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Alien seed beetles (Coleoptera: Chrysomelidae: Bruchinae) in Europe

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Abstract

Under the framework of the DAISIE consortium, whose main mission is to make an inventory of the alien invasive species of Europe and its islands, we review the current state of knowledge and provide an up-to-date catalogue and distributional status for alien seed beetles (Coleoptera: Chrysomelidae: Bruchinae) in Europe. This work is based on studies of the species detected from the last century to the present, but with greater emphasis on the beginning of the 21st century, during which new biological studies have been carried out and findings made in European countries. The main objective of this paper is to focus on this last fact, which has promoted new views on the existing and potential threat of exotic bruchids in relation to climate change. This must now be regarded as a matter of concern for European agricultural and environmental policies. Only species of exotic origin introduced in European regions outside their native range were considered. Therefore, species of European origin spreading to new countries within Europe are not treated. Also, we provide a new approach to classifying alien seed beetle species according to their ability to become established, distinguishing between the well-established and those that may appear in seed stores but are not capable of invading natural and agricultural ecosystems. We present a taxonomic characterization of the alien bruchids found in Europe, providing an illustrated key based on external morphological characters of adults. The key facilitates the identification of the sixteen most frequently recorded genera, which represent 37 of the 42 species of exotic species recorded in Europe up to the present, whether established, not established or occasional. Finally, we provide a summary of the state of knowledge of the taxonomy and biology of the 20 most worrying species as pests, both established and non-established. This includes, where appropriate, an illustrated key for the identification of species. The study reveals that the majority of exotic bruchid species in Europe originate in Asia and Africa, from host plant species imported for ornamental or forestry purposes, and that a greater effort in European customs control is advisable.

Key words: invasive species, DAISIE, catalogue, identification keys, taxonomy, biology, Chrysomelidae: Bruchinae

Introduction

The impact of biological invasions by exotic species (non-native) on the conservation of biodiversity and the functioning of native ecosystems is becoming increasingly evident (Wittenberg & Cock 2001, Sax *et al.* 2005, Melbourne *et al.* 2007, Sax *et al.* 2007, Roques *et al.* 2010, Pimentel 2011). In the last 200 years, a significant number of exotic species have become established successfully in large areas of Europe (Hulme 2007), a phenomenon which, according to all forecasts, is set to increase in the coming decades (Sala *et al.* 2000) and could accelerate the degradation of local ecosystems (Vilà *et al.* 2007).

This problem balances ecological deterioration with substantial economic losses due to pests (Williamson 2002). Given the manifest inability of European states to address this problem strategically (Miller *et al.* 2006), the European Biodiversity Strategy has promoted research on this problem and its control measures (European Commission 2006). One response has been the creation of the DAISIE consortium (Delivering Alien Invasive Species Inventories for Europe), formed by collaborators with different backgrounds and specialisations. Their first analysis of the situation was published in the “*Handbook of Alien Species in Europe*” (DAISIE 2009).

Following the DAISIE report, the leaf beetles and seed beetles (currently Coleoptera: Megalopodidae, Orsodacnidae and Chrysomelidae [including Bruchinae]) exotic to Europe were investigated and evaluated by Beenen & Roques (2010), who listed 14 alien bruchid species. As bruchids or seed beetles are insects that feed on seeds of various plant families, but most often the Fabaceae (= Leguminosae), some species become pests of legumes that we use as a food source for both people and livestock. However, in recent years we have witnessed a significant proliferation of species that develop on ornamental plants, some of which have become invasive in different parts of the world, including Europe. In all cases seed trade,—whether for the production of food or ornamental plants—has caused the import of these species into Europe from exotic regions. Although fortunately many species do not become established in natural habitats, others do so with extraordinary efficiency, becoming integrated in European ecosystems, especially in the Mediterranean.

The aim of this study is to review the state of knowledge of exotic bruchids (Coleoptera: Chrysomelidae: Bruchinae) in the territory of Europe, including its islands, and update the data available on their biology. A revised classification of alien bruchids is provided, incorporating new criteria according to the capacity of bruchid species to become established in natural and agricultural ecosystems, gardens and storehouses. Also, a taxonomic characterization of these insects is proposed, by providing identification keys to genera and species based on external morphological characters that are easy to observe without requiring dissection of genitalia. Additionally, we provide information on the current state of knowledge and research on various aspects of the taxonomy and biology of the most important alien seed beetles identified in Europe, 15 species of which are well established and 5 are not yet established but nevertheless dangerous as potential storage pests. For all of these, we try to provide basic tools to improve knowledge and encourage action relevant to these insects in customs control systems, in order to prevent the importation of invasive species and, where appropriate, to determine pertinent treatment. We aim to provide a useful tool for anyone involved in phytosanitary, plant protection and quarantine inspection and monitoring systems, in order to encourage the safe export and import of agricultural, horticultural and forest commodities in Europe, as well as for those who are involved in biological conservation of European agroecosystems.

Material and methods

The term ‘alien species’ is defined in this paper as those allochthonous species in Europe that are of ascertained exotic or cryptogenic origin, living outside of their natural range and outside of their natural dispersal potential. The words alien, exotic and non-native are interchangeable and treated as synonymous in the text of this paper. We only considered those species that are exotic throughout Europe and not only in parts of it. Therefore, only species of exotic origin that have been introduced in European regions outside their native range were considered. Species of European origin spreading to new countries within Europe are not treated.

The starting point for this study was the inventory of exotic bruchids in Europe provided by Beenen & Roques (2010). From the faunistic point of view, we revised the literature on Bruchinae from Europe, especially the “*Catalogue of Palaearctic Coleoptera. Volume 6. Chrysomeloidea*” by Löbl & Smetana (see Anton 2010) and later additions (Yus Ramos *et al.* 2011, Yus Ramos 2012). A detailed study of the inventory of Beenen & Roques (2010) revealed the need for an update to incorporate species that were not included and, at the same time, introduce new criteria for the classification of exotic bruchids, such as the status of ‘non-established’ species, in order to assess their danger or threat to European ecosystems. We also consider potential storage pests, because species not established in the natural environment may nevertheless pose a danger in storehouses or granaries. We have therefore updated the categories for each species based on the criteria that we set out in this study. These are supported by international conventions on phytosanitary control. We distinguish two categories encompassing four traits among exotic bruchid species (Table 1).

TABLE 1. Categories of presence and definition of traits for alien seed beetles in Europe.

Categories	Traits	
established species	natural environment	Species that breed successfully in agricultural and natural ecosystems of the European continent and its islands
	natural and confined environment	Species that develop life cycle stages indoors, alternating with phases in outdoors environments. Usually they are pests
non-established species	confined environment	Species not breeding in agricultural or natural ecosystems, only in storehouses where they become pests of stored grains
	occasional and non-viable breeding	Species that have been detected occasionally in Europe and have not been subsequently confirmed

a. established: exotic species that are **well adapted to agricultural or natural ecosystems** in Europe, **developing their entire life cycles outdoors**. These are the most invasive species because they are less localised and can spread throughout the European continent and its islands. This applies, for example, to *Acanthoscelides pallidipennis* (Motschulsky), a species that was accidentally introduced to Hungary and has now spread throughout most of southern Europe, wherever its host *Amorpha fruticosa* L. is present.

b. established: exotic species that were accidentally introduced via infested seeds. When these seeds are stored in storehouses, adults emerge and breed outdoors, seeking their host plants and infesting their seeds. When these seeds are harvested and stored, the bruchids end their cycle inside the storehouse. Adults can be univoltine, in which case they do not reproduce in warehouses and are forced to search for host plants outdoors (e.g. the African *Bruchus rufimanus* Boheman on wild species of *Vicia* L.). Alternatively, they may be multivoltine, with the ability to feed on dried, stored seeds and produce several generations in warehouses until resources are depleted, then spreading outdoors to feed on the seeds of crops (e.g. the American *Acanthoscelides obtectus* Say on *Phaseolus* L. spp). In such cases, besides being a **pest of stored seeds**, these species may **behave as invasives, spreading outdoors either by invading other crops or their wild relatives**.

c. non-established: exotic species that are introduced with imported and stored seeds, which might be overlooked by phytosanitary inspection during customs controls. When these species are of tropical origin (e.g. *Callosobruchus maculatus* (Fabricius), *C. chinensis* (Linnaeus), *Zabrotes subfasciatus* Horn) they are often multivoltine (able to develop several generations per year) in the stable climatic conditions provided by storehouses. These species are considered pests because they **cause damage to stored seeds**, which can be substantial if measures are not taken early enough. However, these species **do not tolerate external environmental conditions** in Europe, where temperatures often drop below their thermal tolerance range, so that they cannot breed or expand into agricultural or natural ecosystems. Although these species keep their pest status, they cannot be regarded as invasive, in contrast to other exotic species that have adapted to anthropogenic habitats and have a high reproductive output and ability to disperse and invade similar habitats (e.g. cockroaches). Exotic bruchids of tropical origin are unable to reproduce in temperate climates unless they have specific seeds to feed on and stable climatic conditions. These are only available in warehouses in which the preferred temperature and humidity levels are met and infected seeds are brought in for storage. Such opportunities are very limited spatially and temporally, so these bruchids are unable to invade similar habitats by themselves. Thus, they cannot be considered invasive.

d. non-established (occasional): exotic species imported to Europe by accident, usually within seeds, from which the adults emerge. These adults **are unable to breed in stored dried seeds and do not tolerate external environmental conditions**, so that they cannot begin a new cycle. Their breeding is interrupted and they do not represent any threat, as proliferation is unfeasible even in confined environments such as storehouses and greenhouses. This is the case with species such as *Specularius impressithorax* (Pic), a tropical bruchid that is occasionally detected in some European countries but has never been able to become established even though its host plants, *Erythrina* L. spp., are grown in gardens and greenhouses. Thus, these species do not become pests or invasives and can be considered '**occasional**'. In this sense they are of less importance, but still worth considering

from the point of view of faunistics and possible future introductions. They should therefore be inventoried for consideration by customs controls.

The number of actual and potential alien species in the 'non-established' category is so important that they deserve their own status and are treated as such hereafter. Therefore, we consider three categories for clearer analysis of the status of alien bruchid species in Europe: 'established', 'non-established' and 'occasional'. Moreover, we have updated the distribution of alien bruchid species in Europe using data that have been published on species detected in different countries, many of them by the authors of this article. Latin binomials are provided together with author and year of publication (Table 2).

The geographic range covered in this paper is primarily Europe in its geographic sense (i.e. the continent and its associated continental islands), but we also include other regions with political and (bio)geographical affiliations with Europe and which fall within the Western Palaearctic region. This expanded range extends from west to east from Iceland and the Macaronesian islands (Azores, Madeira and Canary islands) in the Atlantic Ocean to European Russia (with the Urals, Russia-Kazakhstan border and Caucasus Mountains as its eastern limits). The neighbouring Asian countries located in the south of the Caucasus and Near East were also included in the species list and distribution maps: the Transcaucasian countries (Georgia, Armenia and Azerbaijan), Turkey, Cyprus and the countries bordering the Mediterranean Sea in the Near East (Syria, Lebanon and Israel). Of these Asian countries, only Cyprus and the European part of Turkey are considered under the three criteria of established status for alien seed beetles in Europe. These two areas are therefore included in the analysis. Species of bruchids with their origin in westernmost Asia and present in Europe are considered as alien species to Europe.

Keys have been developed to allow for the identification of all tribes and most genera of alien seed beetles present or recorded in Europe and its islands. For genera with only one species recorded in Europe, no further differentiation is provided. For genera with several species (whether they are established or non-established, but are potentially damaging as storage pests) illustrated keys have been developed to differentiate the species represented in the present catalogue. Keys, together with figures, are based on the specimens deposited in the scientific collection of the senior author (RYR). The scale of the photographs of adults is represented by a bar to the right of each image, which is equivalent to 1 mm. The systematic treatment adopted is based on the classic proposal by Bridwell (1932, 1946), updated by Kingsolver (2004) for the New World species and Luckjanovitch & Ter-Minassian (1956) and Borowiec (1988) for the Old World species, as well as additional elements that have been contributed by our own studies (Yus Ramos 1977, 2007a, Yus Ramos *et al.* 2007b).

Throughout this article, plant species belong to the Fabaceae unless their families are given in parentheses.

The information provided for each species is the result of a literature review on research carried out in recent years on morphology of pre-imaginal stages and adults, life cycles, feeding and reproductive ecology, and relevant data on the control of invasive and pest species. Extensive information exists on the cosmopolitan pest species (e.g. *Acanthoscelides obtectus*, *Callosobruchus chinensis*, etc.) and it is impossible to refer to all of these references, so we summarise the most relevant data.

Discussion

For the following analysis we have used the list of exotic bruchid beetles of Europe and its islands provided by Beenen & Roques (2010) and compiled under the DAISIE consortium as a starting point, in which all species are considered 'established'. After applying the new criteria that we have adopted and incorporating up-to-date knowledge on the biology, composition and distribution of alien seed beetles in Europe (summarised in Table 2), the following observations are made:

Diversity and Origin of Alien Bruchids

The inventory of Beenen & Roques (2010), which was last updated on 1 February 2010, provides a total of 14 species in 9 genera (Table 2). As a result of the present review, we have expanded the inventory to a total of 42 species in 20 genera (Table 3): Amblycerini 3 genera/4 species, Bruchini 13/27 and Pachymerini 4/11. This represents an increase of 28 new species to the list. This list is compiled from new records and old ones that went unnoticed in the aforementioned catalogue.

TABLE 2. Alien species of Bruchinae detected in Europe. Abbreviations: NA = North America, CA = Central America, CSA = Central and South America, SA = South America, TAF = Tropical Africa, TPAF = Tropical and Palaeartic Africa, PAF = Palaeartic Africa, TAS = Tropical Asia, TEPAS = Tropical and East Palaeartic Asia, WPAS = West Palaeartic Asia, EPAS = East Palaeartic Asia. Country codes abbreviations refer to ISO 3166 (see Appendix 1). E = Established species, N = Non-established species, O = Occasional species.

Taxon	Native range	1st record in Europe (year, country)	Recorded countries	Host plants	Beenen & Roques, 2010	Present review
Amblycerini						
<i>Amblycerus robiniae</i> (Fabricius, 1781)	NA	2001, HU	HU	<i>Gleditsia triacanthos</i>	1	3
<i>Spermophagus abdominalis</i> (Fabricius, 1781)	TAF, TEPAS	Unknown, GB	GB ¹	Unknown		O
<i>Spermophagus latithorax</i> (Boheman, 1829)	TAF	Unknown, GB	GB ¹	Unknown		O
<i>Zabrotes subfasciatus</i> (Boheman, 1833)	CA	1858, FR	AL, AT, BE, BG, CH, CZ, DE, ES, ES-CAN, FR, GB, GR, GR-CRE, HU, IL, IT, IT-SIC, NL, PL, PT, PT-AZO	<i>Phaseolus vulgaris</i> , <i>Vigna sinensis</i> and other stored legumes	N	
Bruchini						
<i>Acanthoscelides macrophthalmus</i> (Schaeffer, 1907)	NA	2008, CY	CY	<i>Leucaena leucocephala</i>	12	15
<i>Acanthoscelides obtectus</i> Say, 1831	CSA	1889, IT	AD, AL, AM, AT, BA, BE, BG, BY, CH, CY, CZ, DE, DK, EE, ES, ES-BAL, ES-CAN, FI, FR, FR-COR, GB, GE, GR, GR-CRE, GR-NEG, GR-SEG, HR, HU, IE, IL, IS, IT, IT-SAR, IT-SIC, LB, LJ, LT, LU, LV, MD, MK, MT, NL, NO, NO-SVL, PL, PT, PT-AZO, PT-MAD, RO, RS, RU, SE, SI, SK, SY, TR, UA	<i>Phaseolus vulgaris</i> and other stored legumes	E	E
<i>Acanthoscelides pallidipennis</i> (Motschulsky, 1874)	NA	1972, HU	AD, AM, AT, BA, BG, CH, CZ, DE, FR, GR, HR, HU, IT, LU, MK, PL, RO, RS, RU, SK1	<i>Amorpha fruticosa</i>	E	
<i>Borowiecius varicolor</i> (Boheman, 1833)	TAF	Unknown, IT	IT	<i>Rhynchosia</i> sp.		O
<i>Bruchidius atrolineatus</i> (Pic, 1921)	TAF	Unknown, GB	GB ¹	<i>Vigna</i> sp.		O

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TABLE 2. (Continued)

Taxon	Native range	Ist record in Europe (year, country)	Recorded countries	Host plants	Beenen & Roques, 2010	Present review
<i>Bruchidius raddianae</i> Anton & Delobel, 2003	TPAF	2008, ES	ES	<i>Acacia karroo</i>		E
<i>Bruchidius siliquastris</i> Delobel, 2007	Uncertain (EPAS?)	2003, FR	BE, BG, CZ, ES, FR, GI, HU, MC, SK, TR	<i>Cercis siliquastrum</i>	E	
<i>Bruchidius terrenus</i> (Sharp, 1886)	EPAS	2010, BG	BG, ES, GR, IT, TR	<i>Albizia julibrissin</i>		E
<i>Bruchus lentis</i> Froelich, 1799	Uncertain (PAF?)	Unknown	AM, AT, AZ, BE, BG, CH, CZ, DE, ES, FI, FR, GB, GE, GR, HU, IL, IT, PL, RS, RU, SE, SK, SY, TR, UA	<i>Lens culinaris</i>		E
<i>Bruchus pisorum</i> (Linnaeus, 1758)	WPAS	1850, CZ	AD, AL, AM, AT, AZ, BA, BE, BG, BY, CH, CY, CZ, DE, DK, EE, ES, ES-BAL, ES-CAN, FI, FR, FR-COR, GB, GE, GR, GR-CRE, GR-NEG, GR-SEG, HR, HU, IE, IL, IS, IT, IT-SAR, IT-SIC, LB, LI, LT, LU, LV, MD, MK, MT, NL, NO, NO-SVL, PL, PT, PT-AZO, PT-MAD, RO, RS, RU, SE, SI, SK, SY, TR, UA	<i>Pisum sativum</i> , <i>Lathyrus sp.</i> , <i>Vicia sp.</i>	E	
<i>Bruchus rufimanus</i> Boheman, 1833	PAF	1894, PT	AD, AL, AM, AT, BA, BE, BG, BY, CH, CY, CZ, DE, DK, EE, ES, ES-BAL, ES-CAN, FI, FR, FR-COR, GB, GE, GR, GR-CRE, GR-NEG, GR-SEG, HR, HU, IE, IL, IS, IT, IT-SAR, IT-SIC, LB, LI, LT, LU, LV, MD, MK, MT, NL, NO, NO-SVL, PL, PT, PT-AZO, PT-MAD, RO, RS, RU, SE, SI, SK, SY, TR, UA	<i>Lathyrus venetus</i> , <i>Phaseolus vulgaris</i> , <i>Vicia faba</i> , <i>Cicer sp.</i> , <i>Lens sp.</i> , <i>Lupinus sp.</i> , <i>Pisum sp.</i> , <i>Vicia sp.</i>	E	
<i>Callosobruchus analis</i> (Fabricius, 1781)	TAS	Unknown	BE, EE, FI, FR, GB, RU	<i>Cajanus cajan</i> , <i>Cicer arietinum</i> , <i>Glycine max</i> , <i>Lablab purpureus</i> , <i>Lens culinaris</i> , <i>Pisum sativum</i> , <i>Vigna spp.</i>		N
<i>Callosobruchus chinensis</i> (Linnaeus, 1758)	TAS	1878, FR	AD, AL, AT, BA, BE, BG, BY, CH, CY, CZ, DE, DK, EE, ES, ES-BAL, ES-CAN, FI, FR, FR-COR, GB, GR, GR-CRE, GR-NEG, GR-SEG, HR, HU, IE, IL, IS, IT, IT-SAR, IT-SIC, LI, LT, LU, LV, MD, MK, MT, NL, NO, NO-SVL, PL, PT, PT-AZO, PT-MAD, RO, RS, RU, SE, SI, SK, UA	<i>Cajanus cajan</i> , <i>Cicer arietinum</i> , <i>Dolichos biflorus</i> , <i>Lens culinaris</i> , <i>Nelumbo nucifera</i> , <i>Vicia faba</i> , <i>Vigna spp.</i> and other stored seed legumes	N	

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TABLE 2. (Continued)

Taxon	Native range	Ist record in Europe (year, country)	Recorded countries	Host plants	Beenen & Roques, 2010	Present review
<i>Callosobruchus maculatus</i> (Fabricius, 1775)	TAF	1878, FR	AL, BE, BG, CH, CZ, DE, DK, ES, FI, FR, GB, GR, GR-CRE, HU, IL, IT, IT-SIC, PL, PT, PT-AZO, RU, SE	<i>Cajanus cajan</i> , <i>Cicer arietinum</i> , <i>Glycine max</i> , <i>Lablab purpureus</i> , <i>Lens culinaris</i> , <i>Macrotyloma geocarpum</i> , <i>Phaseolus vulgaris</i> , <i>Pisum sativum</i> , <i>Vigna spp.</i> and other stored legumes	N	
<i>Callosobruchus phaseoli</i> (Gyllenhal, 1833)	TAS	1945, FR	AL, CZ, ES, FR, GB, GR, GR-CRE, IL, IT, IT-SIC, PL	<i>Cajanus cajan</i> , <i>Cicer arietinum</i> , <i>Lablab purpureus</i> , <i>Phaseolus vulgaris</i> , <i>Pisum sativum</i> , <i>Lupinus sp.</i> , <i>Vigna spp.</i> and other stored legumes	N	
<i>Callosobruchus rhodesianus</i> (Pic, 1902)	TAF	Unknown, GB	GB	<i>Cajanus indicus</i> , <i>Vigna unguiculata</i>		O
<i>Conicobruchus albopubens</i> (Pic, 1931)	TAF	Unknown, GB	GB ¹	Unknown		O
<i>Megabruchidius dorsalis</i> (Fahraeus, 1839)	EPAS	1989, IT	CH, HU, IT	<i>Gleditsia triacanthos</i> , <i>G. sinensis</i>	E	
<i>Megabruchidius tonkineus</i> (Pic, 1904)	TAS	1980, DE	BG, CH, DE, FR, HU, RU	<i>Gleditsia triacanthos</i>	E	
<i>Merobruchus julianus</i> (Horn, 1894)	NA	Unknown, IT-SIC	IT-SIC	<i>Acacia berlandieri</i> , <i>A. reggii</i> , <i>A. roemeriana</i> , <i>A. wrighthii</i>		O
<i>Mimosestes mimosae</i> (Fabricius, 1781)	CA	1867, PT-AZO	DE, DK, ES, ES-CAN, FR, HU, IT, PL, PT-AZO, TR	<i>Acacia farnesiana</i> , <i>Cicer arietinum</i> , <i>Phaseolus vulgaris</i> , <i>Vicia faba</i>	E	
<i>Penthobruchus germaini</i> (Pic, 1894)	SA	Unknown	FR, IT-SIC	<i>Parkinsonia aculeata</i>		O
<i>Pseudopachymerina spinipes</i> (Erichson, 1833)	SA	1885, DE	BE, CZ, DE, DK, ES, FR, GR, GR-CRE, IL, IT, IT-SIC, PL, SY, TR	<i>Acacia cavenia</i> , <i>A. farnesiana</i>	E	
<i>Specularius albus</i> (Pic, 1928)	TAF	Unknown, IT	IT	<i>Erythrina sp.</i>		O
<i>Specularius erythraeus</i> (Pic, 1908)	TAF	Unknown, GB	GB ¹	<i>Erythrina sp.</i>		O
<i>Specularius impressithorax</i> (Pic, 1932)	TAF	2000, NL	GB, NL	<i>Erythrina abyssinica</i> , <i>E. cafra</i> , <i>E. crista-galli</i> , <i>E. fusca</i> , <i>E. lysisthemon</i> , <i>E. pallida</i> , <i>E. sandvicensis</i> , <i>E. senegalensis</i> , etc.		O
<i>Sulcobruchus natalensis</i> (Pic, 1903)	TAF	Unknown, GB	GB ¹	Unknown		O

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TABLE 2. (Continued)

Taxon	Native range	Ist record in Europe (year, country)	Recorded countries	Host plants	Beenen & Roques, 2010	Present review
Pachymerini						
<i>Caryedon acaciae</i> (Gyllenhal, 1833)	TAF	2007, ES	ES, HU	<i>Acacia karroo</i>	1	10
<i>Caryedon angerti</i> (Semenov, 1896)	TAF	Unknown, HR	HR	<i>Acacia gerrardii</i> , <i>A. spirocarpa</i> , <i>A. tortilis</i> , <i>Prosopis farcta</i>		E
<i>Caryedon gonagra</i> (Fabricius, 1798)	TAS	Unknown, FR	FR, IL ²	<i>Acacia farnesiana</i> , <i>A. tortilis raddiana</i> , <i>2Bauhinia variegata</i> , <i>Cassia brewsteri</i> , <i>C. fistula</i> , <i>C. tomentella</i> , <i>Dichrostachys cinerea</i> , <i>Gleditsia triacanthos</i> , <i>Senna didymobotrya</i> , <i>Tamarindus indica</i>		O
<i>Caryedon longipennis</i> (Pic, 1898)	TAF	Unknown, GB	GB	<i>Combretum cordofanum</i> , <i>C. ghasalense</i> , <i>C. glutinosum</i> , <i>C. hartmannianum</i> , <i>C. lamprocarpum</i> , <i>C. micranthum</i> , etc.		O
<i>Caryedon pallidus</i> (Olivier, 1790)	TAF	Unknown, IT	IT	<i>Acacia ataxacantha</i> , <i>Cassia mimosoides</i> , <i>C. sieberiana</i> , <i>Senna alexandrina</i> , <i>S. italica</i> , <i>S. obtusifolia</i> , etc.		O
<i>Caryedon serratus</i> (Olivier, 1790)	TAF	1900, CZ	BE, CY, CZ, DE, ES, ES-CAN, FR, GR, GR-CRE, IT, PT, SE	<i>Arachis hypogaea</i> , <i>Bauhinia rufescens</i> , <i>Cassia areneh</i> , <i>C. sieberiana</i> , <i>Ptilostigma reticulata</i> , <i>P. thoningii</i> , <i>Tamarindus indica</i> , <i>Acacia sp.</i> , <i>Prosopis sp.</i> ³	E	
<i>Caryedon sudanensis</i> Southgate, 1971	TAF	Unknown, GB	GB	<i>Senna alexandrina</i>		O
<i>Caryobrychus gleditsiae</i> (Linnaeus, 1763)	NA	2008, ES-CAN	ES, ES-CAN	<i>Sabal etoni</i> , <i>S. mexicana</i> , <i>S. minor</i> ; <i>S. palemitto</i> , <i>S. uresana</i> , <i>Serenoa repens</i> , <i>Washingtonia filifera</i>		O
<i>Caryopemon cruciger</i> (Stephens, 1839)	TAF	Unknown, FR	CZ, FR, GB	<i>Abrus precatorius</i>		O
<i>Caryopemon lholstei</i> Pic, 1924	TAS	Unknown, FR	FR	<i>Abrus precatorius</i>		O
<i>Pachymerus cardo</i> (Fähræus, 1839)	CSA	Unknown, GB	GB ¹	Unknown		O
42					14	28

¹ Included with updated nomenclature according to Duff (2012).

² From Delobel *et al.* 2003, who consider that the record of *Caryedon serratus* of Anton *et al.* 1997 probably refers to *C. gonagra*.

According to estimates by Beenen & Roques (2010), 50% of exotic bruchids in Europe are of Asian origin. In this review, we found that the proportion of Asian bruchids is lower (accounting for both tropical and Palaearctic Asian origin (see Table 4)) because they comprise 11 species, or 25.6% of the total. This is fewer than those of African origin (tropical and Palaearctic (see Table 4)), with 21 species (48.8%). A further 11 species (25.6%) are of American origin.

TABLE 3. Status and origin of the alien species of Bruchinae to Europe. See Table 2 for meaning of abbreviation.

Established species	Native range	Non-established species	Native range	Occasional species	Native range
<i>Acanthoscelides macrophthalmus</i>	NA	<i>Zabrotes subfasciatus</i>	CA	<i>Amblycerus robiniae</i>	NA
<i>Acanthoscelides obtectus</i>	CSA	<i>Callosobruchus analis</i>	TAS	<i>Spermophagus abdominalis</i>	TAF, TEPAS
<i>Acanthoscelides pallidipennis</i>	NA	<i>Callosobruchus chinensis</i>	TAS	<i>Spermophagus latithorax</i>	TAF
<i>Bruchidius radiannae</i>	TPAF	<i>Callosobruchus maculatus</i>	TAF	<i>Borowiecius varicolor</i>	TAF
<i>Bruchidius siliquastris</i>	EPAS?	<i>Callosobruchus phaseoli</i>	TAS	<i>Bruchidius atrolineatus</i>	TAF
<i>Bruchidius terrenus</i>	EPAS			<i>Callosobruchus rhodesianus</i>	TAF
<i>Bruchus lentis</i>	PAF?			<i>Conicobruchus albopubens</i>	TAF
<i>Bruchus pisorum</i>	WPAS			<i>Merobruchus julianus</i>	NA
<i>Bruchus rufimanus</i>	PAF			<i>Penthobruchus germaini</i>	SA
<i>Megabruchidius dorsalis</i>	EPAS			<i>Specularius albus</i>	TAF
<i>Megabruchidius tonkineus</i>	TAS			<i>Specularius erythraeus</i>	TAF
<i>Mimosestes mimosae</i>	CA			<i>Specularius impressithorax</i>	TAF
<i>Pseudopachymerina spinipes</i>	SA			<i>Sulcobruchus natalensis</i>	TAF
<i>Caryedon acaciae</i>	TAF			<i>Caryedon angeri</i>	TAF
<i>Caryedon serratus</i>	TAF			<i>Caryedon gonagra</i>	TAS
				<i>Caryedon longipennis</i>	TAF
				<i>Caryedon pallidus</i>	TAF
				<i>Caryedon sudanensis</i>	TAF
				<i>Caryobruchus gleditsiae</i>	NA
				<i>Caryopemon cruciger</i>	TAF
				<i>Caryopemon lholstei</i>	TAS
				<i>Pachymerus cardo</i>	CSA
15		5		22	

In terms of biogeographical origin, the results are similar (Table 5). Species of Afrotropical origin are clearly most abundant, with 19 species representing 42.2% of the total. The other species groups fall some distance behind: species of Palaearctic origin (especially represented by those of Palaearctic Asian origin; Table 4) come second with 8 species (17.8%); species of Oriental origin next with 7 species (15.6%); species of Neotropical origin with 6 (13.3%) and finally Nearctic species with 5 (11.1%).

Tables 4 and 5 show the number and proportion of species according to origin, under the new proposed criteria. If we consider only ‘established’ species and their continental origin (Table 4), we note that the African, Asian (both tropical and Palaearctic) and American species are equally dominant, each with 5 species. This is a very different proportion to that provided by Beenen & Roques (2010) in their only category: ‘established’. The Asian species dominate in the ‘non-established’ category with 3 species, but among those considered ‘occasional’, the most numerous are of African origin with 15 species, all of which have been introduced to Europe with ornamental plants.

TABLE 4. Numbers of alien species of Bruchinae to Europe according to their native range versus their status. See Table 2 for abbreviations. Note that total and occasional numbers do not coincide with the final list of species given in this paper because *Spermophagus abdominalis* has a wide native range encompassing the TAF and TEPAS areas.

	Established species	Non-established species	Occasional species	Total
NA	2	0	3	5
CA	1	1	0	2
CSA	1	0	1	2
SA	1	0	1	2
PAF	2	0	0	2
TPAF	1	0	0	1
TAF	2	1	15	18
WPAS	1	0	0	1
EPAS	3	0	0	3
TAS	1	3	2	6
TEPAS	0	0	1	1

If biogeographical origin is taken into account, we observe very different numbers and proportions among species of ‘established’ status (Table 5). Within this category, species of Palaearctic origin are the most important with 7 species (43.7%). This dominance is not surprising due to climatic and ecosystem similarities between North Africa and the western and eastern parts of Palaearctic Asia, from where these species originate, and South and Central Europe (especially the Mediterranean), where they have mainly become established. Of the ‘non-established’ species, bruchids of Oriental origin are the most abundant, with 3 species representing 60% of the total in this category. Finally, bruchids of Afrotropical origin are clearly dominant in the ‘occasional’ category, constituting 15 species (62.5%). European phytosanitary authorities should pay more attention to the control of food and ornamental plants from tropical Africa, from where more potential bruchid species could become invasive in future. Figures 1 and 2 show these results on a comparative basis.

TABLE 5. Numbers and percentage (in brackets) of alien species of Bruchinae in Europe according to main biogeographic region of origin versus status. Brackets within the different statuses: first number corresponds to percentage within the category, second number refers to percentage of total. Note that total numbers do not coincide with the final list of species given in this paper because *Spermophagus abdominalis* and *Bruchidius radiannae* are included in 3 and 2 biogeographic regions respectively.

	Established species	Non-established species	Occasional species	Total
Nearctic	2 (12.5 / 4.4)	0	3 (12.5 / 6.7)	5 (11.1)
Neotropical	3 (18.8 / 6.7)	1 (20 / 2.2)	2 (8.3 / 4.4)	6 (13.3)
Palaearctic	7 (43.7 / 15.6)	0	1 (4.2 / 2.2)	8 (17.8)
Afrotropical	3 (18.8 / 6.7)	1 (20 / 2.2)	15 (62.5 / 33.3)	19 (42.2)
Oriental	1 (6.2 / 2.2)	3 (60 / 6.7)	3 (12.5 / 6.7)	7 (15.6)

Status, Presence and Distribution

Not all of the 42 species of exotic bruchids detected in Europe and its islands can be classified as ‘established’, for the reasons outlined above. We believe that a species is established when it can develop its entire life cycle outdoors (whether in natural or anthropogenic habitat), as this is how an exotic species becomes ‘invasive’. Therefore, we considered it useful to follow the above criteria and distinguish between species that are: ‘established’ (15 species), ‘non-established’ (5 species) and ‘occasional’ (22 species) (Table 3). The 14 species considered ‘established’ in Beenen & Roques’ (2010) catalogue are too many and only 9 of these can be placed in this category according our definition. The remaining 5 species are unable to reproduce outside storehouses and must in our opinion be included under ‘non-established’.

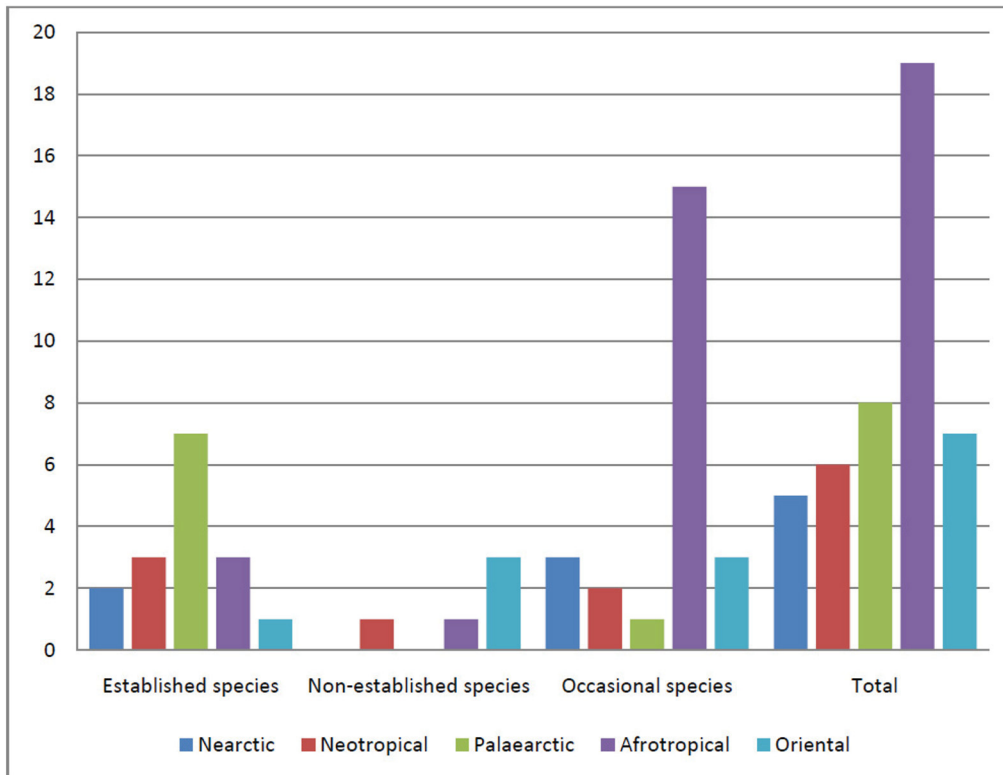


FIGURE 1. Comparative numbers of alien species of Bruchinae in Europe according to main biogeographic region of origin versus status.

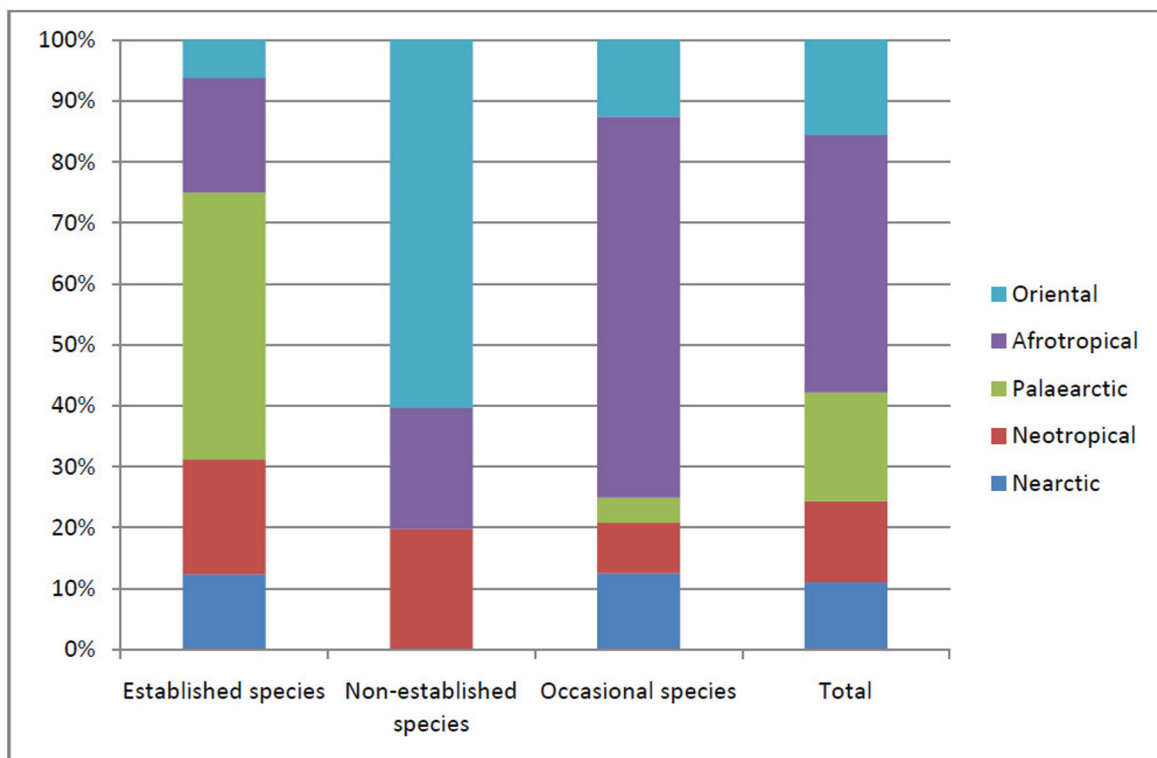


FIGURE 2. Comparative percentages of alien species of Bruchinae in Europe according to main biogeographic region of origin versus status.

Present distributions of alien bruchids in Europe are shown in Figures 3 and 4. Table 6 displays the total number of species of alien bruchids recorded by country, by both status and biogeographical region of origin. Close attention should be paid to the fact that the species cited by country are given according to their status in Europe as a whole and not on a country by country basis. This is especially important for established species, as it means that a species classified as ‘established’ could have been recorded in a country where it is not established. This procedure has been followed due to bioclimatic differences within Europe, which allow for the potential presence of particular species in some countries but not others (reflected in Table 6 and Figure 3).

TABLE 6. Numbers by country of total species recorded, species by status and species by biogeographical origin for alien seed beetles in Europe. See Appendix I for country codes abbreviations.

	Total	Established	Non- Established	Occasional	Nearctic	Neotropical	Palearctic	Afrotropical	Oriental
AD	5	4	1	0	1	1	2	0	1
AL	7	3	4	0	0	2	2	1	2
AM	5	5	0	0	1	1	3	0	0
AT	7	5	2	0	1	2	3	0	1
AZ	2	2	0	0	0	0	2	0	0
BA	5	4	1	0	1	1	2	0	1
BE	11	7	4	0	0	3	4	2	2
BG	11	8	3	0	1	2	5	1	2
BY	4	3	1	0	0	1	2	0	1
CH	10	7	3	0	1	2	4	1	2
CY	6	5	1	0	1	1	2	1	1
CZ	13	8	4	1	1	3	4	3	2
DE	12	9	3	0	1	4	3	2	2
DK	7	5	2	0	0	3	2	1	1
EE	5	3	2	0	0	1	2	0	2
ES	16	11	4	1	1	4	6	4	2
FI	7	4	3	0	0	1	3	1	2
FR	19	10	5	4	1	5	4	3	6
GB	21	4	5	12	0	3	4	12	4
GE	4	4	0	0	0	1	3	0	0
GI	1	1	0	0	0	0	1	0	0
GR	12	8	4	0	1	3	4	2	2
HR	6	4	1	1	1	1	2	1	1
HU	14	10	3	1	2	3	5	2	2
IE	4	3	1	0	0	1	2	0	1
IL	10	5	4	1	0	3	3	1	3
IS	4	3	1	0	0	1	2	0	1
IT	19	10	4	5	2	5	5	5	2
LB	3	3	0	0	0	1	2	0	0
LI	4	3	1	0	0	1	2	0	1
LT	4	3	1	0	0	1	2	0	1
LU	5	4	1	0	1	1	2	0	1
LV	4	3	1	0	0	1	2	0	1
MC	1	1	0	0	0	0	1	0	0

.....continued on the next page

TABLE 6. (Continued)

	Total	Established	Non- Established	Occasional	Nearctic	Neotropical	Palaeartic	Afrotropical	Oriental
MD	4	3	1	0	0	1	2	0	1
MK	5	4	1	0	1	1	2	0	1
MT	4	3	1	0	0	1	2	0	1
NL	6	3	2	1	0	2	2	1	1
NO	4	3	1	0	0	1	2	0	1
PL	11	7	4	0	1	4	3	1	2
PT	8	5	3	0	0	3	2	2	1
RO	5	4	1	0	1	1	2	0	1
RS	6	5	1	0	1	1	3	0	1
RU	9	6	3	0	1	1	3	1	3
SE	7	5	2	0	0	1	3	2	1
SI	4	3	1	0	0	1	2	0	1
SK	7	6	1	0	1	1	4	0	1
SY	5	5	0	0	0	2	3	0	0
TR	8	8	0	0	0	3	5	0	0
UA	5	4	1	0	0	1	3	0	1

Figure 3A shows that a large number of species of alien bruchids have been recorded in Western Europe: the United Kingdom (UK hereafter), France, Italy and Spain (from the highest number of species to the lowest), followed by countries in Central and Southeast Europe. Of the established species (Figure 3B), a large number of alien seed beetles are present in Southwest Europe (Spain, France and Italy) and Central Europe (Hungary). However, an important number of species is also present in other countries of Central and Southeast Europe. The differences are even smaller when only the non-established species are considered (Figure 3C) as they do not show a clear pattern, with a similar number of species recorded in countries of Southern, Central and Northern Europe. For ‘occasional’ species (Figure 3D), by contrast, there are three countries (the UK being especially noteworthy, together with France and Italy) where a clear effort is made by phytosanitary authorities and entomologists to detect and identify species of exotic bruchids found in imported food and ornamental goods.

In terms of biogeographical region of origin, Figure 4 shows that the five Nearctic species are widely and equally distributed in Southern, Central and Northern Europe (Figure 4A). Species of Neotropical origin are primarily recorded from Western Europe (Figure 4B): France and Italy have the highest totals (5 species each), but other countries in Western, Central and Southeast Europe have similar numbers (3 or 4 species). Species from the Palaeartic outside of Europe seem to be especially abundant in Southern Europe, becoming gradually less frequent to the north, although records are distributed throughout Europe (Figure 4C). Afrotropical species are recorded especially frequently in Southwest Europe, with the noteworthy exception of the UK (Figure 4D) from where 12 species have been recorded, the highest total for any European country. This is basically due to the many species of tropical African origin of ‘occasional’ status that are recorded (see Figure 3D and Table 2). Finally, species of Oriental origin have been recorded in all European countries, but incidence is highest in France (6 species) and the UK (4 species) (Figure 4E).

Beenen & Roques (2010) listed four species—*Callosobruchus chinensis*, *C. maculatus*, *C. phaseoli* and *Zabrotes subfasciatus*—that cannot be considered ‘established’, because they are unable to reproduce outdoors without controlled environmental conditions and disappear when the appropriate methods of prevention and control are employed. These species have never been found in the natural environment so they cannot be considered ‘invasive’, but they by no means cease to be pests indoors, in grain stores and greenhouses. To these should be added a species of *Callosobruchus*, *C. analis*, an Asian species linked to legumes that are consumed by humans (e.g. *Cicer arietinum* L.). This species has been detected in countries such as Belgium, Finland, France, UK and Estonia (Anton 2010) but has not become established. A single, anecdotal record of *C. rhodesianus* from the UK (Anton 2010) is not considered here.

The case of the paleotropical species *Caryedon serratus* is exceptional because it has been found in tamarinds (*Tamarindus indica* L.) cultivated in gardens on the island of Tenerife (Canary Islands) (Yus Ramos 2008) and can be considered as established here. The Canary Islands are on the African continental shelf and are climatically distinct from continental Europe and the Mediterranean, where there is no evidence that *C. serratus* is reproducing outdoors. *C. serratus* had formerly been detected in dried peanuts (*Arachis hypogaea* L.) imported to continental Spain, but it has not been detected again. Moreover, the European records of *C. serratus* indicated in Beenen & Roques (2010) could refer to similar detections in dried peanuts or even correspond to other species, such as *C. acaciae* or *C. gonagra*, with which *C. serratus* is often confused. It would be necessary to confirm these records by re-examining voucher specimens.

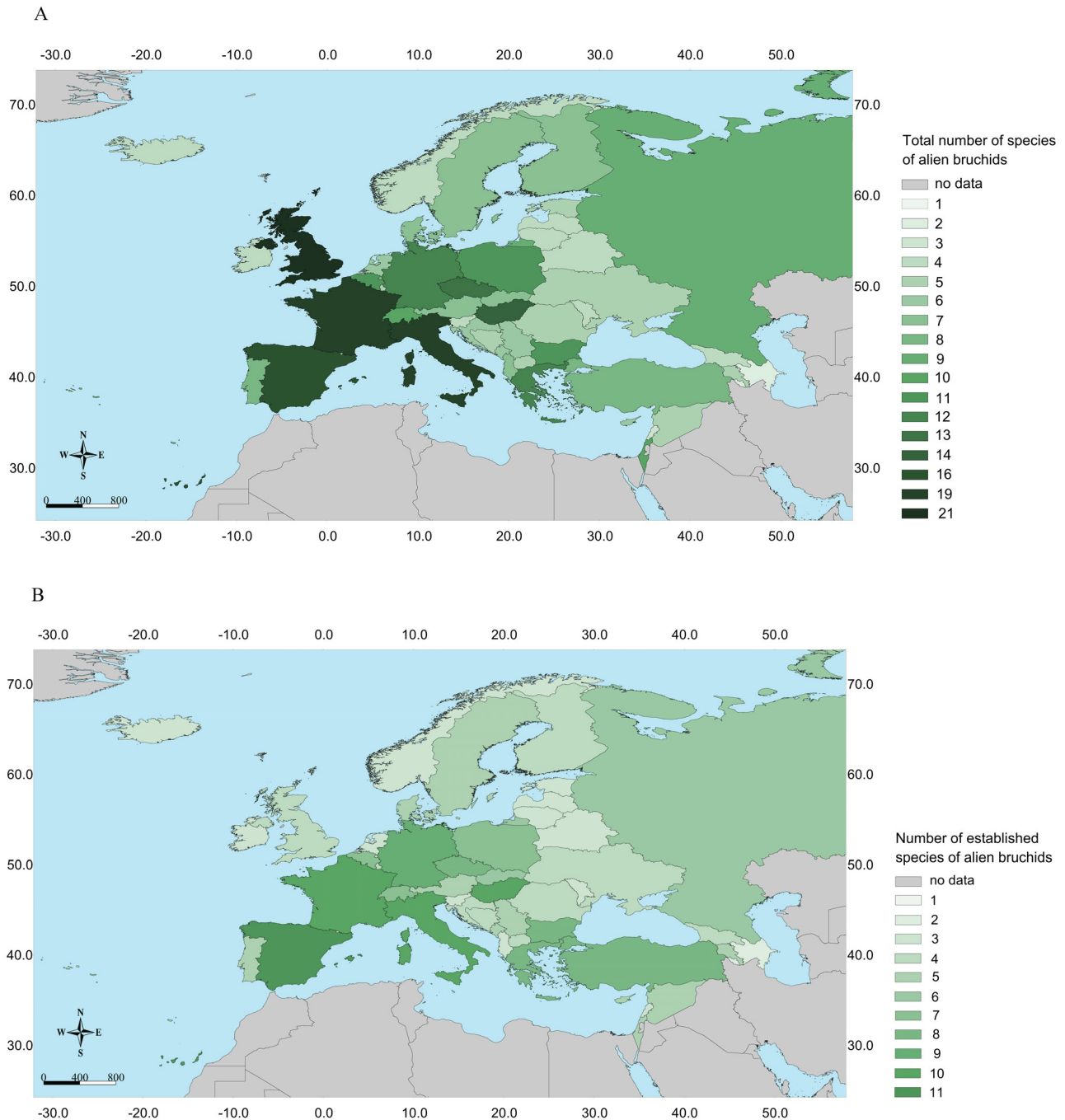


FIGURE 3A, B. Categorical diversity distribution of seed beetle species alien to Europe in continental European countries and their islands, East Mediterranean Asian countries and Caucasian countries, according to their status: A = Total number of species of alien bruchids, B = Number of established species of alien bruchids, C = Number of non-established species of alien bruchids and D = Number of occasional species of alien bruchids.

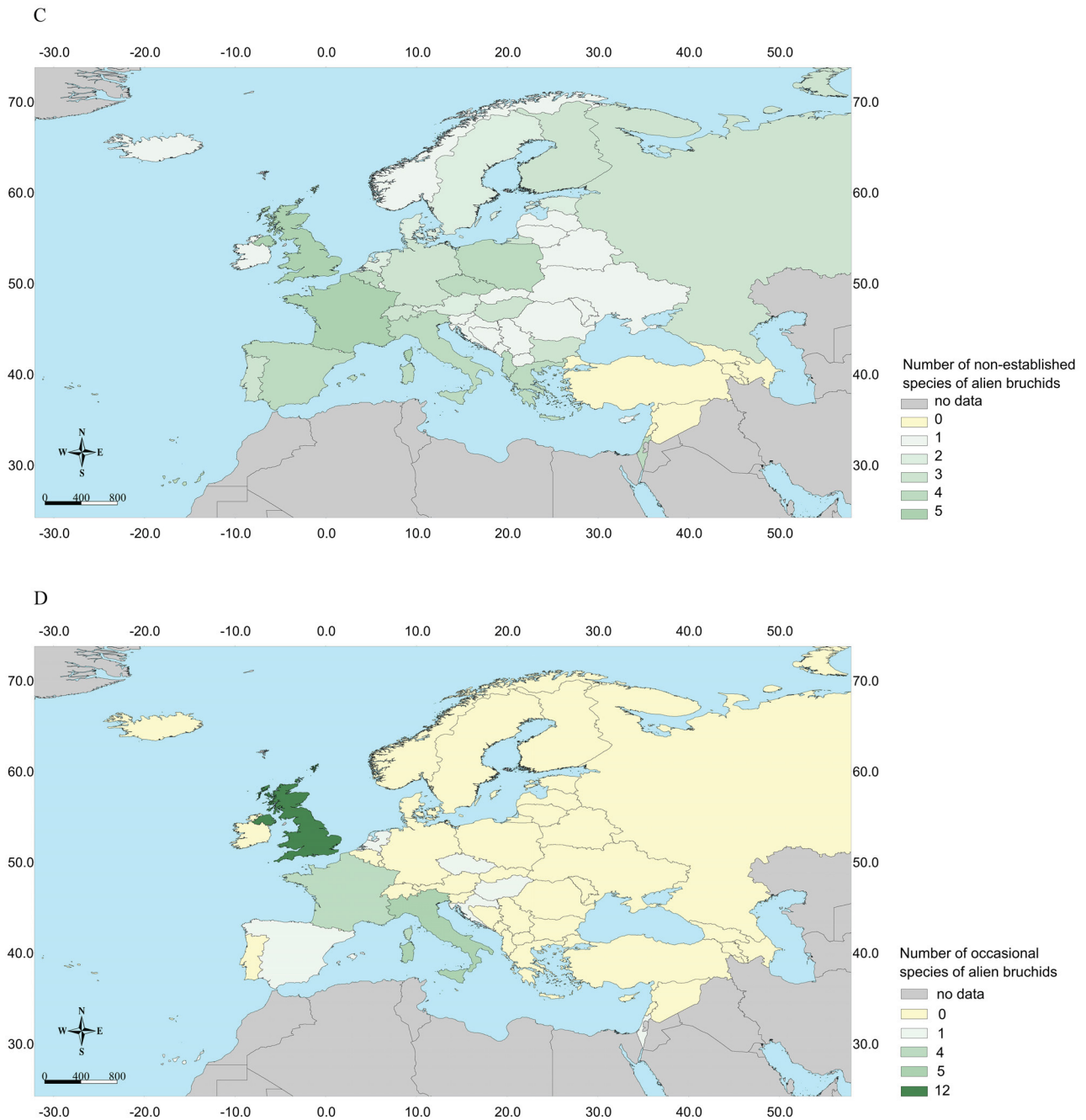


FIGURE 3C, D. Categorical diversity distribution of seed beetle species alien to Europe in continental European countries and their islands, East Mediterranean Asian countries and Caucasian countries, according to their status: A = Total number of species of alien bruchids, B = Number of established species of alien bruchids, C = Number of non-established species of alien bruchids and D = Number of occasional species of alien bruchids.

The case of *Zabrotes subfasciatus* also requires clarification. This is a species of American origin that is a pest of *Phaseolus vulgaris* L.. It has been detected occasionally in some European countries with infested seed lots that have arrived from places where this pest is established. In Europe, *Z. subfasciatus* does not normally leave storehouses because external environmental conditions are not suitable for its development, but within a storehouse it can produce several generations annually, as it is polivoltine. However, we have an outdoor record from Portugal (Yus Ramos 2007b), where it was collected within crops. That does not necessarily indicate that this species is acclimatised, as this record has not been confirmed with subsequent catches and it may only have been the result of some individuals having escaped from a nearby storehouse. Therefore, we consider that this species should not be classified as ‘established’.

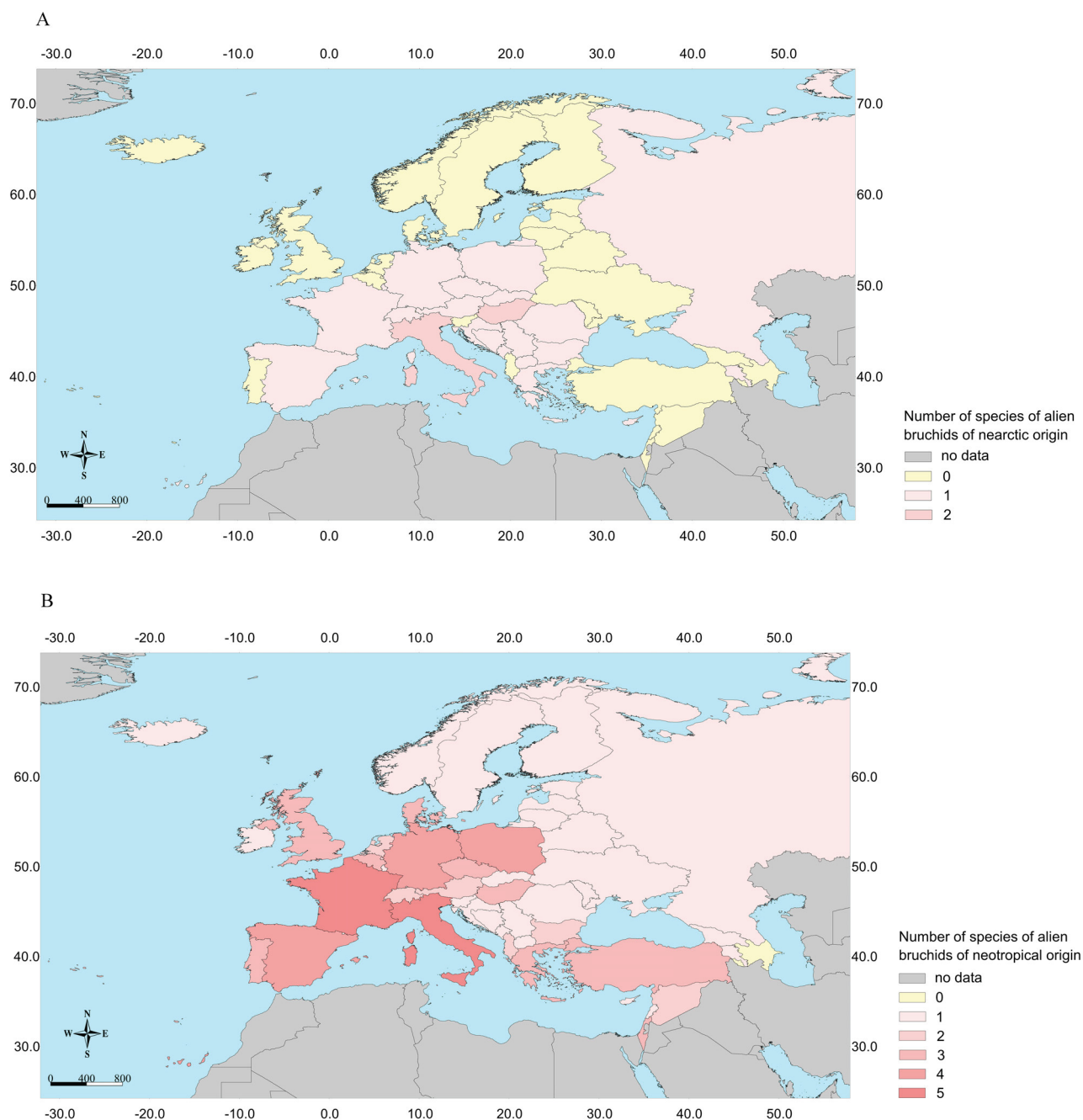


FIGURE 4A, B. Categorical diversity distribution of seed beetle species alien to Europe in continental European countries and their islands, East Mediterranean Asian countries and Caucasian countries, according to their biogeographic origin: A = Number of species of alien bruchids of nearctic origin, B = neotropical origin, C = palaeartic origin, D = afrotropical origin and E = oriental origin.

The catalogue of Beenen & Roques (2010) rightly includes *Pseudopachymerina spinipes* and *Mimosestes mimosae*, two species from the New World that are well adapted to the Mediterranean climate. The first of these, *P. spinipes*, which is of South American origin, was studied by us (Yus Ramos *et al.* 2007a) as it is a well-established species in Spain, both in gardens and in the wild. It is known from the eastern Iberian Peninsula since the early twentieth century (Yus Ramos 1977), using *Acacia farnesiana* (L.) Willd. as its host plant in the absence of its usual host *Acacia caven* (Molina) Molina and displaying a very high rate of infestation. Its taxonomic status was clarified by Decelle (1966) and it has been recorded in numerous southern European countries: Spain, France, Italy, Greece, and Turkey. It has even reached Central Europe: Belgium, Germany and Poland, showing its adaptive capacity. The second species, *M. mimosae*, is Neotropical (Central and South America) and was definitely

imported in the nineteenth century with seeds from the New World (*Phaseolus vulgaris*, *Vicia faba* L., *Cicer arietinum*, etc.). It is not apparently a polivoltine species and does not reproduce in storehouses, so it seeks its hosts outdoors. Although not abundant, it must be considered ‘established’ in Europe. It is known from France, Italy, Denmark, Germany, Hungary, Poland and Turkey (Anton 2010). It has also been detected in mainland Spain (Yus Ramos 1977, 2007a) and the Canary Islands (Yus Ramos 2008).

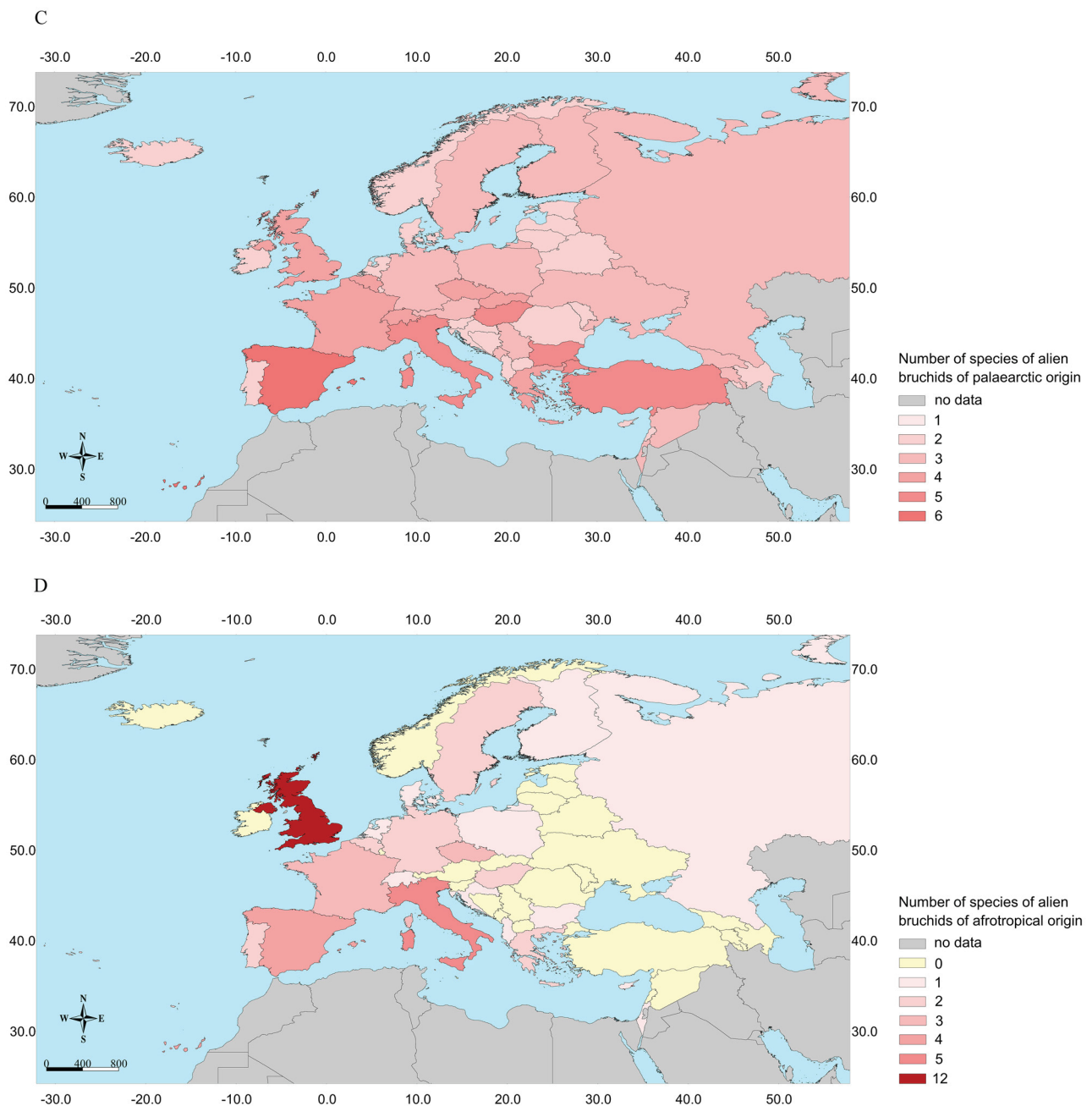


FIGURE 4C, D. Categorical diversity distribution of seed beetle species alien to Europe in continental European countries and their islands, East Mediterranean Asian countries and Caucasian countries, according to their biogeographic origin: A = Number of species of alien bruchids of nearctic origin, B = neotropical origin, C = palaeartic origin, D = afrotrropical origin and E = oriental origin.

Records of the New World genus *Acanthoscelides* are also relevant because two species are well established in Europe. *Acanthoscelides obtectus*, which is of Central and South American origin where it was already an important pest of *Phaseolus vulgaris*, was introduced to Europe in the nineteenth century with infested seeds. Since then, it has adapted perfectly to this new environment, alternating phases of its life cycle in storehouses with others on crops. It is one of the most fearsome pests of *Phaseolus* crops in Europe. The other species, *Acanthoscelides*

pallidipennis is associated with false indigo (*Amorpha fruticosa*), an invasive plant from North America that has spread throughout Central Europe. This exotic bruchid was initially detected by Borowiec (1980) in Bulgaria, who considered it a new species that he named *A. tarnawskii*. It was immediately synonymised by Wendt (1981), who correctly identified it from specimens collected in Hungary and the former Yugoslavia. It was later detected in many other countries, always following its host plant: Albania, Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Italy, Slovakia, Russia, Switzerland and Serbia. This demonstrates its strong invasive tendency.

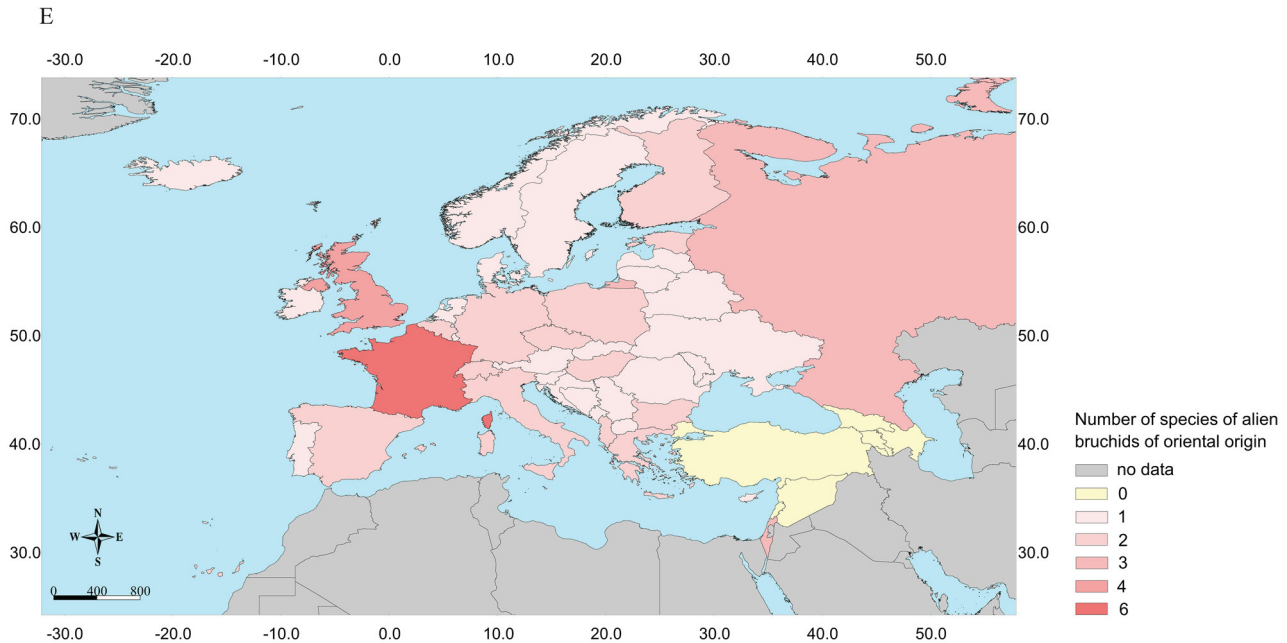


FIGURE 4E. Categorical diversity distribution of seed beetle species alien to Europe in continental European countries and their islands, East Mediterranean Asian countries and Caucasian countries, according to their biogeographic origin: A = Number of species of alien bruchids of nearctic origin, B = neotropical origin, C = palaeartic origin, D = afrotropical origin and E = oriental origin.

Several outbreaks of exotic species have taken place in recent years, establishing themselves in Europe and currently expanding their ranges. Beenen & Roques' (2010) catalogue includes some of these, such as *Megabruchidius dorsalis* (recorded for the first time from Italy by Migliaccio & Zampetti (1989)) and *Megabruchidius tonkineus* (first reported in Germany by Wendt (1980)). These two species have now been recorded beyond their initial localities (Yus Ramos 2009). *M. tonkineus*, which was initially recorded from Germany (Chemnitz), has also been found in Hungary (Budapest and other nearby cities) (Jermy *et al.* 2002, György 2007), Bulgaria (Plovdiv) (Stojanova 2007), France (Montpellier) (Delobel & Delobel 2008), Greece (Thessaloniki) (Yus Ramos 2009), Russia (northwest Caucasus) (Korotyayev 2011) and Switzerland (Bern) (György & Germann 2012). Moreover *M. dorsalis*, which was initially recorded from Italy (Rome), has also been found in Hungary (Budapest) and Switzerland (Basel) (Yus Ramos 2009). Both species reproduce well in gardens that grow its host plant *Gleditsia triacanthos* L. and in Hungary at least they coexist on the same trees (Yus Ramos 2009).

Beenen & Roques (2010) also mentioned *Bruchidius siliquastris*, which was described by Delobel (in Kergoat *et al.* 2007) from France (Montpellier) and cited from other localities in southern France and Hungary. Additional records came from the Iberian Peninsula, where it is present in Spain (Jerez de la Frontera (province of Cádiz, south of Spain) and several localities in the province of Barcelona (northeast of Spain)) and Gibraltar (Yus Ramos *et al.* 2009d). Subsequently, the species has been cited from Belgium (CEBE 2009), Slovakia (Kollár *et al.* 2009), the Czech Republic (Šefrová 2010), Bulgaria (Stojanova *et al.* 2011), Monaco (Ponel *et al.* 2011) and Turkey (Hizal & Parlak 2013). It seems that this species is spreading, especially in parks and gardens with *Cercis siliquastrum* L., its host plant. Its exotic status is doubtful because we cannot be sure of its origin; some authors consider it to be a cryptogenic species. The host plant, *Cercis siliquastrum*, is native to the Mediterranean area and it is unusual that *B. siliquastris* had not been detected until recently, as *C. siliquastrum* is also an ornamental plant that is widespread in cities, gardens and parks throughout the region. According to its author (Delobel in Kergoat *et*

al. 2007), *B. siliquastris* was detected in China in seeds of a tree of the genus *Cercis* L. (not designated to any species). The author thus speculates that this bruchid originated in China, living there in association with an unknown species of *Cercis* and taking *Cercis siliquastrum* as a vicariant host after importation to the Mediterranean area.

Beenen & Roques (2010) included two exotic species of *Bruchus* as established: *B. rufimanus* and *B. pisorum*. We agree because both species are now common in the wild but appear to be native to Asia Minor and Africa, eventually spreading throughout the Mediterranean and then around the world. They are now subcosmopolitan due to commercial trade in seeds: beans (*Vicia faba*) in the case of *B. rufimanus* and peas (*Pisum sativum* L.) in the case of *B. pisorum*. However, we must clarify some points. *Bruchus lentis* should be included in this list of exotic bruchids to Europe. This is a species of unknown origin but is very common in North Africa, from where it possibly originates. From there it would have spread through southern and central Europe, becoming the most serious pest of lentils (*Lens culinaris* Medik.) in Spain, southern France, Italy and Greece. Moreover, in the aforementioned catalogue, the detection dates for the two species in Europe are given as 1850 for *B. pisorum* and 1894 for *B. rufimanus*, when in fact these pests (or very probably these same species) were already known since ancient times. For example, bruchid pests are known from lentils that are over 5,000 years old (Burleigh & Southgate 1975) and from beans in the ancient Roman city of Pompeii from over 2,000 years ago (Jashemski 1974). In addition, the original description of these species was based on specimens collected in Europe well before the dates given by Beenen & Roques (2010). Other introductions of exotic species from distant countries were detected much later, in the eighteenth and nineteenth centuries, when traffic of seeds became much more intense thanks to advances in intercontinental transport systems.

We found that many species that have been recorded in Europe currently hold the status of 'occasional' rather than 'established'. This is the case with *Amblycerus robiniae*, a species of North American origin that is associated with *Gleditsia triacanthos*. This species was detected in Hungary (Merkl 2001) from seeds of its host plant imported from the USA, but since then it has not been recorded again in Europe. Another case is that of *Borowiecius varicolor*, a species of Afrotropical origin that was intercepted in Italy in 1833 with seeds of its host plant *Rhynchosia* Lour. and identified by Boheman as *Bruchus varicolor* (Anton 2010). A similar case is with species of the genus *Specularius* from the Afrotropical region, such as *S. albus* in Italy, and *S. impressithorax* in Britain (Anton 2010), both of which were recorded with seeds of their host plants, the ornamental genus *Erythrina*. *S. impressithorax* was also recorded recently in the Netherlands (Heetman & Beenen 2008), also from *Erythrina* seeds that had been imported for ornamental purpose, but as with other cases it has not been found again. Another rare species of Central and North American origin is *Merobruchus julianus*, cited from Sicily (Italy) by Migliaccio & Zampetti (1989) and possibly imported with seeds of *Acacia berlandieri* Benth.. That record has not been confirmed subsequently with more interceptions. Another case is that of *Penthobruchus germani*, first detected in 1893 in the botanical garden of Bordeaux (France) from the seeds of its host plant *Parkinsonia aculeata* L. from Montevideo (Uruguay). It was originally identified as *Pachymerus germani* (see Hoffmann 1945). The species was later found in Sicily (Italy) (Anton 2010). Both of these are occasional findings that are typical of non-established species.

A large group of species that are of occasional occurrence in Europe are the Pachymerini, of which only *Caryedon germari* can be considered indigenous in Eastern Europe. Of the 11 exotic species of this tribe found in Europe, only *Caryedon acaciae* can be considered established, in southern Spain, where it uses *Acacia karroo* Hayne as its host plant (Yus Ramos & Coello 2007, 2008c). It is also reported occasionally from Hungary (Anton 2010). *C. serratus* has been recorded from Tenerife (Canary Islands) on tamarinds (*Tamarindus indica*) (Yus Ramos 2008) and may eventually attack peanuts (*Arachis hypogaea*). It has been detected in countries such as Belgium, Cyprus, the Czech Republic, France, Germany, Greece, Italy, Portugal, Spain and Sweden. The remaining nine species (Table 2) should be considered occasional (Table 3), since they are not well-adapted to European ecosystems. In addition to these two species, the following species of the genus *Caryedon* have appeared in Europe: *C. angerei*, a rare species of African origin, which was found once in Croatia (Anton 2010), probably from some imported *Acacia* Mill.; *C. gonagra*, a species from the Oriental region that is detected occasionally in France (Anton 2010) and is sometimes confused with *C. serratus*, with which it was considered synonymous, having been revalidated recently by Delobel *et al.* (2003); *C. longipennis*, which was formerly included in the genus *Caryoborus*, was detected in Great Britain (Anton 2010), possibly from imported seeds of *Combretum* Loeffl. (Combretaceae); *C. pallidus*, an African species initially included in the genus *Caryoborus* is a frequently recorded

species that has usually been confused with other species but the only reliable record is from Italy (Anton 2010), where it was possibly intercepted from seeds of *Cassia* L.; *C. sudanensis* is also very rare. It is also of African origin and has been recorded in Great Britain (Anton 2010), probably from Sudanese seeds of *Senna alexandrina* Mill..

Very few records exist of the genus *Caryopemon*. For example, the Oriental species *C. cruciger* has been detected in the Czech Republic and the UK (Anton 2010), but also recently in Montpellier (France) (unpublished data), possibly from seeds of *Abrus precatorius* L.. Hoffmann (1945) also cites *C. thostei*, detected in Paris (France) in seeds of *Abrus precatorius* from Sri Lanka, the seeds of which are often used as necklace beads. Also, only one record of the Neotropical species *Pachymerus cardo* (Fåhræus, 1839) exists, recorded from the UK by Duff (2012). Finally, *Caryobruchus gleditsiae* is a common Pachymerini from the southern United States, where it develops in seeds of the sabal palm (*Sabal palmetto* (Walter) Lodd. Ex Schult. & Schult.f.) (Arecaceae). The species was recorded by Anton (2010) from Spain alone, but his record probably refers to our previous finding (Yus Ramos 2008) on the island of Tenerife (Canary Islands) and not mainland Spain. A specimen was found alive outdoors in the botanical garden of Santa Cruz de Tenerife. It was near its host plant, several sabal palms that had apparently been imported from Florida (USA). However, it has not been confirmed with more specimens, so we doubt that this species has been able to become established, although the climate of the Canary Islands could allow its development.

New Arrivals

There are some species among the outbreaks of exotic bruchids that have occurred in Europe recently that do not appear in Beenen & Roques' (2010) catalogue. Two bruchid species of African origin—*Bruchidius raddiana*, previously described from North Africa by Anton & Delobel (2003), and *Caryedon acaciae*—were found in the provinces of Cádiz and Málaga (southern Spain) (Yus Ramos & Coello García 2007, 2008a). Both species are now well established in that area of the Iberian Peninsula. They are common on African acacias (*Acacia tortilis* subsp. *raddiana* (Savi) Brenan), but in Spain they use a different acacia as host, hitherto unknown as the plant host of these species and highly invasive: *Acacia karroo*. Both bruchids coexist on the same trees, but while *Bruchidius raddiana* specialises in legumes remaining on the tree, *Caryedon acaciae* prefers legumes that have fallen on the ground. The level of infestation is very high and we think that their expansion around the Mediterranean is likely, as *Acacia karroo* is a weed or cultivated as a hedge throughout the region.

Other exotic seed beetles that have been detected in recent years are *Acanthoscelides macrophthalmus* in Cyprus (Vassiliou & Papadoulis 2008), associated with *Leucaena leucocephala* (Lam.) de Wit, and *Bruchidius terrenus* in Bulgaria (Stojanova 2010), associated with *Albizia julibrissin* Durazz., both with very high infestation levels (> 80% of the seeds examined). The first species, *A. macrophthalmus*, is native to Central and South America where it feeds on seeds of trees and shrubs of the genus *Leucaena* Benth., including *Leucaena leucocephala*. *Bruchidius terrenus* is from the Eastern Palaearctic region, where it was already known as a pest of *Albizia* Durazz. and other Fabaceae such as *Robinia pseudoacacia* L. and *Acacia confusa* Merr.. Both species grow well outside, but *A. macrophthalmus* has not been found away from its current European location. This suggests that it has been introduced recently, but *a priori* it seems that this bruchid would not have problems reproducing and spreading throughout southern Europe, following a similar distribution pattern to other recently introduced species such as *Megabruchidius tonkineus* or *Bruchidius siliquastri*. In fact, the second species, *B. terrenus*, has already been detected on *Albizia julibrissin* in northwest Greece (Stojanova 2010), in the province of Barcelona (northeast Spain) (Yus Ramos *et al.* 2011), Turkey (Istanbul) (Hizal & Parlak 2013) and Italy, under *Eucalyptus* L'Hér (Myrtaceae) bark (Yus Ramos *et al.* 2011).

Modes of Introduction

In terms of introduction pathways, we considered two categories: food (human or livestock) and horticulture (ornamental and forestry). From these categories, we note that the majority of species (27 in total) entered Europe with plants imported for horticultural reasons: 64% versus 36% that were imported with food. Among the

'established' species, the ratio is maintained, with the horticultural category having a ratio of 67%, whereas in the 'non-established' species all species fall into food category. Finally, among the 'occasional' species, almost all were introduced by means of horticulture. This pattern is possibly due to a greater relaxation in customs control of species of horticultural interest, possibly because losses due to pests have a lower economic impact on horticulture than in food. If so, it would be advisable to increase the knowledge of how to detect these insects as the damage, although not of direct economic importance, could potentially be very important for European ecosystems especially if, as is the case with *Bruchidius siliquastris*, an invasive species of bruchid attacks a native species of plant.

Taxonomic Characterisation

In order to facilitate the identification of the genera of 37 (of 42 recorded) exotic species of bruchids (established and non-established) in Europe, we have developed the following key, using external characters of adults and supplementing it with images (see the plates). Leaving aside the genera *Spermophagus* (2 species), *Conicobruchus* (1 species), *Sulcobruchus* (1 species) and *Pachymerus* (1 species), whose exotic species are extremely rare in Europe (found only once in imported seeds, all in the UK and over a century ago), the following key will assist in identifying the most relevant genera according to their frequency of detection in Europe.

Key to genera of exotic bruchids detected in Europe

- 1 Right hind tibia without mucro but with two acute and moveable long apical spurs, like pronounced spines (Fig. 5A); hind femur usually without spurs on its inner edge (only in rare cases with no more than one short and blunt tooth) (Fig. 5A); sub-rounded body, sometimes elongated (Amblycerini) 3
- Hind tibiae straight or curved without moveable spurs, sometimes with only a mucro in the inner apical angle, more or less long than the small apical spines forming the crown (Fig. 5B); hind femur with or without spines or denticles on its inner edge (Fig. 5B); body generally oval-oblong 2
- 2 Antennae shorter or longer than half body length but never longer than the body length; hind femur thicker and wider than the fore and middle femur, often with one or more teeth along its inner edge (Fig. 5B); hind tibia straight, longer than femur, without spines at the apex (Fig. 5B); eyes notched and rarely protruding (Fig. 5C); pygidium large, not covered by elytra; pubescence often forming a pattern of spots or bands (Bruchini) 4
- Antennae always shorter than half body length; hind femur more strongly widened, much wider than coxa, one carina along its inner edge with a crest or comb, often denticulate (Fig. 5D); hind tibia curved; eyes not notched and strongly protruding forward (Fig. 5E); pygidium relatively small and partially covered by elytra; pubescence monotonous, usually yellowish red, not forming a striking pattern of spots or bands (Pachymerini) 14
- 3 Body more elongated; eyes emarginated at most to one third of their length (Fig. 5F); metathorax with parasutural striae on each side of the pleural groove; fore coxae well separated by the prosternal process (Fig. 5G) *Amblycerus*
[One species: *Amblycerus robiniae* (Fabricius, 1781) (Fig. 7A), not established, occasional]
- Body rounded; eyes emarginated at most up to half of their length (Fig. 5H); metathorax without parasutural striae; fore coxae contiguous or separated only by a thin vertical plate (Fig. 5I) *Zabrotes*
[One species: *Zabrotes subfasciatus* (Fabricius, 1781) (Fig. 7B), not established but may be a pest in stored seeds]
- 4 Pronotum square or trapezoidal, transverse, usually with a lateral denticle (Fig. 5J); hind femur with a concavity resulting in a blunt or sharp denticle in the external ventral margin (Fig. 5K); male middle tibia with apical spines or plates (Fig. 5L)
. *Bruchus*
[Three species: *Bruchus pisorum* (Linnaeus, 1758) (Fig. 11E), *B. rufimanus* Boheman, 1833 (Fig. 11A) and *B. lentis* Froelich, 1799 (Fig. 11I), all established and can be pests on crops, but not stored seeds]
- Pronotum usually campaniform, conical or concave, rarely transverse, always without lateral denticle (Fig. 5M); hind femur without concavity, denticles or spines, or spines on inner ventral margin, or with concavity, spines and/or denticles on the carina of inner margin, outer margin or both (Fig. 5N); male middle tibia usually without apical spines or plates 5
- 5 Hind femur ventrally bicarinate with a concavity that produces an anteapical denticle on each carina of the internal and external ventral margins (Fig. 5O) 6
- Hind femur with only one ventral carina in the lower inner margin, with or without concavity, denticle or series of anteapical denticles (pecten) (Figs. 5P, Q) 7
- 6 Subapical denticles of the hind femur acute (Fig. 5O), sometimes the external is blunt, in which case elytra lack basal tubercle; dimorphic antennae, but if not then the pre-scutellar gibbositities at base of pronotum have a white pubescence
. *Callosobruchus*
[Four species, *Callosobruchus analis* (Fabricius, 1781) (Fig. 14C), *Callosobruchus chinensis* (Linnaeus, 1758) (Fig. 14A), *Callosobruchus maculatus* (Fabricius, 1775) (Fig. 14G) and *Callosobruchus phaseoli* (Gyllenhal, 1833) (Fig. 14E), none established, but may be pests in storage].

- Subapical denticles of the hind femora unequal, the outer is blunt and the inner is sharp (Fig. 5R); elytra with one basal tubercle on 4th–5th interstria; antennae not sexually dimorphic, with no white pre-scutellar gibbosity at base of pronotum *Borowiecius*
[A single species: *Borowiecius varicolor* (Boheman, 1833) (Fig. 7C), not established, occasional]
- 7 Hind femur without spines, or with simple subapical spines or with robust spines forming a pecten (Figs. 5P, Q); posterior margin of the spine sometimes serrated 8
- Hind femur always with at least two subapical spines or forming a pecten (Fig. 5S) 10
- 8 Hind femur without subapical spines, or with a single spine, posterior margin of the spine serrated (Fig. 5T); antennae without sexual dimorphism; pronotum with gibbosity; female pygidium always with two elongated holes or pits (Figs. 12D, H); body relatively bulky *Megabruchidius*
[Two species: *Megabruchidius tonkineus* (Pic, 1904) (Fig. 12A) and *M. dorsalis* (Fahraeus, 1839) (Fig. 12E), both established in gardens and parks]
- Hind femur with at least one subapical spine, not serrated along its posterior margin (Fig. 5B); antennae with or without sexual dimorphism; female pygidium rarely with tiny holes or pits and if so, body length 3 mm or less and lacking pronotal gibbosity 9
- 9 Hind femur with or without denticle in the lower inner margin of its subapical area; when present, the denticle is tiny, narrow and weak (Fig. 5N); Old World species *Bruchidius*
[Three species: *Bruchidius raddianae* Delobel & Anton, 2003 (Fig. 10G), *B. siliquastris* Delobel, 2007 (Fig. 10A) and *B. terreus* (Sharp, 1886) (Fig. 10D), established in gardens and parks; also in natural habitats]
- Hind femur with or without denticle in the lower inner margin of its subapical area; when present, denticle usually relatively robust, often wide at the base and sometimes followed by other anterior denticles that become progressively smaller, like a pecten (Fig. 5Q); New World species *Acanthoscelides*
[Three species: *Acanthoscelides macrophthalmus* (Schaeffer, 1907) (Fig. 9C), *A. obtectus* (Say, 1831) (Fig. 9E) and *A. pallidipennis* (Motschulsky, 1884) (Fig. 9A), all established, one of them (*A. obtectus*) constitutes a pest of crops, with cycles in storehouses; the other two in gardens and parks or in natural habitats]
- 10 Antenna shorter, slightly dentate, not reaching the base of the pronotum in both sexes, sometimes longer, but then pectinate; pronotum without gibbosity, at most with impressions 11
- Antenna longer, dentate or serrate, reaching the base of the pronotum in both sexes; pronotum with gibbosity 13
- 11 Female pygidium with a large, wide, round and polished area (Fig. 6A); antennae short in both sexes, not extending to the hind coxae; if antennae longer, then pectinate; pronotum with impressions; body robust *Specularius*
[Two species: *Specularius albus* (Pic, 1928) and *S. impressithorax* (Pic, 1932) (Fig. 7D), not established; occasional]
- Female pygidium without polished area; antennae always short in both sexes; pronotum without impressions; body more slender 12
- 12 Abdominal sternites with polished area; ventral groove of hind femur polished; elytral striae clearly punctate; 3rd and 4th elytral striae without impression at base; hind leg with very wide femur and curved tibia (Fig. 6B); elytral pubescence forming checkerboard pattern (Fig. 6D) *Penthobruchus*
[One species: *Penthobruchus germaini* (Pic, 1894), not established, occasional]
- Abdominal sternites without polished areas; ventral groove of hind femur unpolished; hind leg with femur less wide and tibia straighter (Fig. 6C); elytral pubescence dense, variegated *Merobruchus*
[One species: *Merobruchus julianus* (Horn, 1894) (Fig. 8C), not established, occasional]
- 13 Pronotum with evident lateral carina (Fig. 6E); head without hairless area at vertex; male hind femur not grooved ventrally *Pseudopachymerina*
[One species: *Pseudopachymerina spinipes* (Erichson, 1833) (Fig. 7E), established in gardens, parks and natural habitats]
- Pronotum without lateral carina; if carina present, head with hairless area at vertex; male hind femur usually grooved ventrally (Fig. 6F) *Mimosestes*
[One species: *Mimosestes mimosae* (Fabricius, 1781) (Fig. 8A) established, it can attack legume crops without causing infestations; also present in natural habitats]
- 14 Pronotum semicircular, its posterior margin semicircular between the elytra (Fig. 6G); head elongate, eyes emarginated up to half of their length (Fig. 6H); hind femur with wide spines before pecten (Fig. 6I) *Caryopemon*
[Two species: *Caryopemon cruciger* (Stephens, 1831) (Fig. 8E) and *C. lhostei* Pic, 1924, both not established and occasional]
- Pronotum trapezoidal or square, without semicircular posterior margin between the elytra (Fig. 6J); head usually short, eyes emarginate at most until 1/4 of its length (Fig. 6K); hind femur without wide spines before pecten (Fig. 6L) 15
- 15 Pronotal lateral rib obsolete or visible only in the posterior half of lateral margin (Fig. 6J); antenna not serrated (Fig. 6M) *Caryedon*
[Six species: *Caryedon acaciae* (Gyllenhal, 1833) (Fig. 8D), *C. angeri* (Semenov, 1896), *C. gonagra* (Fabricius, 1798), *C. longipennis* (Pic, 1898), *C. pallidus* (Olivier, 1790), *C. serratus* (Olivier, 1790) and *C. sudanensis* Southgate, 1971, none established and all occasional, except *C. acaciae* which is established in gardens and natural habitats]
- Pronotal lateral rib complete (Fig. 6N); antennae serrated from the fourth segment, with basal segment enlarged (Fig. 6O) *Caryobruchus*
[A single species: *Caryobruchus gleditsiae* (Linnaeus, 1763) (Fig. 8B), not established and occasional]

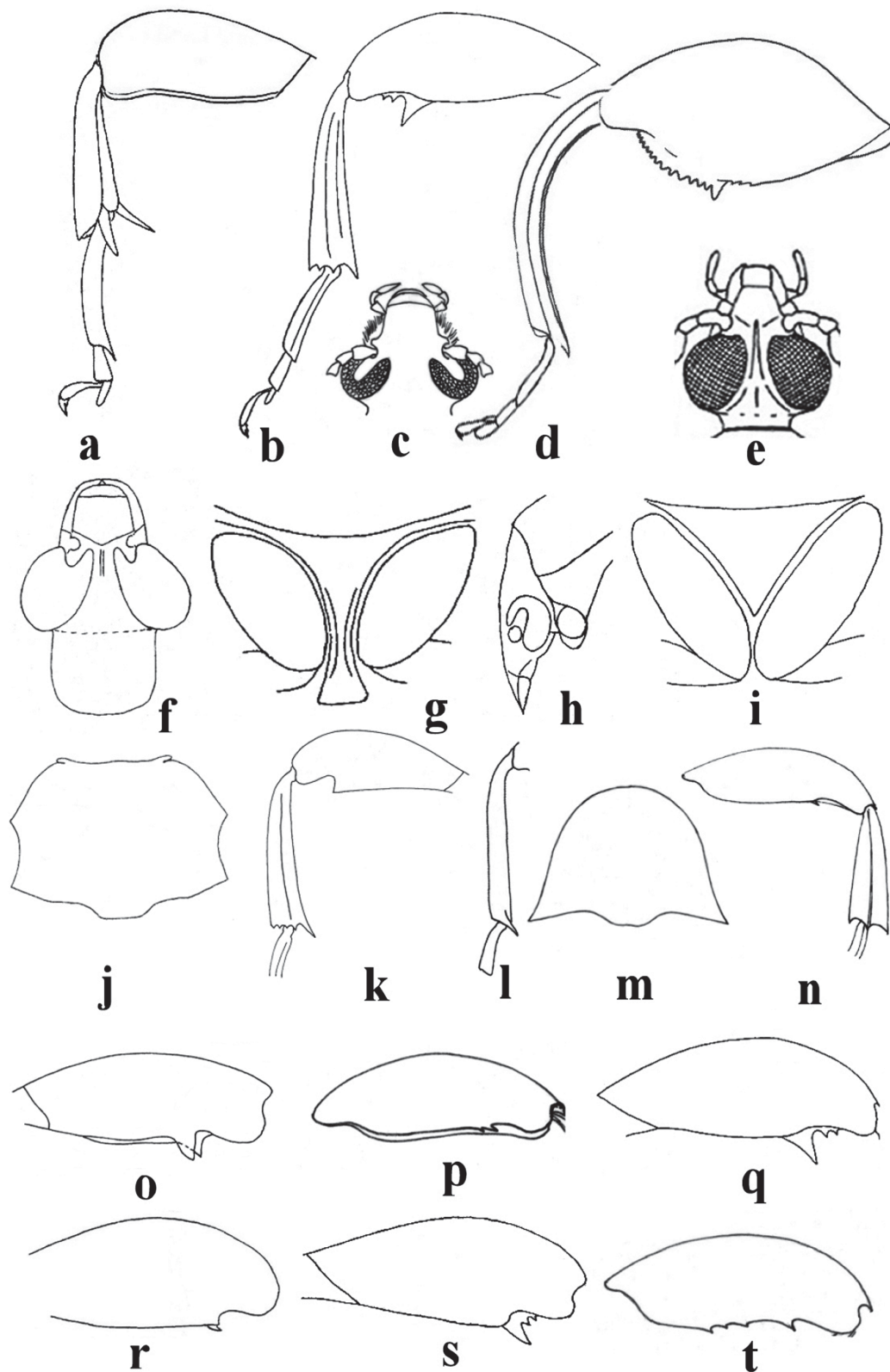


FIGURE 5. A, Hind leg of *Spermophagus*; B, Hind leg of *Acanthoscelides*; C, Head (dorsal) of *Bruchidius*; D, Hind leg of *Caryedon*; E, Head (dorsal) of *Caryedon*; F, Head (dorsal) of *Amblycerus*; G, Fore coxae of *Amblycerus*; H, Head (dorsal) of *Zabrotes*; I, Fore coxae of *Zabrotes*; J, Pronotum of *Bruchus*; K, Hind leg of *Bruchus*; L, Middle leg of *Bruchus*; M, Pronotum of *Bruchidius*; N, Hind leg of *Bruchidius*; O, Hind femur of *Callosobruchus*; P, Hind femur of *Bruchidius*; Q, Hind femur of *Acanthoscelides*; R, Hind femur of *Borowiecius*; S, Hind femur of *Specularius*; T, Hind femur of *Megabruchidius*.

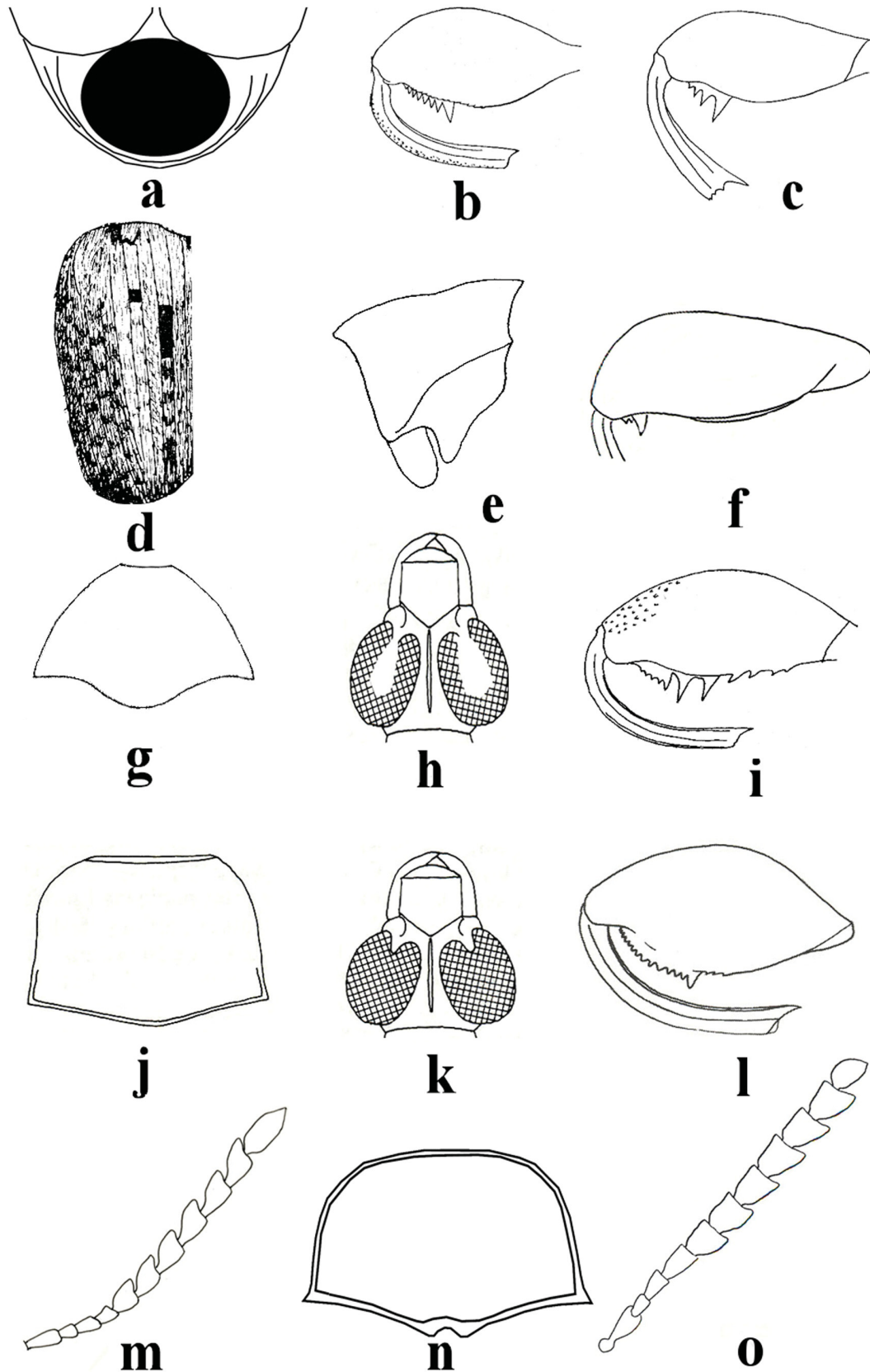


FIGURE 6. A, Pygidium of *Specularius*; B, Hind leg of *Penthobruchus*; C, Hind leg of *Merobruchus*; D, Elytral pubescence pattern of *Penthobruchus*; E, Pronotum (lateral) of *Pseudopachymerina*; F, Hind leg of *Mimosestes*; G, Pronotum of *Caryopemon*; H, Head of *Caryopemon*; I, Hind leg of *Caryopemon*; J, Pronotum of *Caryedon*; K, Head (dorsal) of *Caryedon*; L, Hind leg of *Caryedon*; M, Antennae of *Caryedon*; N, Pronotum of *Caryobruchus*; O, Antennae of *Caryobruchus*.

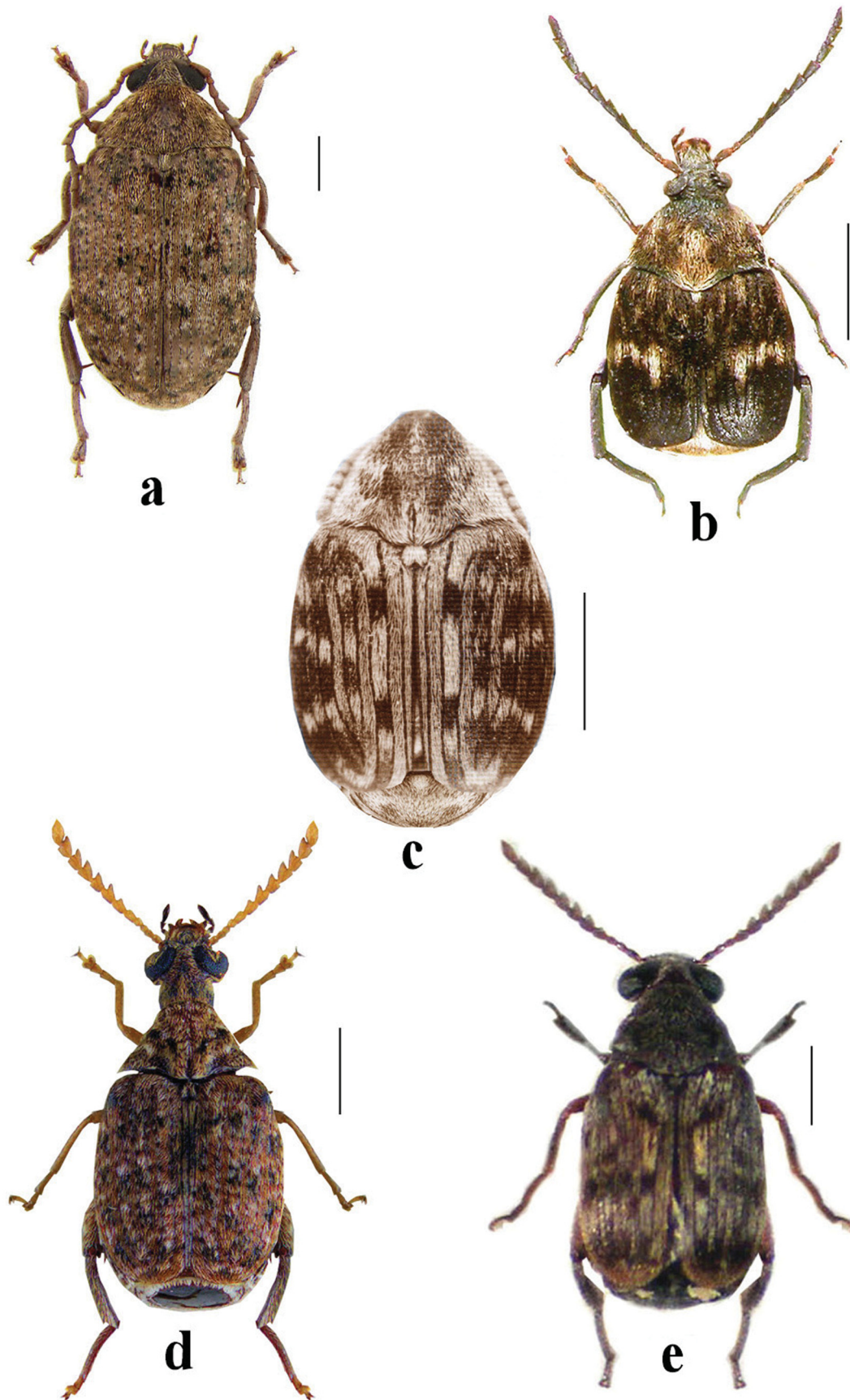


FIGURE 7. Adults of alien Bruchinae to Europe: A, *Amblycerus robiniae*; B, *Zabrotes subfasciatus*; C, *Browiecius ademptus*; D, *Specularius impressithorax*; E, *Pseudopachymerina spinipes*.

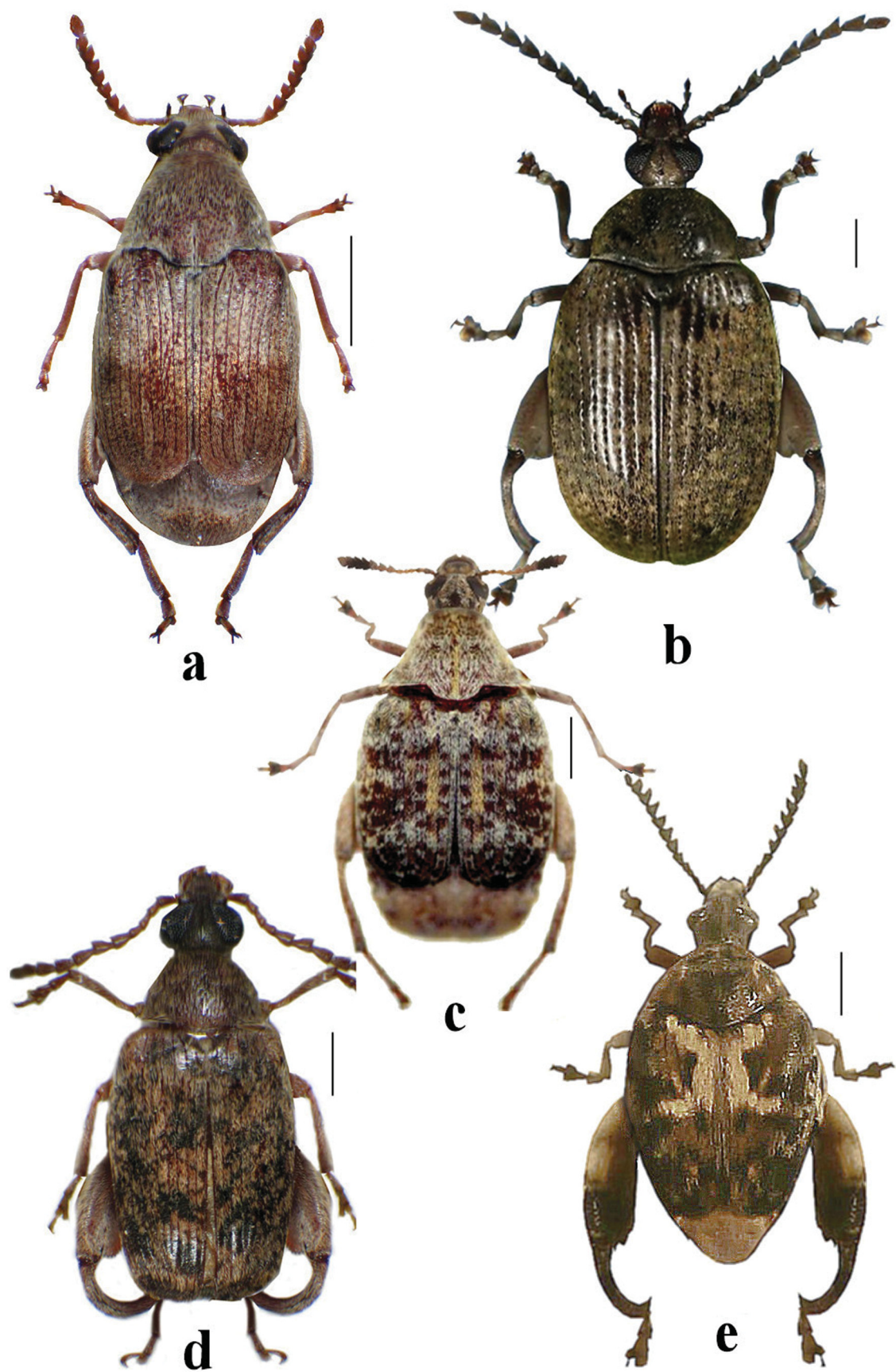


FIGURE 8. Adults of alien Bruchinae to Europe: A, *Mimosestes mimosae*; B, *Caryobruchus gleditsiae*; C, *Merobruchus julianus*; D, *Caryedon acaciae*; E, *Caryopemon cruciger*.

Key to established species of *Acanthoscelides*

(Figure 9)

- 1 Body very small (body length 1.1–2.7 mm); elytra with black integument, often pigmented red in a variable pattern; antennae short, moniliform; hind femur with three individual narrow subapical denticles decreasing in size towards the apex; hind tibia with very long mucro (Figs. 9A, B) *Acanthoscelides pallidipennis*
- Body larger (body length 2.9–4.2 mm); elytra with integument entirely black or entirely reddish, pubescence forming a pattern of spots; antennae longer with more or less dentate segments; hind femur with three wider triangular denticles fused into the base (pecten); hind tibia with shorter mucro 2
- 2 Antennae entirely reddish-yellow; dimorphic, with more protruding eyes and serrate antennae in males; hind femur wider with the 3 denticles of the pecten more robust; elytra with a more defined pattern of light spots (Figs. 9C, D) *Acanthoscelides macrophthalmus*
- Antennae black with reddish base and apex, scarcely dimorphic, with protruding eyes and serrate antennae that are slightly marked in both sexes; hind femur narrower with the two subapical denticles less robust; elytra with spots of low contrast (Figs. 9E, F) *Acanthoscelides obtectus*

Key to established species of *Bruchidius*

(Figure 10)

- 1 Integument black, except the abdomen which is reddish; pubescence sparse, not covering the integument, giving the body a uniform blackish aspect; antennae, hind legs and fore and middle femur entirely black; female pygidium with a pair of elliptical pits that are not flanged (Figs. 10A–C) *Bruchidius siliquastri*
- Integument reddish; pubescence abundant covering the integument, forming patterns of light and dark spots on the elytra; antennae and legs entirely reddish; female pygidium without pits or with flanged pits 2
- 2 Smaller and rounded; light colored pubescence forming white and brown spots; female pygidium with a pair of narrow and flanged elliptical pits; male ventral setiferous spot larger and rounded (Figs. 10G–I) *Bruchidius raddianae*
- Larger and elongated; pubescence dark, forming grey and black spots; female pygidium without pits; male ventral setiferous spot smaller and narrower (Figs. 10D–F) *Bruchidius terrenus*

Key to established species of *Bruchus*

(Figure 11)

- 1 Mucro of the hind tibia longer than the apical denticles of the tibial crown; male middle tibia with an apical spur and a lateral groove; pronotum with a medial lateral tooth (Figs. 11A–D) *Bruchus rufimanus*
- Mucro of the hind tibia not longer than apical denticles of the tibial crown; male middle tibia with an acute apical spur but without a lateral groove; pronotum with a medial lateral tooth or displaced anteriorly 2
- 2 Body length generally exceeding 3.7 mm; lateral tooth of the pronotum large and sharp, apparently displaced anteriorly from the middle area; elytral pubescence forming a contrasting pattern of patches and bands; sometimes with the last antennal segment yellowish (Figs. 11E–H) *Bruchus pisorum*
- Body length not exceeding 3.8 mm; lateral tooth of the pronotum smaller, located in the middle part; elytral pubescence forming a low-contrast pattern of patches and bands; the last antennal segment always black (Figs. 11I–L) *Bruchus lentis*

Key to established species of *Megabruchidius*

(Figure 12)

- 1 Hind tibia with a long apical spur or mucro extending slightly beyond the middle of the first tarsal segment; pronotum subconical, very faintly sinuate laterally; females with narrower pygidial pits; pygidium of female narrower, longer than wide at the base; integument brown; pronotum with less pronounced gibbosity (Figs. 12A–D) *Megabruchidius tonkineus*
- Hind tibia with a shorter spur or mucro, slightly longer than the coronal denticle but not exceeding the basal third of the first tarsal segment; pronotum campaniform, clearly sinuate laterally; females with wider pygidial pits; pygidium of female wider, as long as wide at the base; pronotum with more pronounced gibbosity (Figs. 12E–H) *Megabruchidius dorsalis*

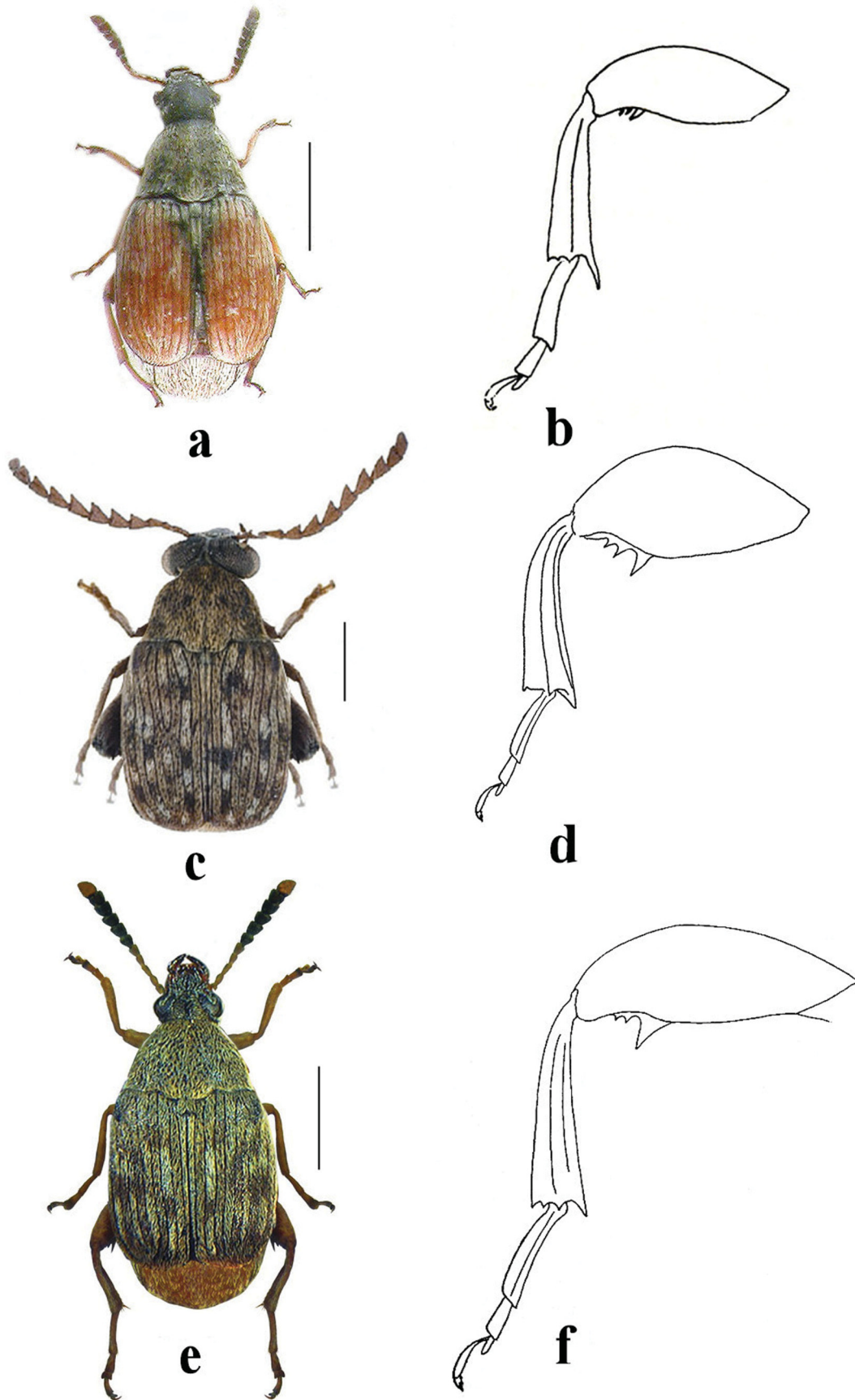


FIGURE 9. *Acanthoscelides* species alien to Europe. A–B, *Acanthoscelides pallidipennis*: A, Adult; B, Hind leg. C–D, *Acanthoscelides macrophthalmus*: C, Adult; D, Hind leg. E–F, *Acanthoscelides obtectus*: E, Adult; F, Hind leg.

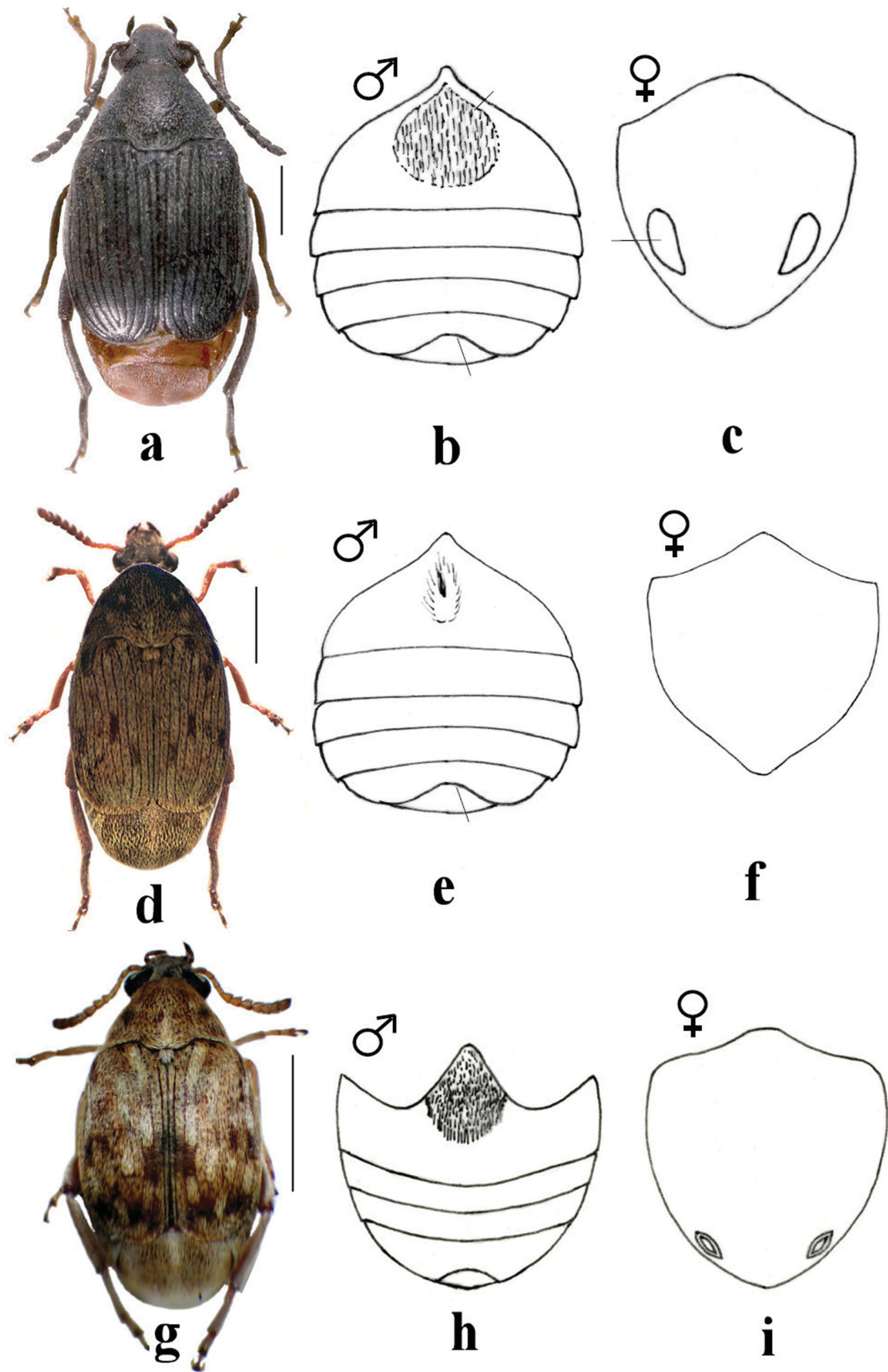


FIGURE 10. *Bruchidius* species alien to Europe. A–C, *Bruchidius siliquastri*: A, Adult; B, Male sternites; C, Female pygidium. D–F, *Bruchidius terrenus*: D, Adult; E, Male sternites; F, Female pygidium. G–I, *Bruchidius raddianae*: G, Adult; H, Male sternites; I, Female pygidium.

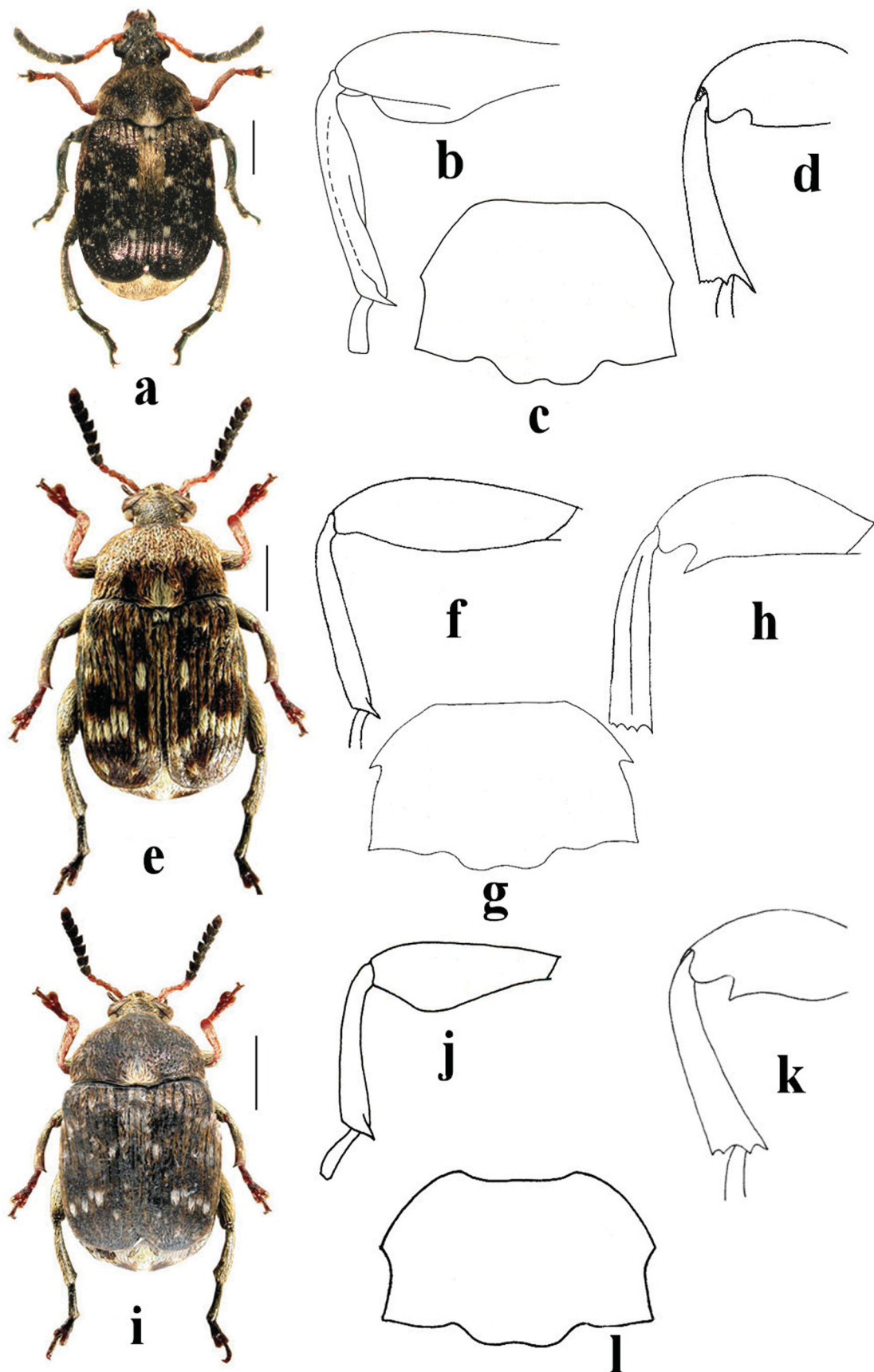


FIGURE 11. *Bruchus* species alien to Europe. A–D, *Bruchus rufimanus*: A, Adult; B, Hind leg; C, Pronotum; D, Middle leg. E–H, *Bruchus pisorum*: E, Adult; F, Hind leg; G, Pronotum; H, Middle leg. I–L, *Bruchus lentis*: I, Adult; J, Hind leg; K, Pronotum; L, Middle leg.

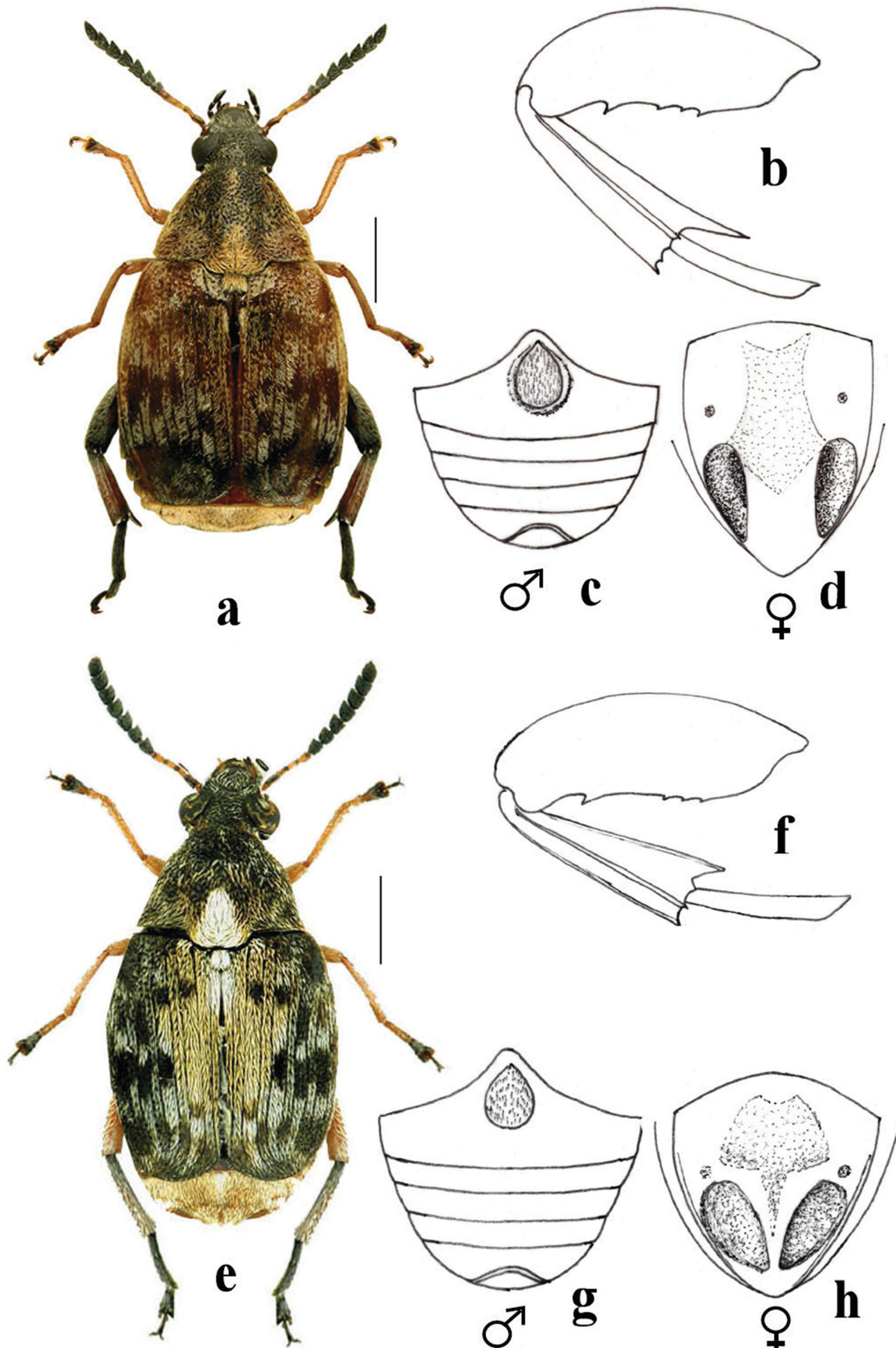


FIGURE 12. *Megabruchidius* species alien to Europe. A–D, *Megabruchidius tonkineus*: A, Adult; B, Hind leg; C, Male sternites; D, Female pygidium. E–H, *Megabruchidius dorsalis*: E, Adult; F, Hind leg; G, Male sternites; H, Female pygidium.

Key to established species of *Caryedon*

(Figure 13)

- 1 Elytra without clearly defined spots or pubescence on the integument, at most indefinite darker lines on the thorax and elytra. Pecten of the hind femur with a first big tooth, followed by 10 or 11 smaller ones (Fig. 13A) *Caryedon acaciae*
- Elytra with clearly defined light or dark spots that are also present on the hind femur and sometimes on the thorax. Pecten of the hind femur with a first large tooth, followed by 12 to 14 smaller ones (Fig. 13B) *Caryedon serratus*

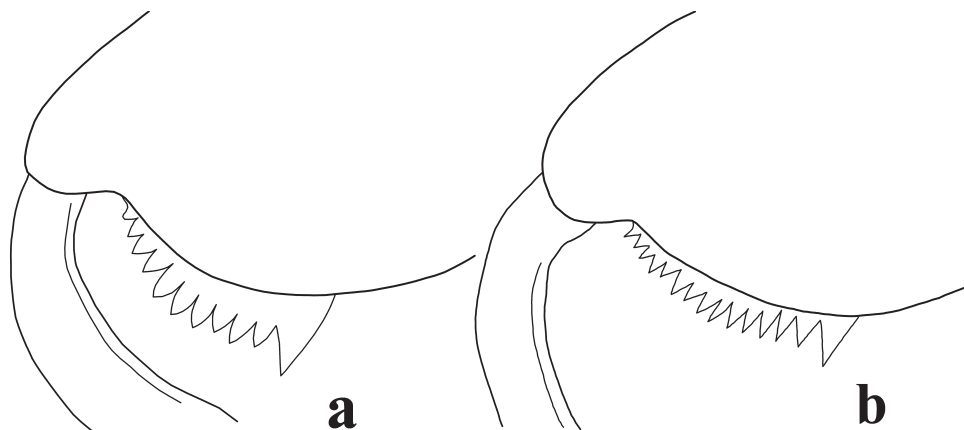


FIGURE 13. *Caryedon* species alien to Europe. A, Hind femur of *Caryedon acaciae*; B, Hind femur of *Caryedon serratus*.

Key to non-established species of *Callosobruchus* (seed storage pests)

(Figure 14)

- 1 Male antennae pectinate; elytral striae 3–4 with prominent subbasal denticles (Figs. 14A–B) *Callosobruchus chinensis*
- Male antennae not pectinate: serrate, crenulate or weakly dentate; elytral striae without subbasal denticles 2
- 2 Male antennae serrate; hind femur with a tooth on the outer side and several smaller internal teeth (sometimes followed by a longer one) (Figs. 14C–D) *Callosobruchus analis*
- Male antennae crenulate or slightly dentate; hind femur with one tooth on each side, but without small teeth on the inner side. 3
- 3 More elongate; hind femur with two equal teeth; eyes very close dorsally, almost making contact (Figs. 14E–F) *Callosobruchus phaseoli*
- Less elongate; hind femur with 2 somewhat unequal teeth, the external being obtuse and the internal acute; eyes not as close dorsally (Figs. 14G–H) *Callosobruchus maculatus*

Invasive species and Non-established Pests

As indicated above, of the 42 species that make up the provisional inventory of exotic bruchids of Europe and its islands, 15 are established and invasive, whereas 5 are not established but can cause serious damage to stored grains. The next section provides summarised information on the most interesting aspects of these 20 species.

1. *Acanthoscelides obtectus* (Say, 1831)

This is a cosmopolitan species of Central and South American origin (Neotropical region), first detected in Europe in 1889 in consignments of *Phaseolus vulgaris* from America. International trade has facilitated its spread and it has now been detected throughout the world. It has been detected in virtually all European countries and is considered one of the most important pests of bean crops. Its potential as a pest is due to the alternation of annual generations in crops (1 generation/year) and in storehouses (2–3 generations/year), with its optimum temperature of development at 27–30°C. Its main host plants are species of *Phaseolus*, but it has also found in *Cicer arietinum*, *Glycine max* (L.) Merr., *Lens culinaris*, *Pisum sativum*, *Vicia faba*, *Vigna radiata* (L.) R. Wilczek and others. This

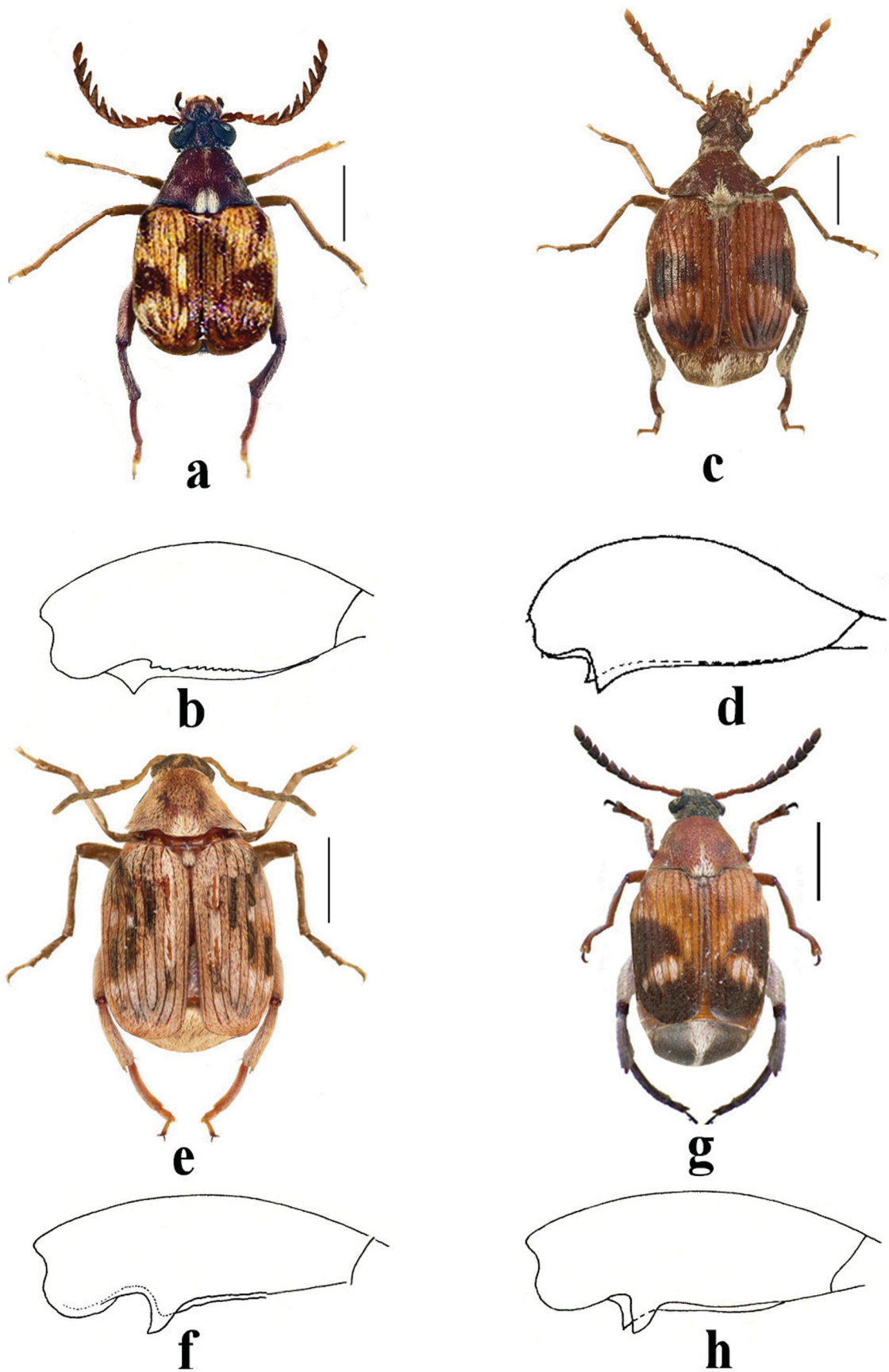


FIGURE 14. *Callosobruchus* species alien to Europe. A–B, *Callosobruchus chinensis*: A, Adult; B, Hind femur. C–D, *Callosobruchus analis*: C, Adult; D, Hind femur. E–F, *Callosobruchus phaseoli*: E, Adult; F, Hind femur. G–H, *Callosobruchus maculatus*: G, Adult; H, Hind femur.

shows that it is a serious threat to all commercial legumes. The larva I was described by Pfaffenberger & Johnson (1976) and the larvae I–IV by Pfaffenberger (1985b). Studies on its biology are very abundant. A comprehensive summary of the state of knowledge until the mid-twentieth century is provided by Hoffmann *et al.* (1963) and then Delobel & Tran (1993), but studies have continued to the present. For example, Bonet (1981) studied its life cycle and Leroi & Jarry (1981) studied its physiology.

2. *Acanthoscelides pallidipennis* (Motschulsky, 1874)

A species native to North America (Nearctic region), where it lives in association with *Amorpha* L. (*A. fruticosa*, *A. californica* Torr. & A.Gray). *Amorpha fruticosa* (false indigo) was imported to Europe in the eighteenth century for ornamental purposes in gardens and soon invaded the natural environment, colonizing riverbanks. However, the bruchid was not detected until 1972, when it appeared in collections in Hungary. It was initially identified by Decelle (1979) as *Acanthoscelides seminulum* (Horn), which was synonymized by Kingsolver (1979) as *A. pallidipennis*. Shortly after, Borowiec (1980) found it in Bulgaria and designated it as the new species *A. tarnawskii*, which was synonymised by Wendt (1981) and later confirmed by the same Borowiec (1983). Following its discovery in Hungary, it was also located in the former Yugoslavia, Bulgaria, Czechoslovakia, Germany and other countries, spreading virtually throughout Central Europe and Russia together with its host plant, now considered invasive. The species has already reached the Far East of the Palaearctic: in Korea (Borowiec 1983) and then in China, where it was identified as *A. plagiatius* (Tan *et al.* 1980) which was synonymised by Zhang & Liu (1991). It was then found in Japan (Tao *et al.* 1999). Its larva I was described under the synonym *A. collusus* (Fall) by Pfaffenberger & Johnson (1976). Various aspects of its life cycle and ecology were examined by Rogers & Garrison (1975), Szentesi (1999) and Tuda *et al.* (2001). The latter also recorded some parasitoids of the genus *Eupelmus* Dalman, 1820 (Eupelmidae). Other parasitoids are also known from this species, such as *Horismenus missouriensis* (Ashmead, 1888) and *H. productus* (Ashmead, 1894) (Eulophidae) (Kingsolver 2004). Recently, some aspects of its biology were treated by Boe & Johnson (2008).

3. *Acanthoscelides macrophthalmus* (Schaeffer, 1907)

This species is distributed from the southern USA to northern Mexico, where it is associated with shrubs or trees of the genus *Leucaena* (*L. leucocephala*, *L. pulverulenta* (Schtdl.) Benth., *L. retusa* Benth., etc.). *Leucaena* species (especially *L. leucocephala*) imported as forage and as ornamental trees have been accompanied by this bruchid. It has been documented feeding on many other *Leucaena* species in Hawaii (Samuelson 1991) and in Central and South America (Hughes & Johnson 1996). In 1998 it was found in West Africa (Delobel & Johnson 1998) and it has also been detected in Asia: in Taiwan (Wu *et al.* 2007) and Japan (Tuda *et al.* 2009), where it is also associated with other plants in the Mimosoideae of the genera *Mimosa* L., *Entada* Adans. and *Albizia*. However, *Leucaena leucocephala* is an invasive plant and this bruchid species has been used in South Africa since 1999 for biological control programmes (Oleckers 2011, Sharratt & Oleckers 2012). In Europe it was first detected in Cyprus (Vassiliou & Papadoulis 2008), but the rate of infestation varies between years (Vassiliou *pers. comm.*). It has not been detected in any other European country yet, but there is a clear possibility of short-term expansion. Its larva I was described by Pfaffenberger & Johnson (1976) and various aspects of its biology have been addressed: Hughes & Johnson (1996) studied its feeding ecology, whereas Effowe *et al.* (2010) looked at its possible usefulness as a host of the parasitoid *Dinarmus basalis* (Rondani, 1877) (Pteromalidae), which is used for the biological control of *Callosobruchus* pests. A more complete study on its biology was published by Wu (2008), who wrote his doctoral thesis on the life cycle of this bruchid.

4. *Bruchidius raddianae* Anton & Delobel, 2003

This small bruchid, which was named (but not described: *nomen nudum*) by Decelle (1979) as *Bruchidius sahelicus* and confused by De Luca (1965) as *Bruchidius albosparsus*, was recently described by Anton & Delobel (2003) in

their review of the *centromaculatus* group of the genus *Bruchidius* in Africa. Described originally from Algeria in North Africa, it has also been found in Burkina Faso, Egypt, India, Iran, Israel, Jordan, Libya, Mali, Morocco, Mauritania, Niger, Oman, Saudi Arabia, Senegal, Sri Lanka, Sudan, Tunisia and Yemen. Its range is roughly equivalent with that of its main host plant, *Acacia tortilis* subsp. *raddiana*, an African acacia that spans the northern half of the continent, extending into Asia. It has also been found in other host plants of the genus *Acacia*, such as *A. ehrenbergiana* Hayne, *A. farnesiana*, *A. gerrardii* Benth., *A. nilotica* subsp. *tomentosa* (Benth.) Brenan, *A. senegal* (L.) Willd., *A. sieberiana* DC. and even on *Dichrostachys cinerea* (L.) Wight & Arn. (Anton & Delobel 2003). Its presence in Europe was not demonstrated until 2008 (Yus Ramos & Coello García 2008a), when it was found in Cádiz and Málaga (southern Spain) on a new host plant: the African acacia *Acacia karroo*, an invasive plant initially imported to form hedges. This bruchid is well established, with high infestation rates, but it is currently restricted to the south of Spain. The proximity and similarity in climate to the type locality in North Africa is a good reason to suspect that this insect had no difficulty becoming established in the south of the Iberian Peninsula, once a proper host plant was found. I–IV larvae were described by Yus Ramos & Coello García (2008b) and the life cycle was initially studied by Derbel *et al.* (2007) in Tunisia. It was completed by Yus Ramos & Coello García (2008b) in Spain, who also provided data on their parasitoids.

5. *Bruchidius siliquastris* Delobel, 2007

This species was recently discovered by Delobel (in Kergoat *et al.* 2007) from seeds of *Cercis siliquastrum* in Montpellier (southern France). *Cercis siliquastrum* is a native tree that is fully adapted to Mediterranean ecosystems, but it is often used as an ornamental worldwide. Curiously however, this bruchid had never been found previously and was not present in old collections, so we have to assume that it was introduced to Europe recently. The genus *Cercis* includes species from Central Asia to China, as well as North America. *Bruchidius siliquastris* has been found in China in the seeds of an undetermined species of *Cercis*. According to Delobel's hypothesis (in Kergoat *et al.* 2007), *B. siliquastris* could be native to the Eastern Palaearctic, having been imported to Europe with *Cercis* for ornamental purposes and then invading the Mediterranean *Cercis siliquastrum*. The same author cited this species in Hungary, but its presence was soon confirmed in the Iberian Peninsula, specifically in Gibraltar (Yus Ramos *et al.* 2009a), and it was soon found in Cádiz and Barcelona provinces (Spain) (Yus Ramos *et al.* 2009d). It was subsequently found in Belgium (CEBE 2009), Slovakia (Kollár *et al.* 2009), the Czech Republic (Šefrová 2010), Bulgaria (Stojanova *et al.* 2011), Monaco (Ponel *et al.* 2011) and Turkey (Hizal & Parlak 2013), so it appears that the species is spreading rapidly through Europe. I–IV larvae and other pre-imaginal stages were described by Yus Ramos *et al.* (2009c, 2010). The life cycle, reproductive behavior and feeding behavior were studied by Yus Ramos *et al.* (2009b, d), including data on their parasitoids. Also, Stojanova *et al.* (2011) provided findings on parasitoids and demonstrated the oligophagous nature of *B. siliquastris* on several *Cercis* species. Hizal & Parlak (2013) provided information on infestation rates and parasitoids.

6. *Bruchidius terrenus* (Sharp, 1886)

Known since 1886, *B. terrenus* was described by Sharp from specimens collected in Japan. Chûjô (1937) confirmed its presence in the same country and gave its host plant, *Albizia julibrissin*. In 1963 it was detected in China by Nakane and in 1984 it was found again in Japan by Morimoto (in Morimoto 1990). It is native to the Eastern Palaearctic, but was recently detected in several states in the southern USA (Hoebecke *et al.* 2009) in seeds of *Albizia julibrissin*. The next record was from Europe, where it was detected by Stojanova (2010) in Bulgaria and northwestern Greece, on the same plant. In the same year it was also detected in several localities in the province of Barcelona (northeastern Spain), Italy (Yus Ramos *et al.* 2011) and very recently in Turkey (Hizal & Parlak 2013). Apparently, the species breeds successfully, so we can assume that it is well established and prone to expansion. Yus Ramos *et al.* (2011) provide a detailed redescription of the imago, the life cycle of the species and its parasitoids. Descriptions of the pre-imaginal stages are pending. Stojanova (2010) and Hizal & Parlak (2013) also gave data on infestation rates. The latter provided information on parasitoids as well.

7. *Bruchus pisorum* (Linnaeus, 1758)

This is a species of uncertain origin, but it is possibly native to Asia Minor, from where its host plant *Pisum sativum* later extended throughout the Mediterranean via commercial trade by the Phoenicians, as well as to Asia via trade routes. With increasing intercontinental trade between the eighteenth and nineteenth centuries, it was also imported to American countries (Bain & Prévost 2007), so that it is now considered a cosmopolitan species. Its status in Europe is therefore 'established'. Beenen & Roques (2010) point out that it was first detected in Europe in 1850 in the Czech Republic. Currently it can be found living on wild plants of *Pisum sativum*. It is not known on any other host plant and is clearly monophagous, requiring pollen from this plant to mature its gonads. It is a univoltine species that causes damage to crops, but not stored seeds. Females lay about 400 eggs that hatch after 10 days, penetrating immediately into the seed and taking 40–45 days to develop (a single individual per seed). Its larva IV was described by Pfaffenberger (1977) and by Arora (1978). The literature on its biology is very extensive given its high economic interest. Larson *et al.* (1938) is one of the first references from the USA. Grigokov (1960) addressed its biological cycle. A summary of the state of knowledge until the mid-twentieth century is in Hoffmann *et al.* (1963).

8. *Bruchus rufimanus* Boheman, 1833

This species' origin is either in Africa according to some authors or Asia Minor according to others, where it lived on wild species of *Vicia*. When humans started to grow beans (*Vicia faba*), this bruchid possibly became a pest. This is probably how it spread throughout the Mediterranean and Asia along the trade routes of antiquity and was later exported throughout the world thanks to the advances of intercontinental maritime transport. Beenen & Roques (2010) indicate that in Europe it was first recorded in Portugal in 1894, but it was probably present long before. For example, beans (*Vicia faba*) that had been attacked by bruchids were found in the ruins of Pompeii (Jashemski 1974) and these would surely have belonged to this species. It is fully established in the natural environment, having been found in a wide variety of species of the tribe Vicieae: *Lathyrus venetus* (Mill.) Wohlf., *Vicia bithynica* (L.) L., *V. hybrida* L., *V. lutea* L., *V. narbonensis* L., *V. pannonica* Crantz & *V. villosa* Roth (Delobel & Delobel 2005). It is a univoltine species, so it does not cause damage to stored seeds, but it causes serious losses in bean crops. After laying, the egg takes 13 days to hatch and the larva then continues its development within the seed (each bean can accommodate up to 5–6 individuals). The adult emerges after about three months, including 10–15 days of pupation. Its larva I was described by Riley (1891) and its larva IV by Pfaffenberger (1977). The literature on its biology is extensive due to similar reasons to the previous species. An account of the state of knowledge until the mid-twentieth century is in Hoffmann *et al.* (1963). Medjdoub-Bensaad *et al.* (2007) carried out recent research into its ecology.

9. *Bruchus lentis* Froelich, 1799

The origin of this species is uncertain, but there are speculations about a possible North African origin, because it is known to have attacked lentils since antiquity. Lentils that were attacked by bruchids, most likely *B. lentis*, have been found at archaeological sites in Egypt dating back to 3,000 BCE (Burleigh & Southgate 1975). The other bruchid predator of lentils, *B. signaticornis* Gyll., is relatively rare in North Africa, being more abundant in Southern Europe. Currently, *B. lentis* is considered a cosmopolitan species with a worldwide distribution due to trade of infested seeds. Because of its uncertain origin, there is no consensus on whether this species should be considered invasive in Europe and indeed Beenen & Roques (2010) exclude it. We take into consideration two facts that suggest 'invasive' status: (1) it is more common in North Africa and very rare in the wild in Europe (2) in Europe, it can be found only in lentil crops. This species has been detected in virtually all countries of Central and Southern Europe (Anton 2010) where it is well established in agroecosystems. It causes more damage to lentil crops (*Lens culinaris*) than the native *B. signaticornis* (De los Mozos 1992), which usually develops in plants of the genera *Lathyrus* L. and *Vicia* (Delobel & Delobel 2005). It is a univoltine species, so it is not dangerous to stored seeds. Its biology is well known because of its economic interest. It has been studied in detail by De Luca (1956) in

Algeria and Genduso (1960) in Italy, although some biological and physiological aspects are not well known yet, unlike other *Bruchus* species which are pests of seeds during storage. The eggs hatch after 10 days and the larvae develop within seeds in about 30 days (one larva/seed), destroying the seed completely. Its pre-imaginal stages were described by De Luca (1956). A summary of the state of knowledge until the mid-twentieth century is provided by Hoffmann *et al.* (1963). A further problem caused by this bruchid is the production of allergic reactions (e.g. asthma) in some people who eat infested lentils (Armentia *et al.* 2006).

10. *Pseudopachymerina spinipes* (Erichson, 1833)

This species, known as *Pseudopachymerus lallemani* (Hoffmann 1945) until Decelle (1966) clarified its taxonomy, is native to South America. It is associated with plants of the genus *Acacia*, known as ‘aromos’ (*A. caven* & *A. aroma* Hook. & Arn.) in countries such as Argentina, Chile, Bolivia, Peru and Brazil (Terán 1962, 1990). This bruchid was discovered in South America and described by Erichson in 1833. From there it must have been exported to Europe along with ‘aromos’ seeds, which were in demand by the perfume industry at that time. The first news we have about its presence in Europe is from 1885, when it was found in seeds of *A. caven* (given as synonymous of *A. cavenia* Hook. & Arn.) in Germany but did not become established. Its existence was known in Mediterranean countries such as Spain and Italy at least since the early twentieth century (Pic 1913), becoming fully established with an invasive plant from Central America as its host: *Acacia farnesiana*. Subsequently, news of its presence in North Africa arrived from Algeria (Hoffmann 1945, De Luca 1961), Tunisia (Normand 1937, Hoffmann 1945), Egypt (Shomar 1963) and Morocco (Kocher 1958, Yus Ramos 1977). In the Middle East it has been recorded in Israel, Syria and Turkey (Udayagiri & Wadhi 1989). It is known from Spain since 1919 (De la Fuente 1919) and was confirmed present in 1977 by Yus Ramos (1977). In a recent review, it was recorded throughout the Mediterranean coast of Spain, mirroring the distribution of *Acacia farnesiana* in warm and arid sites near the coast (Yus Ramos *et al.* 2007a). It extends to the southern European countries of France, Italy and Greece. The larvae I–IV have been described briefly by Terán (1962) and in greater detail by De Luca (1963). Its life cycle was studied initially in Argentina by Terán (1962) and in Algeria by De Luca (1963). This was completed in a recent revision from Spain by Yus Ramos *et al.* (2007a). Some aspects of its biology were also studied by Saiz *et al.* (1987) and Saiz (1993).

11. *Megabruchidius tonkineus* (Pic, 1904)

This is a species from the Oriental region that was described by Pic from Tonkin. It was detected in Europe for the first time by Wendt (1980) in Germany, who identified it as *Bruchidius tonkineus*. Following this, the species was transferred to the genus *Megabruchidius* by Borowiec (1984). This bruchid was not considered established until Jermy & Szentesi (2002) and Jermy *et al.* (2002) found it in seeds of *Gleditsia triacanthos* in a garden in the center of Budapest (Hungary), later confirming its wide dispersal throughout the gardens of Budapest and other Hungarian cities (György 2007). In the same year, Stojanova (2007) recorded it from Bulgaria. The following year Delobel & Delobel (2008) cited it from France and more recently it has been recorded in Switzerland (György & Germann 2012). Therefore it is a well-established species in Central Europe, in gardens, parks and boulevards where its host plant (*Gleditsia triacanthos*) is present. Its pre-imaginal stages have not yet been studied. Its biology was studied in Hungary by Jermy & Szentesi (2002), Jermy *et al.* (2002) and György (2007). A revision of the genus in Europe was carried out by Yus Ramos (2009).

12. *Megabruchidius dorsalis* (Fahraeus, 1839)

This species, which is rarer than the previous one, is well known in the Oriental region, where it is native. After its original description, Borowiec (1984) found specimens from Hong Kong that he described as a new species named *Megabruchidius bifoveolatus*, but he later synonymised it with *M. dorsalis* (Borowiec 1987). The species was then found in Argentina by Di-Iorio (2005), who identified it as *Bruchidius endotubercularis*, a species described by

Arora (1977) from India that was also synonymised with *M. dorsalis* (Yus Ramos 2009). It was first recorded in Europe by Migliaccio & Zampetti (1989), who found it in the Botanical Garden of Rome, where it was already established and feeding on seeds of the Caesalpinieae *Gleditsia triacanthos* and *G. sinensis* Lam.. This record was followed by Yus Ramos (2009), who discovered it in gardens in Budapest (Hungary). He found it on the same trees of *Gleditsia triacanthos* where *M. tonkineus* was found and its resemblance to this species may explain why it hadn't been detected. In the same year it was confirmed from Switzerland (Yus Ramos 2009), indicating that this species is established in Europe and has a clear tendency to expand its range, probably in the same countries where *M. tonkineus* is present. Its larval stages have not been studied yet and its biology is poorly understood, but the data available suggest that they are probably similar to that of *M. tonkineus*.

13. *Mimosestes mimosae* (Fabricius, 1781)

This species is native to Central and South America, from where it is known since the eighteenth century, having been described by Fabricius based on specimens from Santo Domingo (Dominican Republic). It was subsequently described again by several authors, resulting in a long list of synonyms (Kingsolver & Johnson 1978). In its native habitat it is associated with shrubs of the genera *Acacia* (e.g. *Acacia farnesiana*, *A. globulifera* Saff., *A. macracantha* Willd., etc.), *Caesalpinia* L. (*C. coriaria* (Jacq.) Willd., *C. sclerocarpa* Standl.), *Mimosa* (*M. pudica* L.) and others, but it is quite polyphagous and will also feed on crops such as *Vicia faba*, *Cicer arietinum*, and *Phaseolus vulgaris*. It was almost certainly imported to Europe with these pulses and was already known from the Azores (island of Santa Maria) in 1867, from where it was named *Bruchus breweri* Crotch, 1867, which was synonymised by Kingsolver & Johnson (1978). There is no evidence of its presence in continental Europe until Abeille de Perrin (1888) cited it from Marseille (France) and also Italy and Turkey. Later, Hoffmann (1945) recorded it under the genus *Acanthoscelides* from France, Germany and Italy. This is verified by many faunal works on these countries. In Spain it was first cited by Yus Ramos (1977) and was confirmed by Yus Ramos (2010) from the natural environment. Decelle (1975) recorded this bruchid from the Canary Islands. This was corroborated by Borowiec & Anton (1993) and then Yus Ramos (2008), who found it in seeds of *Acacia farnesiana*. Currently it can be considered as an established and widespread species in Southern Europe, although not abundant. It only very occasionally causes damage to crops and then usually in marginal environments. Its larvae I–IV have not yet been described, but they could be similar to those of *M. amicus* described by Pfaffenberger & Johnson (1976). Its biology is poorly understood, although some data on reproductive biology were provided to the generic level by Johnson & Siemens (1996). Some aspects of the evolution of its trophic biology were studied by Kato *et al.* (2010).

14. *Caryedon acaciae* (Gyllenhal, 1833)

With the exception of *Caryedon germari*, which is native to Eastern Europe, all the other species of the genus *Caryedon* are exotic in Europe. Of the several species occasionally recorded, only one species in this genus has established itself successfully in continental Europe: *Caryedon acaciae*. It is not possible to know exactly when this species was first detected, because many of the specimens cited under this name actually refer to other species. For example, Hoffmann (1945) and Hoffmann *et al.* (1963) cited it as *Pachymerus acaciae* (considering it synonymous with *Caryoborus pallidus*), whereas by its description one can easily see that this record really refers to *Caryedon serratus*, a pest of peanuts (*Arachis hypogaea*) which has been intercepted in Europe but has not become established. Cancela da Fonseca (1956) cited a species in Portugal that was identified as *Caryedon acaciae*, also from peanuts, therefore referring again to *Caryedon serratus*. It was not until the review by Johnson *et al.* (2004) that it was possible to clarify the taxonomic confusion, demonstrating that this bruchid actually feeds on seeds of various species of *Acacia* (*A. farnesiana*, *A. nilotica* (L.) Delile, *A. polyacantha* Willd., *A. tortilis* subsp. *raddiana*, etc.) and has a distribution that spans much of Africa and the Middle East. Its presence in Europe was not proven until Yus Ramos & Coello García (2007) detected it in Cádiz (south of Spain), where it was well established in an *Acacia* of South African origin, hitherto unknown as a host plant: *Acacia karroo*. However, Anton (2010) also mentions this species from Hungary, although not as established. So although this species is still

restricted to Southern Europe, it must be regarded as established. Its larva IV was described by Arora (1978) and the I–IV larval stages and pupae were described by Yus Ramos & Coello García (2007). The life cycle was also studied by Yus Ramos & Coello García (2008c), who included data on reproductive and nutritional biology, as well as some parasitoids.

15. *Caryedon serratus* (Olivier, 1790)

This is an Afrotropical species that is occasionally detected in some European countries in association with peanuts (*Arachis hypogaea*), its main host plant. It also frequents tamarinds (*Tamarindus indica*), as in the Canary Islands, where it is established in gardens (Yus Ramos 2008). This species is unable to establish itself, either in the wild or in storehouses, in continental and Mediterranean Europe. It has often been confused with other species such as *Caryedon acaciae*, for example by Hoffmann (1945) and Hoffmann *et al.* (1963), who cited it as *Pachymerus acaciae* (considering it synonymous with *Caryoborus pallidus*), whereas it can easily be seen by the description that it refers to *Caryedon serratus*. Cancela da Fonseca (1956) also cited a species referred to as *Caryedon acaciae* from Portugal, but also from peanuts, so that it can also be referred to *Caryedon serratus*. Its larvae I and IV were described by Prevett (1967, 1971) and by Arora (1978). Its biology is widely known thanks to its pest status and many references can be found in the scientific literature.

16. *Zabrotes subfasciatus* (Boheman, 1833)

This is a well-known species from Central America that is known from ancient times as a pest of beans (*Phaseolus vulgaris*) but is also found in many other related species such as *P. acutifolius* A.Gray, *P. coccineus* L. and *P. lunatus* L., as well as the genus *Vigna* Savi (*V. angularis* (Willd.) Ohwi & H. Ohashi, *V. mungo* (L.) Hepper, *V. unguiculata* (L.) Walp., *V. unguiculata* subsp. *sesquipedalis* (L.) Verdc.) and even in *Cajanus cajan* (L.) Millsp., *Cicer arietinum* and *Pisum sativum*. This shows the potentially enormous losses that it can cause in legume crops. From its native range, it spread to South America in the nineteenth century (where it is a pest today) and has been exported worldwide, although it has only established itself in the tropics. In Africa it has been a pest since 1875 (Madagascar), attacking *Vigna* crops. It is known from Europe since the nineteenth century, having been mentioned by Lucas (1858) in France, Zacher (1930) in Germany, Hoffmann (1945) in France again and then Yus Ramos (1977) in Spain. Currently this bruchid is known from practically all of Europe (Anton 2010). It is not established far from storehouses, as it needs an optimum temperature of 32°C and a humidity of 70% for its development. This restricts its presence in the wild to the tropics. However, this bruchid can breed and become a pest in storehouses. Also, we should not rule out the possibility that climatic change could allow it to develop in the wild in Southern Europe in future. The species should be closely monitored due to its potentially major threat to the European environment. Its larva I was described by Pfaffenberger & Johnson (1976), the larva IV by Arora (1978), Steffan (1945), Zacher (1930) and Pfaffenberger (1990b). Its biology has been widely studied, given its economic interest, e.g. Zacher (1930), Steffan (1945), Howe & Currie (1964) and others. A summary of the state of knowledge until the mid-twentieth century is in Hoffmann *et al.* (1963) and Delobel & Tran (1993). More recently, its reproductive biology has been studied, among others, by Dendy & Credland (1991) and Sperandio & Zucoloto (2009).

17. *Callosobruchus analis* (Fabricius, 1781)

A species of uncertain origin, presumably from the Oriental region from where probably it first spread to East Africa with legumes that are traditionally consumed by humans in these regions, such as the genus *Vigna*, and *Cajanus cajan*, *Cicer arietinum*, *Glycine max*, *Lablab purpureus* (L.) Sweet, *Lens culinaris* and *Pisum sativum*. This shift to other legumes from other regions has possibly facilitated its spread throughout the world and it is now considered cosmopolitan. In Europe, it was detected later than other *Callosobruchus* and is currently known only from five Central and Northern European countries: Belgium, Finland, France, the UK and Estonia (Anton 2010). Paradoxically it has not yet been recorded in any Mediterranean country. This is a polyvoltine species that is

capable only of invading dried seeds stored in storehouses. Therefore, it cannot be considered 'established' in Europe. In tropical areas it can leave the storehouse and lay eggs in crops, but this has not been demonstrated in Europe, probably due to the conditions it requires: a temperature between 30–33° C and an atmospheric humidity of 70%, conditions that are restricted to the tropics. Its larva IV was described by Vats (1974) and Arora (1978). The biology of this species has not been as well studied as that of other *Callosobruchus*, but the works of Pajni & Jit (1976), Haines (1989), and Begum *et al.* (1984) should be highlighted. A more updated summary can be found in Delobel & Tran (1993).

18. *Callosobruchus chinensis* (Linnaeus, 1758)

This species of Oriental origin is known since ancient times, with a range of different names ascribed to it that are currently in synonymy (Anton 2010). It is cosmopolitan and is one of the most widespread species of bruchids, although somewhat less so than *C. maculatus*, as for some reason it is not so successful in Africa. As in other species, its colonising success is due to its feeding on a broad range of seeds produced for human consumption, especially tropical species of the genus *Vigna* (*V. aconitifolia* (Jacq.) Marechal, *V. angularis*, *V. radiata*, *V. subterranea* (L.) Verdc., *V. umbellata* (Thunb.) Ohwi & H. Ohashi, *V. unguiculata*), but also other genera: *Nelumbo nucifera* Gaertn. (Nelumbonaceae), *Cajanus cajan*, *Cicer arietinum*, *Lens culinaris*, *Vicia faba*, etc. It is not very tolerant of *Vigna mungo*, *Pisum sativum* and especially *Glycine max*. This link with legumes for human consumption explains its expansion through the seed trade in part. The other reason is its polyvoltine nature, as it is capable of developing in storehouses via successive cycles, thereby constituting a formidable pest. The year 1878 has been proposed as the date of its first detection in Europe, from France. In Spain it was recorded as a rare species by Yus Ramos (1977). Borowiec & Anton (1993) cited it in Croatia. Today it has been detected in nearly all European countries (Anton 2010). However, it has never been detected outside storehouses, which indicates that this species is not established in Europe. This may be because optimal conditions for its development are at an average temperature of 30°C and an atmospheric humidity of 70%, which are not reached in natural habitats in Europe, although climate change could favor its establishment in Southern Europe in future. Its larva IV was described by Vats (1974), Arora (1978) and Pfaffenberger (1998). Its biology has been studied extensively, partly because it has often been used in laboratories as a model for biological studies. A summary of the state of knowledge until the mid-twentieth century is in Hoffmann *et al.* (1963) and Delobel & Tran (1993). Studies have continued until the present, for example those dealing with cuticular changes by Podoler & Applebaum (1969) and Pajni (1987), some ecological aspects by Shinoda & Yoshida (1990) and more recently those of Ryoo & Chun (1993) on oviposition and parasitism and Bhattacharya & Banerjee (2000) on its life cycle.

19. *Callosobruchus maculatus* (Fabricius, 1775)

Unlike other *Callosobruchus* species, *C. maculatus* appears to be of Afrotropical origin. It is known since ancient times and has several synonyms (Anton 2010). This is a cosmopolitan species that is even more widespread than *C. chinensis*, because it is also found on the African continent, due to its greater tolerance for different cultivated legumes: not only all species of the genus *Vigna*, but also others such as *Cajanus cajan*, *Cicer arietinum*, *Lablab purpureus*, *Glycine max* (even in its flour!), *Macrotyloma geocarpum* (Harms) Marechal & Baudet, *Lens culinaris*, *Pisum sativum* and others. In Europe it was first cited in 1878 from France (Beenen & Roques 2010), although it was probably already known before then. Since then this species has been detected in virtually all European countries (Anton 2010, Beenen & Roques 2010). It was detected in Spain by Yus Ramos (1977) and in Portugal by Borowiec & Anton (1993). This bruchid has never been found outside storehouses, so it cannot be considered 'established' in Europe, but it could develop as a pest in storehouses because of its polyvoltine nature, thanks to its ability to penetrate dry seeds. This inability to invade the outside environment is possibly because its optimal temperature and humidity are 30°C and 70% respectively. These are usually conditions typical of tropical areas, but they may exist inside storehouses in Europe. However, climate change could favor the establishment of this species in Southern Europe. Its larvae I and IV were described by Pevett (1971); the larva IV by Vats (1974), Arora (1978) and Pfaffenberger (1998). The literature on its biology is extremely extensive as it is of important economic

interest. It is also one of the most commonly used laboratory animals, especially for physiological and ecological studies. A summary of the state of knowledge until the mid-twentieth century is in Hoffmann *et al.* (1963) and later in Delobel & Tran (1993). Work continues to the present, e.g. Qi & Burkholder (1982) on endocrine regulation; Giga & Smith (1983), Moreno *et al.* (2000) and Zannou *et al.* (2003) on its life cycle. A comprehensive manual on the biology of this insect was published recently by Beck & Blumer (2011).

20. *Callosobruchus phaseoli* (Gyllenhal, 1833)

This is a less well-known and widespread species than other *Callosobruchus*. It is of uncertain origin but is possibly from the Oriental region. Hoffmann *et al.* (1963) attributed an American origin to it that is unlikely, as this genus does not exist in the New World. In any case, this species has also become cosmopolitan due to commercial trade of legume seeds. It is known from a smaller range of host plants than the other species of the genus, but with additional plants such as beans (*Phaseolus vulgaris*) (from where it took its scientific name), the genus *Vigna* (*V. mungo*, *V. radiata*, *V. umbellata* and *V. unguiculata*) and other legumes such as *Cajanus cajan*, *Cicer arietinum*, *Lablab purpureus* and *Pisum sativum*. The species was first detected in Europe in 1945, in France (Beenen & Roques 2010). It has now been detected in the Czech Republic, the UK, Greece, Italy, Poland and Spain (Anton 2010), as well as Albania (Beenen & Roques 2010). As with other *Callosobruchus* species, *C. phaseoli* is not established in Europe, since it has never been found outdoors. It is only able to reproduce in storehouses as it requires temperatures ranging between 30–32.5°C and a humidity level of 70%, environmental conditions more typical of tropical and subtropical countries. Its status in Southern Europe will depend on how climate change progresses. The pre-imaginal stages have not been described yet. Its biology has barely been studied; Utida (1971) provides some of the only data on the environmental conditions required by the species.

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References

- Abeille de Perrin, E. (1888) Tableau synoptique des Bruchides et Urodonides Français. *Revue d'Entomologie*, 7, 77–90.
- Anton, K.-W. (2010) Subfamily Bruchinae. In: Löbl, I. & Smetana, A. (Eds.), *Catalogue of Palaearctic Coleoptera. Vol. 6. Chrysomeloidea*. Apollo Books, Stenstrup, pp. 339–353.
- Anton, K.-W. & Delobel, A. (2003) African species of the *Bruchidius centromaculatus* group with “eyed” female pygidium (Coleoptera: Bruchidae: Bruchinae). *Genus*, 14 (2), 159–190.
- Anton, K.-W., Halperin, J. & Calderon, M. (1997) An annotated list of the Bruchidae of Israel and adjacent areas. *Israel Journal of Entomology*, 31, 59–96.
- Armentia, A., Lombardero, M., Blanco, C., Fernández, S., Fernández, A. & Sánchez, R. (2006) Allergic hypersensitivity to the lentil pest *Bruchus lentis*. *Allergy*, 61 (9), 1112–1116.
<http://dx.doi.org/10.1111/j.1398-9995.2006.01123.x>
- Arora, G.L. (1978) Taxonomy of the Bruchidae (Coleoptera) of Northwest India. Part II. larvae. *Oriental Insects, Supplement*, 8, 1–48.
- Beck, C.W. & Blumer, L.S. (2011) *A Handbook on Bean Beetles, Callosobruchus maculatus*. National Science Foundation, 12 pp.
- Beenen, R. & Roques, A. (2010) Leaf and Seed Beetles (Coleoptera, Chrysomelidae). Chapter 8.3. In: Roques, A., Kenis, M., Lees, D., Lopez-Vaamonde, C., Rabitsch, W., Rasplus, J.-Y. & Roy, D.B. (Eds.), *Alien terrestrial arthropods of Europe. BioRisk*, 4 (1), 267–292.
- Begum, A., Ahmed, M. & Seal, D.R. (1984) Influence of temperature on population increase of pulse beetle, *Callosobruchus analis* Fabricius (Coleoptera: Bruchidae). *Bangladesh Journal of Zoology*, 12, 21–26.
- Bhattacharya, B. & Banerjee, T.C. (2000) Divergent life-history traits of *Callosobruchus chinensis* (L.) (Coleoptera: Bruchidae) infesting stored pulses. *Oriental Insects*, 34 (1), 203–214.
<http://dx.doi.org/10.1080/00305316.2000.10417258>
- Boe, A. & Johnson, P.J. (2008) Seed predation by *Acanthoscelides submuticus* and *A. pallidipennis* (Coleoptera: Bruchidae) in

- false indigo in the northern great plains. *Proceedings of the South Dakota Academy of Science*, 87, 223–227.
- Bonet, A. (1981) Biología del complejo *Acanthoscelides obtectus* Say (Col.: Bruchidae) en poblaciones silvestres y cultivadas de *Phaseolus*. *Folia Entomológica Mexicana*, (XVI Congreso nacional de entomología, Abril 6–8, 1981), 48, 45–46.
- Borowiec, L. (1980) A new species of *Acanthoscelides* Schilsky from Bulgaria (Coleoptera, Bruchidae). *Polskie Pismo Entomologiczne*, 50, 167–170.
- Borowiec, L. (1983) A survey of seed-beetles of Bulgaria (Coleoptera, Bruchidae). *Polskie Pismo Entomologiczne*, 53, 107–127.
- Borowiec, L. (1984) Two new genera and species of seed-beetles from the oriental region. (Coleoptera, Bruchidae, Bruchinae). *Polskie Pismo Entomologiczne*, 54, 115–129.
- Borowiec, L. (1987) The genera of seed-beetles (Coleoptera, Bruchidae). *Polskie Pismo Entomologiczne*, 57, 3–207.
- Borowiec, L. (1988) *Bruchidae—strakowce* (Insecta: Coleoptera). Fauna Polski, volume 11. Polska Akademia Nauk Instytut Zoologii, Warsaw, 226 pp.
- Borowiec, L. & Anton, K.-W. (1993) Materials to the knowledge of seed beetles of the Mediterranean Subregion (Coleoptera: Bruchidae). *Annals of the Upper Silesian Museum, Entomology*, 4, 99–152.
- Bridwell, J.C. (1932) The subfamilies of the Bruchidae (Coleoptera). *Proceedings of the Entomological Society of Washington*, 34 (6), 100–106.
- Bridwell, J.C. (1946) The genera of beetles of the family Bruchidae in America north of Mexico. *Journal of the Washington Academy of Sciences*, 36 (2), 52–57.
- Burleigh, R. & Southgate, B.J. (1975) Insect Infestation of Stored Egyptian Lentils in Antiquity. *Journal of Archaeological Science*, 2, 391–392.
[http://dx.doi.org/10.1016/0305-4403\(75\)90010-2](http://dx.doi.org/10.1016/0305-4403(75)90010-2)
- Cancela da Fonseca, J. (1956) *Contribuição para o estudo da ecologia de Pachymerus acaciae* Gyll. (Coleoptera, Bruchidae). Estudos, Ensaios e Documentos XIX. Ministerio de Ultramar. Junta de Investigações do Ultramar, Lisboa, 125 pp.
- CEBE (2009) *Bruchidius siliquastri* Kergoat, P. Delobel & A. Delobel (2007). Available from: <http://cebe.waarnemingen.be/waarneming/view/44682777> (accessed 26 May 2013)
- Chûjô, M. (1937) Some additions and revisions of Bruchidae (Coleoptera) from the Japanese empire. *Transactions of the Natural History Society of Formosa*, 27, 189–201.
- DAISIE (2009) *Handbook of Alien Species in Europe*. Springer, Dordrecht, 400 pp.
- Decelle, J. (1966) La bruche sud-américaine des acacias: *Pseudopachymerina spinipes* (Erichson). *Bulletin & Annales de la Société Royale d'Entomologie de Belgique*, 102 (5), 109–116.
- Decelle, J. (1975) Les Bruchidae (Coleoptera) des Iles Canaries. *Bulletin et Annales de la Société royale belge d'Entomologie*, 111, 109–142.
- Decelle, J. (1979) Un Bruchide nord-américain, *Acanthoscelides seminulum* (Horn), en voie d'indigenation en Europe centrale et meridionale. *Bulletin et Annales de la Société royale belge d'Entomologie*, 115, 28.
- De la Fuente, J.M. (1919) Lista inédita de los Coleópteros de España. *Boletín de la Real Sociedad Española de Historia Natural*, 19, 178–188.
- Delobel, B. & Delobel, A. (2005) Les plantes hôtes des bruches (Coleoptera Bruchidae): données nouvelles et corrections. *Bulletin mensuel de la Société linnéenne de Lyon*, 74 (7–8), 277–291.
- Delobel, P. & Delobel, A. (2008) Une nouvelle Bruche asiatique importée en France: *Megabruchidius tonkineus* (Pic) (Col., Bruchinae). *Bulletin de la Société Entomologique de France*, 113 (2), 227–229.
- Delobel, A. & Johnson, C.D. (1998) First record of a seed-beetle on *Leucaena leucocephala* in West Africa. *Leucnet News*, 5, 25–26.
- Delobel, A., Sembène, M., Fédière, G. & Roguet, D. (2003) Identity of the groundnut and tamarind seed-beetles (Coleoptera: Bruchidae: Pachymerinae), with the restoration of *Caryedon gonagra* (F.). *Annales de la Société Entomologique de France (n.s.)*, 39 (3), 197–206.
<http://dx.doi.org/10.1080/00379271.2003.10697375>
- Delobel, A. & Tran, M. (1993) *Les Coléoptères des denrées alimentaires entreposées dans les régions chaudes*. Faune tropicale XXXII. Orstom Editions, Paris, 425 pp.
- De los Mozos, M. (1992) Brúquidos (Coleoptera: Bruchidae) asociados al cultivo de la lenteja (*Lens culinaris* Medikus) en Castilla-La Mancha: especies implicadas y valoración de la plaga. *Boletín de Sanidad Vegetal, Plagas*, 18, 347–353.
- De Luca, Y. (1956) Contributions à l'étude morphologique et biologique de *Bruchus lentis* Fröhl. Essais de lutte. *Annales de l'Institut Agricole et des Services de Recherches d'Experimentation Agricole de l'Algérie*, 10 (1), 1–94.
- De Luca, Y. (1961) Caractères de la morphologie imaginale de *Pseudopachymerus lallemanti* Marseul (Coléoptères, Bruchidés). *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord*, 52, 253–264.
- De Luca, Y. (1963) Aspect morphologique de la larve néonate de *Pseudopachymerus lallemanti* Marseul (Coléoptères, Bruchidés). *Entomologische Berichten*, 23 (2), 37–40.
- De Luca, Y. (1965) Remarques morphologiques et chétotaxiques sur *Bruchidius albosparsus* (Col. Bruchidae). *Annales de la Société Entomologique de France (n.s.)*, 1, 479–487.
- Dendy, J. & Credland, P.F. (1991) Development, fecundity and egg dispersion of *Zabrotes subfasciatus*. *Entomologia Experimentalis et Applicata*, 59 (1), 9–17.
<http://dx.doi.org/10.1111/j.1570-7458.1991.tb01481.x>

- Derbel, S., Noumi, Z., Anton, K.-W. & Chaieb, M. (2007) Life cycle of the coleoptera *Bruchidius raddianae* and the seed predation of the *Acacia tortilis* subsp. *raddiana* in Tunisia. *Comptes Rendus Biologies*, 330 (1), 49–54.
<http://dx.doi.org/10.1016/j.crv.2006.09.003>
- Di-Iorio, O.R. (2005) An asian species of Bruchinae (Coleoptera: Chrysomelidae) developing in the seeds of *Gleditsia triacanthos* L. (Caesalpiniaceae) in Argentina. *Agrociencia*, 39 (3), 327–337.
- Duff, A.G. (2012) Non-established introductions. In: Duff, A.G. (Ed.), *Checklist of Beetles of the British Isles. 2nd Edition*. Pemberley Books, Iver, pp. 131–135.
- Effowe, T.Q., Amevoin, K., Nuto, Y., Mondedji, D. & Glitho, I.A. (2010) Reproductive capacities and development of a seed bruchid beetle, *Acanthoscelides macrophthalmus*, a potential host for the mass rearing of the parasitoid, *Dinarmus basalis*. *Journal of Insect Science*, 10 (129), 1–14.
<http://dx.doi.org/10.1673/031.010.12901>
- European Commission (2006) *Halting the loss of biodiversity by 2010—and beyond—Sustaining ecosystem services for human well-being*. Communication from the Commission.
- Genduso, P. (1960) Observations on the Bruchids of lentil (*Lens esculenta* Moench). 1st note. *Bruchus lentis* Fröel.—*Bruchus ervi* Fröel. *Bollettino dell'Istituto di Entomologia Agraria e dell'Osservatorio di Fitopatologia di Palermo*, 3, 139–162.
- Giga, D.P. & Smith, R.H. (1983) Comparative life history studies of four *Callosobruchus* species infesting cowpeas with special reference to *Callosobruchus rhodesianus* (Pic) (Coleoptera: Bruchidae). *Journal of Stored Products Research*, 19 (4), 189–198.
[http://dx.doi.org/10.1016/0022-474x\(83\)90007-3](http://dx.doi.org/10.1016/0022-474x(83)90007-3)
- Grigokov, S.P. (1960) Contribution to the bionomics of the pea Bruchid *Bruchus pisi* L. *Nauchni Trudove, Vissih Selskostopanski Institut "Georgi Dimitrov", Sofia, Agronomicheski Fakultet, Seriya Obshto Zemedelie*, 8, 357–364.
- György, Z. (2007) To the biology of the honey locust seed beetle, *Megabruchidius tonkineus* (Pic, 1904) (Coleoptera: Chrysomelidae: Bruchinae). *Folia Entomologica Hungarica*, 68, 89–96.
- György, Z. & Germann, C. (2012) First record of the invasive *Megabruchidius tonkineus* (Pic, 1904) for Switzerland (Coleoptera, Chrysomelidae, Bruchinae). *Mitteilungen der Schweizerischen entomologischen Gesellschaft*, 85 (3–4), 243–249.
- Haines, C.P. (1989) Observations on *Callosobruchus analis* (F.) in Indonesia, including a key to storage *Callosobruchus* spp. (Col., Bruchidae). *Journal of Stored Products Research*, 25 (1), 9–16.
[http://dx.doi.org/10.1016/0022-474x\(89\)90003-9](http://dx.doi.org/10.1016/0022-474x(89)90003-9)
- Heetman, A.J.A. & Beenen, R. (2008) Twee exotische zaadkevers ingevoerd met bonen (Coleoptera, Bruchidae). *Entomologische Berichten*, 68 (5), 187–188.
- Hizal, E. & Parlak, N.N. (2013) *Bruchidius terrenus* and *Bruchidius siliquastris* (Coleoptera: Chrysomelidae: Bruchinae) — First Records for Turkey. *Florida Entomologist*, 96 (1), 66–70.
<http://dx.doi.org/10.1653/024.096.0109>
- Hoebeke, E.R., Wheeler, A.G., Kingsolver, J.M. & Stephan, D.L. (2009) First North American records of the East Palearctic seed beetle *Bruchidius terrenus* (Coleoptera: Chrysomelidae: Bruchinae), a specialist on Mimosa (*Albizia julibrissin*, Fabaceae). *Florida Entomologist*, 92 (3), 434–440.
<http://dx.doi.org/10.1653/024.092.0304>
- Hoffmann, A. (1945) *Coléoptères Bruchides et Anthribides. Faune de France*, 44. Fédération Française des Sociétés de Science Naturelles. Office Central de Faunistique, Paul Lechevalier, Paris, 184 pp.
- Hoffmann, A., Labeyrie, V. & Balachowsky, A.S. (1963) Famille des Bruchidae. In: Balachowsky, A.S. (Ed.), *Entomologie appliquée à l'agriculture. Tome I: Coléoptères (1^{re} partie)*. Masson et Cie Editeurs, Paris, pp. 434–494.
- Howe, R.W. & Currie, J.E. (1964) Some laboratory observations on the rates of development, mortality and oviposition of several species of Bruchidae breeding in stored pulses. *Bulletin of Entomological Research*, 55 (3), 437–477.
<http://dx.doi.org/10.1017/s0007485300049580>
- Hughes, C.E. & Johnson, C.D. (1996) New host records and notes on Bruchidae (Coleoptera) from *Leucaena* Benth. (Leguminosae, Mimosoideae) from Mexico, Central and South America. *Journal of Applied Entomology*, 120 (1–5), 137–141.
<http://dx.doi.org/10.1111/j.1439-0418.1996.tb01580.x>
- Hulme, P.E. (2007) Biological invasions in Europe: drivers, pressures, states, impacts and responses. In: Hester, R.E. & Harrison, R.M. (Eds.), *Biodiversity under threat*. RSC Publishing, Cambridge, pp. 56–80.
- Jashemski, W.F. (1974) The Discovery of a Market-Garden Orchard at Pompeii: The Garden of the "House of the Ship Europa". *American Journal of Archaeology*, 78 (4), 391–404.
<http://dx.doi.org/10.2307/502753>
- Jermy, T. & Szentesi, Á. (2002) A tonkini óriás-zsizsik [*Megabruchidius tonkineus* (Pic, 1904)] felbukkanása hazánkban. *Növényvédelem*, 38 (7), 346–348.
- Jermy, T., Szentesi, Á. & Anton, K.-W. (2002) *Megabruchidius tonkineus* (Pic, 1904) (Coleoptera: Bruchidae) first found in Hungary. *Folia Entomologica Hungarica*, 63, 49–51.
- Johnson, C.D. & Siemens, D.H. (1996) Oviposition behavior, guilds, distribution and new host records for the genus *Mimosestes* Bridwell (Coleoptera: Bruchidae) from Colombia, Ecuador, Venezuela and Mexico. *The Coleopterists Bulletin*, 50 (2), 155–160.

- Johnson, C.D., Southgate, B.J. & Delobel, A. (2004) A revision of the Caryedontini (Coleoptera: Bruchidae: Pachymerinae) of Africa and the Middle East. *Memoirs of the American Entomological Society*, 44, 1–120.
- Kato, T., Bonet, A., Yoshitake, H., Romero-Nápoles, J., Jinbo, U., Ito, M. & Shimada, M. (2010) Evolution of host utilization patterns in the seed beetle genus *Mimosestes* Bridwell (Coleoptera: Chrysomelidae: Bruchinae). *Molecular Phylogenetics and Evolution*, 55 (3), 816–832.
<http://dx.doi.org/10.1016/j.ympev.2010.03.002>
- Kergoat, G., Delobel, P. & Delobel, A. (2007) Phylogenetic relationships of a new species of seed-beetle infesting *Cercis siliquastrum* L. in China and in Europe (Coleoptera: Chrysomelidae: Bruchinae: Bruchini). *Annales de la Société entomologique de France (n.s.)*, 43 (3), 265–271.
<http://dx.doi.org/10.1080/00379271.2007.10697522>
- Kingsolver, J.M. (1979) New Synonymies and new Combinations in North American Bruchidae (Coleoptera). *The Coleopterists Bulletin*, 33 (3), 341–342.
- Kingsolver, J.M. (2004) *Handbook of the Bruchidae of the United States and Canada (Insecta, Coleoptera). Technical Bulletin number 1912. Vol. 1. & 2 (Illustrations)*. United States Department of Agriculture, xi + 324 pp. & ii + 198 pp.
- Kingsolver, J.M. & Johnson, C.D. (1978) *Systematics of the genus Mimosestes (Coleoptera: Bruchidae)*. United States Department of Agriculture, Technical Bulletin number 1590, 106 pp.
- Kocher, L. (1958) Catalogue commenté des Coléoptères du Maroc. Fasc. VIII (Phytophages). *Travaux de l'Institut Scientifique Chérifien, Série Zoologie*, 19, 1–172.
- Kollár, J., Hrubík, P. & Tcakova, S. (2009) Monitoring of harmful insect species in urban conditions in selected model areas of Slovakia. *Plant Protection Science*, 45 (3), 119–124.
- Korotyaev, B.A. (2011) On invasion of an East Asian seed beetle, *Megabruchidius tonkineus* (Pic) (Coleoptera, Bruchidae), developing in *Gleditsia* seeds, in the Northwest Caucasus. *Entomological Review*, 91 (9), 1167–1169.
<http://dx.doi.org/10.1134/s0013873811090089>
- Larson, A.O., Brindley, T.A. & Hinman, F.G. (1938) *Biology of Pea Weevil in the Pacific Northwest, with suggestions for its control on seed peas. Technical Bulletin number 599*. United States Department of Agriculture, , 48 pp.
- Leroi, B. & Jarry, M. (1981) Relations d'*Acanthoscelides obtectus* avec différentes espèces de *Phaseolus*: Influence sur la fécondité et possibilités de développement larvaire. *Entomologia Experimentalis et Applicata*, 30 (1), 73–82.
<http://dx.doi.org/10.1111/j.1570-7458.1981.tb03587.x>
- Lucas, M.H. (1858) [Spermophagus semifasciatus]. *Bulletins trimestriels de la Société Entomologique de France in Annales de la Société Entomologique de France, Bulletin entomologique*, 1^{er} trimestre 1858, 28.
- Lukyanovich, F.K. & Ter-Minassian, M.E. (1957) *Seed beetles (Bruchidae). Fauna of the USSR, 67: Coleoptera. Vol. 24 (1)*. Zoologicheskii Institut Akademii nauk SSSR, Moscow 209 pp. [in Russian]
- Medjdoub-Bensaad, F., Khelil, M.A. & Huignard, J. (2007) Bioecology of broad bean bruchid *Bruchus rufimanus* Boh. (Coleoptera: Bruchidae) in a region of Kabylia in Algeria. *African Journal of Agricultural Research*, 2 (9), 412–417.
- Melbourne, B.A., Cornell, H.V., Davies, K.F., Dugaw, C.J., Elmendorf, S., Freestone, A., Hall, R., Harrison, S., Hastings, A., Holland, M., Holyoak, M., Lambrinos, J., Moore, K. & Yokomizo, H. (2007) Invasion in a heterogeneous world: resistance, coexistence or hostile takeover? *Ecology Letters*, 10 (1), 77–94.
<http://dx.doi.org/10.1111/j.1461-0248.2006.00987.x>
- Merkl, O. (2001) Rovarküldöttek (Insect emissaries). *Élővilág*, 10, 12–17.
- Migliaccio, E. & Zampetti, M.F. (1989) *Megabruchidius dorsalis* e *Acanthoscelides pallidipennis*, specie nuove per la fauna italiana (Coleoptera, Bruchidae).. *Bollettino dell'Associazione Romana di Entomologia*, 43 (1–4), 63–69.
- Miller, C., Kettunen, M. & Shine, C. (2006) *Scope options for EU action on invasive alien species (IAS)*. Final report for the European Commission. Institute for European Environmental Policy (IEEP), Brussels, 109 pp.
- Moreno, R.A.P., Duque, G.A., de la Cruz, J. & Tróchez, P.A. (2000) Life cycle and hostes of *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Revista Colombiana de Entomología*, 26 (3/4), 131–135.
- Morimoto, K. (1990) A synopsis of the bruchid fauna of Japan. In: Fujii, K., Gatehouse, A.M.R., Johnson, C.D., Mitchel, R. & Yoshida, T. (Eds.), *Bruchids and Legumes: Economics, Ecology and Coevolution. Series Entomologica. Vol. 46. Proceedings of the Second International Symposium on Bruchids and Legumes (IISBL-2) held at Okayama (Japan), September 6–9, 1989*. Kluwer Academic Publishers, Dordrecht, 131–140 pp.
- Normand, H. (1937) Contribution au Catalogue des Coléoptères de la Tunisie (11^e fascicule). *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord*, 28 (2), 116–143.
- Olckers, T. (2011) Biological control of *Leucaena leucocephala* (Lam.) de Wit (Fabaceae) in South Africa: a tale of opportunism, seed feeders and unanswered questions. *African Entomology*, 19 (2), 356–365.
<http://dx.doi.org/10.4001/003.019.0219>
- Pajni, H.R. (1987) Ecological status of host range and polymorphism in Bruchidae. In: Donahaye, E. & Navarro, S. (Eds.), *Proceedings of the Fourth International Working Conference on Stored Product Protection, Tel Aviv, Israel, 21–26 September 1986*, 506–516 pp.
- Pajni, H.R. & Jit, S. (1976) Some observations on the biology of *Callosobruchus analis* (Fabr.) (Bruchidae: Coleoptera). *Research bulletin of the Panjab University, Science*, 27 (3/4), 141–146.
- Pfaffenberger, G.S. (1977) Comparative descriptions of the final larval instar of *Bruchus brachialis*, *B. rufimanus*, and *B. pisorum* (Coleoptera: Bruchidae). *The Coleopterists Bulletin*, 31 (2), 133–142.

- Pfaffenberger, G.S. (1985b) Description, differentiation, and biology of the four larval instars of *Acanthoscelides obtectus* (Say) (Coleoptera: Bruchidae). *The Coleopterists Bulletin*, 39 (3), 239–256.
- Pfaffenberger, G.S. (1990b) A scanning electron microscopic view of the final larval instar of *Zabrotes subfasciatus* (Coleoptera: Bruchidae: Amblycerinae). *The Coleopterists Bulletin*, 44 (1), 37–49.
- Pfaffenberger, G.S. (1998) Family Bruchidae. In: Stehr, F.W. (Ed.), *An introduction to immature insects of North America*. Vol. 2. Kendal/Hunt Publishing Company, Dubuque, pp. 561–568.
- Pfaffenberger, G.S. & Johnson, C.D. (1976) *Biosystematics of the First-Stage Larvae of Some North American Bruchidae* (Coleoptera). *Technical Bulletin number 1525*, Agricultural Research Service, United States Department of Agriculture, iv + 75 pp.
- Pic, M. (1913) Bruchidae. In: Junk, W. & Schenkling, S. (Eds.), *Coleopterorum Catalogus*. Vol. 26. Pars 55. W. Junk, Berlin, pp. 74.
- Pimentel, D. (Ed.) (2011) *Biological invasions: economic and environmental costs of alien plant, animal, and microbe species*. Second Edition. CRC Press, Boca Raton, Florida, xiv+449 pp.
- Podoler, H. & Applebaum, S.W. (1969) Cuticular darkening in *Callosobruchus chinensis* L. (Coleoptera: Bruchidae) as affected by dietary ascorbic acid. *Journal of Stored Products Research*, 5 (4), 423–425.
[http://dx.doi.org/10.1016/0022-474x\(69\)90018-6](http://dx.doi.org/10.1016/0022-474x(69)90018-6)
- Ponel, P., Fadda, S., Lemaire, J.-M., Matocq, A., Cornet, M. & Pavon, D. (2011) Arthropodes de la Principauté de Monaco. Coléoptères, Hétéroptères. Aperçu sur les Fourmis, les Isopodes et les Pseudoscorpions. MONACOBIODIV Rapport final—1er février 2011, 100 pp. Available from: <http://www.troglogrites.fr/MonacoBiodivEntomo.pdf> (accessed 26 May 2013)
- Prevett, P.F. (1967) The larva of *Caryedon serratus* (Ol.): The Groundnut Seed Beetle (Coleoptera: Bruchidae). *Journal of Stored Products Research*, 3 (2), 117–123.
[http://dx.doi.org/10.1016/0022-474x\(67\)90021-5](http://dx.doi.org/10.1016/0022-474x(67)90021-5)
- Prevett, P.F. (1971) The larvae of some Nigerian Bruchidae (Coleoptera). *Transactions of the Royal Entomological Society of London*, 123 (3), 247–312.
<http://dx.doi.org/10.1111/j.1365-2311.1971.tb00845.x>
- Prévost, M.-A. & Bain, A. (2007) L'implantation d'une colonie terre-neuvienne au XVII^e siècle: l'apport des analyses archéobotanique et archéontomologique. In: Bain, A., Chabot, J. & Mousesette, M. (Eds.), *La mesure du passé: contributions à la recherche en archéométrie (2000–2006)*. British Archaeological Reports International Series 1700. Archaeopress, Oxford, pp. 205–216.
- Qi, Y.-T. & Burkholder, W.E. (1982) Sex pheromone biology and behavior of the cowpea weevil *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Journal of Chemical Ecology*, 8 (2), 527–534.
<http://dx.doi.org/10.1007/bf00987800>
- Riley, C.V. (1891) The pea and bean weevils. *Insect Life*, 4, 297–302.
- Rogers, C.E. & Garrison, J.C. (1975) Seed Destruction in Indigobush *Amorpha* by a Seed Beetle. *Journal of Range Management*, 28 (3), 241–242.
<http://dx.doi.org/10.2307/3897538>
- Roques, A., Kenis, M., Lees, D., Lopez-Vaamonde, C., Rabitsch, W., Rasplus, J.-Y. & Roy, D.B. (Eds.) (2010) *Alien Terrestrial Arthropods of Europe, Part 1, 2. Biorisk*. Vol. 4. Pensoft Publishers, Sofia, 1028 pp.
- Ryoo, M.I. & Chun, Y.S. (1993) Oviposition behavior of *Callosobruchus chinensis* (Coleoptera: Bruchidae) and weevil population growth: effects of larval parasitism and competition. *Environmental Entomology*, 22 (5), 1009–1015.
- Saiz, F. (1993) Importance of the persistence in the tree of fruits of *Acacia caven* in the infestation by *Pseudopachymerina spinipes* (Coleoptera: Bruchidae). *Revista Chilena de Entomología*, 20, 31–34.
- Saiz, F., Daza, M. & Casanova, D. (1987) Relaciones fenológicas entre *Pseudopachymerina spinipes* (Bruchidae) y *Acacia caven* (Leguminosae). *Anales del Museo de Historia Natural de Valparaíso*. Chile, 18, 55–64.
- Sala, O.E., Chapin III, F.S., Armesto, J.J., Berlow, E., Bloomfield, J., Dirzo, R., Huber-Sanwald, E., Huenneke, L.F., Jackson, R.B., Kinzig, A., Leemans, R., Lodge, D.M., Mooney, H.A., Oesterheld, M., Poff, N.L., Sykes, M.T., Walker, B.H., Walker, M. & Wall, D.H. (2000) Global biodiversity scenarios for the year 2100. *Science*, 287 (5459), 1770–1774.
- Samuelson, G.A. (1991) Bruchid in koa haole pods—*Acanthoscelides macrophthlamus*. *Hawaiian Entomological Society Newsletter*, 1, 2.
- Sax, D.F., Stachowicz, J.J., Brown, J.H., Bruno, J.F., Dawson, M.N., Gaines, S.D., Grosberg, R.K., Hastings, A., Holt, R.D., Mayfield, M.M., O'Connor, M.I. & Rice, W.R. (2007) Ecological and evolutionary insights from species invasions. *Trends in Ecology and Evolution*, 22 (9), 465–471.
<http://dx.doi.org/10.1016/j.tree.2007.06.009>
- Sax, D.F., Stachowicz, J.J. & Gaines, S.D. (Eds.) (2005) *Species Invasions: Insights into Ecology, Evolution, and Biogeography*. Sinauer Associates, Sunderland, Massachusetts, xiii+495 pp.
- Šefrová, H. (2010) Faunistic records from the Czech Republic (302). Coleoptera: Chrysomelidae: Bruchinae. *Klapalekiana*, 46, 229–230.
- Sharratt, M.E.J. & Olckers, T. (2012) The biological control agent *Acanthoscelides macrophthalmus* (Chrysomelidae: Bruchinae) inflicts moderate levels of seed damage on its target, the invasive tree *Leucaena leucocephala* (Fabaceae), in the KwaZulu-Natal coastal region of South Africa. *African Entomology*, 20 (1), 44–51.

<http://dx.doi.org/10.4001/003.020.0106>

- Shinoda, K. & Yoshida, T. (1990) Life History of the Azuki Bean Weevil, *Callosobruchus chinensis* L., (Coleoptera: Bruchidae), in the Field. In: Fujii, K., Gatehouse, A.M.R., Johnson, C.D., Mitchel, R. & Yoshida, T. (Eds.), *Bruchids and Legumes: Economics, Ecology and Coevolution. Series Entomologica. Vol. 46. Proceedings of the Second International Symposium on Bruchids and Legumes (IISBL-2) held at Okayama (Japan), September 6–9, 1989*. Kluwer Academic Publishers, Dordrecht, 149–159 pp.
- Shomar, N.F. (1963) A monographic revision of the Bruchidae of Egypt (U.A.R.) (Coleoptera). *Bulletin de la Société entomologique d'Égypte*, 47, 141–196.
- Sperandio, L.A.A. & Zucoloto, F.S. (2009) Oviposition behavior of wild *Zabrotes subfasciatus* (Coleoptera, Chrysomelidae) females deprived of the host *Phaseolus vulgaris* (Fabaceae). *Iheringia. Série Zoologia*, 99 (4), 403–408.
<http://dx.doi.org/10.1590/s0073-47212009000400010>
- Steffan, J.R. (1945) Contribution a l'étude de *Zabrotes subfasciatus* Boheman. *Mémoires du Muséum national d'Histoire naturelle Paris (n.s.)*, 21 (2), 55–84.
- Stojanova, A. (2007) *Megabruchidius tonkineus* (Pic, 1904) (Chrysomelidae: Bruchinae), a new seed beetle to the Bulgarian fauna. *Acta Zoologica Bulgarica*, 59 (1), 109–110.
- Stojanova, A. (2010) Seed beetle *Bruchidius terrenus* (Sharp) (Coleoptera: Chrysomelidae: Bruchinae) – New invasive species to the bulgarian fauna. *Biotechnology & Biotechnological Equipment*, 24 (2), 646–647.
- Stojanova, A.M., György, Z. & László, Z. (2011) A new seed beetle species to the Bulgarian Fauna: *Bruchidius siliquastri*, Delobel (Coleoptera: Chrysomelidae: Bruchinae). *Ecologia Balkanica*, 3 (1), 117–119.
- Szentesi, Á. (1999) Predispersal seed predation of the introduced false indigo, *Amorpha fruticosa* L. in Hungary. *Acta Zoologica Academiae Scientiarum Hungaricae*, 45 (2), 125–141.
- Tan, J.J., Yu, P.Y., Li, H.X., Wang, S.Y. & Jiang, S.Q. (1980) *Economic Insect Fauna of China. Fascicle 18. Coleoptera: Chrysomeloidea (1)*. Science Press, Beijing, xiii–213 pp. [in Chinese]
- Tao, M., Nakagawa, T. & Umemoto, H. (1999) Discovery of a bruchid beetle species from *Amorpha fruticosa* seeds from China. *Kyushu Shokubutsu Boeki*, 564, 4. [in Japanese]
- Terán, A.L. (1962) Observaciones sobre Bruchidae (Coleoptera) del Noroeste Argentino. *Acta Zoologica Lilloana*, 18, 211–242.
- Terán, A.L. (1990) Observaciones sobre Bruchidae del Noroeste Argentino VII. *Pseudopachymerina spinipes* (Erich.) y *P. grata* n. sp. (Coleoptera). *The Coleopterists Bulletin*, 44 (1), 25–28.
- Tuda, M., Shima, K., Johnson, C.D. & Morimoto, K. (2001) Establishment of *Acanthoscelides pallidipennis* (Coleoptera: Bruchidae) feeding in seeds of the introduced legume *Amorpha fruticosa*, with a new record of its *Eupelmus* parasitoid in Japan. *Applied Entomology and Zoology*, 36 (3), 269–276.
<http://dx.doi.org/10.1303/aez.2001.269>
- Tuda, M., Wu, L.-H., Tateishi, Y., Niyomdham, C., Buranapanichpan, S., Morimoto, K., Wu, W.-J., Wang, C.-P., Chen, Z.-Q., Zhu, H.-Y., Zhang, Y.-C., Murugan, K., Chou, L.-Y. & Johnson, C.D. (2009) A novel host shift and invaded range of a seed predator, *Acanthoscelides macrophthalmus* (Coleoptera: Chrysomelidae: Bruchinae), of an invasive weed, *Leucaena leucocephala*. *Entomological Science*, 12 (1), 1–8.
<http://dx.doi.org/10.1111/j.1479-8298.2009.00297.x>
- Udayagiri, S. & Wadhi, S.R. (1989) *Catalog of Bruchidae*. Memoirs of the American Entomological Institute, no. 45. American Entomological Institute, Gainesville, 301 pp.
- Utida, S. (1971) Influence of temperature on the number of eggs, mortality and development of several species of Bruchid infesting stored beans. *Japanese Journal of Applied Entomology and Zoology*, 15 (1), 23–30.
<http://dx.doi.org/10.1303/jjaez.15.23>
- Vats, L.K. (1974) Distinctive characters of the larvae of two species of *Bruchidius* Schilsky (Bruchidae: Coleoptera). *Indian Journal of Entomology*, 36 (2), 113–117.
- Vassiliou, V.A. & Papadoulis, G. (2008) First record of *Acanthoscelides macrophthalmus* (Schaeffer) (Coleoptera: Bruchidae) in Cyprus. *Entomologia Hellenica*, 17 (2007–2008), 52–55.
- Vilá, M., Corbin, J.D., Dukes, J.S., Pino, J. & Smith, S.D. (2007) Linking plant invasions to environmental change. In: Canadell, J.G., Pataki, D.E. & Pitelka, L.F. (Eds.), *Terrestrial ecosystems in a changing world*. Springer, Berlin, pp. 93–102.
- Wendt, H. (1980) Erstmaliges Auftreten des Vorratsschädling *Bruchidius tonkineus* (Pic, 1904) in der DDR. *Deutsche Entomologische Zeitschrift N.F.*, 27 (4–5), 317–318.
<http://dx.doi.org/10.1002/mmnd.19800270410>
- Wendt, H. (1981) Eine für Südost-Europa neue Samenkäfer-Art (Coleoptera: Bruchidae). *Folia Entomologica Hungarica*, 42, 223–226.
- Williamson, M. (2002) Alien plants in the British Isles. In: Pimentel, D. (Ed.), *Biological invasions: economic and environmental costs of alien plant, animal and microbe species*. CRC Press, Boca Raton, pp. 91–112.
- Wittenberg, R. & Cock, M.J.W. (Eds.) (2001) *Invasive alien species: a toolkit of best prevention and management practices*. CAB International, Wallingford, xii–228 pp.
- Wu, L.H. (2008) *Bionomics of the Leucaena seed beetle (Acanthoscelides macrophthalmus (Schaeffer, 1907)) (Coleoptera: Bruchidae)*. Doctoral Thesis. Department of Entomology, National Taiwan University, Taipei, 68 pp.

- Wu, H.S., Wu, W.J., Wang, C.P. & Chen, S.W. (2007) A new record of bruchid beetle from Taiwan (*Acanthoscelides macrophthalmus*) (Coleoptera: Bruchidae). *Plant Protection Bulletin (Taipei)*, 49 (1), 75–80.
- Yus Ramos, R. (1977) *Estudio taxonómico-biológico de la Familia Bruchidae (Col.) en la Península Ibérica e Islas Baleares*. Trabajos y Monografías de la Estación Experimental “La Mayora” (CSIC), nº 2, Málaga, 569 pp.
- Yus Ramos, R. (2007a) Genera de Coleópteros de la Península Ibérica e Islas Baleares: familia Bruchidae (Coleoptera, Chrysomeloidea). *Boletín de la Asociación Española de Entomología*, 31 (1–2), 65–114.
- Yus Ramos, R. (2007b) Revisión de los Amblycerinae (Coleoptera: Bruchidae) ibero-baleares: caracterización y catálogo provisional. *Boletín de la Asociación Española de Entomología*, 31 (3–4), 101–150.
- Yus Ramos, R. (2008) Catálogo comentado de los brúquidos de las islas Canarias (Coleoptera: Bruchidae). *Vieraea*, 36, 29–54.
- Yus Ramos, R. (2009) Revisión del género *Megabruchidius* Borowiec, 1984 (Coleoptera: Bruchidae) y nuevas citas para Europa. *Boletín de la Sociedad Entomológica Aragonesa*, 45, 371–382.
- Yus Ramos, R. (2010) Correcciones al Catálogo de Coleópteros Bruchinae Paleárticos de Löbl & Smetana (2010) (Coleoptera: Bruchidae). *Boletín de la Asociación Española de Entomología*, 34 (1–2), 219–234.
- Yus Ramos, R. (2012) Novedades de la fauna ibero-balear de brúquidos (Coleoptera: Bruchidae) a incluir en el Catálogo de Coleópteros Paleárticos de Löbl & Smetana (2010). *Boletín de la Asociación Española de Entomología*, 36 (3–4), 335–350.
- Yus Ramos, R., Bensusan, K. & Pérez, C. (2009a) *Bruchidius siliquastris* Delobel, 2007, una nueva especie para la fauna ibérica de brúquidos (Coleoptera: Bruchidae). *Boletín de la Sociedad Entomológica Aragonesa*, 44, 151–156.
- Yus Ramos, R., Bensusan, K., Pérez, C. & Coello García, P. (2009b) Aproximación a la biología de *Bruchidius siliquastris* Delobel, 2007 (Coleoptera: Bruchidae) en *Cercis siliquastrum* L.. *Boletín de la Sociedad Entomológica Aragonesa*, 44, 435–440.
- Yus Ramos, R., Bensusan, K., Pérez, C. & Coello García, P. (2009c) Descripción de estadios preimaginales de *Bruchidius siliquastris* Delobel, 2007 (Coleoptera: Bruchidae). *Boletín de la Asociación Española de Entomología*, 33 (1–2), 161–170.
- Yus Ramos, R. & Coello García, P. (2007) *Caryedon acaciae* (Gyllenhal, 1833), nueva cita para la Península Ibérica y Europa (Coleoptera: Bruchidae). Descripción de los estadios pre-imaginales y del adulto. *Boletín de la Sociedad Entomológica Aragonesa*, 41, 423–436.
- Yus Ramos, R. & Coello García, P. (2008a) Un nuevo brúquido de origen africano para la fauna ibero-balear y europea: *Bruchidius raddianae* Anton y Delobel, 2003 (Coleoptera: Bruchidae). *Boletín de la Sociedad Entomológica Aragonesa*, 42, 413–424.
- Yus Ramos, R. & Coello García, P. (2008b) Ciclo biológico y comportamiento reproductor de *Bruchidius raddianae* Anton y Delobel, 2003 (Coleoptera: Bruchidae) en la acacia sudafricana (*Acacia karroo* Haynes) en la Península Ibérica. *Boletín de la Sociedad Entomológica Aragonesa*, 43, 297–308.
- Yus Ramos, R. & Coello García, P. (2008c), Descripción del ciclo biológico de *Caryedon acaciae* (Gyllenhal, 1833) en la acacia sudafricana (*Acacia karroo* Haynes) en el sur de la Península Ibérica (Coleoptera: Bruchidae). *Boletín de la Sociedad Entomológica Aragonesa*, 43, 351–360.
- Yus Ramos, R., Coello García, P., Bensusan, K. & Pérez, C. (2010) Descripción de la larva I de *Bruchidius siliquastris* Delobel, 2007 (Coleoptera: Bruchidae). *Boletín de la Asociación Española de Entomología*, 33 (3–4), 367–374.
- Yus Ramos, R., Coello García, P., Ventura Pérez, D., Bensusan, K. & Pérez, C. (2009d) Ciclo biológico de *Bruchidius siliquastris* Delobel, 2007 (Coleoptera: Bruchidae) en *Cercis siliquastrum* L. Primera cita para España peninsular. *Boletín de la Sociedad Entomológica Aragonesa*, 45, 349–356.
- Yus Ramos, R., Fernández-Carrillo, J.L. & Fernández-Carrillo, E. (2007a) Sobre la presencia del gorgojo de las acacias, *Pseudopachymerina spinipes* (Erichson, 1833) en la Península Ibérica (Coleoptera: Bruchidae). *Boletín de la Sociedad Entomológica Aragonesa*, 40, 511–522.
- Yus Ramos, R., Kingsolver, J.M. & Romero-Nápoles, J. (2007b) Sobre el status taxonómico actual de los brúquidos (Coleoptera: Bruchidae) en los Chrysomeloidea. *Dugesiana*, 14 (1), 1–29.
- Yus Ramos, R., Ventura, D., Coello García, P. & Stojanova, A. (2011) *Bruchidius terrenus* (Sharp, 1886) (Coleoptera: Bruchidae): Primera cita para la Península Ibérica y para Italia, caracterización del imago y primeros datos biológicos. *Boletín de la Sociedad Entomológica Aragonesa*, 48, 253–260.
- Zacher, F. (1930) Untersuchungen zur Morphologie und Biologie der Samenkäfer (Bruchidae-Lariidae). Beiträge zur Kenntnis der Vorratsschädlinge. 6. Beitrag. *Arbeiten aus der Biologischen Reichsanstalt für Land- und Forstwirtschaft*, 18 (3), 233–384.
<http://dx.doi.org/10.1007/bf02338783>
- Zannou, E.T., Glitho, I.A., Huignard, J. & Monge, J.P. (2003) Life history of flight morph females of *Callosobruchus maculatus* F.: evidence of a reproductive diapause. *Journal of Insect Physiology*, 49 (6), 575–582.
[http://dx.doi.org/10.1016/s0022-1910\(03\)00029-5](http://dx.doi.org/10.1016/s0022-1910(03)00029-5)
- Zhang, S.F. & Liu, Y.P. (1991) Identification of *Acanthoscelides* species of *Amorpha fruticosa*. *Forest Pest and Disease*, 1 (1991), 42–43. [in Chinese]

APPENDIX I. Country codes abbreviations used are according to the International Organization for Standardization list ISO 3166:

http://www.iso.org/iso/english_country_names_and_code_elements.

Abbreviation	Country—Island	Abbreviation	Country—Island
AD	Andorra	IL	Israel
AL	Albania	IS	Iceland
AM	Armenia	IT	Italy
AT	Austria	IT-SAR	Italy—Sardinia island
AZ	Azerbaijan	IT-SIC	Italy—Sicily island
BA	Bosnia and Herzegovina	LB	Lebanon
BE	Belgium	LI	Liechtenstein
BG	Bulgaria	LT	Lithuania
BY	Belarus	LU	Luxembourg
CH	Switzerland	LV	Latvia
CY	Cyprus	MC	Monaco
CZ	Czech Republic	MD	Moldova
DE	Germany	MK	Macedonia
DK	Denmark	MT	Malta
EE	Estonia	NL	Netherlands
ES	Spain	NO	Norway
ES-BAL	Spain—Balears islands	NO-SVL	Norway—Svalbard
ES-CAN	Spain—Canary islands	PL	Poland
FI	Finland	PT	Portugal
FR	France	PT-AZO	Portugal—Azores islands
FR-COR	France—Corsica island	PT-MAD	Portugal—Madeira island
GB	United Kingdom	RO	Romania
GE	Georgia	RS	Serbia
GI	Gibraltar	RU	Russia (European Part)
GR	Greece	SE	Sweden
GR-CRE	Greece—Crete	SI	Slovenia
GR-NEG	Greece—North Aegean islands	SK	Slovakia
GR-SEG	Greece—South Aegean islands	SY	Syria
HR	Croatia	TR	Turkey
HU	Hungary	UA	Ukraine
IE	Ireland		