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Pharmaceutical ethnobotany in the Montseny biosphere reserve (Catalonia, Iberian Peninsula). General results and new or rarely reported medicinal plants

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Abstract

An ethnobotanical survey was carried out in the massif of Montseny, which is situated in north-east Catalonia (Iberian Peninsula), covers 826 km^2 and has a population of 80 000. From 1993 to 2000 we interviewed 180 people and collected ethnobotanical information about 351 medicinal plants, with 4023 use-reports. Through comparison with a large set of studies, we detected 501 unreported or uncommon uses that corresponded to 201 plant species, 57 of which had never or very rarely been cited as medicinal or toxic. General results and key findings on the plant ethnopharmacology (number of medicinal plants, modes of consumption, types of illnesses treated) of this area are presented here, together with information on new or rarely reported medicinal plants.

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Introduction

Since ancient times humans have been closely related with their habitat. This relationship has been a two-way process; while modifying their natural environment they have also been influenced by the nature that surrounded them. As a result of our use of plants we now have a large and rather well known catalogue of useful species. Some authors believe that popular knowledge about plants and animals, named ethnobiodiversity (Hernández Bermejo 1998; Vallès et al 2000), is a component of biological diversity. In industrialised countries, such as those of western Europe, this knowledge is disappearing at a high rate, because of accelerated acculturation, defined by Ember & Ember (1997) as the adoption (at least partially) of a so-called modern culture, to the detriment of a traditional one, which is considered inferior. This process, together with the increasing depopulation of rural zones, has meant that the passing down of customs from generation to generation is now in imminent danger of disappearing.

Medicinal and food uses have always been two of the most relevant reasons for popular plant management, and are among the most persistent ones, even in cultures that are progressively losing their close relationships with nature. It is for this reason that ethno-directed (i.e. with an ethnobotanical or ethnopharmacological basis) research is very useful in drug discovery and development (Chadwick & Marsh 1994; Cox & Balick 1994; Khafagi & Dewedar 2000; Heinrich & Gibbons 2001). We therefore believe that it is of utmost importance to obtain data about popular uses of medicinal plants before this knowledge disappears. Collection of this information has a two-fold purpose: it contributes to the inventory of the cultural heritage of a country and of civilization as a whole, and to the first step in the search for new drugs or other beneficial effects from plants or plant-derived products.

The Iberian territories (including the Iberian Peninsula, the Balearic Islands and the Pyrenees) are particularly appropriate for ethnobotanical studies, because of their high ethno- and biodiversity. On the one hand, they host several cultures, basically those related to the Spanish, French, Occitan, Catalan, Galician-Portuguese and Basque languages, along with some other more geographically restricted languages, Aragonian and Asturian (Vallès et al 2001). On the other hand, with around 8500 vascular plant taxa (Castroviejo 1997), the flora is the richest in Europe and in

the Mediterranean region and constitutes one of the hotspots for world biodiversity conservation (Médail & Quézel 1999; Myers et al 2000). Bearing in mind the precariousness of the popular knowledge of plants, several ethnobotanical researches have been carried out in these and similar industrialised zones in Europe over the past 15 years. A list of some relevant European, and almost all Iberian, contributions to ethnobotany can be drawn up from the references cited in Raja et al (1997), Bonet et al (1999), Agelet & Vallès (2001) and Vallès et al (2001).

The present study deals with medicinal plants used by inhabitants of the biosphere reserve of the massif of Montseny. This paper includes the key findings concerning the plant ethnopharmacology of the area studied, with the general results and the new or very scarcely reported medicinal vascular plants. This study is a part of our research programme on Catalan ethnobotany (cf. Agelet & Vallès 2001, and references therein), which aims to contribute to the knowledge of cultural heritage and to drug development.

Territory studied and Methodology

In the massif of Montseny, 27 municipalities, with an area of 826 km^2 and a population of 80 000, were studied. This region is a mountainous inland area located in the north-eastern part of the Iberian Peninsula (longitude 2° 14′–2° 34′ E; latitude 41° 40′–41° 53′ N), has a maximum altitude (Turó de l'Home) of 1706 m and belongs to the Catalan Prelitoral range. The climate ranges from Mediterranean to sub-alpine; the rainfall ranges from 860 to 1050 mm/year and the mean temperature oscillates between 0.5 °C (January, high altitude) and 21°C (August, low altitude). The vascular flora of Montseny is rather rich, with around 1500 taxa (Bolòs et al 1986). The vegetation belongs basically to the dominia of the holm-oak (*Quercus ilex* L. subsp. *ilex*) forest, with considerable presence of cork oak (*Q. suber* L.). Forests dominated by other oaks (*Q. humilis* Mill., *Q. petraea* (Matt.) Liebl. and related taxa) and by beech (*Fagus sylvatica* L.) are also found, as well as plantations of *Castanea sativa* Mill. The southernmost European spruce populations (*Abies alba* Mill.) are also found in the zone, together with plantations of several other conifers. Sub-alpine meadows occupy the upper part of the massif. Forest management of cork and timber extraction, and field and garden cultivation on the plains have greatly modified the original landscape. The population is decreasing moderately, which is consistent with the current trend observed in rural areas, especially in the mountains. This depopulation is more accentuated in small settlements or isolated farms (called in Catalan mas or masia, in plural masos or masies), which are being abandoned in favour of larger villages and towns. While agriculture is important, especially gardens and orchards, industrial activity is not very high and is mainly linked to water and to forest products. Almost half the active population is involved in the service sector. The region is well connected to nearby cities of the country, such as Perpinyà, Girona and Barcelona, the capital of Catalonia. A large part of Montseny (about 500 km^2) has been designated a natural park since 1977 and a UNESCO Man and Biosphere (MaB) programme reserve since 1978. Its high biodiversity together with the relatively high persistence of rural life make Montseny a very attractive territory for ethnobotanical studies.

Information was obtained for this study by the method of ethnobotanical interview. During our meetings with people (usually individually and sometimes in small groups), we tried to follow all the processes concerning plant management, from collection to use. This was performed through general conversations without a closed questionnaire. Direct questions (e.g. don't you use this plant for this purpose? or don't you know this plant by this name?) were avoided, so as not to coerce the informants and lessen their spontaneity; we verified that many people are influenced by those questions and very often tend simply to answer yes. When possible, the conversations were recorded, with the permission of the informants. Plant collection was often carried out together with the persons interviewed, whom we also asked to show us where and how they stored and prepared the plants concerned. When this was not possible, specimens that we had previously collected in the region were shown to the informants to confirm the identity of each taxon. All 27 municipalities of the massif were visited. From 1993 to 2000, 172 mostly elderly people (61% women, 39% men; age range 31–96 years old; mean age 66, women 68.5, men 62) were interviewed; in addition, eight children were also interviewed. In most cases, there was more than one interview session. Informants were not scientifically knowledgeable and were born in the region studied or had lived there most of their lives.

Voucher herbarium specimens of each taxon reported were prepared and deposited in the Herbarium of the Laboratori de Botànica, Facultat de Farmàcia, Universitat de Barcelona (BCF), recently incorporated into the new Herbarium of the Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona (BCN); we maintained the system of BCF numbers, with which some of the specimens reported in previous papers had been designated. Complete records of the interviews were kept in the above-mentioned laboratory. Further details of the interviews are given in the PhD thesis of the first author (Bonet 2001). For plant nomenclature, we followed Bolòs et al (1993). Complete citation, including authorities, of the taxa is given in Tables 1 and 2, and the first time they appear in the text for the species not listed in these tables.

To evaluate the degree of originality of the plant uses reported, we compared our results with a very extensive corpus of Iberian and European ethnobotanical studies and a wide selection of other papers and treatises that deal with medicinal plants all over the world. The core of this literature set is formed by the 77 references used, to date, by our group, reported in Agelet & Vallès (2001) and in references therein, but an additional comparative effort was done, and the literature now used to check our results amounts to 115 papers (Bonet 2001).

Table 1 The 10 most commonly used plants in folk phytotherapy in Montseny and their main uses.

Plant species	Number of citations	Number of different uses	Main uses
Sambucus nigra L.	247	51	Anticatarrhal, intestinal antiseptic, ocular antiseptic, digestive, adipsic, antipyretic
Thymus vulgaris L.	152	36	Antiseptic, vulnerary, intestinal anti-inflammatory
Olea europaea L.	139	35	Antihypertensive, vulnerary, haemostatic, anti-otalgic
Tilia platyphyllos Scop.	93	11	Sedative, anticatarrhal, anticephalalgic
Abies alba Mill.	87	14	Bechic, anticatarrhal, bronchopulmonary decongestive
Anemone hepatica L.	85	9	Hepatic anti-inflammatory
Matricaria recutita L.	84	17	Digestive, ocular antiseptic, gastrointestinal anti-inflammatory
Ruta chalepensis L. ssp. *chalepensis*	82	26	Ocular antiseptic, sedative, abortive
Mentha pulegium L.	82	16	Gastrointestinal anti-inflammatory, digestive, antidiarrhoeal
Herniaria glabra L.	79	20	For acetonaemia, intestinal anti-inflammatory, diuretic

Results and Discussion

From the information obtained, a catalogue of Montseny ethnoflora was built, which constituted 584 plant species, of which 513 had some traditional uses in the study area. With respect to their categories of use, 351 species were used for health remedies (human and veterinary medicine), 280 for food (human and animal) and 236 had other traditional use. Noxious or toxic activity was reported for 98 species, 69 of which were used in medicine.

The complete catalogue of the Montseny ethnoflora is given in Bonet (2001). Table 1 shows the 10 most used plants in the region, with their main applications; they are all very well known and widespread medicinal plants. Conversely, Table 2 presents some of the most relevant plant species for which we did not find any medicinal use in the literature and those for which only one or two reports existed to date; this table is restricted to plants with three or more use-reports, and, following the reliability criterion of Le Grand & Wondergem (1987) and Johns et al (1990), the unreported or rarely reported medicinal plants with particular uses cited by at least three independent informants are indicated by an asterisk.

Use-reports (4023) were recorded for the 351 medicinal plants cited, which can be grouped into 183 types of therapeutic activity. The most frequently treated pathologies are reported in Table 3. Most applications (94%) addressed human medicine, whereas only a very small part (6%) were linked to veterinary medicine; a few remedies (1.66%) were used with the same purpose in man and in animals. Medicinal plants are often used in combination: 365 plant mixtures were reported, and informants explained their belief of a synergic effect between distinct species. Toxic, noxious or side effects were reported for 98 plant species, 70% of which were used for therapeutic purposes. Food uses were reported for 280 species (133 for man, 97 for animals and 50 for both); many plants were eaten or drunk (including plant-based liquors) as foods and were, at the same time, considered as medicinal. Details on non-crop food plants in Montseny are given in Bonet & Vallès (2002).

Richness and reliability of medicinal plant knowledge assessed by quantitative ethnobotany indicators

Table 4 presents some quantitative data on medicinal plants in 18 regions (including Montseny) where ethnobotanical studies have been carried out with a similar methodology. The number of informants for this study is the third largest in these areas, and the number of medicinal plants reported is among the highest, occupying sixth place, very close to fourth and fifth. These figures already testify to the richness of the pharmaceutical ethnoflora of Montseny; some ethnobotanical indices and the number of new reports of uses or of medicinal plants will provide a more definite idea.

The ethnobotanicity index (Portères 1970) is defined as the ratio between useful plants and total flora, expressed as a percentage. Here we calculated what we refer to as the pharmaceutical ethnobotanicity index, because only medicinal plants were considered. This index in Montseny (23.2%) is among the highest in all the territories considered, which indicates a high level of plant knowledge: around a quarter of the flora of the massif was used for medicinal purposes; it is close to those calculated for Pallars (29.1%; Agelet & Vallès 2001), the Caurel mountains (27.9%; Blanco 1996), Tunisia (27.7%; Le Floc'h 1983; Boukef 1986), the Gata cape region (25.3%; Martínez et al 1997) and the São Mamede mountains (23.1%; Rodrigues 2001).

Another indicator is specifically linked to medicinal plant use: the utilization index (U/C; Muntané 1991, amended by Bonet et al 1999). This is defined as the ratio, expressed as a percentage, between the mean number of medicinal and aromatic plants used (U) and those cited and claimed to be useful (C) by the informants. It reports on the percentage of medicinal plants that are currently used (not only known or remembered). Only 43.4% of the plants had persistent uses in Montseny; in addition, for 4% of the plants reported, our informants could give us only a popular name and no use. This indicates that the effective use of the plants is low, and that some traditional customs involving plants will be lost

Table 2 Plants used in folk phytotherapy in Montseny, previously unreported or very scarcely cited either as medicinal or as toxic or noxious, and with three or more use-reports.

Scientific name (voucher specimen)	Local Catalan names	Parts used	Popular use	Preparation	Administration	Frequency of citation	Previous reports of the same use
Amaryllidaceae							
Amaryllis belladonna L. (BCF 44380)*	Belladona	Bulb	Resolvent	Poultice (with *Crocus sativus* L.)	Topical	3	—
Asteraceae							
Centaurea pectinata L.							
ssp. *pectinata* (BCF 45032)*	Herba de l'àcid ric	Aerial part	Antiuricaemic	Tisane	Oral	1	—
	Herba del sucre		Hypoglycaemic			12	—
Chondrilla juncea L. (BCF 44101)	Màstec/màstecs	Root	Antipruriginous	Liniment	Topical	1	—
	Màsterecs		For abdominal hernia			2	—
		Young leaf	Vulnerary and antiseptic			1	—
			Blood depurative	Direct ingestion	Oral	1	—
			Vitaminic			1	—
Reichardia picroides (L.) Roth. ssp. *picroides* (BCF 44770)*	Cosconilla/ cosconilles Escanyavelles	Aerial part	Hypoglycaemic	Tisane	Oral	5	Selga 1998; Bonet et al 1999
Brassicaceae							
Brassica napus L. (BCF 45057)	Nap	Root	Bechic	Syrup	Oral	2	—
			For burns	Liniment	Topical	1	—
Caprifoliaceae							
Lonicera etrusca Santi (BCF 47641)*	Lligabosc	Flower	Sedative	Tisane Distillation	Oral	3	—
Fagaceae							
Quercus x *cerrioides* Willk.							
Et Costa (BCF 37886)*	Roure	Bark	Haemostatic	Tisane	Oral	1	—
		Fruit	For burns	Poultice	Topical	1	—
			Muscular restorative	Tisane	Oral	1	—
		Gall	Antidiarrhoeal in man and in animals			3	—
Gentianaceae							
Centaurium pulchellum (Swartz)							
Druce ssp. *pulchellum* (BCF 47428)*	Centaura	Flowered aerial part	Antianorectic	Tisane	Oral	7	Laberche & Laberche 1991
	Herba de santaura						
	Santaura		Anthelminthic			2	Laberche & Laberche 1991
			Digestive			1	Laberche & Laberche 1991
			Gastrointestinal anti-inflammatory			2	—
			Hypoglycaemic			2	—

Table 2 (*Cont.*)

Scientific name (voucher specimen)	Local Catalan names	Parts used	Popular use	Preparation	Administration	Frequency of citation	Previous reports of the same use
Lamiaceae							
Stachys byzantina C. Koch (BCF 47218)*	Bàlsam	Leaf	Antipyrotic	Embrocation and poultice	Topical	1	Parada 1997
	Bàlsam de tall		Cicatrizant	Direct application		4	Parada 1997; Bonet et al 1999
	Bàlsam pelut						
	Herba peluda		Resolvent			1	—
	Orelles de conill						
			Vulnerary			4	Selga 1998
Liliaceae							
Aloe maculata All. (BCF 45099)*	Bàlsam	Leaf	Antiseptic	Direct application	External	5	—
	Bàlsam de les cremades		For burns				
	Bàlsam de tall		Vulnerary				
	Pites de foc						
Orobanchaceae							
Orobanche rapum-genistae Thuill. (BCF 49412)	Lliri	Stem's basal portion	Anticatarrhal	Liniment	Topical	1	—
			Anti-otalgic	Oil maceration		1	—
			Pharyngeal antiseptic and anti-inflammatory	Liniment		1	—
Poaceae							
Phalaris canariensis L. ssp. *canariensis* (BCF 49381)	Escaiola	Seed	For gout	Tisane	Oral	1	—
			Hypocholesterolaemic			1	Mulet 1990; Bonet 1991
			Hypoglycaemic			1	—
Polygonaceae							
Rumex obtusifolius Schott (BCF 46393)	Paradelles	Leaf	Resolvent	Poultice	Topical	2	Villar et al 1992
	Santes Maries		Vulnerary			1	Villar et al 1992
Polypodiaceae							
Asplenium adiantum-nigrum L. ssp. *onopteris* (L.) Heufler (BCF 47646)	Cama negra	Frond	Antimycotic in newborns	Collutorium	Topical	1	—
	Foguera borda						
	Herba cancera		For jaundice in animals	Tisane	Oral	1	—
	Herba felera						
			Antiparasitic in animals			1	—

Table 2 (*Cont.*)

Scientific name (voucher specimen)	Local Catalan names	Parts used	Popular use	Preparation	Administration	Frequency of citation	Previous reports of the same use
Asplenium septentrionale (L.) Hoffm.	Herba prima	Frond	Urinary anti-inflammatory	Tisane		1	—
			For prostatitis			2	—
			Lithotriptic			1	—
			Renal anti-inflammatory			1	—
			Renal depurative			2	—
Polystichum setiferum L. (BCF 47639)	Falguera Foguera de jardí Foguera mosquera	Frond	Insect repellent	—	—	1	—
Rubiaceae							
Galium lucidum All. (BCF 47192)	Flor de Sant Joan Herba de Sant Joan	Aerial part	Anti-apoplectic	Tisane	Oral	1	—
			Diuretic			1	—
			Noxious: weakening in man and animals; diarrhoeal in animals (cows)	Direct ingestion		1	—
		Flowered aerial part	Antihypertensive and antipelohemic	Tisane		1	—
			For warts	Poultice	External	1	—
Salicaceae							
Salix cinerea L. ssp. *oleifolia* (Sm.) Macreight (BCF 46398)*	Gatell	Internal bark	Hypocholesterolaemic	Tisane	Oral	1	—
		Stump, root, internal bark	Hepatic anti-inflammatory			7	—
Salix fragilis L. (BCF 42616)	Vimegueres Vimenera/vimeneres	Internal bark and branch	Anthelminthic	Tisane	Oral	2	—
	Vímet/vímets	Flower	Antipneumonic			1	—
Saxifragaceae							
Saxifraga paniculatavill. (BCF 49480)*	Corona de rei	Aerial part	Abortive	Tisane	Oral	7	—
			Post-labour antiseptic in animals			2	—
Thymelaeaceae							
Daphne laureola L. ssp. *laureola* (BCF 44982)	Marxívols Senet	Latex	Antiverrucose	Direct application	Topical	1	—
	Senet bord	Leaf	Purgative	Tisane	Oral	1	Fernández-Ocaña 2000
		Stem and leaf	Antianorectic			1	—

Table 2 (*Cont.*)

Scientific name (voucher specimen)	Local Catalan names	Parts used	Popular use	Preparation	Administration	Frequency of citation	Previous reports of the same use
Violaceae							
Viola sylvestris Lam. (BCF 42711)	Violer/violers Violes Violetes	Flower	Bechic	Tisane	Oral	1	—
		Flowered aerial part	Pharyngeal antiseptic and anti-inflammatory			1	—
		Leaf	Coadjuvant in treatment after stomach operation			1	—

*Plants with single uses reported by three or more informants.

Table 3 Most common plant and plant mixture activity in Montseny.

Medicinal property (or system or ailment treated)	Percentage of use-reports
Plants	
Digestive	15.83
Anti-inflammatory	13.00
Respiratory	10.64
Traumatic events (wound-healing, antipyrotic)	9.35
Infections or infestations (anthelminthic, febrifuge, coadjuvant in cures against viral illnesses, such as measles or hepatitis)	8.43
Genitourinary (diuretic, lithotriptic)	8.31
Circulatory (antihypertensive, cardiac and circulation stimulative, blood depurative, antihaemorrhoidal)	6.71
Skin and subcutaneous tissue	4.50
Mental troubles (sedative, hypnotic)	3.55
Analgesic	3.23
Plant mixtures	
Anticatarrhal	11.23
Buccopharyngeal antiseptic	6.80
Antihypertensive	5.20
Osteoarticular and muscular analgesic and anti-inflammatory	4.66

Data is based on 4023 plant use-reports and 365 plant mixtures.

or forgotten in a few years. In almost all the other territories, similar figures of around 50% are found for this index (Table 4). This finding can be attributed to acculturation, which affects many European areas. According to the data of our and other studies (see Table 4 and references cited there), and to the comments of other European colleagues (A. Pieroni, School of Pharmacy, University of London, personal communication), the collection of data on folk plant uses will soon be impossible. It is therefore urgent to start ethnobotanical research in these areas to avoid the loss of data that can be precious for the development of new useful plant products.

A number of methods have been proposed to assess the reliability and consistency of medicinal plant use, to select

Table 4 Comparison of results of ethnobotanical studies in Montseny and in other Mediterranean territories.

Region	Extension (km^2)	Population	Flora[s]	MP[t]	NI[u]	EI[v]	U/C[w]
Montseny[a]	826	79373	1500	351	172	23.2	43.4
Pallars[b]	2530	18800	1500	437	264	29.1	49.2
Huesca[c]	15671	222000	2500	553	—	22	50
Castelló[d]	6679	385823	2128	365	150	17.2	—
Granada[e]	12531	761734	—	241	—	—	—
Cabo de Gata[f]	800	20000	1000	253	153	25.3	—
Cerdanya[g]	1086	23000	1600	234	155	15	30.4
Vall del Tenes[h]	260	17969	—	150	28	—	70.8
Cyprus[i]	9251	639000	1900	379	—	—	19.9
Tunisia[j]	154520	7900000	2000	553	130	27.7	27.7
Israel-Palestine[k]	20700	4486600	—	150	100	—	—
Córdoba[l]	13718	724000	1641	145	106	8.8	—
Sierra de Cazorla[m]	2143	72423	1933	344	183	17.8	88.8
Caurel[n]	260	2400	800	223	45	27.9	—
Serra de São Mamede[o]	317	—	800	150	45	23.1	—
Segarra[p]	646	17040	—	92	29	—	52.6
Alt Empordà[q]	178	41300	1650	149	46	11	93
Guilleries[r]	594	18880	1100	158	27	20	87

[a]Bonet (2001) and this study; [b]Agelet (1999); [c]Villar et al (1992); [d]Mulet (1990); [e]González-Tejero (1989); [f]Martínez (1993), Martínez et al (1996, 1997); [g]Muntané (1991); [h]Bonet (1991), Bonet et al (1992); [i]Arnold-Apostolides (1991); [j]Le Floc'h (1983), Boukef (1986); [k]Friedman et al (1986), Palevich et al (1986); [l]Casana (1993), Galán (1993); [m]Fernández-Ocaña (2000); [n]Blanco (1996); [o]Rodrigues (2001); [p]Raja (1995), Raja et al (1997); [q]Parada (1997), Bonet et al (1999), Parada et al (2002); [r]Selga (1998), Bonet et al (1999), Parada et al (2002); [s]approximate number of vascular plant species in the territory, when available; [t]number of medicinal plants cited; [u]number of informants; [v]ethnobotanicity index (Portères 1970); [w]utilization index (Muntané 1991; Bonet et al 1999).

the most promising taxa for further chemical or pharmacological research in view of new drug development. The frequency of citation of each plant or each use is one approach. Le Grand & Wondergem (1987) and Johns et al (1990) proposed that a use is reliable when reported by at least three independent informants. Eleven uses of the new or rarely cited medicinal plants presented in Table 2 meet this condition. Trotter & Logan (1986) defined the informant consensus factor (F_{ic}) as the ratio between the number of use-reports minus the number of taxa used and the number of use-reports minus one. They calculated this factor for each medicinal plant category, as did others, such as Heinrich et al (1998) and Leonti et al (2001). A high value of this factor, ranging from 0 to 1, is interpreted as a relatively small number of taxa used to treat a type of ailment, which indicates that the informants rely strongly on these plants. Therefore these taxa are good candidates for further investigations. In Montseny, the general F_{ic} (for all medicinal plants) was 0.91. A slightly lower figure can be calculated in a Pyrenean region (0.87; Agelet & Vallès 2001); studies conducted in several Mexican areas showed different degrees of informant consensus (0.88, 0.75, 0.79, 0.86; Heinrich et al 1998; Leonti et al 2001), also lower than the F_{ic} value in Montseny. In addition, the informant consensus factor in Montseny was also high for all the main groups of medicinal plant activity: digestive (673 use-reports, 143 species used, $F_{ic} = 0.78$), anti-inflammatory (532, 136, 0.75), respiratory troubles (428, 90, 0.79), traumatic injuries (376, 74, 0.81), infections (339, 82, 0.76), genitourinary ailments (327, 68, 0.79), circulation problems (270, 73, 0.73) and skin complaints (181, 70, 0.61). These values of the informant consensus factor are higher than those reported for several Mexican regions by Heinrich et al (1998) and Leonti et al (2001), except for skin diseases (0.69 in Leonti et al (2001)). We considered the category of skin diseases in the sense of Cook (1995) — whose classification we followed in general — that does not include wounds and burns (classed as traumatic events); this is a cause for the relatively low informant consensus index in this therapeutic group, much lower than the remaining. The high values of both the general informant consensus factor and those of the different therapeutic groups indicate strong constancy and consistency in medicinal plant use in Montseny.

Predominant families and species

The 351 medicinal species reported belonged to 89 botanical families, of which the following predominated: Asteraceae (12.25%), Lamiaceae (7.40%), Rosaceae (5.41%), Fabaceae (5.41%), Poaceae (3.70%), Apiaceae (3.13%), Polypodiaceae (2.56%), Solanaceae (2.56%), Liliaceae (2.28%), and Brassicaceae (1.99%). Four botanical families accounted for more than 30% of the medicinal plants used in Montseny, and around 50% were included in 10 families.

Sambucus nigra, *Thymus vulgaris* and *Olea europaea* were the three most reported species (Table 1); the former was particularly remarkable by the frequency of use-reports (247) and also by the diversity of uses (51). Most of the leading species in Montseny, including the three most cited plants, are also among those most used in many other Catalan regions (Bonet 1993; Raja et al 1997; Bonet et al 1999; Agelet & Vallès 2001; Muntané 2002; Parada et al 2002). Other species, such as *Abies alba*, are also shared with mountain territories (Agelet & Vallès 2001; Muntané 2002). Moreover, several species that are rarely reported in other areas can be considered as indicators of Montseny folk phytotherapy. This is true of *Asplenium septentrionale*, among others, which has only been reported from Italy (Gastaldo 1970). We also highlight the very wide use — with anticatarrhal, antihypertensive, analgesic and anti-inflammatory purposes — of *Saxifraga vayredana* Luiz., an endemic plant to the study area. The detection and sustainable use of a plant with a restricted distribution area testifies the deep knowledge that our informants have of their surrounding environment.

Parts of plants used and methods of drug preparation

The whole plant, or the aerial part, was most often used in the preparation of remedies (34%), followed by leaf (21%) and floral structures — flowers, floral tops and inflorescences, the two latter cases often associated with young leaves — (17%). Fruit or infructescence (10%) and cauline structures (6%) were also used frequently.

Internal use (70%) largely predominated over external (30%). The different, very simple, procedures of water extraction (basically infusion, decoction and maceration) constitute the most universal forms of preparation, not only in Montseny but also in other territories (Mulet 1991; Bonet et al 1992, 1999; Raja et al 1997; Agelet & Vallès 2001; Muntané 2002; Parada et al 2002). Nevertheless, three remarkable and laborious forms of preparation were widespread in Montseny. Firstly, a syrup made with *Abies alba* cones, with balsamic and antitussigenic properties. Immature cones are cut and macerated with sugar, and the syrup formed is used either directly or after boiling to avoid fermentation; when *A. alba* is not available, different *Pinus* species cones are used in the same way. Similar processes have been reported in other Catalan mountain territories (Agelet 1999; Muntané 2002). Secondly, the essential oil (commonly called spirit) of *Sambucus nigra*, with anti-inflammatory, digestive, anticatarrhal, febrifuge and ocular antiseptic activity among many other uses. It is prepared from the inflorescences by a kind of dry distillation, the heat being provided by hot coal that is not in direct contact with the flowers; the essence obtained is diluted in water before use. This method seems quite limited to the region studied, where it is very common, and some neighbouring territories (Agelet et al 1990; Bonet 1993; Parada et al 2002). Thirdly, the so-called oil and pitch, made by mixing olive (*Olea europaea*) oil and black pitch (obtained by distillation of *Pinus sylvestris* L. resin). This product, currently used widely in the region, can be more or less viscous depending on the proportion of the ingredients. It is applied to burns and furuncles, as a wound healer, and

is also used for ejecting spines and, in veterinary medicine, for immobilizing fractured bones; it is often applied with *Verbascum thapsus* L. leaves.

Plant activity

Following Cook's (1995) classification, digestive pathologies, inflammation, respiratory disorders, traumatic injuries, infections, infestations and circulatory, genitourinary and skin diseases accounted for almost three quarters of the total use-reports collected (Table 3); this is consistent with the results of other studies in different Mediterranean territories carried out with the same methods (González-Tejero 1989; Arnold-Apostolides 1991; Mulet 1991; Bonet 1993; Martínez et al 1997; Agelet 1999; Muntané 2002; Parada et al 2002). Our results confirm those already obtained from other Catalan regions (Bonet et al 1992, 1999; Raja et al 1997; Agelet & Vallès 2001; Muntané 2002) concerning the general type of health problems treated with medicinal plants: in spite of some reports on plants with very strong activity against severe or acute illnesses, most folk plant remedies are addressed to the treatment of mild or chronic diseases. This fact notwithstanding, it is worth stressing that many of the chronic diseases treated (bronchial problems or high blood pressure among others) are important health troubles, so that the use of plants is not restricted to irrelevant ailments. Our results are consistent with those of Reuter (1991) concerning the possibility of using European plants in phytotherapy.

New or very scarcely reported medicinal plants

Our informants reported 501 new or uncommon uses of 201 plant species, 57 of which had never, or very rarely, been cited as medicinal or toxic; we considered as new the uses or plants that did not appear in the 115 references used for comparison (Bonet 2001), and as uncommon those that appeared in one or two of these studies. These figures are very high, especially taking into account that the research carried out in recent years in neighbouring areas to Montseny (Table 4) has improved very much the knowledge about Mediterranean medicinal plant use and that the number of literature references used in our study is higher than in previous ones. The number of previously unreported uses in regions close to Montseny was 1856 in Castelló de la Plana (around 10 references used for comparison; Mulet 1990), 599 in Cerdanya (~10; Muntané 1991), 41 in Vall del Tenes (~20; Bonet 1991), 42 in Segarra (~20; Raja 1995), 101 in Alt Empordà (~80; Parada 1997), 105 in Guilleries (~80; Selga 1998) and 857 in Pallars (~80; Agelet 1999). From our, and other, results we conclude that in Western Europe (which is often considered as non-suitable for ethnopharmacological research), pharmaceutical ethnobotany studies are still useful approaches to detect new, rarely reported or relevant medicinal uses of plants, which may provide the basis for new drugs.

Several of the uses of new or scarcely reported medicinal plants in Montseny (Table 2) have been previously attributed to taxonomically related species. For example, some of the uses of *Centaurium pulchellum* coincide with those of *C. erythraea* Rafn; the abortive properties of *Saxifraga paniculata* are well known for other species of the genus, such as *S. longifolia* Lap. and *S. callosa* Sm. in Dickson subsp. *catalaunica* (Boiss.) D. A. Webb; the antihelminthic use of *Salix fragilis* has been reported for *S. viminialis* L. (Mulet 1991); the hypoglycaemic activity of *Centaurea pectinata* agrees with that of many species of the genus, such as *C. aspera* L. In other cases, the same use in Montseny or a similar one has been reported in other Iberian or Mediterranean zones. The lithotriptic and renal depurative activity of *Asplenium septentrionale* are strongly related to that previously reported (diuretic and depurative in general) in Italy (Gastaldo 1970) and Catalonia (Bonet et al 1999); the hypocholesterolaemic property of *Phalaris canariensis* and similar effects to the antipyrotic, bechic and cicatrizing activity of *Brassica napus* have been reported in Castelló de la Plana (Mulet 1991); in Andalusia, Fernández-Ocaña (2000) reported the purgative action of *Daphne laureola*. Moreover, some plants claimed to be active in Montseny have been previously reported to date only from bordering areas, such as *Reichardia picroides* for hypoglycaemic properties and *Viola sylvestris* for bechic properties, which have been recorded only from a territory called Guilleries (Jàvega et al 1993; Bonet et al 1999; Parada et al 2002). This indicates a certain consistency between plant uses in culturally close regions.

Stachys byzantina is a plant from south-west Asia which is often used in Mediterranean areas for its ornamental value. After some years of cultivation for this purpose, people in Catalonia have started using it as a medicinal plant. These medicinal uses, all of them external and linked to skin problems, agree with the very scarce previous reports, only in neighbouring Catalan regions (Bonet et al 1999; Parada et al 2002). The situation is almost identical with the South American ornamental *Verbena chamaedryfolia* Juss., used in Montseny as a diuretic and only previously reported medicinally as a renal antilithiasic in another territory studied by our group (Bonet et al 1999; Parada et al 2002). The introduction of foreign plants to the local ethnopharmacopoeia, an example of the vitality of plant use, has always occurred; one of the clearest old cases is the South American *Lippia triphylla* (L'Hér.) O. Kuntze, which since ancient times can be found in almost every rural house, and is highly appreciated for its digestive properties, among others. So common is this plant that people consider it a native species.

Some new or rarely reported plants, such as *Brassica napus*, are grown for food and have additional medicinal properties. We also found some non-crop food plants such as *Chondrilla juncea*, which is commonly eaten as a salad (Bonet & Vallès 2002), and at the same time claimed to be haematocathartic and a source of vitamins when ingested fresh. This is an example of the close relationship between medicinal and food plants. We already found that 77.3% of plants used as food or beverages in Montseny are also claimed to be medicinal (Bonet & Vallès 2002). The situation is similar in many regions of the world (cf. Bonet & Vallès 2002 and references therein) from ancient times: Gispert & González (1993) described a similar panorama in prehispanic Mexico. Given the increasing interest in

so-called pharmafoods, nutraceuticals or functional foods (Etkin 1998), a further study of the interface between medicinal and food plants would be useful for the development of new plant products.

Concluding remarks

The present data confirm different facts in folk plant medicine, already observed by our group during research carried out in different Catalan regions: knowledge of popular phytotherapy is still alive; there is a relatively high number of new or very scarcely reported medicinal plants or plant uses; some endemic medicinal plants (or with restricted distribution area) are used; and the effective use of medicinal plants is rapidly decreasing. These assessments lead us to some conclusions. Firstly, Western European regions are appropriate for pharmaceutical ethnobotanical studies as a first step in the search for new bioactive products; there is no reason for this research to be restricted, as it currently is, to tropical or subtropical zones. Secondly, it is urgent to perform these studies before popular knowledge dies out. Thirdly, possible conflict between plant use and conservation must be addressed to avoid biodiversity erosion.

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