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RESEARCH ARTICLE

Flora and plant genetic resources of ancient olive groves of Apulia (Southern Italy)

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Abstract A floristic study of vascular flora of ancient olive groves of Apulia (Italy) was carried out from 2009 to 2011. Research was made in the fields and in the ecological infrastructures of four olive groves, located in protected areas: National Park of Gargano, Park of Dune Costiere, State and Marine Natural Reserve of Torre Guaceto and of Le Cesine. Floristic analysis was carried out by Raunkiaer and Braun-Blanquet. Biological forms and chorological types were named according to Raunkiear. Overall, 408 taxa were identified, of which 332 species, 73 subspecies and 3 varieties, belonging to 275 genera and 74 families. A small segment of 18 taxa, out of 408, was considered of conservation interest. For these taxa the topography of the collecting site, plant community, population density, degree of vulnerability and habitats were recorded, according to the Directive 92/43/EEC. Another segment of 111 taxa, out of a total of 408, was considered important for usage, which for the sake of presentation has been divided in five arbitrary categories: food crops, fodder crops, medicinal, aromatic and officinalis, crop wild relatives and edible wild species. For each of these taxa, an attempt to provide relevant information was made. Only two taxa, i.e., *Muscari parviflorum* and *Aegilops uniaristata* are common to both segments. The work was carried out within the competence of the LIFE+ CENT.OLI.MED. (LIFE07 NAT/IT/000450) project, with the aim to gather information for improving conservation and management of olive groves of Apulia, as well as of their related wild life.

Keywords Ancient olive groves · Apulia · Crop wild relatives · Floristic study · Italy

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Introduction

It is widely accepted that one of the most important plants in the history and culture of the Mediterranean people is the olive tree (*Olea europaea* L. subsp. *europaea*, synonymous *Olea europaea* L subsp. *sativa* (Weston) Arcang.).

Today, olives are produced in 39 countries worldwide on an area of over 8 million hectares and is the most extensively cultivated temperate fruit crop in the world (FAO 2002). Production has increased 44 % since 1992. Olive oil production was 2.4 million of tons in 2002. Over 75 % of the world's olive oil is produced in just 3 countries: Spain, Italy, and Greece.

In Italy, Apulia is the most important region since it provides 40 % of the italian oil production (Bartolini et al. 2005). These data show the importance of olive

trees in the world, as well as in Apulia. In Italy, fossilized remains of the olive tree's ancestor were found near Livorno, dating from twenty million years ago, although actual cultivation probably did not occur until the fifth century B.C. (Zohary 1973). Olives were first cultivated in the Eastern part of the Mediterranean and moved westwards over the millennia. Beginning in 5000 B.C., olive cultivation spread from Crete to Syria, Palestine, and Israel; commercial networking and application of new knowledge then brought it to Southern Turkey, Cyprus, and Egypt. Until 1500 B.C., Greece was the most heavily cultivated. With the expansion of the Greek colonies, olive culture reached Southern Italy and Northern Africa in the eighth century B.C. Olive trees were planted in the entire Mediterranean basin under the Roman rule (Acerbo 1937; Zohary 1973; Schäfer-Schuchardt 1988).

Ancient olive groves are among of the most important elements of the Apulian landscape, and especially evocative of the coast and hills of the Italian peninsula and of the Mediterranean basin (Perrino et al. 2012).

These Apulian habitats, in addition to their undeniable cultural and landscape values have a major environmental importance, since they can offer a shelter to many plant and animal species, some of which considered of conservation interest. In fact, the presence of many types of plant communities, such as nitrophilous and subnitrophilous communities, spontaneous grasses, field margins (*Stellarietea-mediae*), annual meadow (*Brachypodietalia distachyi*), perennial termoxerophilous grasslands (*Lygeo-Stipetea*), small patches of chasmophytic vegetation (*Asplenietea trichomanis*), nanophanerofitic and chamaephytic garigues (*Cisto-Ericion*), evergreen sclerophyllous scrubs (*Oleo-Ceratonion*) (Perrino et al. 2013), and scattered trees as *Ceratonia siliqua*, *Ficus carica*, *Laurus nobilis*, *Prunus dulcis*, and sometimes *Juglans regia*, *Morus alba*, *Prunus domestica*, *Punica granatum*, *Pyrus communis*, plus many species of *Quercus* s.l. and *Sorbus domestica* (Perrino et al. 2011), make the existing agro-ecosystems suitable for hosting several species of amphibians, reptiles, mammals and especially of birds. These agro-ecosystems have called the attention of scientists (Biondi et al. 2007) suggesting to include them in Annex I of the EEC Directive 92/43, as priority habitat "*Centuries old olive groves with evergreen Quercus* spp. *and arborescent Mattoral*" (code 6320).

Considering the spreading of olive trees throughout the Mediterranean countries, one can conclude that the olive agro-ecosystems of Apulia are about 2.800 years old (Zohary 1973). Enough old to deserve a study of the vascular flora that has evolved along with and that has contributed to the development of the said agro-ecosystems. So, a botanical study of the vascular flora of ancient olive groves of Apulia with the objective to analyse their biodiversity, with the main emphasis on threatened and of conservation interest, was undertaken in the frame of the above mentioned Life+ project, carrying on a previous work on the same monumental olive trees (Perrino et al. 2011).

Since in the last decades, several scientists (Hammer et al. 1992; Perrino et al. 2004) explored Apulia for collecting plant genetic resources, ancient crop varieties and their wild relatives, a special attention was also paid to plant species used by man, threatened or not by genetic erosion and/or extinction, with the aim to provide more information for improving *in situ* and *ex situ* conservation and valorization of plant biodiversity, linked with ancient olive groves.

Materials and methods

The present study was planned and carried out, from 2009 to 2011, in the frame of the LIFE+ CENT.O-LI.MED. (LIFE07 NAT/IT000450) Project, for which the protection and sustainable management of biodiversity is of paramount importance for the achievement of the Millennium Development Goals (MDG).

Research work was made in four ancient olive groves, located in different areas of Apulia, where they represent typical environments of the Region.

The selected ancient olive groves are located along the cost, in protected areas of Apulia (Southern Italy): National Park of Gargano (Vico del Gargano, province of Foggia), Park of Dune Costiere between Torre Canne e Torre San Leonardo (Fasano, province of Brindisi), State Natural Reserve and Marine Natural Reserve of Torre Guaceto (Carovigno, province of Brindisi), State Natural Reserve of Le Cesine (Vernole, province of Lecce) (Fig. 1). In the Park of Dune Costiere the olive trees grow on the bottom of a ephemeral river; in the site of Natural Reserve Le Cesine, olive trees, extensively farmed, is contiguous to the wetland and to a *Pinus halepensis* stand, whose reforestation began in the early years of the last

Fig. 1 Geographical position of olive groves surveyed

century; in the National Park of Gargano the olive trees grow on a steep slope on the seafront; and finally, in the Natural Reserve of Torre Guaceto olive orchards grow on a flatty land. Even if the selected olive groves have common features, such as organic farming management from an ecological point of view each of them shows its own peculiarities. Each grove presents a small number of olive trees per hectare, never less than 48 plants, extensively managed. The low number of tillage does not impede natural dissemination, compatible with a continuous grass cover and the presence of man-made and/or natural infrastructures, such as hedgerows, small dry stone walls, open free areas, trees and shrubs along field edges.

Usually, at least in Apulia, the trend is that ancient olive groves are prevalently managed by organic farming or traditional agriculture, characterized by a low environmental impact, as in the case of the four ancient olive groves chosen in the present survey, while modern olive orchards are managed mainly by industrial agriculture, with a high o very high environmental impact. In the first case, wild plants have more chances to survive and this explains why genetic erosion in ancient olive groves is expected to be very low or much lower than that occurring in modern and/or industrial olive orchards.

The list of species was built up step by step, according to several surveys made for floristic analysis and for an evaluation of the level of biodiversity, before and during each planned action and sampling.

In each olive grove, floristic analysis was carried out at two levels: the field, i.e., strictly the olive orchard, and the ecological infrastructures, as above described. The analysis was worked out by three different methodologies: (A) surveys in the fields were made according to the Raunkiaer method (Cappelletti 1976), as simplified by Vazzana and Raso (1997), i.e., using a metal frame of 0.25 m and performing a number of launches, that varied (from 6 to 10) in function of the uniformity of the vegetation and the chance to detect new species; (B) samplings were performed in the ecological infrastructure according to the method of Braun-Blanquet (1932); (C) visual and oriented surveys, based on the experience of the botanist, were made to detect species that could escape with A and B methodologies. The data collected with the first two methods (A and B) will be used to calculate the Shannon–Weaver's indices (1949) that will be published in a different paper.

Table 1 Acronyms of the biological forms and chorologic types found in the olive groves

Biological forms

Ch, chamaephytes; P, phanerophytes; G, geophytes; H, hemicryptophytes; NP, nanophanerophytes; T, therophytes

Chorologic types

A, Atlantic; Ad, Amphiadriatic; Afs, south-African; Ams, southern American; Ase, eastern Asiatic; Aus, Australian; Ascm, centre Asiatic-Medit.; Assw, south-western Asiatic; Asw, western Asiatic; Avv, adventitious; C, Cosmopolitan; Cb, Circumboreal; Cn, China; Cs, Subcosmopolitan; Ctr, Thermocosmopolit; E, European; Ea, Euroasiatic; Easw, western European-Asiatic; Eat, Euroasiatic temperate; Ec, central-European; Eca, European-Caucasic; Ecca, central-European Caucasic; Ecs, south-central European; Es, southern European, Esb, Eurosiberian; Ese, south-eastern European; Esep, south-eastern European Pontic; Esesp, southern European and southern Siberian Pontic; Esp, southern European Pontic; Hi, Himalaya; I, Endemic; Ma, Medit.-Atlantic; Masb, Medit.-Subatlantic; Me, Eurimedit.; Mea, Eurimedit.-Atlantic; Meas, Eurimedit.-Subatlantic; Mec, central-Medit.; Mece, centre-eastern Medit.; Mecw, central-Medit. western; Mem, Eurimedit.-Macaronesian; Menp, northern Euromedit.-Pontic; Mess, Eurimedit. southern-Siberian; Met, Eurimedit.-Turanian; Mne, north-eastern Medit.; Mm, Medit.-Mountain; Mmc, Medit.-Macaronesian; Mmms, southern Medit.-Macaronesian; Mmne, north-eastern Medit.-Mountain; Mmw, western Medit.-Mountain; Mn, northern Medit.; Ms, Stenomedit.; Msa, Stenomedit.-Atlantic; Msd, southern Medit.; Msde, south-eastern Medit.; Msdw, south-western Medit.; Mse, eastern Stenomedit.; Msm, Stenomedit.-Macaronesian; Msn, northern Stenomedit.; Msp, Stenomedit. Pontic; Mss, southern Stenomedit.; Mssw, south-western Stenomedit.; Mst, Stenomedit.-Turanian; Msw, western Stenomedit.; Mt, Medit.-Turanian; Mts, southern Medit.-Turaniano; Mw, western Medit.; Nen, Neotropical nat.; Oes, Orophil south-European; Oesec, Orophil European-Caucasic south-eastern; Omne, north-eastern Orophil-Medit.; Omw, western Orophil-Medit.; P, Pontic; Pn, Pantropical; Tmp, Paleotemperate; Tmpw, western Paleotemperate; Tpp, Paleotropical; Tps, Subtropical; Tpsp, Paleo-Subtropical

Species were determined according to Pignatti (1982) and Tutin et al. (1964–80). Taxa nomenclature follows Conti et al. (2005) and subsequent integration (Conti et al. 2007), except for the genus *Aegilops*, *Taraxacum* and *Thymbra capitata*, for which Van Slageren (1994), Pignatti (1982) and Morales Valverde (1987), were adopted respectively. The systematics of families and their arrangement was made according to Smith et al. (2006) for the vascular cryptogams megaphylls, to Haston et al. (2007, 2009) for the Angiosperms, and to the criteria proposed by Angiosperm Phylogeny Group (Stevens 2008; APG III 2009) for the boundaries. The biological forms and the chorology were named according to Raunkiear (1934) and their acronyms are reported in Table 1. Taxa are listed in alphabetical order and grouped in families according to Pignatti (1982). Geographic position (U.T.M.—WGS84), site name, distribution data, motivation of conservation interest, general information on plant communities, and the relationships with the habitat of Directive 92/43 EEC (European Commission Dg Environment 2007; Biondi and Blasi 2009) are reported only for taxa of conservation interest (see the ad hoc paragraph: Analysis of taxa of conservation interest). For these species, different acronyms indicating the reasons of conservation interest were used. They are: CR: critically endangered; EN: endangered; VU: vulnerable; LR: lower risk; NT: near threatened; I: endemic; Ad: amphiadriatic, PI: phytogeographic interest; B: International Convention of Berne, 1979; CI: Convention on International Trade in Endangered Species (Cites 1973); DH: Habitat Directive 92/43 EEC; r: rare; (*) common to all of the surveyed olive groves. The threatened categories of species follow Conti et al. (1997), and only for *Aegilops uniaristata* and *Asyneuma limonifolium* subsp. *limonifolium,* the categories follow Perrino and Wagensommer (2012) and Perrino et al. (2012) respectively.

As far as plant species used by man is concerned, different acronyms were used, according to the category they have been assigned: CRO for food crops; FOD for fodder crops; MAP for medicinal and aromatic plants; CWR for crop wild relatives and EWS for edible wild species (see Floristic list of Appendix). In practice, since these plants may have more than one use, the criterion to assign a plant to one category, instead of another, was that of considering its most frequent and/or important use. For plants used by man the most cited sources of information have been Hammer et al. (1992, 1999), Perrino et al. (2004) and Zeven and Zhukovsky (1975).

Results

Acronymes of biological forms and chorological types are listed in Table 1. Percentages of species per family (Table 2) and per chorological spectrum (Table 3)

Table 2 Number and percentage of species per family in fields and ecological infrastructures, merged and separately. Percentages are calculated dividing the number of species per family by the total of all species

Family	Fields and ecological infrastructures		Fields		Ecological infrastructures	
	%	n°	%	n°	%	n°
Asteraceae	12.7	52	13.2	31	13.0	49
Poaceae	11.3	46	13.2	30	11.9	45
Fabaceae	11.3	46	12.4	29	10.9	41
Lamiaceae	4.9	20	2.1	5	5.0	19
Brassicaceae	3.7	15	5.6	13	3.7	14
Caryophyllaceae	3.2	13	3.4	8	2.7	10
Plantaginaceae	2.9	12	3.4	8	2.9	11
Asparagaceae	2.7	11	3.0	7	2.7	10
Boraginaceae	2.7	11	2.6	6	2.7	10
Ranunculaceae	2.7	11	2.1	5	2.7	10
Rubiaceae	2.7	11	3.4	8	2.9	11
Apiaceae	2.2	9	3.4	8	1.9	8
Rosaceae	2.2	9	0.9	2	2.4	9
Caprifoliaceae	2.0	8	1.7	4	2.1	8
Cistaceae	1.7	7	–	–	1.9	7
Convolvulaceae	1.7	7	0.9	2	1.9	7
Euphorbiaceae	1.7	7	1.7	4	1.9	7
Geraniaceae	1.5	6	2.6	6	1.6	6
Papaveraceae	1.2	5	2.1	5	0.8	3
Rutaceae	1.2	5	–	–	1.3	5
Amaryllidaceae	1.0	4	0.9	2	0.8	3
Orchidaceae	1.0	4	0.9	2	1.1	4
Polygonaceae	1.0	4	0.9	2	0.8	3
Scrophulariaceae	1.0	4	0.9	2	1.1	4
Urticaceae	1.0	4	1.7	4	0.8	3
Amaranthaceae	0.7	3	1.3	3	–	(1)
Campanulaceae	0.7	3	0.9	2	0.8	3
Fagaceae	0.7	3	–	–	0.8	3
Gentianaceae	0.7	3	0.9	2	0.5	2
Iridaceae	0.7	3	–	(1)	–	(1)
Malvaceae	0.7	3	1.4	3	0.5	2
Oleaceae	0.7	3	–	(1)	0.8	3
Orobanchaceae	0.7	3	0.9	2	0.8	3
Primulaceae	0.7	3	0.9	2	0.8	3
Adoxaceae	0.5	2	–	(1)	0.5	2
Anacardiaceae	0.5	2	–	(1)	0.5	2
Araceae	0.5	2	0.9	2	0.5	2
Hypericaceae	0.5	2	–	(1)	0.5	2
Juncaceae	0.5	2	–	(1)	0.5	2
Liliaceae	0.7	2	–	–	0.5	2
Linaceae	0.5	2	0.9	2	0.5	2
Moraceae	0.5	2	–	–	0.5	2
Rhamnaceae	0.5	2	–	–	0.5	2
Xanthorrhoeaceae	0.5	2	–	–	0.5	2
Others	7.4	30	9.4	22	8.8	33
Total	100	408	100	233	100	377

(1) indicates the presence of one species, counted in "Others"

Table 3 Number and percentage of species per chorological spectrum in fields and ecological infrastructures, merged and separately

Chorotype	Fields and ecological infrastructures		Fields		Ecological infrastructures	
	%	n°	%	n°	%	n°
Stenomediterranean	21.8	88	20.1	46	23.1	86
Eurimediterranean	20.1	81	21.8	50	19.6	73
Eastern Mediterranean range	6.5	26	6.6	15	5.9	22
Western Mediterranean range	3.2	13	2.2	5	3.2	12
Southern Mediterranean range	2.7	11	1.7	4	3.0	11
Macaronesian Mediterranean range	2.5	10	3.9	9	2.4	9
Atlantic Mediterranean range	2.2	9	3.1	7	2.1	8
Northern Mediterranean range	1.5	6	0.0	0	1.6	6
Mediterranean-Mountain	1.0	4	0.4	1	1.1	4
Pontic	0.5	2	0.0	0	0.5	2
Euroasiatic	4.5	18	4.4	10	4.3	16
Eurosiberian	1.2	5	1.3	3	1.3	5
European s.l.	4.0	16	1.7	4	4.0	15
Amphiadriatic	0.5	2	0.0	0	0.5	2
Endemic	1.0	4	0.4	1	1.1	4
Paleotemperate	4.7	19	4.8	11	4.6	17
Paleo-Subtropical and Subtropical	2.5	10	3.1	7	2.7	10
Neotropical nat.	0.5	2	0.4	1	0.5	2
With widely distribution	14.6	59	21.0	48	14.2	53
Others	4.5	18	3.1	7	4.3	16
Total	100	403	100	229	100	373
Sub-total						
Mediterranean	61.5	248	59.7	137	61.9	231
With widely distribution	14.6	59	21.0	48	14.2	53
From Pontic to Neotropical nat.	19.4	78	16.2	37	19.6	73
Others	4.5	18	3.1	7	4.3	16
Total	100	403	100	229	100	373

Percentages are calculated dividing the number of species per chorological spectrum by the total of all species. For 5 taxa it was not possible to fit them in a chorotype

were calculated dividing the number of the detected species by the total number of species found in all olive groves. Since the figures indicating the number of species per family or per chorotype do not express number of plants, but simple presence or absence, they are not suitable for any statistical analysis. That is why similarities or differences among olive groves, between fields and infrastructures are presented and discussed only on the base of presence/absence character. Data such as the number of individuals per sampling/per olive grove, per level and per year, will be performed in a next paper, where the approach will be different from a floristic one.

In whole, 408 taxa were recorded, including 332 species, 73 subspecies and 3 varieties, belonging to 275 genera and 74 families of vascular flora (Table 2). The three most represented families are: Asteraceae (12.7 %) with 52 taxa, followed by Poaceae (11.3 %) and Fabaceae (11.3 %), both with 46 taxa. The other families, each with 20 taxa or less, include the remaining 264 taxonomical entities.

The biological spectrum of life forms is presented separately for the fields and ecological infrastructures (Fig. 2), only for the fields (Fig. 3) and only for the ecological infrastructures (Fig. 4). That of the fields and infrastructures shows that the *therophytes* (T) are the most abundant (45.1 %), followed by *hemicryptophytes* (H), with a significative presence (26.7 %), and *geophytes* (G) and *phanerophytes* (P), with lower percentages (10.3 and 9.8 % respectively). The

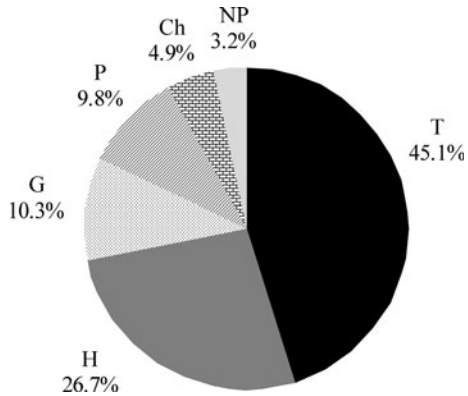

Fig. 2 Life forms in merged fields and ecological infrasctructures.*Ch* Chamaephytes, *G* geophytes, *H* hemicryptophytes, *NP* nanophanerophytes, *P* phanerophytes, *T* therophytes

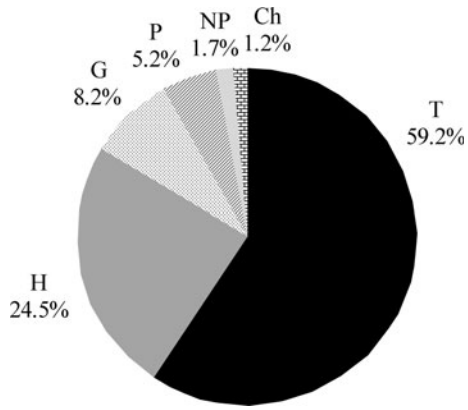

Fig. 3 Life forms in the fields. *Ch* Chamaephytes, *G* geophytes, *H* hemicryptophytes, *NP* nanophanerophytes, *P* phanerophytes, *T* therophytes

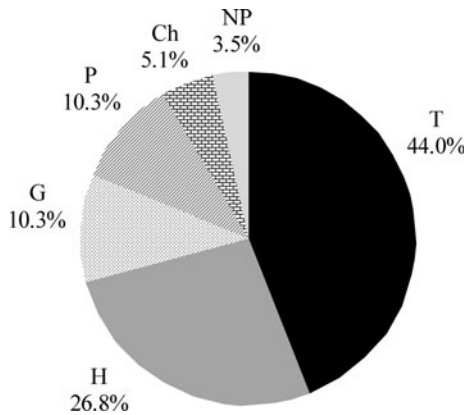

Fig. 4 Life forms in the ecological infrasctructures. *Ch* Chamaephytes, *G* geophytes, *H* hemicryptophytes, *NP* nanophanerophytes, *P* phanerophytes, *T* therophytes

remaining life forms, namely *chamaephytes* (Ch) and *nanophanerophytes* (NP), are much less present (4.9 and 3.2 % respectively).

The biological spectrum of life forms in the fields (Fig. 3) shows a high presence of *therophytes* (59.2 %), i.e., of annual forms, taking an advantage on other life forms, i.e., of perennial ones, especially of *chamaephytes* and *phanerophytes*, which occur with very low presence (1.2 and 5.2 % respectively).

The biological spectrum in the ecological infrastructures (Fig. 4) shows to be very similar to that of the merged fields and ecological infrastructures, except for a slight increases in perennial forms (56.0 %) and decrease of the annual ones, i.e., only of the therophytes (44.0 %).

The chorological spectrum is presented in three distinct data sets: merged and separately fields and ecological infrastructures (Table 3). It shows that the presence of the Mediterranean types in the fields (59.7 %) is slightly different from that in the ecological infrastructure (61.9 %). In particular, the Stenomediterranean types in the ecological infrastructure are slightly prevalent (23.1 %) to those in the fields (20.1 %), while the Eurimediterranean types in the fields are slightly prevalent (21.8 %) to those in the ecological infrastructures (19.6 %). In any case, both types show percentages always higher than 19.0 %, which means that, on an average, Stenomediterranean (21.8 %) and Eurimediterranean types (20.1 %) represent each about 1/3 of all of the Medietrranean types (61.5 %).

Taking into consideration the other chorotypes, the most prevalent species are those with widely distribution, as shown by the percentage corresponding to fields and ecological infrastructures (14.6 %), a percentage that is higher in the fields (21.0 %) than in the ecological infrastructures (14.2 %). Other chorotypes less present but still worth of consideration in the fields and in the ecological infrastructures are the Paleotemperate (4.7 %) and the Eurasiatic (4.5 %) ones, whose percentages change very little or nothing when looking only at the fields (4.8 and 4.4 % respectively) or only at the ecological infrastructures (4.6 and 4.3 % respectively). The other 8 classified chorotypes (Pontic, Eurosiberian, European s.l., Amphiadriatic, Endemic, Paleo-Subtropical, Subtropical and Neotropical nat.) show percentages variable from 0.0 to 0.4 % in the fields, occurring for Pontic and Neotropical nat. respectively, to a maximum of 4.0 % in ecological

infrastructures (as for European s.l.). Individually Pontic, Eurosiberian, European s.l., Amphiadriatic, Endemic, Paleo-Subtropical, Subtropical and Neotropical nat. are present with a very low percentage, but altogether as a group with a value of 19.4 %, they are more present they are more present (19.4 %) than the species with widely distribution, that reach the maximum value of 14.6 %, both in the fields and in the ecological infrastructures. The same group is more present in the ecological infrastructure (19.6 %) than in the fields (16.2 %). The species with widely distribution are less present in the ecological infrastructure (14.2 %) than in the field (21.0 %); On the contrary, other geoelements, especially European entities, range from 1.7 % in the fields to 4.0 % in the ecological infrastructure. The chorotypes reported as "others", appear to be slightly more present in the ecological infrastructures (4.3 %) than in the fields (3.1 %).

The results show also the presence of 18 critical taxa, of which three are at risk, four are endemic and the others are rare or important for conservation interest, especially at regional and/or national level (Floristic list of Appendix).

Finally, 111 species, out of 408, were recognized as plants used by man (Floristic list of Appendix). According to the most prevalent use they have been assembled in five categories: 29 food crops; 29 fodder crops; 26 medicinal and aromatic plants; 17 crop wild relatives and 10 edible wild species comestibles.

As far as crop wild relatives is concerned, it is important to point out that they must be understood as wild relatives in a very broad sense, at various levels of the well known gene pools described by Harlan and de Wet (1971). More precisely, for some of them, whether there is or not gene exchange between cultivated and wild relatives, it will be the matter of a different study. More details about this point are reported in the paragraph of crop wild relatives.

Discussion

The Poaceae and Fabaceae are slightly more abundant in the field (25.3 %) than in the ecological infrastructures (22.8 %) (Table 2). This relatively small difference (2.5 %) between the two surveyed areas, may be explained by assuming that the flora of ecological infrastructures may be influenced more by the flora growing in the natural neighboring habitats.

Only 27 taxa, 6.6 % of the entire flora, are common to the four olive groves and 59.3 % of them are *therophytes*. The analysis shows that *therophytes* (annual species), with a presence of 45.1 %, are significantly dominant within the group of life forms (Fig. 2). This dominance was expected since annual species are prevalent in bioclimatic regions, characterized by hot and dry periods with a very short growing seasons and since therophytes are more competitive than other biological forms in habitats prone to human-induced changes (Raunkiaer 1934).

The comparison between fields (Fig. 3) and ecological infrastructures (Fig. 4) shows that the *therophytes* are dominant on other biological forms, both in the field (59.2 %) and in the ecological infrastructures (44.0 %), where *therophyte* have a significant drop-down of 15.2 % (59.2–44.0) in favour of the perennial forms (H, P, G, Ch, NP). In other words, in seminatural environments, i.e., in ecological infrastructures, perennial species take a competitive advantage over some species of *therophytes*, and altogether increase from 40.8 % (24.5 + 8.2 + 5.2 + 1.7 + 1.2) to 56.0 % (26.8 + 10.3 + 10.3 + 5.1 + 3.5).

With a future perspective to make comparison among olive groves of different areas of the Mediterranean Basin (Southern Italy, Sardinia, Sicily, the Mediterranean coasts of Spain, Southern Balkan Peninsula, Balearic Islands, Crete and Cyprus), it has been suggested to provide a key to simplify the geographical distribution of 32 Mediterranean geoelement, discovered in the following 9 chorological types: Medit.-Mountain, Medit.-Macaronesian range, Medit.-Southern range, Medit.-Northern range, Medit.-Eastern range, Medit.-Western range, Medit.-Atlantic range, Eurimediterranean and Stenomediterranean (Table 4). In particular, the Stenomediterranean types are the Mediterranean types in the strict sense, whose areal does not go over the northern limit of diffusion of the olive trees, while the Eurimediterranean ones are included within the area of grapevine (*Vitis vinifera*) and therefore they extend to the southern part of Central Europe (Ubaldi 2003). The Mediterranean-Atlantic are Eurimediterranean types, generally mountane ones, whose areal also includes the Atlantic Europe regions. It is possible to distinguish the "Circumediterranean" (distributed around the Mediterranean) types, that can be Steno- or Eurimediterranean ones, and may have predominantly southern distribution (Medit.-Southern), northern distribution

Table 4 Mediterranean chorotypes used and correspondence to Pignatti (1982) geoelements (adapted from Perrino et al. 2011)

Acronyms	(Pignatti, 1982)	Used in this work
Me	Eurimediterranean s.s.	Eurimediterranean
Ms	Stenomediterranean s.s.	Stenomediterranean
Ma	Mediterranean atlantic	Atlantic Mediterranean range
Masb	Mediterranean sub-atlantic	
Mea	Eurimediterranean atlantic	
Meas	Eurimediterranean sub-atlantic	
Msa	Stenomediterranean atlantic	
Mem	Eurimediterranean macaronesian	Macaronesian Mediterranean range
Mmc	Mediterranean macaronesian	
Mmms	Mediterranean south-macaronesian	
Msm	Stenomediterranean macaronesian	
Mes	Mediterranean eastern	Eastern Mediterranean range
Mess	Eurimediterrranean south-siberian	
Mse	Stenomediterranean eastern	
Mst	Stenomediterranean turanian	
Mece	Mediterranean centre-eastern	
Mmne	Mediterranean mountain north-eastern	
Mne	Mediterranean north-eastern	
Met	Eurimediterranean turanian	
Mts	Mediterranean south-turanian	
Mt	Mediterranean turanian	
Men	Mediterranean northern	Northern Mediterranean range
Mn	Stenomediterranean northern	
Msn	Eurimediterranean northern	
Menp	Eurimediterranean northern-pontic	
Msd	Mediterranean southern	Southern Mediterranean range
Msdw	Mediterranean south-western	
Mss	Stenomediterranean southern	
Mmw	Mediterranean-mountain western	Western Mediterranean range
Mssw	Stenomediterranean south-western	
Msw	Stenomediterranean western	
Mw	Mediterranean western	
Omw	Orophil-Mediterranean western	
Mm	Mediterranean mountain s.s.	Mediterranean Mountain

(Medit.-Northern), eastern distribution (Medit.-Eastern) or western distribution (Medit.-Western).

The chorological spectrum (Table 3) shows that the Mediterranean stock (see sub-total) is well represented (61.5 %) and that it is notably higher than the one known for Apulian flora (52.0 %) (Marchiori et al. 2000). So, these olive orchards are Mediterranean ecosystems, a character that becomes weaker in the fields, where species with a widely distribution take an advantage, confirming the results of the biological analysis.

The percentages of the Eastern Mediterranean (6.5 %) and Pontic types (0.5 %) for the merged fields and ecological infrastructures, may be seen as a similarity or as a strong correlation with the flora of eastern geographical areas and, in particular, with the Eastern Mediterranean, primary center of origin of olive trees (Acerbo 1937; Zohary 1973; Schäfer-Schuchardt 1988).

Interestingly, a high number of species of conservation interest, 18 out of 408, some seriously endangered,

was detected in highly anthropized environments, as it is presented and discussed in the following paragraph.

Analysis of taxa of conservation interest

Aegilops uniaristata [Ad, VU]. GPS: N4641298, E578448; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 29 m a.s.; Habitat 92/43/EEC: 6220* (subtype 3) "*Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea*" (San Miguel 2008). Eastern Mediterranean distribution, known in Croatia, Greece (including the islands), Albania and Italy, while it is doubtful in Turkey (Van Slageren 1994). In Italy it was considered exclusive of Apulia (Groves 1887; Pignatti 1982; Bianco et al. 1989; Marchiori et al. 1993; Caforio and Marchiori 2006; Perrino 2011). Currently it is known for Basilicata Region, while it is doubtful for Calabria (Conti et al. 2005). It is listed as vulnerable (VU) (Perrino and Wagensommer 2012) and as at risk of extinction in the Atlas of Species (Scoppola and Spampinato 2005). The Fasano population counts only three individuals. It seems that the edge of an olive tree grove is one of its favourite habitats (Van Slageren 1994; Perrino 2011; Perrino et al. 2011).

Asyneuma limonifolium subsp. *limonifolium* [Ad, PI, NT]. GPS: N4641293, E578442; Place: Fasano (Brindisi); Plant community: garrigues; altitude: 31 m a.s.; Habitat 92/43/EEC: not identified. Paleoegeic species of phytogeographic interest, present on both coasts of the Adriatic Sea (Francini Corti 1966). Its distribution includes the north-eastern Mediterranean area (Greuter et al. 1984; Castroviejo et al. 2010). In Italy, it is known in Apulia and eastern Basilicata. The station of Fasano, after those of Monopoli (Bianco and Sarfatti 1961; Cavallaro et al. 2007; Perrino and Signorile 2009) and Polignano a Mare (Perrino and Signorile 2010; Vita and Forte 1990), is the western limit of its distribution. Some authors (Brullo et al. 1994), on the basis of specimens collected in Punta Palascia (Otranto—Lecce), have shown the existence of a karyological corrispondence of these populations with those of Greece and Turkey. The observed population consists of a few individuals. In Apulia, the *taxon* presents a Near Threatened risk (Perrino et al. 2012).

Barlia robertiana [CI]. GPS: N4641171, E578340; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951); altitude: 214 m a.s.; Habitat 92/43/EEC: not identified. In Italy, this big orchid is known in the southern territories, while it is lacking in some central and northern regions. Both variants, with purple to greenish shades and whitish tepals, the latter being more rare, were observed.

Crepis brulla [I]. GPS: N4641265, E578408; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951); altitude: 200 m a.s.; Habitat 92/43/EEC: not identified. Small endemic species exclusive to the southern Italy (Apulia, Basilicata and Calabria) (Conti et al. 2005). Found in several types of vegetation, but always with a few individuals.

Crepis corymbosa [I]. GPS: N4519987, E710627; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 34 m a.s.; Habitat 92/43/EEC: 6220* (subtype 3) "*Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea*" (San Miguel 2008). It is endemic in central and southern Italy, Ionian Islands, Corfu and Kefalonia (Pignatti 1982). It is observed within the annual meadow and, more rarely, within the scrubland communities. This species lacking the fruit (achene) can be easily confused with other species of the same genus.

Cyclamen hederifolium [CI]. GPS: N4641079, E578410; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951); altitude: 224 m a.s.; Habitat 92/43/EEC: not identified. A species common in all of the Italian Regions, included in the CITES list. Few observed individuals coming from near woods.

Epilobium parviflorum [r]. GPS: N4473077, E782136; Place: Le Cesine (Vernole—Lecce); Plant community: humid grasslands; altitude: 6 m a.s.; Habitat 92/43/EEC: 6420 *Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion*. It is a wide distribution (Paleotemperate) *taxon*, rare in Italy. It grows in muddy wet habitat, such as Le Cesine olive grove, where it grows on the vegetation marge, between the wetland and the field.

Erica forskalii [VU]. GPS: N4472988, E782234; Place: Le Cesine (Vernole—Lecce); Plant community: garrigue; altitude: 7 m a.s.; Habitat 92/43/EEC:

not identified. Mediterranean eastern species, known in Italy, ex Yugoslavia, Albania, Bulgaria, Greece, Crete, Eastern Aegean Islands, Turkey, Cyprus, Lebanon, Syria, Israel and Jordan (Greuter et al. 1986). In Italy, it is known only in Southern Apulia (Brullo et al. 1986; Conti et al. 2005). Observed in the scrub vegetation, bordering the olive grove.

Gagea granatellii [VU]. GPS: N4520081, E710649; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 31 m a.s.; HABITAT 92/43/EEC: 6220* (subtype 3) "*Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea*" (San Miguel 2008). Endemic taxon of western Mediterranean area (Tison 1998). In Italy, it has been found in central and southern regions (Conti et al. 2005, 2007). Its included in the Regional Red List of Apulia and Sicily, with the status of vulnerable (VU), while in Abruzzo, Marche, Molise and Basilicata it is at lower risk (LR) (Conti et al. 1997). Few individuals were found in an annual meadow.

Gagea mauritanica [CR]. GPS: N4520081, E710695; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 32 m a.s.; HABITAT 92/43/EEC: 6220* (subtype 3) "*Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea*" (San Miguel 2008). This species is endemic of western Mediterranean (Peruzzi and Tison 2007). In Italy is documented only to Apulia and Sicily Regions (Peruzzi et al. 2009). Only two individuals seen in a vegetation like that of *G. Granatelli*.

Helianthemum jonium [I]. GPS: N4520146, E710764; Place: Fasano (Brindisi); Plant community: garrigue (*Helianthemum jonii-Fumanetum thymifoliae* Taffetani et Biondi 1992); altitude: 30 m a.s.; HABITAT 92/43/EEC: not identified. Endemic species to Morocco (Ruiz De La Torre 1956) and Central and Southern Italy (Emilia Romagna, Apulia, Basilicata and Molise) (Conti et al. 2005). The population grows into *Thymbra capitata* (L.) Cav. garrigue. In some cases, isolated individuals are found in scrub vegetation.

Muscari parviflorum [PI, r]. GPS: N4509660, E645633; Place: Torre Guaceto (Carovigno—Brindisi); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951); altitude: 27 m a.s.; HABITAT 92/43/EEC: not identified. Species of phytogeographical interest, with central and eastern Mediterranean distribution, extended from Spain and northern Africa to western Asia (Tutin et al. 1980). It is rare in many regions of Italy (Conti et al. 2005). The station of Torre Guaceto is the first found for the province of Brindisi, the second in Apulia after that of Salento (Mele et al. 2001). The population of the Torre Guaceto olive grove counts about 100 individuals, but in the territory may be larger.

Ophrys incubacea [CI]. GPS: N4520177, E710787; Place: Fasano (Brindisi); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951); altitude: 28 m a.s.; HABITAT 92/43/EEC: not identified. It is a relatively common species in grasslands and uncultivated communities, but rare in olive groves.

Orchis palustris Jacq. [CI, EN]. GPS: N4473078, E782160; Place: Le Cesine (Vernole—Lecce); Plant community: humid grasslands; altitude: 6 m a.s.; HABITAT 92/43/EEC: 6420 *Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion*. Euro-asiatic species (if it includes *O. elegans*) or eurimediterranean (if it includes *O. palustris* s.s.) (Alessandrini and Medagli 2008), which, in Italy, shows a scattered distribution (Conti et al. 2005). The population shows few individuals, that grow in the same habitat of *Epilobium parviflorum*.

Orchis purpurea [CI]. GPS: N4641017, E578387; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer et Preising ex Rochow 1951) and scrub vegetation (*Oleo-Ceratonion siliquae* Br.-Bl. 1936 em. Rivas Martínez 1975); altitude: 240 m a.s.; HABITAT 92/43/EEC: not identified. Eurasiatic species, found in Europe and in Turkey, unique for its size it may reach a meter of height. Rare in Apulia, it was observed at the margins of the olive groves, road banks and forest oak (Del Fuoco 2003). The flower looks like an old country-side woman (with a hat and wide skirt) and is called "Lady Orchid".

Satureja cuneifolia [PI]. GPS: N4520145, E710764; Place: Fasano (Brindisi); Plant community: garrigue (*Cisto-Ericion* Horvatić 1958); altitude: 29 m a.s.; HABITAT 92/43/EEC: not identified. Amphiadriatic (Greuter et al. 1986), in Italy found only in Apulia and Basilicata Regions (Conti et al. 2005). The observed population is well preserved.

Scrophularia lucida [Ad, PI]. GPS: N4520019, E710650; Place: Fasano (Brindisi); Plant community:

rocky slopes (*Campanulion versicoloris* Quezel 1964); altitude: 34 m a.s.; HABITAT 92/43/EEC: 8210 "*Calcareous rocky slopes with chasmophytic vegetation*". It is a casmophytes of amphiadriatic and phytogeographic interest; known in France, Italy, Greece and the Aegean Islands (Crete and Karpathos). In Italy, it is known only in Apulia and Basilicata, while it is uncertain in Piemonte (Conti et al. 2005). It was observed on the drystone walls bordering the valley of the field.

Stipa austroitalica subsp. *austroitalica* [I, B, DH]. GPS: N4520082, E710696; Place: Fasano (Brindisi); Plant community: perennial grasslands; altitude: 32 m a.s.; HABITAT 92/43/EEC: not identified. Endemic species of high conservation interest. The subsp. *austroitalica,* one of the four subspecies (Moraldo and Ricceri 2003), was found with few isolated individuals.

Analysis of plant species used by man

As previously stated, 111 plant species, out of 408, were recognized as plants that are somewhat used by man (Floristic list of Appendix). For a rational presentation, the 111 species were grouped in five categories: food crops; fodder crops; medicinal and aromatic plants; crop wild relatives; edible wild species. Most of the species should be included in more than one category, simple because they have more than one use, but for practical reasons it was decided to include them only in one category, the one considered the most appropriate. In any case, when a species was recognized important for more than one use, it was pointed out. Only two, out of 111species, i.e., *Muscari parviflorum* and *Aegilops uniaristata*, are also mentioned among the group of the 18 species of conservation interest (Floristic list of Appendix). The rest of the species are not threatened by genetic erosion and/or extinction or at least not all of them are threatened in the same way, but since they represent important plants used by man it was decided to point out some of their peculiarities with the aim to emphasize their value and enhance their conservation and valorization. For this purpose, references such as Zeven and Zhukovsky (1975), Hammer et al. (1992, 1999), Perrino et al. (2004) have been the main sources of information.

Food crops

This category counts 29 species and they are so well known that there is no need to present and discuss their uses. However, some of them, such as *Avena sativa*, *Ficus carica*, *Morus alba*, *Juglans regia*, *Citrus aurantium*, *C. limon*, *C. sinensis*, *Capparis spinosa*, *Opuntia ficus-indica*, *Foeniculum vulgare*, *Origanum vulgare* subsp. *viridulum*, *Rosmarinus officinalis*, *Prunus avium* subsp. *avium*, *Prunus dulcis*, *Allium ampeloprasum*, *Capparis spinosa*, *Raphanus sativus*, *Pistacia lentiscus*, *Pistacia terebinthus* subsp. *terebinthus*, are almost widely cultivated. Whereas, others, such as *Amaranthus retroflexus*, *Muscari comosum*, *Ceratonia siliqua*, *Mespilus germanica*, *Rubus canescens*, *Rubus ulmifolius*, *Morus alba*, *Myrtus communis* subsp. *communis*, *Diplotaxis erucoides* subsp. *erucoides*, *D. tenuifolia*, and *Borago officinalis* (Floristic list of Appendix) are minor o neglected crops. Often, among world wide crops, as in the case of *Citrus* crops, one can find local varities, like *Citrus limon* "Femminello", *C. sinensis* "Biondo commune del Gargano" and *C. sinensis* "Duretta del Gargano", that are unique in the world and cultivated only on Gargano, which makes them vulnerable, suggesting actions for strengthening their *in situ*/*on farm* conservation and valorization. This promiscuity of plant species in the ecosystem of ancient olive groves not only increases biodiversity, including that of relevant pollinators, but it also creates the environmental conditions that enhance disease resistance (Keesing et al. 2010).

Fodder crops

This category is represented by 29 species. Some of them are important fodders also or mainly on a global scale. A part from *Sorghum halepense*, *Piptatherum miliaceum* subsp. *miliaceum* and *Piptatherum miliaceum* subsp. *thomasii*, that are *Poaceae*, all of the other genera, from *Lupinus*, *Melilotus*, *Sulla, Tetragonolobus*, and *Trigonella*, each present with one species, to *Lathyrus* with 3 species, *Medicago* and *Vicia* with 5 species each and *Trifolium* with 8 species, are *Fabaceae*. Once, some of these species were though to be progenitors of cultivated plants, as it is the case of *Sorghum halepense* that gave rise to a new perennial diploid: *S. almum* (Zeven and Zhukovsky 1975). Previously, the two species of *Piptatherum*, above mentioned, were included in *Oryzopsis* (similar to rice), but further research moved them into *Piptatherum*, a genus with 30 species (Romaschenko et al. 2011). *P. miliaceum* (syn. *Oryzopsis miliacea* subsp.

miliacea) is a Eurasian *taxon*, now established in several parts of the world. In its native range it grows, often as a common species, primarily in disturbed areas, wadis, and oases, penetrating into the semidesert regions of northern Africa and western Asia. It is used as a fodder in northern Africa (this explains why it was placed in this category). In Maryland (USA), it was found even on a ballast dump (Barkworth 2007) and considered to be a good plant for phytoremediation (García et al. 2004), from soil depollution from heavy metals. Among *Fabaceae*, the following facts are worth of quoting. *Melilotus sulcatus* must be mentioned for its coumarine deficiency and resistance to drought. *Sulla capitata*, has a high capacity of colonizing new soils (gullies, ravines), but also as a medicinal plant. *Tetragonolobus purpureus*, is cultivated for its edible green seed pods, but also as a fodder (Hammer et al. 1999; Perrino et al. 2004). *Trigonella monspeliaca* (syn. *Medicago monspeliaca*), is largely cultivated as a forage in many areas of the world. The three species of *Lathyrus* (*L. cicera*, *L. ochrus* and *L. sylvestris* subsp. *sylvestris*) are used as food and feed and in the case of *L. sylvestris* also as an ornamental plant. None of the five *Medicago* species are present in the list of the 30 species cited by Zeven and Zhukovsky (1975). *Medicago truncatula*, due to its very small genome and fast rate of growth, is used as a model for studying the biology of Fabaceae. *Vicia sativa*, *V. sativa* subsp. *macrocarpa* and *V. villosa*, three of the five species found in the olive groves, are present in the list of the 18 species cited by Zeven and Zhukovsky (1975). *V. sativa* and *V. villosa* are also cited by Hammer et al. (1999) and Perrino et al. (2004). *V. angustifolia*, the wild relative of *V. sativa* (Mettin and Hanelt 1964; Hanelt and Mettin 1989) was not found in the olive groves. Both *V. hybrida* and *V. lutea*, two of the five species found in the olive groves, are not mentioned by Zeven and Zhukovsky (1975). Useful information on their relationships with other species of the genus *Vicia* are reported also by Maxted (2008). Only two species, *Trifolium pratense* and *Trifolium resupinatum*, out of eight species of *Trifolium* found in the olive groves, are present in the list of the 29 species cited by Zeven and Zhukovsky (1975) and of the nine species cited by Hammer et al. (1999) and Perrino et al. (2004). *T. pratense* (red clover) is wide spread in Europe, West and Central Asia and North Africa. It was probably first cultivated in the Netherlands, in the beginning of the sixteenth Century (Zeven and Zhukovsky 1975). The wild type has more leaves and new shoots emerge from internode at the butt end, while the cultivated type has less leaves and new shoots emerge from the leaf rosette. The variable wild type is described as var. *pratense* and the cultivated one as var. *sativum* (syn. *T. sativum*) (Zeven and Zhukovsky 1975). The specimens found in the olive groves are closer to the wild type, but they are still under observation. *T. resupinatum* (syn. *T. suaveolens*), known as Persian clover, is widespread from the Mediterranean region to Iran, Afghanistan and India (Zeven and Zhukovsky 1975), and it is the most popular among new Australian crops (Australian new crops 2013). *Trifolium squarrosum*, native of the area and only recently domesticated (Hammer et al. 1990; Perrino et al. 2004) is a threatened species in Bulgaria (Boller et al. 2003). This, as well as other legumes, is often used also as a cover crop or intercrop. From an agricultural point of view, the presence in the olive groves of so many species of legumes ensures the sourcing of organic nitrogen, improved fertility and soil structure, along with improved oil quality.

The Mediterranean basin is the center of origin and/or of diversification of several forage species, but it seems that not all the species have been adequately investigated. The project of olive groves may offer the possibility to develop studies aimed to identify new potential fodders in collaboration with experts in animal feeding.

Medicinal and aromatic plants

Another interesting category o plants, consisting of 26 species, is that of medicinal and aromatic plants. Most of them are well known only by local and traditional people, but almost neglected by the majority of people. A few and selected items and/or specialities for each taxon are reported. *Ceterach officinarum* is used for making infusions as a diuretic, astringent and enlargement of spleen (Chiej 1984). *Pinus halepensis* (Aleppo pine), is the most widely distributed pine of the Mediterranean Basin; the resin is used to flavor the Greek wine and for the wicks; the dry powder of the bark is used for diaper rash and to solve respiratory problems (González-Tejero et al. 2008); the essential oil possesses antifungal activity against *Aspergillus flavus, A. niger, Fusarium oxysporum, Rhizopus stolonifer* and thus can be used as a natural treatment for

fungal infections, as well as natural preservative in food (Abi-Ayad et al. 2011); in the Maltese Archipelago is one of several medicinal plants used for inhalation and ointment for catarrh and as diuretic (Attard and Pacioni 2012). *Laurus nobilis* is used as a digestive, antiseptic, balsamic, carminative, and antitussive; fluid extracts and essence are also used as an infusion and tincture (Chiej 1984). *Gladiolus italicus*: the decoction of roots and flowers of this plant is used for heart and lung infections (Mosaddegh et al. 2012), while leaves and bulbs are used as galactogogue, aphrodisiac and emmenagogue (Penza 1969). *Rosa sempervirens*, is a good source of secondary metabolites with high potential antioxidant properties and for producing jam (Ghazghazi et al. 2012). *Paliurus spina-christi*: decoction from fruits is used internally for heart diseases, diabetes, kidney stones and abdominal pain (Tuzlaci et al. 2010); decoction from fruits and roots is used for headache, bronchitis, urethra inflammation, toothache, as stomachic, for rheumatism, hemorrhoid, kidney ailments, as tonic and antitussive (Koçyiğit and Özhatay 2006); poultices from leaves are used to cure wounds and furuncles (Ugulu 2011); fruits gathered from wild plants in Turkey are exported to USA (Report 2003). *Urtica dioica* subsp. *dioica* (Stinging nettle), is a perennial plant that has antioxidant properties and thanks to the stinging hairs is rarely eaten by herbivores, so it provides long-term shelter for insects, such as aphids or caterpillars of many butterflies and moths; insects, in turn, provide food for small birds (Mavi et al. 2004; WHO 2004). *Urtica urens* (dwarf nettle) is an annual plant, whose seeds are anthelmintic, purgative and anti enuretic; extracts of the plant are the basis of many hair lotions with marked action antiseborroic and slightly revulsive on the scalp; used also for psoriasis, vaginal discharge and for draining the liver; it is also cardiotonic, diuretic, tonic astringent, vasoconstrictor, hemostatic and anti-anemic, though these properties are not always confirmed by the European Medicines Agency (2007). The mating system of both species of *Urtica* have been investigated, (Lahav-Ginott and Cronk 1993; Woodland et al. 1982) and it seems that natural hybridization may occur between them. *Hypericum perforatum* is antidepressant, antiviral, and antibacterial; pharmacological activities, including photosensitive reactions, may be due to hypericin and flavonoid constituents (Barnes et al. 2001). *Ruta chalepensis* is a good herbal remedy for a number of ailments, such as fever and inflammation and even as a digestive (Al-Said et al. 1990). *Malva sylvestris* subsp. *sylvestris*, is used against irritations of the mucosa of the mouth and throat, irritative cough, ulcers, and also as a vegetable. *Chenopodium hybridum* is edible, but with causion since leaves and seeds contain saponins, which are toxic; it is used also as hemostatic, against irregular menstruation, uterine bleeding, hematemesis, epistaxis, hemoptysis, hematuria (China Wikipedia 2013). *Buglossoides purpureocaerulea* is used for its antioxidant activity and in Southern Italy is appreciated for its beneficial effects on liver diseases (Negro et al. 2013). *Solanum nigrum*, has fruits that possess a potential CNS-depressant action (Perez et al. 1998); the plant is a cadmium hyperaccumulator, suggesting to be good for phytoremediation and to be a good indicator of fields contaminated by heavy metals (Wei et al. 2005); it is a cosmopolite *taxon*, underutilized and neglected crop (Edmonds and Chweya 1997); it is one of the 90 species cited by Zeven and Zhukovsky (1975). *Calamintha nepeta* is recognized for its aromatic, diaphoretic, expectorant, febrifuge and stomachic properties (PFAF 2012). *Marrubium vulgare* possesses tonic, aromatic, stimulant, expectorant, diaphoretic and diuretic properties. It is helpful for bronchial asthma and non-productive cough. It was formerly much esteemed in various uterine, visceral and hepatic affections and in phthisis (Chopra et al. 1956). The plant possess hypoglycemic (Roman et al. 1992), vasorelaxant (El-Bardai et al. 2003), antihypertensive (El-Bardai et al. 2004), analgesic (De Souza et al. 1998), anti-inflammatory (Sahpaz et al. 2002), antioxidant (Weel et al. 1999) and antioedematogenic activity (Stulzer et al. 2006), and many other biological activities. The genus *Salvia* with over 900 species is not monophyletic, which means that all members have evolved from different ancestors (Walker et al. 2004). *Salvia verbenaca*, found in the olive groves, is a hexaploid ($2n = 6x = 60$) and is used as a medicinal plant, but it was much more used in Roman time (Hammer et al. 1999; Perrino et al. 2004). *Satureja montana* is known for its antibacterial, antioxidant, antiseptic, astringent, good sore throats and carminative properties, and is recommend for gas and digestive upsets, including colic, diarrhea and indigestion (Bezić et al. 2005). *Thymbra capitata* is cited for its antilisterial activity (Faleiro et al. 2005). *Acanthus spinosus* as a medicinal plant may be used against bleeding and diarrhea (Caramia 2005); a phytochemical investigation revealed the presence of useful chemicals in the leaves (Loukis and Philianos 1980); it is used also

as an ornamental plant and in the garden with its allelochemicals may control weeds (Putnam 1988); in addition, *A. spinosus* is in the red data book of Bulgaria (Dimitrova 2011), where, according to the national and international Nature conservation register, the *taxon* is in the list of those species with a nature preservation status, as reported on Biological Diversity Law (BDL), promulgated in Official Gazette, issue 77/2002 (Radanova 2009). *Achillea millefolium* is well known for its antioxidant activity and folklore remedies (Candan et al. 2003; Perrino et al. 2004). *Calendula officinalis* is a medicinal and ornamental plant (Hammer et al. 1999; Perrino et al. 2004). *Calendula arvensis* is also used as a medicinal plant. *Eupatorium cannabinum* is a toxic plant, but in very small quantities may be antitumoral, diaphoretic, febrifugal, laxative, tonic, diuretic, depurative and cholagogue (PFAF 2012; Arvis et al. 1990). *Matricaria chamomilla* has sedative and spasmolytic effects and acaricidal activity (Avallone et al. 2000; Macchioni et al. 2004). *Sambucus nigra* is used as condiment, aromatic, food, cosmetic, pharmacological and ornamental plant (Hammer et al. 1999).

Since the Mediterranean basin is the center of origin and/or of diversification of several medicinal, aromatic and officinal plants, it is probable that in the future, the development of the project may consider the possibility to investigate this group of plant species in more details in collaboration with national and international laboratories, specialized in biochemistry, pharmacopy, phytotherapy and ethnobotany.

Crop wild relatives

With 17 species is the most intrigued category. Not all of the 17 species are wild relatives in the strict sense, i.e., that they exchange genes with their putative cultivated patterns. Even so, they have been placed in this category because of their very close taxonomical and systematic position, in addition to their similar way of use, as a food, feed, medicinal, etc. Some of them could be placed in the tertiary and/or secondary gene pool, while others, for which gene flow is certain, can be included in the primary gene pool (Harlan and de Wet 1971). An example of taxa for which we have no knowledges about geneflow is that of the 3 wild species of *Muscari* (*M. commutatum*, *M. neglectum* and *M. parviflorum*) that grow along with the edible and somewhat often cultivated *Muscari comosum* (L.) Mill. (see crop category). The genus *Muscari* consists of 35–55 bulbous species, grouped into four subgenera, within a distribution area, extending from the Macaronesian region to the Caucasus, although being mainly found in the Mediterranean basin. These information would suggest taxonomical and genetic investigation to provide further contributions to the so complicated evolution of this group of polyploid species, with different ploidy level, even within the same species (Suárez-Santiago et al. 2007). Analogous considerations may be developed for the 2 species of *Aegilops* (*A. ovata* and *A.uniaristata*), that can somewhat be placed in one of the gene pools of *Triticum* sp., and the same can be said for *Dasypyrum villosum*. *Avena barbata* ($2n = 28$) is not the wild ancestor of *Avena sativa* ($2n = 42$), also because they have a different genome formula (AsAs and AACCBB respectively), but since the genetic origin of *A. sativa* is not yet fully understood (Zeven and Zhukovsky 1975) and since the two species share the A genome, it would not be so mistaken to consider *A. barbata* as a species close to *A. sativa*, also because they have been sharing, for centuries, if not millennia, exactly the same environment. None of the 2 species of *Hordeum* (*H. murinum* L. and *H. murinum* subsp. *leporinum*), found in the ancient olive groves, have something to do with *H. spontaneum* ($2n = 14$), which is thought to be the wild parent of *H. vulgare* ($2n = 14$), though one has to say that the origin of the crop is still under discussion (Svitashev et al. 1994). *Pyrus spinosa* though not present among the many species (more than 30) cited by Zeven and Zhukovsky (1975), along with other wild species, such as *P. nivalis* (Heywood and Zohary 1995) and *P. syriaca* is interfertile with the cultivated *P. communis* (Hammer et al. 1999; Perrino et al. 2004). *Linum bienne* is a possible wild forebear of the cultivated *Linum usitatissimum*; the latin name *usitatissimum* means most useful, pointing to the several traditional uses of the plant and their importance for human (Zhukovsky 1964; Brezhnev and Korovina 1981; Hammer et al. 1999; Perrino et al. 2004). *Raphanus raphanistrum* L. is a wild leaf vegetable that may have contributed to increase the genetic diversity of *Raphanus sativus* landraces via introgression (Hammer et al. 1999; Perrino et al. 2004); the primary centre of origin of *Raphanus sativus*, with $2n = 18$ (genome RR), a very polymorphic species, including annual and biennial forms, is suggested to be Japan and the coastal areas of the

mainland; if this is so, the crop may have derived from different wild species, including *Raphanus raphanistrum*, also with 2n = 18 (arrived from Greece or Asia Minor); both, cultivated and wild forms spreaded over the Old World probably introgressing with other wild species and ecotypes (Wein 1964). It is also probable that feral radish evolved from cultivated forms (Campbell and Snow 2009). *Sinapis alba* occurs as a weed (subsp. *dissecta*) and as a weed and cultivated (subsp. *alba*). The wild subsp. *alba*, found in the olive groves, is mostly used as a medicinal plant, rarely as a vegetable (Hammer et al. 1999; Perrino et al. 2004). Often *Sinapis alba* is reported as syn. of *Brassica alba*. Though *S. alba* (2n = 24) is not the wild relative of *B. oleracea* (2n = 18) and of *B. napus* (2n = 38), genes for resistance to the beet cyst nematode (*Heterodera schachtii*) have been transferred by means of sexual and somatic hybridization from *S. alba* to *B. napus* (Lelivelt et al. 1993). *Sinapis arvensis* subsp. *arvensis* is an annual plant, whose leaves are edible at the juvenile stage; the seeds, except for birds, are toxic, especially if consumed in large quantities; once the seeds are ground, they produce a kind of mustard. Molecular-based phylogenetic studies have indicated that *S. arvensis* is the most likely progenitor species giving rise to *Brassica nigra* (genome B) and that these taxa constitute a separate lineage from that containing *B. rapa* and *B. oleracea* (genomes A and C, respectively). This close relationship of *S. arvensis* and *B. nigra* is strongly supported by several data sets, from cytological to hybridization, electrophoretic, morphological and shared presence of genome B (Warwick and Black 1991; Warwick et al. 2000). Successful hybridizations of *S. arvensis* have been achieved with *B. napus* L. and hybrids *B. napus* × *S. arvensis* were successfully backcrossed to *B. napus* (Plümper 1995). *S. arvensis* is a useful source of blackleg fungus (*Leptosphaeria maculans*) resistance for the oilseed rape *B. napus* (Snowdon et al. 2000). *Sinapis* can exchang genes even with *Raphanus* (Bang et al. 1996). *Beta vulgaris* can be found in crop, wild and weedy forms, all of which are interfertile. Genetic diversity in wild beets appear to be very high in comparison with that observed in the cultivated beets (Desplanque et al. 1999). The wild plants may form sources of resistance to disease, such as *Cercospora*, yellow mosaic and to increase the variability to select for new high yielding types (Zeven and Zhukovsky 1975). In Italy there are different wild types (Hammer et al. 1999). In Europe "The sugar beet breeding gene pool is considered to be narrow. It mainly lacks sufficient genetic variation for resistance and tolerance to biotic and abiotic stress" and sources to face drought stress, due to climatic changes can be found exploiting excisting wild types of the three gene pools (Pgr Forum 2004). *Cichorium intybus* L. is a wild biennial or perennial herbaceous plant. Young plants are edible and are much used by local people, all over Apulia. As a medicinal plant it exhibits antihepatotoxic, antimicrobial, antinflammatory, anticoagulant, antioxidant, anticancer and antimalarial activity (Hazra et al. 2002). It is considered the wild type of many cultivated forms of *C. intybus* var. *sativum*. The cultivation area of this *taxon* coincides with that of its wild relative, *C. intybus*, which may lead to gene flow between wild and cultivated types. For this reason the genetic diversity within and between types was studied and it was found that both wild and cultivated populations are not much differentiated, as expected for a largely allogamous species, but the gene pool of cultivated individuals can nevertheless be distinguished from the gene pool of wild individuals (Van Cutsem et al. 2003). The possibility to exchange genes with other species includes *C. endivia*, which can be included in the secondary or primary gene pool of *C. intybus* and vice versa (Hammer et al. 1999; Perrino et al. 2004). *Lactuca serriola* is probably the wild relative of the cultivated lettuce (*L. sativa*). Both cultivated and wild *Lactuca* differ greatly in shoot and root characteristics (Johnson et al. 2000). Usually, wild progenitors of crop plants tend to have root systems that can exploit more unpredictable and stressful soil environments than their cultivated forms (Chapin et al. 1989; Jackson and Koch 1997). For this reason efforts are made to improve the root system of *L. sativa* landraces by crossing them with the wild *L. serriola* (Johnson et al. 2000). The present marked variation of lettuce is probably a product of hybridization with *L. serriola* (Hammer et al. 1999; Perrino et al. 2004), but may have also been induced by some natural mutation (Whitaker 1969).

All or nearly all of the wild species listed in this category will be further investigated in collaboration with genebanks and international organizations. In fact, crop wild relatives (CWR) are a key component for food production and security and for the maintenance of agro-ecosystems. They have been successfully used in plant breeding, but many of them are becoming

increasingly threatened. The establishment of genetic reserves is one of the approaches for CWR conservation that has been assessed in Europe under the AEGRO project (AGRI GENRES 057 "An Integrated European *In Situ* Management Work Plan: Implementing Genetic Reserves and On Farm Concepts") co-funded by the European Commission, DG AGRI within the framework of council regulation 870/2004.

Edible wild species

The 10 species included in this category are wild plants gathered for human feeding. Often, they are recognized as wild leafy vegetables (Maggioni and Spellman 2001). They are: *Asparagus acutifolius*, *Portulaca oleracea* subsp. *oleracea*, *Carduus pycnocephalus* subsp. *pycnocephalus*, *Reichardia picroides*, *Sonchus asper*, *Sonchus oleraceus*, *Sonchus tenerrimus*, *Taraxacum officinale*, *Urospermum picroides* and *Smyrnium olusatrum*. For each species, some relevant peculiarities that indicate their use as food are provided. *Asparagus acutifolius* is a native, perennial plant widely distributed throughout the Mediterranean areas, whose flowers are classified as dioecious and are mainly bee-pollinated; in general it does not reproduce by self-pollination and grows in bushy and semi-dry places, sunny or semi-shade, mainly on limestone (Sica et al. 2005); it is becoming an interesting niche crop for marginal areas in Europe (Benincasa et al. 2007); the shoots are eaten boiled and dressed with oil and vinegar, in an omelet, in oil, risotto, soups, stews and soups; the decoction of the shoots is taken orally as a diuretic and generic anti-inflammatory; breeders have crossed *A. acutifolius* with the well known cultivated species *A. officinalis*, as well as with other wild species of *Asparagus* (González Castañón and Falavigna 2008). *Portulaca oleracea* subsp. *oleracea* is a cosmopolitan weed whose place of origin is doubtful or unknown (Walters 1920) or possibly it has originated in western Asia (Hammer 1986; Hammer et al. 1999); it seems to be a polyploid complex, with four ploidy levels: diploid ($2n = 18$), tetraploids, hexaploid and pentaploid (Danin et al. 1978); it is considered the wild form of the cultivated *P. oleracea* subsp. *sativa*, originated in the Old World (Danin et al. 1978; Hammer 1986); both subspecies are edible and have similar comestible characteristics, usable both for humans and for animals (Bosi et al. 2009); according to different classical authors, it was one of the leafy vegetables (from both spontaneous and cultivated plants) eaten in Italy during the first century A.D. (Pitrat and Foury 2003); Varrone praised its dietary virtues (Arcidiacono and Pavone 1994). *Carduus pycnocephalus* subsp. *pycnocephalus*: at least in Calabria is among several weeds eaten by man (Conforti et al. 2008); the leaves, despinulated, are used in the kitchen; the fleshy root is used boiled or steamed and is excellent as a side dish for meat and fish, and is used as a substitute roasted coffee; the dried flowers are used for the coloration of aliments; it is also thought to have a great potential as an antitumoral plant, because of the high phenolic and favonoid contents in its plant extracts (Conforti et al. 2008); though some *Carduus* species are known to accumulate nitrates in toxic quantities, *C. pycnocephalus* has apparently not been incriminated as a toxic weed (Goeden 1974); the genus *Carduus* is native to the Eastern Hemisphere, where its distribution extends over Europe, central Asia, and East Africa; Flora Europaea recognizes 48 species (Franco 1921). *Reichardia picroides* is widely used as a wild vegetable in Italy (Hammer et al. 1999), but also in other areas of the Mediterranean, in some of which the roots are also consumed. Recently, cultivation has been attempted (Ficarra 2013). *Sonchus asper* is native to Europe, West Asia, and North Africa. The plant has been introduced to North America, South America, East Asia, South Africa, Australia, and New Zealand (Hyatt 2006); it is considered by the University of Alaska Anchorage (UAA) an invasive species with a rank of 46, from 0 to 100, where 0 represents a plant that poses no threat and 100 a plant that poses a major threat to native ecosystems; all *Sonchus* species are listed as noxious weeds in Ontario; it reproduces only by seeds (DiTomaso and Healy 2007), with each plant producing 20,000 to 26,000 seeds (Hutchinson et al. 1984). Seeds can survive between 2 and 8 years in the soil in field conditions; it is a host for several nematode and aphid species and supports several major plant viruses (Hutchinson et al. 1984); the plant is edible and may be grazed by herbivores (Lewin 1948); all these information would suggest to consider *S. asper* an indesirable weed, but not in its native area (including Italy), where there is a lack of studies on the relationship with other species of the ecosystem, especially from the point of view of any benefits that may arise avoiding the plants to reach flowering and spread, which is

possible if they are subjected to grazing or harvesting as vegetables when they are in the rosette stage, a common practice for plants that grow in the olive groves. *Sonchus oleraceus*, though considered a pest (weed) in more than 55 countries, is more edible than *S. asper* and therefore appreciated in the popular Italian cooking (Ficarra 2013); in different parts of the world is also appreciated as a medicinal plant with many different properties: anticancer, anti-inflammatory, cathartic, digestive, diuretic, vermicide, and many others (PFAF 2012). *Sonchus tenerrimus* is edible and used as a medicinal plant: "Pliny the Elder, naturalist of ancient Rome in the first century A.D. argued that a plate of crespigno fed Theseus, the mythical greek hero, before he went to face the Minotaur. In the Middle Ages it was grown in the gardens of the simple within the monasteries, to use as a diuretic and depurative". *Taraxacum officinale* is used both in the kitchen and the popular pharmacopoeia; the therapy of leaves or roots is called "tarassacoterapia"; it is a plant of great interest in beekeeping, which provides both pollen and nectar (Rutherford and Deacon 1972; Cyr and Bewley 1990). *Urospermum picroides* has the basal leaves and buds that are used cooked, before flowering and preferably mixed with other plants, either as a vegetable or in soups and stuffings; it is a bitter plant (Acta Plantarum 2013). *Smyrnium olusatrum* has leaves and young shoots that can be eaten raw in salads or cooked in soups, stews and others; the plant comes into growth in the autumn and the leaves are often available throughout the winter, with a strong celery-like flavor; leafy seedlings can be used as a parsley substitute; the spicy seeds are used as a pepper substitute (Ficarra 2013; PFAF 2012). After this presentation of comestible plant species, one has, however, to stress the point that the number of comestible species that grow in the olive groves is higher than 10. Infact, are comestible species also some of those included in the category of crops, as for example the following eight species: *Muscari comosum*, *Rubus canescens*, *Rubus ulmifolius*, *Myrtus communis* subsp. c*ommunis*, *Capparis spinosa*, *Diplotaxis erucoides* subsp. *erucoides*, *Diplotaxis tenuifolia* and *Amaranthus retroflexus*. The same reasoning can be applied to at least three species included in the category of medicinal, aromatic and officinal plants, i.e., *Urtica dioica* subsp. *dioica*, *U. urens* and *Solanum nigrum*, or to at least six species included in that of the crop wild relatives, i.e., *Raphanus raphanistrum, Sinapis alba*, *Sinapis arvensis* subsp. *arvensis*, *Beta vulgaris*, *Cichorium intybus* and *Lactuca serriola*, and, finally, to at least four species included in that of fodders, i.e., *Lathyrus cicera*, *Lathyrus ochrus*, *Lathyrus sylvestris* subsp. *sylvestris*, and *Tetragonolobus purpureus*. The sum of all these edible species, included in other categories, is equal to 21. In this way, the total number of comestible species is then not 10, but 31. On the other hand, the 10 species included in the category of comestibles could have also been included in the category of medicinal, aromatic and officinal plants and even of other categories. But as explained earlier it was decided to list them only in one category, the one that reflects better their prevalent use on a small or global scale.

A part from specific peculiarities, the all species, grouped under the voice of plants used by man must be considered as an important reservoir of plant genetic resources to be saved both *in situ* and *ex situ*. The reasons are that, for years or centuries, these species have been changing genes or pieces of DNA with other species of the community, through different natural mechanisms, and therefore their genomes are carrying gene sequencing nearly ready for meeting climiting or environmental changes.

Conclusions

The vulnerability of the agro-ecosystems of ancient olive groves was already pointed out by Perrino et al. (2011). The results of the present study provide further information for improving conservation and management of plant biodiversity and especially of plant species at risk and/or having conservation interest, that are able to survive in ancient olive groves. Thus, they are important not only for their beautiful landscape, olive production, efficient carbon dioxide sequestration and for their ability to face climatic changes, but also for conserving entire agro-ecosystems, in which several endangered plant, animal and microbial species may survive and provide speciation, adaptation and evolution. In fact, in whole, 408 taxa, belonging to 275 genera and 74 families of vascular flora were found to grow in ancient olive groves. The three most represented families are: Asteraceae (12.7 %) with 52 taxa, followed by Poaceae (11.3 %) and Fabaceae (11.3 %), both with 46 taxa. The other families, each with 20 taxa or less, include the remaining 264 taxa.

Ancient olive groves provide environments suitable to conserve endangered plant species and/or of conservation interest. In fact, 18 taxa, out of 408, considered to be critical, were found to grow in olive groves and not likely to see in modern and industrialized olive orchards. For some of these species, conservation actions have been undertaken for plants growing in natural habitats of National Park of "Alta Murgia" and Natural Regional Park "Terra delle Gravine". In these two protected areas of Apulia, specimens of *Aegilops uniaristata*, *Asyneuma limonifolium*, *Helianthemum jonium*, *Satureja cuneifolia*, *Scrophularia lucida* and *Stipa austroitalica* subsp. *austroitalica* were collected and stored, for *ex situ* conservation, at the Germplasm Bank of the Botanical Garden Museum, University of Bari (BG-MOBB). Actions for *in situ* conservation, in the same protected areas, have been taken only for *Stipa austroitalica* subsp. *austroitalica*.

The results have shown that the spectrum of plant species in the fields and infrastructures, is different from that in the fields and that in the infrastructures. That of the fields and infrastructures shows that the therophytes, are more abundant (45.1 %), that perennial species: hemicryptophytes (26.7 %), geophytes (10.3 %), phanerophytes (9.8 %), chamaephytes (4.9 %) and nanophanerophytes (3.2 %). That of the fields shows an increase of the therophytes (59.2 %), against a decrease of other life forms (perennial species), especially of chamaephytes (1.2 %) and phanerophytes (5.2 %). Finally, that of ecological infrastructures shows to be very similar to that of the merged fields and ecological infrastructures, except for a slight increases in perennial life forms (56.0 %) and a decrease of the therophytes (44.0 %). In seminatural environments, i.e., in ecological infrastructures, perennial forms take a competitive advantage over some therophytes, showing an increase from the fields (40.8 %) to the ecological infrastructures (56.0 %).

The percentages of the Eastern Mediterranean (6.5 %) and Pontic types (0.5 %) for the merged fields and ecological infrastructures, though show low values they seem to suggest similarities or strong correlations with the flora of eastern geographical areas and, in particular, with the Eastern Mediterranean, primary center of origin of olive trees.

From an agricultural point of view, the co-evolution of at least 111 plant species, out of the 408, belonging to plants used by man, it is of great importance both for *in situ* conservation and valorization of plant genetic resources related to the agroecosystems of ancient olive trees.

It is difficult to say which species are really threatened and which are not because of lack of monitoring data. This is why the European Community must continue to support monitoring studies, started with LIFE+ CENT.OLI.MED project. In any case, it is out of question that species of conservation interest and the habitats of Directive 92/43 EEC must be preserved. We can assume that farmers who have chosen to preserve their ancient olive groves with agricultural practices with low environmental impact are also interested to protected wild species. However, there are three historical-cultural problems that should not be underestimated. The first one is that we do not know what will be the attitude of the new generation of farmers. The second one is that we do not know if in a reasonable time we will be able to raise awareness for species of conservation interest and for those used by man (food and not food), which have been found in the ancient olive groves. The third problem is that farmers who do not have interest in the protection of biodiversity and that often react negatively to *in situ* conservation actions, are or may be an obstacle to conservative farming practices. Obviously, the solution to these problems is of political nature.

Although the results show a scientific advancement, they suggest to extend the present study to other olive groves of Apulia, to other regions of Italy and of the Mediterranean basin, with the aim to have a more comprehensive picture of the vascular flora, including plants used by man, to further improve our knowledge on olive groves agro-ecosystems. Bearing in mind that an improvement in planning and management of the olive groves would help to meet both the economical and social aspects of olive production and the conservation of the related ecosystems. In turn, it would meet the philosophy of the "LIFE+ CENT.OLI.MED" Project and that of one of the goals of the Millennium Development Goals (MDG): "ensure environmental sustainability".

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Appendix: Floristic List

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Polypodiidae				
Dennstaedtiaceae				
Pteridium aquilinum (L.) Kuhn subsp. *aquilinum*	G	C		
Pteridaceae				
Adiantum capillus-veneris L.	G	Pn		
Aspleniaceae				
Ceterach officinarum Willd.	H	Ese		MAP
Pinidae				
Pinaceae				
Pinus halepensis Miller	P	Ms		MAP
Magnoliidae				
Lauraceae				
Laurus nobilis L.	P	Ms		MAP
Araceae				
Arisarum vulgare Targ.-Tozz.	G	Ms		
Arum italicum Miller subsp. *italicum*	G	Ms		
Dioscoraceae				
Tamus communis L.	G	Me		
Colchicaceae				
Colchicum cupanii Guss.	G	Ms		
Smilacaceae				
Smilax aspera L.	NP	Tps		
Liliaceae				
Gagea granatellii (Parl.) Parl.	G	Msd	VU	
Gagea mauritanica Durieu	G	Mssw	CR	
Orchidaceae				
Barlia robertiana (Loisel.) Greuter	G	Ms	CI	
Ophrys incubacea Bianca	G	Ms	CI	
Orchis palustris Jacq.	G	Me	CI-EN	
Orchis purpurea Huds.	G	Ea	CI	
Iridaceae				
Gladiolus italicus Mill.	G	Me		MAP
Hermodactylus tuberosus (L.) Mill.	G	Msn		
Romulea columnae Sebast. et Mauri	G	Ms		
Xanthorrhoeaceae				
Asphodelus fistulosus L.	H	Tpsp		
Asphodelus ramosus L. subsp. *ramosus*	G	Ms		
Amaryllidaceae				
Allium ampeloprasum L.	G	Me		CRO
Allium roseum L.*	G	Ms		
Allium subhirsutum L.	G	Ms		
Allium trifoliatum Cirillo	G	Mse		
Asparagaceae				
Asparagus acutifolius L.*	NP	Ms		EWS
Charybdis pancration (Steinh.) Speta	G	Msm		
Loncomelos narbonensis (Torm. in L.) Raf.	G	Me		
Muscari commutatum Guss.	G	Mece		CWR
Muscari comosum (L.) Mill.	G	Me		CRO
Muscari neglectum Guss. ex Ten.	G	Me		CWR
Muscari parviflorum Desf.	G	Mece	PI-r	CWR
Ornithogalum comosum L.	G	Mm		
Ornithogalum gussonei Ten.	G	Ms		
Ornithogalum umbellatum L.	G	Me		
Ruscus aculeatus L.	Ch	Me		
Juncaceae				
Juncus articulatus L.	G	Cb		
Juncus hybridus Brot.	T	Ma		
Cyperaceae				
Isolepis cernua (Vahl) Roem. et Schult.	T	Cs		
Poaceae				
Achnatherum bromoides (L.) P. Beauv.	H	Ms		
Aegilops ovata Auct.	T	Mst		CWR
Aegilops uniaristata Vis.	T	Ad	Ad-VU	CWR
Agrostis stolonifera L.	H	Cb		
Aira caryophyllea L. subsp. *caryophyllea*	T	Tps		
Arundo donax L.	G	Cs		

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Arundo plinii Turra	G	Ms		
Avena barbata Pott ex Link*	T	Me		CWR
Avena sativa L.	T	–		CRO
Brachypodium retusum (Pers.) P. Beauv.	H	Msw		
Brachypodium sylvaticum (Huds.) P. Beauv.	H	Tmp		
Briza maxima L.*	T	Tps		
Briza minor L.	T	Cs		
Bromus diandrus Roth	T	Tpsp		
Bromus hordeaceus L.	T	Cs		
Bromus madritensis L.	T	Me		
Catapodium rigidum (L.) C.E. Hubb.*	T	Me		
Cynodon dactylon (L.) Pers.	G	C		
Cynosurus echinatus L.	T	Me		
Dactylis glomerata L. subsp. *glomerata*	H	Tmp		
Dactylis glomerata L. subsp. *hispanica* (Roth) Nyman	H	Ms		
Dasypyrum villosum (L.) P. Candargy	T	Met		CWR
Digitaria sanguinalis (L.) Scop.	T	Cs		
Hordeum murinum L.	T	Cb		CWR
Hordeum murinum L. subsp. *leporinum* (Link) Arcang.	T	Cb		CWR
Hyparrhenia hirta (L.) Stapf subsp. *hirta*	H	Tpp		
Lagurus ovatus L. subsp. *ovatus*	T	Ms		
Lolium perenne L.	H	Cb		
Lolium rigidum Gaudin	T	Tpsp		
Parapholis incurva (L.) C.E. Hubb.	T	Ma		
Phalaris minor Retz.	T	Tpsp		
Phalaris paradoxa L.	T	Ms		
Phleum pratense L.	H	Cb		
Piptatherum miliaceum (L.) Coss. subsp. *miliaceum*	H	Mst		FOD
Piptatherum miliaceum (L.) Coss. subsp. *thomasii* (Duby) Freitag	H	Ms		FOD
Poa annua L.	T	C		
Poa bulbosa L.	H	Tmp		
Polypogon monspeliensis (L.) Desf.	T	Tps		
Rostraria cristata (L.) Tzvelev	T	Cs		
Setaria viridis (L.) Beauv.	T	Cs		
Sorghum halepense (L.) Pers.	G	Ctr		FOD
Stipa austroitalica Martinovský subsp. *austroitalica*	H	I	B-DH-I	
Stipa capensis Thunb.	T	Ms		
Trachynia distachya (L.) Link	T	Ms		
Vulpia ciliata Dumort.	T	Me		
Vulpia ligustica (All.) Link	T	Ms		
Papaveraceae				
Fumaria capreolata L. subsp. *capreolata*	T	Me		
Fumaria officinalis L.	H	Mem		
Fumaria parviflora Lam.	T	Mt		
Papaver hybridum L.	T	Mt		
Papaver rhoeas L. subsp. *rhoeas**	T	Mes		
Ranunculaceae				
Anemone hortensis L. subsp. *hortensis*	G	Mn		
Clematis cirrhosa L.	P	Mst		
Clematis vitalba L.	P	Eca		
Delphinium halteratum Sm. subsp. *halteratum*	T	Ms		
Nigella arvensis L.	T	Me		
Nigella damascena L.	T	Me		
Ranunculus bullatus L.	H	Ms		
Ranunculus ficaria L.	G/H	Ea		
Ranunculus millefoliatus Vahl	H	Mm		
Ranunculus neapolitanus Ten.	H	Mmne		
Ranunculus sardous Crantz	T	Me		
Crassulaceae				
Sedum rubens L.	T	Meas		
Zygophyllaceae				
Tribulus terrestris L.	T	C		
Fabaceae				
Acacia cyanophylla Lindley	P	Aus		
Anagyris foetida L.	P	Mss		
Anthyllis vulneraria L. subsp. *maura* (Beck) Maire	H	Mssw		
Astragalus hamosus L.	T	Mt		

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Bituminaria bituminosa (L.) C.H. Stirt.	H	Me		
Calicotome villosa (Poir.) Link	P	Ms		
Ceratonia siliqua L.	P	Mss		CRO
Coronilla scorpioides (L.) W.D.J. Koch	T	Me		
Dorycnium hirsutum (L.) Ser.	Ch	Me		
Emerus major Mill. subsp. *emeroides* (Boiss. et Spruner) Soldano et F. Conti	NP	–		
Hippocrepis ciliata Willd.	T	Ms		
Lathyrus cicera L.	T	Me		FOD
Lathyrus ochrus (L.) DC.	T	Ms		FOD
Lathyrus sylvestris L. subsp. *sylvestris*	H	E		FOD
Lotus corniculatus L.	H	C		
Lotus edulis L.	T	Ms		
Lotus ornithopodioides L.	T	Ms		
Lupinus cosentinii Guss.	T	Mw		FOD
Medicago arabica (L.) Huds.	T	Mw		FOD
Medicago minima L.	T	Tscm		FOD
Medicago orbicularis (L.) Bartal.	T	Me		FOD
Medicago polymorpha L.	T	Me		FOD
Medicago truncatula Gaertn.	T	Ms		FOD
Melilotus sulcatus Desf.*	T	Msd		FOD
Onobrychis aequidentata (Sm.) D'Urv.	T	Mse		
Onobrychis caput-galli (L.) Lam.	T	Ms		
Ononis reclinata L.	T	Mts		
Ononis viscosa (L.) subsp. *breviflora* (DC.) Nyman	T	Mw		
Scorpiurus muricatus L.	T	Me		
Spartium junceum L.	P	Me		
Sulla capitata (Desf.) B.H. Choi et H. Ohashi	T	Msw		FOD
Tetragonolobus purpureus Moench	T	Ms		FOD
Trifolium campestre Schreb.	T	Mmpw		FOD
Trifolium lappaceum L.	T	Me		FOD
Trifolium pratense L.	T	Cs		FOD
Trifolium resupinatum L.	T	Tmp		FOD
Trifolium scabrum L. subsp. *scabrum*	T	Me		FOD
Trifolium squarrosum L.	T	Me		FOD
Trifolium stellatum L.	T	Me		FOD
Trifolium tomentosum L	T	Tmp		FOD
Trigonella monspeliaca L.	T	Me		FOD
Vicia hybrida L.	T	Me		FOD
Vicia lutea L.	T	Me		FOD
Vicia sativa L.	T	Cs		FOD
Vicia sativa L. subsp. *macrocarpa* (Moris) Arcang.	T	Cs		FOD
Vicia villosa Roth	T	Me		FOD
Rosaceae				
Geum urbanum L.	H	Cb		
Mespilus germanica L.	P	Esp		CRO
Prunus avium L. subsp. *avium*	P	P		CRO
Prunus dulcis Miller D.A. Webb	P	Msd		CRO
Pyrus spinosa Forssk.	P	Ms		CWR
Rosa sempervirens L.	NP	Ms		MAP
Rubus canescens DC.	NP	Men		CRO
Rubus ulmifolius Schott*	NP	Me		CRO
Sanguisorba minor Scop.	H	Tmp		
Rhamnaceae				
Paliurus spina-christi Miller	P	Ese		MAP
Rhamnus alaternus L. subsp. *alaternus*	P	Me		
Moraceae				
Ficus carica L.	P	Mt		CRO
Morus alba L.	P	Ase		CRO
Urticaceae				
Mercurialis annua L.	T	Tmp		
Parietaria judaica L.	H	Mem		
Urtica dioica L. subsp. *dioica*	H	Cs		MAP
Urtica urens L.	T	Cs		MAP
Fagaceae				
Quercus cerris L.	P	Mn		
Quercus ilex L. subsp. *ilex*	P	Ms		
Quercus pubescens Willd. subsp. *pubescens*	P	Esep		
Juglandaceae				
Juglans regia L.	P	Assw		CRO
Betulaceae				
Ostrya carpinifolia Scop.	P	P		
Oxalidaceae				
Oxalis pes-caprae L.*	G	Afs		
Euphorbiaceae				

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Chamaesyce maculata (L.) Small	T	An		
Euphorbia characias L.	NP	Ms		
Euphorbia exigua L. subsp. *exigua*	T	Me		
Euphorbia helioscopia L. subsp. *helioscopia**	T	C		
Euphorbia peplus L.	T	Esb		
Euphorbia segetalis L.	T	Mw		
Euphorbia terracina L.	T	Ms		
Phyllanthaceae				
Andrachne telephioides L.	Ch	Me		
Violaceae				
Viola reichenbachiana Jordan ex Boreau	H	Esb		
Linaceae				
Linum bienne Mill.	H	Me		CWR
Linum strictum L.	T	Ms		
Hypericaceae				
Hypericum perforatum L.	H	Tmp		MAP
Hypericum triquetrifolium Turra	H	Mse		
Geraniaceae				
Erodium cicutarium (L.) L'Hér	T/H	Cs		
Erodium malacoides (L.) L'Hér. subsp. *malacoides*	T	Ms		
Geranium dissectum L.	T	Cs		
Geranium molle L.*	H	Cs		
Geranium purpureum Vill.	T	Me		
Geranium rotundifolium L.	T	Tmp		
Onagraceae				
Epilobium parviflorum Schreb.	H	Tmp	**r**	
Myrtaceae				
Myrtus communis L. subsp. *communis*	P	Ms		CRO
Anacardiaceae				
Pistacia lentiscus L.	P	Mss		CRO
Pistacia terebinthus L. subsp. *terebinthus*	P	Me		CRO
Rutaceae				
Citrus aurantium L.	P	Cn		CRO
Citrus limon (L.) Burm. f. var. *femminello*	P	Hi		CRO
Citrus sinensis (L.) Osbeck "var. biondo commune del Gargano"	P	Cn		CRO
Citrus sinensis (L.) Osbeck "var. duretta del Gargano"	P	Cn		CRO

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Ruta chalepensis L.	Ch	Mss		MAP
Malvaceae				
Althaea hirsuta L.	T	Me		
Malva cretica Cav.	T	Ms		
Malva sylvestris L. subsp. *sylvestris*	H	Esb		MAP
Thymelaeaceae				
Daphne gnidium L.	P	Msm		
Cistaceae				
Cistus creticus L.	NP	Mec		
Cistus monspeliensis L.	NP	Ms		
Cistus salviifolius L.	NP	Ms		
Fumana laevipes (L.) Spach	Ch	Ms		
Fumana thymifolia (L.) Spach ex Webb	Ch	Ms		
Helianthemum jonium Lacaita	Ch	I	I	
Helianthemum salicifolium (L.) Mill.	T	Me		
Resedaceae				
Reseda alba L.	T	Ms		
Capparaceae				
Capparis spinosa L.	Np	Ea		CRO
Brassicaceae				
Biscutella didyma L. subsp. *apula* Nyman	T	Mts		
Capsella bursa-pastoris (L.) Medik. subsp. *bursa-pastoris*	H	C		
Cardamine hirsuta L.	T	C		
Diplotaxis erucoides (L.) DC. subsp. *erucoides*	T	Msw		CRO
Diplotaxis tenuifolia (L.) DC.	H	Masb		CRO
Erophila verna (L.) DC.	T	Cb		
Lepidium draba (L.) Desv. subsp. *draba*	G/H	Mt		
Moricandia arvensis (L.) DC.	T	Ms		
Raphanus raphanistrum L.	T	Cb		CWR
Raphanus sativus L.	T	-		CRO
Rapistrum rugosum (L.) Arcang.	T	Me		
Sinapis alba L.	T	Mes		CWR
Sinapis arvensis L. subsp. *arvensis*	T	Ms		CWR
Sisymbrium irio L.	T	Tm		
Thlaspi arvense L.	T	Asw		

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Santalaceae				
Osyris alba L.	NP	Me		
Polygonaceae				
Rumex acetosa L. subsp. *acetosa*	H	Cb		
Rumex buchephalophorus L. subsp. *buchephalophorus*	T	Mmc		
Rumex crispus L.	H	Cs		
Rumex pulcher L.	H/T	Me		
Caryophyllaceae				
Arenaria serpyllifolia L. subsp. *serpyllifolia*	T	Cs		
Cerastium glomeratum Thuill.*	T	Cs		
Minuartia verna (L.) Hiern subsp. *attica* (Boiss. et Spruner) Graebn.	Ch	Me		
Petrorhagia dubia (Raf.) G. Lopez et Romo	G	Msd		
Petrorhagia prolifera (L.) P.W. Ball. & Heywood	T	Me		
Petrorhagia saxifraga (L.) Link subsp. *gasparrinii* (Guss.) Greuter et Burdet	H	Me		
Sagina apetala Ard. subsp. *apetala*	H	Me		
Silene conica L.	H	Tmp		
Silene italica (L.) Pers.	H	Me		
Silene latifolia Poiret	T/H	Ms		
Silene nocturna L.	T	Mmms		
Silene vulgaris (Moench) Garcke	H	-		
Stellaria media (L.) Vill. subsp. *media*	T	C		
Amaranthaceae				
Amaranthus retroflexus L.	T	C		CRO
Beta vulgaris L.	H	Me		CWR
Chenopodium hybridum L.	T	Cb		MAP
Portulacaceae				
Portulaca oleracea L. subsp. *oleracea*	T	Cs		EWS
Cactaceae				
Opuntia ficus-indica (L.) Miller	P	Nen		CRO
Ericaceae				
Erica forskalii Vitm.	Ch/NP	Mes	VU	

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Primulaceae				
Anagallis arvensis L.*	T	Me		
Cyclamen hederifolium Aiton	G	Msn	CI	
Samolus valerandi L.	H	Cs		
Rubiaceae				
Asperula aristata L.	H/Ch	Mm		
Galium aparine L.	T	Ea		
Galium lucidum All.	H	Me		
Galium palustre L. subsp. *elongatum* (C. Presl.) Lange	H	Me		
Galium spurium L.	T	Ea		
Galium verrucosum Huds.	T	Ms		
Galium verum L.	H	Ea		
Rubia peregrina L.*	P	Msm		
Sherardia arvensis L.*	T	Cs		
Theligonum cynocrambe L.	T	Ms		
Valantia muralis L.	T	Ms		
Gentianaceae				
Blackstonia perfoliata (L.) Huds. subsp. *perfoliata*	T	Me		
Centaurium erythraea Rafn	H	Tmp		
Centaurium pulchellum (Sw.) Druce subsp. *pulchellum*	T	Tmp		
Apocynaceae				
Cynanchum acutum L. subsp. *acutum*	P	Tpsp		
Boraginaceae				
Alkanna tinctoria (L.) Tausch subsp. *tinctoria*	H	Ms		
Borago officinalis L.	T	Me		CRO
Buglossoides arvensis (L.) I. M. Johnst.	T	Me		
Buglossoides purpureocaerulea (L.) I.M. Johnst.	H	Esp		MAP
Cerinthe major L.*	T	Ms		
Cynoglossum creticum Mill.	H	Me		
Echium parviflorum Moench	T	Ms		
Echium plantagineum L.	T/H	Me		
Heliotropium europaeum L.	T	Met		
Myosotis arvensis (L.) Hill subsp. *arvensis*	T	Easw		
Phacelia tanacetifolia Benth.	T	An		
Convolvulaceae				

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Calystegia sepium (L.) R. Br. subsp. *sepium*	H	Tmp		
Calystegia sylvatica (Kit.) Griseb.	H	Ese		
Convolvulus althaeoides L.	H	Ms		
Convolvulus arvensis L.	G	C		
Convolvulus cantabrica L.	H	Me		
Convolvulus elegantissimus Mill.	H	Mse		
Cuscuta epithymum L.	T	Eat		
Solanaceae				
Solanum nigrum L.	T	C		MAP
Oleaceae				
Fraxinus ornus L. subsp. *ornus*	P	Menp		
Olea europaea L.*	P	Ms		
Phillyrea latifolia L.	P	Ms		
Plantaginaceae				
Kickxia spuria (L.) Dumort.	T	Ea		
Linaria reflexa (L.) Desf.	T	Msdw		
Linaria vulgaris Mill. subsp. *vulgaris*	H	Ea		
Misopates orontium (L.) Raf. subsp. *orontium*	T	Tmp		
Plantago afra L.	T	Ms		
Plantago bellardii All.	T	Msd		
Plantago lagopus L.	T	Ms		
Plantago lanceolata L.	H	Ea		
Plantago major L.	H	Cs		
Plantago serraria L.	H	Ms		
Veronica hederifolia L.*	T	Ea		
Veronica polita Fries*	T	Cs		
Scrophulariaceae				
Scrophularia lucida L.	H/Ch	Mm	Ad-PI	
Scrophularia peregrina L.	T	Ms		
Verbascum pulverulentum Vill.	H	Ecs		
Verbascum sinuatum L.	H	Me		
Lamiaceae				
Acinos alpinus (L.) Moench	Ch	Oes		
Ajuga chamaepitys (L.) Schreber	T	Me		
Calamintha nepeta (L.) Savi	H	Oes		MAP
Clinopodium vulgare L.	H	Cb		
Lamium amplexicaule L.	T	Tmp		
Lycopus europaeus L.	H	Cb		
Marrubium vulgare L.	H	Cs		MAP
Micromeria graeca (L.) Benth. ex Rchb. subsp. *graeca*	Ch	Ms		
Origanum vulgare L. subsp. *viridulum* (Martin-Donos) Nyman	H	Ea		CRO
Prasium majus L.	Ch	Ms		
Rosmarinus officinalis L.	NP	Ms		CRO
Salvia verbenaca L.	H	Msa		MAP
Satureja cuneifolia Ten.	Ch	Msn	PI	
Satureja montana L.	Ch	Omw		MAP
Sideritis romana L. subsp. *romana*	T	Ms		
Stachys germanica L. subsp. *salviifolia* (Ten.) Gams.	H	Mne		
Teucrium capitatum L. subsp. *capitatum*	Ch	Ms		
Teucrium flavum L.	Ch	Ms		
Teucrium scordium L.	H	Eca		
Thymbra capitata (L.) Cav.	Ch	Mse		MAP
Orobanchaceae				
Bartsia trixago L.	T	Me		
Parentucellia latifolia (L.) Caruel	T	Me		
Parentucellia viscosa (L.) Caruel	T	Mea		
Acanthaceae				
Acanthus spinosus L.	H	Mse		MAP
Verbenaceae				
Verbena officinalis L.	H	C		
Campanulaceae				
Asyneuma limonifolium (L.) Janch. subsp. *limonifolium*	H	Ad	Ad-PI-NT	
Legousia hybrida (L.) Delarbre	T	Ma		
Legousia speculum-veneris (L.) Chaix	T	Me		
Asteraceae				
Achillea millefolium L.	H	Esb		MAP
Anthemis arvensis L.*	T/H	Cs		
Bellis annua L. subsp. *annua*	T	Msm		

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Bellis sylvestris Cirillo	H	Ms		
Calendula arvensis (Vaill.) L.*	T	Me		MAP
Calendula officinalis L.	T/H	-		MAP
Carduus pycnocephalus L. subsp. *pycnocephalus*	H	Mt		MAP
Carlina corymbosa L.	H	Ms		
Centaurea nicaeensis All.	H	Mssw		
Chondrilla juncea L.	H	Me		
Cichorium intybus L.	H	Tmp		CWR
Cirsium arvense (L.) Scop.	G	Ea		
Cota tinctoria (L.) J. Gay	H/Ch	Ecp		
Crepis apula (Fiori) Babc.	T	I	I	
Crepis corymbosa Ten.	T	I	I	
Crepis leontodontoides All.	H	Mmw		
Crepis vesicaria L.	T/H	Masb		
Crupina crupinastrum (Moris) Vis.	T	Ms		
Dittrichia viscosa (L.) Greuter	H	Me		
Erigeron canadensis L.	T	Avv.		
Eupatorium cannabinum L.	H	Tmp		MAP
Galactites elegans (All.) Soldano	H	Ms		
Glebionis coronaria (L.) Spach	T	Ms		
Glebionis segetum (L.) Fourr.	T	Me		
Helichrysum italicum (Roth) G. Don	Ch	Es		
Hyoseris scabra L.	T	Ms		
Hypochaeris achyrophorus L.	T	Ms		
Inula conyzae (Griess.) Meikle	H	Easw		
Klasea flavescens (L.) Holub	H	Msdw		
Lactuca serriola L.	H/T	Mess		EWS
Leontodon crispus Vill. subsp. *crispus*	H	Es		
Leontodon hispidus L.	H	Eca		
Leontodon tuberosus L.	H	Ms		
Matricaria chamomilla L.	T	Cs		MAP
Onopordum illyricum L.	H	Ms		
Pallenis spinosa (L.) Cass. subsp. *spinosa*	H	Me		
Picris hieracioides L.*	H	Esb		
Pulicaria dysenterica (L.) Bernh.	H	Me		
Reichardia picroides (L.) Roth*	H	Ms		MAP
Rhagadiolus stellatus (L.) Gaertn.	T	Me		
Senecio leucanthemifolius Poir. subsp. *leucanthemifolius*	T	Ms		
Senecio vulgaris L.	T	C		
Sonchus asper (L.) Hill	T	Ea		EWS
Sonchus oleraceus L.*	T	Ea		EWS
Sonchus tenerrimus L.	T	Ms		EWS
Symphyotrichum squamatum (Spreng.) G.L. Nesom	T/H	Nen		
Taraxacum officinale Weber	H	Cb		EWS
Tragopogon porrifolius L.	H	Me		
Tripolium pannonicum (Jacq.) Dobrocz.	H	Ea		
Urospermum dalechampii (L.) F. W. Schmidt	H	Me		
Urospermum picroides (L.) Scop. ex F.W. Schmidt	T	Me		EWS
Xanthium spinosum L.	T	Ams		
Adoxaceae				
Sambucus nigra L.	P	Eca		MAP
Viburnum tinus L. subsp. *tinus*	P	Ms		
Caprifoliaceae				
Centranthus calcitrapae (L.) Dufr. subsp. *calcitrapae*	Ch	Ms		
Centranthus ruber (L.) DC. subsp. *ruber*	Ch	Ms		
Dipsacus fullonum L.	H	Me		
Knautia integrifolia (L.) Bertol. subsp. *integrifolia**	T	Me		
Lonicera implexa Aiton subsp. *implexa*	P	Ms		
Scabiosa columbaria L.	H	Ea		
Sixalis atropurpurea (L.) Greuter et Burdet subsp. *grandiflora* (Scop.) Sold. et Conti	H	Ms		
Valerianella muricata (Stev. ex M. Bieb.) J.W. Loudon	T	Ms		
Araliaceae				
Hedera helix L.	P	Meas		
Apiaceae				
Ammoides pusilla (Brot.) Breistr.	T	Ms		
Daucus carota L. subsp. *carota**	H	Cs		

Species	Acronyms			
	LF (3)	CT (3)	CIN (1)	PUM (2)
Eryngium campestre L.	H	Me		
Foeniculum vulgare Miller	H	Msd		CRO
Scandix pecten-veneris L.*	T	Cs		
Smyrnium olusatrum L.	H	Ma		EWS
Tordylium apulum L.	T	Ms		
Tordylium officinale L.	T	Mne		
Torilis arvensis (Huds.) Link	T	Cs		

Sub-total						
Category	CRO	FOD	MAP	CWR	EWS	Total
Number of taxa	29	29	26	17	10	111

Acronyms indicating the reason of conservation interest (CIN): *CR* critically endangered, EN: endangered, *VU* vulnerable, *LR* lower risk, *NT* near threatened, *I* endemic, *Ad* amphiadriatic, *PI* phytogeographic interest, *B* International Convention of Berne, 1979, *CI* Convention on International Trade in Endangered Species (CITES 1973), *DH* Habitat Directive 92/43 EEC, *r* rare; (*) common to all of the four surveyed olive groves

Acronyms indicating the main use of the plant (PUM). *CRO* Food crops, *FOD* fodder crops, *CWR* crop wild relatives, *MAP* medicinal and aromatic plants, *EWS* edible wild species

Other acronyms: *LF* Life form, *CT* chorological type (see also Table 1)

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