predators and parasites, recorded in recent decades, is a measure of the reduced number of intentional



**Fig. 3** Mean number of new alien predator and parasite species recorded, following intentional and unintentional introductions, in Europe (including major islands) per year during the time periods. Number above the bar = total number of introduced species per period. Data from Roques et al. (2010)

introductions over this period (Fig. 3). There has been an increase in the number of species recorded as a consequence of unintentional introductions which mirrors the trend for phytophages (Figs. 3, 4). The release of biological control agents through the 1980s has undoubtedly contributed to the trends observed in records of new alien species.

Classical and augmentative biological control of insects has been applied for 120 and 90 years, respectively (van Lenteren et al. 2006). More than 2000 species of natural enemy have been released worldwide and populations of at least 165 pest species have been permanently reduced (Greathead 1995; Gurr and Wratten 2000). Until recently the potential risks of biological control agents for control of arthropod pests have not been considered in pre-release evaluations (van Lenteren et al. 2003; van Lenteren et al. 2006). This has largely been attributed to the very low number of reports of negative effects of such releases (van Lenteren et al. 2006). However, in recent years the situation has changed and in many countries more stringent regulatory requirements need to be met before an exotic biological control agent can be released (FAO 1996; van Lenteren et al. 2003; Kairo et al. 2003; Hunt et al. 2007). This has undoubtedly resulted in a decline of intentional introductions and is responsible for the trends observed in Fig. 3.

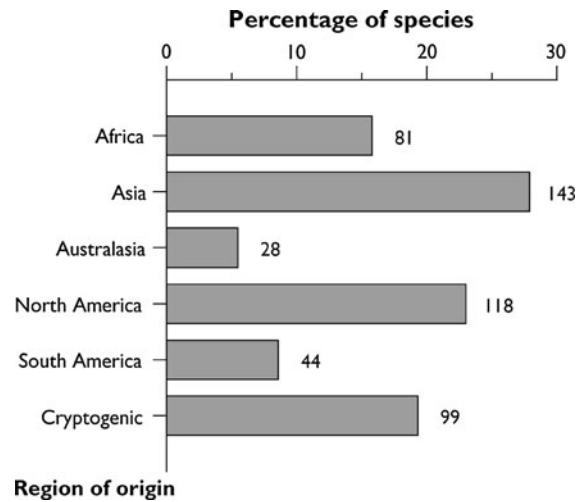
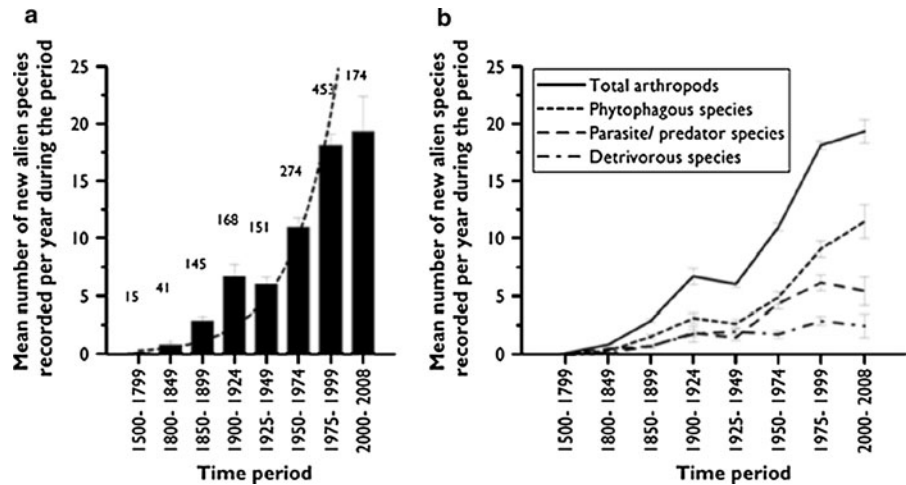
## Biogeographic trends

The origin of 19.3% of the alien predators and parasites in Europe is unknown and they are regarded as cryptogenic (Fig. 5). Of those where origin is known, however, more than a quarter originated from Asia (27.9%). North America and Africa contributed 22.9% and 15.8%, respectively (Fig. 5). Interestingly, the recruitment of species into Europe from each continent has varied considerably over time. Arrival of species from North America has been declining since 1980 but from Asia a linear increase can be observed until 2000 after which there has been a slight decline (Fig. 6).

## Spread in Europe

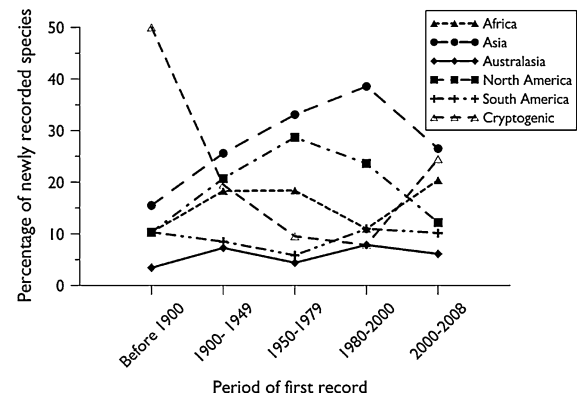
One-fifth (20.7%) of the alien arthropod predators and parasites were recorded first in Italy. France and

**Fig. 4** Mean number ( $\pm$ SE) of new alien arthropod species recorded per year in Europe (including major islands) from 1500 to 2008. **a** total arthropods (Best fit:  $y = -0.411 - 0.407x + 0.304x^2$ ;  $r^2 = 0.965$ ) **b** total and mean number per functional group. (Updated from Roques 2010)



**Fig. 5** Region of origin of the arthropod parasite and predator species alien to Europe (including major islands). Numbers indicate the total. Data from Roques et al. (2010)

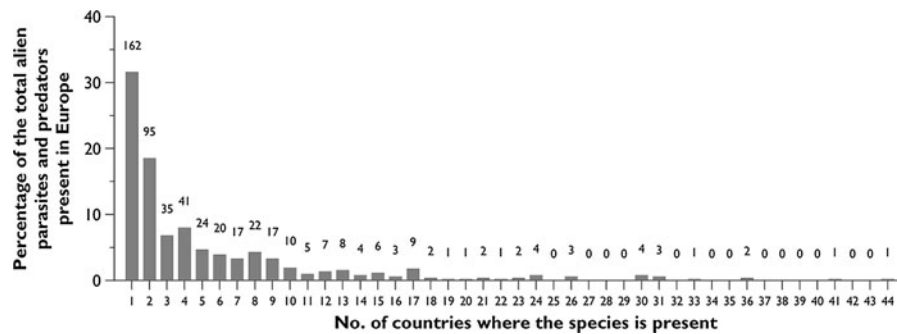
Great Britain have also been the first recipients of a large number of species with 41 (9.7%) and 31 (7.4%) alien species being recorded first in these countries, respectively. The spread of most species is extremely limited: only 12 species (3.3%) are observed in 30 countries or more and 257 species (50.1%) are only present in one or two countries (Fig. 7). Not surprisingly, the spread of a species is strongly correlated with the date of arrival (Spearman rank correlation between the number of colonized countries and the duration of the presence in Europe since first record (until 2008):  $r = 0.45$ ;  $P < 0.001$ ;  $n = 452$ ). 46.6% of the species recorded before 1900 are now present in more than ten



**Fig. 6** Percentage of the arthropod predator and parasite species in relation to the total of all alien arthropods recorded over time for each region. Data from Roques et al. (2010)

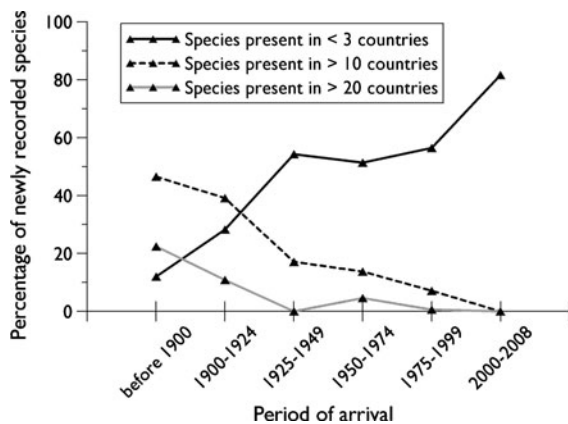
countries, whereas only 7.1% of the species recorded from 1975 to 1999 are similarly widespread (Fig. 8). None of the species recorded since 2000 have spread to more than ten countries.

Alien arthropod predators and parasites are distributed heterogeneously across Europe (Fig. 9). Italy has a high representation of these species which could relate to the widespread use of biological control agents in this region (supported also by the high proportion of first records of alien arthropod predators and parasites from Italy). A number of European islands are at the other end of the range with very few alien arthropod predators and parasites represented. The distribution of alien species within Europe appears to be positively correlated with the trading activity of the country: the more imports a country receives the more alien species are recorded (Kobelt



**Fig. 7** Spread of arthropod predator and parasite species alien in Europe expressed as the number of countries (and major islands) in which the species has been recorded as established

and their frequency. Number above the bar is the number of alien predators and parasites recorded. Data from Roques et al. (2010)



**Fig. 8** Percentage of alien arthropod predators and parasites present in either three (or less), ten (or more) or 20 (or more) European countries against date first recorded. Data from Roques et al. (2010)

and Nentwig 2008; Roques 2010; Pyšek et al. 2010; Essl et al. 2011). Undoubtedly the size of a country and number of available habitats will also influence the number of alien species recorded. Britain is a relatively small country but has the fifth highest number of alien predators and parasites. Perhaps an indication of trading activity but also the predominantly urban landscape, particularly in England, could be favouring alien species (Roques et al. 2009; Roy et al. 2011).

### Ecological and economical impacts

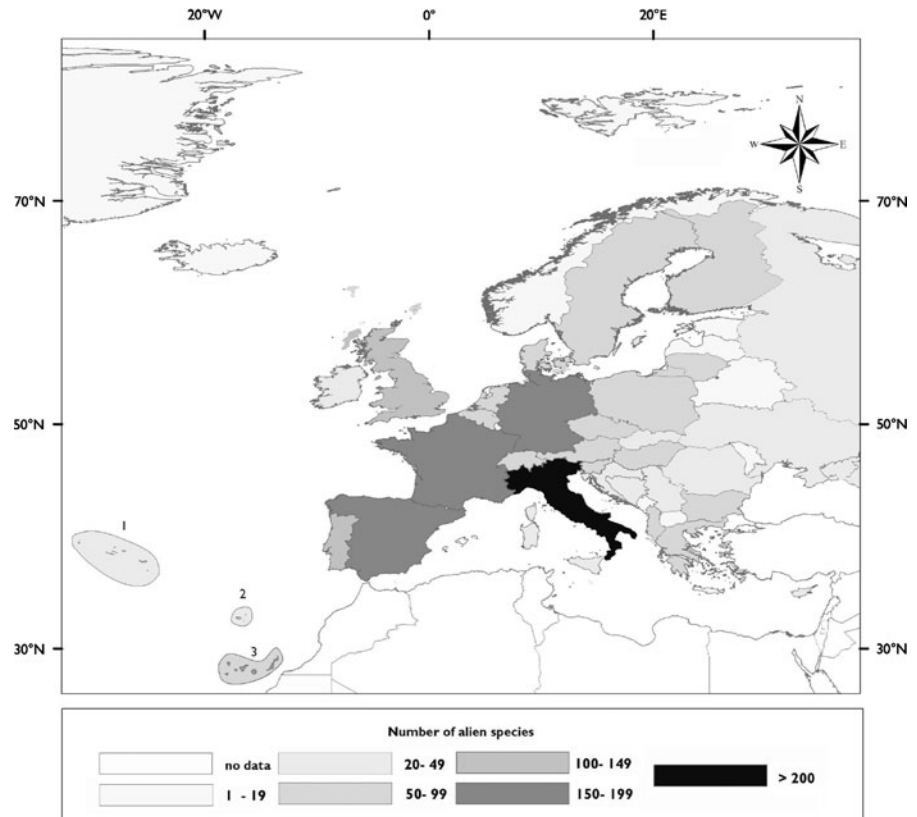
Alien arthropod species can have both ecological and economical impacts. Many of the economic impacts

are attributed to phytophagous alien species that directly reduce productivity (Roques et al. 2009). However, some species are considered a nuisance to humans because of their behaviour (Roy et al. 2009). The problems associated with nuisance insects are varied, ranging from human health (vectors of disease, allergens and irritants, pain through biting and stinging), annoyance when in high numbers (tendency to occur in large numbers results in intolerable annoyance) to being household pests (damaging or destroying the contents of houses including fabrics, structural timbers and stored products). *Harmonia axyridis* and a number of alien ant species are considered to be a nuisance because of their propensity to reach high numbers in houses and gardens. *Harmonia axyridis* aggregates in buildings in autumn and reports of more than one thousand individuals in a single household are not unusual (Majerus et al. 2006; Roy et al. 2006; Brown et al. 2008b).

Alien arthropod predator and parasite species can have profound ecological impacts within invaded ranges (Kenis et al. 2009). Perhaps the greatest threat is to native biodiversity through direct interactions such as hybridisation with native species (Lawson Handley et al. 2011), preying or parasitising native species (Kindlmann et al. 2011). Additionally, they can have indirect impacts on native species and ecosystems through competition, carrying diseases or sharing natural enemies with native species (Kenis et al. 2009; Roy et al. 2011). The concept of invasional meltdown, in which a number of alien species interact synergistically resulting in dramatic alterations to ecosystems (O'Dowd et al. 2003;



**Fig. 9** Distribution of alien parasites and predators in European countries and major islands (1 = Azores; 2 = Madeira and 3 = Canary Islands). Data from Roques et al. (2010)



Simberloff 2006), outlines the most extreme outcome of the subsequent arrival of invasive alien species. There are many examples of alien arthropods causing ecological impacts on oceanic islands (Causton et al. 2006), including invasional meltdown (O'Dowd et al. 2003), but there are very few examples of alien arthropods (mainly predators) adversely affecting native biodiversity or ecosystems in Europe (Kenis et al. 2009; Roques et al. 2009).

The ecological impacts of alien arthropod predators found in Europe have been well documented although in some cases from studies on other continents. Invasive ants, such as *L. humile*, displace native ants and other animals both through resource competition and direct predation as has been shown through studies in the US (Human and Gordon 1996). *Harmonia axyridis* outcompetes and displaces native aphidophagous insects (Brown et al. 2011b; Aebi et al. 2011). The Asian hornet, *Vespa velutina nigrithorax* de Buysson (Hymenoptera: Vespidae), is established and spreading in south-west France and preys on honeybees, *Apis mellifera* L. (Hymenoptera: Apidae), and may consequently have an economic impact through diminished

pollination services (Beggs et al. 2011). Similarly a number of introduced parasitoid species have displaced native aphelinids (Viggiani 1994; Viggiani and Gerling 1994). There is considerable scope for further research on the ecological impacts of alien arthropod predators and parasites. This, coupled with an increased understanding of invasion pathways, could facilitate more effective risk assessment and surveillance.

### Future trends

The dramatic increase in the establishment of alien invertebrates, including arthropod predators and parasites, is anticipated to continue over the next few decades as global trade continues to expand (Roques et al. 2009). Intentional introductions of species have decreased in recent years but this is offset by an increase in unintentional translocations. Additionally, environmental change, particularly climate change and habitat destruction, is predicted to promote the arrival, establishment and spread of alien species in

Europe (Evans et al. 2011b). Many of the alien arthropod records are from urban or man-made habitats. Few alien species seem to have colonised natural ecosystems. Mature, natural communities are considered more resistant to potential invaders because they have lower levels of niche opportunity (Shea and Chesson 2002), i.e. low availability of resources. However, whether such predictions are upheld because they reflect reality or whether there is simply a lack of data from natural systems requires addressing.

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**A. Roques** is a forest entomologist, and the Head of the Forest Zoology Research Station of Orléans with the National Institute for Agricultural Research (INRA). He was leader of the IUFRO Working Party “Cone and Seed Insects” from 1986 to 1994. His present work focuses on the insect responses to anthropogenic changes, especially global warming and biological invasions. He coordinated the inventory of the alien terrestrial invertebrates established in Europe within the DAISIE project.