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DISTRIBUTION OF THE GENUS *STERNBERGIA* WALDST. & KIT. (AMARYLLIDACEAE) IN TUSCANY (CENTRAL ITALY)

Abstract - The authors report an updated distribution of the genus *Sternbergia* Waldst. & Kit. (*Amaryllidaceae*) in Tuscany by the analysis of herbarium specimens, bibliographic references and records in the field. *S. colchiciflora* occurs in six localities, four in southern Tuscany and two in northern Tuscany. One out of them, the first in Firenze province, is here recorded. On the contrary, *S. lutea* is widespread in the region, but the distinction between natural populations and those escaped from cultivation is not always certain. Habitat suitability model at regional level for *S. colchiciflora* is also reported.

Key words - Flora, phytogeography, potential distribution, *Sternbergia*, Tuscany.

Riassunto - *Distribuzione del genere* Sternbergia *Waldst. & Kit. (Amaryllidaceae) in Toscana (Italia centrale)*. Gli autori presentano una distribuzione aggiornata del genere *Sternbergia* Waldst. & Kit. (*Amaryllidaceae*) in Toscana, tramite l'analisi di campioni d'erbario, riferimenti bibliografici ed indagini di campo. *S. colchiciflora* risulta presente in sei località, quattro nella Toscana meridionale e due nella Toscana settentrionale. Una di queste stazioni, la prima in provincia di Firenze, viene qui segnalata. *S. lutea* risulta invece maggiormente diffusa, ma non è sempre agevole distinguere tra popolamenti naturali ed altri sfuggiti alla coltivazione. Viene inoltre presentato un modello di distribuzione potenziale a livello regionale per *S. colchiciflora*.

Parole chiave - Flora, fitogeografia, distribuzione potenziale, *Sternbergia*, Toscana.

Introduction

The genus *Sternbergia* was described by Waldstein & Kitaibel (1803) after the discovery of a new «*Narcissus*» species in the arid grasslands of Hungary. The name was dedicated to the memory of the Hungarian botanist Caspar von Sternberg (1761-1838). Three species were originally included within this genus, all of them being already described two centuries before by Clusius (1601) on the basis of some iconographies depicted in 1597. The distribution range of the genus goes all across the Mediterranean, SE Europe and W Asia. According to a recent taxonomic revision (Pasche & Kerndorff, 2002) the genus presently includes 9 species: *S. candida* B. Mathew & T. Baytop, *S. colchiciflora* Waldst. & Kit., *S. clusiana* (Ker Gawl.) Ker Gawl. ex Spreng., *S. fischerana* (Herbert) Rupr., *S. greuteriana* Kamari & Artelari, *S. lutea* (L.) Ker Gawl. ex Spreng., *S. pu*lchella Boiss. & Blanche, *S. schubertii* A. Schenk and *S. sicula* Tineo ex Guss. Three out of 9 species occur in Italy (Conti *et al.*, 2005): *S. colchiciflora*, *S. lutea* and *S. sicula*, being only the first two reported for Tuscany. Aim of the present work is to update the phytogeographic knowledge of the genus *Sternbergia* in Tuscany and to elaborate a potential distribution map for the rare *S. colchiciflora*, at regional level.

Morphology, ecology and distribution of the two species

Sternbergia colchiciflora Waldst. & Kit.

Description: small hysteranthous geophyte; leaves 2-5, 5.5-13 × 0.5 cm, slightly keeled, rounded at apex, twisted, glaucous, with smooth or ciliate margins; spathe hyaline; flowers 1; perigon up to 9 cm in length, tepals 4.5-6 × 0.5-0.6 cm, lanceolate, acute, sometimes mucronate, sulphur-like yellow, whitish at the base; capsule 1-1.3 × 0.7-0.9 cm. Chromosome number: $2n = 20$ (Peruzzi *et al.* 2008 and literature cited therein). Distribution: Spain, France, Italy, ex Yugoslavia, Hungary, Romania, Bulgaria, Greece, ex URSS northern to Black Sea-Krym-Caucasus, Turkey, Syria, Lebanon, Israel, Algeria and Morocco (Mathew, 1983, 1984; Fernández Alonso, 1986; Morales & Castillo, 2004). *S. colchiciflora* is quoted in Italy for central-southern Apennine, Sicily and Sardinia (Pignatti, 1982; Conti *et al.*, 2005). Recently, Sicilian (Madonie and Etna; Brullo *et al.*, 2004) and S. Italian (Pollino; Peruzzi *et al.*, 2006) populations were re-investigated. Tuscan populations represent the northern limit of the species range in Italy. Habitat: sunny grasslands on rocky (generally calcareous) substrates, frequently on «red soil», at 240-1400 m a.s.l. In Sicily, it occurs in two distinct populations: the first one is linked to limestones in Madonie area and it was described as *S. exscapa* Tin., while the second one grows on lavic rocks in Etna area and it is considered as a distinct species (*S. aetnensis* Guss.) by some authors (Gussone, 1827, 1845; Lojacono Pojero, 1909; Brullo *et al.*, 2004). Phenology: flowering in September-October (Pignatti, 1982); the anthesis has very short duration, one week at most. The flowers are

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small and difficult to observe; perigon tube is always hypogeal. Generally, this species shows an high frequency of cleistogamy, ca. 70% (Peruzzi *et al.*, 2006), despite the bright colour of the flowers and the intense scent of burnt sugar. This feature could be an adaption of the species to the paucity of insects during flowering time and to the scarce visibility of the flowers. Seed dispersal is myrmechocorous (observed in the field), by means of an elaiosome.

***Sternbergia lutea* (L.) Ker Gawl. ex Spreng.**
Description: medium-sized synanthous geophyte, bulb subsphaerical; leaves up to 9, 8-25 × 1-2 cm, keeled, rounded at apex, with papillose margins; spathe partially green, acute; flowers 1-3, on peduncles 5-20 cm long; perigon showy, tepals 3.5-7 × 1-2 cm, spathulate-lanceolate, rounded at apex or shortly mucronate, bright yellow; capsule 1.5-2.5 × 1-1.5 cm. Chromosome number: $2n$ = 22, 33 (Peruzzi *et al.*, 2008 and literature cited therein), 30 (Morales & Castillo, 2004). Distribution: Spain, Italy, Sicily, ex Yugoslavia, Albania, Greece, ex URSS, Iran, Turkey, Israel and Iraq, N Africa (Tunisia, Algeria and Morocco) (Morales & Castillo, 2004). This species is widespread in Italy as native species and often also as cultivated ornamental. Typically, cultivated plants are triploid and natural populations are diploid. Habitat: grasslands, screes and open wood margins, on rocky (generally calcareous) substrates, at 200-1000 m a.s.l.

Materials and methods

Present distribution
The distribution of the genus *Sternbergia* was established on the basis of information coming from herbarium specimens, bibliographic data and field investigations during years 2005-2008. *Herbarium Centrale Italicum* of Firenze (FI), *Herbarium Horti Pisani* of Pisa (PI), *Herbarium Universitatis Senensis* of Siena (SIENA) and private herbarium of one of the authors (Herb. Frignani) were consulted. *Exsiccata* are ordered according to province and chronology. For each specimen, if applicable, collection locality, collection date, name of collector and herbarium acronym were listed. Bibliographic research dealt with floristic literature and books on Tuscan flora. Literature data are listed according to province and in chronological order. New localities are supplied with geographic coordinates (UTM datum ED 50).

Habitat suitability model and potential distribution
Beginning from the actual sites of occurrence of *S. colchiciflora*, we tried to build a predictive model based on their environmental features. Habitat Suitability Models (HSM) permit to integrate the relationships species-environment and represent an useful tool for planning field research and conservation project of rare species (Duprè, 1996; Nichols, 2001). The Mahalaclass model implemented within the GIS software Idrisi was used. This model has a fuzzy approach in the territory classification by means of estimated probability of species occurrence (Eastman, 2003). Mahalaclass classificator uses Mahalanobis distance (Mahalanobis, 1936), a multivariate statistic distance which is based on the covariance of the considered variables respect to training sites (sites of actual occurrence of the species). The considered parameters were: a) geographic (altitude, aspect and exposition), b) climatic (temperature, precipitations and relative humidity), c) geologic (kind of substrate) and d) vegetational (estimation of plant biomass). Topographic parameters were derived from a digital model of Tuscany (DEM) at 50 meters resolution. Climatic parameters were inferred from 10 years of measurements effected by «Agenzia Regionale per lo Sviluppo e l'Innovazione nel Settore Agricolo-forestale» in 121 climatic stands. The values were then interpolated by obtaining a spatial regional model for each climatic variable considered. Normalized Difference Vegetation Index (NDVI, Tucker *et al.*, 1986) was used for vegetation data.

Results and discussion

Sternbergia colchiciflora
Specimens seen - Province of Florence: Sesto Fiorentino (Firenze), Monte Morello, cresta meridionale del Poggio del Giro (UTM: 32T PP 80.57), 670 m s.l.m., pascoli ad ovest del sentiero, 16 Mar 2008, *L. Peruzzi, G. Gestri, B. Pierini* (PI); **Province of Grosseto**: Montieri (Grosseto), Cornate di Gerfalco, brometo xerico presso la vetta, 900 m s.l.m, 28 Feb 2000 *F. Frignani, C. Angiolini* (SIENA); Castell'Azzara (Grosseto), Monte Penna, pascoli aridi presso la vetta, 1050 m s.l.m., 15 Mar 2006 *F. Frignani, T. Giallonardo* (SIENA); **Province of Prato**: Prato, Monti della Calvana, tra La Retaia e Poggio Cocolla (UTM: 32T PP 71.63), 790 m s.l.m., in carpineto con *Cornus mas*, 25 Mar 2008, *G. Gestri* (PI); Prato, Monti della Calvana, tra La Retaia e Poggio Cocolla (UTM: 32T PP 71.63), 790 m s.l.m., in rimboschimento a pino nero, 30 Mar 2008, *G. Gestri* (PI); **Province of Siena**: Trequanda (Siena), prateria arida su calcare, presso la Cava del Madonnino, 650 m s.l.m., 15 Mar 2006, *A. Mazzeschi* (SIENA); Sarteano (Siena), Monte Cetona, pascoli aridi presso il Varco, 870 m s.l.m., *A. Mazzeschi* (SIENA).

Bibliographic data - Province of Prato: Monti della Calvana (Gestri, 2009); **Province of Grosseto**: Cornate di Gerfalco (Frignani *et al.*, 2004); Monte Penna (Frignani *et al.*, 2008); **Province of Siena**: Monte Cetona (Mazzeschi & Selvi, 1999); Trequanda (Frignani *et al.*, 2005).

Until 1999 *Sternbergia colchiciflora* was known only for Mt. Cetona; during the last decade other four populations have been found both in southern and northern Tuscany. We add now one more locality to this scenario, for a total of six populations (Fig. 1). Populations of northern Tuscany define the northward range of *S. colchiciflora* in Italy.
A potential distribution map was built, which will be useful as a basis for future field research (Fig. 2). The

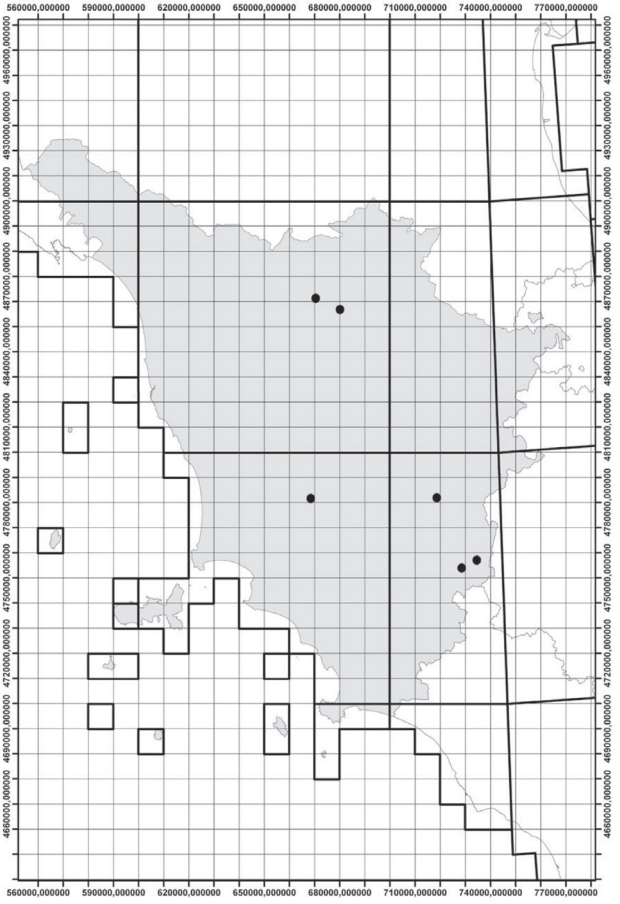

Fig. 1 - Distribution of *Sternbergia colchiciflora* in Tuscany on a UTM ED 50 grid map (the 10x10 km grid is arbitrary).

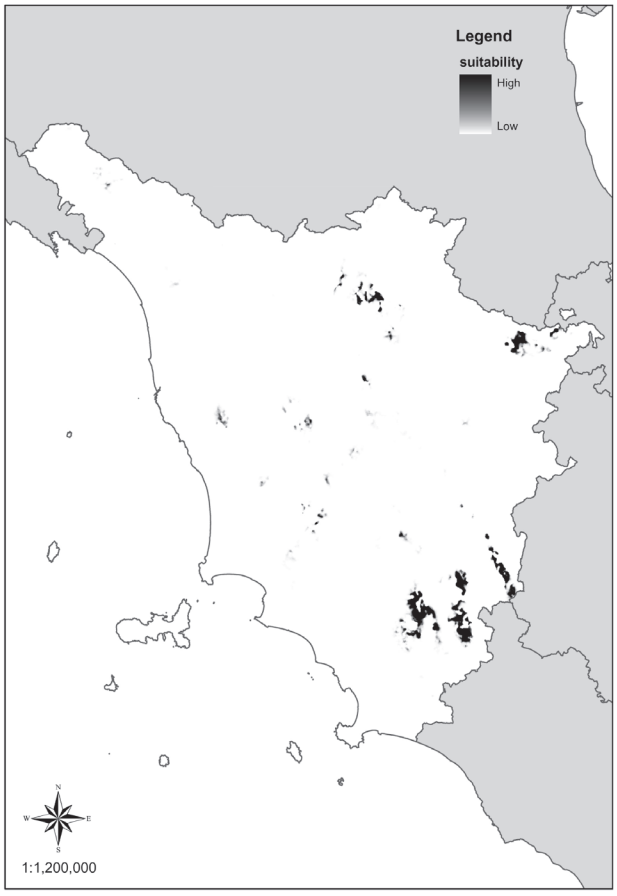

Fig. 2 - Potential distribution of *Sternbergia colchiciflora* in Tuscany.

elaborated model found a suitable habitat for the species severely fragmented, in being strictly linked to peculiar edaphic (basic soil on limestone) and vegetational (natural or semi-natural grasslands) conditions. Morevoer, this kind of habitat is actually in regression, due to abandonment of traditional land use. It is noteworthy to say that *S. colchiciflora* in northern Tuscany is still present also under artificial woods, which however could cause soon the local extinction of the species. Three main nuclei of potentially suitable localities are identified in the map: the first one (Monte Morello and Monti della Calvana) in northern Tuscany; the second one near the NE administrative border of the region (Casentino - Pieve S. Stefano); the third one (Monte Cetona and Monti di Trequanda close to Appennino Umbro; Monte Labbro, Stribugliano, S. Fiora, Monte Civitella, Campiglia d'Orcia e Bagni San Filippo near the Mount Amiata area) in southern Tuscany extending near the administrative borders with Latium. In central Tuscany some punctiform suitable locality can be seen in the Colline Metallifere area (among them: Cornate di Gerfalco and Poggio di Prata) and in Grosseto province.

Sternbergia lutea

Specimens seen - Province of Arezzo: (?) ai Ponti, s.d., *Amidei* (FI, PI); Castello di Gressa in Casentino, Sep 1863, *Marcucci* (FI); Cast. di Gressa in Casentino 28 Sep 1863, *Marcucci* (PI); In gramineis ad castella vetera Etruriae, in Valle Arni Superiore (Bibbiena di Chitignano, in Casentino), Sep 1877, *Marcucci* (FI); Alta Valle Tiberina pr. Lignano, 7 Oct 1933, *Pichi Sermolli* (FI); **Province of Florence**: prope Florentiam sotto la Villa di Monte Polsi in Val di Pesa, abbondante e spontaneo sotto la casa di un contadino, s.d., s.c. (FI); Siena, Malmantile, s.d., *Bergest* (FI); secus viam Di Contro dictam (?), Sep, s.c. (FI); contorni di Firenze, 1830, *Ricasoli* (FI); prope Certaldo a Cutigliano, 30 Sep 1843, *Parlatore* (FI); Etruria: Malmantile, 1 Oct 1859, *Caruel* (PI); Firenze, Gamberaja, Sep 1866, *Levier* (FI); Gamberaja, 18 Sep 1866, *Levier* (FI); Italia media. Fiesole près Florence, 14 Sep 1868, *Levier* (FI); Fiesole près Florence, 25 Sep 1868, *Levier* (FI); Gamberaja, 21 Sep 1870, *Levier* (FI); env. of Florence, Malmantile, Sep 1874, *Archbald* (FI); in herbidis sylvanum prope «Castelfalfi», Sep 1877, *Bastianini* (FI, PI); Malmantile empolese, lungo la siepe presso la chiesa, 23 Oct 1879, *Martelli* (PI);

luoghi lungo uno stradone Marignolle presso il Dittamo, 2 Sep 1881, *Tanfani* (FI); Lastra a Signa prope Florentiam, Oct 1881, *Groves* (FI); in umbrosis hic inde circa Florentiam, sic rara, Oct 1886, *Levier* (FI); Cerreto Guidi, 7 Oct 1893, s.c. (FI); Malmantile lungo la strada tra la (?), 26 Sep 1899, *Martelli* (FI); in Mugello - alle Pozze presso San Martino (?) 15 Oct 1904, *Sommier* (FI); prope Florentiam fra Doccia (Sesto) e Morello in grande abbondanza lungo la via presso una casa colonica, 1 Nov 1905, *Sommier* (FI); Soffiano nelle siepi, Sep 1907, *Martelli* (FI); prope Florentiam fra Grassina e Irata via Chianti lungo la via, 1 Nov 1909, *Sommier* (FI); fra Tavarnuzze e Impruneta pochi passi avanti la Cappella della bella querce, abbondante assai (?), 22 Feb 1914, *Sommier* (FI); fra Paterno e Carvili, verso Vernalese, 15 Mar 1914, *Sommier* (FI); prope Florentiam cima del Cupolino (Monte Rinaldi - via bolognese), 3 Oct 1915, *Gennari* (FI); prope Florentiam siepe lungo la via che si parte a Massola e va a Rovezzano passando per la Villa Sforzi (?), 18 Feb 1916, *Sommier* (FI); **Province of Grosseto**: Toscana: Monte Argentario (Grosseto), La Cacciarella, 25 Sep 1989, *Tosi* (FI); **Province of Livorno**: Arcipelago toscano - Isola d'Elba, Bagnaia, nella valle, 2 Sep 1977, *Fossi Innamorati* (FI); Toscana, Isola d'Elba (Livorno), loc. San Giovanni, lungo la strada, alt. 10-30 m, esp. Nord, 26 Sep 1992, *Luccioli* (FI); **Province of Lucca**: In apennino a Tereglio in arvis, 8 Nov 1856, *Caruel* (PI); Monte Pisano a Vicopelago nella torre, 1861, *Bottini* (PI); in Monte Pisano a Vicopelago, Sep 1863, *Arcangeli* (PI); Monte Pisano a Gattaiola, Sep 1863, *Beccari* (FI); presso Lucca a Gattajola, 1869, *Beccari* (FI); Gattaiola presso la chiesa, a due miglia da Lucca, 15 Oct 1877, Bottini (PI); S. Margherita a Mortici (?), 3 Oct 1880, *Della Nave* (FI); **Province of Massa-Carrara**: Fivizzano, Nov 1929, *Pellegrini* (PI); **Province of Pisa**: Montecastello (Pisa), castagneto, s.d., *Casini* (FI); luoghi salvatici presso la Striscia (Volterra), s.d., *Biondi* (FI); alla Striscia nel Volterrano, 13 Sep 1872, *Biondi* (FI); **Province of Pistoia**: Pescia: nei poggi delle Marzolle presso la Villa Cecchi, 9 Oct 1887, *Fantozzi* (FI); Casalguidi a sud di Pistoia, Oct 1886, *Costa-Reghini* (PI); **Province of Prato**: Prato, Monte Le Coste, lungo il sentiero, poco sopra Cerreto, 16 Mar 2008, *L. Peruzzi, B. Pierini, G. Gestri* (PI); **Province of Siena**: Senae, in pratis arvis, Sep 1898, s.c. (FI); Montaperti (Siena), poggi erbosi lungo la strada di S. Ansano, 250 m s.l.m., 10 Oct 1984, *E. Ferrarini* (SIENA); Sovicille (Siena), lungo la strada fino ad Ancaiano, 377 m s.l.m., 16 Sep 1938, *R. Cucini* (SIENA); Siena presso le mura della Fortezza, 330 m s.l.m., s.d., *A. Andreucci* (SIENA); Siena, presso le mura fuori Porta San Marco, 350 m s.l.m., 20 Oct 2007, *F. Frignani* (Herb. Frignani); Castellina Scalo (Siena), lungo la strada per Poggibonsi, 188 m s.l.m., 12 Oct 2008, *F. Frignani* (Herb. Frignani); Sovicille (Siena), nei pressi della Pieve di Ponte allo Spino, 188 m s.l.m., 12 Oct 2008, *F. Frignani* (Herb. Frignani).

Bibliographic data - Province of Arezzo: a Chitignano («Catignano») (Caruel, 1864); Castello di Gressa in Casentino (Caruel, 1865); in Casentino al Castello di Gressa, Bibbiena e a Chitignano (Baroni, 1908);

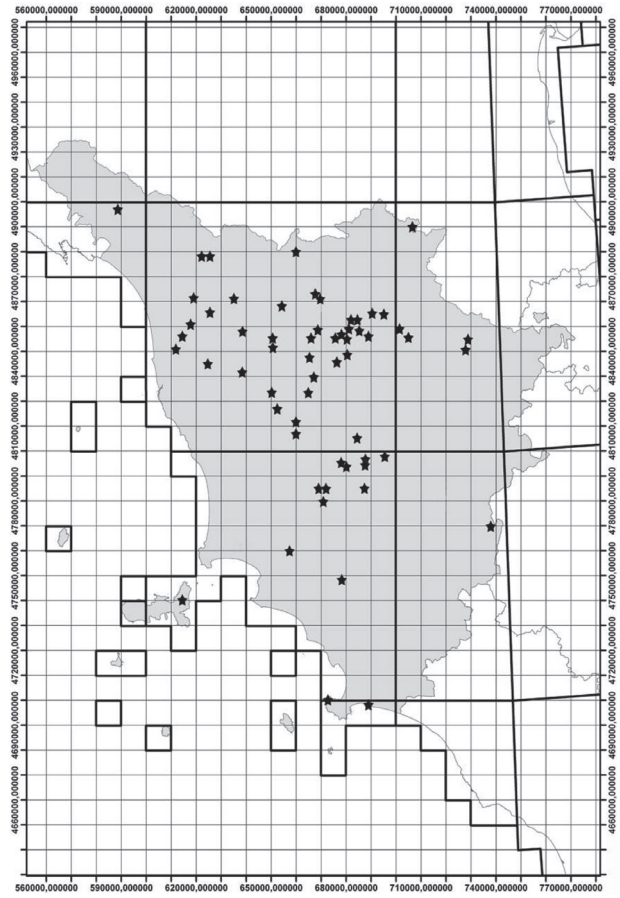

Fig. 3 - Distribution of *Sternbergia lutea* in Tuscany on a UTM ED 50 grid map (10x10 km grid is arbitrary).

Province of Florence: l'Agro fiorentino a Malmantile, l'Impruneta, a S. Felice a Ema, al Pian di Ripoli, Citille di Val-d'Elsa, Certaldo ad Albagnano (Caruel, 1864); Cerreto Guidi, in Mugello sulle falde di m. Giovi fra S. Martino e Le Pozze, sotto Vallombrosa a Paterno (Baroni, 1908); **Province of Grosseto**: in Maremma presso le rovine di Ansidonia (Baroni, 1908); **Province of Lucca**: Lucca a Mastiano, a Vicopelago, a Gattajola, e App. Lucchese a Tereglio (Caruel, 1864); nel Lucchese a Coreglia (Baroni, 1908); **Province of Pisa**: Pisa (Savi, 1798); M. Pisano, Volterra ai Ponti (Caruel, 1864); **Province of Pistoia**: val di Nievole alla base dei poggi intorno a Pescia (Baroni, 1908); **Province of Prato**: presso Prato (Caruel, 1864); **Province of Siena**: Siena alla Fortezza (Caruel, 1864).

S. lutea is widespread in Tuscany, occurring most frequently in Valdarno and around Siena (Fig. 3). Many confirmed historical records and some of the new localities here reported refer to populations doubtfully native, which are often close to inhabited centres.
The question about the naturality of *S. lutea* in Tuscany, cannot be addressed by means of a potential distribu-

tion map, built with the same inductive approach used for *S. colchiciflora*. This is because the species occurs in small landscape patches (e.g. road margins or gardens), whose size is smaller than the resolution of the layers used (= ca. 28.5 meters).

Conclusions

Recent findings of *Sternbergia colchiciflora* in Florence and Prato provinces move about 80 km northwards the range limit of this species in Italy. Since *S. colchiciflora* is very difficult to observe in the field, it is likely that further findings will be possible in future, especially with *ad hoc* field researches in the areas highlighted by our potential distribution map (Fig. 2). On the other hand, suitable habitats for this species are in regression due to abandonment of traditional land use and this could severely damage this species in Tuscany. For these reasons it could be regarded as a Near Threatened (NT) species, according to the IUCN criteria (IUCN, 2001).
Concerning *S. lutea*, its native status in Tuscany is in many cases controversial: it is a widespread species (many historical records were confirmed, and also new localities were reported), but its presence seems to be of anthropogenic origin, occurring often near towns and villages, gardens and road margins. This species is not considered at extinction risk in Tuscany. Not only it is very likely that *S. lutea* still occurs in all the historic sites, but maybe also that the distribution presented here is underestimated.

Identification key for Tuscan *Sternbergia* species

1. Hysteranthous, with twisted leaves, tepals 4.5-6 × 0.5-0.6 cm ..... *S. colchiciflora*
1. Synanthous, with not twisted leaves; tepals 3.5-7 × 1-2 cm ..... *S. lutea*

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