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RESEARCH PAPER

Exotic species in the Erbario Estense: new plants from the world to sixteenth-century Italy

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Abstract

Renaissance herbaria may provide precious information on exotic plants known or even introduced in Italy during the fifteenth and sixteenth centuries AD. In the Erbario Estense, preserved in the Archivio di Stato di Modena (northern Italy), there are 14 species considered as allochthonous neophytes or not present in the Italian flora. First, we accurately verified the taxa identification; then, we searched for the same species in the other coeval Italian Renaissance herbaria and collected the information present in the written sources of the second half of the 1500s (concerning, above all, the use of these species as medicinal plants); finally, we paid attention to their current uses in ethnobotanical tradition and their market value. For 12 taxa, we could confirm the former identification; whereas for 2, we came to a different conclusion; the comparison with other Renaissance herbaria, particularly Aldrovandi's, greatly helped this evaluation process. The species treated here are not placed according to a precise order nor do they have particular medicinal values in common: probably, the specimens were simply added to the existing nucleus, as the species were known or were proven to be rather useful. We shall be able to gain further knowledge when it shall be possible to study all the remaining species. In any case, the Erbario Estense is an important testimony for sixteenth-century botany, that contains some of the most ancient specimens of exotic species that are of common use in large parts of the world today.

Graphical abstract

Extended author information available on the last page of the article

Keywords Ancient herbaria · Species identification · Ethnobotany · Phytomedicine · Ferrara

1 Introduction

In Europe, one of the most significant floristic changes of the last five centuries is the introduction of exotic species (Simberloff and Rejmánek 2012; Pyšek et al. 2020), in many cases originating from the far east or the New World, thanks to geographic exploration during the late 1400s and 1500s (Peccenini 1994). Some of these species were brought to Europe as food plants or for their true or presumed medicinal properties, or as decorative plants; others, at least initially, were a sort of botanical curiosity, an occasion to show a precious and expensive rarity for royal courts, or rich families who were passionate about gardening and aimed to influence politics (Mattirolo 1900; Ubrizsy Savoia 1993; Paoli 2019).[1] Especially from the 1540s onwards, these new plants became a study object for scholars (Cristofolini 1992; Signorini 1996); in the same period, the first botanical gardens of Europe were founded, not only for scientific research, but also as a status symbol of enlightened monarchs to exhibit power and wealth (Pignatti 2016). In botanical gardens, in fact, one could find not only medicinal plants, cultivated for scientific and educational reasons, but also various exotic species, that formed the most interesting and attractive collections: the cultivations of ornamental bulbous plants coming from southern Europe or Asia in the *hortus academicus* of Leiden are a good example in this sense (Perini 2016). As to the species with pharmaceutical properties, from the discovery of America onwards, the eastern parts of the world began competing with the transatlantic pharmacopeia. Nicolás Monardes studies and experiments, cultivates plants in his own garden, and makes tests on his patients. In a former article (Vicentini et al. 2020a), we remembered his *Historia Medicinal de las cosas que se traen de nuestras Indias Occidentales*, where tobacco is treated for the first time (Monardes 1571). Francisco Hernández, *Protomédico general de las Indias*, speaks of chocolate and tobacco. These two products, once imported in Europe, are removed from the ritual register of the Indian and placed into the one containing European medicine. The knowledge of local therapeutic uses was often extorted from native local populations. There is, however, a sort of communication issue between the approaches of diverse worlds, leading to misunderstandings and irreducibility between the Indian pharmacopeia and the European approach to medicine (Boumediene 2016). Medicinal botany historians often believed that consumption of foreign herbal remedies was aimed to consume diversity: men and women were simply drawn to any mind of exotic remedies (Schiebinger 2004; Norton 2008; Gänger 2015). Many Europeans who consumed these remedies, which were extremely popular, regarded them as fetishes. Studies were even made on their consumption based on the ratio between import and population (Gänger 2015). Therefore, in medicine, the interest in exotic plants can be measured with different parameters, going beyond the scientific approach deducible from their relevance in printed books, botanical gardens, and ancient herbaria.

Not rarely, exotic species were imported thanks to the trading houses that merchants had in Eastern Europe or the Levant: this trafficking, first limited to fruit, already began in the XIII century (Targioni Tozzetti 1853). Not forgetting the fundamental role of the Spanish and Portuguese in bringing many important American plants to Europe, thanks to their control over the transatlantic trades with the New World (Paoli 2019). Various of these species subsequently established in the European flora; others instead disappeared a long time ago, so that their presence could not have been reported in the national Floras (cfr. Buldrini et al. 2023a), because of the culture dying out or simply a change in the vogue or tastes of the population, that led to their import from abroad to cease altogether. Often, the very first tangible records of the species brought to Europe, thanks to these explorations, are contained in the few still existing Renaissance herbaria (e.g., Vicentini et al. 2018, 2020a; Buldrini et al. 2023b), whose value is, therefore, inestimable both from a historical and scientific viewpoint (Moggi 2012). For the poor state of preservation of the specimens and the non-formalised polynomial nomenclature, the identification of some species may be uncertain or controversial (e.g., Costa et al. 2016, 2018), causing errors in the estimation of the period of their introduction in Europe or specific countries. Nevertheless, the comparison with other herbaria and coeval textual sources can help to correct such misinterpretations, therefore adopting a multidisciplinary approach is fundamental (cfr. Pulvirenti et al. 2015; Costa et al. 2016; Bosi et al. 2017, 2022).

In the small universe of the still existing Renaissance herbaria, the Erbario Estense, preserved in the Archivio di Stato di Modena, still holds a special place (Vicentini et al. 2020b). It is one of the least rich in *exsiccata* (only 182

[1] It is due to note that, in fact, the chromatic variety of European gardens, up to the end of the XVI century, was overall limited, because of the limited color range of the flowerings of the species cultivated at that time (nearly all of them belonging to Europe's native flora) and the scarcity of deciduous plants with a vivacious foliage during Autumn (Maniero 2015).

specimens known today, corresponding to 162 taxa currently recognised – Camus and Penzig 1885; Baldini et al. 2022), but holds several species of non-European origin, some of them not present in the other sixteenth-century herbaria of Italian manufacture. This provided the basis for the work here described, focused on the introduction of such species to Italy. We searched for the earliest traces of these species, both in the Renaissance Italian herbaria and in the main medical–pharmaceutical written sources. We also searched ethnobotanical present-day information, to show a possible continuation in their uses, both in Italy and in the rest of the world.

2 Materials and methods

We extracted all species regarded as allochthonous for the flora of Italy (*sensu* DRYADES 2023) which are present in the Erbario Estense, keeping apart the archaeophytes because, in many cases, they have been present in Europe for millennia and can therefore be considered as part of the spontaneous European flora ("honorary natives" *sensu* Stace and Crawley 2015). The archaeophytes will be treated in detail, together with the autochthonous species, in a subsequent study dedicated to the remaining parts of the Erbario Estense.

Performing a scrupulous control of every specimen, we checked the identifications made by Camus and Penzig (1885), re-identifying the *exsiccata* whenever necessary, according to the keys published by Austin (1982), Deroin (2001), Pignatti et al. (2017–2019), Staples (2018), Anton et al. (2019). The specimens are generally quite well preserved and with all parts which are fundamental for a reliable identification, therefore we could recognise the species with a good degree of certainty. In case of uncertain or perhaps erroneous identifications, we also compared the specimens of the Erbario Estense to more recent specimens preserved in the *Herbarium Centrale Italicum* in Florence (FI—Table 1).

Only the neophytes and the species not present in the Italian Flora were searched for in the other Italian Renaissance herbaria (*sensu* Baldini et al. 2022—Table 2): Erbario Aldrovandi, Erbario "Scuola di Aldrovandi", and Erbario "Bauhin a Bologna", all of them preserved in Bologna (BOLO); Erbario Cesalpino and Erbario Anonimo Toscano (formerly Erbario Merini), preserved in Florence (FI); Erbario Ex Cibo B, preserved in Biblioteca Angelica in Rome; Erbario *En Tibi*, preserved in Leiden but of Italian origin (Stefanaki et al. 2018, 2019); Erbario Imperato, preserved in the Biblioteca Nazionale di Napoli (Ciarallo 1986). The research was performed looking through the names by which the species were known during the XVI century (see Durante 1585; Bauhin 1623 and Penzig 1924 for a list of these names).

The current uses confirmed by clinical practice, paying special attention to those confirming ancient ones already reported by Mattioli (1568) and Durante (1585), were then sought after. Finally, the main ethnobotanical and economic information related to these species was surveyed, on both an Italian and global scale (Table 3).

3 Results and discussion

Regarding the most recent Italian floras and checklists (Pignatti et al. 2017–2019; Galasso et al. 2018; DRYADES 2023), in the Erbario Estense 24 allochthonous species were detected (globally 28 *exsiccata* in 26 sheets), of which 10 archaeophytes (for details, see below in the text), 8 neophytes (4 invasive, 2 casual/cultivated, 2 naturalised), and 6 species currently not present in Italy (Table 1). As for 22 of them we could confirm the identification performed by Camus and Penzig (1885), only updating the nomenclature wherever necessary (for a total of 22 taxa surely recognised at the species level, here included *Nicotiana tabacum* L.—Vicentini et al. 2020a), whereas for 2 species (here included *Nardostachys jatamansi* (D. Don) DC.—Vicentini et al. 2018), we arrived at a different conclusion. The families represented are 20 and only Solanaceae, Euphorbiaceae, and Fabaceae include more than one species (3, 2, and 2, respectively).

Among the neophytes and the species currently not present in Italy, 6 of them are of American origin with the remaining ones originating from an Asian native range or more diversified. Of these 14 species, 12 were introduced in Italy, 10 of them between the early and late XVI century; for the two remaining species, instead, there is no evidence of them having been imported to Italy (*sensu* Saccardo 1909; Maniero 2015—Table 1).

The archaeophytes are 10: (1) *Alcea rosea* L., (2) *Aloe vera* (L.) Burm. f., (3) *Antirrhinum majus* L., (4) *Carthamus tinctorius* L., (5) *Crocus sativus* L., (6) *Euphorbia lathyris* L., (7) *Papaver somniferum* L., (8) *Petroselinum crispum* (Mill.) Fuss, (9) *Ricinus communis* L., (10) *Trigonella foenum-graecum* L. Of these, 7 species (1, 2, 3, 6, 7, 8, 10) are considered naturalised in Italy, 2 (4, 5) are casual and only one (9) invasive (*sensu* Galasso et al. 2018; DRYADES 2023). They have been known in Italy since ancient times; the latest arrivals (*Aloe vera*) dating back to 1415 (Saccardo 1909; Maniero 2015), but were in fact well known at least since the Roman period (André 2010). Two species are cultigenous: *Alcea rosea* (probably a hybrid *A. setosa* (Boiss.) Alef. × *A. biennis* Winterl—POWO 2023) and *Crocus sativus* (probably derived from a selection of *C. cartwrightianus* Herb.—see Colasante 2014 for further details). All of these

Table 1 Synopsis of the specimens of neophytes and species not present in Italy today preserved in the Erbario Estense

Erbario Estense			Previous identification	Plant part and its state of preservation		Identified species, family and native range			Introduction in Italy (*sensu* Saccardo 1909; Maniero 2015) and current status in the Italian Flora (*sensu* Galasso et al. 2018; DRYADES 2023)	
c. 13	13	"Dittamo di Candia"	*Ballota pseudodictamnus* Benth. cfr.	Four little pieces of shoots with some leaves*	Decent	*Pseudodictamnus mediterraneus* Salmaki & Siadati cfr.	Lamiaceae	EUROPE (Greece), ASIA (Turkey), AFRICA (Libya, Egypt)	1827	N NAT
c. 17	21	"Lauro gregio"	*Prunus Laurocerasus* L.	Three leaves (only imprint)	Specimen disappeared	*Prunus laurocerasus* L.	Rosaceae	EUROPE (North-East), AFRICA (Libya), ASIA (Iran)	1563	N INV
c. 30 and c. 54	36 and 65	"Noce vomitta" and "Noce Mettella"	*Datura Stramonium* L.	Leaf; branch with leaves and a flower	Poor and good	*Datura stramonium* L.	Solanaceae	AMERICA (Central)	1585	N INV
c. 38	45	"Balsamina"	*Momordica Balsamina* L.	Three leaves	Poor/decent/poor	*Momordica balsamina* L.	Cucurbitaceae	TROPICS & SUBTROPICS (Africa, Arabian Peninsula, Australia)	1415	n.p
c. 45	58	"Tabacho ouer Herba Regina"	*Nicotiana Tabacum* L.	Leaves and branch with flowers	Good	*Nicotiana tabacum* L.	Solanaceae	AMERICA (South—Bolivia)	1570	N CAS CLT
c. 51	62	"Trifolio acetoso"	*Oxalis stricta* L.	Branches with leaves and fruits	Decent	*Oxalis stricta* L.	Oxalidaceae	ASIA (China, Japan), AMERICA (North)	1532	N INV
c. 58	69 and 70	"Marauiglio di Spagna Zalo" and "Marauiglio di Spagna Rosso"	*Mirabilis Jalappa* L.	Branches with leaves and flowers	Decent	*Mirabils jalapa* L.	Nyctaginaceae	AMERICA (Central)	1583	N INV
c. 90	112	"Senna Vera delle spiciarie, che vien di leuante"	*Cassia* sp. (cfr. *Cassia obovata* Colladon)	Branches with leaves and fruits*	Good	*Senna* cfr. *italica* Mill.	Fabaceae	AFRICA, ASIA (Arabian Peninsula, Iran, Iraq, India)	1532	n.p
c. 92	114	"Garoffoli delle Spiciarie"	*Caryophyllus aromaticus* L.	Twigs (fragmented) with leaves and floral buds	Poor	*Syzygium aromaticum* (L.) Merr. & L.M. Perry	Myrtaceae	ASIA (Maluku)	—	n.p

Table 1 (continued)

Erbario Estense			Previous identification	Plant part and its state of preservation		Identified species, family and native range			Introduction in Italy (*sensu* Saccardo 1909; Maniero 2015) and current status in the Italian Flora (*sensu* Galasso et al. 2018; DRYADES 2023)	
c. 94	120	"Spigo nardo"	*Andropogon Nardus* L.	Plant basis	Decent	*Nardostachys jatamansi* (D.Don) DC.	Caprifoliaceae	ASIA (Himalaya, China, Myanmar)	—	n.p
c. 116	141	"Masturtio ouer Nasturtio d'India ed il suo fiore"	*Tropaeolum minus* L.	Branch with leaves and flowers	Decent	*Tropaeolum minus* L.	Tropaeolaceae	AMERICA (South—Ecuador, Peru)	1642	n.p
c. 117	142	"Pomi d'Ettiopia ouer Pomi d'oro"	*Solanum Lycopersicum* L.	Branches with leaves and flowers	Good	*Solanum lycopersicum* L.	Solanaceae	AMERICA (South—Peru)	1551	N CAS CLT
c. 118	143	"Vescicaria"	*Cardiospermum Halicacabum* L.	Branches with leaves, flowers and fruits*	Good	*Cardiospermum halicacabum* L.	Sapindaceae	TROPICS & SUBTROPICS	1532	N NAT
c. 119	144	"Veluschio ceruleo cosi ditto da Castor Durante"	*Ipomea Quamoclit* L.	Leaf and branch with leaf and two flowers	Decent	*Ipomoea nil* (L.) Roth	Convolvulaceae	AMERICA (Tropical & Subtropical)	1532	n.p
Sheet number, plant number and its inscription			Camus and Penzig (1885)	Direct observations between the years 2022 and 2023 (* in these samples, in addition to glue, also paper strips were used to fix the specimen to the sheet)		Vicentini et al. (2018, 2020a, b) and this work	*sensu* POWO (2023)		N = neophyte; INV = invasive; NAT = naturalized; CAS = casual; CLT = cultivated; n.p. = not present	

Position in the herbarium, former and current identification, state of preservation of the *exsiccata*, native range, year of introduction and current status in Italy are shown

Table 2 Neophytes and species not present in Italy today preserved in the Erbario Estense: presence in other Italian Renaissance herbaria

	Erbario "Anonimo Toscano" (1545–1550)	Erbario Ex Cibo B (1550–1553)	Erbario Aldrovandi (1551–1586)	Erbario Cesalpino (1557–1563)	Erbario *En Tibi* (1558)	Erbario "Bauhin a Bologna" (mid-1500-early 1600)
Cardiospermum halicacabum L.		X	X	X		X
Datura stramonium L.						X
Ipomoea nil (L.) Roth			X		X	
Mirabils jalapa L.			XX			
Momordica balsamina L.			XX	X		
Nardostachys jatamansi (D. Don) DC.		X	X		X	
Nicotiana tabacum L.			XXX			
Oxalis stricta L.		X	X			
Prunus laurocerasus L.			X	X		
Pseudodictamnus mediterraneus Salmaki & Siadati	X	X	X	X		X
Senna italica Mill.		XX	XX		X	
Solanum lycopersicum L.		X	X		X	
Syzygium aromaticum (L.) Merr. & L.M. Perry						
Tropaeolum minus L.			XXX			
Identification	Chiovenda (1927, 1932)	Chiovenda (1909)	Soldano (2000, 2001, 2002, 2003, 2004, 2005)	Caruel (1858)	Stefanaki et al. (2018)	Cristofolini (2023)

species can be used for food, medicine, fodder, dyeing, or ornamental purposes (*sensu* Guarrera 2006; Pignatti et al. 2017–2019). As already said, these species will be treated in depth in a future article.

3.1 Neophytes and species not present in the Italian Flora

Besides *Nicotiana tabacum* L. (see Vicentini et al. 2020a), we were able to confirm the identification performed by Camus and Penzig (1885) for 12 sheets, for a total of 10 taxa surely recognised at species level and another for which it is not possible to fully confirm the species (as done by Camus and Penzig; see Table 1).

"Dittamo di Candia" (c. 13r., n. 13): cfr. *Pseudodictamnus mediterraneus* Salmaki & Siadati (formerly named *Ballota pseudodictamnus* Benth.; Fig. 1a).

The specimen consists of 4 small shoot fragments with few small (1 cm or less) sub-orbicular leaves: given the absence of diagnostic characters we accepted the identification made by Camus and Penzig (1885), who attributed the specimen as belonging to this species "with great probability". Based on Pignatti et al. (2017–2019, sub *B. pseudodictamnus* (L.) Benth.), *P. mediterraneus* is the sole species of this genus coinciding with the specimen of the Erbario Estense.

According to Saccardo (1909), the first time the species was mentioned for the Italian territory was in 1827, but actually it was already present in most of the Renaissance Italian herbaria (Table 2); therefore, we can argue that its introduction into Italy may be dated back to the first decades of the 1500s, possibly even before. In the second half of the XVI century, *P. mediterraneus* was not present in Ferrara, at least according to the lists of plants cultivated in the gardens of the city; however, it is highly probable that it was already known, since various new plants arrived in the Este Duchy directly from Crete, thanks to exploring carried out by scholars or directors of botanical gardens who were in touch with

Table 3 Modern ethnobotanical information on the taxa treated in the present article

	Current uses reported for ethnobotany in Italy							Current main uses as economic plants in the world				
	Food and spice	Medicinal and cosmetic	Fodder	Veterinary	Pesticide	Craft	Ritual and magical	Food	Spice	Medicinal	Other uses	Ornamental
Cardiospermum halicacabum									Leaf (young)	TM		X
Datura stramonium		X	X	X	X	X	X			Leaf, seed	Poison	
Ipomoea nil										TM		X
Mirabils jalapa									Seed	TM		X
Momordica balsamina								Fruit	Leaf (young)	TM	Poison	X
Nardostachys jatamansi									Leaf, rhizome	TM		
Nicotiana tabacum		X		X	X	X	X			Leaf	Poison; social (smoke)	
Oxalis stricta									Leaf (fresh)			
Prunus laurocerasus	X	X							Leaf (fresh), fruit	Leaf	Poison	X
Pseudodictamnus mediterraneus							X					
Senna italica										TM	Poison	
Solanum lycopersicum	X	X		X	X	X	X	Fruit		Fruit	Social (smoke)	
Syzygium aromaticum									Floral bud	Floral bud		
Tropaeolum minus								Leaf	Leaf		Materials (essential oils)	X
	sensu Guarrera (2006)							Seidemann (2005); van Wyk (2005, 2013); van Wyk and Wink (2014); Wiersema and León (2015); CABI DL (2023); TM = traditional medicine				

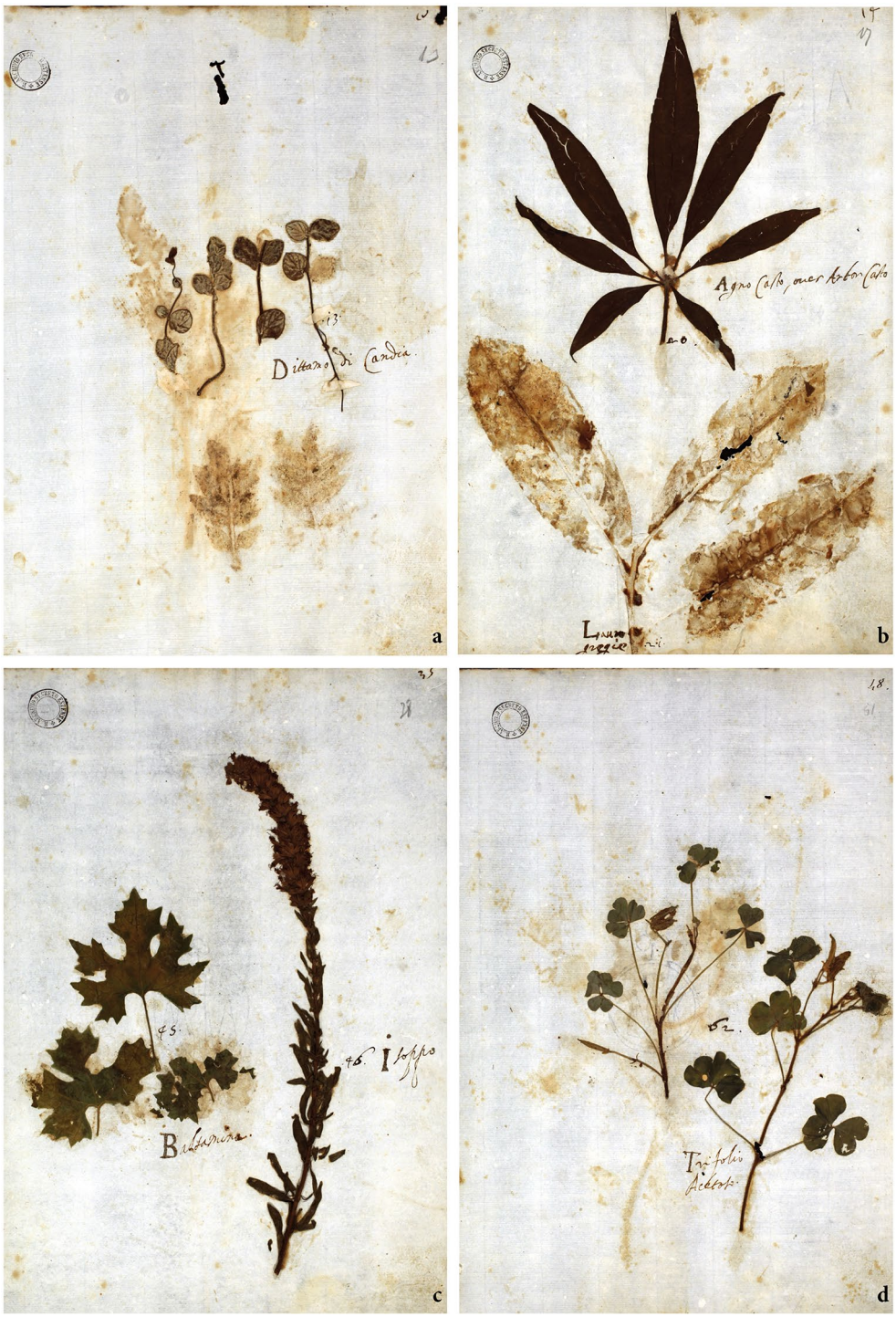

Fig. 1 Some of the specimens of exotic species preserved in the Erbario Estense. **1a**: c. 13r., n. 13—*Dittamo di Candia* (=cfr. *Pseudodictamnus mediterraneus* Salmaki & Siadati), **1b**: c. 17r., n. 21—*Lauro gregio* (=*Prunus laurocerasus* L.), **1c**: c. 28r., n. 45—*Balsamina* (=*Momordica balsamina* L.), **1d**: c. 51r., n. 62—*Trifolio acetoso* (=*Oxalis stricta* L.), **1e**: c. 117r., n. 142—*Pomi d'Ettiopia ouer Pomi d'oro* (=*Solanum lycopersicum* L.), **1f**: c. 118r., n. 143—*Vescicaria* (=*Cardiospermum halicacabum* L.), **1g**: c. 90r., n. 112—*Senna Vera delle spiciarie, che vien di leuante* (=*Senna* cfr. *italica* Mill.), **1h**: c. 119r., n. 144—*Veluschio Ceruleo cosi ditto da Castor durante* (=*Ipomoea nil* (L.) Roth). The specimens are datable to the 1570–1598 period (see Camus and Penzig—1885—for further details)

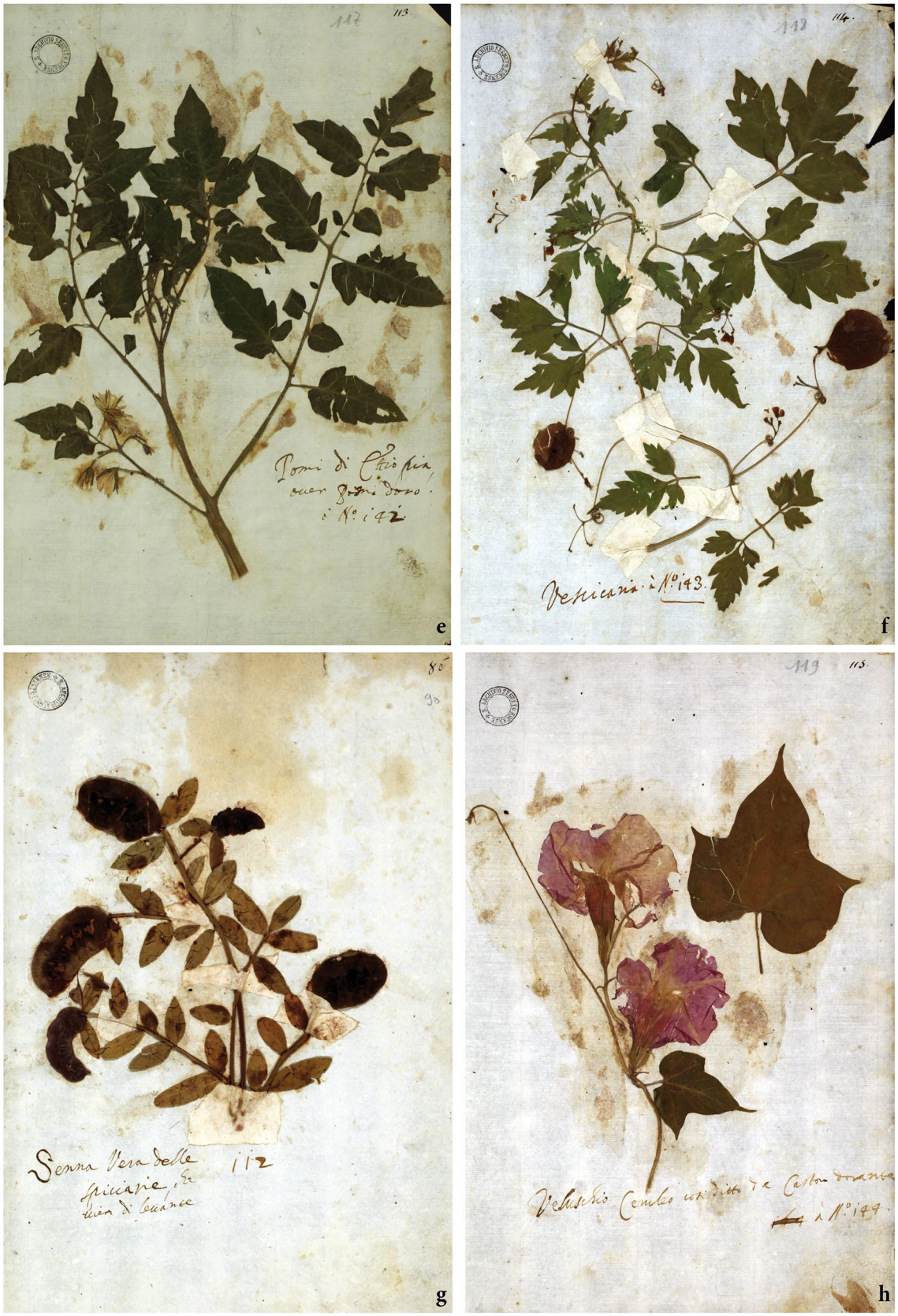

Fig. 1 (continued)

Cesare d'Este (see Vicentini et al. 2020b). We can believe that *P. mediterraneus* was one of the plants that classical authors called *dictamnus*, which is why Europeans searched for it in the East. It is no surprise that in Greece this species has been part of traditional medicine at least since the VIII century (cfr. Martínez-Francés et al. 2015, sub *B. pseudodictamnus* (L.) Benth.).

Mattioli (1568) and Durante (1585) say that this plant is called *dittamo* or *pulegio salvatico* and is native to Crete; it is similar to the *pulegio* (=*Mentha pulegium* L. or *M. arvensis* L., cfr. Mariotti 1997), but with larger branches, covered with a dense hair. It has the same properties of the *pulegio domestico* (=*M. pulegium* or *M. arvensis*, but cultivated—Mattioli 1568; Mariotti 1997), but much more effective. Both Mattioli (1568) and Durante (1585) list many uses: it stimulates the menstrual flow, eases childbirth (even completely calming the pains), the expulsion of dead foetuses and of the placenta; branches and flowers, when eaten, help to extract arrows from the human body and their poultice is useful for the spleen oppilation; the juice poultice or minced with polenta has a purgative effect; the herb poultice, applied to the skin, helps pull out wood splinters and thorns; the juice drunk along with wine cures snake bites and is an excellent antidote for toxic medicines and magic spells; it also cures the wounds caused by iron or poisonous animal bites. No medicinal uses are attested today.

"Lauro gregio" (c. 17r., n. 21): *Prunus laurocerasus* L. (Fig. 1b).

Despite it is present only as a trace on the herbarium sheet, it is clearly recognisable for its oblanceolate leaves, 3–4 cm broad and 8–15 cm long, with denticulate margin (Pignatti et al. 2017–2019).

According to Saccardo (1909) and Maniero (2015), the species was introduced in Italy in 1563 and cultivated in the botanical garden of Padova in 1591,[2] but its arrival in Italy should be perhaps noted at least a decade before. In the Erbario Aldrovandi, there is in fact a specimen datable to 1553 that Aldrovandi had from the garden of prince Doria in Genoa (vol. V, c. 213r., n. 1: Soldano 2002) and in the Erbario Cesalpino there is another specimen, datable at 1557–1563, that Cesalpino had from the same prince Doria from Genoa (c. 19r., n. 60: Caruel 1858). In the second half of the XVI century, the species was nearly surely present in Ferrara too, in Ippolito Obizzi's Public Garden (sub "Laurus Regio cerasus": cfr. Biblioteca Universitaria di Bologna, Fondo Ulisse Aldrovandi, ms. 143—*Peregrinarum rerum catalogi*, cc. 50, 216; see Frati 1908: 83).

Durante (1585) names this species "lauro regio" and says that no medical virtues attributable to it are still known, whereas he refers those of "lauro alessandrino", instead. Mattioli (1568) does not speak of the "lauro regio": he only cites a "lauro", that is identifiable as *Laurus nobilis* L., and a "lauro alessandrino", identifiable as *Streptopus amplexifolius* (L.) DC. (Mariotti 1997).

Since the beginning, *P. laurocerasus* was surely used as an ornamental plant in the Italian Renaissance gardens (e.g., Gharipour 2017), but it was perhaps used for therapeutical purposes too: even if its toxicity has been ascertained, it is still used to treat infections of mouth and respiratory system (van Wyk and Wink 2014).

"Noce vomitta" (c. 30r., n. 36) and "Noce Mettella" (c. 54r., n. 65): *Datura stramonium* L. (Fig. 2a).

It is easily recognisable for the lobate leaves, with acute lobes and as long as 1/3–1/2 of the half of the lamina, and the calyx with lobes as long as broad (Pignatti et al. 2017–2019).

In Italy *D. stramonium* arrived only in 1585: the only other congener species which was already present was *D. innoxia* Mill., arrived in 1551 (Saccardo 1909; Maniero 2015; both sub *D. metel* L. and *D. fastuosa* L.). In the other Italian Renaissance herbaria *D. stramonium* is present only in the Erbario "Bauhin a Bologna" (c. 34r. (a), c. 74r. (a); Table 2, Fig. 2b), prepared with material collected from mid-1500 to the first decades of 1600 (Cristofolini 2023), therefore these two specimens could even be a little more recent than those of the Erbario Estense. To find another sample of *D. stramonium* we should take into account the herbarium of Petrus Cadé (1566), preserved in Utrecht, made with plants collected between Belgium and the Netherlands (c. 83r., on the right: "Stramonea sive pomum spinosum"; Christenhusz 2004). In the other Italian herbaria of the XVI century, in fact, the sole species present is *D. innoxia*: in the Erbario Aldrovandi (vol. II, c. 121r., n. 1: Soldano 2000, sub *D. metel* L.), Erbario Ex Cibo B (vol. III, c. 108r., n. 851: Chiovenda 1909, sub *D. metel* L.), Erbario Cesalpino (c. 147r., n. 393: Caruel 1858, sub *D. fastuosa* L.) and in the Erbario *En Tibi* (c. 277r., n. 437: Stefanaki et al. 2018). *D. innoxia* was also cultivated in the botanical garden of Padova in late 1500 (Porro 1591, sub "Noci metel"). The different names given to *D. stramonium* are either due to the still imperfect knowledge of the diverse species of this genus, as shown by Bauhin (1623) and Ubrizsy Savoia (1993), or to the imperfect botanical competences of the person who made the Erbario Estense (see Camus and Penzig 1885 for further explanations in this sense).

According to Durante (1585), this species is called "noce metella" or "stramonium". It has the same effects of the mandragora, causes sleep, eases the pain. It kills: to avoid the

[2] Actually, Porro (1591) cites three species not recognisable as *P. laurocerasus* L.: «Lauro regio, ò datilo di Tribisonda», i.e., *Diospyros lotus* L., «Lauro Alessandrino», i.e., *Streptopus amplexifolius* (L.) DC. or a species of *Ruscus*, and «Lauro saluatico», i.e., *Viburnum tinus* L. (cfr. specimens in the Erbario Aldrovandi, Bauhin—1623—and Mariotti—1997—).

Fig. 2 Specimens of *Datura stramonium* L. **2a**: Erbario Estense, c. 54r., n. 65—*Noce Mettella* (specimen datable to the 1585–1598 period: see Camus and Penzig—1885—and Maniero—2015—for further details), **2b**: Erbario "Bauhin a Bologna", c. 74r—*Malum spinosum/Solanum manicum alterum Dioscoridis/Nux Matel Avicenæ Cesalpino/Primum Solanum Pomo spinoso semine albo C. B./Stramonia seu Pomum Spinosum Tragi/Stramonia Dodo. cui et Nux Mathel/Stramonium Peregrinum./Lycopersicum Galeni/Hyosciamus Peruuianus Cordo Historia/Solanum spinosum./Nux Mathel Avicenæ/Solanum Romanum Monspellij/Solani pomiferi genus tertium G.h./Nux Mathel siue Stramonia Alpino* (specimen datable from the second half of the XVI century to the first decades of the XVII: see Cristofolini—2023—for further details). Collections of the herbarium of the University of Bologna (BOLO). Sistema Museale di Ateneo—Alma Mater Studiorum Università di Bologna

death by poisoning one must act quickly, inducing vomiting and bathing arms and legs in warm water. Mattioli (1568) refers some interesting considerations about this species: at first, he believed that "noce vomica" and "noce metella" were the same thing, although with uncertainty, but later he corrected himself and understood that they are different plants. Today, the plant's sedative and antispasmodic properties have been confirmed as genuine (Soni et al. 2012).

"Balsamina" (c. 38r., n. 45): *Momordica balsamina* L. (Fig. 1c).

It can be distinguished from the congener *M. charantia* L., the sole species of this genus currently ascertained in Italy, for the broadly ovate leaves, reniform or orbicular, palmate with 3–5 lobes as long as half of the lamina at most, and the petiole length not overpassing 6 cm (Jeffrey 1967; Pignatti et al. 2017–2019; DRYADES 2023). The species had already been present in Italy since 1415 (Saccardo 1909; Maniero 2015).

Mattioli (1568) and Durante (1585) agree on the medicinal properties. The "balsamina" heals wounds, removes and heals scars, and eases toothache. The oil obtained by squeezing the seed or fruit infusion in olive oil is useful for wounds, ulcers, pain of the uterus and haemorrhoids. By greasing their vaginal opening, women can easily become pregnant. Mattioli (1568) also adds that it is good for colic and gut pains. Today, its effectiveness for the gastrointestinal apparatus is confirmed, as well as having antiseptic, anti-inflammatory, and analgesic properties (Thakur et al. 2009).

"Trifolio acetoso" (c. 51r., n. 62): *Oxalis stricta* L. (Fig. 1d).

We confirm the identity: we examined all of the samples collected in Emilia-Romagna and Veneto currently preserved in FI. The diagnostic features are the diameter of the stem which is no more than 0.5 mm, the leaves inserted on the stem, the flowers borne by axillary peduncules and laid out in inflorescences, stems and leaf petioles hairy,

Fig. 3 Specimens of *Mirabilis jalapa* L. **3a**: Erbario Estense, c. 58r., n. 69—*Marauiglio di Spagna Zalo*, n. 70—*Marauiglio di Spagna Rosso* (specimens datable to the 1570–1598 period: see Camus and Penzig—1885—for further details), **3b**: Erbario Aldrovandi, vol. XV, c. 72r.—*Marauiglia, seu Herba mirabilis flore uariegato colore luteo et rubro* (specimen sent by Galeazzo Paleotti from his private garden in Bologna, datable to 1581: see Soldano—2005—for further details). COPYRIGHT © Università di Bologna/Sistema Museale di Ateneo—Erbario e Orto Botanico

absence of stipules (Pignatti et al. 2017–2019). In the second half of the sixteenth century, the species was present in Ippolito Obizzi's Public Garden (sub "Alleluia, trifolium acetosum": cfr. Biblioteca Universitaria di Bologna, Fondo Ulisse Aldrovandi, ms. 143—*Peregrinarum rerum catalogi*, cc. 50, 216; see Frati 1908: 89).

Both Mattioli (1568) and Durante (1585) agree on the therapeutical virtues of the "trifolio acetoso". It cures the *ardori di stomaco* (likely stomach ache or acidity), it is effective against vomiting and has a refreshing effect on the liver. The water distilled from the plant or the juice is febrifuge. The leaves, applied as poultice, can cure inflammations. The juice is also a remedy against mouth, tongue and palate ulcers. The benefits for stomach and liver have been confirmed as true (Dzinyela et al. 2021).

"Marauiglio di Spagna Zalo" (c. 58r., n. 69) and "Marauiglio di Spagna Rosso" (c. 58r., n. 70): *Mirabilis jalapa* L. (Fig. 3a).[3]

It is recognisable by the glabrous calyxes and the 2.5–3 cm long corolla tube (Pignatti et al. 2017–2019). The first introduction in Italy of this species dates back to 1583 (Saccardo 1909; Maniero 2015). Among the other Italian Renaissance herbaria, *M. jalapa* is present only in the Erbario Aldrovandi (vol. XV, cc. 72r. and 73r.: Soldano 2005; Fig. 3b).

In Durante (1585), this species is named "Meraviglia di Spagna", "Herba Magnæ admirationis", and is described as not applicable for medical purposes, despite it being cultivated all over Italy as ornaments. No pharmaceutical usage

[3] Interestingly, the collector already noticed the variability of the color of the flowers of *M. jalapa*, a fact that stimulated many genetic studies and breeding experiments on incomplete dominance in the forthcoming centuries.

Fig. 4 Specimen of *Syzygium aromaticum* (L.) Merr. & L.M. Perry preserved in the Erbario Estense (c. 92r., n. 114—*Garoffoli delle spiciarie*). The specimen is datable to the 1570–1598 period (see Camus and Penzig—1885—for further details)

is reported, since the results were still under examination at that time (Durante 1585), and not treated by Mattioli (1568). Modern medicine, instead, underlined numerous therapeutical properties (Rozina 2016).

"Garoffoli delle spiciarie" (c. 92r., n. 114): *Syzygium aromaticum* (L.) Merr. & L.M. Perry (formerly named *Caryophyllus aromaticus* L.; Fig. 4).

It is easily recognisable by the typical shape of the floral buds. Currently, there are no real data concerning its introduction in Italy: only the drug arrived in Europe (i.e., the floral buds), first thanks to the commerce between Venice and the Levant, then thanks to the Portuguese and Dutch conquests in Indonesia (Merat and De Lens 1835). This species, native to the Maluku Islands, is cultivated only in some equatorial countries, because it requires a warm wet climate (POWO 2023). We can, therefore, presume that the inflorescences arrived directly from the places of origin, probably through trading, that was totally monopolised by the Dutch as said by Castiglioni (1791–1794): figure 609 in Mattioli (1568) accurately represents an inflorescence of *S. aromaticum* (Mariotti 1997), proving that the species was already well known in Italy. At the present stage of the researches, no further samples of *S. aromaticum* are known in the other Italian Renaissance herbaria.

In Durante (1585), the species is called the "Garofani frutti". Both Mattioli (1568) and Durante (1585) refer the same medicinal properties: the floral buds are useful for stomach or liver problems when eaten, and together with quince juice they can stop vomiting. It improves eyesight as well. For internal use and local applications, it removes the *caligini* and the *nugolette degli occhi* (= vision dimming caused by a cornea stain—Guidotti and Zanoni 2019). It is useful to treat the hydropisia called *anasarca* (= diffused hydropisia—Guidotti 2012). When drunk along with cow's or goat's milk, it facilitates procreation of male children. Administrated by mouth, it protects from the plague and fights halitosis. Today, its gastric properties are confirmed (Dharani 2016; El-Saber Batiha et al. 2020).

"Masturtio ouer Nasturtio d'India ed il suo fiore" (c. 116r., n. 141): *Tropaeolum minus* L. (Fig. 5a).

The herbarium sample has leaves 2–2.5 cm wide, with subtle teeth at the apex of the veins, leaf petioles not overpassing 10 cm, petals at most *circa* 18 mm long; therefore, it is clearly identifiable as *T. minus* (Sparre and Andersson 1991; J.F. Morales *in verbis*). In the other Italian Renaissance herbaria, there are three specimens of *T. minus* in the Erbario Aldrovandi: vol. XIV, c. 279r., dated from 1568–1580, vol. XV, cc. 67r. and 115r., respectively dated at 1581 and 1583 (Fig. 5b). They were identified as *T. majus* by Soldano (2004, 2005), but are actually attributable to the former species given the overall small size and the leaves not exceeding 3–4 cm in diameter, with thin acute teeth at the end of the principal veins (Sparre and Andersson 1991). It is important to note it because, before our study, no *exsiccata* of *T. minus* were known in Italy for the XVI century, apart from that of the Erbario Estense. According to Cappelletti and Cassina (2013) and Maniero (2015), *T. minus* would have been introduced in Italy in 1642, but it is quite probable that its arrival should actually be dated back to the second half of the 1500s. In Europe it was imported probably around 1570 (Sparre and Andersson 1991). It was also widely cultivated in Rome in private gardens (Durante 1585). The presence of this species in a herbarium prepared in Ferrara might be explained thinking of the wide correspondence network involving many scholars of that epoch. Some botanists and simplists of the city (e.g., Ippolito Obizzi, Alfonso and Alessandro Pancio, Evangelista Quattrami) were indeed in touch with the most important scientific personalities of the Renaissance, such as Ulisse Aldrovandi, Charles de l'Escluse, Matthias De l'Obel and Nicolás Bautista Monardes Alfaro (De Toni 1911; Vecchi 2014; Vicentini et al. 2020a, 2020b; Di Tommaso 2022); therefore, we can presume that one of these correspondents provided seeds or living plants to be cultivated in the gardens. However,

Fig. 5 Specimens of *Tropaeolum minus* L. **5a**: Erbario Estense, c. 116r., n. 141—*Masturtio ouer Nasturtio d'India ed il suo fiore* (specimen datable to the 1570–1598 period: see Camus and Penzig—1885—for further details), **5b**: Erbario Aldrovandi, vol. XV, c. 115r.—*Nasturtium Indicum* (specimen sent from Florence by Giuseppe Casabona, datable to 1583: see Soldano—2005—for further details). COPYRIGHT © Università di Bologna/Sistema Museale di Ateneo—Erbario e Orto Botanico

in the lists of the plants which were *in horto padiglionis Serenissimi Ducis* and *in uiridario super coquina Serenissimi Ducis* (*sc*. in Ferrara), there is no mention of *T. minus*: this suggests that its cultivation was probably still scarcely or not at all widespread, at least in Ferrara.

Mattioli (1568) does not speak about this species, but only of the "agretto" or "nasturtio", that is *Lepidium sativum* L. (Mariotti 1997). Durante (1585) calls it "mastuorzo" and in his opinion this plant (although still not experimented) would have the same properties of the "agretto": diuretic, useful for conditions of the respiratory system (coughing, breathing difficulty), analgesic (the juice would be effective for toothache). In dermatology and cosmesis, it would be good for treating wounding ulcers, scrofula and mange. Today, the antibiotic and expectorant activity is confirmed (Bussmann et al. 2011).

"Pomi d'Ettiopia ouer Pomi d'oro" (c. 117r., n. 142): *Solanum lycopersicum* L. (Fig. 1e).

It is easily recognisable for the characteristic bi-pennatosected leaves with segments elliptic and very different in width, some of 3–6 cm alternated to some of 1 cm or less (Pignatti et al. 2017–2019). The species in Italy should have been present at least since 1551 (Saccardo 1909; Maniero 2015); according to Capocaccia Orsini and Doria (1991), instead, it was brought to Italy before 1544. In the last years of the XVI century, it was cultivated in the botanical garden of Padova (Porro 1591, sub "Pomi d'oro detti dal volgo"). *S. lycopersicum* was first used as an ornamental species and subsequently for food. It was cultivated in Monardes' own garden.

Mattioli (1568) rapidly speaks about it when describing the "melanzane" (*S. melongena* L.), simply naming some morphological traits such as the color of the fruits. Durante (1585) partly cites what Mattioli wrote, adding that the "pomi d'oro" or "pomi d'Ethiopia"[4] are a sort of

[4] This name reveals the tendency to attribute a geographical provenance from the Old World to the American species recently discovered, a quite common practice in the first half of the 1500s (cfr. Ubrizsy Savoia 1993). The authority of the Ancients still was important at that epoch, also because Greek and Roman treatises, either by direct tradition or through the interpretation of the Arab school, were the sole terms of comparison available to the scholars of the XVI century. In addition, the still imperfect botanical knowledge of the

"melanzane" (in English, aubergine or eggplant) and provide scarce and bad aliment. Today, many interesting therapeutical properties have been ascertained: *S. lycopersicum* is anthelmintic, anti-inflammatory, anticarcinogenic, antimycotic, antioxidant and prevents the oxidative stress and platelet aggregation. It is rich in essential antioxidants, useful for kidney, hair, brain, and nervous system (to prevent neurodegenerative diseases), to treat diabetes, cell damage, excessive levels of cholesterol, lead poisoning, stroke, vasodilatation, dysentery. It is also a cure for rheumatic pain, back and lumbar pain, acute pain of pectoral muscles, chest ache due to respiratory problems and husky voice. It diminishes the risk of breast, head, and neck cancer, and reduces the symptoms of the urinary tract and the risk of cardiovascular problems due to diabetes of type 2 (Shukla et al. 2013).

"Vescicaria" (c. 118r., n. 143): *Cardiospermum halicacabum* L. (Fig. 1f).

It is recognisable for the biternated leaves, the tendrils borne in pairs, the fruits pubescent (Davies and Verdcourt 1998). According to Saccardo (1909) and Maniero (2015), it was introduced in Italy in 1532 and surely was in Bologna in 1551: the first Italian herbarium samples, in fact, are in the Erbario Aldrovandi, Erbario Ex Cibo B and Erbario Cesalpino (Table 2). Today, in some regions of Mediterranean Italy, another congener species (*Cardiospermum grandiflorum* Sw., first recorded in Sicily in 1995—Schicchi 1999) is becoming common as an ornamental plant escaped from cultivation (DRYADES 2023).

For internal use, its virtues are as follows (Durante 1585): eating the fruits or drinking the water it secretes, it is diuretic (Mattioli—1568—asserts that it also mitigates the burning of urine) and favors the expulsion of kidney stones; a wine with the same properties is obtained from the ripe fruits, squashed and mixed with grapes; the roots also make snakes fall asleep. Today, the action on the urinary tract is confirmed (Raza et al. 2013).

"Senna Vera delle spiciarie, che vien di leuante" (c. 90r., n. 112): *Senna* cfr. *italica* Mill. (formerly named *Cassia obovata* Collad.; Fig. 1g).

It can be distinguished from *S. alexandrina* Mill., the other species known at that time in Italy (Saccardo 1909; Maniero 2015), by the leaves with 6–7 elliptic and obtuse leaflets, with an apex slightly notched at the top, the legumes curved, falciform, thrice longer than their width (Colladon 1816). Anyway, the identification is not entirely confirmed, since the specimen was probably recomposed, fixing the legumes as if they were borne at the end of the leaves, which is why we prefer to write *Senna* cfr. *italica* Mill. (Camus and Penzig also doubtfully suggested their identification). The species was introduced in Italy in 1532 (Saccardo 1909; Maniero 2015) and, by the end of the XVI century, was cultivated in Padova in the botanical garden (Porro 1591, sub "Sena"). In reality, it was not only imported and sold, but also grown in open air conditions in Sicily already in the X century, during the Arabian rule (Metcalfe 2017). Today, *S. italica* is not present in Italy, but only the congener *S. alexandrina*.

In Durante (1585), this species is called "sena" and its virtues are to strengthen brain, nerves, sight and hearing, curing the ulcers and soothing itching. Also in Mattioli (1568), the "sena" is described (identified as *Senna italica* Mill. = *C. obovata* Collad.—Mariotti 1997, sub *Cassia italica* (Mill.) Lam. ex Steud.). Today, it is useful to sanitize the scalp when it suffers from excessive sebaceous secretion, dandruff, psoriatic-like scaling, that can cause itching (Forestier 1981). Leaves, pods, and ripe seeds are used for their purgative properties. They are most often taken as a decoction or maceration, to treat stomach aches, fever, jaundice, venereal diseases and bilious crises, as well as an abortifacient and against intestinal worms. The leaves, fresh or dried and pulverised, are used as a dressing for skin problems, such as burns and ulcers. The tea made from flowers is used as a laxative and to induce childbirth (Adjou et al. 2021; Towanou et al. 2023).

As previously occurred for the "spigo nardo" (*Nardostachys jatamansi* (D. Don) DC., see Vicentini et al. 2018), another specimen of the Erbario Estense required a different identification from the one suggested by Camus and Penzig (1885).

"Veluschio Ceruleo cosi ditto da Castor durante" (c. 119r., n. 144): *Ipomoea nil* (L.) Roth (Fig. 1h).

It was formerly attributed to *I. quamoclit* L. by Camus and Penzig (1885), but actually it cannot be considered as such. *I. quamoclit*, in fact, has ovate-elliptic and highly pinnatifid leaves, formed by 8–15 pairs (on average) of linear acute segments; flowers are red, hypocrateriform, with a 2–3 cm long corolla tube and an approximately 2 cm wide corolla mouth (POWO 2023). The specimen of the Erbario Estense, instead, has trilobate leaves, quite hirsute both in the upper side and in the margin, every leaf lobe has an acute apex; sepals are lanceolate with an almost linear apex, hirsute in the proximal part and hairy also in the distal part; flowers still retain strips of pale color (yellow-brownish in the *exsiccatum*, clearly distinct from the purple of the corolla).

Two species, in particular, caught our attention due to their similarity to the specimen under examination: *I. indica* (Burm.) Merr. and *I. nil* (L.) Roth. *I. indica* has petiolate

Footnote 4 (continued)

late Renaissance probably led to various new species and their provenances to be confused. In Bauhin (1623: 167), for example, there are a *Solanum pomiferum fructu rotundo striato molli*, also known as *Poma amoris*, *Lycopersicon* and *Mala Peruviana* (= *Solanum lycopersicum* L.), and a *Solanum pomiferum fructu rotundo striato duro*, also known as *Mala aethiopica* (= probably another species of Solanaceae, unidentified by Linnaeus 1753).

leaves, ovate or trilobate with an acute apex (the same individual bears leaves of both types), finely and densely pubescent on the upper side, (4-)5–9(-15) cm wide; flowers have glabrous to sparsely pilose or pubescent sepals (up to 22 mm long), with long apex, varying from acuminate to gradually linear-acuminate, the corolla is funnelform, 5–8 cm long, azure-blue, mauve or violet, with white longitudinal strips in the middle of the petals (Austin 1982; Deroin 2001; Staples 2018; Anton et al. 2019). *I. nil* has petiolate leaves, ovate to circular, cordate, obscurely trilobate or 3-palmatilobate up to 5-lobate, less frequently entire, hirsute, (4-)5–15 cm wide; flowers have hirsute sepals (particularly in the proximal part), lanceolate or linear-lanceolate (up to 30 mm long) with acute or even very acuminate apex, the corolla is funnelform, 5–6 cm long, violet, pink or white (Austin 1982; Deroin 2001; Staples 2018; Anton et al. 2019). The diagnostic characters are the sepals and the degree of hairiness (Austin 1982; Deroin 2001; Anton et al. 2019), therefore, based on the descriptions reported above, the specimen of the Erbario Estense is ascribable to *I. nil*.

It should be noted that the specimen in the Erbario Aldrovandi identified as *I. nil* is actually more similar to the description of *I. indica*, for the scarcity of hairs on the leaves and sepals.

Durante (1585, p. 473) writes about the "vilucchio": for internal use, the juice is purgative, the seeds are diuretic when drunk with wine, the water distilled from the flowers is effective to combat internal inflammations, whereas water distilled from the leaves is diuretic (the balsamic time is May) if administrated on an empty stomach. The leaf decoction is effective for the urinary gravel. For external use, the water distilled from the flowers, applied with pieces of linen, is effective for eye redness and other inflammations. Today, the anti-inflammatory activity is widely recognised (Zeng et al. 2022).

3.1.1 Comparison with other Renaissance herbaria and notes on current ethnobotany

The comparison with 8 Italian Renaissance herbaria (see Materials and methods) revealed the presence of these exotic species in 6 of them, apart from *Syzygium aromaticum*, which is exclusive of the Erbario Estense. Almost all of the species considered in this work (12 out of 14) are also present in the Erbario Aldrovandi, that is, therefore, the collection with most affinity to the group of plant species here treated. The most frequent species (5 herbaria out of 6) is *Pseudodictamnus mediterraneus*, but also *Cardiospermum halicacabum* (4 herbaria out of 6) and *Nardostachys jatamansi* and *Senna italica* are well represented (3 herbaria out of 6), probably because the latter have been species of renowned medical virtues since ancient times (Mattioli 1568; Durante 1585; Vicentini et al. 2018); whereas, the former was a novelty of very recent introduction (first citation in 1532: Saccardo 1909; Maniero 2015). In addition, the herbaria where there are *exsiccata* of this species were born in the same cultural environment, that is Luca Ghini's school, who taught botany first in Pisa (where he was known by Andrea Cesalpino—De Ferrari 1980) and then in Bologna (where he was known by Ulisse Aldrovandi and Francesco Petrollini—Fantuzzi 1774; De Toni 1910). Aldrovandi was in touch with Petrollini, at least in the years when he graduated (De Toni 1910; Di Tommaso 2022), and Cesalpino was in touch with Aldrovandi (De Ferrari 1980); therefore, it is not unlikely to imagine a frequent exchange of opinions, knowledge and plant specimens, as this was common practice among scholars during the Renaissance (e.g., Nuovo 2006; Tavoni 2010; Buldrini et al. 2023b). In addition, the Erbario Aldrovandi, apart from *Syzygium aromaticum* that is not present in any of the other herbaria besides the Estense (even if the species was surely well known, as demonstrated by Mattioli's essay of 1568), also lacks *Datura stramonium*, that is found only in the Erbario "Bauhin a Bologna" (Table 2). Hence, it is thought that the specimens of this species preserved in the latter collection are either contemporary to those of the Erbario Estense, i.e., dated back to the 1585–1598 period (cfr. Camus and Penzig 1885; Saccardo 1909; Maniero 2015), or provided in the very first decades of the XVII century (Cristofolini 2023).

Today, all of the exotic species present in the *exsiccata* of the Erbario Estense can be regarded as plants of economic interest. Many of them are used as spices (some of them also fit for consumption) or as medicinal species (often in traditional medicine), also thanks to their active principles, which are poisonous if not dosed correctly. Half of these species are known for their ornamental value too, that for *Ipomoea nil* is the sole reason for including it among the economic plants on a world scale (Wiersema and León 2015). In Italy, only for 5 species out of 14 some ethnobotanical uses (*sensu* Guarrera 2006) are known. Apart from *Prunus laurocerasus* and *Pseudodictamnus mediterraneus*, overall, the three Solanaceae are perfectly integrated in the Italian tradition: *Solanum lycopersicum* and *Nicotiana tabacum*, obviously, but also *Datura stramonium* (Table 3).

3.2 Invasiveness of the species

As said before, according to DRYADES (2023), only 8 species out of 14 are present in Italy today (Table 1), 4 of which are invasive at a national scale (*Datura stramonium*, *Mirabilis jalapa*, *Oxalis stricta*, *Prunus laurocerasus*); the areas where they really behave as invasive are confined to just a few regions, generally the most economically developed or those most subject to urban growth. The first observations of a spontaneous expansion are in 1763 for *D. stramonium* and 1844 for *P. laurocerasus*, both in Lombardy (Banfi and

Galasso 2010), in 1860 for *M. jalapa* in Tuscany (Arrigoni and Viegi 2011), where they were cultivated as ornamental species since being imported to Italy. For *O. stricta* there is no reliable information in this sense, rather, because it can easily be confused with similar congeners, given the subtle morphological characters which separate them (Pignatti et al. 2017–2019).

4 Conclusions

We analysed the exotic species preserved in the Erbario Estense, one of the smallest herbarium collections among the Renaissance ones, but undoubtedly interesting for the connections it is revealing between Italian, Spanish, Swiss, and English scholars of the XVI century. The species here treated are not placed according to a precise order and have in common no particular medical virtues: they rather give the impression that the specimens were simply added to the existing nucleus, as the species were known by the author (or authors) of the herbarium. Probably, it will be possible to understand something more when all of the remaining species will eventually be studied, trying to detect a possible order or a common thread of the entire volume. In this regard, it is useful to remember that the Erbario Estense as we know it today could be part of a wider collection, as already supposed (Vicentini et al. 2020b), that got lost during the centuries. Anyway, this herbarium is an important testimony for sixteenth-century botany, that contains some of the most ancient specimens of exotic species that today are of common use in large parts of the world.

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