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A comparison of medicinal plant use in Sardinia and Sicily—De Materia Medica revisited?

Marco Leonti*, Laura Casu, Francesca Sanna, Leonardo Bonsignore

Dipartimento Farmaco Chimico Tecnologico, Università di Cagliari, Facoltà di Farmacia, Via Ospedale 72, 09124 Cagliari (CA), Italy

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ABSTRACT

Aim of the Study: Written records of oral medical traditions have had significant impact on the development of medicine and the pharmacopoeias. Modern ethnobotanical studies in Europe and the Mediterranean region, however, have so far largely overlooked the richness and accuracy of historic sources and ignored their probable influence on the development of today's local traditional medicines. Here, we explore the common fundament of traditional knowledge for the medicinal plant uses in Sardinia and Sicily by comparing the selection of medicinal species and specific uses with those of Dioscorides' De Materia Medica.

Materials and methods: We use (i) a quantification of citations for medicinal species mentioned in ethnobotanical studies conducted in Sardinia and Sicily (ii) a comparison of the flora and medicinal flora with a χ^2 -test (iii) a binomial approach recently introduced into ethnobotany (iv) a comparison of the most frequently used species with the indications cited in Dioscorides' De Materia Medica (v) and a crosscheck of all mentioned species with their appearance in Berendes' translation of De Materia Medica.

Results: We identified a core group of 170 medicinal species used on either islands, which accumulate 74% of all citations and are best represented in De Materia Medica. The 15 most frequently used species of both islands demonstrate intriguing parallels for indications with Dioscorides' work.

Conclusion: The ethnopharmacopoeia of Sicily and Sardinia are shallow stereotypes of the different editions of De Materia Medica and talking of oral tradition in this respect is a contradiction. The medicinal species of Sardinia and Sicily are largely widespread and common species, including many weeds, which are not facing threat of extinction. Therefore, using traditional medicinal practices as an argument for conservation biology or vice versa is not scientifically sound.

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1. Introduction

The earliest evidence of a classical Mediterranean drug and food plant in relation with human culture comes from the area of the Linear Pottery Culture (Linienbandkeramik Kultur), outside from its natural habitat, and stems from *Papaver somniferum* ssp. *setigerum* L. Mostly charred seeds of wild but cultivated (Bakels, 1982; Knoerzer, 1971) opium poppy were found in cultural sediments dated 5000 BC in the area between Pleszow (Poland) (Wasylikowa, 1989), Roessing (Germany) (Willerding, 1988) and Michelsberg (France) (Bakels, 1984) with an accumulation of finds in the northern Rhineland between Cologne and Aachen (Knoerzer, cited in Willerding, 1980). The earliest subfossil remains of *Hyoscyamus niger* L. seeds were found in a filled up Linear Pottery pond in Kueckhoven (Germany) and dated 5090 BC (Dendrochron.

(Knoerzer, 1992), while the earliest find of *Atropa belladonna* L. seeds comes from an early Neolithic tomb at Manerba (Italy) dated to around 4000 BC (Barfield et al., 1992). It is, however, not possible to deduct a medicinal use from such archeobotanical rests. The first secure evidence for a medicinal or ceremonial utilization of a drug plant in the Mediterranean holds a goddess figurine from the late Minoic Gazi in Crete (1400–1200 BC), made from clay, and decorating the cover of this journal. However, since at least 4000 years we do have written records of oral medical traditions, which had a significant impact on the development of medicine (Mann, 1984, cited in Johns, 1990, p. 264). In fact, many plants from ancient herbals are included in modern pharmacopoeias (Mann, 1984, cited in Johns, 1990, p. 264).

We have previously analysed the use of wild gathered food plants in different parts of Mediterranean Europe (Leonti et al., 2006). Inspired by Logan and Dixon (1994) and Johns (1990) we hypothesized that the modern pharmacopoeias co-evolved with the spread of weeds during the Neolithic period when the increasing use of these weeds as a food source, promoted the knowledge

* Corresponding author. Tel.: +39 070 6758712; fax: +39 070 6758553.
 E-mail addresses: mleonti@unica.it, marcoleonti@netscape.net (M. Leonti).

about the pharmacological properties of such species. In another study we analyzed the antiquity of medicinal plant usage by comparing the medicinal plant usage of two Macro-Mayan ethnic groups (Leonti et al., 2003a).

In this work we compare the use and selection of medicinal plants by the inhabitants of Sicily and Sardinia, two Mediterranean islands of Italy. More precisely, we explore the fundament of common traditional knowledge for the medicinal plant use by the inhabitants of these two islands.

We implement different methods and methodologies: (i) a quantification of citations for medicinal species mentioned in ethnobotanical studies conducted on either islands, (ii) a binomial analysis recently introduced into ethnobotany by Bennett and Husby (2008), (iii) a comparison of the floras and a cross-cultural analysis of the medicinal floras with a χ^2 -test (iv) a comparison of the 15 most frequently used species of either islands with the indications cited by Dioscorides' De Materia Medica and (v) a cross-check of all mentioned species with their appearance in Berendes' translation of De Materia Medica.

A study of the drug and plant content of works by Cervantes like that of Don Quixote (Lopez-Muñoz et al., 2006; Pardo-Santayana et al., 2006) and the reconstruction of ancient materia medica of whole regions or communities through the analysis of written sources and documents (Lev, 2002; Lev and Amar, 2006) has been approached before. As well, a crosscheck of a collection of botanical materia medica from a monastery with the species of Dioscorides' De Materia Medica has been undertaken (Lardos, 2006). Ethnobotanical studies in the Mediterranean are mushrooming but do, however, largely overlook the heritage of traditional medicine and ignore the influence of historic written sources like Dioscorides' De Materia Medica and the interpretations thereof on the development of today's local traditional medicines. The influence of the classical works is generally acknowledged but if reference is made, then it is done not exceeding a lump sum mentioning of these operas.

We chose Sardinia and Sicily for this comparison because they are adequate geographic areas for our approach because (i) the territory of both islands is covered fairly well with ethnobotanical studies, (ii) the flora and ethnoflora of islands can be assessed readily, (iii) both islands received similar cultural influences but to a different extent, (iv) they share many ecological habitats and plant species.

1.1. The Mediterranean flora

The Mediterranean region is considered to be a major centre of plant diversity and is estimated to harbour about 24,000–25,000 species (Heywood, 1999). The region termed "Mediterranean" comprises different ecological conditions, a range of different climates, and has experienced different cultural impacts (Heywood, 1999). It is these parameters together with the palaeo-geographic history, bringing together the continents of Africa and Eurasia, which are responsible for the observed species richness (Giardina et al., 2007).

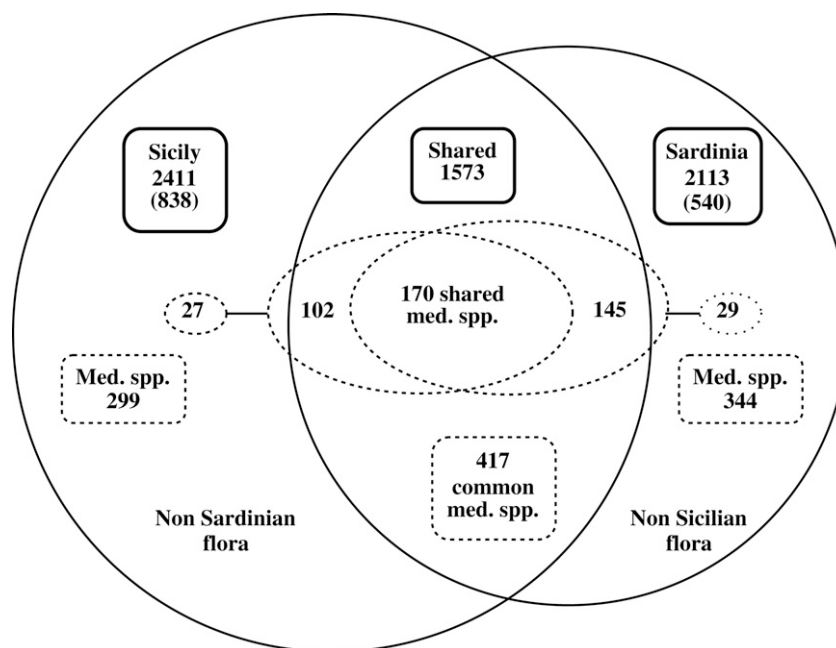
The actual Mediterranean flora, in particular the flora of southern Italy is a lowland flora characterized by the coastal environment. Only through the petering out river valleys the flora of the coastal fringe protrudes farther inland (Eberle, 1975, p. 20). With increasing distance from the sea and rising altitude the climate changes resulting in milder summer drought, colder winters, and more temperate summers. This graduation of the climate finds its reflection in the formation of distinct vegetation zones. The Mediterranean flora resides in coastal proximity and in the adjacent hillsides and lower montane zones usually not higher than 400–500 m a.s.l. The distribution of the typical Mediterranean vegetation falls together with the cultivation of the oil tree (*Olea*

europaea L.) and the vegetative association of the Macchia. The margin of the distribution of the oil tree is followed by a belt of deciduous trees, like summer green oaks (*Quercus* spp.) and chestnut (*Castanea sativa* L.).

1.2. History of medicinal plant use in the Mediterranean—De Materia Medica

According to Riddle (1985, p. xvii), the knowledge of medicine of the modern era from Viking north to the Indian Ocean came more from the efforts of one man, Pedanius Dioscorides (ca. AD 40–80), than from any other person. His five-volume book, De Materia Medica, was the standard guide to drugs until the 17th century and has seen numerous re-editions of the Greek text and the Latin and Arabic translations. There were as well printings produced in modern languages like Italian, French, German, Czech, Spanish, Dutch and English (Riddle, 1985, p. xix). De Materia Medica is an assemblage of information about the properties of around 1000 natural product drugs derived mostly from the plant kingdom but including as well drugs from animal and mineral sources (Riddle, 1985, p. xviii). Dioscorides included remedies from southern Arabia like myrrh (*Commiphora* spp.) and frankincense (*Boswellia* spp.) and exotics from the East such as cloves (*Syzygium aromaticum* (L.) Merr. and L.M. Perry) and cinnamon (*Cinnamomum* spp.) and makes references to plant habitats ranging from India, Turkey, Egypt, Somalia and Syria, to Greece, Italy, Sardinia, Africa, Spain and other regions (Riddle, 1985, p. 3). One technical problem with a straightforward interpretation of Dioscorides' work is, however, plant identification. Modern scientific names for individual plants do not correspond exactly with Dioscorides' "kinds" of plants and animals (Riddle, 1985, p. xxv). In 1902 the German pharmacist Julius Berendes translated De Materia Medica into German and achieved to identify drugs from around 670 plant species. In the introduction he explains: "Dioscorides was able to describe some plants with such a precision that they can be distinguished without trouble. For the larger part we have to make use of the medical application, the habitat, the distribution, the tradition, as well as the actual names" (Berendes, 1902, p. 4). Berendes' plant identifications are based on authors like Carl Fraas, John Sibthorp, Heinrich Friedrich Link and Curtius Sprengel, all of them specialists of the Greek and ancient flora. However, one should be concerned that there are possibilities for errors (Riddle, 1985, p. xxv). Berendes (1902, p. vi) used Curtius Sprengel's text for his translation, which was printed in Greek in 1829–1830 and, which on his part, was based on Janus Saracenus' commentary from 1598 (Riddle, 1985, p. xxv). The scanned opera of Berendes (1902) can be skimmed through online at: <http://www.heilpflanzen-welt.de/buecher/Dioskurides-Arzneimittellehre/>.

With respect to Italy it was Andrea Matthioli's opera "I Discorsi" edited for the first time in 1544 that divulged Dioscorides' cognition. However, Matthioli a botanist and physician did not content himself with a mere translation. Matthioli not only commented Dioscorides' chapters introducing different uses and observations but also introduced new species from the New World like tomato (*Lycopersicon esculentum* Mill.), prickly pear (*Opuntia ficus-indica* L.) as well as *Citrus* spp. and others. Andrea Matthioli tolerated neither rivals nor corrections and those daring to disagree with him were abused (Osbaldeston, 2000). The other authority on Dioscorides was Andrés Laguna, a physician and philosopher from Segovia, Spain. His Castilian translation from 1555 was reprinted more than 20 times with the last edition being that of Madrid in 1752 (Amat di San Filippo, 1990, p. 206). Both, Laguna's and Matthioli's translations came with woodcut illustrations (Matthioli, 1568; Laguna, 1555) imposing the plant identification of the 2 authors and giving less margin for different interpretations. Probably it were



Graphic 1. Total flora and medicinal flora of Sicily and Sardinia.

mainly the medical doctors and clergymen who made use of these books and divulged their content.

1.3. Sardinia—cultural history and traditional medicine

Sardinia (Ichnusa, Sandaliòtis or Sardò for the ancient Greek (Lilliu, 1967)) is the second largest island of the Mediterranean. The highest elevation lies in the Gennargentu massive with 1834 m a.s.l. The colonisations that created new homes, new human and cultural perspectives typical of Sicily and Magna Graeca did not occur to that extent in Sardinia. The colonisations of Sardinia almost exclusively had the intention to exert political and military power and had an exploitive character. Compared to Sicily the colonizers left only few cultural and ethnic-ethnic transformations and potentiations (Lilliu, 1967).

Characteristic for Sardinia is the Nuraghe Civilization, which flourished from the chalcolithic period until the Roman Conquest (240 BC). The Nuraghe is a conical stone tower up to 20 meters in height and built from huge single blocks weighing up to several tons. It is not entirely clear what role the Nuraghi played but one of the obvious and most discussed purposes is that they served to ward off looters and invaders such as the Phoenicians (1200 BC onwards) and the Punicians (500 BC onwards). As a result of the Punic wars, Sardinia as well as Sicily became Roman provinces.

Wagner (1950) speaks of Sardinian dialects and identifies “Logudorese” as the most conserved form. He argues that once Sardinian was more homogenous and that the different influences gave rise to what others identify as languages of their own right such as Gallurese, Nuorese, Sassarese, Campidanese and Logudorese.

After the Second World War Sardinia was defined as the most underdeveloped region of Europe (Lussu, 1951). Still in this period the economic basis of the large part of the population was subsistence agriculture and nomadic pastoralism. Traditional medicine was the main health-care system until the Second World War and is conserved until nowadays by the elder generations (c.f. Atzei, 2003, p. xv et seqq.).

Traditional medicine comprises empirical as well as magical believes and practices. One of the most widespread cultural syndromes worldwide treated by a magical approach is “S’ogu liau” (“il malocchio” in Italian). It still is a common opinion that everybody has a potential to release the “aggression of the eye” or “evil eye”. In the province of Cagliari people say that those who transmit the evil eye have the goat in the eye, i.e. the eye of the devil. Generally one starts to be a potential carrier of the “ogu liau” with the onset of adolescence (Cossu, 1996, p. 60). “S’ogu liau” derives from desire, admiration and jealousy and can be released by adult persons of either sexes and affect anybody (Cossu, 1996, p. 61). In any case, it is an instant, a moment difficult to control, which causes the crisis; it is the encounter of the looks, more precisely those of the pupil. Different therapeutic and preventive rituals do exist as for instance wearing the eye of Santa Lucia (opercula of the sea-snail genus *Turbo*). It is generally a woman who received the gift to cure with “brebus” (esorcistic prayers) and Christian prayers like the “Pater Noster” and the “Ave Maria” from a female relative of her own family. The symptoms include loss of vital spirit, loss of appetite, a general feeling of weakness and death may be the ultimate outcome. During the diagnosis and cure a hand full of wheat or barley grains are thrown into a bowl filled with water. The resulting air bubbles confirm that there was a bad energy (spirit) present and meanwhile symbolizes its extrusion. Furthermore, salt is sprinkled and olive oil, stones, horn of the moufflon, deer or ox, carbon and paper may be implemented.

Malaria was endemic to Sardinia and known since the invasion of the Phoenicians who are thought to have introduced the parasite. The last cases are recorded for the years 1948–1950 (Istituto Superiore di Sanità, 2001).

Until the year 1626 the main instrument of reference for the medical doctors in Sardinia was Matthioli’s edition (1568) of “De Materia Medica”. Afterwards, the Faculty of Medicine, which was following the Spanish school, adopted an edition of the opera translated and commented in Castilian by Laguna (Amat di San Filippo, 1990, p. 206).



Graphic 2. Citations of medicinal plants in Sicily and Sardinia.

1.4. Sicily—cultural history and traditional medicine

Sicily is the largest of all Mediterranean Islands. The highest peak of the island is the Monte Etna, a volcano rising up to 3300 m a.s.l. The ancient tribes of Sicily (Siculi, Sicani, Elimi) were quickly absorbed when the Greek began to colonize Sicily and southern Italy to form Magna Graeca (750 BC). After the annexation by the Roman Empire (200 BC) Sicilian cities conserved Hellenistic structures and typology pertaining their Greek culture until Christianisation (200 AD) (La Biblioteca di Repubblica, 2005, p. 56). Therefore, in Sicily, which was among the epicentre of Greek culture, the Greek language continued to be lingua franca even under Roman patrimony. Now, Sicilian is considered a language of its own, which is spoken in the southern part of the peninsula of Italy (Calabria and Salento) and Sicily (Lo Piparo, 1990).

After the fall of the Roman Empire (400 AD) Vandals and Ostrogoths invaded and conquered Sicily and after 535 AD Sicily became province of the Byzantine Empire until ca. 1040. In the following the Arab and Spanish presence in Sicily were those who left most cultural, social, and economic traces. The Arabs introduced technical innovations into agriculture abandoning Roman monoculture.

Malaria was endemic to Sicily and eradicated only after the Second World War.

Hippocrates already described the symptoms of malaria, and the Athenian army was taken by malaria when they were couching in a swampy area trying to conquer Syracuse in 413 BC (Valenti and Tore, 1988, pp. 24–43). De Materia Medica and especially the edition commented by Matthioli was the fundamental text of pharmacology until the 18th century throughout the Italian peninsula (Cosmacini, 1997, p. 264).

Pitrè (1896) refers that besides the medical doctors and the pharmacists the barbers had a sort of a medical status operating blood-letting, cauterizations, opening of abscesses and that they were frequented in case of luxations, fractures, extraction of teeth, and above all venereal diseases like syphilis. Another person frequently located was the “erbauolo” (herbalist). Pitrè writes: “The herbalist suggests the juice of chicory (*Cichoria* sp.), sow-thistle (*Sonchus* sp.), decoction of mallow (*Malva* sp.), marshmallow (*Althaea* sp.), barley (*Hordeum vulgare* L.), Bermuda grass (*Cynodon dactylon* Pers.), almond milk (*Amygdalus dulcis* Mill.), “canapuccia” (drink made from *Cannabis sativa* L. seeds), and a drink made from

melon seeds (*Cucumis* sp.)”. The shop of the herbalist is covered with bundles of herbs like henbane (*Hyoscyamus niger* L.), mallow (*Malva* sp.) and sedum (*Sedum telephium* L.) as well as the herbs to bathe like rosemary (*Rosmarinus officinalis* L.), oregano (*Origanum* sp.) and thyme (*Thymus* sp.), which serve for the first bath of the newborn as well as for other stimulating baths.

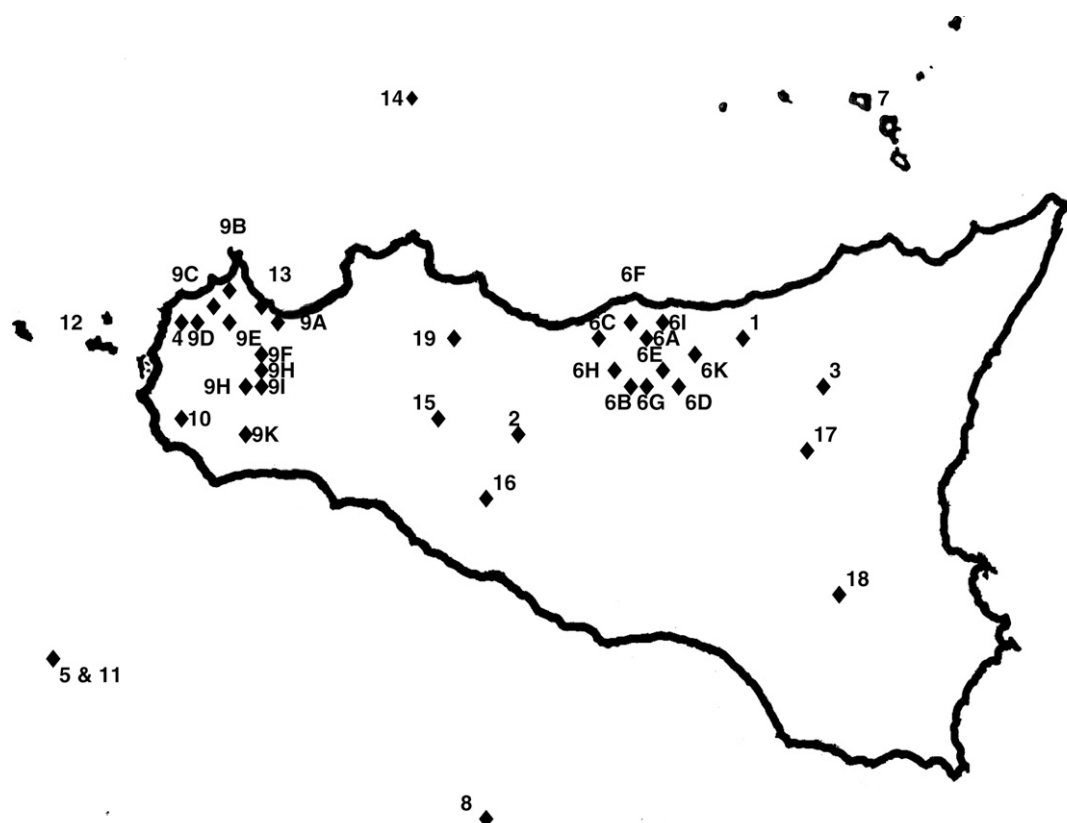
2. Methodology

2.1. Total flora

The total flora (angiosperms, gymnosperms and pteridophyta) of Sardinia and Sicily were assessed based on “An annotated checklist of the Italian Vascular Flora” (Conti et al., 2005) and the “Updating of the checklist” (Conti et al., 2006), excluding neophytes and infraspecific taxa from the floral list. For the classification of the plant families the APG II (2003) was followed. Old world crop species, which have been introduced to these regions millennia ago, were included. We counted a total of 2411 species for the territory of Sicily (including the surrounding islands) listing 2352 angiosperms, 11 gymnosperms and 48 pteridophyta. For the territory of Sardinia we counted a total of 2113 species comprising 2056 angiosperms, 9 gymnosperms and 48 pteridophyta. According to Conti et al. (2005) Sardinia houses slightly more than 200 endemic species, while Sicily is home to about 230 endemic species.

2.2. Medicinal flora

We performed a thorough literature search on traditional medicinal plant usage in Sicily (Map 1) and Sardinia (Map 2). A large part of these studies were published in local journals in Italian. We gathered 15 publications referring to medicinal plant use in Sardinia including 17 field-study sites and 19 publications reporting medicinal plant use in Sicily including 37 field-study sites. Plant species for which a medicinal usage was mentioned were pooled in a database indicating the frequency of independent studies citing a medicinal use. Since especially earlier works did not supply plant lists with frequency of citations we ignored use-report counts of later works in order to facilitate the meta-analysis. According to the indications and uses reported in the various studies we defined use-categories wherein we grouped and counted the citations per plant species (c.f. Leonti et al., 2001).



Map 1. 1: Mistretta; Messina (Lentini and Raimondo, 1990), 2: Mussomeli; Caltanissetta (Amico and Sorge, 1997), 3: Cesarò; Messina (Barbagallo et al., 1979), 4: Erice; Trapani (Lentini and Aleo, 1991), 5: Pantelleria; Trapani (Galt and Galt, 1978), 6A–K: Madonie, Palermo (Raimondo and Lentini, 1990), 7: Eolie, Messina (Lentini et al., 1995), 8: Pelagie, Agrigento (Lentini et al., 1996), 9A–K: Trapanese; Trapani (Lentini, 1987), 10: Mazara del Vallo; Trapani (Lentini et al., 1987–1988), 11: Pantelleria; Trapani (Lentini et al., 1996), 12: Egadi; Trapani (Lentini et al., 1997), 13: Riserva Naturale Dello Zingaro; Trapani (Lentini and Mazzola, 1998), 14: Ustica; Palermo (Lentini et al., 1994), 15: Bivona; Agrigento (Catanzaro, 1970), 16: Sant'Angelo Muxaro; Agrigento (Lentini, 1996), 17: Bronte; Catania (Arcidiacono et al., 1999), 18: Monterosso Almo; Ragusa (Napoli and Giglio, 2002), 19: Mezzojuso; Palermo (Ilardi and Raimondo, 1992).

Therefore, a single study may account for one citation of a plant species per category of use. Several studies included are limited to a list of medicinal species without indicating a specific medicinal usage. Therefore, the citation frequency may exceed the summed up citations per category of use per plant. For either island the 15 species or species-complexes with most citations are represented (Table 1: Sicily; Table 2: Sardinia) indicating the number of citations per category of use. In the following the detailed

uses of the top 15 species of either islands are specified and presented in chapters entitled after De Materia Medica, paying tribute to Dioscorides. The first line reports the plant species as identified by Berendes (1902) while eventual changes of the binomial plant names are reported in brackets. The first paragraph presents the uses reported by Dioscorides, while the second one summarises the uses from the ethnobotanical studies of Sicily and Sardinia.

Table 1
Most cited plants in Sicily (max. possible citations: 37).

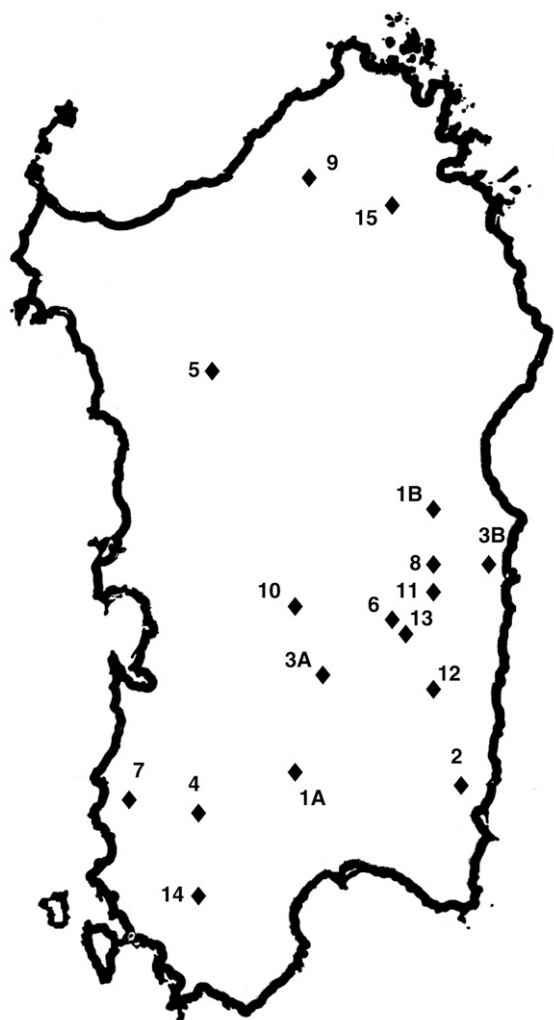
Plant species	Family	Uses	Part used	Cit.
<i>Laurus nobilis</i> L.	Lauraceae	GA (25) RESP (2)	Leaves	33
<i>Borago officinalis</i> L.	Boraginaceae	GA (18) UR (15) RESP (3) DERM (2)	Herb	33
<i>Cynodon dactylon</i> L.	Poaceae	UR (22) GA (7) DERM (2)	Root	30
<i>Malva sylvestris</i> L. and <i>M. nicaeensis</i> All.	Malvaceae	GA (15) DERM (9) UR (6) RESP (3)	Herb, flowers, roots	29
<i>Opuntia ficus-indica</i> L.	Cactaceae	UR (19) GA (11) SK-MU (8) DERM (7)	Flowers, cladodes	25
<i>Parietaria diffusa</i> L.	Urticaceae	UR (11) DERM (9) GA (7) SK-MU (3) RESP (2)	Herb	25
<i>Urtica membranacea</i> Poir.	Urticaceae	GA (13) DERM (10)	Herb, root	24
<i>Rubus ulmifolius</i> Schott. & <i>Rubus fruticosus</i> L.	Rosaceae	DERM (17) GA (7)	Leaves	23
<i>Ruta chalepensis</i> L.	Rutaceae	GA (17) SK-MU (5) GYN (3) NERV (2)	Leaves	23
<i>Artemisia arborescens</i> L.	Asteraceae	GA (11) DERM (7) FEV (3)	Herb	20
<i>Cichorium intybus</i> L.	Asteraceae	GA (19) UR (4)	Herb	18
<i>Foeniculum vulgare</i> Mill.	Apiaceae	GA (13) UR (3) RESP (3) GYN (2)	Seeds, herb, roots	18
<i>Calamintha nepeta</i> Savi	Lamiaceae	GA (4) DERM (4) SKMU (2)	Herb	17
<i>Asphodelus ramosus</i> L. and <i>Asphodelus fistulosus</i> L.	Asphodelaceae	DERM (10)	Root	17
<i>Inula viscosa</i> (L.) Aiton	Asteraceae	DERM (8)	Leaves	16

GA, gastrointestinal disorders; UR, urological problems; RESP, respiratory complaints; DERM, dermatologic problems; SK-MU, skeleto-muscular disorders; CARD-VASC, cardio-vascular application; FEV, fever; EAR, problems of the ear; NERV, headache, toothache, analgesic; GYN, gynaecology.

Table 2
Most cited species in Sardinia (max. possible citations: 17).

Plant species	Family	Most frequent uses	Part used	Cit.
<i>Malva sylvestris</i> L.	Malvaceae	GA (16) DERM (14) RESP (8) UR (6) NERV (3)	Herb, root, flower, fruit	17
<i>Pistacia lentiscus</i> L.	Anacardiaceae	DERM (9) GA (6) RESP (3) SK-MU (3)	Resin, fruit, leaves, roots,	15
<i>Smilax aspera</i> L.	Liliaceae	UR (8) GA (7) SK-MU (5) DERM (5) RESP (3) NERV (3)	Root, leaves, fruits	15
<i>Parietaria judaica</i> L.	Urticaceae	GA (10) UR (8) DERM (7) NERV (5) RESP (3)	Aerial parts	14
<i>Rosmarinus officinalis</i> L.	Lamiaceae	GA (10) RESP (7) DERM (5) NERV (4) SK-MU (3) UR (3)	Aerial parts	14
<i>Laurus nobilis</i> L.	Lauraceae	GA (13) SK-MU (5) RESP (5) DERM (2)	Leaves, fruits	14
<i>Sambucus nigra</i> L.	Caprifoliaceae	EYE (8) DERM (6) GA (4) SK-MU (3) NERV (3)	Leaves, flowers	12
<i>Arbutus unedo</i> L.	Ericaceae	GA (10) DERM (6) CARD-VASC (3) UR (3)	Roots, leaves, fruits, bark	13
<i>Marrubium vulgare</i> L.	Lamiaceae	RESP (7) FEV (5) SK-MU (4) GA (3) NERV (3) DERM (2) GYN (2)	Aerial parts	12
<i>Myrtus communis</i> L.	Myrtaceae	GA (7) RESP (7) DERM (5)	Leaves, fruits	12
<i>Olea europaea</i> L.	Oleaceae	GA (7) CARD-VASC (7) DERM (7) FEV (4) EAR (3)	Oil, leaves, bark	12
<i>Borago officinalis</i> L.	Boraginaceae	RESP (9) UR (4) DERM (4) GA (3) NERV (2)	Aerial parts	11
<i>Artemisia arborescens</i> L.	Asteraceae	GA (10) RESP (5) DERM (2) SK-MU (2)	Aerial parts	11
<i>Asphodelus ramosus</i> L. and <i>Asphodelus fistulosus</i> L.	Asphodelaceae	DERM (10) RESP (4)	Rhizome	11
<i>Ruscus aculeatus</i> L.	Liliaceae	UR (5) SKMU (4) CARD-VASC (3) NERV (2)	Rhizome, fruits, leaves	11

GA, gastrointestinal disorders; UR, urological problems; RESP, respiratory complaints; DERM, dermatologic problems; SK-MU, skeleto-muscular disorders; CARD-VASC, cardio-vascular application; FEV, fever; EAR, problems of the ear; NERV, headache, toothache, analgesic; GYN, gynaecology.



Map 2. 1A: Campidano; Cagliari (Bruni et al., 1997), 1B: Urzulei; Ogliastra (Bruni et al., 1997), 2: Sarrabus, Cagliari (Palmese et al., 2001), 3A: Escolca; Cagliari (Loi et al., 2005), 3B: Lotzorai; Ogliastra (Loi et al., 2005), 4: Marganai; Carbonia-Iglesias (Ballero and Fresu, 1991), 5: Monteleone; Sassari (Ballero and Poli, 1998), 6: Seui; Ogliastra (Ballero and Fresu, 1993), 7: Fluminimaggiore, Carbonia-Iglesias (Ballero et al., 2001), 8: Villagrande Strisaili, Ogliastra (Loi et al., 2004), 9: Tempio Pausania, Olbia-Tempio (Ballero et al., 1997), 10: Laconi; Oristano (Ballero et al., 1997), 11: Arzana; Nuoro (Ballero et al., 1994), 12: Perdasdefogu; Ogliastra (Ballero et al., 1997), 13: Ussassai; Ogliastra (Ballero et al., 1998), 14: Carbonia-Iglesias (Atzei et al., 1994), 15: Gallura; Olbia-Tempio (Atzei et al., 1991).

2.3. Statistics

We use a χ^2 -test for a cross-cultural analysis on the basis of the effectively shared and non-shared medicinal species and calculate a 95% confidence interval. The number of shared medicinal plants to be expected if the selection had been done at random serves as a reference value to exemplify the cultural concordance.

In order to test for significantly overused and underused plant families among the medicinal flora of Sardinia and Sicily we apply a binomial approach recently introduced into ethnobotanical analysis by Bennett and Husby (2008). This approach builds up on the questions addressed by Moerman and colleagues (Moerman, 1991, 1996; Moerman et al., 1999) but substitutes the regression analysis by a more accurate binomial method permitting inferential statistics.

3. Results and discussion

3.1. Comparison of the floras

The two islands share 1573 plant species: 1142 eudicots (72.6%) 373 (23.6%) monocots, 6 magnoliid, 3 ceratophyllales, 9 gymnosperms and 40 pteridophyta. Sicily houses 838 species (638 eudicots (76.1%), 184 monocots (22.0%), 5 magnoliid, 1 ceratophyllales, 2 gymnosperms and 8 pteridophyta) not present in Sardinia while Sardinia harbours 540 species (437 eudicots (80.9%) and 92 (17.0%) monocots, 1 magnoliid, 2 ceratophyllales and 8 pteridophyta) not occurring natively in Sicily (Graphic 1). In the following we use the term "non-Sardinian flora" to refer to the species present in Sicily but not in Sardinia, while the term "non-Sicilian flora" includes the species present in Sardinia but not in Sicily.

The null hypothesis that the non-Sicilian angiosperms and the non-Sardinian angiosperms have an equal portion of eudicots and monocots was refused at $\alpha=0.05$ with a χ^2 value of 4.95. This might be the reflection of a more continental distribution of geophytes.

3.2. Comparison of the medicinal floras

In total the flora common to both islands (1573) accumulate 417 medicinal species while the non-Sicilian flora (540) counts with 29 medicinal species and the non-Sardinian flora (838) with 27 medicinal species. Crucial for our analysis are the 170 species (Tables 9a–c, supplementary data) included in the medicinal flora of both islands (Graphic 1).

The data gathered in 17 field-study sites in Sardinia altogether cite 344 native medicinal plant species from 85 families, while 31 plant families feature no medicinally used species. Of the 344 medicinal species 315 species are native to Sicily as well. Besides, 38 neophytes are also used but not included in the comparison. Altogether, the 344 native plants received 1058 citations, while the neophytes account with 75 citations. The 315 species present also in Sicily sum up to 989 citations and the ones absent from Sicily sum up to 69 citations (Graphic 2).

The data gathered in 37 field-study sites in Sicily altogether cite 299 native medicinal plants from 73 plant families, while 36 plant families are not used as a source for medicinal species. Of the 299 medicinal species 272 are native also to Sardinia. The additional 28 neophytes adopted by traditional medicine are not included in the comparison. Overall, the 299 native species account with 1185 citations and the neophytes with 52. The 272 species present as well in Sardinia count with 1133 citations, while those absent from Sardinia were cited 52 times (Graphic 2).

By far the most important medicinal species regarding the number of citations are those 170 plant species used on both islands, which got 923 (Sicily) plus 734 (Sardinia) references and summing up to 1657 citations or 74% of all citations while the remaining 303 species count with 26% of all citations.

Looking at the 15 most frequently cited species in Sicily gastrointestinal conditions stand out as the most important category of use (167 citations, or 45%). The second most frequently cited category of use with nearly half as many citations is that of dermatological problems (85 citations, or 23%) closely followed by urological disturbances (80 citations, or 21%). Respiratory ailments do not seem to be an important issue (to be treated with medicinal plants) counting with just 13 citations or 3.5%.

Doing the same sort of count with the 15 most cited species in Sardinia we get a somewhat different picture. Gastrointestinal (106 citations, or 28%) and dermatological (84 citations, or 22.5%) citations are almost of the same importance, while citations for urological conditions (37 citations, or 10%) are far less frequent while those for respiratory ailments (63 citations, or 17%) are far more numerous than those in Sicily. Formation of urinary stones is a common disorder of people living in areas with unreliable water resources, the so-called stone-belt (Lev and Dolev, 2002), which could explain the need for diuretics in Sicily. To get a complete picture one should however count up the citations made for all species.

The only important application of a neophyte is the use of *Opuntia ficus-indica* L. petals to treat urological problems in Sicily. To treat kidney colic with flowers of *Opuntia ficus-indica* is already referred to by Pitrè (1896). The arrival of *Opuntia ficus-indica* has been embraced with great enthusiasm in Sicily, as it has become both, an important fruit crop and medicinal plant.

Endemic species which are included in the medicinal flora of Sardinia are: *Cymbalaria muelleri* (Moris) A. Chev., *Scrophularia trifoliata* L., *Glechoma sardoa* (Bég.) Bég., *Aristolochia thyrrenia* E. Nardi and Arrigoni, and *Santolina insularis* (Genari ex Fiori) Arrigoni. Endemic species included in the medicinal flora of Sicily are: *Sideritis italica* (Mill.) Greuter & Burdet and *Senecio lycophilifolius* Desf. All these species are of minor importance and with the exceptions of *Santolina insularis*, *Scrophularia trifoliata* and *Sideritis italica* cited in just one ethnobotanical study.

3.3. Comparison of the 15 most cited medicinal species of either islands with Berendes (1902) translation of Dioscorides' De Materia Medica

The confrontation of the specific uses mentioned in De Materia Medica with those reported in the ethnobotanical studies of Sardinia and Sicily shows a high agreement, especially for the cat-

egories of use. It were, however, the minor but specific uses like *Asphodelus* spp. to treat burns and chilblains, *Artemisia* sp. against malaria, *Foeniculum* as an eye remedy, *Pistacia lentiscus* against bad breath and as an anti-sudorific, *Ruscus* against headaches, *Rubus* spp. against gingivitis, *Calamintha* sp. against intestinal parasites, as a vulnerary, against bites of venomous animals and to induce labour, *Myrtus* as an anti-sudorific, *Inula* sp. as a haemostatic, that raised our eyebrows and prompted us to undertake such an investigation. Less congruence were found with *Laurus* and especially with *Arbutus* and *Smilax*. The strawberry tree might in fact be an autochthonous Sardinian element while the uses of *Smilax* seem to have been introduced to Europe after La Conquista as a surrogate for Sarsaparilla (Berendes, 1902).

Among the species not included in Berendes' translation is one prominent one: Borage (*Borago officinalis* L.). Borage is widely used in Sicily as a diuretic vegetable, which has as well emollient properties on the intestine. In Sardinia the most cited category of use for Borage is that of respiratory ailments like cough and bronchitis. However, Matthioli (1568) as well as Laguna (1555) include a chapter on borage. Matthioli (1568) writes in chapter CXXX, pp. 1244–1248 (quarto libro) in his comments on Buglosson (chapter 127 in Berendes): The ones that take into account history will come to the conclusion that the "Buglossa" of Dioscorides is the true borage of our home gardens (notwithstanding Dioscorides' affirmation that the plant thrives in the lowlands and is gathered in July). Then he perambulates in a cumbersome and contradictory explanation why this is the case citing Avicenna and Apuleio. He further writes that those who consider Buglosson being a species of *Echium* are not using their intellect. Finally Matthioli divides Buglosson into three species: "Buglossa vera" (borage), "Buglossa volgare" and "Another buglossa with black flowers". Laguna (chapter 129) follows Matthioli saying that Buglosson is nothing else than what we call "boraja" in Castilian, but omitting Matthioli's circular argumentation.

Apparently rosemary (*Rosmarinus officinalis* L.) has not received much attention by Dioscorides. Matthioli (1568) comments in his Discorsi (terzo libro, Cap. LXXXIII, pp. 831–832) that our "Rosmarino coronario" is known by everybody throughout Italy and planted in the gardens and vineyards because it is not only medicinal but as well used in the cuisine. Rosemary serves against the cold problems of the stomach, against reflux and vomiting. It is good for those who have spleen and liver problems. Furthermore, in form of a lavation it serves against all the cold problems of the head like epilepsy, stupor and somnolence. Taken in form of powder every day it also arrests the white flow of the women.

In general, however, De Materia Medica treats the singular species comprehensively including more specific indications and preparations than reported below. The synthesis of all the Sardinian and Sicilian indications and explanations reported in the various publications for any single plant taken together do not get even close to the comprehensiveness, professionalism and accuracy of De Materia Medica.

Asphodelos (II book, chapter 199): *Asphodelus racemosus* Link (= *Asphodelus ramosus* L.) and *Asphodelus albus* Mill.

Apart from the treatment of several inflammatory dermatologic conditions Dioscorides reports that "if oil is scalded in the gauged roots (of Asphodelos) it will be good against chilblains and burns". Its roots cure cough if taken in wine.

A particularly specific congruence can be observed with the usage of the roots of Asphodelos: While in Sardinia the use of the roots of *Asphodelus ramosus* L. against chilblains dominates, in Sicily the roots of (*Asphodelus ramosus* L. and *Asphodelus fistulosus* L.) are used as a cutaneous disinfectant, against burns and to treat respiratory ailments.

Seris (II book, chapter 159): *Cichorium intybus* L.

After Dioscorides chicory is astringent, cooling and good for the stomach. Boiled it helps against diarrhoea if taken with vinegar; more the wild ones which are more salubrious because when eaten they are an exquisite remedy against a weak and heated stomach.

In Sicily wild chicory is eaten and praised for its refreshing and cooling action on the gastrointestinal tract. To season boiled leaves of chicory with vinegar is still a common recipe in Sardinia.

Helxine (IV book, chapter 86): *Parietaria judaica* L.

“The leaves have a cooling astringent property and therefore heal zoster, swellings, burns, . . . inflammations and oedema”, while its juice is good against chronic cough and helps against inflamed tonsils.

In Sicily its paramount use is that of a diuretic and against affection of the urinary tract while the treatment of dermatologic afflictions like furuncles comes second. Another important category of use in Sicily is that of light gastrointestinal disturbances. As well in Sardinia the uses against disorders of the gastrointestinal tract like gastritis and as a diuretic are more frequent than uses for dermatologic conditions.

Schinos (I book, chapters 50, 51, 89, 90): *Pistacia lentiscus* L.

Mastic oil is astringent and is effective against stomach-ache and dysentery. Mastic resin is used with benefit against cough. The oil of the ripe fruits is effective against scabies of the draft cattle and dogs. . . it retains sudor. Chewing the resin fortifies the teeth ridge and confers fragrance to the oral cave.

The uses in Sardinia match those of De Material Medica largely. The resin is used against diarrhoea and stomach-ache, as a vulnerary, the oil of the fruits against scabies and a fumigation of the resin against ticks, the infusion of the leaves against cough and even the use against bad breath and as an anti-sudorific are reported. The anti rheumatic uses are not described by Dioscorides while he additionally describes the uses against uterus bleeding.

Malache (II book, chapter 144): *Malva sylvestris* L. and *Malva rotundifolia* L. (= *Malva neglecta* Wallr.)

It is good for the belly. . . and it is salubrious for the bowels and the bladder. The boiled and pounded leaves together with oil cure burns and zoster-like inflammations. A hip-bath taken in the decoction soothes the uterus.

In Sicily *Malva sylvestris* L. and *Malva nicaeensis* All. and in Sardinia *Malva sylvestris* and *Malva parviflora* L. are used most frequently against gastrointestinal pains as a laxative and as a diuretic. A decoction of the herb is used to treat gingivitis while cataplasms are used to treat furuncles and ulcerous wounds.

Myrsyne agria (IV book, chapter 144): *Ruscus aculeatus* L.

The leaves and the fruits, taken with wine, are diuretic, have the power to promote the menstrual period, and to crash bladder stones. They cure jaundice, dysuria and headaches. The decoction of the root taken with wine has the same properties. The young shoots are eaten as a vegetable like asparagus. They are somewhat bitter and diuretic.

In Sardinia the roots are used as a diuretic and the fruits against joint pains, sciatica, and against neuralgia and to treat varices.

Elaia (I book, chapters 136, 137 and 139): *Olea europaea* L.

Dioscorides describes the use of olive oil as an excipient in the manufacture of ointments. Furthermore he praises its astringent powers “it is light for the stomach, cures wounds and strengthens the teeth. . . as well it retains sudor. The liquid, which is excreted when green wood is burned, heals impetigo contagiosa, scabies and lichen. Anti-hypertension activities of the leaves are not reported by Dioscorides.

In Sardinia olive oil is most frequently used as a laxative and to treat burns.

Peganos (III book, chapter 45): *Ruta graveolens* L.

Eaten as well as taken in form of an infusion rue stops diarrhoea and helps against a bloated stomach. It induces the menstrual period and kills the fruit of womb. It works as well against sciatica, pain of the joints and periodic chills. Boiled and drunk it expels the tapeworm.

The main use of *Ruta chalepensis* L. in Sicily is to expel worms. Other uses are to treat rheumatic pains and sciatica. It is the only plant that received more than 2 citations for its use in women's medicine: once it is cited to treat dysmenorrhoea and twice as an abortifacient.

Batos (IV book, chapter 37): *Rubus tomentosus* Borkh., *Rubus caesius* L., *Rubus fruticosus* L.

A decoction of the twig tops works against diarrhoea and soothes menstruations. Chewing the leaves strengthens the gums and cures thrush. Leaves used as a wrapper stop abscesses and cure favus.

The main application in Sicily of *Rubus ulmifolius* Schott. is against furuncles and gingivitis. An infusion of the leaves is used against diarrhoea.

Daphne (I book, chapter 106): *Laurus nobilis* L.

Dioscorides writes that laurel leaves have warming and emollient properties, and that's why hip-baths of the decoction thereof suit to treat uterus and bladder problems. The green leaves are slightly astringent and applied in triturated form they heal bee and wasp stings. The decoction taken internally, however, burdens the stomach and provokes vomiting. The bark of the root crushes the (kidney) stones, kills the fruit (of womb) and is medicinal for liver troubles.

Laurel leaves are the most frequently reported medicinal agent in Sicily to treat stomach-ache and indigestion. The practice to use laurel leaves as a digestive might be reflected in Dioscorides' annotation that the roots' bark suits for liver problems but all together it is an ambiguous analogy.

Komaron (I book, chapter 175): *Arbutus unedo* L.

Dioscorides loses few words to treat the strawberry tree. He writes that the fruits are edible but harmful to the stomach and causing headache.

While in Sicily the medicinal use of the strawberry tree is considerable in Sardinia the decoction of the leaves are used to treat diarrhoea, intestinal pains and is used as well as a vulnerary.

Smilax tracheia (IV book, chapter 142): *Smilax aspera* L.

Dioscorides writes that the leaves and the fruits are antidotes against deadly poisons. . . and that “. . . people narrate that if a maceration thereof is given a newborn, it will not be affected by any kind of noxious agent”.

Berendes comments that in Italy and Greece the root of *Smilax aspera* L. has been used as a substitute for the American Sarsaparilla (*Smilax officinalis* Kunth) to treat syphilis.

In Sardinia the roots of *Smilax aspera* are used as a diuretic, as a hepatoprotective, against skin diseases and to treat rheum.

Akte (IV book, chapters 171 and 172): *Sambucus nigra* L.

The fresh tender leaves used as a compress together with roll barley relieves cutaneous inflammations and are a good remedy against burns and dog bites. The plant is diuretic and the leaves prepared as a vegetable drain the mucus and the bile.

In Sardinia the decoction of the leaves and flowers are used to treat eye infections while cataplasms of the leaves are used against erysipelas and epidermal ulcer. Internally the leaves are used as a spasmolytic.

Kalamintha (III book, chapter 37): *Mentha tomentella* Hoffmanns and Link. (= *Mentha pulegium* L.), *Mentha gentilis* L., *Thymus calamintha* Scop. (= *Calamintha officinalis* Moench).

Kalamintha is able to kill the tapeworm and intestinal worms. . . "the finely chopped leaves. . . kill the embryo and promote the menstruation". "Cooked in wine and applied as a wrapper it turns dark scars white". "Internally and externally it helps in case of snake-bites".

Ethnobotanical studies in Sicily recorded uses of *Calamintha nepeta* Savi against intestinal parasites, as a vulnerary, against bites of venomous animals and to induce labour.

Myrsyne (I book, chapter 155): *Myrtus communis* L.

Dioscorides reports the fruits and the juice thereof against problems of the stomach and dermatologic conditions like abscess and eschar. The finely ground leaves are reported as a good means against humid ulcer and as an anti-sudorific.

Myrtle is an especially important plant in Sardinia as its fruits are macerated in alcohol and manufactured into the national liquor named "mirto" (myrtle). The ethnobotanical studies report uses of the leaves and the fruits as a digestive and as an agent to treat respiratory ailments (not mentioned by Dioscorides). Other citations refer to uses as a vulnerary, against haemorrhoids and to treat sweaty feet.

Akalyphe (IV book, chapter 92): *Urtica urens* L., *Urtica pilulifera* L., *Urtica dioica* L.

Dioscorides mentions 2 varieties of nettle and lists the uses against divers dermatologic problems without referring to the use for the hair or against dandruff. Furthermore he reports that the leaves cooked together with mussels soothes the stomach, drives away flatulence and propel the urine. Cooked together with "ptisane" (potion made from barley porridge) it purifies the breast.

In Sicily *Urtica membranacea* Poir. *Urtica dioica* L. and *Urtica urens* L. are used as a gastrointestinal purifier and anti-diarrhoeic. Leaves are used in form of a cataplasm against haemorrhoids and to prevent hair loss and dandruff.

Marathron (III book, chapter 74): *Anethum foeniculum* L. (= *Foeniculum vulgare* Mill.)

The herb and the seeds have the power to promote the secretion of milk. The decoction of the stalk is beneficial to those with kidney and bladder problems because it drives the urine. In cases

of fever. . . it eliminates sickness and the burn of the stomach. The sun-dried juice of the stalks is used as an ingredient in eye remedies.

The field studies on traditional medicine in Sicily report first of all on the digestive, carminative and anti-acidity properties of the seeds and the stalk. Furthermore the diuretic action and the use against reddened eyes are mentioned. The use as an expectorant is not included in Dioscorides' work.

Absinthion, Absinthion talassion and Abrotonon (III book, chapters 23, 24, 26): *Artemisia absinthum* L., *Artemisia maritima* L., *Artemisia abrotanum* L.

De Materia Medica specifies several *Artemisia* (Wermouth) species. *Artemisia absinthum* is warming, astringent, promotes digestion and the urine. It is a good agent against stomach-ache (Cap. 23). *Artemisia maritima* taken solely or cooked with rice and taken with honey kills the ascaris and roundworms and expels them readily (Cap. 24). *Artemisia abrotanum*. . . can be used for an unguent against shiver. . . is as well a remedy for inflamed eyes. . . and cooked with bruised grains of barley it opens swellings (Cap. 26).

Ethnobotanical studies of Sicily most frequently report digestive and vermifuge properties for *Artemisia arborescens* L. The second most important use category is that of dermatologic complaints such as furuncles, acne, eczema and varices. Once it is cited against fever and twice against malaria. In studies of traditional medicine in Sardinia *Artemisia arborescens* L. is referred against helminthiasis and against colics. Respiratory ailments are the second most important category of use, which does not find any parallel in De Materia Medica except from the indication against shortage of breath. As a febrifuge *Artemisia arborescens* L. is referenced once.

Prasion (III book, chapter 109): *Marrubium vulgare* L.

Dioscorides writes that the decoction of the leaves. . . together with honey is given those who suffer from tuberculosis, asthma and cough. . . and drains the phlegm from the breast. It is prescribed to the women in order to induce menstruation and to expel the placenta. The leaves together with honey as a cataplasm clean dirty abscesses. Moreover it dispels jaundice.

Sardinian studies most frequently report the uses for respiratory ailments such as cough, asthma and bronchitis as well as its mucolytic properties. Furthermore it is cited as a remedy against fever as a digestive and against hepatic problems, and to treat infections of the vagina, against abscesses and to treat rheum.

Elenios (book I, chapter 27): *Inula helenium* L.

Dioscorides states among other uses that the pounded and eaten leaves help those who suffer from haemorrhages.

In Sicily the most frequent use of *Inula viscosa* (L.) Aiton is that of a haemostatic.

Agrostis (IV Book, Chapter 30): *Triticum repens* L. (= *Agropyron repens* L.), *Cynodon dactylon* Pers.

The finely pounded roots agglutinate wounds. . . the decoction thereof acts against stomach-ache, urea problems, bladder ulcer and crushes the (kidney) stone.

It seems in Sicily "agrostis" is interpreted as *Cynodon dactylon* Pers. The roots of Bermuda grass are used against inflammations of the urinary and gastrointestinal tract, as a diuretic and against renal colic and kidney stones.

Libanotis (III book, chapter 79 (89)): *Rosmarinus officinalis* L.

Table 3
Plant families overrepresented among the Sardinian medicinal flora.

Family	S	M	E	M – E	$P \leq M$	$P = M$	$P \geq M$
Lamiaceae	66	26	10.74	15.26	1.00	0.00	0.00
Rosaceae	51	18	8.30	9.70	1.00	0.00	0.00
Urticaceae	9	7	1.47	5.53	1.00	0.00	0.00
Polygonaceae	26	9	4.23	4.77	0.99	0.01	0.02
Malvaceae	20	7	3.26	3.74	0.99	0.02	0.03
Solanaceae	9	5	1.47	3.53	1.00	0.01	0.01
Fagaceae	8	4	1.30	2.70	1.00	0.02	0.03
Oleaceae	5	3	0.81	2.19	1.00	0.03	0.03
Caprifoliaceae	5	3	0.81	2.19	1.00	0.03	0.03
Anacardiaceae	2	2	0.33	1.67	1.00	0.03	0.03
Rafflesiaceae	2	2	0.33	1.67	1.00	0.03	0.03

S, species flora; M, medicinal species; E, expected medicinal species; M – E, residual; $P \leq M$, probability of M or fever; $P = M$, probability of M; $P \geq M$, probability of M or more.

The kind of libanotis, which the Romans call rosmarinus has a warming property and its decoction cures jaundice (if drunk before exercise).

In Sardinia the decoction of rosemary leaves is used in the first place as a digestive, against hepatic problems and diarrhoea. Furthermore it is used to treat cough, asthma and bronchitis, and cutaneous problems like psoriasis and hair loss.

3.4. Plant families over- and underrepresented in the pharmacopoeias: the binomial approach

Generally, Asteraceae and Lamiaceae are overrepresented in holarctic ethnopharmacopoeias, while Poaceae, Cyperaceae and Orchidaceae are selected only rarely for medicinal purposes (Moerman et al., 1999). Different possible reasons for the under- and overrepresentation of certain plant families in ethnopharmacopoeias have been discussed (Stepp and Moerman, 2001, Leonti et al., 2003b).

The plant families significantly overused in Sicily and Sardinia at $\alpha = 0.05$, are almost identical to each other: Lamiaceae, Rosaceae, Malvaceae, Urticaceae, and Solanaceae (Tables 3 and 5). There is one surprising difference: Asteraceae are not among the significantly overused plant families in Sardinia (216 species, 38 medicinal, 35.2 expected, 2.8 residual, pM or fever = 0.73, $pM = 0.06$, pM or more = 0.33). Still, the Asteraceae are the plant family providing most medicinal species in Sardinia.

As well, plant families underrepresented in the Sicilian and the Sardinian medicinal flora are almost the same with nearly identical ranking (ranked after M – E) (Tables 4 and 6). A reason for the low rank of the Plumbaginaceae can be named: The "*Limonium*" genus. There are 51 inventoried species in Sardinia and 41 in Sicily; almost every other bay has its own species of *Limonium*. One reason for the high ranking of the Urticaceae in Sardinia and Sicily is the few family members and that there are just two genera, which comprise species that folk taxonomically may be perceived on the genus level

Table 4
Plant families underrepresented among the Sardinian medicinal flora.

Family	S	M	E	M – E	$P \leq M$	$P = M$	$P \geq M$
Potamogetonaceae	17	0	2.77	–2.77	0.05	0.05	1.00
Orobanchaceae	18	0	2.93	–2.93	0.04	0.04	1.00
Cyperaceae	42	0	6.84	–6.84	0.00	0.00	1.00
Orchidaceae	50	1	8.14	–7.14	0.00	0.00	1.00
Plumbaginaceae	58	1	9.44	–8.44	0.00	0.00	1.00
Caryophyllaceae	107	6	17.42	–11.42	0.00	0.00	1.00
Fabaceae	208	20	33.86	–13.86	0.00	0.00	1.00
Poaceae	206	8	33.54	–25.54	0.00	0.00	1.00

S, species flora; M, medicinal species; E, expected medicinal species; M – E, residual; $P \leq M$, probability for M or fever; $P = M$, probability of M; $P \geq M$, probability of M or more.

Table 5
Plant families overrepresented among the Sicilian medicinal flora.

Family	S	M	E	M – E	$P \leq M$	$P = M$	$P \geq M$
Asteraceae	262	49	32.60	16.40	1.00	0.00	0.00
Lamiaceae	82	22	10.20	11.80	1.00	0.00	0.00
Rosaceae	67	16	8.34	7.66	1.00	0.00	0.01
Malvaceae	19	9	2.36	6.64	1.00	0.00	0.00
Urticaceae	8	7	1.00	6.00	1.00	0.00	0.00
Papaveraceae	24	7	2.99	4.01	0.99	0.02	0.02
Solanaceae	8	4	1.00	3.00	1.00	0.01	0.01
Moraceae	3	3	0.37	2.63	1.00	0.00	0.00
Anacardiaceae	5	3	0.62	2.38	1.00	0.01	0.02
Asparagaceae	6	3	0.75	2.25	1.00	0.03	0.03
Typhaceae	3	2	0.37	1.63	1.00	0.04	0.04

S, species flora; M, medicinal species; E, expected medicinal species; M – E, residual; $P \leq M$, probability for M or fever; $P = M$, probability of M; $P \geq M$, probability of M or more.

(*Urtica* and *Parietaria*). The same might be true for the high ranked Polygonaceae in Sardinia, which include 6 species of the *Rumex* genus. The low ranked Fabaceae and Poaceae are classical food taxa comprising the founder crops.

The plant families contributing most species to the medicinal flora of both islands are: Asteraceae (Si 49/Sa 38), Lamiaceae (Si 22/Sa 26), Fabaceae (Si 20/Sa 16), Rosaceae (Si 18/Sa 16), Apiaceae (Si 17/Sa 14), Brassicaceae (Si 13/Sa 13). After Berendes (1902) the plant families contributing most species to De Materia Medica are: Asteraceae (60), Apiaceae (51), Lamiaceae (51), Fabaceae (35), Rosaceae (29) and Brassicaceae (24). Hence, the first 6 plant families contributing most species to the medicinal flora are the same all over with nearly the same order of importance. The exception are the 51 Apiaceae species mentioned in Berendes' De Materia Medica.

3.5. Cross cultural analysis and χ^2 -test

We can observe a highly significant concentration of medicinal species in the part of the flora shared by both islands. In total the flora common to both islands (1573) accumulate 417 medicinal species while the non-Sicilian flora (540) counts with 29 medicinal species and the non-Sardinian flora (838) with 27 medicinal species (Graphic 1). Reasons for such a distribution might be manifold. The flora common to both islands might generally experience a wider distribution because these species are more ecologically adaptive and they might contain more weedy and annual species with a higher tendency to produce phytochemicals—hence, potentially more pharmacologically active plants, i.e. medicinal plants (c.f. Stepp and Moerman, 2001).

Species with a wider distribution (around the Mediterranean basin) would have also had a higher chance of being selected and recognized as a medicinal species by a specific culture. On the other hand, if once a plant is selected as a medicinal (or food) plant, the probability that its usage or/and its germplasm is being spread in an anthropogenic way (around the Mediterranean basin and elsewhere) rises.

Table 6
Plant families underrepresented among the Sicilian medicinal flora.

Family	S	M	E	M – E	$P \leq M$	$P = M$	$P \geq M$
Plumbaginaceae	46	1	5.72	–4.72	0.02	0.01	1.00
Cyperaceae	59	1	7.34	–6.34	0.00	0.00	1.00
Orchidaceae	67	0	8.34	–8.34	0.00	0.00	1.00
Caryophyllaceae	107	3	13.31	–10.31	0.00	0.00	1.00
Fabaceae	240	16	29.86	–13.86	0.00	0.00	1.00
Poaceae	236	8	29.37	–21.37	0.00	0.00	1.00

S, species flora; M, medicinal species; E, expected medicinal species; M – E, residual; $P \leq M$, probability for M or fever; $P = M$, probability of M; $P \geq M$, probability of M or more.

Table 7
Pearson's χ^2 -test.

	Sardinia used	Sardinia not used	Total
Sicily used	170	102	272
Sicily not used	145	$x=0-1156$	145–1301
Total	315	102–1258	417–1573

Most importantly, 170 species (Tables 9a–c, supplementary data) of the 417 medicinal species present in the flora common to both islands are of medicinal use on both islands. We performed a χ^2 -test on the basis of the effectively shared and non-shared medicinal species (total 417) and calculated a 95% confidence interval for the number of shared medicinal plants to be expected if the selection had been done at random in order to create a reference value for better exemplification (Table 7). Therefore, we adopted the non-used species as a variable x with values between 0 and 1156.

According to the χ^2 -test getting 170 matches might be a plausible result if the peoples had chosen from a pool of plants containing between 477 and 539 ($60 \leq x \leq 122$) (medicinal) species (95% confidence interval, mean = 504; $x = 87$). The fact that they have chosen from a pool of 1573 (potential medicinal) species renders the observed matches highly significant and $H_0 =$ “plants have been chosen at random” is rejected.

Hence, the 170 medicinal species used on both islands clearly reflects a common cultural knowledge or common selection criteria; but where did or does that common knowledge come from? One reason is for sure the inter-cultural selection criteria with the tendency to pick medicinal plants from a few preferred plant families and the almost complete rejection of other plant families as evidenced by the binomial approach. The incorporation of synanthropic weedy species thriving in the crop fields and in human vicinity might be another factor that biases the selection (c.f. Stepp and Moerman, 2001; Leonti et al., 2006).

On the other hand people and peoples exchanged knowledge ever since. What was changing over time was the means of knowledge interchange. Writing profoundly revolutionized the transmission of knowledge and, while De Materia Medica was not the first treatise on drugs and medicinal plants, it surely was the most comprehensive and most widely divulged. De Materia Medica generally includes widespread species (or “kinds” of plants) and commercialized plant products. In fact, in his chapters Dioscorides makes reference to the varying plant names in the different European and Mediterranean regions, which implies a broader distribution of these species or species complexes.

Overall, 47% of the 299 medicinal species of Sicily are mentioned in Berendes' translation while 16% are neither mentioned on the genus level. From the 344 medicinal species of Sardinia 50% are referred to by Berendes while 16% are not so on the genus level. Hence, about the same percentage of medicinal plants of the Sicilian and the Sardinian inventory are mentioned by Berendes.

Of the 170 species used in Sardinia and Sicily, 106 (62%) are identified by Berendes (1902) while other 50 species belong to a genus identified by Berendes (like for instance the *Verbascum* spp.) and 16 species (9%) are not included, neither on the level of the genus (c.f. Tables 9a–c, supplementary data). The fraction of species mentioned in Berendes (1902) is lower in the non-Sardinian and non-Sicilian flora, while the percentage of species not mentioned is higher (Table 8).

This can have two distinct meanings: Either these 106 species included in Berendes' De Materia Medica and the ethnomedicinal flora of Sicily and Sardinia belong to a core-group of plants which are highly effective (and do have an ancient history) or its just a reflection of De Materia Medica and the difficulties peoples had in

Table 8

Medicinal flora Si and Sa 473 spp.	Species cited by Berendes	Genus cited by Berendes	Not cited by Berendes
299 Sicily tot	142 (47%)	110 (37%)	47 (16%)
344 Sardinia tot	171 (50%)	117 (34%)	56 (16%)
170 Sic. & Sar.	106 (62%)	48 (28%)	16 (9%)
102 Sic.	31 (30%)	48 (47%)	23 (23%)
145 Sar.	57 (39%)	53 (37%)	35 (24%)
27 Non-Sar.	5 (19%)	14 (52%)	8 (30%)
29 Non-Sic.	8 (28%)	16 (55%)	5 (17%)

interpreting Dioscorides' text, i.e.: These are the plants that were available and could be deciphered from the various editions of De Materia Medica with less ambiguity. If an experienced pharmacist like Berendes has pronounced difficulties in identifying plants mentioned by De Materia Medica, generations before him, and all the lay and expert men and women that used De Materia Medica from the day onwards that the work was written, had very probably the same. However, for this analysis the correct identification of the plant species originally assembled by Dioscorides is not paramount and we will never have full certainty about the species and the eventual species complexes Dioscorides had in mind. What is important is the interpretation and translation of Dioscorides' text. The data on traditional medicine gathered in Sicily and Sardinia and used in our comparison seem to sustain the probability of Berendes' suggestions on Dioscorides' plant species and vice versa.

De Materia Medica includes a great variety of drugs and many of these were for most of the time not available for the larger part of the inhabitants of Sicily and Sardinia. Such drugs might have been ignored or substituted by local drugs (c.f. Prieto, 2005).

The ethnomedicinal flora of Sardinia contains more species than the ethnomedicinal flora of Sicily. This is unexpected since Sicily harbours more plant species and because more single works were included into the compilation of the medicinal flora of Sicily. As well, Sicily has received more profound cultural impacts and influences during history than Sardinia. We are aware that the field study sites in Sicily cluster in the north-western part (Trapani) and in the eastern part of the province of Palermo and that this could have an impact on the homogeneity and species diversity (Map 1). However, we hypothesize that the higher homogeneity is due to a more intense diffusion of phytotherapeutical knowledge through written records and oral interchange and due to stronger homogenization of the cultural influences in Sicily as a whole. In fact Sicilian (Siculo) is regarded as a language on its own right expressed through various mutually intelligible dialects while the debate on the Sardinian dialects (or languages) continues.

4. Conclusions

We identified a core-group of medicinal species that are medicinal in Sicily as well as in Sardinia. These species unite the major part of the citations and moreover are best represented in Berendes' translation of De Materia Medica. The congruence of many specific uses reported in De Materia Medica with those observed in the ethnomedicinal studies of Sardinia and Sicily prompts us to conclude that many uses derive more or less directly from De Materia Medica and that the medicinal plant knowledge in Sicily and Sardinia is a shallow stereotype of the various editions of De Materia Medica. In view of our data and analysis it gets difficult to talk of a traditional Sardinian or Sicilian ethnopharmacopoeia since it cannot be distinguished readily from each other. However, there do exist species like *Arbutus unedo* and *Myrtus communis* in Sardinia and *Opuntia ficus-indica*, *Laurus nobilis* and *Cynodon dactylon* in Sicily, which are characteristic for the traditional herbal medicine

of either islands. This might as well reflect different patterns of folk pathology and the need for specific cures like the apparent need for diuretics in Sicily.

Early herbals or guides to drugs, especially such comprehensive operas as *De Materia Medica* made it possible to transmit medicinal plant knowledge with a far higher accuracy and more detail than oral tradition would have been able to. *De Materia Medica* had few or no competition for most of the time and therefore was able to homogenize knowledge about medicinal plants all over Europe and the Mediterranean. At the end it seems that it is the knowledge and interpretation of a single author book, the content of which was divulged by medical doctors and clergymen and then reflected by folk application, that has become what is now termed traditional medicine in the area under analysis.

De Materia Medica includes the first thoroughly approached ethnobotanical survey of the Mediterranean because it is a collection of relevant medicinal information for single species from various parts of the Roman Empire and beyond. Nonetheless, ethnobotanical studies in Europe and especially in the Mediterranean continue to ignore the ethnomedicinal richness, the quality and accuracy of the descriptions of Dioscorides and the fact that knowledge over the past 2000 years about medicinal plants has increasingly spread by written words in the Mediterranean and beyond. In this respect, it is problematic to talk of oral traditions referring to the knowledge of medicinal plants in (this part of) the Mediterranean.

The species included in the ethnomedicinal knowledge of both islands contain a large number of taxa thriving in degraded environments such as the various succession zones of the “Macchia Mediterranea”. These are largely widespread and common species, including many weeds, not facing threat of extinction. The few endemic and local species among the medicinal species of both islands does not justify using traditional medicinal practices as an argument for conservation biology or vice versa, at least not in the area under analysis. Such approaches appear not scientifically sound and chumming up. This coincides with conclusions made by Stepp and Moerman (2001): “Widely utilized medicinal plants need to be abundant and accessible. Rare plants are not often found in medicinal floras because they either quickly become extirpated or are brought under cultivation, and thus cease being rare”.

Generally, very few gynaecological uses are recorded, which might reflect an artefact of the fieldwork approach i.e. uneven sex proportion of the informants or the issue has remained unmentioned because the informants were embarrassed. Compared to the indications described in *De Materia Medica* the under-representation of gynaecological uses is noteworthy.

We have chosen a central but geographically limited part of the Mediterranean in our analysis but hypothesize that written sources, i.e. different versions and translations of *De Materia Medica*, have influenced as well the rest of the Mediterranean more profoundly than many would believe and liked to be true. It is the use of written sources that accentuated the homogenization of medicinal plant use in Europe more than anything else, and helped to form the common ethnobotanical heritage of the area.

In the Americas the traditional medicinal systems, believes and concepts were partially replaced and the codices burned by the conquerors. The Mestizo cultures built up new medicinal theories, believes and approaches inspired by the Native indigenous, European Christian and African cultures. Therefore, we have few ideas about ancient native American medicinal systems. In South-America and especially in Mesoamerica intra-cultural comparisons of medicinal plant usage and concepts thereof may reveal indigenous traditions and help to discern from Western influences (c.f. Heinrich et al., 1998). In Europe, the concepts of traditional medicine and medicinal plant heritage continue to be written down

since 2000 years. Therefore, comparisons of medicinal plant usage within Europe and the Mediterranean makes only sense if the historical sources that influenced the areas under comparison are crosschecked in the first place.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jep.2008.10.027.

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