



The importance of threatened host plants for arthropod diversity: the fauna associated with dendroid *Euphorbia* plants endemic to the Canary and Madeira archipelagos

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Abstract

The arthropod fauna associated with seven endemic dendroid *Euphorbia* was sampled and studied in the Canary and Madeira archipelagos. The stem-diameter of the plants was considered, along with their genetic affinity, habitat and number of localities and islands where present. The arthropod assemblages and richness found on each *Euphorbia* species were statistically analysed, to determine which variables influenced the survey results. A total of 179 arthropod species were found, identified, and classified into characteristic or accompanying fauna, according to their relationship with the plants and their types of diet. Faunal assemblages and arthropod species richness differed among the *Euphorbia* species, each thus showing a strong and almost unique host relationship. Species richness increased with the architectural complexity of the host-plant species and number of localities and islands where present. The similarity of faunal assemblages was mainly related to stem diameter. Among diet types, a great number of exclusive and/or endemic taxa associated with this plant genus were xylophages. Our survey revealed that rich arthropod communities are associated with the genus *Euphorbia*, especially on its rare endangered species, and highlights the need to protect their host plants. This in turn will contribute to the conservation of their arthropod communities and their ecosystem functions.

Keywords *Euphorbia* · Arthropod assemblage · Conservation · Xylophagous · Macaronesia

Introduction

Macaronesia is a biogeographical province located in the eastern Atlantic Ocean between the Iberian Peninsula and West Africa. It includes five archipelagos (Azores, Madeira, Selvagens, Canaries and Cabo Verde), as well as small coastal areas of southern Morocco and the southwest Iberian Peninsula (Fernández-Palacios 2010). All the archipelagos

have a volcanic origin, but due to their latitudes there are obviously significant climatic differences between them (Triantis et al. 2010). Other factors such as isolation, wind orientation, geological age and consequently surface area, relief and altitude, have led to a great variety of microclimates and potential niches. These have favoured speciation into a characteristic flora and fauna on each, with a high number of local endemics. In fact, the Madeira and Canary archipelagos are included in the Mediterranean Basin hot-spot (Myers et al. 2000). They contribute more than 3500 plant species of its 20,000 total, of which more than 20% are exclusive (123 species to Madeira and 662 to the Canary Islands) (Borges et al. 2008; Gobierno de Canarias 2018).

The genus *Euphorbia* L. (Euphorbiaceae—spurge family) is one of the most diverse groups of flowering plants on earth and includes at least 2100 species. It presents a high variety of morphotypes, with herbaceous, dendroid, arboreal and cactiform species (Menier 1974; Bramwell and Bramwell 2001; Glimn-Lacy and Kaufman 2006). In the Macaronesian archipelagos there are 14 endemic species of *Euphorbia*, grouped into two subgenera: *Esula* and

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Euphorbia (Arechavaleta et al. 2005; Borges et al. 2008, 2010; Gobierno de Canarias 2018). *Euphorbia* subgenus *Esula* includes most of these endemic species (11), classified into two sections: *Euphorbia* section *Helioscopia* with arboreal species, and *Euphorbia* section *Aphyllis* including dendroid and herbaceous species. The Canary and Madeira archipelagos are those with the greatest number of endemic species within the *Euphorbia* subgenus *Esula* (60%). Within *Aphyllis*, there are five dendroid species endemic to the Canaries (*E. atropurpurea* (Brouss.) Webb & Berthel., *E. berthelotii* Bolle, *E. bourgeauana* J. Gay ex Boiss. in DC., *E. bravoana* Svent., *E. lamarckii* Sweet) and one to Madeira (*E. piscatoria* Aiton), all included in the *Macaronesicae* subsection. The *Euphorbia* section *Helioscopia* is only represented by one species (*E. mellifera* Aiton), present in both archipelagos (Table 1) (Riina et al. 2013).

Some dendroid surges, like *E. lamarckii* in the Canary Islands and *E. piscatoria* in Madeira, are characteristic of the xerophilous and thermosclerophyllous vegetation (Sun et al. 2016) that constitutes a typical feature of the local arid and sub-arid landscapes (Molero and Rovira 1998). However, other endemic species are much less abundant, and even have restricted or threatened populations. *Euphorbia bourgeauana* is catalogued as ‘Vulnerable’ at Canarian regional level and ‘In danger of extinction’ in the Spanish Endangered Species Catalogue, and *E. mellifera* as ‘In danger of extinction’ at both levels but without threat status in Madeira. In addition, *E. bourgeauana* is classified as ‘Vulnerable’, and *E. mellifera* and *E. piscatoria* as ‘Least concern’ in the IUCN Red List of Threatened Species (Marrero 2011; Rivers et al. 2017; Menezes de Sequeira et al. 2017).

These *Euphorbia* plants are home to species-rich animal communities, consisting mainly of arthropods. The host specificity of arthropods on plants and their resulting assemblages depend on many factors, such as plant defence compounds, microhabitat structure, suitability for oviposition, shrub size and architectural complexity, and likelihood of mating encounters (Baker et al. 2012; Campos et al. 2006).

Such assemblages tend to be associated with particular parts of the plant (Bernays and Chapman 1994), such as roots, stems, leaves or bark.

Several authors such as Wollaston (1857, 1864), Martínez de la Escalera (1923), Menier (1974), Jordal and Hewitt (2004), Jordal et al. (2004), Jordal (2006), Stüben (2011) and Stüben and Behne (2015) have previously studied the entomofauna associated with *Euphorbia* in Macaronesia. However, much of this information is related to Coleoptera and more specifically to the true weevils, family Curculionidae. The present study was focused on determining the arthropod fauna found on different populations of endemic dendroid *Euphorbia* species in the Canary and Madeira archipelagos, with special interest for the conservation of entire arthropod assemblages. Specifically, the following questions were addressed: (1) Are different arthropod communities associated with each host-plant species? (2) Do arthropod assemblages depend on specific characteristics of each plant species? (3) Which harbour higher diversity, the rare or the abundant plants? Our initial hypotheses to be tested were that: (1) arthropod assemblages are exclusive to each *Euphorbia* host species, (2) specific characteristics of each plant species influence the arthropod assemblages, and (3) abundant plant species with greater stem diameter and architectural complexity should harbour higher arthropod diversity.

Material and methods

Sampling

Arthropods found on endemic dendroid *Euphorbia* species (henceforth *Euphorbia*) were sampled from 2008 to 2014 on three of the western Canary Islands (Tenerife, La Gomera and La Palma) and the Madeira archipelago (Madeira, Porto Santo and Deserta Grande) (see Fig. 1 and Table S1 in Supplementary Material for the list of species,

Table 1 Characteristics and distribution of the studied *Euphorbia* species (*Esula* subgenus)

Taxon	Section	Morphotype	Stem diameter	Habitat	Threat status*
<i>E. atropurpurea</i>	<i>Aphyllis</i>	Shrub	3–4 cm	Thermosclerophyllous woodland	No
<i>E. berthelotii</i>	<i>Aphyllis</i>	Shrub	7–8 cm	Xerophytic shrub	No
<i>E. bourgeauana</i>	<i>Aphyllis</i>	Shrub	10–15 cm	Thermosclerophyllous woodland	In danger of extinction
<i>E. bravoana</i>	<i>Aphyllis</i>	Shrub	2–3 cm	Thermosclerophyllous woodland	No
<i>E. lamarckii</i>	<i>Aphyllis</i>	Shrub	10–15 cm	Xerophytic shrubs	No
<i>E. piscatoria</i>	<i>Aphyllis</i>	Shrub	7–8 cm	Xerophytic shrubs	Least concern
<i>E. mellifera</i>	<i>Helioscopia</i>	Arboreal	20–25 cm	Laurel forest	In danger of extinction

Distribution data from The Canary Islands Biodiversity Database (Gobierno de Canarias, 2018) and from Borges et al. (2008)

TF Tenerife, LG La Gomera, LP La Palma, EH El Hierro, MA Madeira, PS Porto Santo, DG Deserta Grande

*Only the highest protection category is indicated

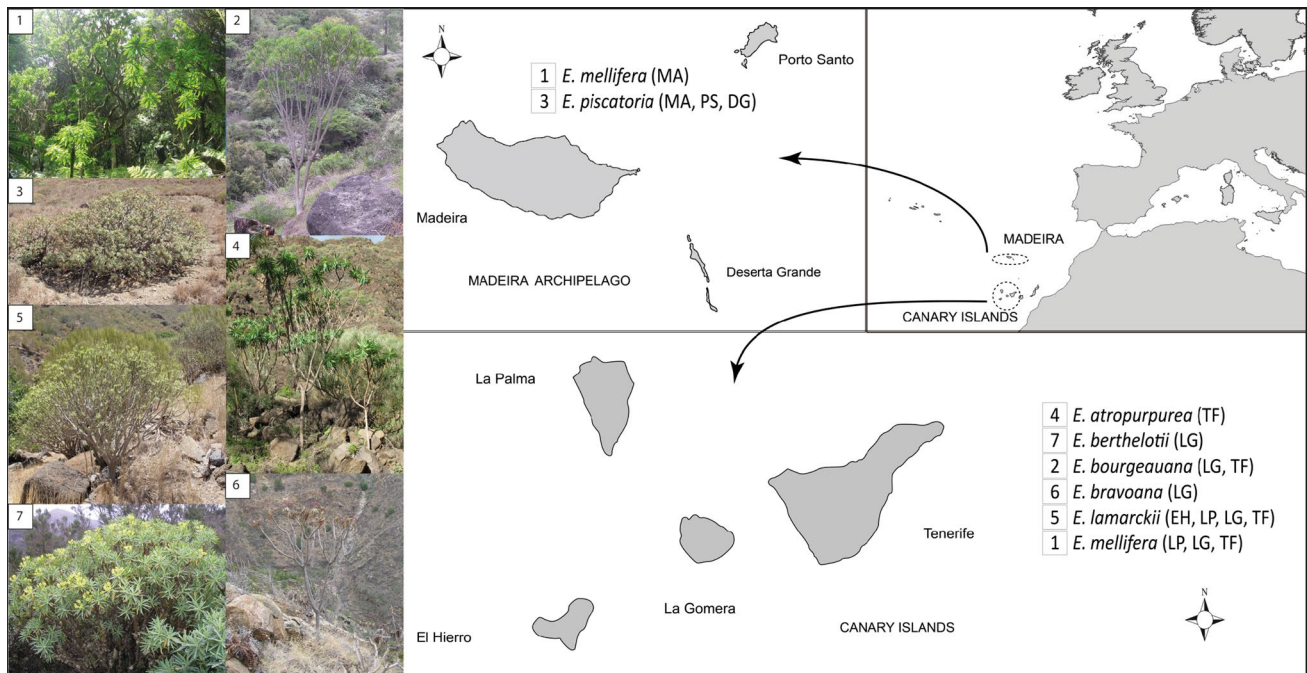


Fig. 1 Habit and presence on each island of *Euphorbia* dendroid species in the Canary Islands and Madeira archipelago. MA Madeira, DG Deserta Grande, PS Porto Santo, EH El Hierro, LP La Palma, LG La

Gomera, TF Tenerife, 1 *E. mellifera*, 2 *E. bourgeauana*, 3 *E. piscatoria*, 4 *E. atropurpurea*, 5 *E. lamarckii*, 6 *E. berthelotii*, 7 *E. bravoana*

localities and host plants). The following plants were sampled on all islands where they are present: *Euphorbia atropurpurea*, *E. berthelotii*, *E. bourgeauana*, *E. bravoana*, *E. lamarckii* in the Canaries, *E. piscatoria* in Madeira, and *E. mellifera* in both archipelagos.

To collect the highest number of arthropod species, different sampling methods were used: (1) direct search on the shrubs, mainly to more effectively detect scarce species in the woody parts (Leather 2005); (2) collecting shoots, stems, and trunks to detect those feeding or living inside plant tissues; (3) adapting the well-established and effective ‘beating’ technique used for collecting free-living insects from accessible vegetation (Matthews and Reid 2002). This latter method was however carried out by gently agitating branches onto an umbrella to avoid damaging the plants, especially threatened species. This care also prevented captured specimens being spoiled with the abundant latex exuded by any wounded stems and leaves. The three procedures were attempted at each locality sampled. However, given the differences in abundance and conservation of the *Euphorbia* species, it was impossible to apply the same protocol to each. For instance, the Canarian *E. bravoana* and *E. mellifera* are extremely rare, with a single site for the former and a few for the latter but often with less than five plants. The specimens collected were preserved either in ethanol or as dry collections stored in the zoological collection of the Department of

Animal Biology, Edaphology and Geology at the University of La Laguna (DZUL).

Species identification

The collected arthropods were identified using available identification keys and/or original descriptions of species. In addition, some individuals were directly compared to preserved DZUL collection specimens in order to check the identifications. We also searched the bibliography and revised the unpublished data on *Euphorbia* in the arthropod collection of the Department of Animal Biology, Edaphology and Geology (University of La Laguna). The arthropods were classified according to feeding behaviour (see Fig. 3) and as ‘characteristic’ or ‘accompanying’ fauna, depending on whether they have a direct trophic relationship with the host plant, or not. This was based on reviewing the information published on such relationships, consulting expert entomologists on certain taxonomic groups when necessary (see Supplementary Tables S2 and S3, and Acknowledgements).

Data analysis

A similarity matrix using the Sørensen index was obtained (hereafter, faunal assemblage) from the presence-absence data for the various *Euphorbia*. A matrix was also built from differences in the number of species

(richness), comparing *Euphorbia* species in pairs. A correlation matrix was elaborated between these two dependent variables (faunal assemblage and richness) and five independent variables, in order to explore the relationship between the two kinds of variables. The following independent variables were analysed for each species: (1) stem diameter (weighted from 1 to 4 in increasing order, see Table 1), (2) number of islands where they were present, (3) number of sampled localities, (4) genetic affinity by the number of nodes separating two *Euphorbia* species, *vide* Riina et al. (2013) and Barres et al. (2017), and (5) type of habitat (identical, similar or completely different habitats weighted from 1 to 3, respectively). To analyse the effects on the independent variables, a GLM was applied to the dataset, following a Gaussian distribution for differences in faunal assemblages and a Poisson distribution for richness.

Finally, to visualise the relationships among the faunal assemblages found on *Euphorbia* species, Nonmetric Multidimensional Scaling (NMDS) based on dissimilarities calculated with the Bray–Curtis index was carried out. The scores for each plant species were correlated with the independent variables to infer the factors explaining the ordination. All statistical analyses were conducted in R version 3.3.1 (R Core Team 2017), taking into account only the characteristic species.

Results

Arthropod biodiversity

A total of 179 species belonging to 81 families and 15 arthropod orders were obtained (see Supplementary Tables S2 and S3 for the list of characteristic and accompanying species, respectively). The orders with the highest number of families and species were Coleoptera, Araneae, Diptera and Hemiptera, respectively (Table 2). More than 50% of the species found were endemic to their archipelago, 50% of these to the Canaries and 30% to Madeira.

The highest numbers of arthropod species were found on *Euphorbia mellifera* (78), *E. bourgeauana* (46) and *E. lamarckii* (45) (Fig. 2). Among endemic arthropods, the richest assemblages in the Canaries were found on *E. mellifera* (37), followed by *E. bourgeauana* (24) and *E. lamarckii* (24), while for Madeira, *E. piscatoria* (12) hosted more endemics than *E. mellifera* (4). The highest number of arthropods exclusive to each *Euphorbia* species—i.e. only detected on one—was on *E. mellifera* (54) followed by *E. lamarckii* (22), *E. piscatoria* (19), *E. bourgeauana* (18), *E. berthelotii* (12), *E. bravoana* (4) and *E. atropurpurea* (3). Focusing on characteristic arthropods only, the greatest diversity was on *E. mellifera* (34), *E. lamarckii* (30) and *E. bourgeauana* (24) (Fig. 2).

According to diet, the most abundant arthropod groups were predators (52) and xylophages (43), followed by four others with similar diversity: saprophages, foliophages,

Table 2 Diversity of arthropod orders and number of families, endemic and non-endemic species related to the studied dendroid spurge

Order	Families	Species	Endemic species			Non-endemic species	Unidentified at species level
			Canarian	Madeiran	Macaronesian		
Araneae	15	25	9	2	1	13	–
Opiliones	1	1	–	–	–	1	–
Pseudoscorpiones	3	3	–	–	–	3	–
Julida	1	2	1	–	–	1	–
Isopoda	1	3	1	–	–	2	–
Diplura	1	1	–	–	–	1	–
Zygentoma	1	4	–	–	1	3	–
Dermaptera	2	2	1	–	–	1	–
Orthoptera	1	3	3	–	–	–	–
Blattaria	3	5	4	–	–	1	–
Hemiptera	7	15	2	–	–	9	4
Hymenoptera	8	11	3	–	–	2	6
Lepidoptera	2	3	2	–	–	–	1
Diptera	10	10	2	–	–	3	5
Coleoptera	25	91	51	6	6	20	8
Total	81	179	79	8	8	60	24

Specimens unidentified at species level were not assigned a category of endemicity

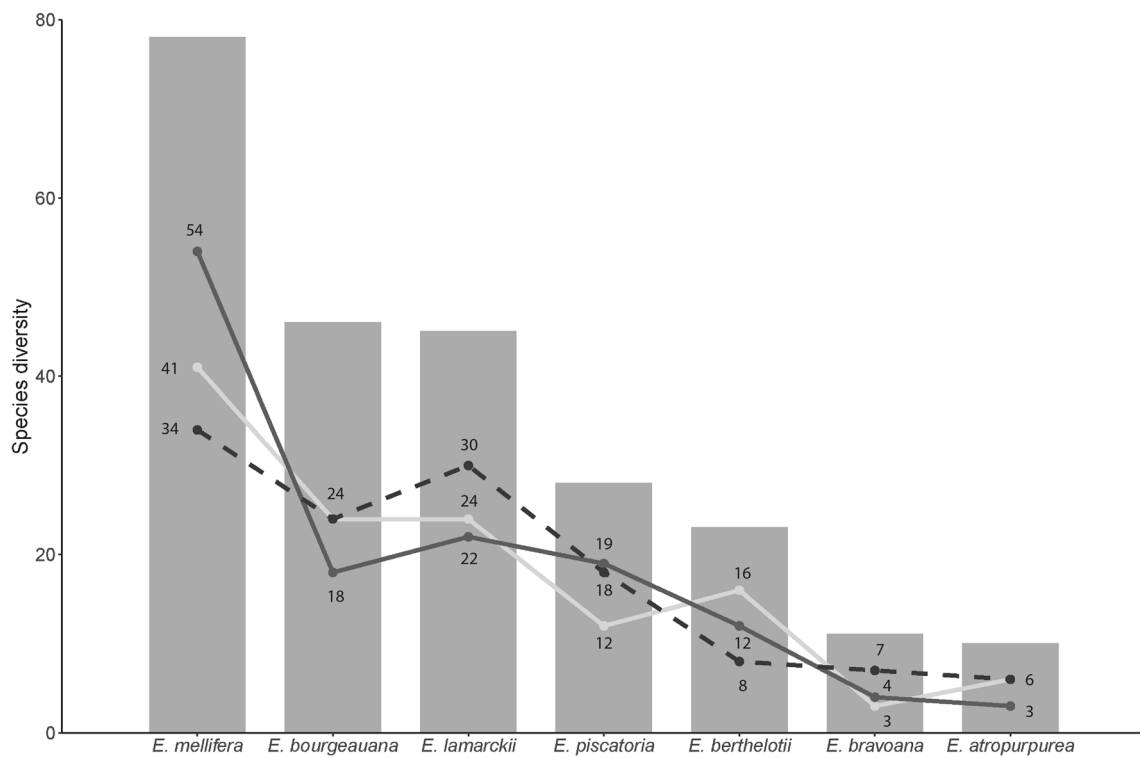


Fig. 2 Total number of arthropod species found on each *Euphorbia* species (bars) and total number of endemic (pale line), exclusive (dark line) and characteristic (discontinuous line) arthropod species

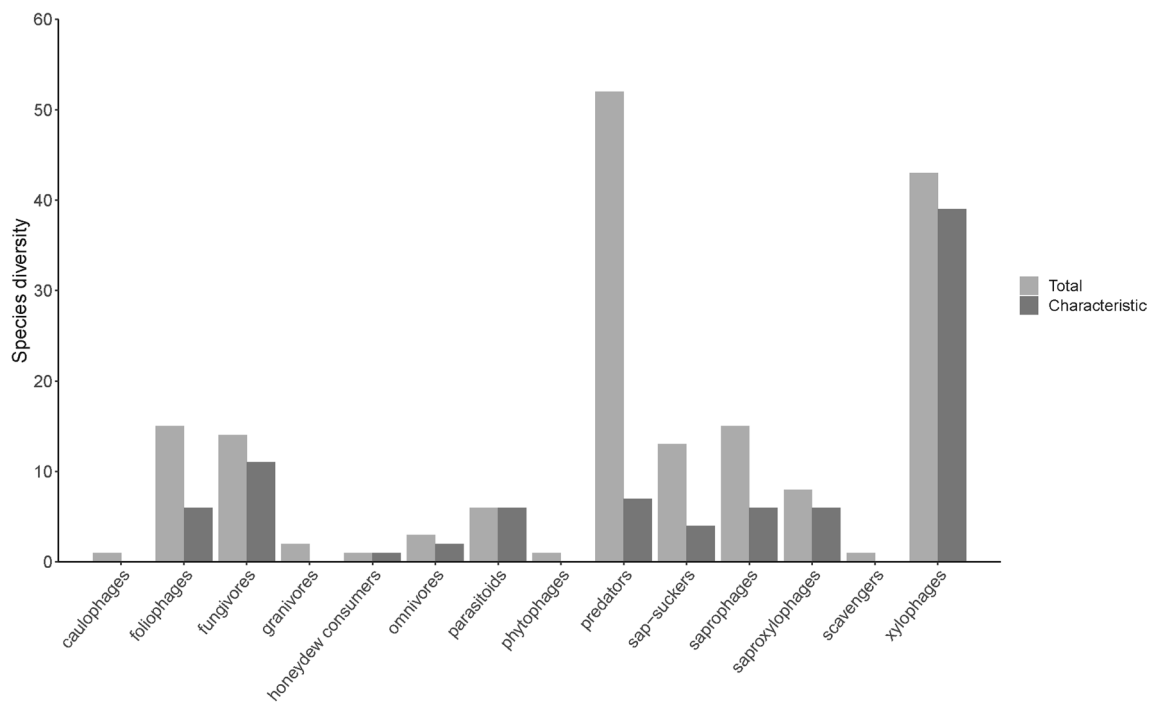


Fig. 3 Number of arthropod species per trophic relationship with *Euphorbia*, for total and characteristic species

fungivores and sap-suckers (Fig. 3). Within characteristic species, the assemblages mainly consisted of xylophages (39) followed by fungivores (11), predators (7), saproxylophages (6), foliophages (6) and parasitoids (6). The diversity pattern of the arthropod species number per *Euphorbia* was similar for characteristic and accompanying fauna. However, the percentage of endemics was slightly higher than in the total pool (59.5% vs. 52.5%, respectively). The faunal composition varied between diet types, since some trophic groups had a higher percentage of characteristic species, such as xylophages (90.7%) or fungivores (78.6%). In other groups there were fewer, such as sap-suckers (30.7%) and predators (13.5%). Focusing on xylophages only, the greatest diversity was on *E. mellifera*, *E. bourgeauana* and *E. lamarckii*, with 13 species each. However, endemism among xylophages was higher than in characteristic species, reaching 74.4%.

Analyses of *Euphorbia* species relationships

A negative correlation was found between faunal assemblage and all the independent variables. This means that the similarity among arthropod assemblages between *Euphorbia* species decreases when the differences between any of these variables increase. Except for number of localities, all tested variables explained the variation in faunal assemblage. A different pattern was found with the number of species, which showed a positive correlation between richness and all the independent variables, except for habitat (Table 3).

Examining the relationships between the seven *Euphorbia* species, *E. bravoana*, *E. berthelotii* and *E. atropurpurea* are closely related, and also cluster with the slightly more distant *E. lamarckii* and *E. bourgeauana*. Arthropod assemblages were more similar within these latter two groups. In contrast, *E. mellifera* and *E. piscatoria* are the farthest away, being the most dissimilar from the rest (Fig. 4). This pattern was supported statistically as the data fit was appropriate

(stress = 0.0325). A strong relationship was found between the first axis and the number of islands (0.8633), and between the second axis and the habitat category (0.8987).

Discussion

A study of the whole arthropod assemblage associated with a group of plants can reveal hidden richness. We found two types of arthropods: (1) those specifically linked to these plants that use them either as a trophic resource or as habitat for their life-cycle, and (2) others not strictly associated that may occasionally use them to locate potential prey or just to rest. Characteristic *Euphorbia* fauna need fresh, dry or decomposed plant material, either to satisfy their nutritional requirements or to establish nests and lay their eggs (Jordal 2006). The xylophagous species that particularly stand out are Cryptorhynchinae (*Acalles* and related genera), Cossoninae weevils (*Mesites*, *Rhopalomesites*, *Pselactus*, *Caulotrumpis* and *Pseudoploephagus*) and *Aphanarthrum* and *Liparthrum* bark beetles (Curculionidae, Scolytinae), since their whole biological cycle occurs in the plant (Jordal et al. 2006). Other noteworthy xylophages are the larvae of longhorn beetles *Deroplia albida* and *Lepromoris gibba* (Coleoptera, Cerambycidae) (Sama 1996; Krátký and Aguiar 2019) and the false blister beetles *Alloxantha seidlitzii* and *Nacerdochroa concolor* (Coleoptera, Oedemeridae) (Kubisz and Borowski 1999), which are common in dead spurge stems. Among fungivores, the genus *Tarphius* (Coleoptera, Zopheridae) is noteworthy. It has five endemic flightless species with larvae developing in decomposed wood (Emerson and Oromí 2005). The family Latridiidae is also well represented by four species belonging to genera *Corticarina*, *Corticaria* and *Metophthalmus*. Regarding sap-sucking species, those of the genus *Acrosternum* (Hemiptera, Pentatomidae) that inhabit the Canaries are highly specialised and live throughout their life-cycle on *Euphorbia* species. The

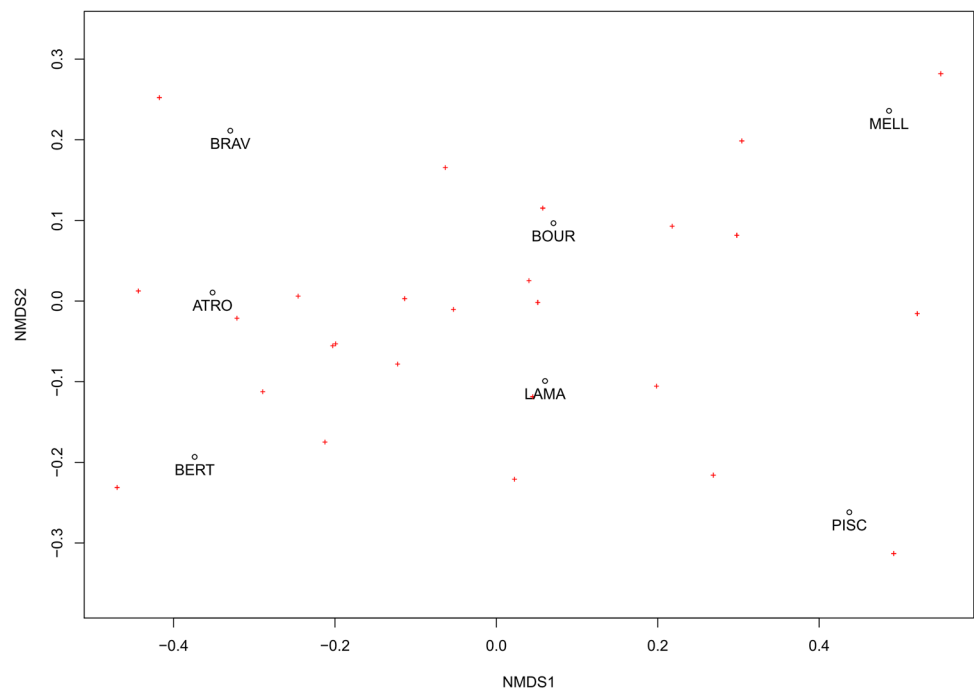
Table 3 Factors affecting faunal assemblage and richness

Dependent variables	Independent variables	Correlation	AIC	LR	P-value
Faunal assemblage	Stem diameter	− 0.4115	19.296	3.8737	0.049
	No. of islands	− 0.4097	19.296	3.8315	0.050
	No. of localities	− 0.0386	19.296	0.0284	0.866
	Genetic affinity	− 0.3944	19.296	3.5007	0.061
	Habitat	− 0.3955	19.296	3.5222	0.061
Richness	Stem diameter	0.4613	286.04	34.576	< 0.001
	No. of islands	0.4711	286.04	38.673	< 0.001
	No. of localities	0.9117	286.04	132.95	< 0.001
	Genetic affinity	0.1626	286.04	4.4502	0.035
	Habitat	0.0076	286.04	0.0099	0.921

Significant effects highlighted in bold

AIC Akaike's information criterion, LR likelihood ratio test, DF degrees of freedom

Fig. 4 Nonmetric Multidimensional Scaling plot showing the relationships among seven *Euphorbia* species. Red crosses represent arthropod species. *ATRO* *E. atropurpurea*, *BERT* *E. berthelotii*, *BRAV* *E. bravoana*, *BOUR* *E. bourgeauana*, *LAMA* *E. lamarckii*, *MELL* *E. mellifera*, *PISC* *E. piscatoria*



most prevalent saproxylophages belong to the genera *Cryptolestes* and *Europs*, with two species each. Among parasitoids, braconid wasps of the genus *Spathius* are known to be ectoparasitoids on xylophagous larvae of various beetle families (Belokobylskij and Zaldívar-Riverón 2014). They thus have great importance in the dynamics of these arthropod assemblages, since most beetles associated with *Euphorbia* are xylobionts. Some insects are strictly foliophagous with spurge leaves as their main trophic resources, such as the the Canary endemic genus *Acrostira* (Orthoptera, Pamphagidae) (López et al. 2007; Hernández-Teixidor et al. 2014), *Aphthona* leaf beetles (Coleoptera, Chrysomelidae) (Fornasari 1996) or the larvae of the hawkmoth *Hyles tithymali* (Lepidoptera, Sphingidae) (Gil-T 2010). Other species are root consumers during their larval stage but the adults feed on leaves, like *Laparocerus distortus* (Coleoptera, Curculionidae) (Machado et al. 2008).

We thus report 61 newly recorded species that should be considered as characteristic *Euphorbia* fauna. Pooled with the 49 already described in the literature, these raise to 110 the number in Madeira and the Canaries. This is relatively high when compared to other studies. For instance, Mifsud et al. (2012) reported 33 characteristic arthropods associated with the genus *Ficus* in the Maltese islands, while Mecke et al. (2001) found 45 species related with *Araucaria angustifolia* in Brazil. Despite a search, we found no similar studies about characteristic arthropods in the Macaronesian archipelagos. In the Azores, long-standing monitoring efforts have explored their arthropod biodiversity. However, these did not distinguish between characteristic and accompanying fauna. Nunes et al. (2015) reported

161 spp. associated with *Juniperus brevifolia* Ribeiro et al. (2005). reported 65 herbivore insects for *J. brevifolia* and 53 for *Erica azorica*, among others, from a total of seven islands, and Rego et al. (2019) 35 for *J. brevifolia* and *Laurus azorica*, 34 for *E. azorica*, 30 for *Ilex perado azorica* and 26 for *Vaccinium cylindraceum* on Terceira. Traditionally, studies focusing on arthropod fauna related to a single host-plant species, genus or family (e.g. Nunes et al. 2015; Sasa and Samways 2015) combine both characteristic and accompanying fauna in their analyses. However, accompanying fauna may include species actually unassociated with the host plant but give rise to a stochastic record that leads to misinterpreted statistical results. Moreover, since such species have no trophic relationship with the host plant, they can move to other plant species within the same ecosystem. In formulating conservation plans, we therefore recommend discerning between characteristic and accompanying fauna. This would more closely estimate the real number of species that can be strongly affected by a decline or loss of their host plant.

The differences in distribution area, number of specimens per locality, stage of maturity and conservation status of these *Euphorbia* made it difficult to obtain a homogeneous sample. However, the data here presented are the most reliable information regarding their real arthropod assemblage. The less similar the host-plant characteristics, the more different was the richness pattern. In agreement with Campos et al. (2006), we found that spurges with greater stem diameter and architectural complexity, such as *E. mellifera*, *E. bourgeauana* and *E. lamarckii*, harboured a greater number of species. Conversely, species with smaller stem diameter

(*E. bravoana* and *E. atropurpurea*) displayed less diversity. As expected, arthropod richness increased with the number of islands and localities in which the plant species was present, due to local faunal singularities. The genetic differences between spurge species also explained the different arthropod species found, since the subsections and species complexes to which they belong are also based on ecological and morphological characters [see Riina et al. (2013) and Barres et al. (2017)]. However, the high number of species detected in *Euphorbia* species from different habitats (*E. mellifera*, *E. bourgeauana* and *E. lamarckii*) made the habitat a non-determinant factor in the richness values. Greater faunal dissimilarity, with more different host-plants, is most prominent in species with more distant stem thickness measurements, since xylophages are very specific to their host plant. Exclusivity of arthropods to certain islands influenced the similarity of the assemblages from one locality to another. Species with highly restricted distributions have fewer possibilities to find another host plant. Not surprisingly, the faunal assemblage tended to be more closely comparable between similar than different habitats, as found by Gessé et al. (2014). All these results show that *Euphorbia* species with restricted distributions deserve conservation programmes, owing to their unique associated faunal assemblage with such a high proportion of endemic and characteristic arthropod species.

According to our data, *E. mellifera* and *E. bourgeauana* are hosts to the highest numbers of species overall and of endemics, together with *E. lamarckii*. This suggests they act as biodiversity reservoirs, since their arthropod assemblages include species unique to these endangered plants and their archipelagos. In fact, both species are the feeding source of *Rhopalomesites proximus* (Wollaston 1861), a threatened beetle catalogued as ‘In danger of extinction’. *Euphorbia bourgeauana* is also a trophic resource for the endemic grasshopper *Acrostira bellamyi* (Uvarov 1922) (Hernández-Teixidor et al. 2014), catalogued as ‘Critically endangered’ by the IUCN. It is notable that endemic xylophages like *Pseudophloeophagus tenax* (Wollaston 1854) and those of the genus *Aphanarthrum*, as well as *Leipaspis lauricola gomerensis* Plata and Prendes, 1981—a predator of xylophagous larvae—were all detected only on *E. mellifera*. In addition, other species that spend their larval stage inside wood were only found in *E. bourgeauana*, such as *Alloxantha seidlitzii* Svihla, 1988 and *Solva palmensis* Báez, 1988. The parasitoid of this type of larvae, *Spathius canariensis* Hedqvist, 1976, was also present on both plants. Variation in arthropod assemblage composition is strongly influenced by host-plant identity or composition, particularly for phytophagous insects (Frenzel and Brandl 2001; Ødegaard et al. 2005). We found that xylophages are highly specialised to the species on which they develop. This pattern is quite common in xylobionts and,

as they cannot move to other plant species, the conservation of their host is vital for them (Krivoshchina 2016). This conclusion of our assessment is another reason to protect *Euphorbia* species.

Population losses will directly affect not just host survival but also each of their arthropod assemblages as a whole. Due to their abundance, arthropods play a major role in ecosystem dynamics and are good indicators for assigning conservation priorities based on monitoring programmes (Kremen et al. 1993). Our data on arthropod fauna indeed reveal an often hidden richness that reinforces the need to conserve these endemic spurges in Madeira and the Canaries, especially those officially under protection. Increased knowledge of associated fauna can thus serve to strategically redirect conservation efforts to protect both plants and animals and their respective ecosystem functions. Many species listed as threatened do not yet have recovery or management plans and actions are insufficient, due to lack of funding. In fact, none of these Macaronesian *Euphorbia* species have an approved plan. Budgets are limited, so it is essential to direct existing resources to key species such as these, given their impressive faunal assemblages. Through protecting these spurge populations and increasing their health status and number, the faunal populations linked to them will almost certainly be positively affected.

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Author contributions DHT designed the research. All other authors listed here contributed to the writing. DHT and PO conducted field collection and all authors contributed to sample identification. DS analysed the data. All authors revised and improved the manuscript.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

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