Ornamental plantings of *Arbutus unedo* L. facilitate colonisations by *Charaxes jasius* (Linnaeus, 1767) in Madrid province, central Spain

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**Abstract.** The distribution of butterfly species is limited by availability of larval host plants growing in suitable climatic conditions. The Two-tailed Pasha, *Charaxes jasius* (Linnaeus, 1767), is a Mediterranean butterfly with only sporadic historical records in Madrid, Spain’s most central province, where the host plant is uncommon and winters are colder than in most parts of the butterfly’s range. We show the first evidence of juvenile stages of the species in two towns of north-central Madrid and compile records of *C. jasius* from Madrid over the past four decades. Our results suggest that, in the absence of widespread host plants, *C. jasius* is using suburban ornamental plantings of its host plant to colonise a region which may be becoming more climatically suitable.

**Introduction**

The Two-tailed Pasha, *Charaxes jasius* (Linnaeus, 1767) (Lepidoptera: Nymphalidae: Charaxinae), has been reported from regions of mainly coastal Mediterranean or Atlantic climates (Kudrna et al. 2015; GBIF 2017). The species’ distribution follows the native range of its main larval host plant, the Strawberry-tree (*Arbutus unedo* Linnaeus), that typically grows in coastal and inland areas with mild climates (Torres et al. 2002).

In the Iberian Peninsula, both the butterfly and its host plant occur mainly in areas of non-continental climate, with the exception of some occasional records of the adult butterfly in inland thermal refuges (Domínguez and Martínez 1993; Garcia-Barros et al. 2004; Molina et al. 2011; Garcia-Barros et al. 2013). In central Spain, *C. jasius* is reported to have settled in the southwestern extreme of Madrid province (Vicente Arranz and Garcia-Carrillo 2009), corresponding to a small remnant population of Strawberry-trees (Domínguez and Martínez 1993; Baonza-Díaz 2001), closer to the stronghold of the butterfly, further to the west in the provinces of Cáceres and Toledo (Garcia-Barros et al. 2004). Strawberry-trees are also grown ornamentally, and can be found throughout Madrid, thus presenting opportunities for *C. jasius* to expand its distribution to areas having more continental conditions.

This study was motivated by the unexpected sighting of an adult *C. jasius* in central Spain, in a north-central town of Madrid province, Colmenar Viejo, situated approximately 80 km from the species’ southwestern stronghold (Vicente Arranz and Garcia-Carrillo 2009). This led us to investigate whether the butterfly is breeding in the area, and if it is making use of ornamental Strawberry-trees
to expand from its southwestern settlement to more northern and central areas. To answer these questions, we carried out (i) a search and created a list of Strawberry-trees present in the town of Colmenar Viejo and in some neighbouring localities, looking for evidence of the butterfly’s presence, and (ii) compiled a list of existing information on the distribution of the butterfly in Madrid province.

**Material and methods**

**Evidence for colonisation of north and central Madrid**

Following the sighting of an adult *C. jasius* in Colmenar Viejo on 12.ix.2017, an inventory of the ornamental Strawberry-trees present in this locality was carried out. The trees were then searched for the presence of *C. jasius* (eggs, larvae and/or adults). In addition, the neighbouring localities of Hoyo de Manzanares, Tres Cantos, Cantoblanco and San Agustín del Guadalix, situated west, south and east of Colmenar Viejo, were also searched. We selected these adjacent localities, as we expected that they would form part of the most likely approach of the butterfly from its southwestern settlement.

A total of 298 ornamental trees, found largely in urban parks and gardens across the five localities, were searched from mid-September to late October 2017, at the end of the summer generation of the butterfly. Seventy-one of the trees were located in Colmenar Viejo, while 201 trees were located in Tres Cantos, 7 in Cantoblanco, 4 in San Agustín del Guadalix and 15 in Hoyo de Manzanares.

**Review of prior records**

Information on the butterfly’s distribution in Madrid province was reviewed using records from the following sources: Gómez Bustillo and Fernández-Rubio 1974; Martínez and Casado 1984; Simón 1986; Gómez de Aizpúrua 1987, 1997; Gómez de Aizpúrua et al. 1999, 2009; Vicente Arranz and García Carrillo 2009; Cobo 2013; García Carrillo et al. 2015. For each source, the locality name, geographic coordinates, observer name and development stage found (egg, larva and/or adult) were compiled into a table.

**Results**

Two butterflies, 25 eggs and one larva were found during the searches of the ornamental Strawberry-trees. Both butterflies, 21 eggs and the larva were found across the town of Colmenar Viejo, while the remaining four eggs were observed on three trees in Tres Cantos, south of Colmenar Viejo (Table 1). No evidence of the butterfly’s presence was found in the three remaining localities, where only a small number of trees was located and searched (Table 1).

The review of prior distribution records spanned the past four decades, and revealed a number of sporadic observations which, like that at Colmenar Viejo, are located far from the butterfly’s southwestern range (Table 2; Fig. 1). The majority of the records from the last 10 years were obtained in west and north-central localities of the province, closer to the Guadarrama mountain range, while the older records were generally found further south (Fig. 1). The two most northern records in the province constituted the two most recent sightings of the butterfly (Table 2; Fig. 1). The northernmost record, from Miraflores de la Sierra, was obtained approximately 15 km from one of the few relict populations of indigenous Strawberry-trees in the country (Molina et al. 2011; Bernal González 2012; García Carrillo et al. 2015), while the second-most northern record, from El Escorial, was obtained in an urbanization with numerous ornamental plantings (García Carrillo et al. 2015). The...
Table 1. List of the localities in Madrid province where Strawberry-trees were examined for the presence of *C. jasius*. The geographical coordinates, number of trees searched and development stage found are also provided.

| Locality                  | Geographical Coordinates | Number trees | Development stage  |
|---------------------------|--------------------------|--------------|-------------------|
| Colmenar Viejo            | 40°40'00.2"N, 3°46'17.5"W | –            | 1 adult           |
|                           | 40°39'57.9"N, 3°46'09.5"W | 1            | 5 eggs, 1 larva   |
|                           | 40°39'49.7"N, 3°46'21.8"W | 1            | 7 eggs            |
|                           | 40°39'11.5"N, 3°46'19.2"W | 15           | 2 eggs            |
|                           | 40°39'40.0"N, 3°45'44.8"W | 5            | –                 |
|                           | 40°39'59.5"N, 3°46'31.0"W | 3            | –                 |
|                           | 40°40'06.5"N, 3°46'30.6"W | 3            | –                 |
|                           | 40°40'05.0"N, 3°46'29.0"W | 2            | –                 |
|                           | 40°39'31.7"N, 3°45'45.7"W | 2            | –                 |
|                           | 40°40'04.4"N, 3°45'56.0"W | 1            | –                 |
|                           | 40°39'48.1"N, 3°45'54.6"W | 1            | –                 |
|                           | 40°40'10.1"N, 3°45'35.3"W | 3            | –                 |
|                           | 40°39'15.1"N, 3°46'32.2"W | 20           | 7 eggs            |
|                           | 40°40'07.6"N, 3°46'38.2"W | 1            | –                 |
|                           | 40°39'36.0"N, 3°45'41.2"W | 5            | –                 |
|                           | 40°39'55.0"N, 3°46'11.6"W | 1            | –                 |
|                           | 40°39'41.7"N, 3°45'54.6"W | –            | 1 adult           |
|                           | 40°39'33.1"N, 3°45'24.7"W | 7            | –                 |
| Tres Cantos               | 40°36'18.3"N, 3°42'33.6"W | 120          | 2 eggs            |
|                           | 40°35'44.0"N, 3°42'22.8"W | 1            | 1 eggs            |
|                           | 40°36'30.9"N, 3°42'27.8"W | 80           | 1 eggs            |
| Cantoblanco               | 40°32'37.7"N, 3°41'42.8"W | 4            | –                 |
|                           | 40°32'30.1"N, 3°41'25.9"W | 3            | –                 |
| San Agustin del Guadalix  | 40°40'53.3"N, 3°36'49.0"W | 4            | –                 |
| Hoy de Manzanares         | 40°37'26.9"N, 3°54'16.9"W | 15           | –                 |
Table 2. List of the localities in Madrid province where *C. jasius* has previously been observed. The geographic coordinates (Geo. coord.), 10×10 km MGRS grid references (MGRS), development stage (Dev. stage), date, observer name (Observ.) and source of each record are also provided.

| Locality         | Geo. coord | MGRS    | Dev. stage | Date       | Observ.                      | Source                                      |
|------------------|------------|---------|------------|------------|------------------------------|---------------------------------------------|
| Meco             | 3°19'45.9"W, 40°33'16.1"N | 30TVK78 | Adult      | 1974, 1999 | J. Álvarez                  | Gómez Bustillo and Fernández-Rubio 1974; Gómez de Aizpúrua et al. 1999 |
| Móstoles         | 4°24'22.2"W, 40°19'25.0"N | 30TVK26 | Adult      | IX-1984    | –                           | Martínez and Casado 1984                  |
| Sierra de la Higuera | 4°34'42.2"W, 40°13'03.2"N | 3OTUK65 | Adult      | IX-1984    | M.A. Martínez and F. Casado | Martínez and Casado 1984                  |
| Casa de Campo    | 3°45'19.0"W, 40°25'20.7"N | 3OTUK37 | Adult      | 12-VI-1982 | L.A. Rovenga                | Simón 1986                                  |
| Somosaguas       | 3°47'48.5"W, 40°25'07.1"N | 3OTUK37 | Adult      | IX-1984    | F. Rodríguez                | Simón 1986                                  |
| Alcalá de Henares | 3°21'57.0"W, 40°28'57.5"N | 3OTUK78 | Adult      | 1987       | C. Gómez et al.             | Gómez de Aizpúrua 1987a                    |
| Cadalso de los Vidrios | 4°26'43.4"W, 40°18'07.3"N | 3OTUK75 | Adult      | 1997       | C. Gómez de Aizpúrua        | Gómez de Aizpúrua 1997                    |
| Aranjuez         | 3°36'19.6"W, 40°01'50.9"N | 3OTUK43 | Adult      | 2009       | C. Gómez de Aizpúrua        | Gómez de Aizpúrua et al. 2009              |
| Cenicientos      | 4°27'50.7"W, 40°15'45.6"N | 3OTUK65 | Adult      | 2009       | J.C. Vicente and A. García Carrillo | Vicente and García Carrillo 2009          |
| Cadalso de los Vidrios | 4°26'43.4"W, 40°18'07.3"N | 3OTUK75 | Adult      | 2009       | J.C. Vicente and A. García Carrillo | Vicente and García Carrillo 2009          |
| Robledo de Chavela | 4°14'08.8"W, 40°30'16.9"N | 3OTUK98 | Larva      | 14-I-2012  | A. Cobo                     | Cobo 2013                                   |
| El Escorial      | 4°07'41.0"W, 40°34'58.7"N | 3OTVK09 | Adult      | 1-VII-2015 | R. de la Peña               | García Carrillo et al. 2015                |
| Miraflores de la Sierra | 3°58.1"W, 40°48'42.1"N | 3OTVL32 | Adult      | 21-VI-2015 | K. Leahy                    | García Carrillo et al. 2015                |

The majority of the records collected were observations of adult butterflies, although a larva had been detected in the west-central locality of Robledo de Chavela in 2013 (Cobo 2013) (Table 2; Fig. 1).

**Discussion**

Our findings of a small number of juvenile stages of *C. jasius* in two north-central localities of Madrid province suggest that a small breeding population occurs in the area. Furthermore, the existence of prior records in localities that are very distant from the butterfly’s southwestern settlement, and where Strawberry-trees do not naturally grow, supports the possibility that the highly mobile *C. jasius* is using ornamental trees to colonise new areas.

Ornamental plantings of larval host plants have been found to play an important role in the expansion of other butterfly species, such as the Common Brimstone, *Gonepteryx rhamni* (Linnaeus, 1758), that has spread along plantings of Alder Buckthorn (*Frangula alnus* Mill.) on roadsides in North Wales (Gutiérrez and Thomas 2000). Breeding populations of the American Monarch, *Danaus plexippus* (Linnaeus, 1758), have been observed in the Azores islands following the introduction of the Swan Milkweed (*Gomphocarpus fruticosus* (L.) W.T. Aiton) for ornamental purposes (Neves et al. 2001). Similarly, Cycadians (genus *Eumaeus* Hübner, 1819) have been reported to follow and use ornamental cycads in Xalapa (Mexico) and Southeast Florida (USA) (Ramírez-Restrepo et al. 2017).

However, although ornamental Strawberry-trees have been present in the town of Colmenar Viejo for 30–40 years (Robert Wilson, pers. comm.), *C. jasius* has only now been recorded there.
This could be a result of the species not being surveyed in that locality before. However, extensive butterfly surveys have previously been conducted across north-central Madrid (Gómez de Aizpúrua 1987, 1997; Vicente Arranz and García Carrillo 2009), yielding only two records of *C. jasius* to date, both of which were adult individuals observed within the last five years (see Table 2). Given our additional observation of a small breeding population in an area where the winters are colder than in most parts of the butterfly’s range, and the scarcity of north-central records until recent years, we believe that warming temperatures may be enabling the butterfly to colonise the ornamental trees and disperse under more continental conditions.

**Conclusions**

Our study extends previous findings on the importance of ornamental host plants for the expansion of butterfly species, showing that *C. jasius* may be using ornamental Strawberry-trees to colonise new areas in central Spain. We also postulate that the butterfly is able to progress under these continental conditions as the region becomes climatically more suitable. Nevertheless, additional sampling should be conducted in spring, to determine whether the butterfly is successfully overwintering in the area, together with an extensive network of surveys across the province, to understand if warming climate conditions are actually playing a role in the butterfly’s expansion.

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