



Rediscovery and taxonomic analysis of *Romulea melitensis* (Iridaceae) from the Maltese islands

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Abstract

The status of the Maltese endemic *Romulea melitensis* remained doubtful since its description by Beguinot in 1907, primarily because plants with the morphological characters as referred in the diagnosis have not been substantiated *in situ*. A sand crocus with the combination of a smallish, dark violet corolla with a yellow throat and perianth segments up to 1.5 mm wide have never been witnessed in the Maltese Islands. A detailed analysis of the protologue and the type of *R. melitensis* has resulted that when Beguinot examined the 30-year-old exsiccatae, two important characters were misinterpreted, leading to the current ambiguous status of *R. melitensis*. A detailed account accompanied by specific illustrations and tabulated datasets are given to address this taxonomic misconception. In effect, *R. melitensis* has wider tepals and the dark colour of the corolla referred in the protologue is exhibited only at the abaxial surface of the tepals in some individuals. Under this adjusted morphological approach, ten populations corresponding to *R. melitensis* have been found in the Maltese islands, three of which matching completely with the taxon's lectotype. In addition, morphological, palynological and chorological studies on these populations strongly suggest that *R. melitensis* is a hybrid between *R. columnae* and *R. variicolor* - a Siculo-Maltese endemic species. An identification key to the species of *Romulea* occurring or reported in the past from the Maltese Islands is supplied in this work.

Keywords: hybrids, identification key, Maltese endemics, *Romulea variicolor*, sand crocus

Introduction

Romulea Maratti (1772: 13) is a monocot genus in the tribe Croceae of the family Iridaceae (Marais 1980, Manning & Goldblatt 2001). Its species are small, bulbous plants with grooved cylindrical-linear leaves and actinomorphic flowers subtended by two herbaceous to scarious bracts. *Romulea* diversified in the sub-Saharan Africa and to a less extent in the Mediterranean region and the Arabian peninsula (Marais 1980, Manning & Goldblatt 2001). Numerous taxa at different rankings have been described from the Mediterranean region, with major contributions authored by Parlato (1860), Beguinot (1907, 1908, 1909) and Manning & Goldblatt (2001). At present, some 30 taxa are currently accepted by Euro+Med (2006–2018), 20 of which are endemic or sub-endemic to the Mediterranean region, particularly to Morocco and other north African territories.

According to a synopsis of *Romulea* occurring in the Maltese Islands (Mifsud 2015), three species are confirmed to occur: *Romulea variicolor* Mifsud (2015: 11) which is common in poorly vegetated rocky ground throughout the islands; *R. columnae* Sebastiani & Mauri (1882: 18) which is scarce in exposed arid ground and footpaths and *R. ramiflora* Tenore (1826: 3) which is rather rare and prefers cooler and damp habitats. *Romulea variicolor* has been described to accommodate a Siculo-Maltese endemic species which was earlier presumed to be *R. ramiflora*. *Romulea variicolor* was further subdivided into three varieties: *R. variicolor* var. *mirandae* Mifsud (2015: 13) with the abaxial surface of the outer whorls characterised by a light green colour; *R. variicolor* var. *martyinii* Mifsud (2015: 13) which instead has a dark violet colour and *R. variicolor* var. *variicolor* which have intermixed green and violet colours (Mifsud 2015).

A fourth species described from, and presumably endemic to Malta is *Romulea melitensis* Beguinot (1907: 327), described from plants collected by Sickenberger on the 14th February 1876 from Fort Tigne, Sliema, Malta. Later, in the second part of his monograph, Beguinot (1908) modified the description of *R. melitensis* to accommodate

characters seen in cultivated plants obtained from bulbs that were originally collected at the rocky coast of Qala tad-Dwejra in Gozo (Malta) by Stephane Sommier and sent to Beguinot in April 1907. While maintaining several of the characters written in the original diagnosis, Beguinot (1908) made the following amendments for *R. melitensis*: more robust plants bearing two flowers (instead of one); the length of the tepals is 15–22 mm (instead up to 13 mm); the corolla varies to light violet (not only dark violet); the throat is whitish (not only yellow); and the leaves are thicker than originally described. Moreover, he added further morphological details, such as the pale violet or green colour of abaxial side of the perianth, the presence of hair at the base of the filaments, the style having a white colour sometimes ending violet at the tip and an oblong-obtuse shape of the fruit capsule. He did not provide any modification about the width of the tepals, possibly in neglect, and hence according to the previous description, *R. melitensis* is distinct for its tepal width of 1.0–1.5 mm. Indeed, in the keys for *Romulea* species, in the third and last volume of his monograph, Beguinot (1909) placed *R. melitensis* in a group of four closely related species which are characterised by having robust, compressed leaves and herbaceous bracts with a hyaline margin. Within this group, *R. melitensis* differed from the closely related *R. ramiflora* s.l. by having a dark violet perianth (contradicting his earlier notes stating that the perianth can be pale), and differ from the Algerian endemic *R. penzigii* Beguinot (1908: 455) by having the tepals linear and only up to 1.5 mm wide, the stamens reaching one half of the tepals' length and for being a Maltese endemic (Beguinot 1909). In other words, Beguinot considered the slender and dark coloured tepals as important diagnostic characters of *R. melitensis*, a concept that was then followed in subsequent major works (Haslam *et al.* 1977, Marias 1980, Pignatti 1982, 2019, Lanfranco 1996).

The occurrence of plants matching with the protologue (Fig. S1) of *R. melitensis* has been questioned and unsubstantiated for many decades by botanists and taxonomists alike. Sand crocuses with 1.5 mm wide tepals with a dark violet colour have never been reported. Ambiguity and confusion had arisen because a later description of *R. melitensis* by Beguinot (1909) was based on two different collections – one by Sommier from Gozo (1907) and the other by Sickenberger from Sliema (1867). Beguinot (1908) simply tried to combine the two different gatherings in one description in his revision of *R. melitensis*, falsely assuming that both are the same species of sand crocus. In any case, Sommier's collection cannot be considered as type material since it was only cited in the later redescription by Beguinot (1908), the type of *R. melitensis* is limited only to the collection of Sickenberger.

However, the original description of *R. melitensis* in Beguinot (1907) was based on a single gathering by Sickenberger. This collection was composed of nine plants gathered at the same time and place. Mifsud (2015) designated one of these syntypes as the lectotype (the first specimen from the left of the herbarium sheet G00370314). The morphological characters of the type specimen and its corresponding original diagnosis should stand for *R. melitensis* in line with Art. 9.1 note 1 of the ICN (Turland *et al.* 2018). Furthermore, after the examination of the protologue (Beguinot 1907) and the type specimen, Mifsud (2015) concluded that *R. melitensis* is a distinct species from any of the three *Romulea* species reported for Maltese islands. However, such plants have neither been confirmed in situ throughout the century after its description, leaving the question of what *R. melitensis* is, or where it occurs. Indeed, the *locus classicus* is indicated as Fort Tigne at Sliema (reported erroneously as Fort Figue in the protologue), a site that at present is completely developed into a touristic area making it impossible to rediscover the same population collected by Sickenberger 150 years ago.

This leaves the question of what are the plants that correspond to *R. melitensis* and therefore the characters match with the type specimens collected by Sickenberger in 1876? This study is aimed to address this gap and find representative examples similar to *R. melitensis* in the Maltese Islands, hence differing from *R. columnae*, *R. ramiflora* and *R. variicolor* which have already been recorded.

Material and methods

Field surveys were carried out between 2011 and 2020. This resulted in finding and examining thoroughly 28 living specimens distributed in nine populations that had close resemblance to the description of *R. melitensis*. The location, habitat, elevation and date of examination of each specimen is given in Table 1. Also, examination of the pollen and microscopic hair at the base of the stamens' filaments was observed using the $\times 100$ and $\times 400$ magnification of a light microscope (Optika model B-293).

High-resolution digital images of the type specimen of *R. melitensis* obtained from G were analysed. The type material collected by Sickenberger (1876) consists of nine plants divided into two sheets (Fig. 1), one with three plants (barcode G00370314, sheet A hereafter) and another with six plants (barcode G00370315, sheet B hereafter). For

reference, these plants were labelled T1 to T3 (left to right) in sheet A and T4 to T9 in sheet B. Three specimens in sheet A and four specimens in sheet B possessed flowers, but there was an additional corolla at the bottom of sheet B, and probably detached from any of the specimens above. This corolla had a more open arrangement and is here referred to as *extra*. Morphological characters such as bulb size, longest leaf length, peduncle length, bracts and tepals (Table 2) were measured by means of Piximetre v. 5.2 software (Assiyov 2020) as for example is shown in Fig. S2. The values obtained were compared to those indicated in the protologue.

TABLE 1. Location, elevation, habitat and date of examined living material of *Romulea melitensis*.

Specimen Code	Date of Collection	Locality	Toponym	Elevation (m)	Habitat
A210b	10-2-2011	Mellieħa	Ġnien Ingraw	150	Shallow damp soil in basins and depression in karst rock accompanied by <i>R. columnae</i> and <i>R. variicolor</i> .
A213a–d	13-2-2011	Nadur (Gozo)	Qortin tal-Magun	150	Located in a 2 × 2 m damp basin in karst rock amongst numerous plants of <i>R. variicolor</i> and few <i>R. columnae</i> .
B302b,h	2-3-2012	Dingli	Ta' Ghar Bittija	250	Located in a rocky footpath populated by <i>R. columnae</i> and scattered plants of <i>R. variicolor</i> . Soil damp, compact, stony and rich in clay.
C202a–c	2-2-2014	Xewkija (Gozo)	Ġnien Ta' Blankas	150	Along a stony footpath with very compact soil under a small partially shaded olive grove. Individuals were intermixed with <i>R. columnae</i> and <i>R. variicolor</i> .
D129a	29-1-2018	San Pawl il-Baħar	Xemxija Heritage Trail	50	Shallow clayey soil in a rock basin with very low-growing vegetation including <i>R. columnae</i> and <i>R. variicolor</i> .
D129b–e	29-1-2018	Mellieħa	Selmun	150	Arid, stony ground located in a clearing dominated by low-growing species including <i>R. columnae</i> and <i>R. variicolor</i> .
D208a–g	8-2-2018	Mellieħa	Selmun	150	Same as above (site revisited and examined few more specimens)
D217a–b	17-2-2018	San Pawl il-Baħar	Xemxija Heritage Trail	50	Temporary rock pool with deep humid soil. <i>R. columnae</i> present close by and <i>R. variicolor</i> about 8 m away.
E211a–c	11-2-2020	Mġarr	Rdum Majjiesa (Majjistral)	150	Side of a footpath with rocky ground and compact stony soil that was sparsely vegetated including <i>R. columnae</i> and <i>R. variicolor</i> .
E217a	17-2-2020	Dingli	Clapham Junction	200	Rocky footpath with few vegetation including a few plants of <i>R. columnae</i> and <i>R. variicolor</i>

A combined character set taken from the type specimens and the protologue of *R. melitensis* was then compared to that of the living specimens collected in the field and *R. linaresii* Parlatores (1858: 251), *R. ramiflora*, *R. columnae* and *R. variicolor*, applying keys and descriptions by Marais (1980), Pignatti (1982, 2019) and Mifsud (2015), in order to ascertain its distinctness and further understand morphological relationships among the species. Old dry flowers were also studied and compared with the type specimens in order to check if ageing resulted in significant changes in the light that *R. melitensis* was described on dried specimens.



FIGURE 1. The nine plants of the type specimen of $\times R. melitensis$ on two herbarium sheets G00370314 (left) and G00370315 (right).

Results

Type features:—The plants included in the type specimen showed a consistent morphology amongst each other (Table 2). They are all rather small plants, with (two–) four leaves up to 12 cm long (ca. 1 mm diameter), that are slightly curved or sometimes kinked at the base. The corolla is subtended by bracts that are about 10 mm long and mostly hyaline, although the texture is less diagnostic in this 150-year-old collection. The perianth varies from 11.1 to 13.1 mm long with narrow perianth segments, measuring 1.6–2.2(–2.6) mm wide. As listed in Table 3, most plants had at least part of their perianth segments with a conspicuous violet colour (T1, T2, T5, T8, and T9), with some appearing beige (T3 and T7). The detached corolla *extra* (see Table 3), which fortuitously was preserved in a more open arrangement, had a light violet colour. The corolla of T1, T9 and *extra* showed an obvious yellow colouration at the throat. The bulb of all specimens was rather small, with an average diameter of 10.5 mm and a dark reddish-brown glossy tunic. All characters from the protologue do correspond to those observed in the type specimen except the length of the scape: 3 to 5 cm in the protologue, only 0.9 to 2 cm in the type specimen.

TABLE 2. Quantitative morphological characters of the nine plants of the type specimen of $\times Romulea melitensis$.

Characters	T1	T2	T3	T4	T5	T6	T7	T8	T9	Mean	Range
Bulb length (mm)	13.5	18	14.2	16.7	15.7	17.3	16.7	15.2	16.6	16.0	13.5–18
Bulb diameter (mm)	10.1	7.6	8.6	12.4	12.3	11.5	9.5	9.7	12.8	10.5	7.6–12.8
Longest leaf length (cm)	4.8	7.4	7.6	4.9	12.4	n/a	11.2	10.1	5.1	7.9	4.8–12.4
Peduncle length (mm)	11.1	9	11.9	n/a	19.6	22	11	13.9	11.6	13.8	9–22
Bract length (mm)	10.1	10.9	9.3	n/a	11.1	11.4	10.9	9.9	8.8	10.3	8.8–11.4
Corolla length (mm)	13.2	12.7	12	n/a	12	n/a	12.9	11.1	12.1	12.3	11.1–13.2
Tepal width (mm)	1.6	1.8	1.8	n/a	2.2	n/a	1.9	1.7	2.6	1.9	1.6–2.6

TABLE 3. Colour interpretation of the corolla of the nine plants of the type specimen of *Romulea melitensis* (T1 to T9).

Specimen	Corolla colour
T1	Dull violet at the lower part above the throat then fades to beige towards the tips.
T2	Mixed dull violet and greyish-brown. Upper part of perianth beige.
T3	Beige with some dull violet colour persisting on the veins.
T4	Corolla missing.
T5	Beige with two tepals retaining a violet colour at the basal half and along the midvein.
T6	Corolla missing.
T7	Perianth segments pale brown without traces of violet. (decolourized ?)
T8	Dull violet at the lower part above the throat then fades to beige towards the tips.
T9	Light violet, with a yellow throat.
<i>extra</i>	Pale violet with yellowish throat and slightly darker veins.

Comparison between *Romulea melitensis* and other Maltese *Romulea* species:—The morphological characters of *R. melitensis* as examined from the types and as extracted from the protologue are listed in Table 4. This analysis resulted that the character set of *R. melitensis* (given in detail in Table S1) is unique and different from any described species, but closely related to *R. columnae* and to a less extent related to *R. variicolor* as indicated in Table 4 and further discussed below.

Discussion

Description of *Romulea melitensis*:—The morphological characteristics of selected populations more or less correspond with the protologue of *R. melitensis* (Beguinet 1907), except for the longer scape length in the protologue, probably because Beguinet measured the scape from the apex of the bulb to the base of the corolla while in this study, in order not to dig out the bulbs, the measurement was taken from ground level to the base of the corolla. However, morphological characters of *R. melitensis* do not concur with any other *Romulea* species. Indeed, the strongly yellow throat, the smaller tepals, the shorter leaves, the more hyaline nature of the bracteole and the subglabrous filaments and corolla throat do not match with *R. variicolor* or *R. ramiflora* but approach those of *R. columnae*. On the other hand, the longer peduncle (scape) reaching up to 2 cm, the more violet colour of the corolla (seldom white), the 10–11 mm long bracteoles with evident herbaceous character, the longer perianth segments (12–13 mm) of *R. melitensis* are different from the characteristics of *R. columnae*. *R. ramiflora* differs in having a larger corolla with a more intense and rather consistent violet-mauve colour with evident pilosity on the throat and lower half of the stamens' filaments, as well longer peduncles and longer leaves that are often erect. *Romulea linaresii* differs in having a violet throat (concolorous with the tepals) and again larger flowers that are darker in colour, more pilose filaments and the stigma shorter than the top of the stamens (Marais 1980, Pignatti 1982, 2019).

When examined in its living form, *Romulea melitensis* is a small, robust plant somewhat resembling *R. columnae* in its size, with leaves up to 13 cm long and flowers with peduncles about 15 mm long but mostly sessile or less than 12 mm. *Romulea melitensis* is characterised by growing in clusters of 5 to 20(–25) densely-packed, identical plants (clones) forming a tuft with many haphazardly-arranged leaves and a small group of flowers at the centre (Figs 2a and 2b). When present in damp conditions, typically in the shallow layer of soil inside basins and depressions (solution pans) in coralline limestone, most of the leaves are straight and erect. In arid conditions, namely dry stony footpaths or rocky clearings, the leaves arc down and are generally prostrate, but the younger leaves are always upright. The bracteoles almost reach the length of 12 mm (same as in *R. variicolor*), but they are much more scarious in texture (Fig. 5a) and approaching that of *R. columnae*. The colour of the corolla varies from whitish-lilac (Fig. 2a) to a medium-toned (not dark) violet (Fig. 5b), but most plants have lilac or light violet flowers (Figs. 2b and 2c). The throat is vivid yellow striped by three, longitudinal, short, dark violet veins and overtopped by a violet collar reaching about half the length of the tepals (Figs 2f and 5c). Hence, the tepal has a yellow base followed by a dark violet band and then abruptly changes to lilac colour at the distal half. The abaxial surface of the outer tepals is distinctly light olive-green fading to a white lateral border, then tinted in flushes of dull violet, greyish-violet or maroon colours at

the basal third and over the midvein where then it fades upwards rather abruptly (Fig. 5b). However, examples with a more violet hue instead of green or even entirely intense violet colour have been found (Figs. 2a and 2b). The size of the perianth segments varies between 11 to 14.5 mm and lies perfectly between the size of *R. columnae* (8–11 mm) and *R. variicolor* (15–21 mm). The width of the perianth segments is about 2.5 mm. The filaments of the anthers (Fig. 2e and Fig. 4a-left) have a particular dirty yellowish-bronze colour. It is more dull than the light or lemon-yellow colour found in *R. variicolor* and *R. ramiflora*. The base of filaments bears sparse short hairs measuring up to 0.25 mm long and are barely visible by the naked eye and may appear glabrous (Fig. 4a-right)

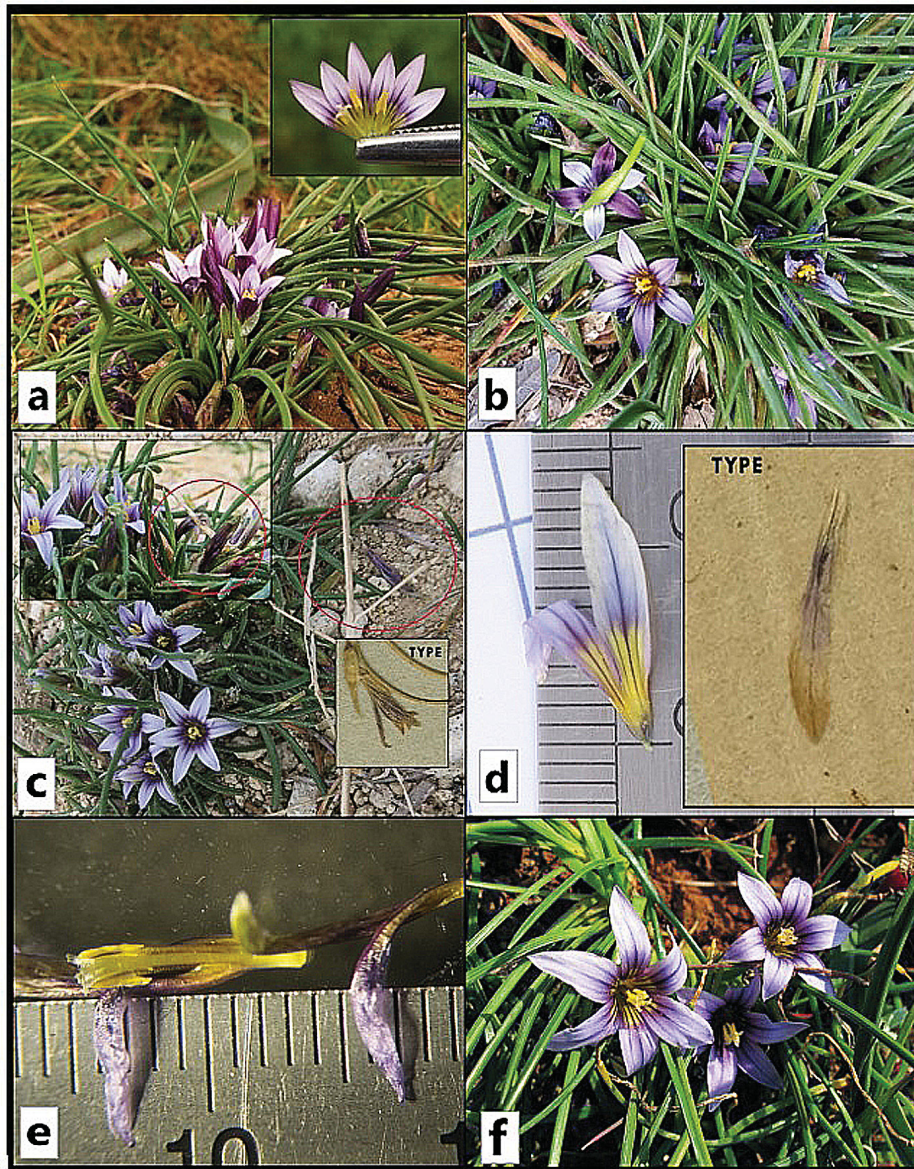


FIGURE 2. Colour variation of tepals in *Romulea melitensis* **a.** Specimen B302h with the under tepals having a dark violet colour, while the adaxial surface is much lighter in colour. **b.** Specimen E217a with an abnormal deep violet colour in the abaxial surface of the outer tepals. **c.** Specimen D129b (in situ) showing old flowers turning dark violet externally and compared with a similar corolla from the type specimens (T2). **d.** Comparison of the tepals from a plant collected in situ (left) and type specimen (right) showing similar shape and colours composed of a yellow throat, a light violet tepal fading above and with a dark midvein. **e.** Dissected flower two days after anthesis showing tepals that shrunk laterally and measuring 1.0–1.8 mm. **f.** Corolla of specimen A213a with a medium-light violet colour, yellow throat and dark band and veins over the throat.

Upon digging up some specimens, the plants had a rather stocky and robust stem. The area between top of bulb and the base of the leaves measured 5–8 mm in thickness. Some examples appeared as if they consist of two, or even three plants emerging from the same bulb with 11–13 leaves. Examples with mature fruit have not been encountered in this survey. These findings therefore concur with the treatment of Beguinot (1907, 1909) that these local sand crocuses merit taxonomic distinction.

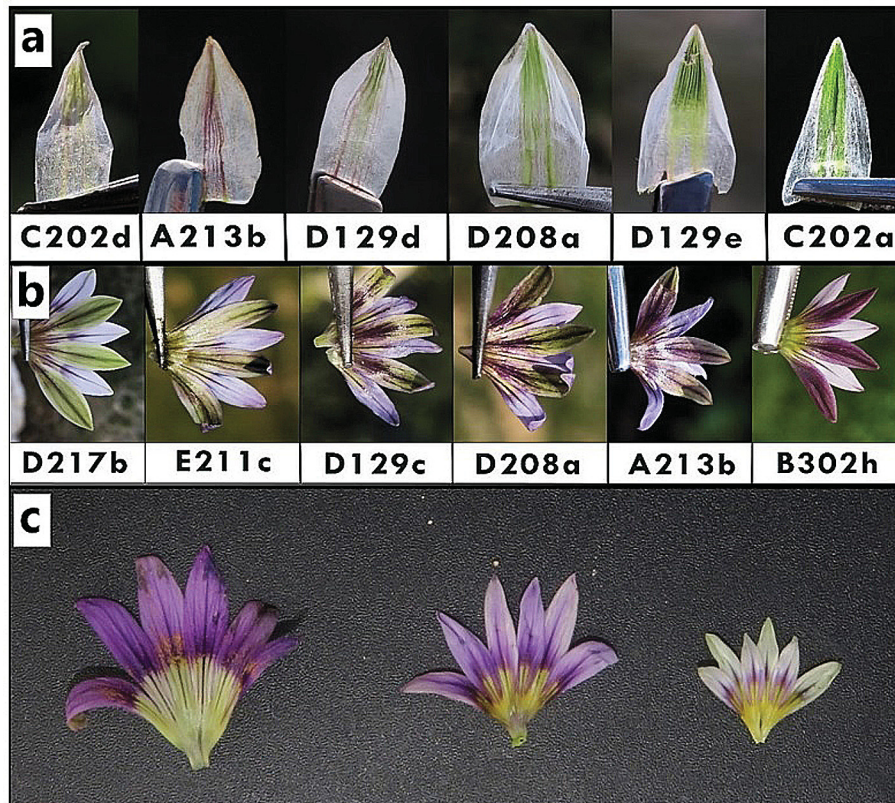


FIGURE 3. Flower features of \times *Romulea melitensis* interpreted as intermediate between *R. variicolor* and *R. columnae*. **a.** Variation of the bracteoles of composed of a wide hyaline margin and a central subherbaceous keel varying from a hyaline texture (e.g. C202d) as in *R. columnae* to a rather strong herbaceous character (e.g. C202a) as in *R. variicolor*. **b.** Variation of the abaxial surface of perianth of \times *Romulea melitensis*. **c.** Comparison of a dissected corolla of *Romulea variicolor* (left), *R. melitensis* (centre) and *R. columnae* (right) found growing in the same locus at an arid clearing at Selmun, Mellicha.

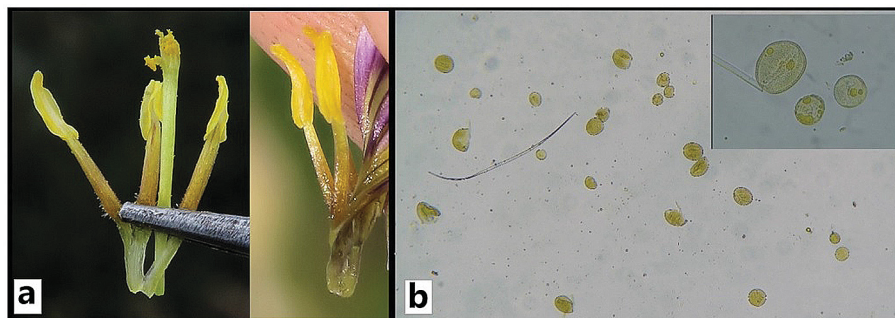


FIGURE 4. *Romulea* \times *melitensis* reproductive structures **a.** Stamens and style (left: D217b, right: A210b) showing subglabrous pilosity at the base of the filaments and a scarce production of pollen. **b.** Pollen grains (E217a): low-resolution image showing shrivelled and fragmented pollen of irregular size; high-resolution image showing translucent empty grains.

Two characters which do not match perfectly with the description of *R. melitensis*, are the width of the tepals that are 0.5–1.0 mm wider in the living specimens; and the intensity of the colour of the perianth, mentioned as “*intense violet*” by Beguinot (1907) but lighter in living specimens. Further meticulous analysis was undertaken and discussed below to well-explain these incongruences because these two characters, that is a corolla with deep violet colour and 1.5 mm wide perianth segments, have been the basis of distinction or *R. melitensis* in previous floras, namely the identification keys of Beguinot (1909) which were probably followed in verbatim by Haslam *et al.* (1977), Marais (1980) and Pignatti (1982, 2019).

Misinterpretation of critical characters:—The two most cited distinct characters of *Romulea melitensis* are the intense violet colour of the perianth and the narrow width of its tepals (Beguinot 1907, 1909, Haslam *et al.* 1977, Marais 1980, Pignatti 1982, 2019). On examining the perianth of the type specimen (Fig. 1, Table 3), it was found that most of the pressed specimens are showing the abaxial side. Therefore, the alleged intense violet colour must refer to

the abaxial surface of the corolla not the adaxial one. Moreover, the dark violet colour on the outer surface is not spread throughout the entire tepal, but in most cases restricted at the lower half of the flower, and then fades gradually towards the apices. One plant (T1) indeed shows a yellow base, followed by a dull violet region and ending with decolourized beige colour. This three-colour fasciation pattern matched with several living plants of *R. melitensis* as found *in situ* (Fig. 2f). Further evidence that the adaxial surface of the type is in fact not dark is provided by a single tepal that was found detached and lying at the bottom of sheet A with its adaxial surface facing up. This had a yellow throat followed by a light violet colour which faded towards the apex and ornamented with dark veins, matching with many specimens studied in the field (Fig. 2d). In addition, the colour of the partially exposed adaxial surface of specimen *extra*, was also light violet, further confirming that the correct interpretation of the colour of the corolla of the type specimen is light violet, and the dark violet colour refers to the abaxial surface. Four living specimens (A213d, B302h, A203 and E217a) had their corollas with this colour arrangement, thus matching with the types. Another significant observation is that when the flowers of *R. melitensis* (as is also for *R. variicolor*) expires and starts drying, its abaxial surface darkens considerably. For instance, specimen D129b shows a cluster with light violet flowers, but the old flowers attain a dull violet colour, which looks identical to one flower of the type specimen (T2) (Fig. 2c). Therefore, by examining the abaxial surface of the old pressed specimens, Beguinot inculpably presumed that the corolla is intense violet instead of light violet.

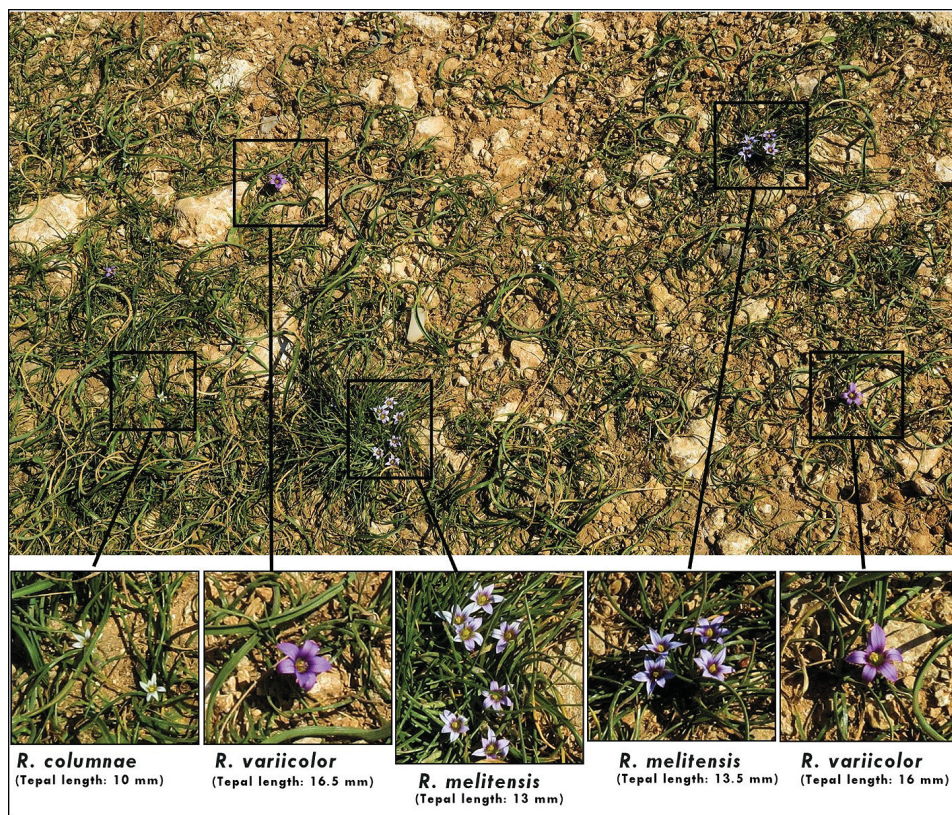


FIGURE 5. Typical habitat of \times *R. melitensis* co-occurring with *R. columnae* and *R. variicolor* at a footpath in Rdm Majjiesa (Majjistral Park), Mellieha, 11-Feb-2020. Lower crop out images are up to scale with each other.

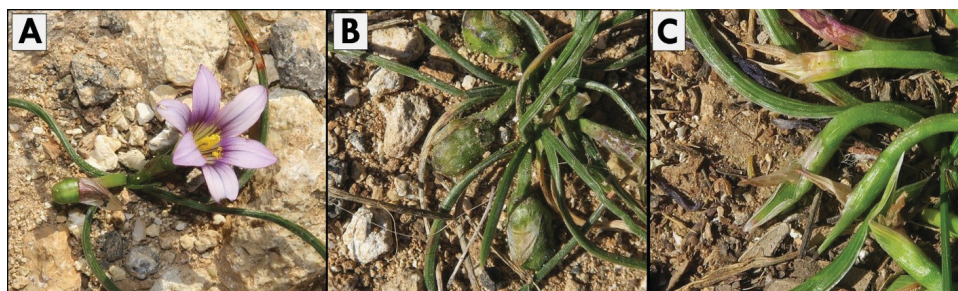


FIGURE 6. Three *Romulea* populations photographed from Clapham Junction, Dingli (22-Feb-2020), showing fruiting of *R. variicolor* (A), *R. columnae* (B) while in \times *R. melitensis* there are no signs of fruit development (C).

TABLE 4. Comparison of morphological characters taken from the protologue (or type) of *Romulea melitensis* with fresh plants from populations found in this study, and with *R. columnae* and *R. varicolor* (from Mifsud 2015).

Characters	<i>R. melitensis</i> type	<i>R. melitensis</i> fresh specimens	<i>R. varicolor</i>	<i>R. columnae</i>
Length of longest leaf	5.0–12 cm	6.0–13 cm	5–20 cm	4–14 cm
Length of bract & bracteole	8.8–11.4 mm	8.5–11.5 mm	9.0–12 mm	7.0–9.0 mm
Herbaceous part of bracteole	Not detailed in the protologue: “wide hyaline margin”; not well examinable in the types: dry and homogenous texture	Present but weak, subhyaline and then hyaline towards the proximal half of the keel	Well defined, leafy throughout the length of the keel except the base	Hyaline with traces of herbaceous areas
Colour of corolla	light violet ¹ to intense violet ²	White, lilac to medium violet always with a dark violet collar above the throat	Lilac to dark violet	White to very pale violet
Length of pedicels	9–22 mm	2–20 mm	3–25 mm	2–8 mm
Length of perianth segments	11.1–13.2 mm	10.5–14.5 mm	14–22 mm	8–12 mm
Width of perianth segments	1.0–1.5(–1.9) mm	2.0–3.0 mm	3.0–4.5 mm	1.5–2.5
Colour of throat	Yellow	Yellow	White	Yellow
Colour of filaments	Not available	Mustard yellow	Whitish-lilac	Mustard yellow
Pilosity of filaments	Not available	Subglabrous scanty hair at the very base of filament, very short (0.2 mm) and seldom seen by the naked eye	Pubescent at the basal fourth, up to 0.5 mm long, often detected by the naked eye	Subglabrous scanty hair at the very base of filament, very short (0.2 mm) and seldom seen by the naked eye
Grouping	Not available	In clusters of up to ±40 individuals forming a small, dense tuft.	Solitary or rarely in a pair	Solitary, or in small spaced group of up to five individuals

¹ the corolla of two plant of the type specimen had this lighter violet colour.

² this colour was detected only at the abaxial surface of the corolla and normally restricted to the lower proximal half of the tepal.

A tepal width of 1.0–1.5 mm is another important cited character for *R. melitensis*, but examples having tepals with this linear shape have not been found in the present study. First of all, using more meticulous software for measuring magnified high-resolution images, the true width of the outer tepals of Sickenberger collection was found to be 1.6–2.2 mm, about 0.6 mm (45%) wider than what Beguinot (1907) reported. One plant (T9) exceptionally measured 2.6 mm wide, matching with the width found in living specimens. Moreover, in this study it was observed that the margins of dried perianth segments of *Romulea melitensis* shrinks (especially if not pressed adequately soon after collection) or become slightly inrolled or pleated inwards. As a result, the actual width of the perianth segment is reduced by a fraction of a millimetre from each side, which is significantly relevant for small tepals that are less than 3 mm wide. This effect was demonstrated on a trial where tepals of unpressed flowers were measured two days after anthesis. The smaller tepals of the inner whorl measured 1.1 mm in width and those of the outer whorl were 1.6 mm wide (Fig. 2e). This suggests that old flowers shrivel and tepal width reduces if compared to living forms. Interestingly, the flower of one plant from type specimen (T9) maintained a width of 2.6 mm. This plant might have been pressed more adequately than the rest, perhaps because its location was well spaced apart from the leaves (these acting as physical spacers between the sheets).

Taxonomy of *Romulea melitensis*:—Three different taxonomic treatments can be applied for *Romulea melitensis*. The easiest one is that of retaining *R. melitensis* as a distinct species, but due to a close morphological relationship with *R. columnae* (Table 4), combining *R. melitensis* as a variety or subspecies of *R. columnae* could also be proposed. However, considering the high variability of the plants, the overall intermediate characters between *R. columnae* and *R. variicolor*, the sexual sterility (scarce and dysfunctional pollen, absence of fruit and elevated degree of vegetative reproduction) and populations of *R. melitensis* always co-occurring with both *R. columnae* and *R. variicolor*, it is here proposed that *R. melitensis* is a hybrid between *R. columnae* and *R. variicolor*.

As mentioned earlier in more detail, the hyaline/herbaceous texture of the bracteole (Fig. 3a), the colour of the corolla, the pattern in the abaxial surface of the outer whorl of the tepals (Fig. 3b) and the size of the corolla are remarkably variable characters. From a morphological point of view, *R. melitensis* shows a number of predominant characters similar to *R. columnae*, namely the small stature of the plants where, for both species, the leaves are up to 13 cm long, the rather short peduncles, the yellow throat, the mustard-yellow filaments which are finely subglabrous at the base and the overall olive-green colour of the abaxial side of the tepals. Characters similar to *R. variicolor* are the bracts' length of 10–11 mm (7–9 mm in *R. columnae*) and the intense violet colour of the abaxial surface of the outer whorls of tepals (Figs. 2a and 2b) seen in a few plants (A213b, B302h and E217a). The latter is purely a character of *R. variicolor*, and never have been observed or documented in *R. columnae* or *R. ramiflora*.

Moreover, there are important characters which are intermediate between the putative parents. The mean corolla length of 12–14 mm is between that of *R. columnae* (9–12 mm) and *R. variicolor* (15–21 mm) as shown in Fig. 3c. The weakly herbaceous and hyaline nature of the keel of the bracteole (Fig. 3a) can be interpreted as an intermediate between the strongly herbaceous keel in *R. variicolor* and an almost completely hyaline one in *R. columnae*. The lilac to light violet colour of the perianth is somewhat intermediate between the white colour of *R. columnae* and the darker violet colour of *R. variicolor* (Fig. 3c). Finally, whereas the abaxial surface of the outer tepals is olive-green as in *R. columnae*, it has a strong influence of a violet hue located at the base of the tepals and along the midvein and which is presumably gained from *R. variicolor* (Fig. 3b). In this regard, some specimens only had traces of violet hue as found in *R. columnae* while others had a completely violet colour as in some examples of *R. variicolor*.

Another important character of *R. melitensis* is the production of scarce and malformed pollen grains. Pollen is barely seen on anthers (Fig. 4a) or on the corolla throats and further confirmed when anthers were examined under a stereomicroscope. Moreover, the pollen grains appeared shrivelled, fragmented and of irregular size when viewed under a light microscope, and almost empty under higher magnification (Fig. 4b). Sterility was further supported by the lack of capsules. For instance, when a mixed population of *Romulea* species were examined on the same day during the end of their flowering period (Clapham Junction, 22 February 2020), both *R. variicolor* and *R. columnae* had well-developed fruits while *R. melitensis* showed no fruit between the bracts (Fig. 6). The low or possibly lack of fertility presumed in *R. melitensis* further support that it is of hybrid origin and possibly led it to evolve and reproduce vegetatively and explaining the formation of clusters of clones.

Last but not least, all populations of *R. melitensis* were accompanied by *R. variicolor* and *R. columnae* often located just a few centimetres away (Fig. 5). The populations at Rdum Majjiesa, Selmun and Xewkija formed hybrid swarms with a high degree of variability even in some 'parents', where occasionally *R. columnae* had light violet corollas and *R. variicolor* had abnormally reduced flower sizes.

These combined observations give strong ground to suggest that this sand crocus is a hybrid produced from a *R. columnae* × *R. variicolor* cross and hence referred to as *Romulea* × *melitensis* Beguinot (pro. sp.). Since of its unique

tufted or dense habit, it is proposed to use the vernacular Maltese name of “Żaghfran tal-blat ta” and the English name “tufted Maltese sand crocus”. Its distribution in the Maltese islands is infrequent but it is mostly found in what nowadays have become a threatened microhabitat due to the local policy of cementing or asphaltting countryside footpaths, lanes and rocky clearings. Moreover, from surveys carried by the author between 2011–2014 (Mifsud 2015) and from the list of accompanying flora of *R. variicolor* (under *R. melitensis*) by Brullo *et al.* (2009), *R. ×melitensis* has not been observed in Sicily and *R. columnae* was not recorded in its vicinity. As a result, *R. ×melitensis* is considered as a strict endemic of the Maltese Islands with a limited distribution in the Central Mediterranean region.

Key to species of *Romulea* in Malta including those recorded in literature

1. Style longer than anthers by at least 3 mm; perianth segments normally > 24 mm long..... *R. bulbocodium*¹
- Style same level of anthers or longer by less than 3 mm; perianth segments < 24 mm long.....2.
2. Throat* distinctly yellow.....4.
- Throat* white to a pale green (rarely with a hint of yellow).....3. (*R. variicolor* s.l.)
3. Colour of abaxial side of outer tepals with both green and violet pigments..... *R. variicolor* var. *variicolor*
- Colour of abaxial side of outer tepals pale green to ash-white (violet absent)..... *R. variicolor* var. *mirandae*
- Colour of abaxial side of outer tepals dark violet (green or ash-white absent)..... *R. variicolor* var. *martyinii*
4. Filaments bronze or dirty mustard yellow, glabrous to scantily subglabrous at the very base; tepals usually ≤ 14 mm long; throat glabrous.....5.
- Filaments white to light yellow, visibly pubescent at least one third the length from the base; tepals usually > 14 mm long; throat with fine hair.....6.
5. Plants growing in clusters forming dense tufts; bract 9–11 mm long; bracteole with herbaceous tissue in the keel, sometimes scarce..... *R. ×melitensis*
- Plants growing individually or close to each other but never forming dense tufts; Bracts < 9 mm long; bracteole completely scarious rarely with remnant herbaceous tissue at the upper part..... *R. columnae*
6. Leaves compressed, 1.0–1.5 mm across; corolla lilac to violet; bracteole with a distinct herbaceous keel; not a sand dune species..... *R. ramiflora*
- Leaves filiform, terete < 1.0 mm across; corolla white; bracteoles completely or mostly hyaline, growing in sand dunes or sandy soil..... *R. rollii*¹

* Throat colour is best determined by dissecting and opening a flower longitudinally, removing the sex organs and brushing the yellow pollen away from the throat.

¹ Species recorded from Malta but presumed to be misidentifications or not confirmed for more than 100 years.

Conclusion

In the review of the genus *Romulea* occurring in the Maltese Islands (Mifsud 2015), remained a hiatus about occurrences of living plants identical to those collected by Sickenberger in 1876 and later described as *R. melitensis* by Beguinot (1907). Results from this study have revealed nine populations that are satisfactorily similar, of which three (at Siggiewi, Dingli and Nadur) are identical to the lectotype. The slender tepals of only 1.0–1.5 mm in width and the dark violet colour of the corolla, as described in the protologue, where incongruent with these findings, but on scrutinising the type specimens of *R. melitensis*, it was found that Beguinot (1907) made justified misinterpretations when the species was described from exsiccatae of ca. 30 years of age. In their natural state, *R. melitensis* have corolla with a lighter violet colour but the abaxial surface could be dark violet as are the type specimens, whereas the perianth segments are actually slightly broader (ca. 2.5 mm) as was the width of one of the best-preserved paratypes.

It is proposed to treat *R. melitensis* as a hybrid between *R. columnae* and *R. variicolor* based on the several intermediate and variable characters between the two putative parents and their omnipresence where *R. ×melitensis* occurs. The sterility in terms of low-quantity and poor pollen production and the lack of developed fruit give further ground to this proposed treatment. *R. ×melitensis* is a strict Maltese endemic and the populations reported as *R. melitensis* in Sicily should instead be attributed to *R. variicolor*.

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Exsicc. SCHIMPER, It. abyss. sect. II. n. 550, ap. UR. It. 1842, sub *Ixia Bulbocodium*; id. in Pl. Abyss. ed. R. J. HOHENACKER n. 550, sub *R. Linaresii*.

Habitat. Abyssinia, in monte Bachit (SEMEN): SCHIMPER in exs. s. cit.; Abyssinia: SCHIMP. in Hb. Ces. (Rom.); Abyssinia 1855: SCHIMP. in Hb. Boiss.

4. *Romulea Battandieri* Bég. n. sp.

R. cormo parvo, ovato, tunicis coriaceis castaneis tecto; scapo unifloro; foliis cylindraco-compressis, latiusculis, basi late vaginantibus, flexuosis, plerumque solo adpressis, flaccidis, scapum superantibus; spathis foliolo inferiore herbaceo angustissime marginato, superiore omnino membranaceo et fusco-punctulato, ad 15 mm longo; perigonio spathis parum longiore, 15—20 mm longo, tubo longiusculo (5—8 mm), laciniis oblongo-lanceolatis, subobtusis, 3—4 mm latis, albidis, tribus venis intense purpureis et ramulosis percursis, fauce dealbata, tubo externe violaceo; staminibus perigonii dimidiam partem attingentibus, antheris filamento longioribus saepe atrophicis; stilo exserto, rarius inter antheras incluso; capsulam maturam non vidi.

Syn. *Romulea Linaresii* Batt. Not. s. quelq. pl. d'Alg. nouv. ou peu conn. in »Bull. Soc. Bot. Franç.» XXXII (1885) p. 343; BATT. e TRAB. Fl. de l'Alg. II (1895) p. 37.

Habitat. Algeria, in cacumine montis Haizer (Kabylia), ad nives deliquescentes: BATTANDIER in Hb. sub *R. Linaresii* Parl.?

Observ. Habitu et perigonii fabrica *R. Linaresii* Parl. refert, a qua et ab omnibus speciebus mediterraneis colore florum diversa. An constans species?

5. *Romulea melitensis* Bég. n. sp.

R. cormo mediocri tunicis debilibus tecto; scapo debili, unifloro, 3—5 cm longo; foliis paucis cylindrico-filiformibus, parum compressis, erecto-patentibus et plus minusve contortis, nervis validis in sicco percursis et ideo rigidiusculis, scapum parum superantibus; spathis subaequalvibus ovato-lanceolatis 40 mm circ. longis, foliolo inferiore herbaceo angustissime marginato, superiore latiuscule hyalino-membranaceo; perigonio mediocri spathis duplo longiore 13 mm longo, tubo angusto $\frac{1}{3}$ circ. perigonii brevior, laciniis linearibus obtusiusculis 4— $\frac{1}{2}$ mm latis, intense violaceis tubo luteo venisque violaceis percursis; staminibus perigonio dimidiam partem aequantibus, antheris filamento brevioribus; stylo incluso.

Habitat. Insula Melita (Malta) ad ripas maris, prope Fort Fiqué: SICKENBERGER in »Herborisations du Levant« 14. II. 1876, in Hb. Barbey-Boissier.

FIGURE S1. Protologue of *Romulea melitensis* (Beguinot 1907).

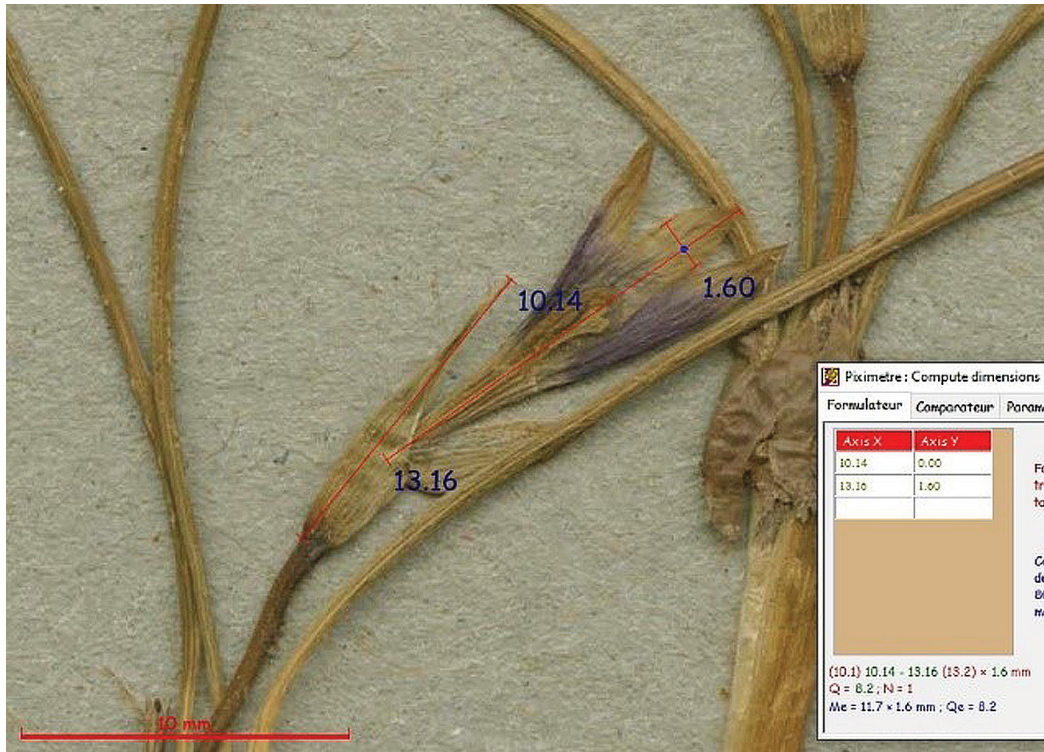


FIGURE S2. Calibrated measurements taken from high resolution digitised images of the type specimens, showing a bract length of 10.14 mm and perianth segments of size 13.16 × 1.60 mm.

TABLE S1. Morphological characters of × *Romulea melitensis* from 28 individuals examined from Malta

Habitat	Exposed, under-vegetated, rocky ground with very compact and stony soil often found in countryside lanes and footpaths that are trampled. In a few cases populations were located in rock basins of coralline limestone that are damp or temporarily flooded. Plants are always found associated with <i>Romulea columnae</i> and <i>R. variicolor</i>
Habit	Clumps of 5 to 20(–25) plants closely packed to each other and forming a dense tuft with several flowers located at its centre.
Number of aerial leaves	5–12 leaves but sometimes a few leaves are missing
Size of longest leaf (mm)	80–130 × 1.0–1.5
Leaf shape and arrangement	Very variable, from fully erect and straight (in damp locations) to arced or gently curved (sometimes with an abrupt bend at the lower part of the leaf) usually with their terminal half prostrate on the ground. Youngest leaves are short and erect.
Cross-section of leaves	Terete and laterally compressed
Number of flowers	2–3
Length of peduncle (mm)	3–15(–22)
Bract morphology	Herbaceous with a thin membranous margin
Bracteole morphology	Membranous and scarious except the central keel occupying about one-third of the width of the bracteole. The keel is weakly herbaceous and intermittently scarious becoming completely hyaline at the base. In some examples, most of the bracteole is scarious with the herbaceous portion limited to remnant patches or two parallel veins along the upper part of the keel.
Bract length (mm)	(8.5–)9–10(–11)
Flower Colour	Mostly lilac to light violet rarely medium violet or pure white. A dark violet collar followed by three short veins is normally present above the throat
Size of perianth (mm)	11–14(–15) × 1.8–3
Throat Colour	Yolk yellow
Veins on tepals	3 dark violet veins with the median vein conspicuously darker, lateral veins shorter.
Abaxial side of outer tepals	Variable, but commonly light olive-green fading to a whitish border then ornamented with a dull maroon or greyish-violet central vein accompanied by flushes of the same colour at the lower part of the tepal. Few examples had violet streaks throughout or even completely dark violet surface.
Filaments colour	Dirty mustard or bronze yellow
Filaments pilosity	Subglabrous or rarely glabrous, with sparse tiny hairs up to 0.2 mm long and barely visible to the naked eye, located at the base of the filament
Length stamens : tepals	Stamens reach almost half the length of the tepals
Level of style with anthers	Same level or the stigma just overtopping the anthers
Pollen colour	Bright yellow, not copious
Further notes	Bulbil dark copper brown, 1.2 cm long × 1.0 cm diameter. Stem robust, thick, up to 8mm wide. Style light yellow. Stigma whitish.
Accompanying flora frequently occurring within populations of <i>R. melitensis</i>	<i>Romulea variicolor</i> ; <i>R. columnae</i> , <i>Moraea sisyrinchium</i> (L.) Ker Gawl., <i>Plantago coronopus</i> L., <i>P. serraria</i> L., <i>P. lagopus</i> L., <i>Trisetaria aurea</i> (Tenore) Pignatti, <i>Trifolium suffocatum</i> L., <i>Prospero autumnale</i> (L.) Speta, <i>Filago pygmaea</i> L., <i>Micromeria microphylla</i> Bentham, <i>Bellis annua</i> L. <i>Galium murale</i> (L.) Allioni