



A taxonomic revision of *Silene nocturna* species complex (Caryophyllaceae) in Italy

LORENZO PERUZZI* & ANGELINO CARTA¹

¹ Dipartimento di Biologia, Unità di Botanica, Università di Pisa, Via Luca Ghini 13, 56126, Pisa, Italy;

e-mail lperuzzi@biologia.unipi.it

* author for correspondence

Abstract

The taxonomy of the closely related *Silene capraria*, *S. neglecta* and *S. nocturna* in Italy is investigated, by means of morphometric and karyological analyses. The chromosome numbers of *S. capraria* and *S. neglecta* (both diploid with $2n = 24$) are here reported for the first time. On the basis of the morphological results, we propose the species rank for *S. neglecta*, and to consider *S. capraria* as a vicariant narrow endemic subspecies of the widespread *S. nocturna*. The name *S. neglecta* is lectotypified on a specimen preserved in the Herbarium Tenore at NAP. With the aim to distinguish these taxa, the useful qualitative and quantitative morphological characters are highlighted.

Key words: diagnostic key, Italian flora, Mediterranean, *Silene* sect. *Scorpioideae*

Introduction

Silene Linnaeus (1753: 416) is one of the largest genera in Caryophyllaceae, including about 450 species (Chowdari 1957), despite recently several genera were segregated from it (Oxelman *et al.* 2001). This genus is of particular interest in evolutionary and ecological studies, as highlighted by Bernasconi *et al.* (2009). The Mediterranean region hosts the majority of the species (Talavera & Muñoz Garmendia 1989) and includes the sect. *Scorpioideae* (Rohrbach 1868: 96) Chowdari (1957: 247). *Silene nocturna* Linnaeus (1753: 416) species complex is included in this section.

In *Flora Europaea*, two taxa are recognized within this complex (Chater *et al.* 1993): *S. nocturna* subsp. *nocturna* and *S. nocturna* subsp. *neglecta* (Tenore 1826: 13) Arcangeli (1882: 88). The same taxa were treated at specific level for Italy by Pignatti (1982), but more recently, Conti *et al.* (2005) followed the taxonomic treatment by Chater *et al.* (1993), also adding *S. capraria* Sommier (1898: 113), on the basis of Foggi *et al.* (2001) (this latter taxon was previously synonymized with *S. nocturna*). *S. nocturna* was typified by Ghafoor (1978) on a Linnaean specimen in LINN! and the same choice was done later by Talavera & Muñoz Garmendia (1989: 421). This specimen was collected in Pennsylvania (United States), where the plant was introduced by Pursh (Rohrbach 1868). *S. capraria* was typified by Foggi *et al.* (2001) on a specimen in FI!, while *S. neglecta* is yet untypified, as far as we are aware.

The characters usually used to distinguish *S. neglecta* from *S. nocturna* are (Pignatti 1982, Chater *et al.* 1993): a) basal portion of the stem, hirsute vs. glabrous/pubescent, b) position of the lower leaves, patent to deflexed vs. erect, c) lower pedicels patent to pendulous vs. erect, d) shape of calyx teeth linear vs. triangular-lanceolate, e) filament with hairs at base vs. glabrous, f) seed diameter, 0.8–0.9 vs. 0.5–0.7 mm. Concerning the seed colour, there is no agreement among the authors: blackish in *S. nocturna* and reddish-brown in *S. neglecta* (Chater *et al.* 1993), or the reverse according to Tenore (1830: 217) and Fiori (1923). *S. capraria* was described as a dwarf cleistogamous variant of *S. nocturna* (Sommier 1896, Foggi *et al.* 2001), but the study of available specimens collected from Capraia and observed in a field survey in April 2012 reveals a higher variability. Besides morphometric studies (Stuessy 2009), chromosome analyses are important and widely used

for taxonomic purpose also within group of related taxa (Siljak-Yakovlev & Peruzzi 2012). Moreover, seed morphology has been successfully used for the identification of taxa belonging to the family Caryophyllaceae because of their variously sculptured seed testa (Bittrich 1993; Minuto *et al.* 2006; Fawzi *et al.* 2010).

Accordingly, in the framework of taxonomic studies carried out on Tuscan Archipelago endemics (Peruzzi & Carta, 2011), the aims of this study are: a) to typify the name *S. neglecta*; b) to verify the taxonomic value of *S. capraria* and c) to clarify the taxonomic relationships between *S. capraria*, *S. nocturna* and *S. neglecta*, both on morphological and karyological data.

Material and Methods

Quantitative morphological investigations are performed on 51 herbarium specimens of *S. capraria*, 43 of *S. neglecta* and 81 of *S. nocturna*; the lectotypes of the taxa are included (Appendix 1). The herbaria checked were FI, LINN, NAP and PI (codes according to Thiers, 2011). The following eight characters were examined: plant size (cm), flower number, inclination of the lowest flower's pedicel [from 0° (erect and addressed to peduncle upwards), to 180° (completely reflexed)], length of the lowest flower's pedicel (mm), calyx length (mm), carpophore length (mm), calyx teeth length and width (mm). The variables were processed singularly by means and T-test for independent samples comparing the same variable among pairs of species (*S. capraria* vs. *S. neglecta*; *S. capraria* vs. *S. nocturna*; *S. neglecta* vs. *S. nocturna*) with R software (www.r-project.org). The data matrix (175 cases x 8 characters) was analyzed using PCA (Principal Component Analysis) method, after standardization of data, with the software of statistical and multivariate analysis Data Desk 6.1.

Seed general morphology was studied with binocular lens and calliper on 10 seeds from each sample (Table 1). Besides, two to four seeds per each sample were studied using SEM (the material was coated by a gold thin layer, then observed and photographed at 10 kV). According to the criteria and terminology used by Fawzi *et al.* (2010), the following characters were considered: seed shape, seed colour, seed length and width (mm), testa cell outline, lateral and dorsal surfaces, number of cell rows in dorsal testa, outline of cells in dorsal testa, anticlinal and periclinal walls of cells in dorsal testa. After verifying no interpopulational (samples) variability, seed length and width data were processed by means and T-test among pairs of species. As regards the chromosome analysis, squash preparations were made from root-tips of germinating seeds collected *in situ* (Table 1), according to the following schedule: pretreatment in 0.4% colchicine solution for 4 hours; Carnoy fixing for 45 min; hydrolysis in HCl 1N for 9 minutes at 60°C; staining with leuco-basic fuchsin for 3 hours. At least ten plates were used in order to establish the chromosome numbers. For *S. capraria* and *S. neglecta*, five plates were measured in order to build the idiograms. M_{CA} (Mean Centromeric Asymmetry) and CV_{CL} (Coefficient of Variation of Chromosome Length) karyotype asymmetry parameters were calculated according to the methodology proposed by Peruzzi & Eroğlu (2013). The same parameters were also calculated for three metaphasic plates of *S. nocturna* available in literature (Talavera & Bocquet 1975, Colombo & Trapani 1991, Díaz Lifante *et al.* 1992).

TABLE 1. Populations sampled for seed morphology and karyological analysis. Seeds were collected from fully ripening capsules in the first half of April 2012.

| | locality | coordinates | collector(s) |
|--------------------|---|-----------------|-----------------------|
| <i>S. capraria</i> | Tuscany: Capraia Island, Tuscan Archipelago (Livorno) | 43°03'N 09°49'E | L. Peruzzi, G. Gestri |
| <i>S. capraria</i> | Tuscany: Capraia Island, Tuscan Archipelago (Livorno) | 43°01'N 09°49'E | A. Carta |
| <i>S. neglecta</i> | Tuscany: Elba Island, Tuscan Archipelago (Livorno) | 42°44'N 10°07'E | B. Pierini |
| <i>S. neglecta</i> | Tuscany: Montecristo Island, Tuscan Archipelago (Livorno) | 42°20'N 10°19'E | A. Carta |
| <i>S. nocturna</i> | Emilia-Romagna | 44°42'N 10°40'E | S. Sturloni |
| <i>S. nocturna</i> | Puglia | 41°33'N 15°52'E | L. Rignanese |
| <i>S. nocturna</i> | Tuscany: Monte Pisano, Vicopisano (Pisa) | 43°41'N 10°30'E | B. Pierini |



FIGURE 1. Lectotype of *Silene neglecta* in Herbarium Tenore, NAP!, designated here (plant on the left side, linked with the bottom label).

Typification of *Silene neglecta*

Tenore's protologue consists of a diagnosis, referring also to "*Silene nocturna* A" as described in his previous works (Tenore 1811–1815: 235, Tenore 1822: 350), concerning the unnamed var. "A". Unnamed varieties "B" and "C" are also described, and var. "B" refers to "*Silene nocturna* B" as described in Tenore (1811–1815: 235, Tenore 1822: 350). Later, Tenore (1830: 216) excluded the var. "B" from his species concept (and referred it again to *S. nocturna*). In Herbarium Tenore conserved at NAP we have been able to find the following specimens: "Astroni" and "Persano" (both the localities cited by the author under var. "A") and "Capri" (cited under var. "C"). These specimens can be considered as original material, despite the absence of explicit collection dates (a constant in Herbarium Tenore, see also Di Pietro et al. 2012, Peruzzi et al. 2012, 2013): indeed, they were originally labelled as "*Silene nocturna*" (exactly as in Tenore's previous publications) and then corrected by the author as "*neglecta nob.*". Among them, the most complete and well developed specimen from "Persano" (Fig. 1), matching well with the protologue, is here selected as the lectotype. This specimen corresponds to the current concept of *S. neglecta* (Chater et al. 1993).

Morphological Results

S. capraria results intermediate between *S. neglecta* and *S. nocturna* concerning the inclination of lowest flower's pedicels, while their length show the highest values; regarding the calyx and carpophore dimensions, *S. capraria* shows instead the lowest values (Table 2). However, all these morphological features taken together (PCA analysis) do not guarantee a clear morphological discrimination among the three taxa (data not shown). The T-test comparison of characters for pairs of systematic units, shows that *S. capraria* is distinct from *S. neglecta* in having less inclined and longer lowest pedicels, smaller calyces and carpophores (Table 3). *S. capraria* is also distinct from *S. nocturna*, in having a smaller size, more inclined and longer lowest pedicels, and smaller calyces (Table 4). Finally, *S. neglecta* is distinct from *S. nocturna* in having more inclined and longer lowest pedicels, larger calyces and carpophores (Table 5).

TABLE 2. Morphological comparison of *Silene capraria*, *S. neglecta* and *S. nocturna*. Quantitative values are expressed as 10–90 percentile intervals, with minimum and/or maximum in brackets, and as mean \pm standard deviation.

| | <i>S. capraria</i> | <i>S. neglecta</i> | <i>S. nocturna</i> |
|---|----------------------------------|------------------------------------|--------------------------------------|
| plant size (cm) | (2–)4–22(–38) 12 \pm 8 | (3–)8–29(–41) 15 \pm 9 | (5–)7–33(–37) 17.1 \pm 9.8 |
| flower number | 1–8(–11) 3.8 \pm 2.6 | (1)2–6(–9) 3.3 \pm 1.8 | 1–7(–10) 3.7 \pm 2.2 |
| inclination of the lowest flower's pedicel (°) | 0–30(–40) 7.6 \pm 10.5 | (0–)5–45(–90) 19.1 \pm 20.6 | 0–5(–20) 2.2 \pm 3.6 |
| length of the lowest flower's pedicel (mm) | (2–)4–20(–35) 11.3 \pm 7.1 | (1–)3–13.6(–19) 6.2 \pm 4.4 | (1–)2–7(–10) 3.7 \pm 2.2 |
| calyx length (mm) | 5–10(–10.5) 7.4 \pm 1.6 | (7.5–)9–11(–12) 9.9 \pm 1 | (6.5–)8–10.5(–12) 9.3 \pm 1 |
| carpophore length (mm) | 0.5–1(–1.5) 0.8 \pm 0.2 | (1–)1.2–2(–2.1) 1.6 \pm 0.3 | (0.5–)0.8–1.2(–1.5) 0.9 \pm 0.2 |
| calyx teeth length (mm) | (0.8–)1–1.7(–2) 1.2 \pm 0.3 | (0.8–)1–2.5(–3.5) 1.7 \pm 0.6 | (0.8–)1–1.6(–2) 1.2 \pm 0.3 |
| calyx teeth width (mm) | 0.5–1.5 0.9 \pm 0.3 | (0.5–)0.7–1.5(–2) 1 \pm 0.4 | (0.5–)0.7–1(–1.5) 0.9 \pm 0.2 |

TABLE 3. Mean differences between *S. capraria* and *S. neglecta* studied specimens, according to T-test. Those characters with df = 94 were assumed with equal variances (after Levene statistics); the others were not assumed with equal variances. Significant differences are evidenced in bold.

| | t | df | p | difference |
|--|----------|-----------|----------|--------------------|
| plant size | -2.033 | 94 | 0.045 | -3.59333 cm |
| flower number | 1.053 | 88.942 | 0.295 | 0.476 |
| inclination of the lowest flower's pedicel | -3.260 | 64.173 | 0.002 | -10.987° |
| length of the lowest flower's pedicel | 4.119 | 85.936 | 0.000 | 4.96667 mm |
| calyx length | -9.439 | 82.636 | 0.000 | -2.56824 mm |
| carpophore length | -12.230 | 78.392 | 0.000 | -0.73412 mm |
| calyx teeth length | -4.247 | 64.004 | 0.000 | -0.44810 mm |
| calyx teeth width | -1.628 | 94 | 0.107 | -0.10627 mm |

TABLE 4. Mean differences between *S. capraria* and *S. nocturna* studied specimens, according to T-test. Those characters with df = 130 were assumed with equal variances (after Levene statistics); the others were not assumed with equal variances. Significant differences are evidenced in bold.

| | t | df | p | difference |
|--|----------|-----------|----------|--------------------|
| plant size | -2.984 | 130 | 0.003 | -4.90123 cm |
| flower number | 0.086 | 130 | 0.932 | 0.036 |
| inclination of the lowest flower's pedicel | 3.536 | 57.494 | 0.001 | 5.408° |
| length of the lowest flower's pedicel | 7.457 | 56.193 | 0.000 | 7.66667 mm |
| calyx length | -7.310 | 74.603 | 0.000 | -1.87836 mm |
| carpophore length | -2.469 | 130 | 0.015 | -0.09165 mm |
| calyx teeth length | 0.089 | 130 | 0.929 | 0.00523 mm |
| calyx teeth width | 0.831 | 130 | 0.408 | 0.03224 mm |

TABLE 5. Mean differences between *S. neglecta* and *S. nocturna* studied specimens, according to T-test. Those characters with df = 124 were assumed with equal variances (after Levene statistics); the others were not assumed with equal variances. Significant differences are evidenced in bold.

| | t | df | p | difference |
|--|----------|-----------|----------|-------------------|
| plant size | -0.729 | 124 | 0.467 | -1.30790 cm |
| flower number | -1.138 | 124 | 0.257 | -0.440 |
| inclination of the lowest flower's pedicel | 5.363 | 45.554 | 0.000 | 16.395° |
| length of the lowest flower's pedicel | 3.746 | 55.966 | 0.000 | 2.7 mm |
| calyx length | 3.689 | 124 | 0.000 | 0.68988 mm |
| carpophore length | 11.898 | 59.426 | 0.000 | 0.64247 mm |
| calyx teeth length | 4.456 | 57.325 | 0.000 | 0.45333 mm |
| calyx teeth width | 2.436 | 54.852 | 0.018 | 0.13852 mm |

Seeds of the *S. nocturna* species complex are reniform in outline, with polygonal testa cells and lateral surface concave. The distinctive macroscopic characters of *S. neglecta* are the dark colour and especially the greater dimension of the seeds (Table 6). Observation of testa micromorphology reveals further differences from one taxon to another (Fig. 2) and a summary of seed characteristics are reported in Table 6. The testa in all species appears to be made by cells having inter-digitated walls (sinuated cell margins), but *S. neglecta* is characterized by polygonal (star-shaped) tuberculate dorsal cells which occupy the dorsal ditch, instead of obovate slightly tuberculate cells. The ditch gives a concave groove on the dorsal surface of the seeds and it is deeper in *S. neglecta*. *S. capraria* may be distinguished from *S. nocturna* by its smaller seeds (Table 7) and the presence of two dorsal cell rows (Fig. 2, a). No significant interpopulational variability was found within *S. capraria*, *S. neglecta* and *S. nocturna* accessions (data not shown).

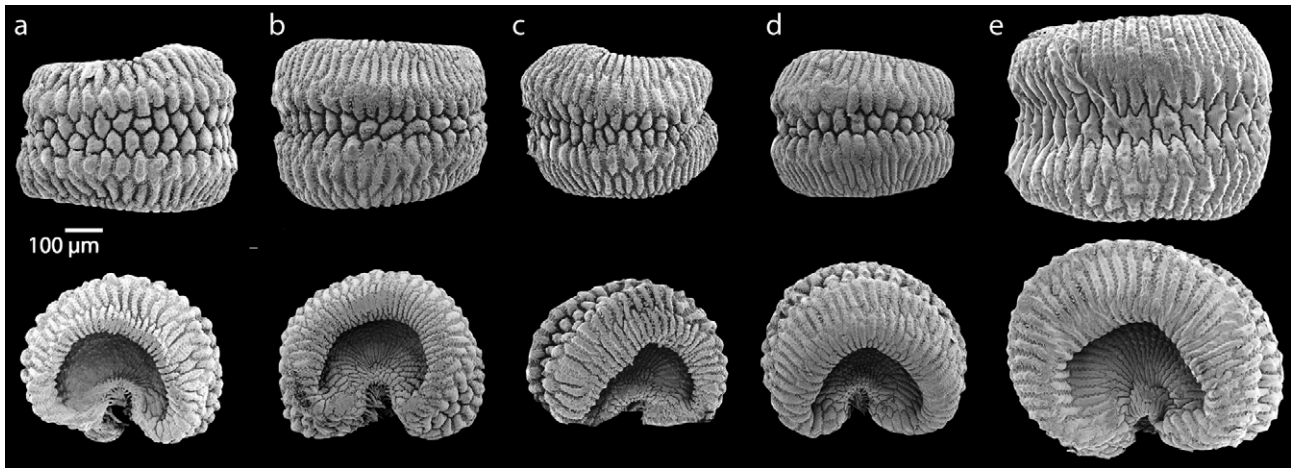


FIGURE 2. Seed micromorphology on SEM for the taxa studied here. For each taxon dorsal and lateral views are shown. (a) *Silene capraria*; (b) *S. nocturna* from Emilia-Romagna; (c) *S. nocturna* from Tuscany; (d) *S. nocturna* from Puglia; (e) *S. neglecta*.

TABLE 6. Micromorphological comparison between seeds of *Silene capraria*, *S. neglecta* and *S. nocturna*. Quantitative values are expressed as 10–90 percentile intervals, with minimum and/or maximum in brackets, and as mean \pm standard deviation.

| | <i>S. capraria</i> | <i>S. neglecta</i> | <i>S. nocturna</i> |
|--|--|--|---|
| seed shape | reniform | reniform | reniform |
| seed colour | usually brown to blackish | usually black | usually brown to blackish |
| seed length (mm) | (0.6–)0.63–0.71(–0.73) 0.67 \pm 0.04 | (0.82–)0.86–1.02(–1.04) 0.94 \pm 0.06 | 0.68–0.73(–0.74) 0.71 \pm 0.02 |
| seed width (mm) | (0.43–)0.45–0.53(–0.54) 0.47 \pm 0.04 | (0.63–)0.67–0.74 0.7 \pm 0.03 | (0.48–)0.8–0.54(–0.55) 0.51 \pm 0.03 |
| testa cell outline | elongated polygonal | elongated polygonal | elongated polygonal |
| lateral surface | concave | concave | concave |
| dorsal surface | concave-grooved | strongly concave-grooved | concave-grooved |
| number of cell rows in dorsal testa | 2 | 1 | 1 (rarely, and incompletely, 2; cfr. Fig. 2c) |
| outline of cells in dorsal testa | obovate-polygonal | polygonal | obovate-polygonal |
| anticlinal walls of cells in dorsal testa | U-undulated | V-undulated | U-undulated |
| periclinal walls of cells in dorsal testa | slightly tubercolate | tubercolate | slightly tubercolate |

TABLE 7. Mean differences in seed dimensions between pairs of species, according to T-test. Significant differences are evidenced in bold.

| | t | df | p | difference (mm) |
|---|----------|-----------|----------|------------------------|
| Seed length | | | | |
| <i>S. capraria</i> – <i>S. neglecta</i> | -17.4114 | 19 | 0.000 | -0.273 |
| <i>S. capraria</i> – <i>S. nocturna</i> | -4.6326 | 19 | 0.000 | -0.044 |
| <i>S. neglecta</i> – <i>S. nocturna</i> | -14.0201 | 19 | 0.000 | -0.229 |
| Seed width | | | | |
| <i>S. capraria</i> – <i>S. neglecta</i> | -19.3067 | 19 | 0.000 | -0.2295 |
| <i>S. capraria</i> – <i>S. nocturna</i> | -3.7353 | 19 | 0.001 | -0.0395 |
| <i>S. neglecta</i> – <i>S. nocturna</i> | -17.7379 | 19 | 0.000 | -0.19 |

Karyological Results

All the studied samples (Table 1) revealed a diploid chromosome number $2n = 24$ (Fig. 3; data not shown for *S. nocturna*). Chromosome size ranges from 0.5 to 2.5 μm . Concerning karyotype asymmetry (Fig. 4), *S. capraria* shows the highest CV_{CL} values and intermediate values of MCA. *S. neglecta* shows instead intermediate values in both parameters, respect with *S. capraria* and *S. nocturna*.

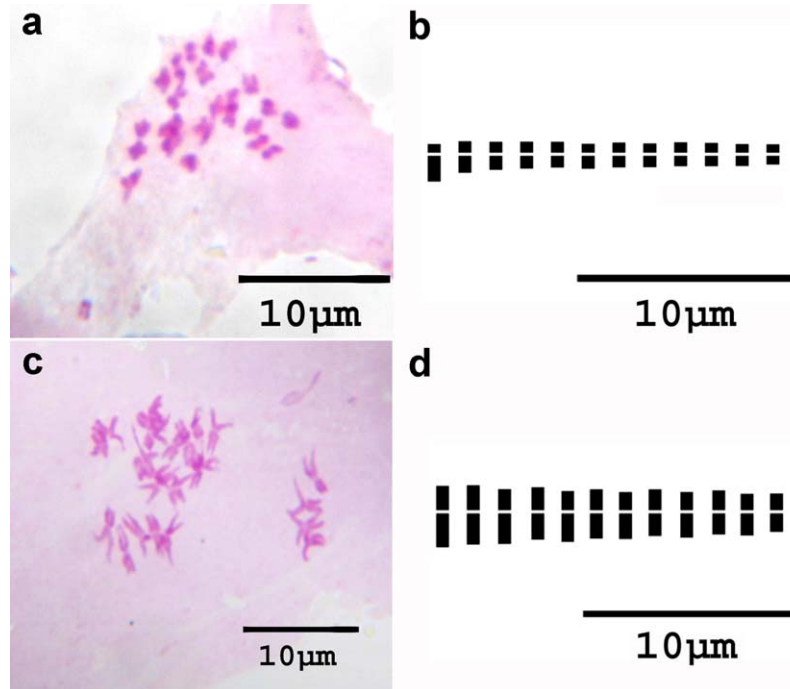


FIGURE 3. Examples of metaphasic plates of *Silene capraria* (a) and *S. neglecta* (c). Mean haploid idiogram of *Silene capraria* (b) and *S. neglecta* (d).

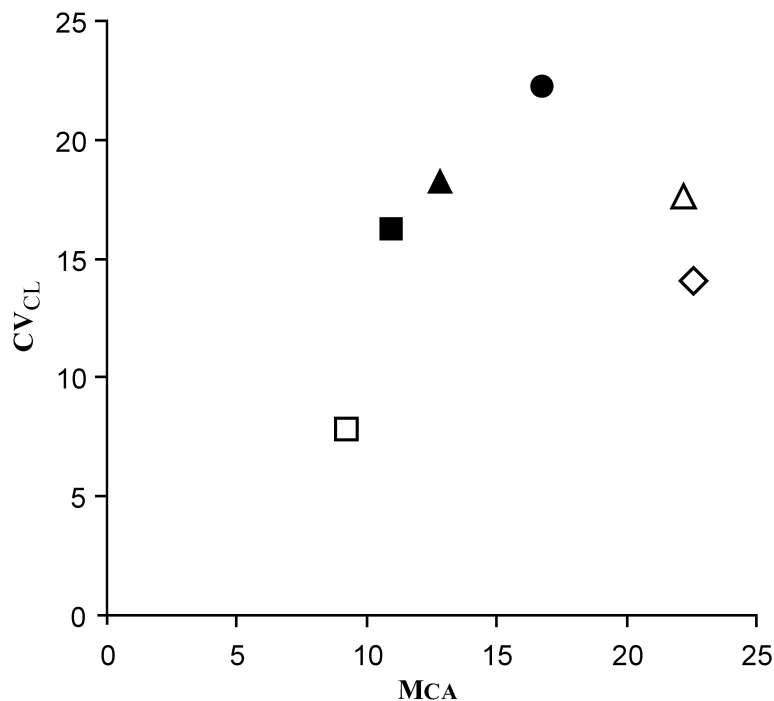


FIGURE 4. Analysis of karyotype asymmetry among *S. capraria* (circle), *S. neglecta* (dark triangle: Elba; dark square: Montecristo) and three *S. nocturna* karyotypes (white symbols): Spain (square), Sicily (rhombus) and Israel (triangle). Coefficient of variation of chromosome length (CV_{CL}) and Mean Centromeric Asymmetry (MCA) were plotted for each species studied. Increasing karyotype asymmetry is reflected in increasing values of CV_{CL} and/or MCA.

Discussion

Our study proved that there is some macromorphological distinctiveness between the three taxa, albeit with evident overlappings. On the contrary, the micromorphological data (seeds) highlighted new and more reliable diagnostic characters. Indeed, although all seeds of the studied taxa are similar from the macromorphology point of view, the taxa may be further distinguished based on testa cells shape and sculpturing, as previously reported for other groups of *Silene* (Hong et al., 1999). The data on *S. capraria* and *S. neglecta* are new, while those on *S. nocturna* are congruent with the only information available in literature (plants from Egypt in Fawzi et al. 2010). In Caryophyllaceae, testa is often variously sculptured (Bittrich 1993), and we confirm that seed morphology of *Silene* has a great diagnostic value at the species level (Bittrich 1993; Fawzy et al. 2010). The structure of the seed testa is closely related to the protection, dissemination and water absorption of a seed; therefore, ecological adaptation may have played an important evolutionary role. Although *S. neglecta* seeds have been found to be generally black, we found a large variation in color of seeds in all samples (brown, grey and black), that might be related to environmental conditions during development (Hong et al., 1999; Mira et al., 2011). Therefore, we notify that this parameter may not be reliable as good diagnostic character.

The chromosome numbers for *S. capraria* and *S. neglecta* are here reported for the first time. Their diploid $2n = 24$ status is shared with *S. nocturna*, as shown by many authors (Löve & Kjellqvist 1974, Degraeve 1980, Colombo & Trapani 1991, Luque & Lifante 1991, Díaz Lifante et al. 1992, Diosdado et al. 1993, Runemark 1996, Valdés & Parra 1997) and confirmed by our own data. Concerning karyotype asymmetry, the three species seem to show some degree of distinction, with *S. nocturna* showing lower CV_{CL} values respect with *S. capraria*. The three accessions for *S. nocturna*, obtained from literature, document some heterogeneity in this species and can be considered as somehow representative of the whole Mediterranean area: Iberian peninsula (Talavera & Bocquet 1975), Sicily (Colombo & Trapani 1991) and Israel (Díaz Lifante et al. 1992).

All things considered, and given that there is no clear geographical and/or ecological separation between *S. neglecta* and *S. nocturna* despite their evident morphological distinctiveness, we deem opportune to keep *S. neglecta* separate at species level, as already suggested by Pignatti (1982). On the contrary, concerning *S. capraria*, our data suggest that a distinction at species level, as favoured by Foggi et al. (2001) and Conti et al. (2005), is an overestimation of its taxonomic value. Thanks to some degree of morphological distinction from *S. nocturna* and its geographical isolation, we propose here to consider it at subspecies level: *S. nocturna* subsp. *capraria*. According to the criteria recently reviewed by Siljak-Yakovlev & Peruzzi (2012), this unit can be considered as a schizoendemic to Capraia Island, at risk of extinction (Foggi et al. 2013). Future studies aimed at comparing *S. nocturna* subsp. *capraria* with other microtaxa of the *S. nocturna* species complex [e.g. *S. nocturna* subsp. *boullui* (Rouy & Foucaud 1896: 114) Gamisans in Gamisans & Jeanmonod (1993: 243), seemingly endemic to Corsica or *S. valsecchiae* Bocchieri (1988: 305), seemingly endemic to Sardinia (Arrigoni 2010)] would be desirable, as well as nomenclatural and taxonomic studies aimed at clarifying the correct application of important Linnaean names – connected with the species complex – such as *S. mutabilis* Linnaeus (1756: 16) and *S. reflexa* (Linnaeus 1753: 416) Aiton (1811: 86) (Jarvis 2007).

Taxonomic treatment

Silene neglecta Tenore (1826: 13) subsp. *neglecta*

Type (lectotype here designated):—ITALY. Campania: Persano, s.d., Tenore s.n. (NAP!).

Silene nocturna Linnaeus (1753: 416) subsp. *nocturna*

Type (lectotype designated by Ghafoor 1978: 91):—U.S.A. Pennsylvania. [*Silene*] *nocturna* 4 HU [Horto Upsaliensis] [on verso:] e semine D. Kalmii ex America, Herb. Linn. No. 583.8 (LINN!).

Silene nocturna L. subsp. *capraria* (Sommier) Peruzzi & Carta, *comb. & stat. nov.*

Bas.:—*Silene capraria* Sommier (1898: 113). Type (lectotype designated by Foggi *et al.* 2001: 13):—ITALY. Tuscany: Insula Capraria (Capraja), Punta del Trattoio, 6 April 1896, *Sommier s.n.* (FI!)

Identification key for the *Silene nocturna* species complex in Italy

1. Seeds ≥ 0.8 mm long, usually black, with cells of dorsal testa polygonal (star-shaped) in outline; carpophore (1–)1.2–2(–2.1) mm long; inclination of the lowest flower's pedicel (in fruit) up to 90°; basal portion of stem usually with hairs longer than 1 mm..... *S. neglecta* Ten.
- Seeds up to 0.8 mm long, usually brown-blackish, with cells of dorsal testa not star-shaped in outline; carpophore (0.5–)1–1.2(–1.5) mm long; inclination of the lowest flower's pedicel (in fruit) up to 40°; basal portion of stem glabrous or pubescent with hairs less than 1 mm long. 2
2. Seeds (0.6–)0.63–0.71(–0.73) mm long, with cells of dorsal testa arranged in two complete rows; calyx 5–10(–10.5) mm long; length of the lowest flower's pedicel (in fruit) (2–)4–20(–35) mm long.....
..... *S. nocturna* subsp. *capraria* (Sommier) Peruzzi & Carta
- Seeds 0.68–0.73(–0.74) mm long, with cells of dorsal testa arranged in one (or, rarely, two incomplete) row; calyx (6.5–)8–10(–12) mm long; length of the lowest flower's pedicel (in fruit) (1–)2–7(–10) mm long.....
..... *S. nocturna* L. subsp. *nocturna*

Acknowledgements

The authors are indebted to Roberta Vallariello (Università di Napoli "Federico II"), for sending the digital pictures of *Silene neglecta* specimens in Herbarium Tenore at NAP. The curators of FI and PI are also gratefully acknowledged for their kind help. We are also grateful to Giovanni Gestri (Prato), Brunello Pierini (Pisa), Luigi Rignanese (Manfredonia) and Stefano Sturloni (Reggio Emilia) for their kind help in collecting and/or providing seeds of the studied species.

References

- Arcangeli, G. (1882) *Compendio della flora italiana*. Loescher, Torino, 889 pp.
- Aiton, W.T. (1811) *Hortus Kewensis Ed. 2, 3*. Longman et al., London, 432 pp.
- Arrigoni, P.V. (2010) *Flora dell'Isola di Sardegna 2*. Carlo Delfino Editore, Sassari, 623 pp.
- Bernasconi, G., Antonovics, J., Biere, A., Charlesworth, D., Delph, L.F., Filatov, D., Giraud, T., Hood, M.E., Marais, G.A.B., McCauley, D., Pannell, J.R., Shykoff, J.A., Vyskot, B., Wolfe, L.M. & Widmer, A. (2009) *Silene* as a model system in ecology and evolution. *Heredity* 103: 5–14.
<http://dx.doi.org/10.1038/hdy.2009.34>
- Bittrich, V. (1993) Caryophyllaceae. In: Kubitzki, K., Rohwer, J. & Bittrich, V. (eds.), *The families and genera of vascular plants*, 2. Springer Verlag, Berlin, pp. 206–236.
- Bocchieri, E. (1988) *Silene valsecchiaae* e *Ferula arrigonii*, due nuove specie della Sardegna. *Bollettino della Società Sarda di Scienze Naturali* 26: 305–310.
- Chater, A.O., Walters, S.M. & Akeroyd, J.R. (1993) *Silene* L. In: Tutin, T.G., Burges, N.A., Chater, A.O., Edmondson, J.R., Heywood, V.H., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (eds.) *Flora Europaea (Ed. 2)* 1. Cambridge University Press, Cambridge, pp. 191–218.
- Chowduri, P.K. (1957) Studies in the genus *Silene*. *Notes of Royal Botanic Garden of Edinburgh* 22: 221–278.
- Colombo, C. & Trapani, S. (1991) Números Cromosómicos de Plantas Occidentales, 556–567. *Anales del Jardín Botánico de Madrid* 47: 179–183.
- Conti, F., Abbate, G., Alessandrini, A. & Blasi, C. (eds.) (2005) *An annotated checklist of the Italian vascular flora*. Palombi Editori, Roma, 428 pp.
- Degraeve, N. (1980) Etude de diverses particularités caryotypiques des genres *Silene*, *Lychnis* et *Melandrium*. *Boletim de la Sociedade Broteriana, série 2*, 2, 53: 595–643.
- Díaz Lifante, Z., Luque, T. & Santa Bárbara, C. (1992) Chromosome numbers of plants collected during Iter Mediterraneum II in Israel. *Bocconea* 3: 229–250.
- Diosdado, J.C., Ojeda, F. & Pastor, J. (1993) IOPB chromosome data 5. *International Organization of Plant Biosystematists*

Newsletter (Zurich) 20: 6–7.

- Di Pietro, R., Viscosi, V., Peruzzi, L. & Fortini, P. (2012) A review of the application of the name *Quercus dalechampii*. *Taxon* 61: 1311–1316.
- Fawzi, N.M., Fawzy, A.M. & Mohamed, A.A.-H.A. (2010) Seed morphological studies on some species of *Silene* L. (Caryophyllaceae). *International Journal of Botany* 6: 287–292.
- Fiori, A. (1923) *Nuova Flora Analitica d'Italia* 1(1–3). Edagricole, Bologna, 480 pp.
- Foggi, B., Grigioni, A. & Luzzi, P. (2001) La flora vascolare dell'Isola di Capraia (Arcipelago Toscano): aggiornamento, aspetti fitogeografici e di conservazione. *Parlatorea* 5: 5–53.
- Foggi, B., Viciani, D., Baldini, R.M., Carta, A. & Guidi, T. (2013) A IUCN appraisal of the endemic plant of the Tuscan Archipelago (Tyrrhenian sea). *Oryx*: in press.
- Gamisans, J. & Jeanmonod, D. (1993) Catalogue des plantes vasculaires de la Corse Ed. 2. Conservatoire et Jardin botaniques de la Ville de Geneve, Geneve, 258 pp.
- Ghafoor, A. (1978) *Caryophyllaceae*. In: Jafri, S.M.H. & El-Gadi (eds), A., *Flora of Lybia* 59. Al Faateh University, Tripoli, 122 pp.
- Hong, S.P., Han, M.J. & Kim, K.J. (1999) Systematic significance of seed coat morphology in *Silene* L. s.str. (Sileneae-Caryophyllaceae) from Korea. *Journal of Plant Biology* 42: 146–150.
<http://dx.doi.org/10.1007/BF03031023>
- Jarvis, C.E. (2007) *Order Out of Chaos*. The Linnean Society of London and Natural History Museum, London, 1016 pp.
- Linnaeus, C. (1753) *Species Plantarum* 1. Laurentii Salvii, Stockholm, 560 pp.
- Linnaeus, C. (1756) *Centuria II Plantarum*. Reg. Acad. Typogr., Uppsala, 38 pp.
- Löve, Á. & Kjellqvist, E. (1974) Cytotaxonomy of Spanish plants. III. Dicotyledons: Salicaceae–Rosaceae. *Lagasalia* 4: 3–32.
- Luque, T. & Lifante, Z.D. (1991) Chromosome numbers of plants collected during Iter Mediterraneum I in the SE of Spain. *Bocconeia* 1: 303–364.
- Minuto, L., Fior, S., Roccotiello, E. & Casazza, G. (2006) Seed morphology in *Moehringia* L. and its taxonomic significance in comparative studies within the Caryophyllaceae. *Plant Systematics and Evolution* 262: 189–208.
<http://dx.doi.org/10.1007/s00606-006-0458-1>
- Mira, S., González-Benito, M.E., Ibars, A.M. & Estrelles, E. (2011) Dormancy release and seed ageing in the endangered species *Silene diclinis*. *Biodiversity and Conservation* 20: 345–358.
<http://dx.doi.org/10.1007/s10531-010-9833-x>
- Oxelman, B., Liden, M., Rabeler, R.K. & Popp, M. (2001) A revised generic classification of the tribe Sileneae (Caryophyllaceae). *Nordic Journal of Botany* 20: 743–748.
<http://dx.doi.org/10.1111/j.1756-1051.2000.tb00760.x>
- Peruzzi, L., Adorni, M., Dura, T., Ghillani, L., Pasquali, G., Rignanese, L., Ronconi, D. & Teruzzi, M. (2012) *Allium cyrilli* Ten. (Amaryllidaceae): typification, taxonomy and update of the Italian distribution. *Phytotaxa* 71: 53–58.
- Peruzzi, L. & Carta, A. (2011) *Crocus ilvensis* sp. nov. (sect. *Crocus*, Iridaceae), endemic to Elba Island (Tuscan Archipelago, Italy). *Nordic Journal of Botany* 29: 6–13.
<http://dx.doi.org/10.1111/j.1756-1051.2010.01023.x>
- Peruzzi, L. & Eroğlu, E. (2013) Karyotype Asymmetry: again, how to measure and what to measure? *Comparative Cytogenetics* 7(1): 1–9.
- Peruzzi, L., Santangelo, A. & Jarvis, C.E. (2013) Lectotypification of Linnaean names in the Italian endemic flora. *Taxon*: in press.
- Pignatti, S. (ed) (1982) *Flora d'Italia* 1. Edagricole, Bologna, 790 pp.
- Rohrbach, P. (1868) *Monographie der Gattung Silene*. W. Engelmann, Leipzig, 249 pp.
- Rouy, G. & Foucaud, J. (1896) *Flore de France* 3. Société des sciences naturelles de la Charente Inférieure, Asnières & Rochefort, 382 pp.
- Runemark, H. (1996) Mediterranean chromosome number reports 6 (590–678). *Flora Mediterranea* 6: 223–243.
- Sommier, S. (1898) Aggiunte alla florula dell'Isola di Capraia. *Nuovo Giornale Botanico Italiano, nuova serie*, 5: 106–139.
- Siljak-Yakovlev, S. & Peruzzi, L. (2012) Cytogenetic characterization of endemics: past and future. *Plant Biosystems* 146: 694–702.
- Stuessy, T.F. (2009) *Plant Taxonomy. The systematic evaluation of comparative data*. Columbia University Press, New York, 539 pp.
- Talavera, S. & Bocquet, G. (1975) Nota sobre el genero *Silene* L. en España. I. Numeros cromosomicos de la sect. *Scorpioideae* (Rohrb.) Chowduri. *Lagasalia* 5: 47–54.
- Talavera, S. & Muñoz Garmendia, F. (1989) Synopsis del género *Silene* L. (Caryophyllaceae) en la Península Ibérica y Baleares. *Anales del Jardín Botánico de Madrid* 45: 407–460.
- Tenore, M. (1811–1815) *Flora Napolitana* 1. Stamperia francese, Napoli, 324 pp.
- Tenore, M. (1822) *Flora Medica Universale* 1. Stamperia francese, Napoli, 620 pp.
- Tenore, M. (1826) *Ad Florae Neapolitanae Prodromum appendix quinta*. Marotta & Vanspandoch, Napoli, 34 pp.
- Tenore, M. (1830) *Flora Napolitana* 4. Stamperia francese, Napoli, 358 pp.
- Thiers, B. (2011) *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Available from <http://sweetgum.nybg.org/ih/> (accessed: 23 February 2013).
- Valdés, B. & Parra, R. (1997) Números cromosómicos de plantas de Marruecos, 1. *Lagasalia* 20: 161–166.

APPENDIX 1. Specimens of *S. capraria*, *S. neglecta* and *S. nocturna* studied.

S. capraria:—ITALY. **Toscana**: Insula Capraria (Capraja), ad viam juxta portum (prope ecclesiam), 22 May 1898, *Sommier s.n.* (FI); fiorita nell'Orto Botanico di Firenze da semi raccolti il 20 maggio 1898 al M.te Castello nell'Isola di Capraia, 30 June 1899, *s.n.* (FI); fiorita nell'Orto Botanico di Firenze da semi raccolti il 22 maggio 1898 nell'Isola di Capraia al Porto, 30 June 1899, *s.n.* (FI); Insula Capraria (Capraja), in cacumine montis "Castello", 20 May 1898, *Sommier s.n.* (FI); Insula Capraria (Capraja), 27 May 1898, *Sommier s.n.* (FI); Insula Capraria (Capraja), 29 May 1898, *Sommier s.n.* (FI); Insula Capraria (Capraja), punta del Trattoio, 6 April 1896, *Sommier s.n.* (FI, lectotype); Insula Capraria (Capraja), Punta dello Zenobito, in clivis maritimis aridis, 6 April 1896, *Sommier s.n.* (FI); Insula Capraria (Capraja), punta dello Zenobito, pendici marine aride, 6 April 1896, *Sommier s.n.* (FI); Isola di Capraia (Livorno), ex Colonia Penale (UTM: 32T NN 67.67), 242 m s.l.m., 1 April 2012, *L. Peruzzi, G. Gestri s.n.* (PI).

S. neglecta:—ITALY. **Campania**: in arvis maritimis circa Persano, s.d., *Tenore s.n.* (FI, lectotype); in collibus siccis apricis..., s.d., *Tenore s.n.* (FI); Capri, s.d., *Tenore s.n.* (NAP, sub *S. neglecta* var. C); arene di Bagnoli, s.d., *Tenore s.n.* (NAP, sub *S. neglecta* var. C); *Silene neglecta* nob., s.d., *Tenore s.n.* (NAP); Astroni, s.d., *Tenore s.n.* (NAP, sub *S. neglecta* var. A); Persano, s.d., *Tenore s.n.* (NAP, sub *S. neglecta* var. A; lectotype); Portici, s.d., *Tenore s.n.* (NAP, sub *S. neglecta* var. C); **Toscana**: Toscana (Grosseto), Isola del Giglio. Cala di Pietrabona, lungo la mulattiera fino a 100 m dalla riva del mare, 20 May 1996, *Baldini s.n.* (FI); Toscana: Isola di Pianosa (Livorno), nel paese, presso il campo da tennis; procedendo verso la battigia, 22 May 1998, *Baldini s.n.* (FI); Toscana: Isola di Pianosa (Livorno), Cala Giovanna presso l'Obelisco, 25 May 1999, *Baldini s.n.* (FI); Isola di Montecristo, Vallone di Cala Maestra, versante N sotto il Colle del Segnale, 4 June 1965, *Fabbri, Bavazzano & Contardo s.n.* (FI); Isola di Montecristo, Vallone di Cala Maestra, versante N sotto il Colle del Segnale, 30 May 1965, *Fabbri, Bavazzano & Contardo s.n.* (FI); Isola di Montecristo, Poggio del Portale, rocce a NO, 30 March 1965, *Fabbri, Bavazzano & Contardo s.n.* (FI); Isola di Montecristo, spiaggia di Cala Maestra, 26 May 1964, *Fabbri, Bavazzano & Contardo s.n.* (FI); Arcipelago Toscano, Isola di Montecristo, Vallone di Cala Maestra, lungo il sentiero La Villa–Le Vasche, m. 29-100, 24 April 1974, *Paoli & Bavazzano s.n.* (FI); Vallone di Cala Maestra, sentiero tra la vigna ed il Collo dei Lecci, alt. 50-530, 2 April 1965, *Fabbri, Bavazzano, Contardo s.n.* (FI); Isola di Montecristo, parete Nord di Monte della Fortezza in una nicchia esposta a Est, 6 May 1966, *Fabbri & Tardelli s.n.* (FI); Arcipelago Toscano–Isola di Montecristo, il Belvedere, m 165 ca., 23, 27 April 1974, *Paoli & Bavazzano s.n.* (FI); Arcipelago Toscano–Isola di Montecristo, Segnale, m 100-115, 1 May 1974, *Paoli & Bavazzano s.n.* (FI); Isola di Montecristo, Vallone di Cala Maestra: nel fosso presso la villa, 1 April 1965, *Fabbri, Bavazzano & Contardo s.n.* (FI); Arcipelago Toscano–Isola di Montecristo, Colle dei Lecci m. 241-456 s.l.m., 7 May 1957, *Chiarugi & Bavazzano s.n.* (FI); Isola Montecristo (olim Oglasa), vulgata, 5 May 1898, *Sommier s.n.* (FI).

S. nocturna:—ITALY. **Toscana**: Isola di Pianosa (Livorno), punta del Marchese-Porto Romano, 23 May 1998, *Baldini s.n.* (FI); Insula "Topi", 15 May 1898, *Sommier s.n.* (FI); tra Castello e la Castellina al piede de Monte Morello, presso Firenze, 24 June 1890, *Sommier s.n.* (FI); ad aqueductum inter Pisa et Asciano, 3 July 1875, *Levier s.n.* (FI); Insula Elba (olim Ilva vel Aetalia), andando al Romitorio di Mon Serrato presso Porto Longone, 8 May 1898, *Sommier s.n.* (FI); Insula Elba (olim Ilva vel Aetalia), Capo della Vite, 20 June 1900, *Sommier s.n.* (FI); Insula Elba (olim Ilva vel Aetalia), Forte Falcone-Porto Terrai: haud rara, 1 May 1900, *Sommier s.n.* (FI); Insula Elba (olim Ilva vel Aetalia), colle sopra la Tonnara d'Enfola, 4 May 1900, *Sommier s.n.* (FI); Insula Elba (olim Ilva vel Aetalia), sopra Mola, sopra il tetto di una capanna abbandonata, 30 March 1900, *Sommier s.n.* (FI); Insula Gorgona (olim Urgo vel Gorgon), 1 April 1899, *Sommier s.n.* (FI); Insula Gorgona (olim Urgo vel Gorgon), 14 May 1899, *Sommier s.n.* (FI); Monte Pisano, Vicopisano (Pisa), loc. SS. Annunziata (UTM: 32T PP 21.39), sentiero roccioso, ca. 25 m s.l.m., 14 May 2010, *L. Peruzzi, B. Pierini, G. Bedini s.n.* (PI); **Lazio**: Ponza, Zannone, 5 May 1900, *Béguinot s.n.* (FI); **Calabria**: Calabria, presso Nicastro, 12 Junr 1899, *Fiori s.n.* (FI); prope Pizzo in Calabria ult., May 1877, *Biondi s.n.* (FI); in herbis prope Pizzo in Calabria ult. prim., 2 May 1877, *Arcangeli s.n.* (FI); in herbis secus viam prope "Scilla" in Calabria utl. 1°, 26 May 1877, *Arcangeli s.n.* (FI); Calabtia I occid. in arvis ad vias etc. circa Rhegium Julium (Reggio), 14 April 1877, *Huter, Porta & Rigo s.n.* (FI); **Sardegna**: Baunei, gariga su calcare con roccia affiorante nell'Altipiano sopra Baunei m 650, 29 May 1982, *Arrigoni & Di Tommaso s.n.* (FI); Sardegna, Cagliari Nuxis; pendici rocciose calcaree in loc. Tamaratricu, calcare paleozoico, 27 April 1985, *Arrigoni s.n.* (FI); UNKNOWN ORIGIN. Herb. Linn. No. 583.8 (LINN; lectotype).