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# VASCULAR FLORA OF THE ANCIENT OLIVE GROVES OF APULIA (SOUTHERN ITALY)

**Enrico Vito Perrino[1,2] & Generosa Calabrese[2]**

[1]University of Bari, Botanical Garden Museum, via E. Orabona 4, 70126 Bari, Italy (enricoperrino@yahoo.it, perrino@iamb.it)

[2]CIHEAM, Agronomic Mediterranean Institute of Bari, via Ceglie 9, 70010 Valenzano (Bari), Italy

**Perrino, E.V. & Calabrese, G.: Vascular flora of the ancient olive groves of Apulia (southern Italy). Nat. Croat., Vol. 23, No. 1, 189–218, 2014, Zagreb.**

A floristic study of the vascular flora of ancient olive groves of Apulia (Italy) was carried out from 2009 to 2012. Research was mainly focussed on the fields and the ecological infrastructures of four olive groves. In total, 408 taxa were identified, of those, 332 species, 73 subspecies and 3 cultivated varieties were classified into 275 genera and 74 families. Only 18 taxa out of the 408 were considered important from a conservation point of view. These 18 taxa were analysed more thoroughly, the topography of the collecting site, plant community, population density and relationships with the habitats being recorded, according to Directive 92/43/EEC. The work was planned and carried out with the aim of providing tools for improving the conservation and management of the olive groves of Apulia.

**Key words:** ancient olive groves, Apulia, floristic study, vascular flora, 92/43/EEC Directive

**Perrino, E.V. & Calabrese, G.: Vaskularna flora starih maslinika Apulije (južna Italija). Nat. Croat., Vol. 23, No. 1, 189–218, 2014, Zagreb.**

U razdoblju od 2009. do 2012. istraživana je vaskularna flora starih maslinika Apulije (Italija). Istraživanje se usredotočilo na polja i ekološku infrastrukturu četiri maslinika. Sveukupno je zabilježeno 408 svojti, od toga 332 vrste, 73 podvrste i 3 kultivirana varijeteta, smještenih u 275 rodova i 74 porodice. Samo 18 svojti od njih 408 se smatra važnima u smislu zaštite. Tih 18 svojti su podrobnije analizirane, i u skladu s Direktivom 92/43/EEC za njih je zabilježena topografija nalazišta, biljna zajednica, gustoća populacije i suodnos sa staništem. Istraživanje je planirano i izvedeno u cilju pronalaženja načina za poboljšanje zaštite i upravljanja maslinicima u Apuliji.

**Ključne riječi:** stari maslinici, Apulija, florističko istraživanje, vaskularna flora, Direktiva 92/43/EEC

## INTRODUCTION

The olive tree (*Olea europaea* L. ssp. *sativa* Hoffman & Link) is widely considered one of the most important plants in the history and culture of the Mediterranean people.

Today, olive trees are grown in 39 countries worldwide over an area of 8 million hectares and this makes the olive tree the most extensively cultivated temperate fruit crop in the world (FAO, 2002). Since 1992, olive production has increased by 44% and in 2002 in 29 countries worldwide oil production was 2.4 million tons. The leading oil producer countries are also the overall olive producing countries, because most of the olive crop is used for oil. Over 75% of the world's olive oil is produced in just three countries: Spain, Italy and Greece. The top ten countries of world production are: Spain (27%), Italy (20%), Greece (16%), Turkey (11%), Syria (6%), Tunisia (3%), Morocco (3%), Egypt (2%), Algeria (2%) and Portugal (2%). Apulia provides about 40% of the Italian

production (Bartolini *et al*., 2005). These data indicate the importance of olive trees in the world, as well as in Apulia Region.

In Italy, fossilized remains of the olive tree's ancestor, dating from twenty million years ago, were found near Livorno, although actual cultivation here probably did not occur until the fifth century B.C. (Zohary, 1973). Olive trees were first grown in the Eastern part of the Mediterranean and then 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 the olive crop to Southern Turkey, Cyprus and Egypt. Until 1500 B.C., the olive was most densely cultivated in Greece.. With the expansion of the Greek colonies, in the eighth century B.C., the olive culture reached Southern Italy and Northern Africa. Under Roman rule olive trees were planted throughout the Mediterranean basin (Acerbo, 1937; Zohary, 1973; Schäfer-Schuchardt, 1988; Guerci, 2005).

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

In addition to their undeniable cultural and landscape values, these Apulian habitats, have a major environmental importance since they offer shelter to many plant and animal species, some of which are of considerable 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 meadows (*Brachypodietalia distachyi*), perennial thermo-xerophilous grasslands (*Lygeo-Stipetea*), small patches of chasmophytic vegetation (*Asplenietea trichomanis*), nanophanerofitic and chamaephytic garigues (*Cistus-Ericion*), evergreen sclerophyllous scrubs (*Oleo-Ceratonion*) (Perrino *et al*., 2012) and scattered trees as *Ceratonia siliqua* L., *Ficus carica* L., *Laurus nobilis* L., *Prunus dulcis* (Mill.) D.A. Webb and sometimes *Juglans regia* L., *Morus alba* L., *Prunus domestica* L., *Punica granatum* L., *Pyrus communis* L., plus many species of *Quercus* s. l. and *Sorbus domestica* L. (Perrino *et al*., 2011), make the existing agro-ecosystems suitable for hosting several species of amphibians, reptiles, mammals and especially of birds, (Biondi *et al*., 2007).

Considering the history and the spread of olive trees throughout the Mediterranean countries, we might conclude that the olive agro-ecosystems of Apulia are about 2.800 years old (Zohary, 1973) and therefore old enough to deserve a study of the vascular flora that has co-evolved along with and that has contributed to the development and perpetuation in time of such agro-ecosystems.

Aiming at providing tools for improving conservation and management of olive groves of Apulia and with the objective of analysing their biodiversity, putting emphasis on threatened plant species and those of conservation interest, a botanical study of the vascular flora of ancient olive groves of Apulia was undertaken in the frame of the LIFE+ project, continuing previous work on monumental olive groves (Perrino *et al*., 2011).

## STUDY AREA

The research work was at first carried out in a number of ancient olive groves, located in different areas of Apulia and representing, as much as possible, the typical agro-environments of the region. Then, four ancient olive groves were selected as located along the coast and falling in four protected areas of the Apulia Region (Southern Italy): the

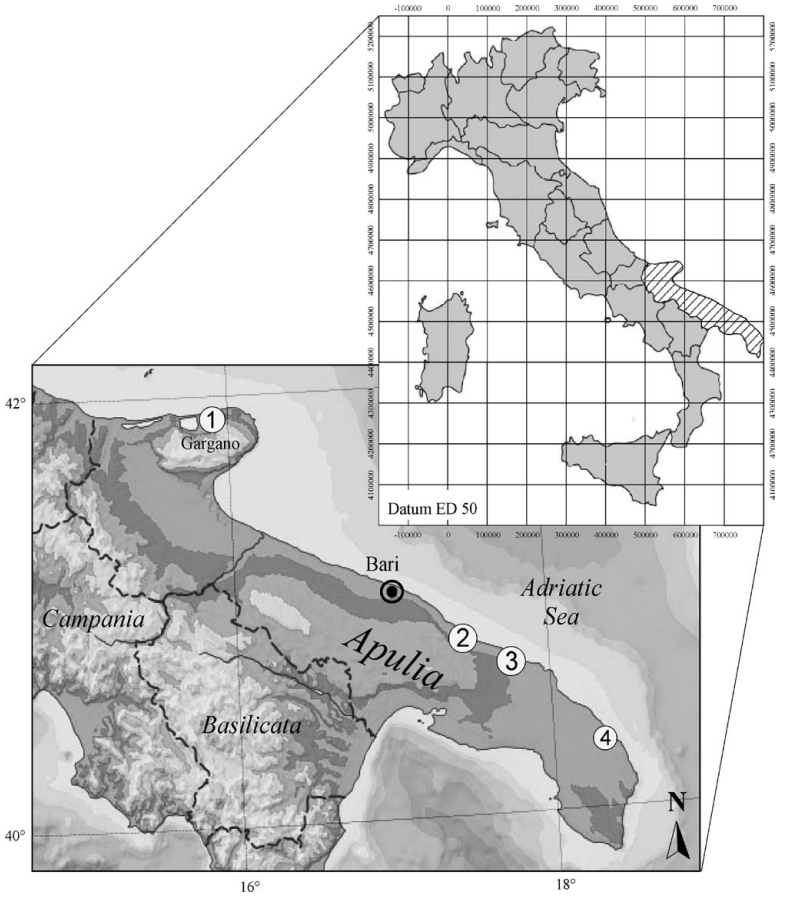


**Fig. 1.** Geographical position of olive groves surveyed (1: Vico del Gargano; 2: Fasano; 3: Carovigno; 4: Vernole).

**Gargano National Park** (Vico del Gargano, province of Foggia), the **Dune Costiere tra Torre Canne e Torre San Leonardo Park** (Fasano, province of Brindisi), the **Torre Guaceto State Natural Reserve and Marine Natural Reserve** (Carovigno, province of Brindisi), the **Le Cesine State Natural Reserve** (Vernole, province of Lecce) (Fig. 1). The olive trees in the National Park of Gargano are located on a steep slope by the shore; the olive trees in the **Park of Dune Costiere** are located on the bottom of a ephemeral river and are managed according to organic farming principles; the olive orchards of the **Natural Reserve of Torre Guaceto** are located on flattish land, managed according to organic farming methods; finally the olive trees in the Natural Reserve Le Cesine, traditionally grown, are contiguous to an ephemeral pond and to a stand of *Pinus halepensis* Miller, the reforestation dating back to the early years of the last century. Each olive grove has only few olive trees per hectare, although never less than 48 plants, and is extensively managed. The low impact tillage practices and the presence of man-made and natural infrastructure features, such as dry stone walls, hedgerows, natural patches and trees and shrubs on the field edges, are compatible with an almost permanent gra-

ss cover and do not impede the natural dissemination of the species present, and therefore indigenous plant species have been able to evolve in quite stable plant communities. As a result of such „traditional" management the selected olive groves present common features although each of them shows its own peculiarities from an ecological point of view.

## METHODS

The present study was planned and carried out from 2009 to 2012, in the framework of the Project: LIFE+ Cent.Oli.Med. (LIFE07 NAT/IT000450), for which the protection and sustainable management of biodiversity is of paramount importance for the achievement of the Millennium Development Goals (MDG).

The list of species was built up step by step, on the basis of the several surveys made for floristic analysis and for the evaluation of the level of biodiversity.

Plant analysis was focused on the fields and on the ecological infrastructures. Species were determined according to Tutin *et al*. (1964-80) and Pignatti (1982). Taxa nomenclature follows Conti *et al*., (2005) and subsequent integration (Conti *et al*., 2007), except for the genus *Aegilops* L., for *Taraxacum* Weber and *Thymbra capitata* (L.) Cav. for which van Slageren (1994), Pignatti (1982) and Morales Valverde (1987) were adopted, respectively. The systematics of the families and their arrangement was made according to Smith *et al*. (2006) for the vascular cryptogams megaphylls; according to Haston *et al*. (2007; 2009) for the angiosperms; while for the boundaries, the criteria proposed by Angiosperm Phylogeny Group (Stevens, 2008; APG III, 2009) where taken into consideration. The biological forms and the chorology were named according to Raunkiear (1934). Taxa are listed in alphabetical order and grouped into families according to Pignatti (1982). For species of conservation interest, abbreviations to indicate their vulnerability were used, i.e. **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 at national and/or regional level; (*) common to the four selected and explored olive groves.

In the case of non-native species additional information is indicated by the following categories: *archaeophyte* (non-native plant species introduced before 1492, i.e. before the era of European colonialism that followed the discovery of America. Conventionally this date is approximated to 1500); *neophyte* (non-native plant species introduced after 1492, i.e. conventionally after 1500, no more observed after 1950); *naturalized* or *stabilized* (non-native species that form stable populations independent of the contribution of new propagules by man); *invasive* (a subset of naturalized species that spread quickly even at a considerable distances from the original sources of propagules); *fortuitous* or *casual* (non-native species that grow and reproduce spontaneously but do not form stable populations and depend on a continuous supply of new propagules provided by man) (Celesti Grapow *et al*., 2010).

The abbreviations related to the biological forms and chorotypes are reported in the *Appendix*. 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 & Blasi, 2009) are provided only for taxa of conservation interest.

## RESULTS AND DISCUSSION

In all, 408 taxa were recorded, including 332 species, 73 subspecies and 3 cultivated varieties (cultivars), belonging to 275 genera and 74 families of vascular flora (Tab. 1). 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, comprise the remaining 264 taxa.

**Tab. 1.** Species by family in fields and ecological infrastructures, merged and separately. (1) indicates the presence of one species, counted in „Others".

| FAMILY | TAXA | | | | | |
|---|---|---|---|---|---|---|
| | FIELDS & 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 |

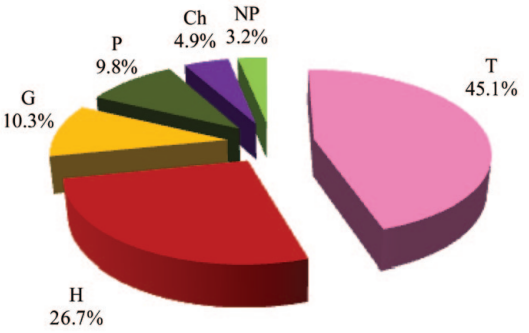


**Fig. 2.** Life forms in fields and ecological infrasctructures. Ch - chamaephytes; G - geophytes; H - hemicryptophytes; NP - nanophanerophytes; P - phanerophytes; T - therophytes.

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

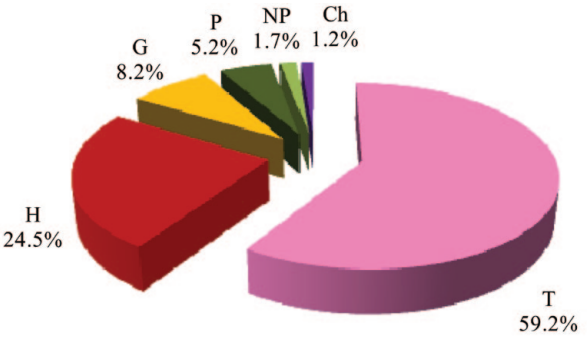


**Fig. 3**. Life forms in the fields. Ch - chamaephytes; G - geophytes; H - hemicryptophytes; NP - nanophanerophytes; P - phanerophytes; T - therophytes.

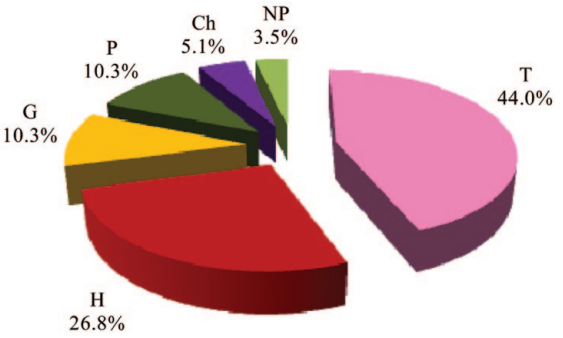


**Fig. 4**. Life forms in the ecological infrasctructures. Ch - chamaephytes; G - geophytes; H - hemicryptophytes; NP - nanophanerophytes; P - phanerophytes; T - therophytes.

changes (Raunkiaer, 1934). *Therophytes* are followed by *hemicryptophytes* (H) with 26.7%, while *geophytes* (G) and *phanerophytes* (P) occur 10.3% and 9.8% respectively. The occurrence of the other life forms, such as *chamaephytes* (Ch) and *nanophanerophytes* (NP), 4.9% and 3.2% respectively, is very low. 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%), but in the last the *therophytes* drop significantly to 15.2% in favour of perennial species (H, P, G, Ch, NP). In fact, in seminatural environments, perennial species have a competitive advantage over some species of *therophytes* and altogether increase from 40.8% to 56.0%.

The *Poaceae* and *Fabaceae* are slightly more abundant in the fields (25.6%) than in the ecological infrastructures (22.8%). This relatively small difference (2.8%) between the two areas surveyed, may be explained by assuming that the flora of ecological infrastructures may be influenced more by the flora growing in the natural neighboring habitats.

With a future perspective of making a comparison among olive groves in different areas of the Mediterranean basin (Southern Italy, the Mediterranean coasts of Spain, Southern Balkan Peninsula, Balearic Islands, Crete and Cyprus, etc.), it has been suggested that a key should be provided to simplify the geographical distribution of 32 Me-

**Tab. 2.** Mediterranean corotypes used and correspondence with Pignatti (1982) geoelements (adapted from Perrino *et al.*, 2011).

| ACRONYMS | COROTYPES | |
|---|---|---|
| | (Pignatti, 1982) | USED IN THIS WORK |
| Me | Euri-Mediterranean s.s. | Euri-Mediterranean |
| Ms | Steno-Mediterranean s.s. | Steno-Mediterranean |
| Ma | Mediterranean atlantic | Atlantic Mediterranean range |
| Masb | Mediterranean sub-atlantic | |
| Mea | Euri-Mediterranean atlantic | |
| Meas | Euri-Mediterranean sub-atlantic | |
| Msa | Steno-Mediterranean atlantic | |
| Mem | Euri-Mediterranean macaronesian | Macaronesian Mediterranean range |
| Mmc | Mediterranean macaronesian | |
| Mmms | Mediterranean south-macaronesian | |
| Msm | Steno-Mediterranean macaronesian | |
| Mes | Mediterranean eastern | Eastern Mediterranean range |
| Mess | Euri-Mediterrranean south-siberian | |
| Mse | Steno-Mediterranean eastern | |
| Mst | Steno-Mediterranean turanian | |
| Mece | Mediterranean centre-eastern | |
| Mmne | Mediterranean mountain north-eastern | |
| Mne | Mediterranean north-eastern | |
| Met | Euri-Mediterranean turanian | |
| Mts | Mediterranean south-turanian | |
| Mt | Mediterranean turanian | |
| Men | Mediterranean northern | Northern Mediterranean range |
| Mn | Steno-Mediterranean northern | |
| Msn | Euri-Mediterranean northern | |
| Menp | Euri-Mediterranean northern-pontic | |
| Msd | Mediterranean southern | Southern Mediterranean range |
| Msdw | Mediterranean south-western | |
| Mss | Steno-Mediterranean southern | |
| Mmw | Mediterranean-mountain western | Western Mediterranean range |
| Mssw | Steno-Mediterranean south-western | |
| Msw | Steno-Mediterranean western | |
| Mw | Mediterranean western | |
| Omw | Orophil-Mediterranean western | |
| Mm | Mediterranean mountain s.s. | Mediterranean Mountain |

diterranean geoelements identified by the following nine chorological types: Medit.-Mountain, Medit.-Macaronesian range, Medit.-Southern range, Medit.-Northern range, Medit.-Eastern range, Medit.-Western range, Medit.-Atlantic range, Euri-Mediterranean and Steno-Mediterranean (Tab. 2). In particular, the Steno-Mediterranean types are the Mediterranean types in the strict sense the range of which does not go over the northern limit of diffusion of the olive trees, while the Euri-Mediterranean types are included within the area of the grapevine (*Vitis vinifera* L.) and therefore they extend to the southern part of Central Europe (Ubaldi, 2003). The Mediterranean-Atlantic are Euri-Mediterranean types, generally mountane ones, whose areal also includes the Atlantic Europe regions. It is possible to distinguish the „Circum-Mediterranean" (distributed around the Mediterranean) types that can be Steno- or Euri-Mediterranean ones and may have predominantly southern distribution (Medit.-Southern), northern distribution (Medit.-Northern), eastern distribution (Medit.-Eastern) or western distribution (Medit.-Western).

The chorological spectrum (Tab. 3) shows that the Mediterranean stock (see sub-total) is well represented (61.5%) and that it is notably higher than that known for Apulia flora (52.0%) (Marchiori *et al*., 2000). It shows also that the presence of the Mediterranean stock in the fields (59.7%) is slightly different from that in the ecological infrastructure (61.9%). In particular, the Steno-Mediterranean types in the ecological infrastructure are slightly higher (23.1%) than those in the fields (20.1%), while the Euri-Mediterranean types are slightly prevaling in the fields (21.8%) than in the ecological infrastructures (19.6%). In any case, both types show percentages always higher than 19.0%, this means that, on average, Steno-Mediterranean types (21.8% of all species) and Euri-Mediterranean types (20.1% of all species) represent about 1/3 of all the Mediterranean types (61.5% of all species).

Taking into consideration the other chorotypes, the most prevalent species are those with wider distribution (14.6% of the total species recorded), their percentage being higher in the fields (21.0%) than in the ecological infrastructures (14.2%). Other chorotypes less present but still worthy of consideration, both in the fields and in the ecological infrastructures, are the Paleotemperate (4.7%) and the Eurasiatic (4.5%) ones. Their percentages change very little or not at all when the fields (from 4.8% to 4.4% respectively) or the ecological infrastructures (from 4.6% to 4.3%) are considered. The following eight categorized chorotypes (Pontic, Eurosiberian, European s.l., Amphi-Adriatic, Endemic, Paleo-Subtropical, Subtropical and Neotropical nat.) show variable percentages going from 0.0-0.4% (occurring for Pontic and Neotropical nat. respectively) in the fields, to a maximum of 4.0% (as for European s.l.) in ecological infrastructures. It worth to note that the European entities range from 1.7% in the fields to 4.0% in the ecological infrastructures. Pontic, Eurosiberian, European s.l., Amphi-Adriatic, Endemic, Paleo-Subtropical, Subtropical and Neotropical types are individually present in very low percentage, but considered as a group they are more present (19.4%) than the species having wider distribution that, when computing together the fields and in the ecological infrastructures, reach only the 14.6%. The just mentioned group is more present in the ecological infrastructures (19.6%) than in the fields (16.2%). The remaining chorotypes reported in the table as „others", appear to be more present in the ecological infrastructures (4.3%) than in the fields (3.1%).

The percentage of the Eastern Mediterranean (6.5%) and Pontic (0.5%) types for both 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 that of the Eastern

**Tab. 3.** Chorological spectrum by fields and ecological infrasctructures, merged and separated. Percentages and number of taxa. It was not possible to fit five of the taxa in a chorotype.

| CHOROTYPE | FIELDS & ECOLOGICAL INFRASTRUCTURES | | FIELDS | | ECOLOGICAL INFRASTRUCTURES | |
|---|---|---|---|---|---|---|
| | % | n° | % | n° | % | n° |
| Steno-Mediterranean | 21.8 | 88 | 20.1 | 46 | 23.1 | 86 |
| Euri-Mediterranean | 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 |
| Amphi-Adriatic | 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** |

Mediterranean basin (Perrino *et al*., 2011), the primary center of origin of the olive tree (Acerbo, 1937; Zohary, 1973; Schäfer-Schuchardt, 1988; Guerci, 2005).

The chorological analysis shows that the olive orchards are agro-ecosystems with a strong Mediterranean characterization and that this characteristic becomes weaker in

the cultivated part of the fields, where species with a wider distribution prevail. This confirms the results achieved in the course of the biological analysis.

In the course of the analysis of such olive groves only twelve non-native species (Celesti-Grapow *et al*., 2010) were found (Tab. 4). *Morus alba* L. and *Opuntia ficus-indica* (L.) Miller were present on the field margins as they were planted by farmers in past years. The first one was introduced before 1500 B.c. and it is a fortuitous species depending on man to be able to form populations. The second, introduced in a more recent period, is considered invasive but its abundance in the agricultural areas is controlled by man. another fortuitous species introduced since ancient time and found in the olive groves is *Raphanus sativus* L. Some other species were found in agricultural areas as a consequence of cultivation and agricultural practices, in particular *Amaranthus retroflexsus* L., *Arundo donax* L., *Chamaesyce maculata* (L.) Small, *Erigeron canadensis* L., *Oxalis pes-caprae* L., *Sorghum halepense* (L.) Pers., *Symphyotrichum squamatum* (Spreng.) G.L. Nesom, which are considered invasive and *Xanthium spinosum* L. which is naturalized. It may be worth noting the occasional presence of *Phacelia tanacetifolia* Benth., recently introduced in our fields and not commonly observed in Apulia. Although 8 out 12 of these non-native species are reported as invasive their presence in terms of abundance was not important, probably because of the low impact exerted by traditional management practices on the overall natural biodiversity of such particular areas, which help in controlling their spread.

## Analysis of taxa of conservation interest

The results show the presence of 18 critical taxa: three of those are at risk (Conti *et al*., 1997; Perrino & Wagensommer, 2012), four are endemic, and the others are rare or important for different reasons at regional and/or national level.

**Tab. 4.** Non-native species found in the olive groves.

| TAXON | INTRODUCTION | STATUS IN APULIA REGION |
|---|---|---|
| *Amaranthus retroflexus* L. | Neophyte | Invasive |
| *Arundo donax* L. | Archeophyte | Invasive |
| *Chamaesyce maculata* (L.) Small | Neophyte | Invasive |
| *Erigeron canadensis* L. | Neophyte | Invasive |
| *Morus alba* L. | Archeophyte | Fortuitous |
| *Opuntia ficus-indica* (L.) Miller | Neophyte | Invasive |
| *Oxalis pes-caprae* L. | Neophyte | Invasive |
| *Phacelia tanacetifolia* Benth. | Neophyte | – |
| *Raphanus sativus* L. | Archeophyte | Fortuitous |
| *Sorghum halepense* (L.) Pers. | Archeophyte | Invasive |
| *Symphyotrichum squamatum* (Spreng.) G. L. Nesom | Neophyte | Invasive |
| *Xanthium spinosum* L. | Neophyte | Naturalized |

***Aegilops uniaristata* Vis. [Ad, VU]**

GPS: N4641298, E578448; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 29 m a.s.l.; 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 & 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 & Wagensommer, 2012) and as at risk of extinction in the Atlas of Species (Scoppola & 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* (L.) Janch. subsp. *limonifolium* [Ad, PI, NT]**

GPS: N4641293, E578442; Place: Fasano (Brindisi); Plant community: garigues; altitude: 31 m a.s.l.; 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 & Sarfatti, 1961; Cavallaro *et al*., 2007; Perrino & Signorile, 2009) and Polignano a Mare (Perrino & Signorile, 2010; Vita & 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 correspondence of these populations with those of Greece and Turkey. The observed population consists of a few individuals. In Apulia, the taxon is considered Near Threatened (Perrino *et al*., 2012).

***Barlia robertiana* (Loisel.) Greuter [CI]**

GPS: N4641171, E578340; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer & Preising ex Rochow 1951); altitude: 214 m a.s.l.; 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* Greuter [I]**

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

***Crepis corymbosa* Ten. [I]**

GPS: N4519987, E710627; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 34 m a.s.l.; 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 meadows and, more rarely, within the scrubland communities. The fruit (achene) of this species can be easily confused with those of other species of the same genus.

***Cyclamen hederifolium* Aiton [CI]**

GPS: N4641079, E578410; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer & Preising ex Rochow 1951); altitude: 224 m a.s.l.; Habitat 92/43/EEC: not identified. A species common in all of the Italian Regions, included in the CITES list. A cew observed individuals spreading from nearby woods.

***Epilobium parviflorum* Schreb. [r]**

GPS: N4473077, E782136; Place: Le Cesine (Vernole - Lecce); Plant community: humid grasslands; altitude: 6 m a.s.l.; Habitat 92/43/EEC: 6420 „*Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion*". It is a widely distributed (Paleotemperate) taxon, rare in Italy. It grows in muddy wet habitats, such as Le Cesine olive grove, where it grows on the vegetation marging, between the wetland and the field.

***Erica forskalii* Vitm. [VU]**

GPS: N4472988, E782234; Place: Le Cesine (Vernole - Lecce); Plant community: garigue; altitude: 7 m a.s.l.; 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* Parl. [VU]**

GPS: N4520081, E710649; Place: Fasano (Brindisi); Plant community: annual meadow (*Brachypodietalia distachyi* Rivas-Martínez 1978); altitude: 31 m a.s.l.; 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; Peruzzi *et al*., 2012). In Italy it has been found in central and southern regions (Conti *et al*., 2005; Peruzzi & Gargano, 2005; Conti *et al*., 2007). It is included in the Red Regional List of Apulia and Sicily, with the status of vulnerable (VU), while in Abruzzo, Marche, Molise and Basilicata it is at lower risk (LR). Few individuals were found in an annual meadow.

***Gagea mauritanica* Durieu [CR]**

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

***Helianthemum jonium* Lacaita [I]**

GPS: N4520146, E710764; Place: Fasano (Brindisi); Plant community: garigue (*Helianthemum jonii-Fumanetum thymifoliae* Taffetani & Biondi 1992); altitude: 30 m a.s.l.; 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. garigue. In some cases, isolated individuals are found in scrub vegetation.

***Muscari parviflorum* Desf. [PI, r] (Fig. 5)**

GPS: N4509660, E645633; Place: Torre Guaceto (Carovigno - Brindisi); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer & Preising ex Rochow 1951); altitude: 27 m a.s.l.; 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* Bianca [CI]**

GPS: N4520177, E710787; Place: Fasano (Brindisi); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer & Preising ex Rochow 1951); altitude: 28 m a.s.l.; 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] (Fig. 6)**

GPS: N4473078, E782160; Place: Le Cesine (Vernole - Lecce); Plant community: humid grasslands; altitude: 6 m a.s.l.; Habitat 92/43/EEC: 6420 „*Mediterranean tall humid herb grasslands of the Molinio-Holoschoenion*". Euroasiatic species (if it includes *O. elegans*) or Euri-Mediterranean (if it includes *O. palustris* s.s.) (Alessandrini & 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* Huds. [CI]**

GPS: N4641017, E578387; Place: Vico del Gargano (Foggia); Plant community: uncultivated community (*Stellarietea mediae* R. Tüxen, Lohmeyer & Preising ex Rochow 1951) and scrub vegetation (*Oleo-Ceratonion siliquae* Br.-Bl. 1936 em. Rivas Martínez 1975); altitude: 240 m a.s.l.; 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 countryside woman (with a hat and wide skirt) and is called the lady orchid.

***Satureja cuneifolia* Ten. [PI]**

GPS: N4520145, E710764; Place: Fasano (Brindisi); Plant community: garigue (*Cisto-Ericion* Horvatić 1958); altitude: 29 m a.s.l.; Habitat 92/43/EEC: not identified. Amphi-Adriatic (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* L. [Ad, PI]**

GPS: N4520019, E710650; Place: Fasano (Brindisi); Plant community: rocky slopes (*Campanulion versicoloris* Quezel 1964); altitude: 34 m a.s.l.; Habitat 92/43/EEC: 8210 „*Calcareous rocky slopes with chasmophytic vegetation*". It is a casmophyte of Amphi-Adriatic 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* Martinovský subsp. *austroitalica* [I, B, DH]**

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

## FLORISTIC LIST

### *POLYPODIIDAE*

*DENNSTAEDTIACEAE*

*Pteridium aquilinum* (L.) Kuhn subsp. *aquilinum* - G - C

*PTERIDACEAE*

*Adiantum capillus-veneris* L. - G - Pn

*ASPLENIACEAE*

*Ceterach officinarum* Willd. - H - Ese

### *PINIDAE*

*PINACEAE*

*Pinus halepensis* Miller - P - Ms

### *MAGNOLIIDAE*

*LAURACEAE*

*Laurus nobilis* L. - P - Ms

*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
*Hermodactylus tuberosus* (L.) Mill. - G - Msn
*Romulea columnae* Sebast. & Mauri - G - Ms

*XANTHORRHOEACEAE*
*Asphodelus fistulosus* L. - H - Tpsp
*Asphodelus ramosus* L. subsp. *ramosus* - G - Ms

*AMARYLLIDACEAE*
*Allium ampeloprasum* L. - G - Me
**Allium roseum* L. - G - Ms
*Allium subhirsutum* L. - G - Ms
*Allium trifoliatum* Cirillo - G - Mse

*ASPARAGACEAE*
**Asparagus acutifolius* L. - NP - Ms
*Charybdis pancration* (Steinh.) Speta - G - Msm
*Loncomelos narbonensis* (Torm. in L.) Raf. - G - Me
*Muscari commutatum* Guss. - G - Mece
*Muscari comosum* (L.) Mill. - G - Me
*Muscari neglectum* Guss. ex Ten.- G - Me
*Muscari parviflorum* Desf. - G - Mece - **PI** - **r**
*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. & Schult. - T - Cs

*POACEAE*
*Achnatherum bromoides* (L.) P. Beauv. - H - Ms
*Aegilops ovata* Auct. - T - Mst
*Aegilops uniaristata* Vis. - T - **Ad** - **VU**
*Agrostis stolonifera* L. - H - Cb
*Aira caryophyllea* L. subsp. *caryophyllea* - T - Tps
*Arundo donax* L. - G - Cs - *archaeophyte invasive*
*Arundo plinii* Turra - G - Ms
**Avena barbata* Pott. ex Link - T - Me
*Avena sativa* L. - T
*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
*Digitaria sanguinalis* (L.) Scop. - T - Cs
*Hordeum murinum* L. - T - Cb
*Hordeum murinum* L. subsp. *leporinum* (Link) Arcang. - T - Cb
*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
*Piptatherum miliaceum* (L.) Coss. subsp. *thomasii* (Duby) Freitag - H - Ms
*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 - *archaeophyte invasive*
*Stipa austroitalica* Martinovský subsp. *austroitalica* - H - **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
*Bituminaria bituminosa* (L.) C.H. Stirt. - H - Me
*Calicotome villosa* (Poir.) Link - P - Ms
*Ceratonia siliqua* L. - P - Mss
*Coronilla scorpioides* (L.) W.D.J. Koch - T - Me
*Dorycnium hirsutum* (L.) Ser. - Ch - Me
*Emerus major* Mill. subsp. *emeroides* (Boiss. & Spruner) Soldano & F. Conti - NP
*Hippocrepis ciliata* Willd. - T - Ms
*Lathyrus cicera* L. - T - Me
*Lathyrus ochrus* (L.) DC. - T - Ms
*Lathyrus sylvestris* L. subsp. *sylvestris* - H - E
*Lotus corniculatus* L. - H - C
*Lotus edulis* L. - T - Ms
*Lotus ornithopodioides* L. - T - Ms
*Lupinus cosentinii* Guss. - T - Mw
*Medicago arabica* (L.) Huds. - T - Mw
*Medicago minima* L. - T - Tscm
*Medicago orbicularis* (L.) Bartal. - T - Me
*Medicago polymorpha* L. - T - Me
*Medicago truncatula* Gaertn. - T - Ms
**Melilotus sulcata* Desf. - T - Msd
*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 & H. Ohashi - T - Msw
*Tetragonolobus purpureus* Moench - T - Ms
*Trifolium campestre* Schreb. - T - Mmpw
*Trifolium lappaceum* L. - T - Me
*Trifolium pratense* L. - T - Cs
*Trifolium resupinatum* L. - T - Tmp
*Trifolium scabrum* L. subsp. *scabrum* - T - Me
*Trifolium squarrosum* L. - T - Me
*Trifolium stellatum* L. - T - Me

*Trifolium tomentosum* L. - T - Tmp
*Trigonella monspeliaca* L. - T - Me
*Vicia hybrida* L. - T - Me
*Vicia lutea* L. - T - Me
*Vicia sativa* L. - T - Cs
*Vicia sativa* L. subsp. *macrocarpa* (Moris) Arcang. - T - Cs
*Vicia villosa* Roth. - T - Me

*ROSACEAE*
*Geum urbanum* L. - H - Cb
*Mespilus germanica* L. - P - Esp
*Prunus avium* L. subsp. *avium* - P - P
*Prunus dulcis* Miller D.A. Webb - P - Msd
*Pyrus spinosa* Forssk. - P - Ms
*Rosa sempervirens* L. - NP - Ms
*Rubus canescens* DC. - NP - Men
**Rubus ulmifolius* Schott - NP - Me
*Sanguisorba minor* Scop. - H - Tmp

*RHAMNACEAE*
*Paliurus spina-christi* Miller - P - Ese
*Rhamnus alaternus* L. subsp. *alaternus* - P - Me

*MORACEAE*
*Ficus carica* L. - P - Mt
*Morus alba* L. - P - Ase - *archaeophyte fortuitous*

*URTICACEAE*
*Mercurialis annua* L. - T - Tmp
*Parietaria judaica* L. - H - Mem
*Urtica dioica* L. subsp. *dioica* - H - Cs
*Urtica urens* L. - T - Cs

*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

*BETULACEAE*
*Ostrya carpinifolia* Scop. - P - P

*OXALIDACEAE*
**Oxalis pes-caprae* L. - G - Afs - *neophyte invasive*

*EUPHORBIACEAE*
*Chamaesyce maculata* (L.) Small - T - An - *neophyte invasive*
*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

*Linum strictum* L. - T - Ms

*HYPERICACEAE*

*Hypericum perforatum* L. - H - Tmp

*Hypericum triquetrifolium* Turra - H - Mse

*GERANIACEAE*

*Erodium cicutarium* (L.) L'Her - 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

*ANACARDIACEAE*

*Pistacia lentiscus* L. - P - Mss

*Pistacia terebinthus* L. subsp. *terebinthus* - P - Me

*RUTACEAE*

*Citrus aurantium* L. - P - Cn

*Citrus limon* (L.) Burm. f. cultivar *femminello* - P - Hi

*Citrus sinensis* (L.) Osbeck cultivar *biondo comune del Gargano* - P - Cn

*Citrus sinensis* (L.) Osbeck cultivar *duretta del Gargano* - P - Cn

*Ruta chalepensis* L. - Ch - Mss

*MALVACEAE*

*Althaea hirsuta* L. - T - Me

*Malva cretica* Cav. - T - Ms

*Malva sylvestris* L. subsp. *sylvestris* - H - Esb

*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**

*Helianthemum salicifolium* (L.) Mill. - T - Me

*RESEDACEAE*
*Reseda alba* L. - T - Ms
*CAPPARACEAE*
*Capparis spinosa* L. - Np - Ea
*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
*Diplotaxis tenuifolia* (L.) DC. - H - Masb
*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 - *archaeophyte fortuitous*
*Raphanus sativus* L. - T
*Rapistrum rugosum* (L.) Arcang. - T - Me
*Sinapis alba* L. - T - Mes
*Sinapis arvensis* L. subsp. *arvensis* - T - Ms
*Sisymbrium irio* L. - T - Tm
*Thlaspi arvense* L. - T - Asw
*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. & Spruner) Graebn. - Ch - Me
*Petrorhagia dubia* (Raf.) G. Lopez & Romo - G - Msd
*Petrorhagia prolifera* (L.) P.W. Ball. & Heywood - T - Me
*Petrorhagia saxifraga* (L.) Link subsp. *gasparrinii* (Guss.) Greuter & 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 - *neophyte invasive*
*Beta vulgaris* L. - H - Me
*Chenopodium hybridum* L. - T - Cb
*PORTULACACEAE*

*Portulaca oleracea* L. subsp. *oleracea* - T - Cs

*CACTACEAE*

*Opuntia ficus-indica* (L.) Miller - P - Nen - *neophyte invasive*

*ERICACEAE*

*Erica forskalii* Vitm. - Ch/NP - Mes - **VU**

*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
*Buglossoides arvensis* (L.) I. M. Johnst. - T - Me
*Buglossoides purpureocaerulea* (L.) I.M. Johnst. - H - Esp
**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 - *neophyte*

*CONVOLVULACEAE*

*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

*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
*Clinopodium vulgare* L. - H - Cb
*Lamium amplexicaule* L. - T - Tmp
*Lycopus europaeus* L. - H - Cb
*Marrubium vulgare* L. - H - Cs
*Micromeria graeca* (L.) Benth. ex Rchb. subsp. *graeca* - Ch - Ms
*Origanum vulgare* L. subsp. *viridulum* (Martin-Donos) Nyman - H - Ea
*Prasium majus* L. - Ch - Ms
*Rosmarinus officinalis* L. - NP - Ms
*Salvia verbenaca* L. - H - Msa
*Satureja cuneifolia* Ten. - Ch - Msn - **PI**
*Satureja montana* L. - Ch - Omw
*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

*OROBANCHACEAE*

*Bartsia trixago* L. - T - Me
*Parentucellia latifolia* (L.) Caruel - T - Me
*Parentucellia viscosa* (L.) Caruel - T - Mea

*ACANTHACEAE*
*Acanthus spinosus* L. - H - Mse

*VERBENACEAE*
*Verbena officinalis* L. - H - C

*CAMPANULACEAE*
*Asyneuma limonifolium* (L.) Janch. subsp. *limonifolium* - H - Ad - PI - NT
*Legousia hybrida* (L.) Delarbre - T - Ma
*Legousia speculum-veneris* (L.) Chaix - T - Me

*ASTERACEAE*
*Achillea millefolium* L. - H - Esb
**Anthemis arvensis* L. - T/H - Cs
*Bellis annua* L. subsp. *annua* - T - Msm
*Bellis sylvestris* Cirillo - H - Ms
**Calendula arvensis* (Vaill.) L. - T - Me
*Calendula officinalis* L. - T/H
*Carduus pycnocephalus* L. subsp. *pycnocephalus* - H - Mt
*Carlina corymbosa* L. - H - Ms
*Centaurea nicaeensis* All. - H - Mssw
*Chondrilla juncea* L. - H - Me
*Cichorium intybus* L. - H - Tmp
*Cirsium arvense* (L.) Scop. - G - Ea
*Cota tinctoria* (L.) J. Gay - H/Ch - Ecp
*Crepis brulla* Greuter - T - **I**
*Crepis corymbosa* Ten. - T - **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. - *neophyte invasive*
*Eupatorium cannabinum* L. - H - Tmp
*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
*Leontodon crispus* Vill. subsp. *crispus* - H - Es
*Leontodon hispidus* L. - H - Eca
*Leontodon tuberosus* L. - H - Ms
*Matricaria chamomilla* L. - T - Cs
*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
*Rhagadiolus stellatus* (L.) Gaertn. - T - Me
*Senecio leucanthemifolius* Poir. subsp. *leucanthemifolius* - T - Ms
*Senecio vulgaris* L. - T - C
*Sonchus asper* (L.) Hill - T - Ea
**Sonchus oleraceus* L. - T - Ea
*Sonchus tenerrimus* L. -T - Ms
*Symphyotrichum squamatum* (Spreng.) G. L. Nesom - T/H - Nen - *neophyte invasive*
*Taraxacum officinale* Weber - H - Cb
*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
*Xanthium spinosum* L. - T - Ams - *neophyte naturalized*

*ADOXACEAE*
*Sambucus nigra* L. - P - Eca
*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 & Burdet ssp. *grandiflora* (Scop.) Sold. & Conti - H - Ms
*Valerianella muricata* (Stev. ex M. Bieb.) J.W. Loudon - T - Ms

*ARALIACEAE*
*Hedera helix* L. subsp. *helix* - P - Meas

*APIACEAE*
*Ammoides pusilla* (Brot.) Breistr. - T - Ms
**Daucus carota* L. subsp. *carota* - H - Cs
*Eryngium campestre* L. - H - Me
*Foeniculum vulgare* Miller - H - Msd
**Scandix pecten-veneris* L. - T - Cs
*Smyrnium olusatrum* L. - H - Ma
*Tordylium apulum* L. - T - Ms
*Tordylium officinale* L. - T - Mne
*Torilis arvensis* (Huds.) Link - T - Cs

## CONCLUSION

The vulnerability of the agro-ecosystems of olive groves was already pointed out in a previous paper (Perrino *et al.*, 2011). The results of the present study provide further information that can help to improve conservation and management of plant biodiver-

**Fig. 5**. *Muscari parviflorum* Desf. in the olive grove of Torre Guaceto.

**Fig. 6.** *Orchis palustris* Jacq. in the olive grove of Le Cesine.

sity and especially of plant species at risk and/or having a conservation interest that found their niches in olive groves. So ancient olive trees are important not only for the beautiful landscape they form, for olive production, efficient carbon dioxide sequestration and for their ability to face climatic changes, but also because the groves in which they grow conserve entire agro-ecosystems, in which several endangered plant, animal and microbial species may survive and provide speciation, adaptation, evolution and development. Studying the flora of olive groves will enable us to build a database capable of providing a tool for improved conservation of agro-biodiversity as an expression of such agro-ecosystems. Greater agro-biodiversity will improve conservation of endangered plant species and/or of species of conservation interest that due to high anthropic pressures appear to be at high risk of extinction (18 taxa). Information for understanding

how critical the risk is, and, to some extent, for taking actions for an adequate protection, conservation and management have been pointed out.

These data suggest that there is need to extend the study to other olive groves of Apulia, to other regions of Italy and to the Mediterranean basin, in order to have a more comprehensive picture of the vascular flora and further to improve our knowledge of olive grove agro-ecosystems. Appropriate planning and sustainable management of olive groves would help in meeting both the economic and social objectives of olive production while achieving a proper conservation of the related ecosystems.

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# APPENDIX

## Abbreviations of biological forms and chorologic types

*Biological forms*. Ch - chamaephytes; P - phanerophytes; G - geophytes; H - hemicryptophytes; NP - nanophanerophytes; T - therophytes.

*Chorologic types.* A - Atlantic; Ad - Amphi-Adriatic; 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 - Euri-Medit.; Mea - Euri-Medit.-Atlantic; Meas - Euri-Medit.-Subatlantic; Mec - central-Medit.; Mece - centre-eastern Medit.; Mecw - central-Medit. western; Mem - Euri-Medit.-Macaronesian; Menp - northern Euromedit.-Pontic; Mess - Euri-Medit. southern-Siberian; Met - Euri-Medit.-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 - Steno-Medit.; Msa - Steno-Medit.-Atlantic; Msd - southern Medit.; Msde - south-eastern Medit.; Msdw - south-western Medit.; Mse - eastern Steno-Medit.; Msm - Steno-Medit.-Macaronesian; Msn - northern Steno-Medit.; Msp - Steno-Medit. Pontic; Mss - southern Steno-Medit.; Mssw - south-western Steno-Medit.; Mst - Steno-Medit.-Turanian; Msw - western Steno-Medit.; 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.