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# Quantification of the size and distribution of the only known population of *Crepis pusilla* (Sommier) Merxm. (Asteraceae, Cichorieae) in Malta

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**Abstract.** *Crepis pusilla* (Asteraceae, Cichorieae) is "Critically Endangered" in the Maltese Islands, being restricted to a 60 metre country path. This study is the first to quantify the population and to precisely determine its distribution. Field surveys between February and May 2023 indicated a total of 27 confirmed individuals or close clusters of *Crepis pusilla* with a diameter ranging between 0.9 cm to 4.8 cm (mean 2.5 cm ± 0.9 cm). Flowering was observed during April and early May 2023, with each plant producing c. 150 achenes.

**Keywords:** Asteraceae, conservation, endangered species, Mediterranean, Malta, population assessment.

## INTRODUCTION

The Dwarf Hawksbeard, *Crepis pusilla* (Sommier) Merxm. (Fig. 1) is a relatively small and distinct member of the Asteraceae, Tribe Cichorieae. It is classified in the subclade Crepinidae of the Cichorieae, being a sister group to the genera *Rhagadiolus*, *Lapsana* and *Lagoseris* (Kilian et al. 2009). The plant is an annual herb, approximately 3-7 cm tall, but usually appressed to the soil substratum, and acauline. Leaves are linear-lanceolate to oblong-spatulate, usually obtuse, entire, toothed, lobed, or pinnatifid, present in a basal rosette. The capitula have 9 to 12 sessile flowers. They may be solitary but are more frequently arranged in a glomerulus of <10 capitula. In the local context, solitary plants have been recorded but the occurrence of clusters of several plants is not unusual.

This species was first described by Sommier (1907) who established the monotypic genus *Melitella* to accommodate its morphological distinctiveness from other members of the Cichorieae, proposing the name *Melitella pusilla*. Shortly afterwards, Borg (1909) proposed a subspecific variety, *Melitella pusil-*


**Figure 1.** *Crepis pusilla* in flower at Dingli, Malta, in April 2023.

*la* var. *laciniata*, mainly based on its laciniate leaf margins and larger size relative to the 'typical' form which he called forma *microflorica*. The species was subsequently reclassified in the large genus *Crepis* by Merxmüller (1968) within which it is nonetheless an anomalous morphological form in view of its atypical habit (basal rosette with central capitula grouped into a glomerulus). In this regard, the reclassification of the species into *Crepis* also fills a gap in the biogeographic distribution of *Crepis* sect. *Zacintha*, between the Algero-Tunisian *Crepis patula* and the Eastern Mediterranean *Crepis multiflora* and *Crepis dioscoridis* (Merxmüller 1968).

Following the first records of Sommier (1907) and Borg (1909), the species was recorded from Libya (Borzi and Mattei, 1913), Crete (Zaffran 1967), Greece (Contrandriopoulos and Zaffran, 1969), Portugal (Batarda-Fernandes, 1972), Mallorca (Duvigneaud 1973), Cyprus (Hadjikyriakou et al. 2004), and Turkey (Greuter 2006+). The record from Libya should be considered doubtful. It was based on a single degraded specimen that was collected on 1 October 1912 (Sommier 1912) well after the growing season had ended. Moreover, Pampanini (1929), based on the type of soil accompanying the specimen, cast doubts on its provenance, suggesting that Borzi's specimen may have been confused with a cultivated one from the Botanic Garden of Palermo. Merxmüller (1968) also recorded the species from Australia, where it is considered an 'environmental weed' (White et al. 2018). However, this is a biogeographic outlier, suggesting that the presence of *C. pusilla* in Australia is attributable to human-assisted dispersal from its native Mediterranean range.

This species is one of the rarest indigenous species in the Maltese Islands, in terms of both distribution and abundance. Sommier's original record (Sommier 1907) derives from northeastern Gozo, between Wied ir-Rihan and Wied Bingemma, close to Nadur, where it was noted in 1906 and 1907. Despite careful searches in similar habitats across Malta, Gozo, and Comino, Sommier did not locate the plant anywhere else. Borg (1909) found what was presumably part of Sommier's original population at Wied Bingemma, Gozo, in 1909 as well as other plants at Wied Marsalforn, Gozo, in the vicinity of 'L-Arkata tan-Nofs', as reported by Gulia (1909). He also found populations of the species from Wied Liemu (part of Dingli) and from 'Dingli', later specified as Ghar Bittija (Borg 1927). The plants at Dingli–Ghar Bittija were larger than the ones in Gozo and were the ones on which the proposed variety *Melitella pusilla* var. *laciniata* was based. This proposal of var. *laciniata* and forma *microflorica* did not meet with consensus (Borg 1909) as the plants in Dingli-Ghar Bittija fell within the range of variation originally described by Sommier (1907). The authors have inspected specimens deposited by Borg in the Herbarium of the Jardí Botànic de la Universitat de Valéncia (JBV). The specimens were collected in 1913 and consist of nine individuals from Dingli-Ghar Bittija (specimen code VAL 135529) and twenty from Nadur, Gozo (specimen code VAL 135530). The distinction between the laciniate leaf margins of the Dingli-Ghar Bittija population and the smooth leaf margins of the Nadur population is marked, but generally unremarkable when considering the variation in leaf morphology characteristic of other members of the tribe.

The population originally recorded in Gozo was numerous ("*abbondantissima*") but restricted to an extent of a few hundred metres along a path. It was growing in compacted soil, coexisting with *Trifolium suffocatum*, *Plantago coronopus*, *Plantago bellardi*, *Cichorium spinosum*, *Filago prostrata* and *Romulea* sp. The population recorded by Borg (1927) at Dingli-Ghar Bittija was growing in a country lane, a habitat which, in the authors' experience, is also characterised by compacted soil and a similar species pool. Borg further remarked that the 'typical plant' in Gozo was growing on clayey soil and the variety at Dingli-Ghar Bittija on 'red soil' ("terreno rosso"). The distribution of records of *Crepis pusilla* in Malta is shown in Figure 2.

The species has, in view of its importance, been followed by several students of the local flora since. The populations recorded by Sommier (1907) and Borg (1909) in Gozo have not been found again. The only site from where it is currently known is Dingli-Ghar Bittija, presumably in or close to the location where it was found by Borg (1909), although the natural habitat type has been drastically reduced in the area due to road surfacing and infrastructure over the years. Other authors who have recorded this species include Lanfranco (1969), Lanfranco (1974), Haslam et al. (1977) and Brullo et al (2020). All these records referred to the population at Dingli-Ghar Bittija.

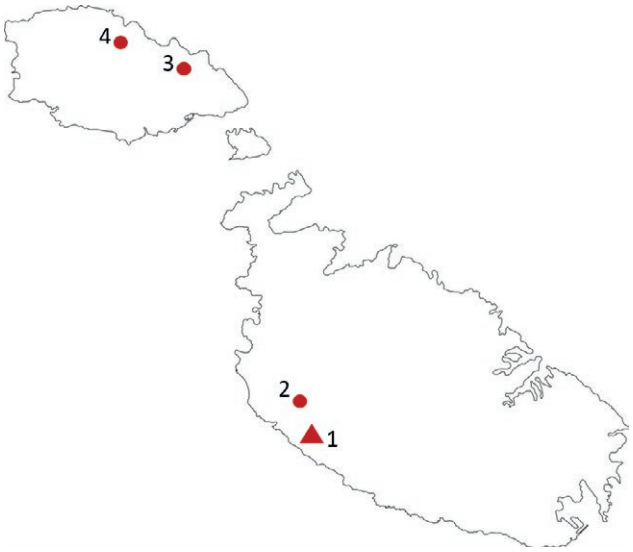


**Figure 2.** Distribution of past (discs) and present (triangle) records of *Crepis pusilla* from Malta. 1: Dingli - Ghar Bittija (Borg,1909), 2: Dingli - Wied Liemu (Borg, 1909) 35°52'29"N, 14°22'29"E, 3: Nadur (Sommier, 1907) 36°03'06"N, 14°18'03"E, 4: Marsalforn – L-Arkata tan-Nofs (Borg, 1909) 36°03'59"N, 14°22'59"E. The coordinates of points 2, 3, and 4 were inferred from literature and are therefore approximate, with a precision of approximately 1 km$^2$.

The habitat of the species in its remaining site is restricted to compacted coastal soils in clearings of a primordial *Periploco-Euphorbietum dendroidis*, now mainly occupied by agricultural areas. According to Brullo et al. (2020), *Crepis pusilla* is an indicator of the *Allietum lojaconoi* association and is a characteristic species of the *Plantagini-Catapodion balearica* alliance. Conversely, Bergmeier (2001) reports the species as being characteristic of shallow seasonal rockpools in Gavdos, Greece, where it is part of the *Tillaea alata-Crepis pusilla* community. Similar pools in Malta have been well-studied since 1988 (Lanfranco and Cuschieri, 2018) and although some of its companion species in the Gavdos pools (such as *Lythrum hyssopifolia* and *Juncus hybridus*) have been regularly noted from pools in Malta, *Crepis pusilla* itself has not.

The aim of this study was to survey the only currently-known location in Malta (Dingli-Ghar Bittija) colonised by this species in order to census the population size as accurately as possible and to map the distribution of individual plants. This is being done to better inform present and future conservation efforts regarding this species.

The present work on *Crepis pusilla* was carried out in the framework of LIFE Seedforce (LIFE20 NAT/IT/001468). The main aim of this project is to improve the conservation status of 29 EU Habitats Directive Annex II species with an 'Unfavourable-Inadequate' or 'Unfavourable-Bad' conservation status, according to reporting under Habitats Directive Article 17.

## MATERIALS AND METHODS

### *Site of study*

The only remaining location where *Crepis pusilla* is known to occur is situated at Dingli-Ghar Bittija, southwestern Malta (location: 35°51'24''N, 14°22'29''E). The site is a country path approximately 150 m in length and 4 m wide, oriented along an approximate east-west axis. The surface layer of the path consists of compacted topsoil that is deeper towards the margins of the path. In many parts of the path, the topsoil is eroded, exposing the underlying Upper Coralline Limestone bedrock. The path is bordered by dry stone walls approximately 2 m high with agricultural land along its northern margin. The southern margin of the path runs approximately parallel to an asphalted road along the cliff edge. Major disturbances, caused by infrastructural work close to the western end of the path, have been noted since 2018.

### *Survey method*

The authors undertook a detailed survey of the population during the Winter/Spring 2023 growing season, making ten visits during the period between 1 March 2023 and 23 May 2023 using ground surveying augmented by UAV-assisted imagery. During this period, the temperature displayed a gradual warming trend (mean shade temperature: 14.1°C to 19.3°C; maximum: 26.7°C on 30 April). Approximately 54.3 mm of rain in seven rainfall events (> 1.0 mm) were recorded. The period of the year selected for survey was, based on the authors' previous observations, known to coincide with the vegetative, flowering, and fruiting phases of the life cycle. During this survey, the number of plants was enumerated, their size measured, and phenological state noted. The diameter of all rosettes was measured. Other patches of potentially suitable habitat in the vicinity were surveyed but no other individuals or populations were noted. During each visit, the country path was surveyed carefully by a team of at least three observers and the position of every known or suspected *Crepis pusilla* individual or cluster was indicated using a removable plastic site-marker. The phenological state of each individual, categorised as 'vegetative', 'flowering', 'fruiting' or 'dry', was noted during each visit. The species may

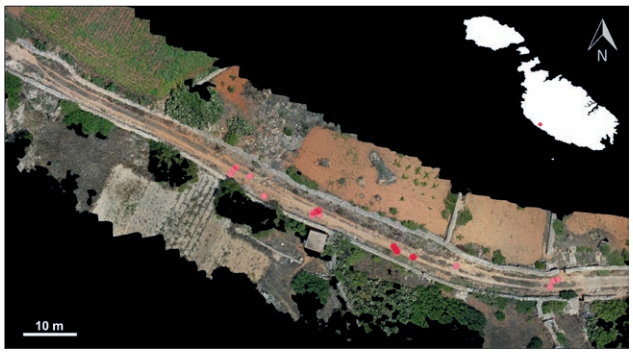


**Figure 3.** Site area of recorded *Crepis pusilla* population with approximate location of clusters of plants (marked by red discs) April 2023. Base photograph is an orthorectified image derived from drone photography and produced by the authors. An outline map of Malta is inset, showing the approximate location of the site with a red dot.

easily be confounded with juvenile *Cichorium spinosum* or *Plantago coronopus*, both of which can occupy the same habitat, and definitive identification was therefore only possible during the flowering phase. The position of every confirmed *Crepis pusilla* individual was determined in terms of x and y displacement relative to an internal frame of reference with a fixed origin and orientation and was accurate to the nearest centimetre. The coordinates obtained for each plant were used to draw a distribution map in R (R Core Team, 2023). This distribution map was overlain on an orthomosaic of the study area obtained through drone photography from an altitude of 30 m, giving a map showing the precise location of each plant against the background. This composite map (Fig. 3), if generated annually, can be used to monitor and evaluate changes in the abundance and distribution of the population.

### *Identification*

The identity of the individual plants was determined during the flowering phase with reference to the description of the species given by Sommier and Caruana Gatto (1915).

### *Reproductive effort*

The reproductive effort of the plants was estimated by calculating the number of seeds produced by each plant, based on a sample of five plants. The number of seeds collected was intentionally limited to this number to minimise impact on natural recruitment.

## RESULTS

### *Population size and distribution*

The field surveys indicated a total of 27 confirmed individuals or close clusters of *Crepis pusilla* with a diameter ranging between 0.9 cm to 4.8 cm (mean 2.5 cm ± s.d. 0.9 cm). This does not imply a population of 27 genetically-distinct individual plants, as some of the plants that were in very close proximity may have either originated from the rhizomes of the same individual or from distinct seeds germinated in close proximity. Nonetheless, this could not be confirmed without removing the plant from the soil, a course of action that the authors obviously could not resort to. The spatial distribution was distinctly non-uniform, with several individuals clustered in clumps. The distribution of the population is shown in Fig. 3, and it is concentrated within a span of 60 m of the path. The *C. pusilla* plants were mainly associated with the central zone of the path, which is most exposed to sunlight and disturbance from trampling, and where the topsoil is most compacted. The species was syntopic with *Erodium moschatum, Galactites tomentosus, Glebionis coronaria, Hordeum* sp., *Lobularia maritima, Medicago polymorpha, Plantago lagopus, Plantago coronopus, Silene colorata, Sonchus oleraceus*, *Romulea varicolor*, *Romulea melitensis*, and *Trifolium nigrescens* all of which were more abundant. The persistence of *Crepis pusilla* in the central portion of the path, where vegetation cover is sparse and soil confluence is low, suggests that it is intolerant of interspecific competition. This hypothesis is not supported by any experimental evidence at the moment and should be tested in a future study prior to the implementation of any targeted reinforcement programmes.

### *Phenology*

Vegetative plants were first noted in February 2023. All plants were still in this phenological state up to early April. First flowering was noted on 11 April 2023. Six days later, on 17 April, peak flowering (defined as the

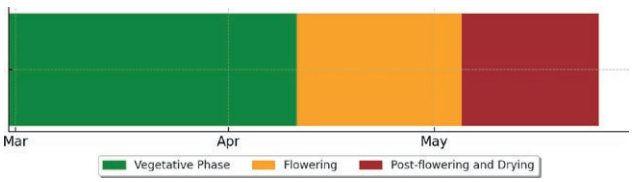


**Figure 4.** Representation of the phenological cycle of *Crepis pusilla* in 2023. Peak flowering was recorded on 17 April 2023.

maximum rate of flowering) was noted as 18 plants were flowering, and some were fruiting. The last flowering was observed on 5 May 2023. During this visit, one plant was still in flower and fruiting, 21 plants were dry and five still retained some foliage. No new plants or plant structures were observed after this date. The phenological pattern observed during the period of study is summarised in Figure 4.

*Reproductive effort*

Preliminary measurements suggest that each plant produces c. 150 achenes although the sample was too small to assess variability across the whole population. No direct pollination was observed during the field visits. However, the small, inconspicuous flowers situated at ground level suggest that apterous insects would be plausible candidates for this function. Similarly, no specific observations of seed dispersal were carried out. However, initial observations suggest that wind-assisted or surface runoff-assisted dispersal are probable routes.

## DISCUSSION AND CONCLUSIONS

The results of this study represent the first precise quantification of the population size, distribution and phenological cycle of this plant in Malta.

*Distribution*

Apart from the initial records of Sommier (1907) and Borg (1909), there are no new published records of the distribution of the species in Malta. However, the pattern of past records suggests that both the extent of occurrence and the area of occupancy have decreased considerably. Of the four sites recorded in 1907-1909, only one (Dingli-Ghar Bittija) still supports a population of the species (Fig. 2). The present population at Dingli-Ghar Bittija is the only one referred to in the literature since at least 1969 (Lanfranco, 1969) and has been the only one known since the late 1940s (G. Lanfranco, pers. Comm. to S. Lanfranco, 2002). Similarly, there are no quantitative records of population size. However, the adjectives used by Sommier (1907) and Borg (1909), "abbondantissima" in Gozo and "molto abbondante" at Dingli-Ghar Bittija suggest that population sizes at the time were larger than they are today. Brullo et al. (2020) recorded the species in two relevés taken in April 1984, with Braun-Blanquet (BB) abundance indices of '1' and '2', with the relevé assigned BB-2 suggesting higher abundance than that recorded during this study. The reasons for this population decline have not been investigated, although they are probably related to urbanisation and consequent habitat loss in the vicinity of the areas from where the plant was recorded. Interspecific competition may also be a contributing factor. However, at present, with no studies beyond the casual-observational, this is speculation.

*Habitat*

The remaining habitat of the plant in Malta is a coastal country path with compacted terrarossa topsoil. Similarly, in Gozo, Sommier (1907) recorded the plant growing in compacted clayey soil whilst Borg (1909) noted the plant in uncompacted terrarossa soil at Dingli-Wied Liemu (Site 2 in Fig. 2). In other parts of its Mediterranean range, the habitat is similar. In Mallorca, the plant is recorded from annual grasslands, on clayey soils with high water retention, often coexisting with *Gymnostyles stolonifera*, *Asteriscus aquaticus*, *Filago pyramidata*, *Filago petroiani*, and *Centaurium pulchellum* (Sáez and Rosselló, 2001). The habitat in Gavdos (Bergmeier 2001) is different, where the plant was recorded as a component of the flora of the margins of seasonal pools, along with *Tillaea alata*.

*Phenology*

The phenological cycle cannot be compared to detailed records, as none were traced in the literature. However, Sommier (1907), in his description of the species, indicated that the plant was flowering on 15 April 1906 (the date of first discovery) and flowering and fruiting on 28 April 1907. Similarly, plants collected by Borg on 11 April 1913, and deposited in the JBV herbarium, were flowering and fruiting. The period of flowering and fruiting of the original population therefore coincides with the one observed during the present study. It stands to reason that an empirical study conducted over several years is necessary to characterise the phenological cycle in greater detail.

*Conservation status*

The entire population is concentrated in a single country path and should therefore be considered to have a regional IUCN conservation status of "Critically Endangered" [CR: C2a(i, ii)+D ] (IUCN Standards and Petitions Committee, 2022). Improvement of the conservation status to 'favourable' would necessitate extensive

population reinforcement, a process that would only be plausible if the characteristics of the life cycle are known in detail. As such, further studies on the reproductive effort, germination requirements and growth of this species must be considered essential.

*Recommendations*

It is recommended that the procedure described in the present study is repeated annually to ensure that the interannual variation in population size is well-characterised. Moreover, targeted surveys in potentially suitable locations, including the *locus classicus* in Nadur, Gozo, should be carried out annually to ascertain the persistence or otherwise of the species as well as to identify candidate sites for targeted reinforcement of the local population. Subsequent studies should also focus on identification of any lifecycle bottlenecks and address the issue of reduced dispersal and range extension of the population.

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**AUTHORS' CONTRIBUTIONS**

Conceptualization: LC, RGR, JB, SL. Data curation: LC, RGR, SL. Formal analysis: LC, RGR, SL. Funding acquisition: JB, SL. Investigation: LC, RGR, JB, SL. Methodology: LC, RGR, SL. Resources: SL. Supervision: JB, SL. Visualization: LC, RGR. Project administration: JB, SL. Software: SL, LC, RGR. Validation: LC, RGR, JB, SL. Writing – original draft: LC, RGR, SL. Writing – review and editing: LC, RGR, JB, SL.

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