The Bees and Wasps (Hymenoptera Aculeata) of the Balearic Islands, their contribution to environmental and economic well-being and to scientific research

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To complement a recent publication on the aculeate Hymenoptera (bees and wasps) biodiversity of the Balearic Islands, this paper focuses on the wider ecological role played by this group within the Balearics. Current knowledge is placed in its wider geographical context, with special emphasis on Mediterranean islands. The paper draws attention to the essential role of bees and wasps within the ecosystem, their value, threats and conservation needs, including sites, biotopes and endemisms. Illustrations are provided to demonstrate the diversity and attractiveness of the many bees and wasps across the Islands.
Keywords: *Aculeates, bees, wasps, biodiversity, endemics, ecosystem, conservation.*

LES ABELLES I LES VESPES (HYMENOPTERA ACULEATA) DE LES ILLES BALEARS, LA SEVA CONTRIBUCIÓ AL BENESTAR AMBIENTAL I ECONÒMIC I A LA RECERCA CIENTÍFICA. Per complementar una publicació recent sobre la biodiversitat d'himenòpters aculeats (abelles i vespes) de les Illes Balears, aquest article se centra en l'ample paper ecològic que juga aquest grup a les Balears. L'actual coneixement se situa en el seu context geogràfic més ampli, amb especial èmfasi en les illes mediterrànies. El document fa una crida sobre el paper essencial de les abelles i les vespes dins de l'ecosistema, el seu valor, les amenaces i les necessitats de conservació, inclosos els llocs, els biòtops i els endemismes. Es proporcionen il·lustracions per demostrar la diversitat i l'atractiu de les nombroses abelles i vespes de les Illes.
Paraules clau: *Aculeats, abelles, vespes, biodiversitat, endemismes, ecosistema, conservació.*

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Introduction

British scientific interest in the taxonomy of bees and aculeate wasps (Hymenoptera: Aculeata) of the Balearic Islands can be traced back to the beginning of the 20th century (Saunders, 1901; 1904) but has accelerated considerably in the last 20 years, culminating recently in the publication of *The Bees and Wasps of the Balearic Islands* (Baldock *et al*., 2020). That work, supported by targeted studies to amplify knowledge across the archipelago, listed 516 species - 236 bees and 280 wasps; an addition of 157 species to the known aculeate fauna of the islands.

The list included 25 species or subspecies considered endemic to one or more of the Balearic Islands. Co-author Alain Livory, accompanied by Rosalyne Coulomb, independently travelled widely across the islands over many years, collecting and identifying aculeates and contributing a long series of records. The project has also been greatly enhanced by the continuing research by scientists at IMEDEA – the Mediterranean Institute of Advanced Studies – through the work and inspiration of Professor Anna Traveset and her colleagues, as well as through long term studies at the Parc Natural de s'Albufera de Mallorca, in cooperation with TAIB – the Albufera Initiative for Biodiversity.

The publication (Fig. 1) places the findings in the context of the Balearic's geological history as well as tracing the history of aculeate recording in the Balearics. The early collectors, the location of collections, historical and recent, are also given. The bulk of the paper, however, is a systematic list annotated to include localities and individual find data (though summarised for the commonest species). The list also includes reference to flowers visited, an area of particular interest at IMEDEA and at the University of the Balearic Islands in Palma, reported in multiple publications. The purpose of the current paper is to draw attention to Baldock *et al*. (2020, *quo vadis*) of which only a small quantity was printed and which has not therefore been widely circulated. It is however freely available online (see reference list). Here we highlight and expand on some of the findings reported in the paper and also draw attention to the essential role that aculeate Hymenoptera play in the ecological well-being of the Balearic Islands and more widely through the Mediterranean.

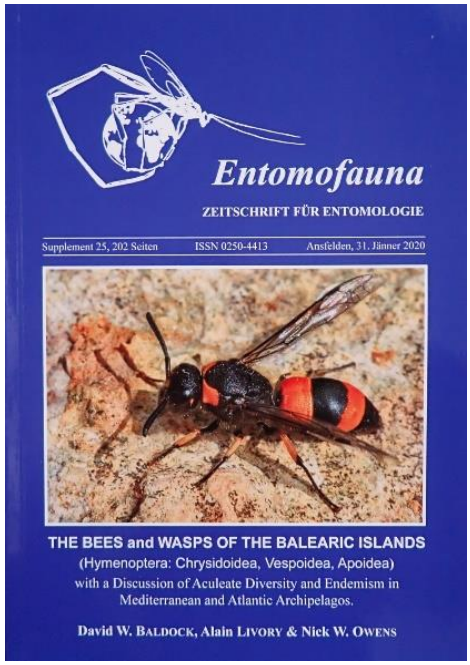

Fig. 1. The publication. The cover shows a female of the endemic vespid wasp *Ancistrocerus ebusianus*.

Fig. 1. *La publicació. La portada mostra una femella de la vespa endèmica Ancistrocerus ebusianus.*

Balearic Aculeates in their wider geographical context

The Mediterranean is one of the world's hot spots for biodiversity (e.g. Cuttelod *et al*., 2009) and this clearly extends to the aculeate Hymenoptera. Apart from the Mediterranean basin itself, major bee hotspots on the world scale include the Chaparral of California, the Fynbos of South Africa, the Kwongan of south-western Australia and the Matorral of Chile. All of these have a 'Mediterranean climate' of cool wet winters and hot dry summers. The number of bee and wasp species across the

Balearic Islands far exceeds totals for comparable areas of land farther north. The whole of the British Isles, for instance, has 271 recorded bee species and close to 200 known aculeate wasps, against the Balearics' 237 bees and 280 wasps – and this despite British naturalists' ready access to county and countrywide field guides (e.g. Baldock, 2008, 2010; Owens, 2017; Falk and Lewington, 2015).

Climate is certainly a major factor but the range of habitats, geo-ecological history and islands' situation all contribute to aculeate Hymenoptera diversity, which sits comfortably alongside the rest of the celebrated, diverse fauna and flora of the Balearics. What is certain is the need for further studies in each of the Balearic Islands to gain a more complete knowledge of species diversity, ecology and distribution and to establish their significance in the context of the Mediterranean as a whole.

Aculeate Hymenoptera on Mediterranean Islands

In addition to the Balearic Islands, the bee fauna of Malta and Cyprus have each received recent detailed attention (Balzan *et al.*, 2016, 2017; Varnava *et al*., 2020). Table 1 summarises the number of bee species recorded on a selection of Mediterranean islands, listed from east to west.

Fig. 2 shows the data plotted against island area on a logarithmic scale. Lesvos and Sicily stand out as having exceptionally rich bee faunas for islands, reflecting their proximity to mainland Greece, Turkey and Italy, for which recorded bee species numbers are 1172, 1786 and 1026 respectively (Discover Life website). Aside from Lesvos and Sicily the trend, as expected, is more or less a straight line, though underlying this simple statistical trend lie many complications related to location, ecology, geology, climate and topography. Some of these issues are discussed further in the Entomofauna paper. Species/area graphs strictly require that the areas concerned are nested, i.e. the smallest lies physically within the next in size and so on. Species diversity tends to rise faster and less predictably with area if based on separated plots, as in the case of islands (Rosenweig, 1995). From their position on the graph, Corsica and particularly Sardinia appear so far to be under-recorded.

Endemic species

Recent research has raised the number of endemic aculeate species or subspecies in the Balearic Islands to twenty-five; 16 wasps and 9 bees. Greater distance from the mainland appears to promote speciation (Table 2). Over long time periods a proportion of island endemics are likely to disperse to the mainland and potentially contribute to bee diversity in the Mediterranean basin as a whole. Comparisons with bee faunas of the Macaronesian islands, including the Canary Islands, are reviewed in the 2020 paper.

Important sites and biotopes in the Balearic Islands

Much more investigation will be needed to put together a catalogue of important sites for aculeates in the Balearics. However, a good starting point would be flower-rich habitats. These are particularly beneficial to bees but also tend

to attract and hold other insects, including predatory wasps, especially where plant diversity is high. Other essential requirements are bare ground and cavities in plant stems or in walls for nesting.

Island	Area/km^2	No. of species	Source
Cyprus	9250	369	Varnava *et al*. (2020)
Lesvos	1633	600	Varnava *et al*. (2020)
Kos	287	140	Balzan *et al*. (2016)
Icaria	254	101	Balzan *et al*. (2016)
Samothakri	178	128	Balzan *et al*. (2016)
Crete	8336	351	Varnava *et al*. (2020)
Sicily	25711	575	Varnava *et al*. (2020)
Malta	316	108	Balzan *et al*. (2017)
Sardinia	23821	296	Varnava *et al*. (2020)
Corsica	8722	263	Varnava *et al*. (2020)
Balearic Islands	4996	237	Baldock *et al*. (2020)
Menorca	702	118	Baldock *et al*. (2020)
Mallorca	3640	203	Baldock *et al*. (2020)
Ibiza + Formentara	654	103	Baldock *et al*. (2020)

Table 1. The number of bee species recorded on some Mediterranean islands.
Note 1 Mallorca has acquired one more bee species since 2020 – the Asian Giant Resin bee (*Megachile sculpturalis;* Ribas-Marquès & Díaz-Calafat, 2021) so the bee total now stands at 203 species.
Note 2: included in Varnava *et al*. (2020) but not included in the table are the bee totals for 19 Aegean Islands. These range from 38 taxa (Milos) to 208 (Chios).
Note 3. Equivalent figures for wasps are not readily available, except for the Balearics. One new wasp species has recently been recorded in Mallorca - the Black and Yellow Mud-dauber Wasp (*Sceliphron caementarium*), an American species which is spreading through Europe and has also been recorded in Britain (Díaz-Calafat, 2020).
Note 4. In a further recent paper (Díaz-Calafat & Garcia, 2022) the genus Cephalonomia (Bethylidae) is reported for the first time in the Balearic Islands. An updated checklist of all Bethylidae species (very small wasps) recorded in the Balearic Islands is provided.
Taula 1. *Nombre d'espècies d'abelles registrades en algunes illes mediterrànies.*
Nota 1 A Mallorca s'ha registrat una espècie més d'abella des del 2020: l'abella gegant de la resina (Megachile sculpturalis; Ribas-Marquès i Díaz-Calafat, 2021), de manera que el total d'abelles se situa ara en 203 espècies.
Nota 2: inclòs a Varnava et al. (2020), però no a la taula dels totals d'abelles de 19 illes de l'Egeu. Aquestes van des dels 38 tàxons (Milos) fins als 208 (Chios).
Nota 3. Les xifres equivalents per a les vespes no estan disponibles fàcilment, llevat de les Balears. Recentment s'ha registrat una nova espècie de vespa a Mallorca: Sceliphron caementarium, una espècie americana que s'està estenent per Europa i també s'ha registrat a Gran Bretanya (Díaz-Calafat, 2020).
Nota 4. En un article recent més (Díaz-Calafat & Garcia, 2022) el gènere Cephalonomia (Bethylidae) s'informa per primera vegada a les Illes Balears. S'ofereix una llista actualitzada de totes les espècies de Bethylidae (vespes molt petites) registrades a les Illes Balears.

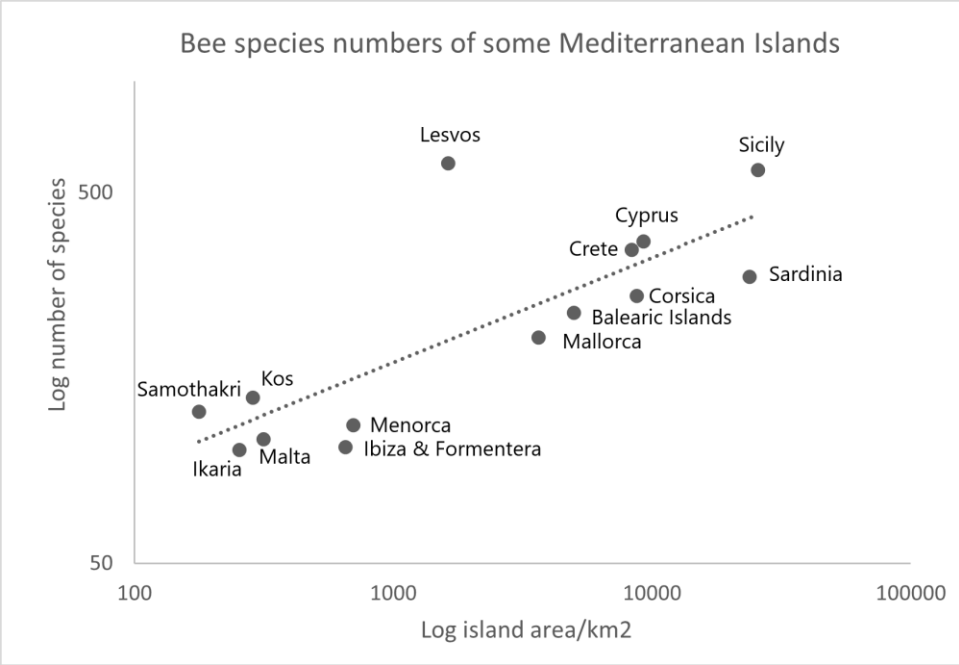

Fig. 2. The number of bee species recorded on some Mediterranean islands.
Fig. 2. *Nombre d'espècies d'abelles registrades en algunes illes mediterrànies.*

Island	No. endemic bee species/subspecies	Total bee species	% endemic
Sardinia	1	296	0.3
Corsica	5	263	1.9
Balearics	9	237	3.8
Sicily	10	575	1.7
Cyprus	21	369	5.7
Crete	52	351	14.8

Table 2. The number of endemic bee taxa in six Mediterranean islands (from Varnava *et al*., 2020; Baldock *et al*., 2020).
Taula 2. *Nombre de tàxons d'abelles endèmiques a sis illes mediterrànies (de Varnava et al., 2020; Baldock et al., 2020).*

One site fulfilling these criteria is Son Bosc, on the southern edge of s'Albufera marshes. This former sand quarry was at one time threatened by development but is now afforded protection by incorporation with the adjacent Natural Park. The removal of sand was followed by abandonment and such sites, often dismissed as of no practical value, can harbour an immense biodiversity including species rarely encountered elsewhere. At Son Bosc this includes the Bee-eater

Merops apiaster Linnaeus, reliant on vertical earth banks in which to burrow and raise young, and about half the world population of the endemic orchid *Anacamptis robusta* (Stephenson) Bateman; the other half is within the Albufera wetland. 188 bee and wasp species have been recorded at s'Albufera which amounts to 37 % of the bee/wasp fauna of the Balearics as a whole. At least 84 species have been recorded at Son Bosc of which 26 species have not been recorded elsewhere in the Balearics. The mere presence of Bee-eaters strongly underlines the significance of Son Bosc and its conservation values. These birds would not be there if their food source was insufficient. A study by The Albufera Initiative for Biodiversity (TAIB) and University of York, UK, entitled *do Bee-eaters eat bees*? found that 77% of food provisioned to chicks were bees and wasps, four taxa of each (Goddard, 2003). [The role of bees and wasps as pollen vectors of *Anacamptis robusta* at s'Albufera is described in a forthcoming paper (Richards & Owens in prep.)].

Other tell-tale signs of Son Bosc's rich insect life come from the large numbers of Eleonora's Falcons *Falco eleonorae* Gene which forage there in late May-early June. Up to 100 of these falcons - and similar numbers of birdwatchers who have discovered this spectacle - arrive close to dusk to feed on dragonflies (Odonata) and, especially the extraordinary beetle *Polyphylla fullo* (Linnaeus) (Escarabat de Sant Joan) which emerges from underground in large numbers at that time. Son Bosc came under special study (Beltrán & Traveset, 2018) because it bordered the Parc Natural de s'Albufera, because it was flower-rich and because it was under threat from inappropriate development. It was only then that the importance of the site for bees and wasps became fully apparent, and indeed for a host of other impressive insects such as the spurge moth *Hyles dahlii* (Geyer) which is a Mallorcan endemic of high evolutionary significance. Beltrán & Traveset (2018) also investigated a flower-rich site at Cala Mesquida, a site not under threat, and again demonstrated the essential nature of such sites for the diversity and well-being of these Hymenoptera. In particular, a species of *Dufourea* collected at the site by R. Castro in 2010 was subsequently described as a *species nova*: *Dufourea balearica* (Ebmer). This small dark bee feeds from the endemic spiny shrub, *Launaea cervicornis* (Boiss.) Font Quer & Rothmaler.

Excellent aculeate sites in Menorca include the dunes and wetlands at Son Bou, where the large black endemic pompilid *Entomobora pseudoplicata* (Wolf) and the endemic wasp *Euodynerus minoricensis* (Sanza, Castro & Gaybuo) occur. The latter wasp can be found in May and June, gathering mud at the edge of puddles for nest construction. Another very good aculeate site on the island is the wetland and dune reserve at s'Albufera des Grau. The number of recorded and published bee species for Menorca was raised from just 13 species to 118 by our studies. On Ibiza and Formentera, some of the best sites are the fields, salt pans and coastline (Platja d'es Codolar) around the airport, where the islands' own endemic wasp, *Pseudepipona gineri* (Schulthess), occurs as well as the Asteraceae specialist bee, *Panurgus calcaratus* (Scopoli), a mainland species but confined in the Balearics to Ibiza and Formentera. The spectacular (but small) orange and black wasp *Ancistrocerus ebusianus* (Lichtenstein, 1884) has been known from Ibiza since the 19th Century, but was also

discovered on the island of Cabrera in 1992. Throughout the Balearics, dunes, including fossil dunes, are superb habitats, but wetlands are also of vital importance and s'Albufera de Mallorca is the only known Balearic site for *Rhopalum gracile* (Wesmael), a small black wasp which nests in vacated reed galls. Wetlands are also vital refuges for insects during hot dry weather.

These are all precious sites and are well protected. Others will certainly exist and merit attention for their invertebrate as well as vertebrate interest. They need to be recognised and retained in a favourable state.

Bees and Wasps, their role within the ecosystem

In these days when environmental values are often considered secondary to economic interests, it is worth reviewing what bees and wasps bring free of charge to general well-being. Not too many insects are held in almost universal high regard, but that certainly applies to the Honey Bee *Apis mellifera* Linnaeus - though with qualifications. The association between humans, *Apis mellifera* and the honey it provides goes back to antiquity, including mentions in the Bible Old Testament. It continues to be appreciated for this product, readily available in food stores with locally produced high quality honey attracting elevated prices. This special association provides additional benefits beyond direct financial gain. Encouraged by humans, the Honey Bee remains a feature of the Balearic countryside. Its intention of course is to collect food – nectar, pollen – for its young but in so doing it acts as pollinator to flowers; and as a further contribution to human well-being this includes fruit trees. Without pollination there would be no fruit, though solitary bees, especially *Osmia* Panzer and *Anthophora* Latreille species, are major pollinators of fruit trees and often more effective than Honey Bees by virtue of their longer tongues. Beekeeping does come with a caveat. Honeybees have probably been in the Mediterranean for at least one million years (Garnery *et al*., 1992). Genetic studies show that Balearic Honey Bees have an affinity with both European and African populations with clear distinctions between the Pityusic and Gymnesic forms (De La Rua *et al*., 2001). Newer, more productive varieties of Honey Bees may lack adaptations to local environments and, if imported, also risk infecting ancestral forms with disease, especially if managed intensively. Large densities of Honey Bees compete with wild bee species which may be more effective pollen vectors and remove less pollen for their own uses than Honey Bees (Geldmann and González-Varo, 2018; Iwasaki and Hogendoorn, 2022).

The contributions made by Honey Bees are nevertheless beyond dispute and they also act as a flag-bearer for over 500 other species of flower-visiting aculeates. Amongst them may be essential taxa for maintaining biodiversity as sole pollinators of certain plant species. One which has received particular attention is the orchid *Ophrys speculum* Link which is reliant on males of the Scoliid Wasp *Dasyscolia ciliata* Fabricius for pollination. A good place to see this activity is Es Comú sand dunes within the Parc Natural de s'Albufera. The pollinator of the endemic *Ophrys balearica* Delforge is said to be the endemic bee subspecies *Chalicodoma sicula balearica* (Lepeletier), but there seem to be no published records or photographs of this association. The Mal-

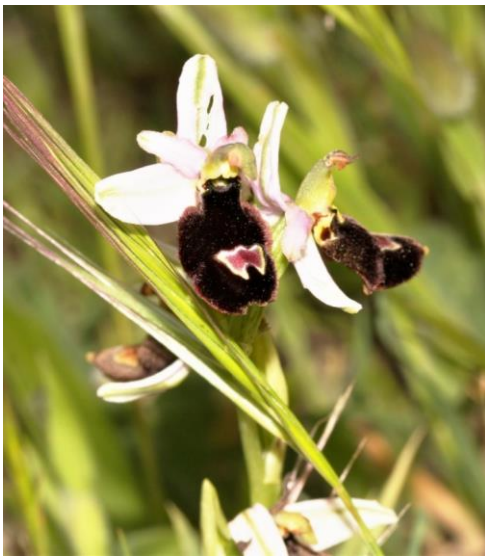

Fig. 3. *Ophrys balearica* Ses Puntes meadow, s'Albufera, Mallorca 24 April 2022.
Fig. 3. *Ophrys balearica, Prat de Ses Puntes, s'Albufera de Mallorca, 24 d'abril de 2022.*

Fig. 4. *Ophrys balearica* Near St. Thomás, Menorca, 30th April 2017.
Fig. 4. *Ophrys balearica A prop de St. Tomàs, Menorca, 30 d'abril de 2017.*

lorca and Menorca forms of *Ophrys balearica* are somewhat different if the images in Fig. 3 and Fig. 4 are representative.

Whereas bees are largely viewed favourably, wasps get a consistently bad press. This is understandable; a wasp sting is excruciating and a threat for those subject to allergic reactions or catatonic shock. Females of almost all aculeates (ants, bees and aculeate wasps) can sting, but males cannot. However, in the case of smaller bees and wasps, the sting is not of any significance to humans. Amongst bees, stinging comes at a physiological cost and can lead to the death of a Honey Bee. Wild bees do not sting without reason. Female wasps use their sting as the means of paralysing prey to feed their larvae and, apart from the common wasp, rarely sting people. Some do have very painful stings however, notably the Pompilidae - the spider-hunting wasps - which need to paralyse their prey rapidly. The glaring exceptions are the Vespids. This social wasp grouping is represented by just one species in the Balearic Islands and that is the German Wasp *Vespula germanica* (Fabricius). The name is not a slight on the German nation. Fabricius who named it in 1793 may have called it after the country in which it was first described. Irrespective of derivation, *Vespula germanica* will be known to residents and visitors as a real nuisance, particularly towards the end of summer when they congregate around picnics or enter houses attracted by sweet substances. Their main purpose is the search for food but they will sting readily if accidentally squeezed or trodden on. This is unfortunate for other species which carry the yellow and black warning colours such as, for instance, the Paper Wasps *Polistes*, another group of social wasps. Those who

walk in the countryside will be aware of their multicelled disc-shaped nests woven into vegetation about a metre off the ground. These wasps may be viewed unfavourably because of their similarity to *Vespula* but such views are misplaced. They are not at all aggressive even when passers-by brush against the nest.

But what would happen if there were no wasps? For most of their period of activity, which ranges from early spring into autumn, their main purpose is to raise young. As a social wasp, the queen *Vespula germanica* finds a suitable site for a nest then proceeds to raise young – initially workers and as summer wears on the next generation of queens and the males (drones). Unlike the social bees their quest is not for nectar, though they will take that for their own needs, but invertebrates and in this they are performing an important ecological management task; they keep invertebrate populations in check. Otherwise we would be knee deep in insects, not just to annoy but wreaking immense damage to agriculture. The response then would be even greater usage of pest control chemicals with all their knock on effects on biodiversity, soils and eventually human health. Each wasp species tends to specialise in particular prey, such as grasshoppers (*Tachysphex* Kohl species), spiders (Pompilidae), flies (many Crabronidae) or in the case of the Honey Bee, the so-called 'bee wolf' *Philanthus triangulum* (Fabricius). Aculeate wasps therefore make very good models for ecological and behavioural research, but this relies in turn on accurate identification and knowledge about habitats and distribution, which the publication seeks to provide.

Many bees and wasps live as 'cuckoos' (technically kleptoparasites) and lay their eggs in the nests of other bees or wasps. Their larvae feed on the supplies of the victim, usually referred to as the host. Amongst Balearic bees, 15% of species are cuckoo bees and for wasps the figure is very high – 25%. The latter figure is influenced by the high diversity of jewel wasps (Chrysididae) in the Balearics, one of which (*Chrysis alcudiae* Reder & Arens) was discovered near Alcudia as recently as 2010. Again, the cuckoo species offer a fascinating model for naturalists and academics to study. The beautiful posters (Figs. 5 and 6), painted by Xavier Canyelles, illustrate some examples of the diversity of Balearic bees and wasps.

Threats

Dislike of wasps, or even bees, leading to direct persecution, is unlikely to have any major impact on the wider population – although it could result in damage to the persecutor as the animal looks to protect itself. The threats are far more insidious. They are also multiple. Leading the way is the use of pesticides. The objective behind their use is to eliminate pests. However, the chemicals are generally not selective. They kill pests but they also kill the farmer's best friends, the bees and wasps which remove copious numbers of pest invertebrates and maintain an equilibrium within the ecosystem. Interrupting that equilibrium leads to unforeseen circumstances. For instance aphids, the enemy of gardener and agriculturalist, are prolific breeders. Some aphid species can produce young almost as soon as they are born! During warmer parts of the year, a new generation can be produced every one to two months. It does not take many survivors of pesticide application for their population to build again to massiv pro-

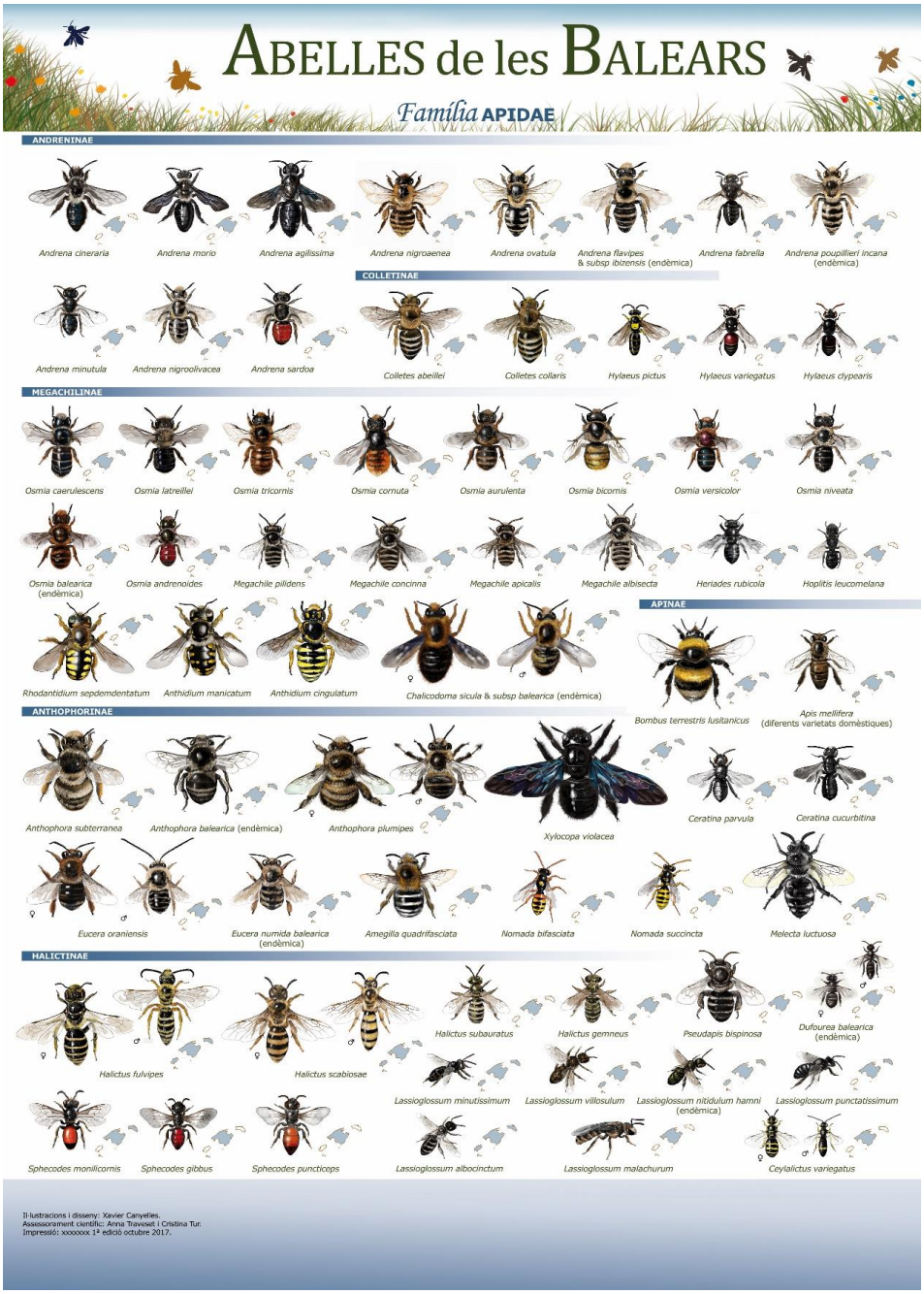

Fig. 5. Balearic Bees © Xavier Canyelles.
Fig. 5. *Abelles balears © Xavier Canyelles.*

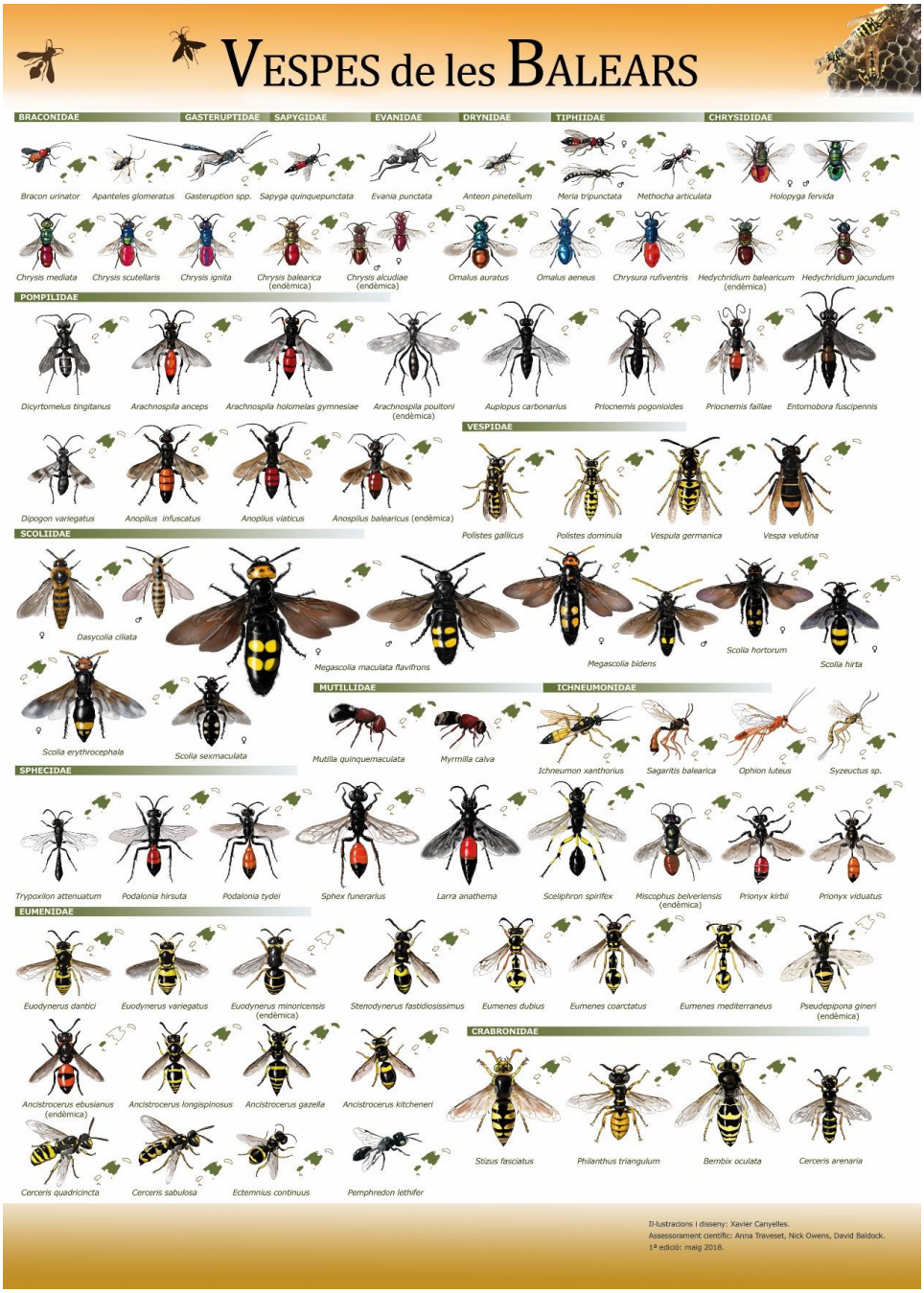

Fig. 6. Balearic wasps © Xavier Canyelles.
Fig. 6. *Vespes balears © Xavier Canyelles.*

portions. Unfortunately, the same pesticide applications may well have taken out the natural control agents – the wasps and other predators including birds, which have much lower reproductive rates

The pesticides which are implicated in falling populations of the Honey Bee, in particular neonicotinoids, have a large and lasting effect on invertebrate populations irrespective of whether they are targeted species or not. This direct exposure is only half their problem. They are confronted too with a steady, often radical, loss of pollination opportunities. Over the last 30 plus years the use of herbicides has led to the elimination of wild flora from cultivations and this will place major stress on bees, not least the Honey Bee but also other aculeates dependent on pollen and nectar for their survival. Beltrán & Traveset (2018) have shown that whereas a number of species are generalists, visiting a range of flower species, others have very narrow niches which, if diminished or lost, may lead to loss of not one but two taxa – the flower and the bee. Little is known about the dependencies of Mallorca's highly valued endemisms but it could be critical if their pollinators are lost.

Conservation

Bee conservation (especially) is very much in the news and that extends to the Balearics. The Hymenoptera studies (along with intervention by Ramsar Secretariat) were major factors in blocking the golf course at Son Bosc; and better appreciation of the importance of the Balearic Islands for aculeates may eventually lead to wider measures to reverse the catastrophic destruction of the islands' flora in the agricultural landscapes of the Balearics. Addressing this and associated issues have wider benefits. Whereas the summer tourist heads predominantly to the beach, fields full of poppies and other colourful plants (1400 taxa on Menorca alone – see *Plants of Menorca* by Pere Fraga i Arguimbau. Note also Elspeth Beckett's *Illustrated Flora of Mallorca*) are a much appreciated highlight for spring tourists. This breathtaking scenario is now hard to find, though spectacular displays still occur, especially in fallow fields. Herbicide use, which appears to have extended to road verges as well as the agricultural land, has wider implications including the loss of agricultural seed-eating birds such as the buntings Emberizidae. This is a Europe-wide problem but most accentuated in Spain where the population of the regional endemic Reed Bunting *Emberiza schoeniclus witherbyi* Jordans, deprived of this food resource, has fallen by 90% over a 30 year period (Atienza, 2006); and a considerable proportion of the world population is in the Balearics (Atienza, 2006). A more measured approach to use of pesticides and other chemicals on the land may also reduce or eliminate their entry into the aquifers providing drinking water to the people – an issue of rising concern in countries across Europe.

Recommendations

This review identifies a series of threats to a group of insects which are generally of positive benefit to humans and to the maintenance and well-being of the ecosystem. Addressing these threats is in the hands of governing authorities and requires policies and planning. However, the first steps towards conservation include awareness: awareness of the problems, awareness of sites which would merit higher levels of protection. Narrow floral

or habitat niches may determine the distribution of some bees and wasps. Knowledge of what and where they are is a ripe area for investigation. We hope this review will encourage progress towards greater appreciation and conservation actions for these undervalued insects. In the meantime a precautionary approach, identification and protection of rare habitats is essential if these niches are not to be lost.

There are several ways in which the general public can help to support aculeate populations. Insects of many kinds live in gardens, civic green spaces and neglected corners, even in densely built-up areas. Such places are readily made more insect-friendly by providing flowering plants (and avoiding spraying). Flowers for bees do not need to be native ones, though traditional, simple flowers are best, since many of the cultivated showy varieties lack nectar or have many petals, which make their pollen and nectar inaccessible. Ideally, local native plant species should be encouraged and many of these will arrive without assistance and some will establish themselves in lawns. The traditional lawn made entirely of grass (let alone plastic) is an insult to the nature of the Balearics! An increasingly used means of attracting nesting bees and wasps is to construct (or buy) a 'bee hotel'. At their simplest these are made by placing hollow plant stems in a box, placed either horizontally or vertically (ideally both). The stems should have a range of diameters from about 2 mm upwards and be at least 10 cm long. Many kinds of bees and wasps will adopt them, and they will also attract interesting parasitic species, such as jewel wasps. Designs and sources can be found online. Bees which nest in walls or compacted earth can be enticed to nest using mud bricks. These are easily made by collecting clay or heavy soil in a bucket, adding some small mixed stones or gravel and some handfuls of dead grass. Water is then added and the mixture is stirred to make a soft mud. This is placed in a frame of wood or other means to set. While it is still soft, holes are made in the mud using a variety of sticks of differing diameter, up to about 1cm for *Anthophora* (flower bee) species. A simple water-proof cover, such as a roof tile, is needed for protection.

Bee hotels and bee bricks should be placed about 1-2 metres from the ground, facing south-east, preferably where there is some shade in the hotter parts of the day. A stack of old logs with beetle holes can be added to increase the accommodation on offer. Naturalists can make important discoveries by observing behaviour, especially if they can identify the species of bee or wasp as well as the plants they are visiting. Younger members of the family might enjoy assisting in making and observing the insect furniture and experiment with designs. The structures are best placed near a garden seat where the insect occupants can be watched and recorded. There is virtually no danger from attracting these insects to the garden and they will provide extra pollination services.

We emphasise the importance of environmental education in schools and through avenues such as natural history societies, art and literature and the social media. It is of vital importance that the next generation is fully aware and appreciative of the uniqueness and diversity of the fauna and flora of the Balearic Islands and their dependence on it. Much is already being achieved through events such as the Environmental Conferences of the Balearic Islands. However, young people across the world

are in many respects more aware and concerned about environmental issues than are adults and there is a growing generational mismatch in attitudes and opportunities, which we should not ignore.

Illustrations

Bees and wasps come in many sizes and patterns. Not all wasps are yellow, black or red and some with these colours are taxonomically bees. To complement the posters shown above, we have put together a series of photographs of Balearic bees and wasps, not only to show their variety and behaviour, but also to demonstrate how attractive they are if prejudices and fears are put to one side.

Acknowledgements

We gratefully acknowledge the Balearic Conselleria de Medi Ambient and the Directorate and staff of the P.N. s'Albufera de Mallorca for their support and permission to operate in the Parc. Biel Perelló and Ramón Gómez de la Cuesta kindly provided translations. We express our gratitude to the Balearic and International volunteers and leaders of Project TAIB, especially Macu Férriz and Laura Royo. Anna Traveset has supported and encouraged our efforts to study aculeates in the Balearic Islands over many years and has accompanied us on several recording visits. Other acknowledgements are given in the *Entomofauna* publication.

Dedicated to David Baldock (1936-2020).
Dedicat a David Baldock (1936-2020).

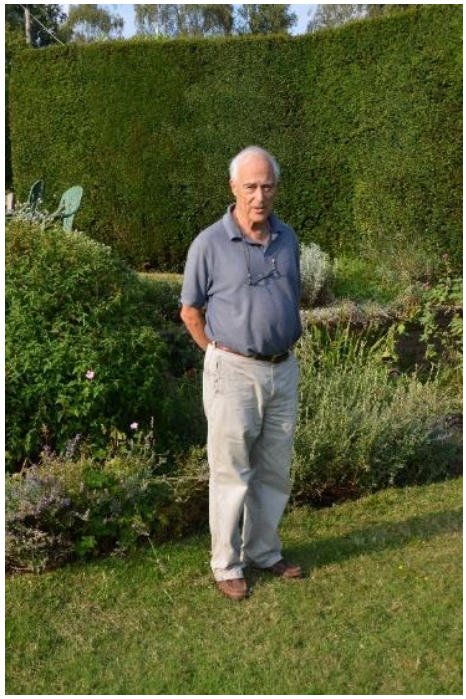

Fig. 7. David Baldock, Surrey garden, 2014.
Fig. 7. David Baldock, Jardí de Surrey, 2014.

Fig. 8. Ibiza, 2018.
Fig. 8. *Eivissa, 2018.*

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Fig. 9. *Amegilla quadrifasciata* female on *Lantana*. Son Bou, Menorca, June 2022. Only the yellow (unpollinated) flowers are visited.
Fig. 9. *Amegilla quadrifasciata femella a Lantana. Son Bou, Menorca, juny 2022. Només visiten les flors grogues (no pol·linitzades).*

Fig. 10. *Ancistrocerus ebusianus* female. St Joan, Eivissa. April 2018. Endemic to Eivissa and Cabrera
Fig. 10. *Ancistrocerus ebusianus femella. St Joan, Eivissa, abril 2018. Endèmica d'Eivissa i Cabrera.*

Fig. 11. *Ancistrocerus kitcheneri* female on *Foeniculum vulgare*. Mallorca, September 2012.
Fig. 11. *Ancistrocerus kitcheneri femella a Foeniculum vulgare. Mallorca, setembre 2012.*

Fig. 12. *Andrena agilissima* female on *Raphanus raphanistrum* Sa Roca S'Albufera de Mallorca, April 2022
Fig. 12. *Andrena agilissima femella on Raphanus raphanistrum. Sa Roca, s'Albufera de Mallorca, abril 2022.*

Fig. 13. *Andrena bicolorata* female on Brassicaceae species. San Joan, Ibiza April 2018

Fig. 13. *Andrena bicolorata femella a Brassicaceae species. San Joan, Eivissa, abril 2018.*

Fig 14. *Andrena flavipes ibizensis* female on *Papaver pinnatifidum*. Ibiza, April 2018. Endemic subspecies of Ibiza.

Fig. 14. *Andrena flavipes ibizensis female a Papaver pinnatifidum. Eivissa, abril 2018. Subespècie endèmica d'Eivissa.*

Fig. 15. *Andrena nigroaenea* female on *Reseda alba*. Menorca, May 2017.

Fig. 15. *Andrena nigroaenea femella a Reseda alba. Menorca, maig 2017.*

Fig. 16. *Andrena nigroolivacea* female on a flower of Asteraceae species. S'Albufereta de Mallorca, April 2022.

Fig. 16. *Andrena nigroolivacea femella sobre una flor d'una espècie d'Astèràcia. S'Albufereta de Mallorca, abril 2022.*

Fig. 17. *Anthidium cingulatum* female on *Prasium majus*. Menorca, May 2015
Fig. 17. *Anthidiuim cingulatum femella a Prasium majus. Menorca, maig 2015.*

Fig. 18. *Anthidium cingulatum* mating pair on *Marrubium vulgare*. Puerto Pollensa, Mallorca, May 2012.
Fig. 18. *Parella d'aparellament d'Anthidium cingulatum a Marrubium vulgare. Puerto Pollensa, Mallorca, maig 2012.*

Fig. 19. *Anthophora balearica* female on *Bituminaria bituminosa*. Ibiza, April 2016.
Fig. 19. *Anthophora balearica femella a Bituminaria bituminosa. Eivissa, abril 2016.*

Fig. 20. *Anthophora hispanica* female on *Bituminaria bituminosa*. Ibiza, April 2018.
Fig. 20. *Anthophora hispanica femella a Bituminaria bituminosa. Eivissa, abril 2018.*

Fig. 21. *Anthophora hispanica* male on *Bituminaria bituminosa*. Ibiza, April 2018.
Fig. 21. *Anthophora hispanica mascle a Bituminaria bituminosa. Eivissa, abril 2018.*

Fig. 22. *Anthophora* species male on *Echium plantagineum*. Sa Roca, s'Albufera de Mallorca. April 2011.
Fig. 22. *Espècie mascle de Anthophora a Echium plantagineum. Sa Roca, s'Albufera de Mallorca. abril 2011.*

Fig 23. *Bembix oculata* female; a predator of diptera. Nest burrows are made in sand. Ibiza, May 2018.
Fig. 23. *Bembis oculata femella; un depredador de dipters. Els caus dels nius es fan a l'arena. Eivissa, maig 2018.*

Fig. 24. *Bombus terrestris* queen on *Hedysarum coronarium.* S'Albufereta de Mallorca. April 2022.
Fig. 24. *Bombus terrestris reina a Hedysarum coronarium. S'Albufereta de Mallorca, abril 2022.*

Fig. 25. *Bombus terrestris* queen on *Papaver setigeru*. Ibiza, April 2018.
Fig. 25. *Bombus terrestris reina a Papaver setigeru. Eivissa, abril 2018.*

Fig. 26. *Ceratina cucurbitina* female on *Rubus ulmifolius*. Son Bou, Menorca, May 2022.
Fig. 26. *Ceratina cucurbitina femella a Rubus ulmifolius. Son Bou, Menorca, maig 2022.*

Fig. 27. *Cerceris quadricincta* female. Nest cells are stocked with weevils. Menorca, May 2017.
Fig. 27. *Cerceris quadricincta femella. Les cel·les niu estan proveïdes de curculiònids. Menorca, maig 2017.*

Fig. 28. *Chalicodoma sicula balearica* female on *Lotus cytisoides*. Es Grau, Menorca, May 2015.
Fig. 28. *Chalicodoma sicula balearica femella a Lotus cytisoides. Es Grau, Menorca, maig 2015.*

Fig. 29. *Colletes albomaculatus* on *Dorycnium pentaphyllum*. Menorca, Cala en Porter, May 2015.

Fig. 29. *Colletes albomaculatus a Dorycnium pentaphyllum. Menorca, Cala en Porter, maig 2015.*

Fig. 30. *Colletes succinctus* female on *Erica multiflora*. Es Comú, s'Albufera de Mallorca, October 2012.

Fig. 30. *Colletes succinctus femella a Erica multiflora. Es Comú, s'Albufera de Mallorca, octubre 2012.*

Fig. 31. *Dioxys cincta* female, a cleptoparasite of bees in the family Megachilidae. Son Bou, Menorca, June 2022.

Fig. 31. *Dioxys cincta femella, un cleptoparàsit de les abelles de la família Megachilidae. Son Bou, Menorca, juny 2022.*

Fig. 32. *Entomobora pseudoplicata* female. Endemic to the Balearics. Son Bou, Menorca, May 2017.

Fig. 32. *Entomobora pseudoplicata femella. Endèmica de las Balears. Son Bou, Menorca, maig 2017.*

Fig. 33. *Eucera elongatula* female on *Chrysanthemum coronarium*. Ibiza, April 2016.
Fig. 33. *Eucera elongatula femella a Chrysanthemum coronarium. Eivissa, abril 2016.*

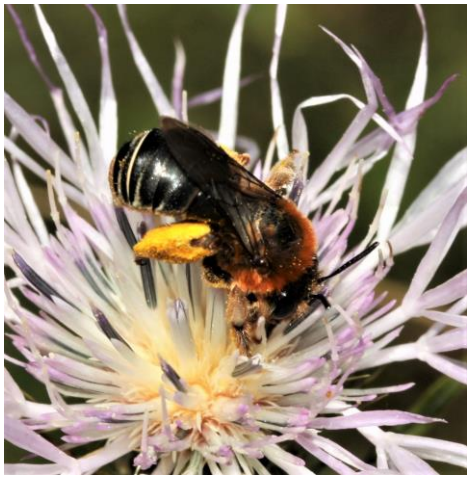

Fig. 34. *Eucera oraniensis* female on *Galactites tomentosa*. S'Albuferera de Mallorca, April 2022.
Fig. 34. *Eucera oraniensis femella a Galactites tomentosa. S'Albufereta de Mallorca, abril 2022.*

Fig. 35. *Eucera oraniensis* male on *Ranunculus* species. Sa Roca, s'Albufera de Mallorca, April 2022.
Fig. 35. *Eucera oraniensis mascle a l'espècie de Ranunculus. Sa Roca, s'Albufera de Mallorca, abril 2022.*

Fig. 36. *Eucera rufa* female on *Papaver rhoeas*. Menorca, May 2015.
Fig. 36. *Eucera rufa femella a Papaver rhoeas. Menorca, maig 2015.*

Fig. 37. *Eumenes* species on *Rubus ulmifolius*. Son Bou, Menorca, May 2022.
Fig. 37. *Espècie Eumenes a Rubus ulmifolius. Son Bou, Menorca, maig 2022.*

Fig. 38. *Halictus gemmeus* female on *Galactites tomentosa*. Ibiza, April 2018.
Fig. 38. *Halictus gemmeus femella a Galactites tomentosa. Eivissa, abril 2018.*

Fig. 39. *Halictus scabiosae* female on *Rubus ulmifolius*. Son Bou, Menorca, June 2022.
Fig. 39. *Halictus scabiosae femella a Rubus ulmifolius. Son Bou, Menorca, juny 2022.*

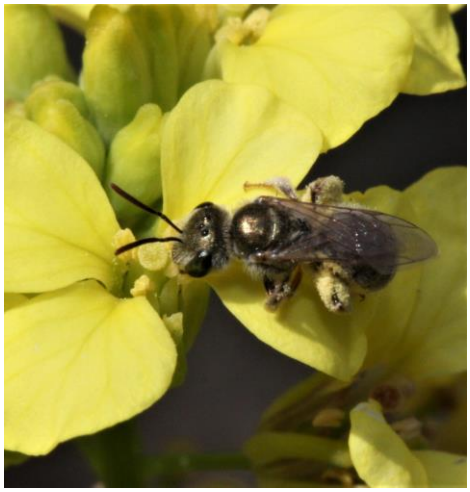

Fig. 40. *Halictus vestitus* on *Raphanus raphanistrum*. Ibiza, April 2018.
Fig. 40. *Halictus vestitus a Raphanus raphanistrum. Eivissa, abril 2018.*

Fig. 41. *Heriades rubicola* female on *Inula crithmoides*. S'Albufera de Mallorca, September 2012.
Fig. 41. *Heriades rubicola femella a Inula crithmoides. S'Albufera de Mallorca, setembre 2012.*

Fig. 42. *Hoplitis adunca* female. Menorca, May 2015.
Fig. 42. *Hoplitis adunca femella. Menorca, maig 2015.*

Fig. 43. *Leptochilus duplicatus* female on *Juniperus phoenicea*. Menorca, May 2017.
Fig. 43. *Leptochilus duplicatus femella a Juniperus phoenicea. Menorca, maig 2017.*

Fig. 44. *Megachile leachella/pilidens* cutting a piece of leaf for its nest. Son Bou, Menorca, May 2022.
Fig. 44. *Megachile leachella/pilidens tallant un tros de fulla per al seu niu. Son Bou, Menorca, May 2022.*

Fig. 45. *Megachile concinna* female on *Inula crithmoides*. S'Albufera de Mallorca, September 2012.
Fig. 45. *Megachile concinna femella a Inula crithmoides. S'Albufera de Mallorca, setembre 2012.*

Fig. 46. *Mutilla quinquemaculata* Son Bou, a parasitoid of bees. Menorca, May 2022.
Fig. 46. *Mutilla quinquemaculata Son Bou, un parasitoide de les abelles. Menorca, maig 2022.*

Fig. 47. *Osmia caerulescens* female on *Bituminaria bituminosa*. Menorca, May 2017.
Fig. 47. *Osmia caerulescens femella a Bituminaria bituminosa. Menorca, maig 2017.*

Fig. 48. *Osmia cornuta* female on *Echium* species. S'Albufera de Mallorca, April 2011.
Fig. 48. *Osmia cornuta femella de l'espècie d'Echium. S'Albufera de Mallorca, abril 2011.*

Fig. 49. *Osmia latreillei iberoafricana*, gathering leaf mastic for nest partitions. Ibiza, April 2018.

Fig. 49. *Osmia latreillei iberoafricana, llentiscle de fulla recollectant per a les parets dels nius. Eivissa, abril 2018.*

Fig. 50. *Osmia niveata* female, nesting in a chest of drawers inside house. San Joan, Ibiza April 2018.

Fig. 50. *Osmia niveata femella, niu en una calaixera dins de la casa. Sant Joan, Eivissa, abril 2018.*

Fig. 51. *Osmia submicans* at nest aggregation on tree stump. Formentara, April 2018.

Fig. 51. *Osmia submicans en l'agregació de nius a la soca de l'arbre. Formentera, abril 2018.*

Fig. 52. *Osmia submicans* male. Menorca, May 2015.

Fig. 52. *Osmia submicans mascle. Menorca, maig 2015.*

Fig. 53. *Osmia versicolor* female. S'Albufereta de Mallorca, April 2022.
Fig. 53. *Osmia versicolor femella. S'Albufereta de Mallorca, abril 2022.*

Fig. 54. *Panurgus calcaratus* mating pair on *Reichardia tingitana*. Not recorded on Menorca or Mallorca. Ibiza April 2016.
Fig. 54. *Parella de Panurgus calcaratus copulant sobre Reichardia tingitana. No citada ni a Menorca ni a Mallorca. Eivissa, abril 2016.*

Fig. 55. *Philanthus triangulum* male. Females are predators of *Apis mellifera*. Mallorca, May 2018.
Fig. 55. *Philanthus triangulum mascle. Les femelles són depredadores d'Apis mellifera. Mallorca, maig 2018.*

Fig. 56. *Polistes dominula* male. S'Albufera de Mallorca, September 2012.
Fig. 56. *Polistes dominula mascle. S'Albufera de Mallorca, setembre 2012.*

Fig. 57. *Polistes gallicus* males on *Ficus carica*. Mallorca, September.
Fig. 57. *Polistes gallicus mascles a Ficus carica. Mallorca, setembre.*

Fig. 58. *Prionyx kirbii* with *Ailopus strepens* prey. Mallorca, September.
Fig. 58. *Prionyx kirbii amb presa Ailopus strepens. Mallorca, setembre.*

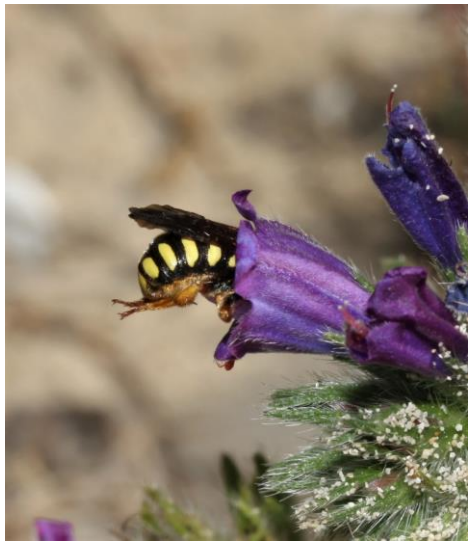

Fig. 59. *Rhodanthidium septemdentatum* female on *Echium plantagineum*. Menorca, May.
Fig. 59. *Rhodanthidium septemdentatum femella a Echium plantagineum. Menorca, maig 2017.*

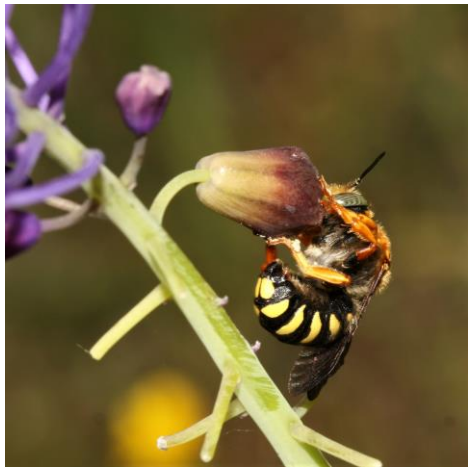

Fig. 60. *Rhodanthidium septemdentatum* male on *Muscari comosum*. Mallorca, April 2022.
Fig. 60. *Rhodanthidium septemdentatum mascle a Muscari comosum. Mallorca, abril 2022.*

Fig. 61. *Rhodanthidium sticticum* female on *Galactites tomentosa*. S'Albufereta de Mallorca, April 2022.

Fig. 61. *Rhodanthidium sticticum femella a Galactites tomentosa. S'Albufereta de Mallorca, abril 2022.*

Fig. 62. *Sapygina decemguttata* emerging after laying an egg in the snail shell *(Theba pisana)* nest of *Osmia versicolor*. Ses Puntes meadow, s'Albufera de Mallorca, April 2022.

Fig. 62. *Sapygina decemguttata que sorgeix després de posar un ou al niu d'Osmia versicolor dins una closca de cargol (Theba pisana). Prat de ses Puntes, s'Albufera de Mallorca, abril 2022.*

Fig. 63. *Sceliphron spirifex* female constructing its mud nest. The nest cells are stocked with spiders. Menorca, June 2022.

Fig. 63. *Sceliphron spirifex femella construint el seu niu de fang. Les cel.les niu estan proveïdes d'aranyes per a l'alimentació de les larves. Menorca, juny 2022.*

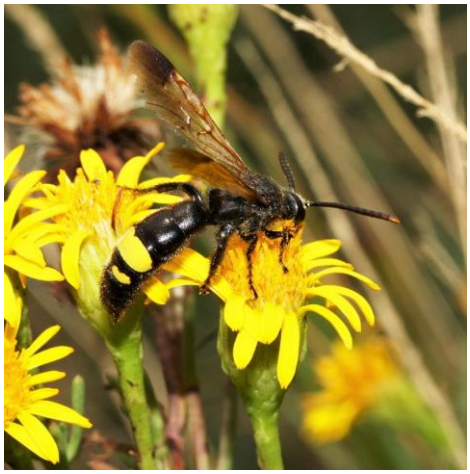

Fig. 64. *Scolia erythrocephala* male on *Inula crithmoides*. Note colour matching with flower. Mallorca, September 2012.

Fig. 64. *Scolia erythrocephala mascle a Inula crithmoides. Tingueu en compte que el color coincideix amb la flor. Mallorca, setembre 2012.*

Fig. 65. *Sphecodes ruficrus* female on *Teucrium capitatum majoricum*. Menorca, May 2022.
Fig. 65. *Sphecodes ruficrus femella a Teucrium capitatum majoricum. Menorca, maig 2022.*

Fig. 66. *Stenodynerus fastidiosissimus fastiodiosissimus* on *Inula crithmoides*. S'Albufera de Mallorca, September 2012.
Fig. 66. *Stenodynerus fastidiosissimus fastiodiosissimus a Inula crithmoides. S'Albufera de Mallorca, setembre 2012.*

Fig. 67. *Vespula germanica* queen taking water. S'Albufera de Mallorca, September 2012.
Fig. 67. *Vespula germanica reina prenent aigua. S'Albufera de Mallorca, setembre 2012.*

Fig. 68. *Xylocopa violacea* female on Fabaceae species. Ibiza, April 2018.
Fig. 68. *Xylocopa violacea femella sobre una espècie de Fabaceae. Eivissa, abril 2018.*