

Ceremonial releases of *Danaus plexippus* (Linnaeus, 1758) (Lepidoptera: Nymphalidae, Danainae) in the Iberian Peninsula, the Balearic Islands and Cyprus: implications for biogeography, potential for colonisation and a provisional listing of Asclepiadoideae from these regions

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Synopsis

Ceremonial releases of the Monarch butterfly, *Danaus plexippus* (Linnaeus, 1758), are shown as the probable reason for unexpected sightings of this species in Cyprus and Ibiza. Further enquiries revealed that such releases are not uncommon in Catalonia and elsewhere in Spain. The presence of *D. plexippus* in southern coastal areas of the Iberian Peninsula has been recognised for decades, but these are the first known reports of this danaine species on the Mediterranean islands of Ibiza and Cyprus. The impact of releases on biogeographical studies of *D. plexippus* in the Mediterranean and the possibilities for further colonisation are discussed.

Key words: Iberian Peninsula, Catalonia, Balearic Islands, Cyprus, Mediterranean, Lepidoptera, Nymphalidae, Danainae, *Danaus plexippus*, Monarch, *D. chrysippus*, host-plants, Apocynaceae, Asclepiadoideae, ceremonial butterfly releases, biogeography, range expansion, future colonisation.

Introduction

Commercial releases of butterflies, notably *Danaus plexippus* (Linnaeus, 1758), the Monarch butterfly, have taken place in North America for over two decades (New, 2008; Bob Pyle, pers. comm.). Concern has been expressed about the increasing popularity of a fashion that promotes the release of butterflies on diverse occasions such as weddings, christenings, funerals and other events (e.g. Pyle, 2010; Glassberg *et al.*, 2013) and the issue remains one of strongly contested views, with others, notably members of the International Butterfly

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Breeders Association, vigorously defending the legal right in most parts of the U.S.A to engage in this activity. For many years before such releases became fashionable, *D. plexippus* had been translocated across North America for experimental and educational purposes, e.g. Urquhart & Urquhart (1972; 1974; see also Brower *et al.*, 1995), in so doing possibly weakening arguments – at least in that country – against the ceremonial releases that were to follow. Although translocations for educational purposes seem confined to North America, ‘event’ releases elsewhere appear to be gaining momentum.

The objective here is not to interrogate in detail the wisdom or otherwise of these historical and ongoing events, rather to draw attention to an increasing trend outside North America and specifically to highlight releases in areas of the Mediterranean where the Monarch butterfly is an alien species. The impact on biogeographical studies in southern Iberia, where *D. plexippus* has become established, and on local recording schemes in the larger part of the Mediterranean where it has not, is of increasing concern. Here, we examine unexpected records of *D. plexippus* in Cyprus, which lies on the boundary of western Asia in the east of the Mediterranean, in the Balearic Islands in the western Mediterranean, and in Catalonia in north-eastern Spain.

Reports of *D. plexippus* sightings from Cyprus and Ibiza, October 2013

David Taylor (DT) sent the first author (EJ) a photograph of *D. plexippus* (Fig. 1) taken on 19 October 2013 at the Tombs of the Kings, Pafos. Just one specimen was observed nectaring on a bush later identified as *Lycium ferocissimum* Miers (Yiannis Christofides, pers. comm.). DT questioned the butterfly's appearance in Cyprus, having checked the first author's website (www.cyprusbutterflies.co.uk), which lists only one danaine species for Cyprus – *Danaus chrysippus* (Linnaeus, 1758) – a fairly regular migrant to Cyprus, although typically in very small numbers. EJ alerted members of the Cyprus Butterfly Study Group (CBSG) to take particular note of any danaid sightings, as misidentification of *D. plexippus* for *D. chrysippus* was considered likely, given the comparative rarity of the latter's appearance in Cyprus and hence its unfamiliarity to some. Various CBSG members visited the Tombs of the Kings' site, but no further sightings of either danaine species were reported.

The ‘alert’ referred to above resulted in one CBSG member (Rob Parker) advising that he had been sent photographs of *D. plexippus* taken in Ibiza by Mervyn Crawford (MC), also in October 2013. Parker, in his reply to MC, confirmed that *D. plexippus* was not listed for the Balearic Islands, citing Kudrna *et al.* (2011), but added that the species had apparently established colonies in Spain and Gibraltar. On requesting further details, MC reported (to EJ) that five Monarch butterflies had been seen on the afternoon of 10 October 2013 in what appeared to be a neglected large garden of about two acres in the vicinity of the Sol Ibiza Hotel in Santa Eulàriades Riu, a popular resort several kilometres to the north-east of Ibiza town. Figure 2 shows one of the butterflies nectaring on a plant tentatively identified as *Dittrichia viscosa* (L.) Greuter, one commonly used as a nectar source by the related *D. chrysippus* in Cyprus (Makris, 2003; EJ, pers. obs.). MC reported a further, likely, although distant sighting of *D. plexippus* on 13 October on waste ground between the Palladium Palace Hotel, Sant Jordi de Ses Salines and the south-eastern perimeter of Ibiza Airport.



Fig. 1. *Danaus plexippus*. Pafos, Cyprus, 19 October 2013.

Photo: David Taylor



Fig. 2. *Danaus plexippus*. Santa Eulàriades Riu, Ibiza, 10 October 2013.

Photo: Mervyn Crawford

The above reports from Cyprus and Ibiza constitute the first known documented reports of *D. plexippus* from these Mediterranean islands. However, in recent years there have been other sightings in several areas of northern Spain and the Balearic Islands, which are detailed below.

Reports of *D. plexippus* sightings from Catalonia and the Balearic Islands, 2003–2012

The occurrence of *D. plexippus* in a few scattered populations along the Spanish southern coast has been documented since the 1980s (Martín & Gurrea, 1988). Although the Spanish colonies apparently went extinct in the mid-1990s (Tarrier, 1993), new colonies became established at the beginning of this century and still persist. In recent years, Haeger and colleagues have studied these populations in detail and established their general patch dynamics and persistence (Haeger, Barbudo & Meléndez, 2010; 2011; Haeger, Barbudo & Zalucki, 2012). The origin of the founders of these populations has been the subject of some debate: they may have originated in North America or from one of several intermediate Atlantic islands, e.g. the Canary Islands (Martín & Gurrea, 1988; García-Barros *et al.*, 2013).

From the 1980s to the turn of the century there have been other occasional sightings along the Atlantic coast, in Galicia (north-western Spain) and Portugal (Fernández-Vidal, 2002; García-Barros *et al.*, 2004). It seems probable that these butterflies relate to individuals blown off course by common weather systems, while migrating from North America to the overwintering sites in Mexico. This suggestion is reinforced by the timing of these records (between September and November) and the concurrence of sightings on the coasts of the U.K. (Asher *et al.*, 2001).

In addition, in the last decade there have been further sightings at some distant northern Spanish sites, especially in Catalonia, where the species has not established populations yet (but see below).

The first records in Catalonia date from 2003 (Sabaté & Loaso, 2004). From 13–22 July about 20 individuals, including three mating pairs, were recorded in the Illa de Buda in the Ebro Delta. In 2004, several more Monarchs were seen again in the same area, this time in September and October (Stefanescu & Luque, 2004). The summer of 2003 was the hottest ever recorded in the region up to that time (Servei Meteorològic de Catalunya), and it was assumed that the exceptionally high temperatures had facilitated a northern expansion of the species from the colonies in southern Spain.

No further Monarchs were recorded in Catalonia until 2011 when a number of individual butterflies were reported from various sites. On 10 April, a Monarch was photographed in a garden centre in the city of Barcelona (Rosa Moreno, pers. obs.); one day later another individual was photographed 100 km to the north in Castelló d'Empúries (Miquel Angel Pérez De-Gregorio, pers. obs.). On 23 May, a further Monarch was photographed in Les Botigues de Sitges, ca 50 km south of Barcelona (Carles Pastor, pers. obs.). At the end of July another was seen in the Zoo of Barcelona (Isabel Miquel, pers. obs.).

In 2012, some new records were obtained. A male was captured in Montseny Natural Park on 17 July, during a count along a transect of the Catalan Butterfly Monitoring Scheme (CBMS-11) (C. Stefanescu, pers. obs.). Even more

surprising was the discovery of large number of larvae of *D. plexippus* (on *Gomphocarpus fruticosus* (L.) W. T. Alton) in October of that year on the beach of Castelldefels, south of Barcelona. Most larvae had successfully pupated by mid-November and some very fresh adults were recorded on the beach by mid-December.

In the Balearic Islands, *D. plexippus* was first reported from Mallorca in November and December 2008 (Encinas & Vicens, 2008). A single specimen was seen in flight on two occasions and wing remains found later were positively identified by the third author (MRH) as belonging to *D. plexippus*. A further confirmed sighting of *D. plexippus* was made at Son Armadans, Palma de Mallorca, on 27 July 2012 (pers. comm. to MRH). Encinas & Vicens (2008) also reported an observation (by G. X. Pons) of a *D. plexippus* sighting on 19 October 2008 in the south of Menorca. The positioning of the island, approximately 75 km east of Mallorca, allows for the possibility of vagrancy to Menorca or vice versa.

Records in other parts of Spain are, to our knowledge, far less common. An individual was photographed in the Botanical Garden in Madrid on 27 October 2009 (José Carlos de la Fuente, pers. obs.) and another was photographed in the province of León, north-western Spain, on 18 June 2011 (Héctor Astiárraga, pers. obs.).

What is the origin of the recent sightings of Mediterranean Monarchs?

The above records raised questions about the origin of Monarch butterflies in both the western and eastern Mediterranean.

On receiving the Cyprus report, EJ, suspecting a wedding release, began an internet search for local wedding organisers, initially concentrating on those based in the Pafos area but later investigating further afield. In total, 31 wedding organisers (seemingly, it is big business!) were either contacted direct, or checks were made on their websites for any references to 'wedding butterfly releases Cyprus'. Nothing remotely informative was found.

As the butterfly house industry is growing in some countries and poses a potential threat due to the accidental or intentional release of alien species (Boppré & Vane-Wright, 2012) this was the next most obvious source to be considered. However, no butterfly houses operate in Cyprus (Marios Aristophanous, pers. comm.) and there is no live butterfly exhibit at Pafos Zoo (David Whaley, pers. comm.).

What had seemed the least likely explanation, that of wind-assisted vagrancy, now began to move up the list of possibilities and in discussion with Dick Vane-Wright (BMNH), it was clear that this explanation, however unlikely, was worthy of consideration. *Danaus plexippus* is variable in its habits, according to location. Unlike the behaviour of the species in North America, where there are two distinct, long-distance migratory movements either side of the Rocky Mountains (e.g. Brower *et al.*, 1995), behaviour in the Iberian Peninsula, where the species is multiple-brooded and non-diapausing, is more restricted (Haeger, Barbudo & Meléndez, 2010), perhaps even sedentary, resembling more closely the behaviour of this species south of Mexico.

The establishment of several persistent colonies in various parts of the Mediterranean Spanish southern coast in recent decades opened the possibility of

further dispersal from these Mediterranean colonies. This had already been suggested by Asher *et al.* (2001) after the species' simultaneous arrival in the U.K. (in 1983 and 1995) with moths from south-western Europe. In this vein, the first records of the Monarch in the Ebro Delta in 2003 and 2004 were assumed to have resulted from the expansion of the southern Spanish colonies in an exceptionally hot summer (Sabaté & Loaso, 2004; Stefanescu & Luque, 2004). This hypothesis seemed even more likely considering that, in Catalonia, the Ebro Delta constitutes the natural entrance point of butterflies like *Danaus chrysippus* moving along the Mediterranean coast.

However, the records of 2011 and 2012 did not seem to conform to this pattern. Firstly, some butterflies had been recorded very early in the season (April and May), that is several months before the typical dispersal events take place (i.e. by the end of summer or early autumn, as in 2003 and 2004). Secondly, sightings have come from very scattered sites (even from a mountain site at Montseny), but not, in very recent years, from the Ebro Delta (see above).

Eventually, the records from Ibiza offered the key to the true origin of the Monarchs recently reported from northern Spain. News of the Ibiza observations encouraged EJ to extend the internet search to local wedding organisers in this area. This revealed a supplier based in Ibiza (<http://www.ibizabutterflies.com/>) offering the sale of 'Release Monarchs for Events'. Among events suggested on the website are 'Weddings, garden parties, anniversaries ... as well as grand openings.' The wording on the website continues: 'Butterfly releases are a great way to bring attention to a new product or business. We also offer live butterflies for fashion photo shoots.' The website further declares that the release of butterflies is sustainable, eco-friendly and environmentally responsible, while offering 'employment to workers that belong to different disabled groups.' Urbanisation is given as a reason for a dwindling population of butterflies on the island but we are assured that the 'project' will help with repopulation of the island's butterflies. There is no mention of *D. plexippus* being a non-native species to Ibiza, with questionable opportunities for establishment (see below).

Additional information is given on the organisation's Facebook page (<https://www.facebook.com/pages/Ibizabutterflies/323861011070527> – last accessed 18.i.2014), on which appears a first entry dated 26 March 2013, stating that the butterflies are indigenous to Spain. Photographs on the Facebook page display releases at events at various times during 2013 (10 April, 30 April, 11 May and 5 October), the last of these releases coinciding with the presence in Ibiza of Mervyn and Sheila Crawford, who were visiting an area approximately 7 km north-west of the release site five days after the 5 October event. The Facebook website refers to wedding releases at Can Pep Simó, Atzaro, Sant Joan de Labritja, Es Vedrà and Santa Eulària des Riu, covering much of the eastern coastline of the island.

Further enquiries by EJ revealed that the wedding organiser in Ibiza had received stock from a Spanish breeder/supplier (Butterfly Weddings, Murcia), who in turn confirmed that he had fulfilled orders to Ibiza and, significantly, also to Cyprus and Mallorca. Cooperatively, the breeder provided the contact details of a wedding organiser in Cyprus (to whom he had supplied livestock) and who, in turn, tacitly confirmed that she had provided live Monarch butterflies for release in Pafos, adding that 'this can be organised in a number of locations as

well.' Hence, the sources of releases on Cyprus and Ibiza were revealed, negating the need for investigations into possible vagrancy.

The supplier openly, and very helpfully, responded to questions about the source of his livestock, which was obtained from another Spanish breeder and probably derives from Canary Island stock. He added that he had supplied not only to Ibiza, Mallorca and Cyprus in 2013, but also to Catalonia, Portugal and Italy, adding that other suppliers in Europe also sell *D. plexippus* to Mediterranean countries. Indeed, additional suppliers offering butterflies for release at weddings were found to be operating in Germany, Switzerland, Portugal and the U.K.

Taking into account all this information, we strongly believe that all the recent records in northern Spain, the Balearic Islands and Cyprus originated from event releases in these areas. We consider that the earliest records in 2003 and 2004 (and, perhaps, in Mallorca in 2008) may have resulted from genuine expansion from southern Spanish colonies, although the 'wedding release' hypothesis cannot be discounted.

Host-plants and potential host-plants for *D. plexippus* in the Mediterranean region

Whether or not the occurrence of Monarchs beyond the currently accepted range of the species is the result of natural dispersal, or has resulted from deliberate release, it is worth considering the potential for the establishment of natural populations in these new areas. This is largely dependent on the presence of potential host-plants.

In North America, 23 genera and 205 accepted taxa of milkweed are known, with 76 species and 91 accepted taxa of *Asclepias* alone (USDA, Plants Database). *Asclepias syriaca* L. is the most abundant of the *Asclepias* species and is the major host-plant of *D. plexippus* (Malcolm & Brower, 1986), but oviposition has also been recorded on 32 other species of *Asclepias* in North America and on six other plant families (Mattila & Otis, 2003). However, far fewer members of the subfamily Asclepiadoideae are present in the Iberian Peninsula, or on the islands under discussion (Table 1). Formerly known as the family Asclepiadaceae, this group is now treated as a subfamily in the Apocynaceae Juss., a family that includes in the Mediterranean the very common *Nerium oleander* L.

In addition to the plants presented in Table 1, host-plants listed for *D. plexippus* in the northern hemisphere include *Gossypium arboreum* (L.) (Malvaceae) and *Euphorbia mauritanica* (L.) (Euphorbiaceae) in the Azores Archipelago (Higgins & Riley, 1970; Neves *et al.*, 2001). In addition, Viedma & Gómez-Bustillo (1985) list *Gossypium herbaceum* (L.) and *E. mauritanica* for the Canary Islands. In considering potential host-plants, a member of the Apocynaceae, *Nerium oleander* L., has been referred to in this context. This similarly very toxic and commonly planted ornamental shrub was mentioned by Hesselbarth *et al.* (1995), but the authors commented (in relation to *D. chrysippus*, rather than *D. plexippus*) that along with other members of the Apocynoideae subfamily, any assumption that *N. oleander* might be a suitable host-plant should be viewed with caution. Certainly, the authors of this paper have never observed either danaine in close association with *N. oleander*.

Of the members of the Asclepiadoideae subfamily present in Iberia (see Table 1), five species – the two *Asclepias* spp., *Cynanchum acutum* L. (widely distributed

Table 1. Potential host-plants of *Danaus plexippus* in the Iberian Peninsula, Balearic Islands and Cyprus.

Confirmed or potential <i>Asclepiadoideae</i> host-plants	Presence in:		Assessment of potential use
	Iberian Peninsula ^{1,2,3}	Balearic Islands ⁴ Cyprus ⁶	
<i>Araujia sericifera</i> Brot.	✓	Mallorca	Not known naturally, but accepted by larvae (Wise, 1963; Felix Lopez, pers. comm.).
<i>Asclepias curassavica</i> (L.)	✓		Confirmed host-plant (e.g. Haeger, Barbudo & Meléndez, 2010).
<i>Asclepias syriaca</i> L.	✓		Confirmed host-plant of choice for <i>D. plexippus</i> (e.g. Zalucki <i>et al.</i> , 2001).
<i>Caralluma europaea</i> (Guss.)	✓		Possibly acceptable? <i>C. europaea</i> is listed as a host-plant for <i>D. chrysippus</i> on Lampedusa (Pisciotta <i>et al.</i> , 2008).
<i>Caralluma munbyana</i> (Decne. ex Munby)	✓		? No information found.
<i>Cionura erecta</i> (L.) Griseb. (syn. <i>Cynanchum erectum</i> L.)			? No information found. Considered extinct in Cyprus – last recorded in 1905.
<i>Cynanchum acutum</i> (L.)	✓	Mallorca Menorca	Confirmed host-plant (e.g. Gil-T., 2006).
<i>Cyprinia gracilis</i> (Boissier) Browicz			Found mostly on the Troodos range between 600–1300 m, over a wide area. No evidence of use of <i>C. gracilis</i> by any danaid sp. has been found, although Hesselbarth, van Oorschot & Wagener (1995) list as a potential host-plant for <i>D. chrysippus</i> in Anatolia, Turkey.
<i>Gomphocarpus fruticosus</i> (L.) (syn. <i>Asclepias fruticosa</i> (L.))	✓	Mallorca Ibiza	Confirmed host-plant, e.g. Stefanescu & Luque (2004); Haeger, Barbudo & Meléndez (2010).
<i>Gomphocarpus physocarpus</i> E. Mey. (syn. <i>Asclepias physocarpa</i> E. Mey., syn. <i>Asclepias gomphocarpa</i> (E. Mey.) Schltr.)	✓	Mallorca ⁵	Suitable, e.g. Zalucki & Kitching (1982).

Table 1. Continued

Confirmed or potential Asclepiadoideae host-plants	Presence in:			Assessment of potential use
	Iberian Peninsula ^{1,2,3}	Balearic Islands ⁴	Cyprus ⁶	
<i>Periploca laevigata</i> Aiton (syn. <i>Periploca laevigata</i> Aiton var. <i>angustifolia</i> Labill.)	✓			Possibly acceptable? Wicmers (1995) found no evidence of use by <i>D. plexippus</i> in the Canary Is., but Zito <i>et al.</i> (2010, 2011), noted that four compounds (pentacosane, hexacosane, heptacosane and hexadecanoic acid), which are pheromones for <i>D. chrysippus</i> , are common to <i>P. laevigata angustifolia</i> and <i>Caralluma europaea</i> – the latter a confirmed host-plant for <i>D. chrysippus</i> – see entry for <i>C. europaea</i> . See also Pesciotta <i>et al.</i> (2008).
<i>Periploca graeca</i> L.	✓			Possibly acceptable? Genus is listed as a host-plant for <i>D. chrysippus</i> in Sulawesi (Vane-Wright & de Jong, 2003: 222).
<i>Vincetoxicum (Cynanchum) canescens</i>			✓	Rare plant of mountains. In view of altitude preference and known unsuitability of other <i>Vincetoxicum</i> spp., unlikely to be suitable as a host-plant.
<i>Vincetoxicum nigrum</i> (L.) Moench. (syn. <i>Asclepias nigra</i> (L.), <i>Cynanchum nigrum</i> (L.) Pers., <i>Cynanchum louiseae</i> Kartesz & Gandhi)	✓	Mallorca Menorca		Unsuitable – oviposition leads to larval death within a few days (DiTomasso & Losey, 2003; Casagrande & Dacey, 2007). See also <i>V. hirundinaria</i> .
<i>Vincetoxicum hirundinaria</i> Medik. (syn. <i>Cynanchum vincetoxicum</i> L.)	✓	Menorca Cabrera		No instance of use found, but in North America, larval use of <i>V. nigrum</i> and <i>V. rossicum</i> (syn. <i>Cynanchum medium</i>), resulted in death after a matter of days (Haribal & Renwick, 1998; Casagrande & Dacey, 2001; 2007; Matilla & Otis, 2003).

¹Flora Iberica website. ²Published papers confirming use as host-plants. ³C. Stefanescu, pers. obs.⁴Data provided by Monserrat Arista Palmero, Departamento de Biología Vegetal y Ecología, Universidad de Sevilla, who also advised (referring to Spain in general) that '*Asclepias curassavica*, *Gomphocarpus physocarpus* and *Araujia sericifera* are frequently cultivated in gardens ...'⁵Moragues & Rita (2005) listed *G. physocarpus* among new records of naturalized exotic flora in the Balearic Islands; its presence on Mallorca was confirmed by Juan Rita (pers. comm.).⁶Data provided mainly by Yiannis Christofides.⁷*A. curassavica* has been observed growing as an ornamental/escapee in hotel gardens in the Coral Bay area (Peter Russell, pers. comm.).

in Catalonia: Bolòs & Vigo, 1995) and both *Gomphocarpus* spp. – are confirmed natural host-plants of *D. plexippus*. Host-plant opportunities are fewer in the Balearic Islands, although *Gomphocarpus fruticosus* can be locally abundant, e.g. on sandy expanses where the torrents meet the sea, such as at the mouth of the Parc Natural de s'Albufereta in the Bay of Pollença (MRH, pers. obs.). In Cyprus, *C. acutum* and *G. fruticosus* are extremely rare, the former not even being discovered in northern Cyprus until 2012, when a single plant was found in Karpasia (Sami Tamson, pers. comm.).

Asclepiadoideae are generally regarded as invasive in nature (see Dana, Sanz-Elorza & Sobrino (2013) for an assessment of invasive potential) and most are alien to the Mediterranean, *C. acutum* being an exception. Despite the ease by which asclepiads spread, through dispersal of their seeds by wind and water, Haeger *et al.* (2010) questioned the categorisation of *A. curassavica* and of both *Gomphocarpus* spp. as invasives (see Sanz-Elorza, Dana & Sobrino, 2001; Dana, Sanz-Elorza & Sobrino, 2013), citing their growth requirements that are often closely influenced by human intervention, e.g. drainage ditches, soil disturbance and livestock farming. Asclepiadoideae are generally ruderal plants of open, moist or riparian areas and are rarely found away from the coast because their frost resistance is very low. For these reasons, Haeger *et al.* (2010) viewed the likelihood of range expansion for Asclepiadoideae to be limited, although spread may be assisted by their use as ornamentals.

Impact on biogeographical studies and climate change research

In discussing the merits or otherwise of butterfly releases at weddings, New (2008) drew attention to a Code of Practice of the South African Butterfly Breeding Association (SABBA), an organisation described on its website as 'a subsidiary company of Conservation of Butterflies in South Africa (CBISA)'. The Code obliged members to release butterflies only within their natural range, but went further by advocating the release only of males in order not to overpopulate the region. Whether or not this suggestion was widely followed is not known. However, the SABBA website now includes a page (<http://www.butterflyweddings.co.za/>) with the announcement, 'The selling of butterflies for weddings will be fazed [sic] out during 2014. In place thereof – 'Butterfly Wedding Venues' will be set up throughout the nine Provinces of South Africa – to accommodate anyone who wishes to get married amongst our beautiful butterflies.' This change of approach has not come about because of impending legislation, but as a voluntary act by SABBA, which further informed, 'it is intended that Butterfly Wedding Venues replace all releases into the wild by SABBA and its members' (Lizanne Whiteley [CBISA/SABBA], pers. comm.).

Inadvertently, New (2008), while prefacing his final comments with a cautionary note advising against indiscriminate releases, i.e. endorsing the need to restrict such releases to within the species' natural range, somewhat downplayed biogeographical concerns in stating, 'there seems little confirmed conservation concern arising from advertised current practices associated with ceremonial releases of butterflies.' However, the key words here are 'advertised current practices', which related to releases in North America (where *D. plexippus* is indigenous) and not to releases in Mediterranean countries, practices which

gained momentum after the paper was written (Tim New, pers. comm.). The International Butterfly Breeders Association (IBBA, 2013) website page written by Harry Pavulaan, which strongly defends releases, carries a similar statement, 'virtually no research has been published on the purported negative effects of butterfly releases.' Nevertheless, in addressing the question of the introduction of species into non-native areas, the IBBA website acknowledges, 'Such practices have the potential of confounding distributional research, especially if conducted on a large scale, and will have to be monitored more closely. I suggest that all released butterflies be tagged or appropriately marked by the breeders, so that at least the first generation "releases" can be identified.'

European suppliers appear to have paid little heed to the provision of stock for release only within normal distribution ranges, which are, of course, very restricted in their area of operation. Release numbers are tailored to requirements, but reference to the Ibiza company's website and Facebook page informs that 50 Monarchs were released on 11 May 2013 at Atzaro — a substantial release on an island of just 571 km², and this was one of several declared releases to follow. The commercial attraction of supplying this species is illustrated by one website that lists prices including transport costs starting at 235 € for 10 butterflies and rising to 525 € for 50 butterflies.

In view of the foregoing accounts, it now becomes clear that in well-studied or reasonably well-studied countries remote from established breeding areas of *D. plexippus* (as with the Cyprus experience), reasons other than range expansion should be considered for the unexpected appearance of any alien butterfly species.

However, the nearer one moves to the accepted distribution range, the greater the dilemma in judging the authenticity of such sightings. For example, our investigations may now raise doubts about the origins of *D. plexippus* in certain parts of southern Spain. Biogeographical studies by Haeger, Barbudo & Meléndez (2010; 2011) in this area have followed movement of the species between patches of host-plants, but is the spread of *D. plexippus* in the south of Spain *entirely* due to natural range expansion, perhaps supplemented by periodic trans-Atlantic immigrations, or has it been aided, even strongly influenced, by artificial releases?

The website <http://www.caprichia.com/blog-caprichia-wedding-planner-marbella-southern-spain-event-designer/page/2> (last accessed 18.i.2014) shows images of a release of *D. plexippus* in Marbella, Andalucía, to the eastern edge of the species' distribution in southern Spain, as shown in Kudrna *et al.* (2011). A similar distribution is shown in Kudrna (2002), but in future, how does one demonstrate natural dispersion in these areas? Event releases are a fairly recent phenomenon in Spain, therefore the initial colonisation by *D. plexippus*, which began in 1979 and developed to a peak in the 1980s (before disappearing in the early 1990s (Gil-T., 2006)), was unlikely to have been influenced by ceremonial releases, but can the same be said for the re-established colonies of a decade or so ago? As a further complication, Europe's 'largest butterfly house' (where *D. plexippus* is known to be present) is to be found in Benalmádena mid-way between Fuengirola and Málaga in Andalucía (<http://www.mariposariodebenalmadena.com/English/> — last accessed 18.i.2014). Escapes, or intentional releases from such establishments by well-intentioned but misguided individuals pose a variety of conservation risks comprehensively presented by Boppré & Vane-Wright (2012).

From the above, it is reasonable to conclude that in the provinces of Granada and Almería in south-east Andalucía, biogeographical work tracking the species' natural spread has been severely compromised by ill-judged releases.

Moreover, the current situation also represents a serious problem in the context of climatic change research. In Ibiza, the appearance of *D. plexippus* could easily have led to a conclusion of natural occurrence through northward range expansion, given the relatively short distance from colony locations in south-east Spain and Gibraltar and the ability of the species to fly long distances. The same may be said about records in northern Spain: increased pole-ward migration of Lepidoptera as a response to climate warming is well-documented (Sparks, Roy & Dennis, 2005; Sparks *et al.*, 2007), and *Danaus plexippus* seems an obvious candidate. However, in relation to the observations reported in this paper, such a conclusion cannot be applied with any degree of certainty to recent Mediterranean records of *D. plexippus*.

Can released *D. plexippus* become established in the wider Mediterranean region?

The key requirements: ample supply of asclepiad host-plants (which are also excellent sources of nectar), absence of frosts to allow their continued survival, together with essential habitat components (see Dennis, 2010), have enabled *D. plexippus* to maintain a presence in southern Iberia (Haeger, Barbudo & Meléndez, 2010; 2011; Haeger, Barbudo & Zalucki, 2012). The host-plants documented in this area were *A. curassavica* and *G. fruticosus* (the latter dominant) with 63 plant patches found in an area of 900 km²; *C. acutum* was found rarely. The extent of the plant patches varied, but the presence of up to 4,500 larval host-plants within some surveyed patches provides a clear indication of the suitability of this area of south-western Andalucía to encourage colonisation. Over a thirty-month period of study, Haeger, Barbudo & Zalucki (2012) reported that immature stages were recorded in 65.5% of fieldwork days, even in winter, and further added that local extinctions and re-colonisations were frequent. Flooding, frost damage of host-plants and defoliation by larvae, were listed among natural causes of local extinction.

In a warming climate, two coastal areas in Catalonia where *C. acutum* is abundant, the Ebro Delta in the south and the mouth of the Fluvià River in the north, have potential to host permanent colonies of danaine species. Frosts are rare in these regions, but the greatest obstacle to colonisation appears to be that of the suitability of *C. acutum* as a host-plant in winter. Whereas Bolòs & Vigo (1995) indicated that *C. acutum* retains its leaves throughout the year, observations at the mouth of the Fluvià River during the winter of 2012/2013 (where *D. chrysippus* had been present in very large numbers in the autumn) showed that aerial parts of *C. acutum* had withered completely, denying newly eclosed *D. chrysippus* adults opportunities for further oviposition (CS, pers. obs.). The protected wetland area around Barcelona Airport and some nearby beach areas further south (e.g. Castelldefels), may offer another area for colonisation; *C. acutum* is absent, but *G. fruticosus* remains available as a host-plant throughout the winter. Here, *D. plexippus* larvae were found on *G. fruticosus* in December 2012.

In considering the possibilities for range expansion of *D. plexippus* into northern Spain, it is apparent that host-plant presence in Andalucía (in the

south), where *A. curassavica* and *G. fruticosus* are the dominant asclepiads and are available for larval use in winter, differs from that in Catalonia, where *C. acutum* dominates, but dies back in winter. Thus, the availability of host-plants for use by larvae throughout the winter is a crucial factor in determining successful colonisation.

In the Balearic Islands, *G. fruticosus* would appear to be the most likely host-plant offering colonisation opportunities, but this has yet to be realised (Pere Vicens, pers. comm.).

In Cyprus, where *D. chrysippus* has yet to succeed in establishing colonies and where host-plants are rare (*G. fruticosus* is known only as an ornamental), the likelihood of *D. plexippus* becoming established seems remote.

However, distribution and density of alien host-plants such as *A. curassavica* and *G. fruticosus* (probably the most likely of potential host-plants to be available for use by *D. plexippus* in the wider Mediterranean), is poorly documented (Brundu *et al.*, 2004), thus making predictions of range expansion, whether release-assisted or natural, highly speculative.

The presence of *Vincetoxicum* spp. (Swallow-worts), native to the Mediterranean areas under discussion, may also prove a hindrance to a successful establishment. In North America, *Vincetoxicum nigrum* (L.) Moench. and *V. rossicum* Kleo., invasive introduced species have been shown to outcompete and displace native *Asclepias syriaca* (Haribal & Renwick, 1998; DiTommaso & Losey, 2003). Although their results are not in complete agreement with other researchers, Casagrande & Dacey (2007; Richard Casagrande, pers. comm.), experimentally in choice and no-choice tests and by means of field surveys, demonstrated that in southern Rhode Island (north-eastern U.S.A.) *D. plexippus*, while showing a significant preference for *A. syriaca*, will oviposit on *Vincetoxicum* spp. The finding led the authors to conclude that 'exotic plants can act as a sink – stimulating oviposition on plants unsuitable for larval development.' Both *Vincetoxicum nigrum* and *V. hirundinaria* Medik. are known in Catalonia; while the former occurs rarely along the coast and in some isolated continental areas to the western part of Spain, the latter is abundant in some interior areas of the northern half of the country (Bolòs & Vigo, 1995).

Danaus plexippus will also need to adapt to the Mediterranean winter to allow a population to subsist. The species has succeeded in establishing colonies in southern regions of Spain, where winters are milder, but as we have hypothesised it is also possible that local populations have been supplemented by releases, casting doubt on the extent of the species' establishment and range expansion, particularly in eastern Andalucía. In other areas where suitable host-plants are found and where there is adequate shelter for overwintering stages, local colonisation may result.

Of course, given the invasive nature of alien Asclepiadoideae, a desire to secure the eradication of its host-plants (see Haeger, Barbudo & Meléndez, 2010) could be another major obstacle to the successful establishment of *D. plexippus*!

Acknowledgements

The following are warmly thanked for providing assistance in the preparation of this paper: Marios Aristophanous (Alethriko, Cyprus); Dubi Benyamini (Bet Arye, Israel); Oriol Borrut (Parc Zoològic de Barcelona, Spain); Lincoln Brower

(Department of Biology, Sweet Briar College, Virginia, U.S.A.); Andrew Brower (Middle Tennessee State University, U.S.A.); Richard Casagrande (Department of Plant Science & Entomology University of Rhode Island, U.S.A.); Yiannis Christofides (Platres, Cyprus); Toni Curcó (Parc Natural del Delta de l'Ebre, Spain), Leonardo Dapporto (Università degli Studi di Firenze, Dipartimento di Biologia Evoluzionistica 'Leo Pardi', Firenze, Italy); Brian Ellis (Mosphiloti, Cyprus); Elena Erotokritou (Department of Environment, Ministry of Agriculture, Natural Resources and Environment, Nicosia, Cyprus); Montserrat Arista Palmero (Departamento de Biología Vegetal y Ecología, Universidad de Sevilla, Spain); Moisès Guardiola (CREAF, Spain), Paul Jones (Pafos, Cyprus); Torben Larsen (London); Michael Lockwood (Girona, Spain); Felix Lopez (Murcia, Spain); Pere Luque (Museu de les Terres de l'Ebre, Spain); Christodoulos Makris (Lemesós, Cyprus); Tim New (Latrobe University, Melbourne, Australia); Rob Parker (Bury-St-Edmunds, U.K.); Robert Pyle (Washington, U.S.A.); Juan Rita (Departamento de Biología en la Universitat de les Illes Balears, Mallorca); Peter Russell (East Wittering, U.K.); Paul Sammut (Malta); José Manuel Sesma (Biodiversidad Virtua, Spain); Sami Tamson (Zodeia, Cyprus); John Tennent (Department of Life Sciences, Natural History Museum, London, U.K.); Dick Vane-Wright (Department of Life Sciences, Natural History Museum, London, U.K.); David Whaley (Stroumbi, Cyprus); Pietro Zito (Dipartimento DEMETRA, Università degli studi di Palermo, Viale delle Scienze, Edificio 4, 90128, Palermo, Italy); Pere Vicens (Inca, Mallorca); Lizanne Whiteley (CBISA/SABBA, South Africa). The authors are grateful to Roger Dennis for his insightful comments on the manuscript.

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Addendum

Although no attempt was made to estimate the number of *Danaus plexippus* released annually in the Mediterranean, the scale of event releases in North America may be gauged from figures released by the International Butterfly Breeders Association at the 'Butterfly Professionals' Conference' in Florida, 12–16 November 2014. Results from a survey of IBBA members (in the United States only) revealed that the farms surveyed 'released 118,230–193,204 monarchs per year.'

Data are absent from non-member operations (farms), of which two in the United States 'merit consideration due to their potential size', and which did not respond to the IBBA's request for details of numbers released. The above figures do not take into account supplies to Butterfly Houses or specimens used for exhibits.

(Information courtesy of Kathy Marshburn, International Butterfly Breeders Association.)