Report of a project carried out thanks to the European Butterflies Group (EBG) Annual Research Bursary in 2022:

Report: Mapping the occurrence of the rare Twin-spot fritillary (*Brenthis hecate*) in North-East Spain

EUROPEAN BUTTERFLIES GROUP

CBMS
Catalan Butterfly Monitoring Scheme

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3th October 2022

Cover photography: Clàudia Pla-Narbona Leon

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1. Introduction

The twin-spot fritillary (*Brenthis hecate*) is a rare and local butterfly in Catalonia, where it has been catalogued as a regionally vulnerable species (Vila et al., 2018; Stefanescu et al., in press). It is a specialist butterfly that depends on *Filipendula vulgaris* Moench (Nel & Luquet, 1981) as a host plant, which flowers during the flight season of the butterfly (late May to mid-June). In Catalonia, *F. vulgaris* is found in middle mountains, in habitats in the Querco-Fagetea plant community (Bolòs & Vigo 1984), mostly on well preserved meadows which may be threatened by overgrazing and habitat transformation (e.g. urbanization, encroachment by lack of surrounding forest management or intensive agriculture) (Ubach & Figueroa 2022).

The twin-spot fritillary has a much more restricted distribution than its host plant in Catalonia (Stefanescu et al., in press). As far as we know, its southern limit occurs around Castellterçol (Moianès county), where one known metapopulation occupies several habitat patches (Ubach & Figueroa, 2022). Apparently, this meta-population seems truly isolated, and the nearest populations known to date are no nearer than 40 km. However, historical data indicates that the species was present in at least three 10x10km squares in Moianès (Figure 1). It remains to be known, however, what are the spatial limits of the mentioned metapopulation and what is the dispersal ability of this species.

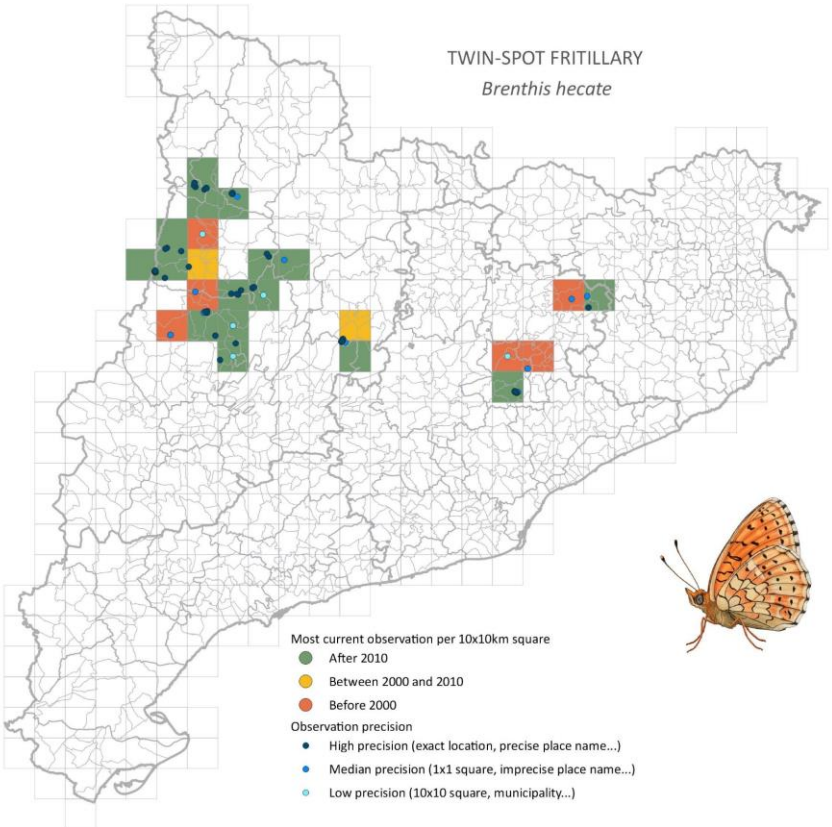

Figure 1. Distribution map of the twin-spot fritillary in Catalonia (from Stefanescu et al., in press).

In this work, the occurrence of both twin-spot fritillary and its host plant have been sampled and mapped in Moianès county, with two objectives: (1) to obtain detailed information on where the actual populations of the butterfly thrive, and (2) to identify other potential areas that could support populations according to the presence of

the host plant. This information could then be used to develop a conservation plan for the concerned meadows, and even to identify potential new sites where introductions or re-introductions of the species from local stock may be undertaken in the future in order to improve the butterfly status.

2. Methodology

The study area is Moianès county, with an area of 337.9 km², located in the central-east part of Catalonia. The sampled patches were selected based on the presence of *F. vulgaris* and its habitat -mostly meadows and ruderal habitats-, an information facilitated by a recent comprehensive work on the county flora (Mercadé, 2016). Thus, from 43 places with *F. vulgaris* a total of 29 patches were selected and visited (Figure 2). Each visit consisted of a 15-minute count (eBMS, 2022) for recording the number of individuals of twin-spot fritillary, the host plant abundance (in m^2), the habitat type and impacts or threats. The sampling period overlapped with the peak of the butterfly's flight season (according to information provided by a CBMS transect in the study area) and included three visits on 7th, 13th and 15th June. After the field work, all sampled patches were mapped using QGIS (QGIS 3.22.11 Białowieża), and their size, the presence of twin-spot fritillary, and its host plant abundance was recorded.

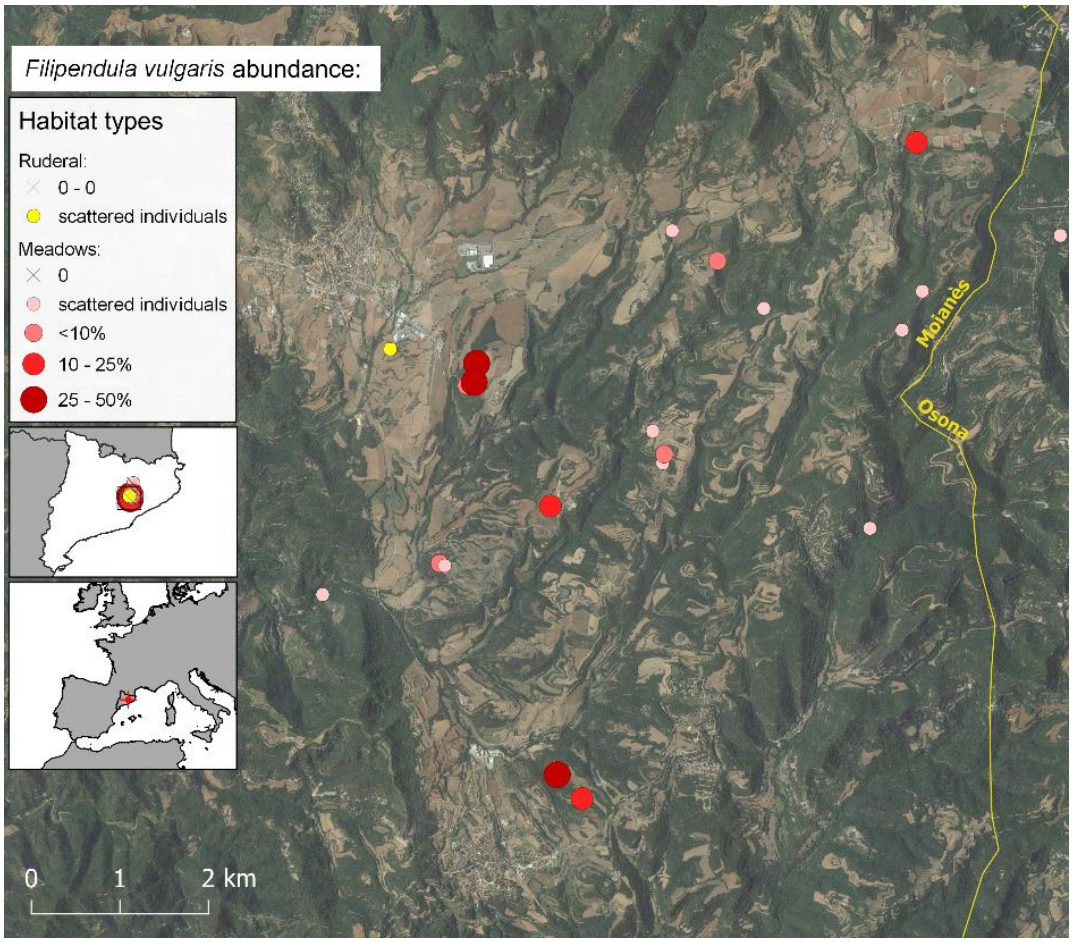

Figure 2. Study area and abundance of *F. vulgaris* in different points of Moianès county (Catalonia) based on the work by Mercadé (2016), which provides information on the plant abundance (based on the cover percentage of the plant in a 15-30 m^2 area in each sampled point) and the habitat type (a binary classification: meadows and ruderal).

3. Results and discussion

3.1. Results

Twin-spot fritillary was found in just four out of the 29 habitat patches (id 1-4), which corresponds to the metapopulation already known before the study. This metapopulation is formed by four suitable patches ranging from 10,332 to 23,464 m^2 (x = 19,003 ± 5,944 m^2). In those four patches, 36 individuals were observed in two different days, 23 on 7th June and 13 on 13th June. The total abundance of *F. vulgaris* in the four patches was 152 m^2 (average abundance per patch of x = 38 ± 10 m^2, ranging from 32 to 53 m^2) (Table 1).

In the other 25 patches, the host plant abundance ranged from 0 to 71 m^2 (x = 15.96 ± 20.22 m^2), but twin-spot fritillary was not detected. Even though, there were some patches (id 7, 16, 23) with highly suitable and apparently not threatened habitat, where the host plant was notably abundant. These patches consisted of well-preserved meadows and presented other suitable patches around (Figure 3, Table 1).

Almost a quarter of patches (24%) were affected or threatened by overgrazing and 14% of patches were affected by habitat reduction for golf courses or crops nearby. Moreover, two patches (7%) were affected by grazing, one (3.5%) had apiculture boxes inside and another one (3.5%) had a power line throughout (Table 1).

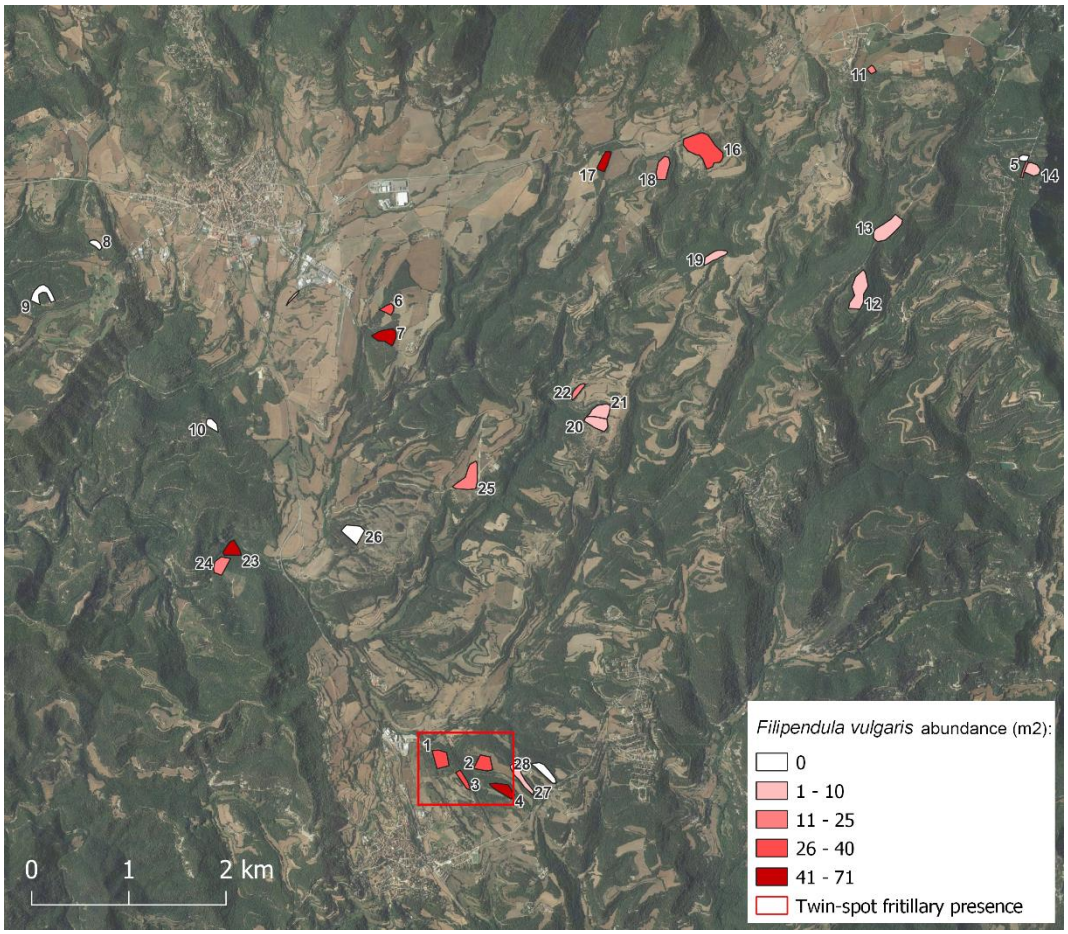

Figure 3. Sampled patches with their host plant abundance (numbers correspond to the ids appearing in Table 1). Twin-spot fritillary presence is highlighted with a red square.

Table 1. The 29 sampled habitat patches (id of each patch is related to the Figure 3) with data on habitat type, number of *B. hecate* individuals (*Bhe* ind.), *F. vulgaris* abundance in m^2 (*Fvu* ab.), impacts or threats, date of sampling date, and patch area in m^2.

id	Habitat type	*Fvu* ab.	*Bhe* ind.	Impacts or threats	Date	Patch area (m^2)
1	Clearing inside an oak forest	34	7	Power line, overgrazing nearby	13/06/22	23,464
2	Meadow with scattered oaks	32	11		07/06/22	22,122
3	Natural meadow	33	6	Golf course nearby	13/06/22	10,332
4	Natural meadow	53	12		07/06/22	20,095
5	Meadow with scattered oaks	0	0		13/06/22	5,357
6	Clearing inside an oak forest	32	0		07/06/22	9,676
7	Open oak forest	50	0		07/06/22	26,308
8	Natural meadow	0	0	Golf course nearby	07/06/22	7,123
9	Grazed meadow	0	0	Overgrazing	07/06/22	23,092
10	Grazed meadow	0	0	Overgrazing	07/06/22	10,165
11	Natural meadow	20	0	Habitat limited, crops nearby	13/06/22	4,713
12	Natural meadow with scattered oaks	2	0	Apiculture	13/06/22	46,866
13	Open oak forest	6	0		13/06/22	42,387
14	Open oak forest	6	0		13/06/22	15,736
15	Ruderal	14	0		13/06/22	3,965
16	Meadow with scattered oaks	35	0		13/06/22	82,657
17	Open oak forest	65	0		13/06/22	15,696
18	Oak forest	15	0		13/06/22	24,497
19	Open oak forest	2	0		13/06/22	17,313
20	Clearing inside an oak forest	4	0	Overgrazing nearby	15/06/22	24,317
21	Grazed meadow	6	0	Grazing, overgrazing nearby	15/06/22	23,752
22	Grazed meadow	18	0	Grazing	15/06/22	9,071
23	Open forest	71	0		15/06/22	18,725
24	Clearing inside an oak forest	23	0		15/06/22	20,403
25	Meadow with scattered oaks	16	0		15/06/22	38,802
26	Grazed meadow	-	-	Overgrazing, enclosed	15/06/22	28,249
27	Natural meadow	8	0		15/06/22	21,822
28	Grazed meadow	0	0	Overgrazing	15/06/22	19,293
29	Ruderal	6	0	Habitat limited, crops nearby	15/06/22	3,410

3.2. Discussion

Our results indicate that the twin-spot fritillary metapopulation found in Castellterçol (id 1-4) is the only one present in the prospected area of Moianès county. This metapopulation is composed by four populations in four connected suitable patches. These known populations occupy patches of middle size (x = 19,003 ± 5,944 m^2) with a great abundance of the host plant (38 ± 10 m^2 detected in 15-minutes count).

These results highlight how vulnerable twin-spot fritillary is in Moianès county, where it attains the southern distribution limit in Catalonia. The four patches consist of well-preserved meadows, often with some oaks, and well connected between them. This spatial configuration suggests that this butterfly species typically presents a metapopulational structure.

It is important to remark that two other patches of similar size (20,558 ± 1,788 m^2), next to the metapopulation (id 27, 28) and with host plant abundance (4 ± 5.65 m^2 detected in 15-minutes count), were not occupied by the butterfly. This strongly suggests that twin-spot fritillary's dispersal ability is very limited, which makes this species conservation even more important and critical.

Concerning impacts and threats, the most relevant in the sampled patches are overgrazing and habitat reduction. However, there are other affectations that may be positive for the species. Regarding grazing, Lafranchis (2000) mentions that this species in southern France occupies ungrazed meadows or, at least, ungrazed during the spring. However, some extent of grazing is needed to prevent habitat encroachment and, eventually, host plant disappearance. Moreover, some studies affirm that power lines, far from being a threat for butterflies, generate open and suitable habitats for butterfly species (Berg et al., 2016; Komonen et al., 2012). Twin-spot fritillary in Moianès is a good example of this, due to the positive impact it has on the species presence (Figure 4).

Figure 4. A suitable patch, with a power line throughout, where twin-spot fritillary was found (id 1).

4. Conservation measures

Following the results obtained in this study, three measures are proposed to ensure the conservation of the twin-spot fritillary in Moianès county:

Firstly, it is vital to protect the four occupied patches and to reduce impacts and threats in order to maintain the suitability of the habitat (Figure 5). Butterfly micro-reserves (Microreserves de papallones, 2022) establishment through stewardship agreements should be an appropriate way to ensure twin-spot fritillary habitat protection and species conservation, due to small size and well delimitation of suitable patches.

Secondly, a lack of knowledge on the biology of the twin-spot fritillary and its habitat requirements is evident. Basic natural history research is therefore a priority for a successful conservation of this butterfly. Regarding habitat management, it is particularly important to understand which grazing regime is needed, according to the topics discussed previously.

Thirdly, the possibility of making translocations from local stock in suitable patches to establish new populations should be assessed. Those suitable patches may be id 6-7, 16-18 and 23-24, which are located at 3 – 8 km from the existent metapopulation. All these potential patches are of middle size, have a high abundance of the host plant, are not threatened and are connected to other suitable patches nearby. This measure is appropriate for species with low dispersal ability and few colonization probabilities, which is the twin-spot fritillary situation. Introductions should reduce extinction risk in Moianès county by increasing metapopulation size. However, probability of success is usually low in translocation projects (Oates & Warren, 1990; Bladon et al., 2022), especially when species requirements are poorly known, as it is the case with twin-spot fritillary.

Figure 5. A suitable patch, with no impacts, where twin-spot fritillary was found (id 3).

5. Acknowledgements

First of all, I want to thank the European Butterflies Group (EBG) for giving me the opportunity of carrying out this study with the Annual Research Bursary help.

Thanks to Andreu Ubach and Constantí Stefanescu (Catalan Butterfly Monitoring Scheme (CBMS) coordination team) for the project ideation and support in the field work, to Arnau Mercadé for the host plant information provided and support in the field work, and to Irene Figueroa and Guillem Mas (Paisatges Vius, Microreserves de papallones) for the work done related to threatened butterfly species, and to *Brenthis hecate* specifically, and their interest in the project and possible future collaboration in the introductions and micro-reserves establishment.

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