A Search in Spain and Portugal for Potential Biocontrol Agents for Gorse (*Ulex europaeus europaeus* L.) in Hawai'i

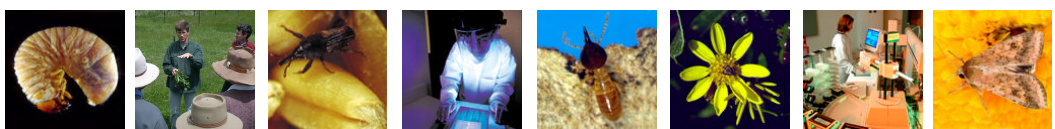
A contracted research project for Parker Ranch Inc., Hawaii, USA

Conducted by CSIRO Entomology

Compiled by the Principal Scientist

Dr. Andy Sheppard

CSIRO Entomology



Executive Summary

In line with reporting at the end of this contracted research project, this is the final report on the suitability of each species as a potential control agent for gorse, *Ulex europaeus europaeus* L. in Hawaii. The two aims of this project were to survey the native evolutionary centre of origin of *Ulex* for autumn active insects that reduce seed production in autumn developed pods and to look for autumn active root boring insects as potential biological control agents for gorse in Hawaii. There were very low levels of pod production by gorse during the autumn flowering period of 2003, despite a preceding hot summer that should have provided the conditions for strong early flower bud development. Gorse pods that clearly developed and matured during this period (classed as brown pods) only generated a potential of 0-300 seeds per mature plant in autumn and suffered only 0.1% seed losses to the apionid seed weevil *Exapion* and 7% seed loss to pod moths of the genus *Cydia*. It was concluded that insect activity on gorse pods in autumn in the native range is not high enough to expect there to be any autumn specific insects available as potential biological control agents for gorse in Hawaii and indeed none were successfully reared out. Most root feeding insect activity found appeared to be from insects active at different times of the year, suggesting further surveys for root feeding insects should take place in spring-summer. This project complimented previous surveys of gorse carried out in the native range in the 1960's and 1980's by CABI.

Background

A range of biological control agents are already established in Hawaii against gorse, *Ulex europaeus europaeus* L., including the shoot moth, *Agonopterix ulicetella* (Stainton), the pod weevil, *Exapion ulicis* (Forster), the gorse thrips, *Sericothrips staphylinus* Haliday, and the gorse mite, *Tetranychus lintearius* Dufour. These are contributing to the control of gorse, however general consensus amongst gorse biological control practitioners around the world that met in April 2003 was that two further key strategies for increasing biological control of gorse remained to be explored (see Appendix 1). Firstly the seed feeding agent, *E. ulicis,* only reduces seed production in spring while flowering and seed production in Hawaii starts with considerable seed production in autumn. Secondly no potential agents have yet been identified that can kill mature plants and surveys have not specifically targeted agents found inside the roots of gorse in the native range. The aim of this project was to carry out surveys of gorse in its native range in autumn to see if autumn active seed feeders, particularly other *Exapion* sp. and members of the pod moth genus *Cydia* in addition to root feeders, could be identified and evaluated as potential biological control agents.

The native range of gorse is from Western Europe as far east as Italy and Germany; however the center of evolution of the genus *Ulex* is the W. Iberian peninsula (W Spain and Portugal) from where at least 15 taxa are now recognized (Talavera et al. 1999[1]). The highest faunal diversity of specialist natural enemies is usually associated with this evolutionary centre of origin. Two previous surveys of biological control agents for gorse have been published. The first by Helmut Zwölfer between 1962 and 1963 surveyed France. The results were published in a CABI interim report listing insects found both on the surveys and from reviews of the literature (Zwölfer 1963). This report does not specifically state the time of year of the surveys, but they were generally considered to have been carried out in spring (see Appendix 1). The second in 1986 carried out by Donal O'Donnell of CABI UK covered NW Spain and Portugal (O'Donnell 1986) and was a spring survey. His report lists all sites with brief site descriptions and the agent species identified. Previous spring visits to the region have also been made by George Markin (USDA-ARS) or his colleagues and Richard Hill (Landcare Research NZ). While these visits did not lead to published reports, gorse was described as occurring in significant amounts as far south as Sintra near W of Lisbon and at least one root feeding insect (the cerambicid *Chlorophorus trificulatus*) had been collected from gorse in Portugal (George Markin pers. comm.). The aim of the surveys in this project was to resurvey the region covered by O'Donnell using two trips in autumn.

[1] http://www.rjb.csic.es/floraiberica/floraiberica/texto/pdfs/07_18%20Ulex.pdf

Methods

Literature search

Prior to the surveys a literature search was carried out to update that published by Zwölfer in 1963. This included an electronic search of Zoological Record and the CABI abstracts database for articles relating to *Ulex*, and a search of web-data bases for herbivorous insect groups which included lists of host plant records.

Surveys

Two surveys were conducted in autumn to early winter 2003. The first, 29 Sept to 3 Oct, covered Portugal in detail at the extreme southern part of the native range of gorse between Coimbra and Figueira da Foz to the north and Lisbon to the south. The aim of this visit was to try and locate plants that were producing seed pods in autumn. As reproductive bud formation in autumn is related to degree-day temperature accumulation through summer (R. Hill pers. comm.) it was assumed that most autumn flowering would occur on plants that had experienced the longest and hottest summers (i.e. in the south) and the summer of 2003 had been one of the hottest European summers on record.

The second survey took place between 25 Nov – 1 Dec. The timing was somewhat later largely based on the first trip, which did not find many plants in flower and focused on the region north of the first survey up through northern Portugal, NW Spain including Galicia and Asturias.

Survey methods consisted of locating sites with more than one species of *Ulex*, but preferentially containing *U. europaeus*. A further aim was also to sample as many native species of *Ulex* as possible and try and understand the biogeographical distribution and flowering phenological overlap of *U. europaeus* and congenerics in the region in case shared genus-specific pod insects were present. At each site, the *Ulex* species and other members of the Genisteae were identified. All gorse plants in the vicinity were searched for flowers and or pods. Where possible, 100 pods as mature as possible, were collected per plant from 10 plants per *Ulex* species and stored separately per plant in paper bags. At each site wherever sick plants were seen plants were dug up to look for root feeders. Where time allowed and in key regions of high *Ulex* abundance, e.g. in the pine plantations of W. Portugal between Peniche and Porto or in the valleys around Orense in NW Spain more extensive up rooting of gorse plants took place to look for evidence of root feeders. When the weather was fine and dry, beat samples of plants were also made and members of the families Curculionidae, Apionidae, Chrysomelidae, Cerambycidae Bruchidae, Buprestidae, Cicadellidae, Psyllidae and Miridae were collected for identification.

Data analysis and species identifcation

Soon after the completion of the surveys, pods were dissected counting the total number of formed seeds per pod and the number per pod that were eaten by either *Exapion* sp. or pod moths of the genus *Cydia*. These were the only two damage types observed. Fungal attack of seeds was also noted. Results were averaged per site and across sites with the same species of *Ulex*. Insects recovered from beatings were sent for identification to known specialists.

Fig 1. Map of sites visited during surveys for gorse biological control agents in September (green) and November (yellow) 2003. Refer to Appendix 2 for site details and *Ulex* species present

Results & Discussion

The literature search generated a list of 133 phytophagous arthropod species known to attack the genus *Ulex* (Appendix 3).

A total of 48 sites were located, 31 of which had *U. europaeus* including sites with the endemic local subspecies *Ulex europaeus latebracteatus* (Mariz) Rothm. that occurs along the coast in Portugal at the southern limit of the native distribution. Overall 7 species of *Ulex* were identified and sampled including also *U. airensis* Espirito Santo & al., *U. minor* Roth, *U. densus* Welw. Ex Webb, *U. gallii* Planch., *U. micrcanthus* Lange, *U. jussiaei* Webb including also a hybrid population of *U. europaeus* x *U. gallii*. *U. europaeus* pods were collected from 20 sites, while *U. europaeus latebracteatus* pods were collected at only two sites as this subspecies appeared not to flower in autumn. Other species that were flowering and producing at least some pods during the surveys were *U. gallii, U. minor* and *U. jussiaei.* While *U. gallii* and *U. minor* are noticeably smaller than *U.europaeus* with smaller flowers, *U. jussiaei* closely resembles *U. europaeus*, superficially in stature and growth form, but flowers earlier and has flowers of similar size but lacking the large flower bracteoles typical of *U. europaeus*.

Table 1. Summary of sites sampled by *Ulex* species and types of samples taken

***Ulex* species**	**Number of sites sampled**	**Number of sites with other *Ulex* sp.**	**Number of sites sampled for pods**	**Number of sites sampled for insects**
U. europaeus europaeus	24	10	20	6
U. europaeus latebracteatus	9	2	2	3
U. gallii	4	4	2	2
U. europaeus x U. gallii	1	1	1	1
U. jussiaei	12	3	3	8
U. minor	9	7	9	4
U. densus	2	2	0	2
U. airensis	2	0	0	1
U. mircranthus	2	2	1	2
*Stauracanthus genistoides**	1	1	1	1

genus most closely related to *Ulex*.

Survey 1. 18 sites were surveyed along the coast and hinterland south of Figueira da Foz (Portugal) was surveyed in detail (Fig. 1) where 4 species of *Ulex* were found; *U. jussiaei, U. europaeus latebracteatus, U. densus* and *U. airensis*. It appeared that the visit was too early, as only the first two species had flowers. *Ulex jussiaei* was the most advanced with about 30% of the plants in flower and 10% with maturing pods. *U. europaeus latebracteatus* had <1% of plants with some flowers resulting from an early small burst of flower buds on last years growth, but none with pods. Apionids were active on all species except *U. airensis,* despite a lack of flowers, and these were collected. These have been sent for identification and to see if there are any not already recorded in the scientific literature as *U. jussiaei* and *U. densus* appear never to have been previously sampled for apionids.

Samples of plants roots of *U. europaeus latebracteatus* were also examined at 5 sites. There were small burrows in most roots from lower stem to lower tap root, similar to the burrows of buprestid beetles, but clearly the makers of the burrows were elsewhere at this time of year. There were also larger burrows that ran from the stem bases into the upper root forming a gall like swelling. All were empty except one, which had a large weevil larva (8 mm) in it, however the larva failed to be reared. Its presence as a mature larva suggests that the insects tunnel in spring/summer. There have been surveys undertaken at this time of year, and this species may already be recorded in the literature.

The southern most *U. europaeus latebracteatus* (and hence *U. europaeus* sensu strictu) was on the cliffs at the coast above Torres Vedras. Around Sintra there were large amounts of *Ulex* throughout the hills and down to the coast, but this was all *U. jussiaei* as evidenced from the presence of flowers. There remains the possibility that *U. europaeus latebracteatus* is there in small amounts given that it was not in flower, but this did not appear to be a major locality for this species.

Survey 2. 30 additional sites were sampled around the coast from San Vicente de la Barquera in northern Spain to Sâo Pedro de Muel and in central regions, linking up with the previous survey and four sites were visited on both surveys. The pods were still moist as it rained most days. The discouraging aspect to the trip was that there was little evidence of significant autumn pod production in *U. europaeus* (either subspecies) in Europe particularly given that the previous summer had been exceptionally hot. The trip confirmed that southern extremity of the range around Sâo Pedro and south includes only subspecies *U. europaeus latebracteatus*. The few plants that had been observed developing flowers during the last visit in October had aborted nearly all the flowerbuds observed in September and it was clearly evident that this subspecies, more so than *U. europaeus europaeus*, does not regularly flower in autumn. Where few pods were found there was some evidence of hybridization with *U. europaeus europaeus*. This meant nearly all the pods collected were from *U. europaeus europaeus* (Table 1).

On *U. europaeus europaeus* rows of new flower buds were evident on last years shoot growth usually along with the odd black pod produced further back on the branches. Intact black pods were collected and categorised as such for the dissections and may have been the resulted of aberrant flowers originating in late summer (many of these were empty). The true autumn pod production was from pods turning brown from green and tended to occur only on the most advanced plants at a site and at a minority of sites seen. Green pods made up a third category and were more frequently present, but on branches where flowers clearly predominated pods. Assuming they survived the winter frosts, these green pods would only mature and dehisce in spring and so are not true autumn pod cohorts.

In the southern part of the range *U. europaeus europaeus* only occurred inland as a motorway verge species and clearly adventitious and recent to this disturbed habitat (most motorways in Portugal have been built in the last 10 years) until the northern Portuguese-Spanish border is approached. The extent of flowering and pod production seen on *U. europaeus europaeus* appeared to be the same everywhere. From Pau in France (passed during the surveys) through to the southern most populations the amount of pod production was the same with as much variation being seen within sites as between them. It was nonetheless quite hard to find the 100 pods per plant off 10 plants

set as a site sample size. There did not, therefore seem any latitudinal advantage of going south and only altitude made a slight difference in flowering phenology. This does raise the question of what triggers flower bud production and why do gorse plants in Hawaii produce significant pods in autumn, when this was not observed on this trip despite the heat of the previous summer. Samples of *Ulex minor, U. gallii* and *U. micranthus* populations were new species encountered on this survey.

Pod dissections

Pods dissections were confined to those species on which pods were found i.e. *U. europaeus* (both subspecies), *U. jussiaei* , *U. minor, U. gallii* and *U. micranthus.* Given

Table 2. Pod dissections results for potential seed production and insect damage levels per pod, per site per *Ulex* species for black, brown, green and all pods combined together with the number of observed insects per pod sample.

Ulex spp.	**Pods**	**Seeds pod^{-1}**	***Exapion* % eaten**	***Cydia* % eaten**	**# *Exapion* sample bag**	**# *Cydia* larvae sample bag**
U. europaeus europaeus	Black	2.84±0.19	1.64±0.97	29.37±7.18		
	Brown	2.10±0.21	0.11±0.08	7.01±1.77		
(20 sites)	Green	0.75±0.25	0.00	7.14±3.33		
	Total	**1.85±0.24**	**0.25**	**7.37±1.92**	**0.50±0.27**	**0.23±0.10**
U. europaeus latebracteatus	Black	2.53	0.00	13.33		
	Brown	0.87	1.75	3.00		
(2 sites)	Green					
	Total	**1.87±0.24**	**0.76**	**2.10**	**0.00**	**0.09**
U. gallii	Black	2.00	0.00	37.50		
(1 site)	Brown	2.52	4.56	0.00		
	Green					
	Total	**0.66±0.20**	**4.51**	**5.36**	**0.25**	**0.25**
U. europaeus x U. gallii	Black	2.22	4.64	49.54		
	Brown	1.83	1.10	9.50		
(1 site)	Green	0.50	0.00	0.00		
	Total	**1.39**	**2.74**	**15.44**	**0.36**	**0.00**
U. jussiaei	Black	4.00	0.00	100.00		
(1 site)	Brown	3.52	0.00	0.00		
	Green					
	Total	**1.09**	**0.00**	**4.04**	**0.00**	**0.00**
U. minor	Black	2.10±0.39	0.00	38.78±14.25		
(9 sites)	Brown	1.42±0.31	0.53±0.39	2.17±1.47		
	Green	0.03±0.02	0.00	0.00		
	Total	**1.01±0.10**	**0.53±0.39**	**4.81±2.55**	**0.31±0.19**	**0.02±0.02**
U. micranthus **(1 site)**	**Total**	**0.3**	**0.00**	**0.00**	**0.00**	**0.00**

the different flowering phenologies not all pods were of the same age and so during dissections all pods were divided into the three categories of black, brown and green pods described above. For the purposes of dissection, brown pods were still maturing but

already had quite large seeds inside, while green pods were still very immature without fully formed seeds. This was done to understand any variation in insect activity in the pods. The brown pods made up 72%, while black pods made up 16% of *U. europaeus* pods dissected. In addition to insect damage, fungal attack of seeds was occasionally observed up to about 20% of seeds, but it was unclear whether such damage occurred after collection of wet pods on immature wet pods. Table 2 shows the results of the dissections. Pods from *U. europaeus* were producing 1-3 maturing seeds per pod in autumn and in most cases a sample of a hundred pods was hard to collect from a single plant. Autumn seed production by gorse in the native range in the year of the surveys therefore only attained a maximum of between 100 and 300 seeds per mature plant. Pod use by insects was low. Seed predation was highest in the black pods, i.e. those that had matured during the late summer peaking at 30% seed loss to pod moths (*Cydia* sp.) and 1.6% loss to *Exapion* sp. The presence of apionid damage (presumably *Exapion ulicis*) only really in black *U. europaeus europaeus* pods suggests this damage resulted from surviving spring active apionids rather than an autumn generation and further suggests there is no autumn specialist apionids attacking this target species. Brown pods, the largest pod category that most effectively represents autumn pod production suffered on average only 7% seed loss to pod moths and 0.1% seed loss to *Exapion* sp. This higher attack by *Cydia* sp. suggests at least some *Cydia* goes through at least a partial autumn generation on *U. europaeus europaeus* and indeed other *Ulex* species like *U. minor* and *U. gallii*. Nonetheless, total autumn seed loss to insects was insignificant in *U. europaeus europaeus* with pods in the surveyed distribution in line with generally low autumn seed production. Apionids on *U. europaeus* are therefore spring active seed predators in the native range, as already known in the exotic range. Attack levels were similar in other *Ulex* species, including those that were clearly autumn flowering species like *U. minor* and *U. jussiaei,* suggesting that seed losses to insects is not high within the genus in autumn.

Beat samples & Identifications.

All apionid weevils, particularly *Exapion* species, recovered from beating *Ulex* species at the different sites have been sent off for identification and are also being used to construct a molecular phylogeny for the species collected through collaboration with the University of Rennes. As there is no longer an payable identification service for European insects sufficiently reliable to identify species within the genus *Exapion*, and the service is dependent on one or two specialists worldwide who receive many such requests, identifications are unlikely to be available before the end of this project. Twenty two larvae of the pod moth genus, *Cydia* sp., emerged from the 3510 pods collected and dissected. Only 5 of these larvae matured to pupae and from these pupae only parasites emerged.

Conclusions

The two aims of this project were to survey for autumn active insects that reduce seed production in gorse pods developed in autumn in the native range of this weed and to look for autumn active root boring insects that might have potential as biological control agents for gorse in Hawaii. There was very low pod production by gorse during the autumn. It is hard to explain why this was, given that gorse regularly flowers and sets seed in autumn in Hawaii and other parts of the exotic range.

If temperature accumulation is the driver of flower formation as some suspect (R. Hill pers comm.) then either the summer climate experienced by gorse in the native range must be cooler than in the autumn flowering areas in the exotic range, or the genotypic control of flowering phenology is less variable in the native populations. Some also claim that gorse may have developed variable flowering patterns to escape specialist seed feeders like the Apionidae (Atlan pers comm.). In which case, why doesn't gorse have a significant seeding period in autumn in the native range when *Exapion ulicis* is inactive? Such studies often raise as many questions as provide answers.

This study demonstrated at least that the levels of insect attack are not high enough to support the initial hypothesis that there might be a specifically autumn active insect that would have potential as a biological control agent for gorse in Hawaii. Most root-feeding insect activity found appeared to be from insects active at different times of the year and indeed a literature survey suggested that the species found on previous surveys, the cerambycid *Chlorophorus trificulatus*, is two generalist to be considered as a biological control agent for gorse.

Acknowledgements

We would like to thank Myriam Barat and Paloma Cubas for assistance in *Ulex* identification and Richard Hill and Anne Atlan for discussions that improved this report and our understanding of what we were observing.

References

Talavera S., Aedo C., Castroviejo S., Romero Zarco C., Sáez L., Salgueiro F.J. & Velayos M. (1999) Flora Iberica; Plantas vasculares de la Península Ibérica e Islas Baleares. Vol VII(I) Leguminosae (partim). Real Jardín Botánico, CSIC Madrid.

O'Donnell D. 1986 A survey of the natural enemies of gorse (Ulex spp.) in Northern Spain and Portugal. Report, CIBC Imperial College Silwood Park

Zwolfer H. 1963 Ulex europaeus project: European investigations for New Zealand Report No. 2 Commonwealth Institute of Biological Control European Station. Pp.30.

APPENDIX 1

Notes on an informal biocontrol of gorse meeting held in Canberra April 2003:

Attending:	Dr Richard Hill	hillr@crop.cri.nz
	Dr John Ireson	John.Ireson@dpiwe.tas.gov.au
	Mr Lincoln Smith	lsmith@pw.usda.gov
	Dr Andy Sheppard	andy.sheppard@csiro-europe.org
	Dr George Markin	gmarkin@fs.sed.us
	Ms Raelene Kwong	rae.kwong@nre.vic.gov.au
	Dr Dennis Isaacson	tansy1942@yahoo.com
	Mr Thierry Thomann	thierry.thomann@csiro-europe.org
	Dr Paul Pratt	prattp@saa.ars.usda.gov
	Dr Mike Pitcairn	mpitcairn@cdfa.ca.gov
	Mr Hugh Gourlay	gourlayh@landcareresearch.co.nz
	Mr Jamie Davey	Jamie.davies@dpiwe.tas.gov.au
	Ms Karina Potter	Karina.Potter@dpiwe.tas.gov.au
	Dr Hernan Norambuena	hnorambu@carillanca.inia.cl

Discussion:

The meeting of this group was organised to discuss the possibilities of establishing an international consortium to fund surveys for new gorse agents in Europe.

An existing agreement has been established between Parker Ranch in Hawaii, Landcare Research in New Zealand, and CSIRO in Montpellier, France for CSIRO to begin autumn surveys in Europe for potential gorse biocontrol agents, in particular an autumn seed feeding agent.

Parker Ranch is funded through a federal grant and the Parker Ranch Trust to control and establish the long-term eradication of gorse on its property in Hawaii. Some US$25,000 of this project has been made available to CSIRO for the field surveys in Europe. Landcare Research has added NZ$5000 in support of these surveys.

Mike Pitcairn stated that California is heading up an International Broom Initiative (IBI) which together with USDA-ARS is seeking US$1.4 Million pa funding support from the US federal government to carry out a long-term project aimed at biological control of all key exotic weeds in the Genisteae. In the proposal CSIRO has been identified as the main research agency that will undertake the native range aspects of this project should it get funded.

Parker Ranch and Landcare Research are combining funds and adding them to this effort to enable CSIRO to start search for gorse agents this year.

George Markin stated that a previous survey had detected a cerambicid root feeder (*Chlorophorus trificulatus*) in Portugal near the city of Coimbra. Specimens were

collected and sent to Hawaii but could not be reared. Richard Hill had found and worked on another root feeding weevil (*Sitona regensteinensis*) but had not reared it successfully.

John Ireson and Raelene Kwong both stated that they maybe able to contribute to a consortium if there was a formal agreement and established group already in place.

Hugh Gourlay stated that Landcare Research was mostly interested in an autumn seed feeder. Recent studies had shown that in New Zealand we were removing up to 60% of the annual gorse seed crop in most areas and close to 100% in predominantly spring seeding areas. Modelling studies have shown that by removing 75% or more of the annual gorse seed crop a significant reduction in gorse cover may result.

Others in the group suggested that a comprehensive survey of gorse in Europe would be useful and especially for a root-feeding agent but that an autumn seed feeder would be a good start. Andy Sheppard stated that without considerable additional funding a comprehensive survey would not be possible.

Richard Hill said that some surveys had already been done on gorse throughout its European distribution, but that these were largely conducted in spring and summer.

In general discussion the group decided that Richard Hill would act as the leader and co-ordinator of an international gorse group, he agreed.

Hugh Gourlay was to organise with Richard a formal agreement that stated the project, its goals, and its existing funding sources so that funding might be sought from other interested countries. I am in the process of doing this and will send you all a Memorandum of Understanding that can be signed by us all. This is an agreement that states what and how we are going to do a project and puts in writing financial and project contributions by each of the signing parties but obligates none of the signatories.

Status of gorse biocontrol programmes in the US, Hawaii, Chile, Victoria, Tasmania, and New Zealand:

NZ:	*Exapion ulicis, Cydia succedana*	(seed feeders)
Released and	*Tetranychus lintearius, Sericothrips staphylinus*	(sap suckers)
established	*Agonopterix ulicitella, Pempelia genistella*	(foliage feeders)
USA West Coast :	*Exapion ulicis, Tetranychus lintearius*	
Tasmania:	*Exapion ulicis, Tetranychus lintearius, Sericothrips staphylinus*	
Chile:	*Exapion ulicis, Tetranychus lintearius, Agonopterix ulicitella*	
Hawaii:	*Exapion ulicis, Tetranychus lintearius, Agonopterix ulicitella, Pempelia genistella* (not established)	
Victoria:	*Exapion ulicis, Tetranychus lintearius, Sericothrips staphylinus*	
St Helena Island:	*Tetranychus lintearius*	

Appendix 2 : List of sites

Site	Country	GR	Altitude	Nearest town*	Road	Date	Ulex sp.	Phenology of plants	Pod samples	Beating sample
1	P		100	Torres Vedras	N8	29-Sep	*jussiaei*	100% fls : 50% pods	✓	✓
2	P		20	Nazaré	to Sâo Pedro	29-Sep	*e.* spp. *latebracteatus*	1st few fl buds		✓
3	P	39 26 32 N 08 50 50 W	243	Valverde	N362	30-Sep	*airensis*	2 fl buds		
4	P		20	Repolho (Fraguas to Rio Maior)	N361	30-Sep	*jussiaei*	100% fls		
5	P		20	Repolho (Fraguas to Rio Maior)	N361	30-Sep	*jussiaei*	100% fls		
6	P		30	Peniche	N247	30-Sep	*e.* spp. *latebracteatus*	Preflowering		
7	P		20	Lourinha	N247	30-Sep	*e.* spp. *latebracteatus*	Preflowering		
8	P		10	Praia de Porto Novo	N247	30-Sep	*e.* spp. *latebracteatus*	Preflowering		
9	P		20	Ponte do Rol	N9	30-Sep	*jussiaei*	100% fls		✓
10	P		20	Burinhosa	to Sâo Pedro	1-Oct	*e.* spp. *latebracteatus*	Preflowering		
							Stauracanthus genistoides	Preflowering		✓
11	P		20	Burinhosa	to Sâo Pedro	2-Oct	*e.* spp. *latebracteatus*	Preflowering		✓
12	P	39 40 14 N	120	Pataias	to Sâo	1-Oct	*e.* spp. *latebracteatus*	30% fls		✓
		09 00 42 W			Pedro	29-Nov	*e.* spp. *latebracteatus*	Preflowering	✓	
13	P		20	Burinhosa	to Sâo Pedro	1-Oct	*e.* spp. *latebracteatus*	Preflowering		
14	P		20	St Martinho de Atvore	N111	2-Oct	*jussiaei*	10% fls		✓
15	P		20	Maiorca	N111	2-Oct	*jussiaei*	10% fls		✓
16	P		20	S. Lourenco	N247	3-Oct	*jussiaei*	100% fls : 50% pods	✓	✓

17	P		20	S. Sebastiao	N247	3-Oct	*jussiaei*	10% fls		✓
							densus	Old pods		✓
18	P		20	Terrugem	N247	3-Oct	*densus*	Old pods		✓
19	P		20	Colares	N247	3-Oct	*jussiaei*	Few flowers		✓
20	E	43 26 29 N 04 59 45 W	68	Belmonte	N632	25-Nov	*e.* spp. *europaeus*	80% fls : 20% pods	✓	✓
21	E	43 33 32 N	141	Las Duenas	N632	25-Nov	*e.* spp. *europaeus*	10% fls : 1% pods	✓	✓
		06 10 26 W					*europaeus x gali*	100% fls : 10%pods	✓	✓
							gallii (?minor too?)	100% fls & pods	✓	✓
22	E	43 35 17 N 07 17 28 W	24	Fazouro	N642	26-Nov	*e.* spp. *europaeus*	10% fls : 1% pods	✓	
23	E	43 46 10 N 07 41 06 W	23	Vila de Bares	AC 100	26-Nov	*e.* spp. *europaeus*	10% fls		
24	E	43 38 12 N 08 04 41 W	22	Vilarubbe	C464	26-Nov	*e.* spp. *europaeus*	50% fls : 10% pods	✓	✓
25	E	43 30 41 N	48	Vista Alegre	C642	26-Nov	*e.* spp. *europaeus*	50% fls : 10% pods	✓	
		08 05 44 W					*gallii*	100% fls : 60% pods		
							minor	100% fls : 60% pods	✓	
26	E	42 56 06 N 08 26 07 W	300	Enfesta? layby km 61	A9 (S)	26-Nov	*e.* spp. *europaeus*	30% fls : 1% pods	✓	
27	E	42 41 20 N	134	Pontecesines	N550	27-Nov	*e.* spp. *europaeus*	10% fls		
		08 41 46 W					*gallii*	80% fls		
28	E	42 19 08 N	131	Moaña	PO313?	27-Nov	*e.* spp. *europaeus*	10% fls		
		08 43 26 W					*gallii*	90% fls	✓	✓
29	P	41 59 11 N	29	Valença	E1	27-Nov	*e.* spp. *europaeus*	50% fls : 2% pods	✓	✓
		08 39 11 W					*minor*	100% fls : 50% pods	✓	✓
30	P	41 46 53 N 08 51 57 W	8	Afife	N13	27-Nov	*e.* spp. *latebracteatus*	60% fl : 20% pods	✓	✓
31	P	41 18 25 N 08 42 14 W	55	Modivas	N13	28-Nov	*minor*	100% fls : 80% pods	✓	✓
32	P	40 52 18 N 08 39 05 W	13	Furadouro (beach)	off N 327	28-Nov	*europaeus* both spp.	80% fls : 20% pods	✓	✓
33	P	40 39 03 N	50	Curia layby	A1 (S)	28-Nov	*e.* spp. *europaeus*	1% fls		
		08 33 38 W					*micranthus*	0.01% fls	✓	✓

							minor	100% fls : 30% pods	✓	
34	P	39 37 18 N 08 44 51 W	386	Sao Mamede	off N356	28-Nov	*jussiaei*	10% fls		
35	P	40 00 38 N	68	Pombal Services	A1 (N)	29-Nov	*jussiaei*	100% fls : 10% pods	✓	
		08 36 01 W					*minor*	100% fls : 1% pods	✓	
36	P	39 32 58 N 08 48 36 W	439	Chao das Pias	off N362	29-Nov	*e.* spp. *europaeus*	80% fls : 10% seed	✓	
37	P	39 42 48 N 08 42 33 W	170	Leiria Services	A1 (N)	29-Nov	*e.* spp. *europaeus*	80% fls : 20% pods	✓	
38	P	39 36 58 N 08 50 44 W	179	Sao Jorge	N243	29-Nov	*minor*	100% fls : 50% pods	✓	✓
39	P	39 34 04 N 08 49 24 W	415	Serro Ventosa	off N362	29-Nov	*e.* spp. *europaeus*	10% fls : 1% pods	✓	
40	P	39 32 11 N 08 48 06 W	444	Poco Chaina	off N362	29-Nov	*airensis*	10% fls		✓
41	P	40 45 21 N	85	Estarreja services	A1 (N)	30-Nov	*e.* spp. *europaeus*	100% fls : 10% pods	✓	
		08 32 07 W					*minor*	100% fls : 5% pods	✓	
42	P	41 36 17 N	189	Barcelos services	A1 (N)	30-Nov	*e.* spp. *europaeus*	30% fls : 10 % pods	✓	✓
		08 32 58 W					*minor*	100% fls : 50% pods	✓	✓
							micranthus	0.01% fls		✓
43	P	41 58 45 N 08 39 12 W	149	Valença Toll	A1 (N)	30-Nov	*e.* spp. *europaeus*	50% fls : 5% pods	✓	
44	E	42 09 03 N 08 25 41 W	242	Vilacoba	A52	30-Nov	*e.* spp. *europaeus*	50% fls :10% pods	✓	
45	E	42 15 50 N 08 11 57 W	428	Melon	A52	30-Nov	*e.* spp. *europaeus*	50% fls : 5% pods	✓	
46	E	42 23 12 N 07 47 59 W	125	Melias	N120	1-Dec	*e.* spp. *europaeus*	50% fls : 5% pods	✓	
47	E	42 31 17 N	466	Brence	N120	1-Dec	*e.* spp. *Europaeus*	50% fl : 1% pods	✓	
		07 22 39 W					*minor*	50% fl : 10% pods	✓	
48	E	42 26 18 N 06 57 08 W	447	Rubia	N120	1-Dec	*e.* spp. *europaeus*	10% fl : 0.1% pods	✓	

* towns on Michelin maps and searchable through
http://www.viamichelin.com/viamichelin/fra/dyn/controller/mapHomePage;jsessionid=0000QZTTBS31ZTTYWJE4BC4E3QY+v0t5qvhg

Appendix 3. Data base of phytophagous arthropods known to use Ulex species developed from a literature search

Order	Family	Genus	species	Author	Source (feeding site - Zwolfer)	Ulex	Genista	Cytisus	Calicotome	Spartium	Others	Zwolfer polyphagy cat	Ref
Acarina	Eriophyidae	*Aceria*	*genistae nr sparti*	Nalepa	S	europaeus	{tinctoria, monspessulana (USA)}	{scoparius, striatus, purgans} = A. genistae		{junceum} = A. spartii		IV	Castagnoli 1978, Farkas 1965, Manson 1989, Roivainen 1953, Chan & Turner 1998, O'Donnell 1986 (lots of evidence to suggest the Ulex one different from Cytisus one), Krauss 62-63, Zwolfer 63 , D. Knihinicki pers. comm. (gave the nr spartii addition)
Acarina	Tetranychidae	*Tetranychus*	*lintearius*	Dufour	L,S	europaeus						VI	Hill, etc, Zwolfer 1963, O'Donnell 1986, Krauss 62-63
Acarina	Tetranychidae	*Bryobia*	*dekocki*	sp. nov		parviflorus							van Eyndhoven & Vacante 1985
Thysanoptera	Thripidae	*Sericothrips*	*staphylinus*	Haliday		europaeus							Kaltenbach 1874, Memmott et al. 1998
Thysanoptera	Thripidae	*Odontothrips*	*ulicis*	Haliday		europaeus							Kaltenbach 1874,O'Donnell 1986, Krauss 62-63
Thysanoptera	Thripidae	*Odontothrips*	*nutabilis*	Bg.		europaeus							Bagnall1924
Thysanoptera	Thripidae	*Thrips*	*flavus*	Schrank		europaeus							O'Donnell 1986,Krauss 62-63
Thysanoptera	Thripidae	*Thrips*	*tabaci*	L		europaeus							Krauss 62-63)
Thysanoptera	Thripidae	*Hercinothrips*	*bicinctus*	Bg.		europaeus							Krauss 62-63 (Madeira)
Thysanoptera	Phlaeothripidae	*Bacillothrips*	*longiceps*	Reuter		europaeus							O'Donnell 1988
Thysanoptera	Phlaeothripidae	*Haplothrips*	*sp.*			europaeus							O'Donnell 1989
Hemiptera	Aphididae	*Aphis*	*ulicis*	Walker	S	europaeus						I	O'Donnell 1986, Zwolfer 1963, Krauss 62-63
Hemiptera	Pseudococcidae	*Phenacoccus*	*aceris*	Signoret		europaeus							O'Donnell 1986 (1 site)
Hemiptera	Coccidae	*Aspidiotus*	*sp.*			spectabilis							Krauss 62-63 (Morocco)
Hemiptera	Coccidae	*Asterolecanium*	*sp.*			parviflorus							Houard 1908/9
Hemiptera	Psyllidae	*Livilla*	*ulicis*	Curtis		europaeus	tinctoria	scoparius			Ononis Calluna?		Kaltenbach 1874, Hodkinson & White 1979, Davis 1985
Hemiptera	Psyllidae	*Livilla*	*cataloniensis*	(Hodkinson & White) comb. N.		parviflorus							Hodkinson & White 1979
Hemiptera	Psyllidae	*Arytaina*	*genistae*	Latreille	S	europaeus	sp.	scoparius, austriacus		juncaeum		III	Heslop-Harrison 1951, Hodkinson & White 1979, Hodkinson & Hollis 1987, Southwood 1968, Watmough (1968) a&b, White & Hodkinson 1982, Zwolfer 1963

Hemiptera	Cicadellidae	*nr Platymetopius*	*sp. A*			europaeus							O'Donnell 1986
Hemiptera	Cicadellidae	*nr Platymetopius*	*sp. B*			europaeus							O'Donnell 1986
Hemiptera	Cicadellidae	*Thamnotettix*	*dilutor*	Kirschbaum		europaeus							O'Donnell 1986
Hemiptera	Cercopidae	*Philaenus*	*spumarius*	L.		sp.	sp.	sp.	sp.	sp.	sp.		O'Donnell 1986
Hemiptera	Cercopidae	*Aphrophora*	*sp.*		S	sp.					sp.?		Krauss 62-63, Zwolfer 63
Hemiptera	Membracidae	*Centrotus*	*corautus*	L.	S	europaeus					Rubus, sp.	VI	Zwolfer 63
Hemiptera	Membracidae	*Gargara*	*genistae*	F.		europaeus	monspessulana	sp.				III	Zwolfer 63, Sheppard pers comm, Syrett et al. 1999
Hemiptera	Tettigometridae	*Tettigometra*	*costulata*	Fieb.	S	sp.							Krauss 62-63 (Morocco)
Hemiptera	Tingidae	*Dictyonota*	*strichnocera*	Fieb		europaeus							Fowler &Griffin 1996
Hemiptera	Cixiidae	*Tachycixius*	*venustulus*	Germar		europaeus							O'Donnell 1986
Hemiptera	Coreidae	*Geocoris*	*enthyrophthalmus*	Reuter		europaeus							O'Donnell 1986 (1 site)
Hemiptera	Miridae	*Asciodema*	*obsoleta*	Fieber		europaeus		scoparius	villosa				O'Donnell 1986, Zwolfer 1963, Dempster, J. P., 1964A. The feeding habits of the Miridae (Heteroptera) living on broom (Sarothamnus scoparius (L.) Wimm.). Entomol. Exp. Appl. 7:149--154, Pericart, J., 1965A. Contribution a la fanistique de la Corse: H,teroptŠres Miridae et Anthocoridae (Hem.). Bull. Mens. Soc. Linn. Lyon 34:377--384
Hemiptera	Miridae	*Capsodes*	*lineolatus*	Goeze		europaeus							O'Donnell 1986, Zwolfer 1963?
Hemiptera	Miridae	*Heterocordylus*	*parvulus*	Reuter		europaeus							O'Donnell 1986, Zwolfer 1963
Hemiptera	Miridae	*Hadrodemus*	*noualhieri*	Reuter		micracanthus							Wagner, E., 1974G. Die Miridae Hahn, 1831, des Mitelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera). Teil. 1 Entomol. Abh. 37 Suppl. iii + 484 pp.
Hemiptera	Miridae	*Atractotomus*	*sp.*			europaeus							Zwolfer 1963
Hemiptera	Miridae	*Platycranus*	*bicolor*	Douglas & Scott		europaeus		scoparius					Ehanno, B., 1960A. Contribution a la connaissance des Insectes H,teroptŠres Miridae Armoricains (2e note). Bull. Soc. Sci. Bretagne 35:313--324.
Hemiptera	Pentatomidae	*Piezodorus*	*lituratus*	F	S	europaeus	sp.	sp.				III	O'Donnell 1986, Zwolfer 1963
Lepidoptera	Gracillariidae	*Phyllonorycter*	*uilicicolella*	Stt.	mining bark of twigs	sp.						I	Emmet 1992, Hering 1957
Lepidoptera	Coleophoridae	*Coleophora*	*saturatella*	Stainton	leaf miner	parviflorus	tinctoria	scoparius, villosus, sp.				III/IV	Emmet 1988, Kloet Hincks 1972, Heath 1991, Suire 1951,1962
Lepidoptera	Coleophoridae	*Coleophora*	*albicosta*	Haw.	in ans on pod	europaeus, parviflorus	germanica, sp.				Potentilla	I	Suire 1951,1962, Zwolfer 1963, L'Homme 1923-46
Lepidoptera	Coleophoridae	*Coleophora*	*marginatella = arctostaphyli*	H.S.	leaf miner	sp.?		scoparius				(III)	Hering 1957
Lepidoptera	Coleophoridae	*Coleophora*	*sp.*		leaf feeder	europaeus							Zwolfer 1963

Lepidoptera	Oecophoridae	*Batia*	*lambdella*	Don.	in dead wood	sp.					various trees and shrubs		Emmet 1992, Spuler 1910, Hering 1957
Lepidoptera	Oecophoridae	*Depressaria*	*umbellana*	Stephens	silken tube in shoot	europaeus, nana, parviflorus	anglica?				Adenocarpus hispanicus (L' Homme 1923-46)	II	Suire 1951,1962, Zwolfer 1963, L'Homme 1923-46, Davis unpublished
Lepidoptera	Oecophoridae	*Agonopterix*	*nervosa*	Haworth	in flower buds flowers and young pods in tube	parviflorus, europaeus, sp.	monspessulana, tinctoria, germanica, hispanica, sp.	scoparius, villosus, arborea	spinosa	junceum	Ilex, Coriaria?	IV	Emmet 1988, Kloet Hincks 1972, Meyrick 1928, Suire 1951,1962, Sheppard unpublished, O'Donnell 1986, Zwolfer 1963 (in N. America, Asia)
Lepidoptera	Oecophoridae	*Agonopterix*	*ulicetella*	Stt.		sp.	pilosa						Heath 1991, O'Donnell 1986
Lepidoptera	Gelechiidae	*Anarsia*	*robertsonella ssp dejoannisi Real*	Curtis	leaf/flower feeder, spun shoots	europaeus, sp.						I	Jacques 1997, Zwolfer 1963
Lepidoptera	Gelechiidae	*Mirificarma*	*ulicinella*	Staudinger	flowers	parviflorus						(I)	Putkin 1984, Suire 1951, Spuler 1910
Lepidoptera	Gelechiidae	*Mirificarma*	*mulinella*	Z.	spun flowers and shoots	europaeus	germanica, tinctoria,	scoparius, sp.	spinosa		Lembotropis nigricans, Bartsia (dubious), Lupinus arboreus,	IV	Suire 1951,1962, Putkin 1984,
Lepidoptera	Gelechiidae	*Anisoplaca*	*ptyoptera*	Meyrick		europaeus					Carmichaelieae		Holder 1996 (exotic)
Lepidoptera	Gelechiidae	*Brachmia*	*gerronella*	Don.	doubtful record								L'Homme 1923-46, Merick 1927
Lepidoptera	Scythrididae	*Scythris*	*grandipennis*	Haw.	shoots	sp. minor, europaeus	sp.	sp.				III/IV	Emmet 1992, Spuler 1910 (Genista rec.), L'Homme 1923-46(Genista rec.), Eckstein 1933 (Cytisus rec.)
Lepidoptera	Scythrididae	*Scythris*	*gallicella*	d. Joannus	shoots	europaeus						I	Davis unpublished (Portugal), L'Homme 1923-46
Lepidoptera	Tortricidae	*Cydia*	*succedana*	Denis & Schiffermuller	pods (2 generations)	parviflorus, sp.	monspessulana, anglica, radiata, tinctoria, cinerea,	scoparius, nigrescens, sp.		junceum	Lotus, Dorycnium, Ononis, Chamaespartium sagittale,	IV/V	Emmet 1988, Kloet & Hincks 1972, Suire 1951,1962, O'Donnell 1986
Lepidoptera	Tortricidae	*Cydia*	*internana*	Guen.	pods	europaeus	sp.					III?	Emmet 1992, Zwolfer 1963, L'Homme 1923-46, Meyrick 1927
Lepidoptera	Tortricidae	*Cydia (= Enarmonia)*	*scopariana*	H.S.	mine young shoots then migrate to underground parts	parviflorus, europaeus	tinctoria	scoparius		junceum		IV	Suire 1951,1962, Zwolfer 1963, Hering 1957, L'Homme 1923-46
Lepidoptera	Tortricidae	*Periclepsis*	*cinctana*	Denis & Shiffermuller		sp.	sp.	sp.			Lotus, Anthyllis, Calluna, Artemisia		Emmet 1988, Heath 1991, Suire 1951,1962
Lepidoptera	Tortricidae	*Argyrotaenia*	*pulchellana*	Haw.		europaeus							Zwolfer 1963, O'Donnell 1986, Krauss 62-63
Lepidoptera	Tortricidae	*Batodes*	*angustioranus*	Haw.	spun tips	europaeus					Crataegus, Laurus, Pinus	VI	Zwolfer 1963

Lepidoptera	Tortricidae	*Archips*	*xylosteana*	L.	polyphagous	europaeus					sp.	VI	Zwolfer 1963
Lepidoptera	Tortricidae	*Tortrix*	*pronubana*	Hb.	shoots	europaeus					Daphne, Asphodelos, Arbutus, Rosmarinus,	VI	Zwolfer 1963
Lepidoptera	Pyralidae	*Pempelia*	*genistella*	Dup.	loose webs	sp.						(I)	Emmet 1992, Spuler 1910, Meyrick 1927
Lepidoptera	Pyralidae	*Uresiphita*	*polygonalis*	Denis & Shiffermuller	light webs	parviflorus, sp.	monspessulana, germanica, tinctoria,sp.	scoparius, villosus, sp.		sp.	Chamaecytisus, Lupinus, Laburnum, Sophora, Pericopsis, Bolusanthus, Baptisia, Anagyris, Piptanthus, Retama, Acacia, Polygonium	V/VI	Emmet 1988, Kloet & Hincks 1972, Leen 1997, Suire 1951,1962, L'Homme 1923-46
Lepidoptera	Pyralidae	*Uresiphita*	*reversalis*			sp.	monspessulana (USA)	sp.		sp.	Chamaecytisus, Lupinus, Laburnum, Sophora, Pericopsis, Bolusanthus, Baptisia, Anagyris, Piptanthus, Hovea, Templetonia, Acacia		Montllor et al. 1990, 1995, Wink et al. 1991, Leen 1997
Lepidoptera	Pyralidae	*Uresiphita*	*ornithopteralis*			sp.	sp.	sp.		sp.	Chamaecytisus, Lupinus, Laburnum, Sophora, Pericopsis, Bolusanthus, Hovea, Templetonia, Viminaria, Acacia		Leen 1997
Lepidoptera	Lycaenidae	*Callophrys*	*rubi*	L.		europaeus	monspessulana, sp.	scoparius			Lotus, Helianthemum, Vaccinium, Rhamnus, Rubus, Cornus etc.	VI	Carter & Hargreaves 1986, Higgins & Riley 1973, Heath 1991, Sheppard unpublished
Lepidoptera	Lycaenidae	*Plebejus*	*argus argus*	L.		sp.					Erica, Lotus, Calluna, Helianthemum, Lotus,	VI	Emmet 1992

Lepidoptera	Lycaenidae	*Celastrina*	*argiolus sp. britanna*	L. (ver.)		sp.					Ilex, Hedera, Cornus, Pyracantha, Rubus	VI	Emmet 1992, L'Homme 1923-46
Lepidoptera	Lycaenidae	*Lampides*	*boeticus*	L.	in pods	sp.					Leguminosae	V	Zwolfer 1963, Hering 1957
Lepidoptera	Lycaenidae	*Everes*	*argiades*	Pll.	shoots	sp.					Lotus, Trifolium, Medicago, Faba	V	L'Homme 1923-46
Lepidoptera	Lycaenidae	*Leptotes*	*pirithous*	L.		sp.					Polyphagous	VI	L'Homme 1923-46
Lepidoptera	Geometridae	*Pseudoterpna*	*pruinata atropunctaria*	Hufnagel		europaeus	anglica	scoparius			Laburnum in captivity, Coronilla		Carter & Hargreaves 1986, Kloet Hincks 1972, Meyrick 1928, Skinner 1984, L'Homme 1923-46
Lepidoptera	Geometridae	*Pseudoterpna*	*caronillaria*	Huber	shoots	europaeus		sp.			Coronilla	IV/V	Zwolfer 1963, O'Donnell 1986, L' Homme 1923-46
Lepidoptera	Geometridae	*Scotopterix*	*peribolata*	Huber	shoots	europaeus	sp.	scoparius				III	Skinner 1984, Spuler 1910
Lepidoptera	Geometridae	*Scotopterix*	*mucronata*	Scop	shoots	sp.	sp.	sp.		sp.		IV	Emmet 1992, L'Homme 1923-46
Lepidoptera	Geometridae	*Scotopterix*	*luridata ssp. Plumbaria*	Fabr.	shoots	sp.	anglica						Emmet 1992
Lepidoptera	Geometridae	*Chesias*	*rufata*	F	shoots	sp.	sp.	sp.			Coronilla	IV/V	L'Homme 1923-46, Emmet 1992
Lepidoptera	Geometridae	*Operophtera*	*brumata*		shoots	europaeus					decidous trees	VI	Zwolfer 1963
Lepidoptera	Geometridae	*Gymnoscelis*	*rufifasciata*	Haw.	flowers	sp					Ilex, Calluna	V/VI	Emmet 1992
Lepidoptera	Geometridae	*Gymnoscelis*	*pumilata*	Hb.	flowers	europaeus		sp.			Erica, Crataegus, Arbutus		Zwolfer 1963
Lepidoptera	Geometridae	*Perconia*	*strigillaria*	Hb.	flowers	sp.		scoparius			Erica, Calluna		Emmet 1992
Lepidoptera	Geometridae	*Isturgia*	*limbaria*	F		europaeus	sp.	sp.				III	Zwolfer 1963 L'Homme 1923-46
Lepidoptera	Noctuidae	*Antitype*	*chi*	L.	polyphagous	europaeus					many	IV	Zwolfer 1963
Lepidoptera	Noctuidae	*Antitype*	*argillaceago*	Hb.	polyphagous	sp.	sp.		sp.		Daphne, Rosmarinus	V/VI	Zwolfer 1963, L'Homme 1923-46
Diptera	Agromyzidae	*Agromyza*	*johannae*	de Meijere	Gall	sp.	sp.	**sp.**		junceum			Spencer 1990 (only on v young leaves), Zwolfer 1963?
Diptera	Sciaridae	*Corynoptera*	*simonae*	Rudzinski		europaeus							Rudzinski 1992
Diptera	Cecidomyiidae	*?Dasineura*	*sp.*			europaeus							O'Donnell 1986,
Diptera	Cecidomyiidae	*Asphondylia*	*ulicis*	Ver.	flower bud galls	europaeus, minor, sp.						II	Zwolfer 1963
Coleoptera	Apionidae	*Lepidapion*	*squamigerum*	J. du Val.	seeds	europaeus	anglica, lucida	scoparius				III	Hoffmann 1958, Alonzo-Zarazaga 1985 (PhD- Cs record), Ehret 1990
Coleoptera	Apionidae	*Lepidapion*	*pseudogallaecianum*	Hoff.	seeds	europaeus, minor						I	Ehret 1990
Coleoptera	Apionidae	*Stenopterapion*	*scutellare*	Kirby	mines stems etc and forms ovoid galls	europaeus, minor						I	Ehret 1990, O'Donnell 1986, Zwolfer 1963, Krauss 62-63

Coleoptera	Apionidae	*Stenopterapion*	*cantabricum*	Desbrochers	mines stems etc and forms ovoid galls	parviflorus	cinerea, florida, sp.	scoparius multiflorus, purgans			Lavandula stoechas	I	Sanz Benito & Gurrea Sanz 1991, Alonzo Zarazaga 1990, Ehret 1990
Coleoptera	Apionidae	*Stenopterapion*	*dubium*	Desbrochers	mines stems etc	sp.							Alonzo Zarazaga 1990,
Coleoptera	Apionidae	*Stenopterapion*	*subsquamosum*	Desbrochers	mines stems etc	sp.							Alonzo Zarazaga 1990,
Coleoptera	Apionidae	*Exapion*	*genistae*	Kirby	seeds	europaeus (var. intermedius)	anglica, pilosa, tinctoria,						Alonzo Zarazaga 1990, Hoffmann 1958, Morris 1990
Coleoptera	Apionidae	*Exapion*	*crassiusculum*	Desbrochers	seeds	europaeus						I	Ehret 1990
Coleoptera	Apionidae	*Exapion*	*lemovicinum*	Hoff.		europaeus, minor						I	Ehret 1990
Coleoptera	Apionidae	*Exapion*	*uliciperda*	Pandellé	seeds	europaeus, **minor**						(I)	Ehret 1990
Coleoptera	Apionidae	*Exapion*	*elongatulum*	Desbrochers	seeds	minor		sp.					Hoffmann 1958,
Coleoptera	Apionidae	*Exapion*	*ulicis (ssp. ulicis & ssp. reyi)*	Forster	seeds	sp. **europaeus,** parviflorus, minor						I/II	Ehret 1990, O'Donnell 1986, Zwolfer 1963, Krauss 62-63
Coleoptera	Apionidae	*Pirapion*	*immune*	Kirby									O'Donnell 1986
Coleoptera	Apionidae	*Protopirapion*	*atratulum (=striatum)*	Germar	flowers	europaeus, minor	tinctoria, cinerea, florida, spp.(casual)	scoparius multiflorus, striatus, purgans, cantabricus,	spinosa (casual)	juncaeum	Quercus, Lavandula	III/IV	Alonzo Zarazaga 1990, Baluzac 1984, Gurrea Sanz et al. 1986,Hoffmann 1958, Morris 1990, Noe-Nygaard 1978, Roudier 1963, Sanz Benito et al. 1990, Sanz Benito and Gurrea Sanz 1991, Velazquez de Castro 1989, Velazquez de Castro et al. 1990, Syrett & Emberson pers. comm., O'Donnell 1986, Zwolfer 1963
Coleoptera	Apionidae	*Protopirapion*	*kraatzi*	Wencker		sp.	sp.	sp.	**spinosa**		Chamaecytisus		Alonzo Zarazaga 1990, Ehret 1990
Coleoptera	Curculionidae	*Polydrusus*	*confluens*	Stephens		europaeus, minor	pilosa, sp.	scoparius multiflorus, purgans, striatus, villosus, grandiflorus, sessilifolius?, sp.			Chamaespartium sagittale,	III?	Hoffmann 1958, Kloet & Hincks 1977, Sanz Benito et al. 1990, Sanz Benito & Gurrea Sanz 1991, Waloff unpublihsed, , Syrett & Emberson pers. comm.
Coleoptera	Curculionidae	*Polydrusus*	*sp.*			europaeus							O'Donnell 1986, Zwolfer 1963
Coleoptera	Curculionidae	*Hypera*	*trilineata*	Marsh	L,S	europaeus, minor					Lotus, Anthyllis, Onobrychis	IV	Zwolfer 1963, Hoffman 1954

Coleoptera	Curculionidae	*Sitona*	*regensteinensis*	Herbst		europaeus, minor	cinerea, florida, pilosa, hispanica, sp.	scoparius, multiflorus, purgans, striatus, grandiflorus, sessifolius?, cantabricus		juncaeum	Echinospartium barnadesii, Erica arborea, Laburnum	IV	Balazuc 1984, Danthanarayana 1965, 1966, 1969, 1970, Hoffmann 1958, Kloet & Hincks 1977, Sanz Benito & Gurrea Sanz 1991, Sanz Benito et al. 1990, Scherf 1959, Velazquez de Castro et al. 1990, Waloff unpublished, Syrett & Emberson pers. comm., O'Donnell 1986, Zwolfer 1963,
Coleoptera	Curculionidae	*Sitona*	*striatellus*	Gyll.		europaeus							O'Donnell 1986
Coleoptera	Curculionidae	*Sitona*	*tibialis*		L,S	europaeus, minor	sp.	scoparius, sessifolius, sp.		juncaeum	Vicia	IV	Syrett & Emberson pers. comm., Freude et al. 1981 , Zwolfer 1963
Coleoptera	Curculionidae	*Pachytychius*	*sparsutus*	Ol.	P,L	europeaus	cinerea, tinctoria, pilosa, florida, monspessulana	scoparius multiflorus, purgans, sessilifolius, striatus, cantabricus			Echinospartium barnadesii, Erica arborea, Chamaespartium tridentatum	IV	Balazuc 1984, Caldara 1978, Gurrea Sanz et al. 1988, Hoffmann 1958, Sanz Benito & Gurrea Sanz 1991, Sanz Benito et al. 1989, 1990, Velazquez de Castro et al. 1990, Hoffmann 1958, , Syrett & Emberson pers. comm., Sheppard, O'Donnell 1986, Zwolfer 1963
Coleoptera	Curculionidae	*Tychius*	*parallelus (=venustus)*	Panzer	P	baeticus, parviflorus	tinctoria, sp.	scoparius, grandiflorus, multiflorus, striatus,		junceum (var spartii)	Chamaespartium sagittale,		Hoffmann 1954, Kloet & Hincks 1977, Velazquez de Castro et al. 1990, Velazquez de Castro & Alonzo Zarazaga 1988, Velazquez de Castro & Caldara 1989, Waloff unpublished, , Syrett & Emberson pers. comm.
Coleoptera	Curculionidae	*Cneorhinus*	*?hispanus*	Herbst		europaeus							O'Donnell 1986
Coleoptera	Curculionidae	*Pleurodirus*	*carinula*	Ol.		europaeus	cinerea, florida	scoparius multiflorus, arboraeus, striatus, purgans, grandiflorus			Adenocarpus, Pinus, Trifolium, Erica, Lavandula, Carduus, Quercus, Echinospartium lusitanicum		Sanz Benito & Gurrea Sanz 1991, Sheppard, Syrett & Emberson per. comm., O'Donnell 1986
Coleoptera	Curculionidae	*Pleurodirus*	*aquisextanus*	Ab.	S	parviflorus						(I)?	Hoffmann 1954
Coleoptera	Curculionidae	*Strophosoma*	*melanogrammus*	Forster	L,S	europaeus	florida	scoparius, purgans, multiflorus			polyphagous	VI	Syrett & Emberson pers. comm., Zwolfer 1963
Coleoptera	Curculionidae	*Strophosomus*	*nebulosus*	Stephens		europaeus							O'Donnell 1986
Coleoptera	Curculionidae	*Strophosomus*	*?ovulum*	Seidlitz		europaeus							O'Donnell 1987
Coleoptera	Curculionidae	*Strophosomus*	*erinaceus*	Chev	L,S	europaeus					Quercus	VI	Zwolfer 1963
Coleoptera	Curculionidae	*Peritelus*	*senex*	Boheman	L,S	parviflorus	monspessulana				Astragalus monspessulanus	III?	Sheppard, Hoffmann 1958
Coleoptera	Curculionidae	*Peritelus*	*prolixus*	Kies	L,S	europaeus	minor, parviflorus, europaeus					(I)	Zwolfer 1963
Coleoptera	Chrysomelidae	*Calomicrus (=Luperus?)*	*circumfusus*	Marsham	L,S	sp., europaeus	scorpius, florida, cinerea, sp.	scoparius, purgans, multiflorus, striatus, cantabricus		sp., junceum	Chamaespartium	IV	Balazuc 1984, Garcia-Ocejo et al. 1990, Gurrea Sanz et al. 1990, Syrett & Emberson pers comm (most Cytisus refs), O'Donnell 1986, Zwolfer 1963, Bedel 1901, Pawlowski 1955

Coleoptera	Chrysomelidae	*Gonioctena*	*olivacea*	Forster	L,S	europaeus	cinerea, florida, sp.	scoparius multiflorus, purgans, striatus, cantabricus			Lupinus arboreus	IV	Balazuc 1984, Dempster et al. 1959, Dempster 1960, Donia 1958, Garcia Ocejo et al. 1990, 1993, Gurrea Sanz et al. 1990, Gurrea Sanz & Garcia-Ocejo 1989, Richards & Walofff 1961, 1962, Waloff unpublished, Waloff & Richards 1958, Waloff 1961, Syrett &Emberson pers.comm.(cantabricus and G. sp.), Zwolfer 1963 (Ulex)
Coleoptera	Chrysomelidae	*Psylliodes*	*? Petasata*	Foudras	L,S	europaeus							O'Donnell 1986
	Chrysomelidae	*Phytodecta*	*variabilis*	Ol.	L,S	spp.				junceum		IV	Calwer ?
Coleoptera	Bruchidae	*Bruchidius*	*? foveolatus*	Gyll	P	europaeus							O'Donnell 1986 (1 site)
	Bruchidae	*Bruchidius*	*affinis (v. Bedeli)*	Frl.	P	europaeus					Lathryrus	IV	Zwolfer 1963, Hoffman 1945
Coleoptera	Bruchidae	*Bruchidius*	*lividimanus*		P	europaeus	monspessulana, sp.	sp., scoparius, multiflorus, striatus, purgans, cantabricus, hirsutus	sp.	sp.	Ononis	IV/V	Sheppard, Syrett & Emberson pers.comm., Hosking 1995, Zwolfer 1963, Hoffamn 1954 (some evidence of host races)
Coleoptera	Bruchidae	*Callosobruchus*	*sp.? Chinensis*		P	europaeus, spectabilis							Davis unpublished, Zwolfer 1963
Coleoptera	Scolytidae	*Phloeophthorus*	*rhododactylus*	Marsham	W,B	sp., europaeus	sp.	sp., scoparius, multiflorus, striatus,	sp.	sp.	Retama	IV/V	Balachowsky 1949, Chapman 1869, Duffy 1953, Simandl & Kletecka 1987, Smith 1958, Syrett & Emberson pers.comm. (Cytisus spp.), Zwolfer 1963, Balachowski 1949
Coleoptera	Attelabidae	*Auletobius*	*pubescens*	Kiesenwetter		europaeus							O'Donnell 1986 (1 site)
Coleoptera	Buprestidae	*Anthaxia*	*funerla*	Ill	W	europaeus, parviflorus	sp.	sp.	sp.	sp.		V	Bedel 1901, Horion1955
Coleoptera	Buprestidae	*Acmaeodera*	*adspersula*	Ill	W		sp.				ployphagous	VI?	Davis unpublished
Coleoptera	Cerambycidae	*Chlorophorus*	*trifasciatus*	F.			sp.				Ononis	III?	Davis unpublished
Coleoptera	Cerambycidae	*Deilus*	*fugax*	Ol.		sp.		sp.	sp.	sp.		IV	Planet 1924

References

Alonso Zarazaga M.A. (1990) Revision of the supraspecific taxa in the Palaearctic Apionidae Schoenherr 1823 (Coleoptera, Curculionoidea). 2. Subfamily Apioninae Schoenherr 1823: introduction, keys and descriptions. Graellsia 46: 19-156

Balazuc J. 1984, Coléoptères de l'Ardeche, contribution a l'inventaire d'une faune régionale. Supplement du Bulletin Mensuel de la Societe Linneenne de Lyon France

Danthanarayana W 1969 Population dynamics of the weevil Sitona regensteinensis (Hbst). on broom. Journal of Animal Ecology 38 1-8

Davis WM unpublished

Duffy EAJ 1953, Handbooks for the Identification of British Insects: Coleoptera, Scolytidae & Platypodidae Vol 5 part 15 Royal Entomological Society of London

Eckstein K. 1933 Die Schmetterlinge Deutschlands Vol 5 Stuttgart

Emmet A.M. (1988) A field guide to the smaller British Lepidoptera. 2nd edit. The British Entomological and Natural History Society, London UK 288 pp.

Emmet A.M. and Heath J. eds. (1992) The moths and butterflies of Great Britain and Ireland Vol. 7 (2): Lasiocampidae – Thyatiridae with life history chart of the British Lepidoptera. Harley Books, UK, 400pp.

Ehret J.-M. (1990) Les Apions de France: clés d'identification commentées (Coleoptera Curculionidae Apioninae) *Bulletin mensuel de* la Societé Linneenne de Lyon 59: 209-292

Freude H., Harde K.W. and Lohse G.A. (eds) (1981) Die Kafer Mitteleuropas. Band 10. Bruchidae, Anthribidae, Scolytidae, Platypodidae, Curculionidae. Goecke & Evers, Krefeld, Germany. 310 pp.

Gurrea P., Alonzo Zarazaga M.A. and Gajate J. (1986) Los *Pirapion* de la Sierra de Gredos (España Central) (Coleóptera, Curculionoidea). Acto de las VIII Jornadas A e E, Sevilla, p. 548-560

Hering M. 1957 Bestimmungstabellen der Blattminen von Europa 3 Vol. S-Gravenhage

Hoffman A. 1954 Coléoptères Curculionides (2). *Faune de France* 59: 1-486, Paris

Hoffmann A. (1958) Coléoptères Curculionides (3). *Faune de France* 62:1209-1841, Paris

L'Homme L. 1923-46 Catalogue des Lépidoptères de France et de Belgique 2 Vols Paris

Kloet G.S. and Hincks, W.D. (1972) A checklist of British insects, 2nd edit. Lepidoptera. Handbooks for the identification of British insects. Volume 11, part 2. Royal Entomological Society of London, 153 pp.

Kloet & Hincks 1978, A checklist of British insects, 2nd edit. Coleoptera and Strepsiptera. Handbooks for the identification of British insects. Volume 11, part 3. Royal Entomological Society of London, 153 pp.

Krauss NLH 62-63, Reports of the exploratory entomologist Div. Ent. Agric. Dept Hawaii.

Leen R. (1998) Host-plant preferences of *Uresiphita reversalis* (Guenee) (Lep. Crambidae) *Journal of Applied Entomology* 122: 537-541

Meyrick E. (1928) A revised handbook of British Lepidoptera. Watkins and Doncaster, London, UK. 914 pp.

Morris M.G.1990 Orthocerous Weevils: Coleoptera Curculionoidea (Nemonychidae, Anthribidae, Urodontidae, Attelabidae and Apionidae) (Handbooks for the Identification of British Insects 5/16).

Noe-Nygaard B. 1978. Aspects of the biology of Apion striatum Kirby (Coleoptera; Curculionidae). Entomologiske Meddelelser 46, 97-101

O'Donnell D. 1986 A survey of the natural enemies of gorse (Ulex spp.) in Northern Spain and Portugal. Report, CIBC Imperial College Silwood Park

Planet L.M. 1924 Histoire naturelle des Longicornes de France in Encyclopédie Entomologique, Vol. II, Paris

Sanz Benito M.J., Gurrea Sanz, P., de los Mosos Pascual, M., Martin Cano, J. and Munguira M. L. (1990) Distribución del nicho ecológico de los Curculionoidea (Coleoptera) in los Cytisus en la Sierra de Alcaraz. Jornados sobre el medio natural Albacentense, Albacete. pp. 203-5.

Sanz Benito M.J. and Gurrea Sanz P. (1991) Inventario y analysis biogeografico preliminar de las especies de Curculionoidea (Coleoptera) de Genisteae en Las Sierras del Sistema Central (Peninsula Iberica). Graellsia 47: 117-127

Simandl J and Kletecka Z. 1987 Community of xylophagous beetles (Coleoptera) on Sarothamnus scoparius in Czechoslovakia Acta Entomologica Bohemoslovaca, 84, 321-329.

Spencer KA 1990 Host specialization in the world Agromyzidae (Diptera) Kluwer Academic Publishers

Spuler A. 1910, Die Schmetterlinge Europas Vol. II – Stuttgart.

Suire J. (1951). Microlepidopteres des plantes caraterisant les zones naturelles de la costiere. Memoires de la Societe d'Etudes des Sciences Naturelles de Nimes N°8, Contribution à la mise en valeur de la Costiere du Gard (Etude du Milieu)

Suire J. (1965) Microlepidopteres de la Costiere du Gard. Doctoral thesis, Ecole de L' Agriculture Montpellier, France.

Syrett P & Emberson R pers. comm.

Velàzquez de Castro A.J., Alonso Zarazaga, M.A. and Gurrea P. (1989) Los *Pirapion* del Sistema Central (España) (Col. Curculionoidea). Boletín de la Asociation Española de Entomologia 13: 29-33

Velázquez de Castro A.J., Alonzo Zarazaga M.A., and Outerelo R.(1990) Curculionoidea (Coleoptera) de Navacerrada, Sierra de Guadarrama (España). Boletín de la Real Sociedad Española de Historia Natural (Sección Biológica) 85: 17-37

Waloff N. unpublished

Zwolfer H. 1963 Ulex europaeus project: European investigations for New Zealand Report No. 2 Commonwealth Institute of Biological Control European Station. Pp.30