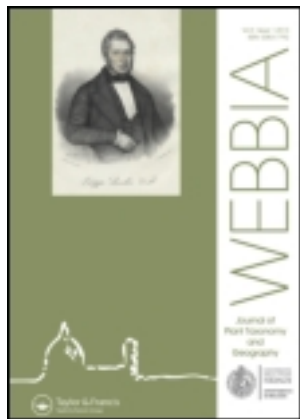


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## Preliminary observations from long-term studies of *Gladiolus* L. (Iridaceae) for the Maltese Islands

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Field studies in 28 random sites in Malta and Gozo were carried out between 2010 and 2012 to investigate *Gladiolus* species on the Maltese islands. The results obtained were significantly very different from the general picture of *Gladiolus* spp. reported for several decades for the Maltese islands, which inferred that the populations were mainly of *G. italicus*, with unsubstantiated records of *G. byzantinus* (a garden cultivar) and *G. dubius* (a doubtful and now unrecognized species). The results from these studies clearly show the abundant presence of *G. communis*, but the rather rare *G. italicus*, the latter not being observed in more than half the sites that have been surveyed. This paper deals with an historical account of *Gladiolus* spp. in Malta, an historical account and the origins of *G. italicus*, a taxonomic distinction between the two species confirmed from Malta and a discussion based on their seeds and origins.

**Keywords:** Iridaceae; *Gladiolus*; flora; Maltese Islands

### Introduction

*Gladiolus* is a genus of about 270 species in the Iridaceae family. It is native to various regions of South (and Tropical) Africa and the Mediterranean, the former having a much larger distribution and number of different species. In the Mediterranean, the ten to twelve species of *Gladiolus* have offered taxonomic confusion because of their similarities to each other and morphological variations as a result of localized evolution (Hamilton 1980). This has led to several descriptions of Mediterranean species, which later were treated by many authors as synonyms or placed in lower taxonomic ranks. In Malta, the situation is not different.

### Historical account and current situation of *Gladiolus* spp. in Malta

In the current Maltese flora, *Gladiolus* is still based on the pioneer floristic works of Zerafa (1827–1831), Grech Delicata (1853), Sommier and Caruana Gatto (1915) and Borg (1927). Grech Delicata (1853) briefly listed three *Gladiolus* spp. viz. *G. segetum* Ker-Gawl, *G. dubius* Guss. and *G. infestus* Bianca, the later cited from Zerapha (1827–1831) Sommier and Caruana-Gatto (1915) confirmed the occurrence of *G. dubius* as an infrequent plant and *G. segetum* as a very common plant, but they introduced the species *G. byzantinus* Mill. as an infrequent species in Malta. Moreover, they made an observation that the wild *Gladiolus* should be re-studied using both flowers and fruits, hence highlighting the taxonomic difficulties. Borg (1927) gave a better picture of the genus where, according to him, three *Gladiolus* spp. occur on the Maltese islands. These were *G. segetum* (= *G. italicus*),

*G. communis* var. *byzantinus* (Mill.) O. Bolòs & Vigo and *G. communis* var. *dubius*. The author stated that the typical form of *G. communis* did not exist in Malta and that *G. segetum* was the most common *Gladiolus* there; occurring mainly in fields among growing crops.

It is clear that, in subsequent and recent floristic works, authors such as Haslam et al. (1977), Weber and Kendzior (2006), Lanfranco (2007) and others have maintained Borg's (1927) position and give (under different synonymous taxa) the same three *Gladiolus* species for Malta: *G. byzantinus*, *G. dubius*, both as uncommon species, and *G. italicus* as a very common species. It is clear that 'common' wild species are neglected by current researchers, who stick to historical records. For instance, the illustrations of *G. italicus* and *G. dubius* by Weber and Kendzior (2006) show more or less the same species with oval/rounded lateral tepals as that shown by *G. communis*. Moreover, common opinion, ecological surveys, checklists and recent floristic articles always state the presence of just one *Gladiolus* species, viz. *Gladiolus italicus*.

### Historical account of *Gladiolus italicus* in the Mediterranean

*Gladiolus* species either have winged or unwinged, pellet-like seeds. The wings in the former type help the seed to be dispersed by wind further away from the mother plant. This seed-form is found in the majority of *Gladiolus* spp., such as in *G. communis*. Only a few other species, by contrast, have evolved unwinged seeds. These 'unusual' species are based in, or originate from, the Eastern Mediterranean. The most common of these species is *G. italicus* (= *G. segetum*), which does not

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originate from Italy as the name implies, but possibly from further east, such as from Turkey. It is often commonly called the cornfield (corn=wheat) gladiolus, because it is very frequently found in crops of wheat throughout the Mediterranean.

Although the lack of wings might appear to be a disadvantage for the plants, it is well observed that unwinged seeds can withstand the threshing process of food-grains better from winged seeds. Unintentionally, humans have as a result selected these species with unwinged seeds in favour to those with winged by repeated threshing practices over many decades. From the established study of old *Gladiolus* finds, it was likely that the pink/purple flowered *G. anatolicus* (Boiss.) Stapf from western Turkey, and similarly, *G. persicus* Boiss. from Iran, were possible candidates for a presumed ancestral species for *G. italicus* (Hamilton 1968).

In 1975, the plants were found in very limited quantities and these areas coincided with the distribution of wild wheat (*Triticum* spp.), which happened to be the diploid ancestral species of today's polyploid crop plants (AH, personal observation, 1975).

Owing to the fact that neither *Gladiolus anatolicus* nor *G. persicus* were a precise match for *G. italicus*, searching continued throughout the area, particularly in open scrubland, which is the usual habitat for Mediterranean *Gladiolus* species. A species was later found in the border areas of Turkey and Syria, which seemed a reasonable candidate for the ancestral *Gladiolus* material (AH, personal observation). This plant had all the characteristics of *G. italicus*, but was distinct in that it was half the normal height of the modern cornfield weed and other morphological characters were similarly dwarf. The theory was that this miniature species would have the normal tetraploid chromosome number of the genus *Gladiolus* ( $2n=60$ ). As the wheat crop was selected for bigger seeds, which is accompanied polyploidisation, the *Gladiolus* species would also have an increase in chromosome number. Specifically, the wild *Gladiolus* would change from the tetraploid condition of  $2n=60$  to the octoploid state of  $2n=120$ , which is the characteristic state of *G. italicus*. (Hamilton 1968).

Plants of this new wild *Gladiolus* species were collected and brought back to England for study. Unexpectedly, the chromosome number of the new species was found to be exactly the same as in the cultivated *G. italicus*

( $2n=120$ ). While the small *Gladiolus* species was definitely incorporated as a weed species into the first cultivation of the wild cereal grass species, the chromosome number did not alter, unlike that of the accompanying wild *Triticum*, which continued to increase as more hybrid grasses were produced and incorporated.

However, plant and seed size did alter with this weed *Gladiolus* species and the increased stature of today's *G. italicus* was produced. These morphological differences of the small species were fit and valid to be described as the new small *Gladiolus* species, viz. *G. antakiensis* A.P. Ham. (Hamilton 1983).

### Materials and methods

During a search for the doubtful *Gladiolus dubius* and *G. byzantinus* between 2006–2009, we realized that all specimens examined from different and random sites in Malta and Gozo had essentially winged seeds; some more broadly winged than others. If, as stated, *G. italicus* was by far the most common species in Malta, at least most of the examined specimens would have unwinged seeds: a very distinct character of the species. This remained unresolved until it could be concluded based on photographs that these were not *G. italicus*.

Twenty sites around Malta and Gozo were visited during the first week of April 2010 and the second week of April 2012 and the last week of May 2012. Morphological studies and species identification have been carried out on site, while a number of specimens (corms and seeds) were collected for chromosome counts and propagation in closed experimental conditions to investigate morphological relationships. The preliminary morphological studies reported here were based on the corolla, tepals, fruits and seeds (Table 1). Unlike what was stated in traditional keys (Hamilton 1980; Pignatti 1982), the filament/anther proportion has little significant importance for distinguishing *Gladiolus* species, such as *G. byzantinus*, *G. italicus*, *G. communis* and *G. dubius*.

Besides the date and the localities (including toponyms), the presence and estimated abundance of *Gladiolus italicus* and *G. communis* have been recorded for each surveyed site in Malta (Table 2). An estimated population size was calculated as well (Table 2). The grading used in the table is based on a rough estimate by sight *in situ*. Apart from this, it gives an idea of the

Table 1. Comparison of distinctive features between *Gladiolus italicus* and *G. communis*.

Morphological character	<i>Gladiolus communis</i>	<i>Gladiolus italicus</i>
Angle of corolla with rachis <sup>(b)</sup>	Typically 45–70°	Almost perpendicular
Colour of corolla <sup>(b)</sup>	Vivid, bright purple, sometimes reddish esp. in the upper tepal	Pure purple, not as bright and vivid as in <i>G. communis</i> .
Shape of lateral tepals <sup>(a)</sup>	Oval to spatulate, sides of tepal convex. (Figure 1B, C)	Oblong to sub-ovate, sides almost parallel or slightly curved (Figure 1A)
Wall of fruit <sup>(b)</sup>	Rather smooth with shallow lateral constrictions	Bulged or beaded with seeds
Seeds <sup>(a)</sup>	Winged (Figure 2, 3B)	Unwinged, pellet-shaped. (Figure 3A)
[Chromosome number]	120	120

Table 2. List of sites that were surveyed for *Gladiolus* spp.

Date	Island	Locality	Toponym	Examined by:	Estimated population size	
					<i>Gladiolus italicus</i>	<i>Gladiolus communis</i>
14-Apr-12	Gozo	Għarb	Maxwell area	AH & SM	-	-
14-Apr-12	Gozo	Għarb	San Dimitri	AH & SM	-	+++
14-Apr-12	Gozo	Għasri	l/o Wied il-Għasri	AH & SM	+	++++
14-Apr-12	Gozo	Għasri	Wied Sdieri	AH & SM	-	++
22-Apr-12	Gozo	Qala	Fields at ta' Cassar	SM	++	++++
22-Apr-12	Gozo	Qala	Fields below tal-Qasam	SM	+++	+++++
14-Apr-12	Gozo	San Lawrenz	Dwejra area	AH & SM	-	+
14-Apr-12	Gozo	San Lawrenz	Wied il-Merill	AH & SM	-	-
14-Apr-12	Gozo	Sannat	Mgarr ix-Xini Valley	AH & SM	++	+++
14-Apr-12	Gozo	Xaghra	Nuffara hill area	AH & SM	+	+++
14-Apr-12	Gozo	Xewkija	Ta' Blankas cart ruts	AH & SM	++	+
14-Apr-12	Gozo	Żebbuġ	Żebbuġ cemetery	AH & SM	-	+++++
13-Apr-12	Malta	Birżebbuġa	Għar Hasan area	SM	-	++
10-Apr-12	Malta	Birżebbuġa	l/o Delimara	AH & SM	-	+++
10-Apr-10	Malta	Dingli	Fields near Savio college	AH & SM	-	++++
10-Apr-12	Malta	Mellieħa	Marfa	AH & SM	-	+++
10-Apr-12	Malta	Mellieħa	Selmun	AH & SM	-	++
10-Apr-12	Malta	Mellieħa	Għajn Hadid Tower	AH & SM	-	++
10-Apr-10	Malta	Mellieħa	Manikata	AH & SM	-	++
10-Apr-10	Malta	Mosta	Wied tal-Ħzejjen	AH & SM	-	+++
15-Apr-10	Malta	Pembroke	ITC Complex Reservoir	SM	-	++
10-Apr-12	Malta	Qrendi	Haġar Qim	AH & SM	+	+++
16-Apr-12	Malta	Rabat	Tas-Salib/Dwejra area	SM	+++	+++++
10-Apr-12	Malta	Sigġiewi	Ġnien il-Far	AH & SM	+++	+++++
10-Apr-12	Malta	Sigġiewi	Verdala / San Biaggio area	AH & SM	-	+++++
21-Apr-12	Malta	Żebbuġ	Wied Qirda	SM	+	+++
10-Apr-12	Malta	Żurrieq	L/o Wied Moqbol	AH & SM	+	+++
10-Apr-12	Malta	Żurrieq	Wied Diegu	AH & SM	-	+++

- Species not observed.

+ Individual specimens (1–5).

++ Few scattered specimens (5–20).

+++ Numerous specimens but not abundant (20–100).

++++ Many specimens (estimated by sight 100–200).

+++++ Abundant over a large area (more than 200 specimens).

population size and, more importantly, the grading demonstrates the ratio between the two reported species in that particular site. However, some sites are larger (e.g. Wied tal-Ħzejjen, Mosta; Mgarr-ix-Xini, Għajnsielem) and the system does not infer that an entire site has been thoroughly surveyed, but only some 'ad hoc' parts.

## Results

### Taxonomy

This preliminary work reports new taxonomic information that is in contrast to the current literature on Maltese *Gladiolus* spp. Only two species have been identified in the Maltese islands, viz. *G. communis* and *G. italicus*, based on main morphological differences between the two species (Table 1). *Gladiolus dubius*, a very doubtful species with obscure validity since its mention in the Flora Europaea (Hamilton 1980), has to be excluded from the Maltese flora. *Gladiolus byzantinus* is essentially a sexually sterile hexaploid (2n=90) and not found in nature: it is a mere garden cultivar described by Philip Miller

Hamilton (2013). Therefore, this species must also be eliminated from the flora of the Maltese islands, unless the on-going cultivar and chromosome analysis shows different results.

Surprisingly, *Gladiolus italicus* was found to be infrequent to rare (locally frequent in only a few sites), whereas *G. communis* is by far the most common species, often abundant in clayey fields that have been abandoned for a long time, especially at the feet of clay slopes (Table 2).

The surveys also resulted in the discovery of interesting specimens. On the 14th April 2012, few specimens of *Gladiolus communis* in Żebbuġ, Gozo, had strong similarities to *G. illyricus* Koch (Figure 3C) and are further studied through closed experimental cultivation. It must be noted that *G. communis* is regarded as originally evolved from *G. illyricus*. On April 19, 2009, two albinotic specimens of *G. communis* were discovered at Wied ix-Xlendi, Munxar (Figure 1D). Albinism in *Gladiolus*, at this chromosome level, is very rare in the wild and it was observed only once from Malta (SM, personal observation, April 2009) and in Morocco (AH, personal observation, April 1968).

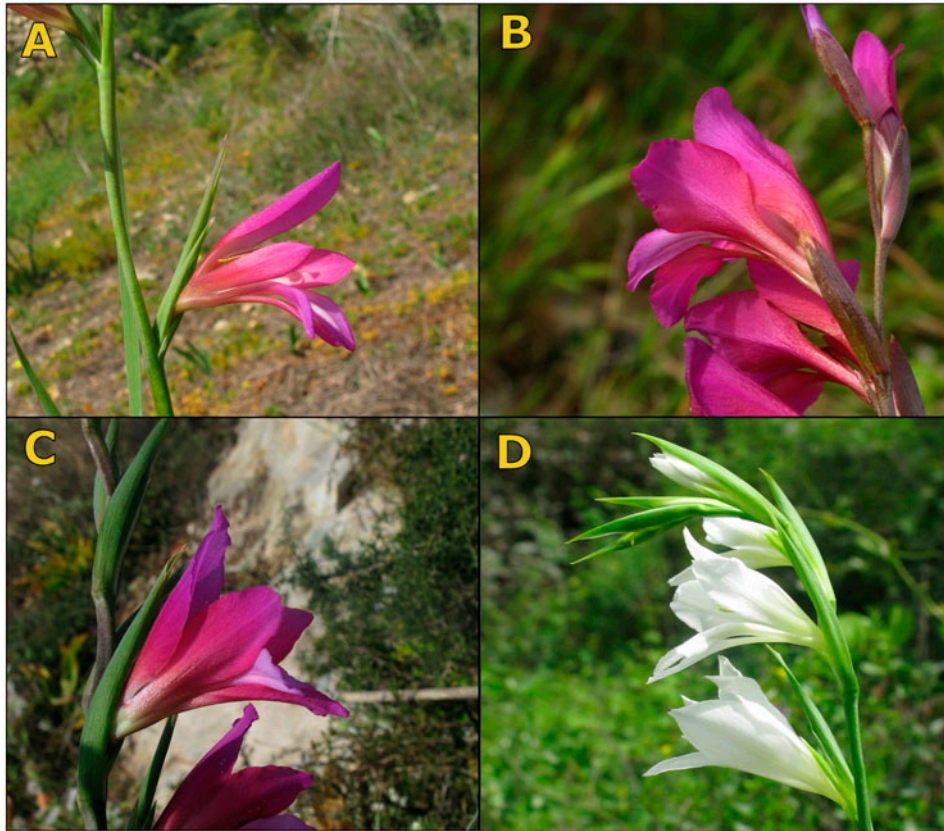


Figure 1. (A–C) Comparison of flowers of *Gladiolus italicus* (A) with *G. communis* (B, C). (D) The very rare albino form of *G. communis* from Xlendi, Gozo. Photos by Stephen Mifsud.

Although a hybrid of *Gladiolus communis* × *italicus* has never been described, Malta offers a good opportunity for hybridisation because the two species were often found to grow together in many sites and both species have the same chromosome number of  $2n=120$ . As a matter of fact, in a few instances, in some specimens, it could not be confidently identified in the field whether it

was *G. italicus* or *G. communis*. Again, these are further studied through cultivation experiments.

### Discussion

Only two species of *Gladiolus* are found in Malta, viz. *G. communis* and *G. italicus*. They have very frequently been confused because previous botanists have used seed characters as main diagnostic characters to separate the species. In addition, their flowers have a very similar purple-pink colour. In this paper, it is shown that the seeds of Maltese *G. communis* have residual wings around their seeds, which superficially imitate the seed appearance of the pelleted seeds of *G. italicus*. While the natural origins of the seed shape are clear and not controversial in *Gladiolus italicus*, the origins of the superficially similar seeds of the Maltese *G. communis* are not so clear. *Gladiolus communis* is a pan Mediterranean species ranging from Morocco in the west to the Balkans in the east. So far, only in Malta, a significant seed variation has been found among this species.

*Gladiolus communis* is a native of open limestone scrubland throughout its range. In terms of agriculture, these areas are of marginal use and depend on thorough clearing of rock and stones in small areas so that cereals can be grown in large enough quantities to make cultivation worthwhile. As these areas were



Figure 2. Typical winged seeds of normal Maltese *Gladiolus communis*; the bulging and darkened area at the centre is the fertile part of the seed surrounded by a well-developed wing. In contrast, other specimens of *G. communis* in Malta were found to have much reduced wings (ref: Figure 3B): derivative forms that have been unconsciously selected by grain harvesting practises.



Figure 3. (A, B) Comparison of the unwinged seeds of *Gladiolus italicus* (A) with seeds of some Maltese specimens of *G. communis* with residual wings (B). (C) specimen of *G. communis* with colour patterns similar to *G. illyricus* from the clay fields in Żebbuġ, Gozo. Photos by Stephen Mifsud.

cleared and used for agriculture, the seeds of native plant species would also have become incorporated into the harvesting processes and would either have been discarded or have reacted in some way with the threshing process. One selection process would have been the accidental incorporation of similarly sized seeds and from that, the selection of tougher, more damage resistant strains that could survive the processes of harvesting (Figure 2).

Clearly, a large seed with prominent wings would be a serious impediment in the harvesting process and much damage would occur. Where there was a variant, which genetically had genes for small or reduced wings, that type would be preferentially selected in this process. The fact that apparently a proportion of the populations of Maltese *Gladiolus communis* have seeds with vestigial wings indicates that they are the product of this anthropologically initiated process and it was particularly successful in an isolated island habitat. Unwinged seeds would have a detrimental effect on the natural wind-blown seed distribution, which is the normal method of seed dispersal in the genus *Gladiolus*.

*Gladiolus italicus* is only found in small colonies around Malta and Gozo. These appear to be small residual populations left over from much older areas of agriculture (e.g. colonies near limestone cart ruts at ta'Blankas olive grove, Xewkija) that have now been abandoned. The distribution of this species is not wide and, in the areas of their progenitor *G. antakiensis* from Syria, Turkey and Lebanon, seed distribution is usually stated as being ant-dispersed caused by the storage of the oil filled seeds buried as food for the ant colonies.

There is no known evidence to date for the same method in Malta for *G. italicus*.

*Gladiolus italicus* is rare, while native *G. communis* is common. *Gladiolus italicus* was relatively recently introduced, probably from Sicily, with the introduction of agriculture to Malta. The seed distribution method for native *G. communis* has not been established, but is likely to be by a native insect adapted to local Maltese conditions.

### Conclusion

*Gladiolus italicus* and *G. communis* have been found to be the only two species of wild *Gladiolus* that occur on the Maltese islands. They were found in, or up to about 100 m away from wheat-cultivated fields or relic fields denoted by rubble walls. In contrast to what is written in floristic literature, *G. italicus* is rare or locally frequent in very few fields, while *G. communis*, which in its strict sense is considered as a new species for the Maltese islands, is commonly found in its habitat throughout the islands. It is suggested that *G. dubius* and *G. byzantinus* should be removed from the inventory of the Maltese flora. Finally, an albino form of *G. communis* was found at Wied ix-Xlendi, Gozo, which is an extremely rare occurrence in the entire Mediterranean region and is a product of in-breeding.

### Dedication

We would like to dedicate this work in remembrance of Gungerd Hägglund, who passed away in September 2004. Gladioli where her favourite garden flowers.

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