Spiders (Araneae) of olive groves and adjacent semi-natural habitats from central Italy

Malayka Samantha Picchi

Abstract. In the Monte Pisano area (Tuscany, central Italy), spiders were collected within two research projects during three years (2010, 2013, 2014). Olive groves and adjacent semi-natural habitats (wood and Mediterranean garrigue) were investigated with three sampling methods (pitfall trapping, beating at branches and hand collection in the canopy). A total of 148 species was identified. The ground spider (Gnaphosidae) Zelotes fulvaster (Simon, 1878) was recorded for the first time in Italy.

Keywords: canepigeon, Mediterranean garrigue, Monte Pisano, wood, Zelotes fulvaster

Material and methods

The research projects were carried out in the years 2010, 2013 and 2014 in the mountain formation of Monte Pisano (about 16000 ha; Bertacchi et al. 2004), between the cities of Pisa and Lucca in the north-west of Tuscany (Italy, highest peak 916 m a.s.l.; Figg. 1), and used different sampling techniques in olive groves and adjacent semi-natural habitats. This area is well suited for olive oil production, in which orchards are traditionally managed with low input practices and where they can be arranged in rain-fed terraces. The climate is typically Mediterranean, with a mean annual temperature of 14.3°C with a dry and hot summer (Niccolai & Marchi 2005, Peel et al. 2007) and average annual precipitation of 1107 mm. Olive groves are placed in hilly landscapes, interspersed in patches of woods and Mediterranean garrigue.

Woods surrounding the olive groves were mainly formed from pine trees (Pinus pinaster Aiton), chestnuts (Castanea sativa Mill.) and oak species (mainly Quercus ilex L. and Q. pubescens Willd.), with associated understory vegetation, whereas Mediterranean garrigue was constituted mainly by shrubs and herbs typical of xerothermic habitats (Polunin & Walters 1985).

In 2010, six sites were sampled. Only ground-dwelling spiders in the olive groves were collected. At each of the six sites, eight pitfall traps with ethylene glycol were set in a transect. Traps were collected three times during summer, from 13 May to 15 Jul., and emptied every three weeks.

The case studies of 2013 and 2014 were part of the QuESA pan-European project (Holland et al. 2014). In addition, the adjacent semi-natural woods or shrublands were studied in their interior (in 2013) and at their edges with the olive groves (2013 and 2014).

In 2013, twelve olive groves bordering woody areas were studied (including some samplings in Mediterranean garrigue patches whose results are included here) and eighteen in 2014 next to patches of woods, shrublands or another olive orchard.

Spiders are widespread predators found in every terrestrial habitat, from the coast to the tops of mountains (Nyffeler & Birkhofer 2017). Italy, a country with a mosaic of landscapes, is extremely rich in spider species within the European Union (Nentwig et al. 2019). Italy also has a high rate of endemicity due to climatic, topographic and geological differences (European Environment Agency 2018). The latest version of the Italian spider checklist documents 1674 species (Pantini & Isaia 2019). The number of recently described new species shows that the knowledge of Italian spiders is still incomplete, especially in the central and southern part of the peninsula (Pantini pers. comm., May 2018). In order to facilitate conservation policies, research on Italian spiders should be encouraged (Franc 2000, Milano et al. 2017) – knowledge advancing through revisions, new descriptions and considering new national records or, at a closer scale, regional records.

In addition, spiders are still understated regarding their role in ecosystems, utility as indicators or potential role in reducing herbivores (Lang 2003, Symondson et al. 1998) like pests against the olive fruit fly Bactrocera oleae (Rossi, 1790) (Picchi et al. 2016, 2020).
Among the sites examined in 2014, five sampling sites were the same as in the previous year and one organic field was the same as in 2010.

In 2013, olive groves and adjacent semi-natural habitats were both sampled using pitfall traps with ethylene glycol for four days in three sampling periods in summer starting on 28. Jun., 20. Jul. and 20. Sep., all according to the protocol of the QuESSA project. Pitfall traps were placed pairwise, in two transects in each habitat, one transect was placed at the centre of the habitat, the other one at the edge.

In 2014, spiders were sampled four times from the canopy of olive trees starting from the edge towards the interior part at four distances, using two techniques: hand collecting of spiders, searching for 8 minutes in the branches and leaves, and a beating technique, both up to 1.5–2.0 m high. For each sampling point, four branches, one in each cardinal direction were beaten ten times and spiders were collected. Four samplings were done from summer to autumn (23. Jun., 22. Jul., 15. Sept. and 15. Oct.) in the daytime, following the life cycle phases of the olive fruit fly (Picchi et al. 2016). In addition, one more sampling point with the same approach as in Picchi et al. (2016) was selected at the margin of the olive groves, inside the adjacent semi-natural habitats (Picchi et al. 2020).

Spiders were mostly identified by the author; part of the spiders sampled in 2010 were identified by Marco Isaia while spiders of uncertain identity collected during the QuESSA project of 2013 were identified by Paolo Pantini. Spiders were identified using Italian and European keys (Roberts 1987, Trotta 2005), the online keys of Nentwig et al. (2019), and comparison with genital images by Oger (2019). Names follow current nomenclature in the World Spider Catalog (2020). Juveniles were assigned to a species only when they had clear characteristics or when an extremely high percentage of the adults of the respective genus were of only one species (Larivée & Buddle 2009). Individuals of the same species were pooled according to their habitat preference. Whenever possible, other individuals were identified to family level, but have not been considered in the lists proposed here. In addition, the lists indicate the microhabitat preference of the spiders if collected on the ground or in the canopy. Moreover, the chorotype (Tab. 2) was assigned to each species (Pantini & Isaia 2018).

Spiders are preserved in 70% alcohol and were deposited in the Department of Life Sciences and Systems Biology of the University of Turin, at the Natural Science Museum “E. Caffi” of Bergamo, and the Biolabs-Institute of Life Science of Sant’Anna School of Advanced Studies (Pisa). The new species record for Italy, Zelotes fulvaster (Simon, 1878), was identified by Paolo Pantini from the Natural Science Museum “E. Caffi” of Bergamo, where specimens of one female and one male are now stored.

**Tab. 1:** List of the sites sampled with coordinates and altitude (m a.s.l.). The table contains detailed information for each site: the microhabitat sampled (Ground: species collected by pitfall traps; canopy: species collected by hand or beating technique, the year of sampling (2010, 2013 and 2014) and the type of habitat (OL = olive groves; WA = woods; GA = Mediterranean garrigue)

| Number | Latitude | Longitude | Altitude (m a.s.l.) | Sampling/Year/Microhabitat |
|--------|----------|-----------|---------------------|----------------------------|
| 1      | 43.80092 | 10.47663  | 95                  | Canopy 2014 OL + GA        |
| 2      | 43.78670 | 10.45860  | 151                 | Canopy 2014 OL + GA        |
| 3      | 43.78335 | 10.39824  | 36                  | Canopy 2014 OL + GA        |
| 4      | 43.78264 | 10.42667  | 42                  | Canopy 2014 OL             |
| 5      | 43.76854 | 10.44690  | 109                 | Canopy 2014 OL + GA        |
| 6      | 43.78422 | 10.57183  | 181                 | Canopy 2014 OL             |
| 7      | 43.70452 | 10.56907  | 216                 | Canopy 2014 OL             |
| 8      | 43.69435 | 10.54685  | 122                 | Canopy 2014 OL + GA        |
| 9      | 43.70472 | 10.51089  | 56                  | Canopy 2014 OL + GA        |
| 10     | 43.76580 | 10.58849  | 184                 | Canopy 2014 OL + WA        |
| 11     | 43.79551 | 10.40088  | 90                  | Ground 2013 OL + GA        |
| 12     | 43.79529 | 10.52366  | 229                 | Ground 2013 OL + WA        |
| 13     | 43.81936 | 10.47199  | 147                 | Ground 2013 OL + WA        |
| 14     | 43.74186 | 10.47574  | 65                  | Ground 2013 OL + WA        |
| 15     | 43.81076 | 10.42178  | 155                 | Ground 2013 OL + WA        |
| 16     | 43.79269 | 10.48643  | 88                  | Ground 2013 OL + WA        |
| 17     | 43.74667 | 10.51883  | 267                 | Ground 2013 OL + WA        |
| 18     | 43.70702 | 10.58295  | 74                  | Ground 2013 OL + WA        |
| 19     | 43.72923 | 10.49694  | 117                 | Ground 2013 OL + WA        |
| 20     | 43.69396 | 10.54387  | 74                  | Ground 2013 OL + GA        |
| 21     | 43.78663 | 10.43274  | 238                 | Ground 2013 OL + WA        |
| 22     | 43.78621 | 10.56945  | 236                 | Ground 2013 OL + WA        |
| 23     | 43.71982 | 10.53319  | 111                 | Ground 2010 OL; Canopy 2014 OL |
| 24     | 43.69019 | 10.54933  | 34                  | Ground 2010 OL             |
| 25     | 43.74228 | 10.51958  | 216                 | Ground 2010 OL             |
| 26     | 43.70192 | 10.57565  | 56                  | Ground 2010 OL             |
| 27     | 43.72694 | 10.50762  | 62                  | Ground 2010 OL             |
| 28     | 43.73032 | 10.58426  | 187                 | Ground 2010 OL             |
| 29     | 43.73020 | 10.59661  | 89                  | Canopy 2014 OL             |
| 30     | 43.73144 | 10.57111  | 230                 | Canopy 2014 OL + WA        |
Results
A total of 30 sites (Tab. 1, Fig. 1; QGIS Development Team 2019) was sampled during the three years of research in the Monte Pisano area, from which 6083 spiders were collected, 3623 identified to species level, including all adults. The specimens belong to 148 species in 27 families (Tab. 2): spiders from the Monte Pisano thus represent about 9% of the Italian araneofauna, and include seven Italian endemics. There were 129 species (3228 individuals, 76 species sampled at the ground and 60 from the canopy; Tab. 3) found inside the olive groves, including the new report of Zelotes fulvaster.

In the woods, 71 species were collected (257 individuals, 41 species from the ground and 32 from the canopy; Tab. 4) and 29 species in the Mediterranean garrigue (138 individuals, 14 from the canopy and 15 from the ground; Tab. 5). The spider assemblages of these olive landscapes consist mainly of Linyphiidae, contributing 50.7% of the total species number. Indeed, Linyphiidae is the most abundant family in canopies in all habitats and among the linyphiids found, Frontinellina frutetorum was the dominant species. It comprised 84.9% of the specimens belonging to this family. Tabs 3, 4 and 5 show that considering only the most numerous families in olive groves, woods and garrigue, Araneidae were collected only in canopies, while Gnaphosidae, Lycosidae and Zodariidae were collected exclusively on the ground.

Considering species richness, the highest number of species in olive groves belonged to Theridiidae and Gnaphosidae with 18 species, in woods to Araneidae (13 species), and in the Mediterranean garrigue Salticidae and Araneidae (5 species). However, the highest number of specimens was observed for Scytodes thoracica on the ground of the woods and Olios argelatius in the Mediterranean garrigue.

In addition to these results, three more families were sampled with 14 species identified to genus level, but these are not included in the tables. Species belonged to 26 chorotypes (Tab. 2), the most represented being the Palearctic type (21%, 31 species). Furthermore, Mediterranean species constituted 15.5% (23 species). Eight species have a European chorotype (5.4%) and one species, Erigone autumnalis, is an introduced species from North and Central America (Pesarini 1996).

Seven species (4.7%) are endemic to central Italy, namely Pimoa rupicola (1 male; ALWA: West Alpine-Apenninic), Eratigena vomeroi (1 female and 1 male; APPS: South Apenninic), Dysdera cf. andreinii (1 female APPE: Apenninic) and Cybaeodes marinae (1 female and 1 male: APPE: Apenninic), Gonatium biimpressum and Zodarion vicinum (15 females and 3 males and 26 females and 19 males; TYRR: Tyrrhenian) and Ozyptila salustri Wunderlich, 2011 (3 males; APPC: Central Apenninic) (acronyms see caption Tab. 2).

Tab. 2: List of spider species (alphabetical order) collected in the case studies of 2010, 2013 and 2014 in olive groves and adjacent semi-natural habitats. For each species, the number of specimens and chorotype are reported (AIM = Afrotropico-Indo-Mediterranean; AFM = Afrotropico-Mediterranean; ALWA = West Alpine-Apenninic; APPC = Central Apenninic; APPE = Apenninic; APPS = South Apenninic; ASE = Asiatic-European; CAE = Centralasiatic-European; CAM = Centralasiatic-Mediterranean; COS = Cosmopolite; EUM = Europeo-Mediterranean; EUR = European; MED = Mediterraneo; OLA = Holartic; PAL = Palaearctic; SIE = Sibero-European; SEU = South European; TEM = Turano-Europeo-Mediterraneo; TUE = Turano-European; TUM = Turano-Mediterraneo; TYRR = Tyrrhenian; WME = W-Mediterraneo; WEU = W-European; INT = Introduced; chorotype according to Stoch & Vigna Taglianti 2006)

| Species | A | B |
|---------|---|---|
| Agelenidae | | |
| Agelena labyrinthica (Clerck, 1757) | 1 | PAL |
| Eratigena faussini (Pavesi, 1873) | 5 | EUR |
| Eratigena vomeroi (Brignoli, 1977) | 2 | APPS |
| Species                                      | A | B |
|----------------------------------------------|---|---|
| *Agyneta hasei* Chyzer, 1897                 |   | SEU |
| *Aculepeira armida* (Audouin, 1826)          |   | ASE |
| *Agelenatae redit* (Scopoli, 1763)           |   | PAL |
| *Araneus angulatus* Clerck, 1757             | 15 | OLA |
| *Araneus diadematus* Clerck, 1757            | 46 | OLA |
| *Araneus marmoratus* Clerck, 1757            |   | OLA |
| *Araneus sturni* (Hahn, 1831)                |   | PAL |
| *Araniella cucurbetina* (Clerck, 1757)       |   | PAL |
| *Argiope bruennichi* (Scopoli, 1772)         |   | PAL |
| *Cyclosa cl. oculata* (Walckenaer, 1802)     |   | PAL |
| *Cyclosa conica* (Pallas, 1772)              |   | OLA |
| *Cyrtarachne ioxides* (Simon, 1870)          |   | OLA |
| *Cyrtophora citricola* (Forsskal, 1775)      |   | AIM |
| *Cibharanae bistuberculata* (Walckenaer, 1802) |   | PAL |
| *Hypoplinga sanguinea* (C. L. Koch, 1844)   |   | PAL |
| *Mangora acalypha* (Walckenaer, 1802)       |   | PAL |
| *Neoscona adianta* (Walckenaer, 1802)       |   | PAL |
| *Zilla diozia* (Walckenaer, 1802)           |   | PAL |
| *Zygia x-notata* (Clerck, 1757)             |   | PAL |
| *Clubiona confusa* Blackwall, 1841           |   | PAL |
| *Dictyna cl. munda* (O. Pickard-Cambridge, 1861) |   | EUR |
| *Brigitta clavata* (Lucas, 1850)             |   | EUR |
| *Dictyna cl. munda* (Linnaeus, 1758)         |   | EUR |
| *Dysderidae*                                |   | EUR |
| *Dysdera cl. andreinii* Caporiacco, 1928     |   | APPE |
| *Dysdera euryst骑ma* (Walckenaer, 1802)     |   | EUR |
| *Harpactea arguta* (Simon, 1907)            |   | EUR |
| *Filitistidae*                               |   | EUR |
| *Filitista insidiosa* (Forsskal, 1775)      |   | EUR |
| *Gnaphosidae*                               |   | EUR |
| *Aphantopanae cl. croatica* (L. Koch, 1866) |   | EUR |
| *Civizelotes dentatidens* (Simon, 1914)     |   | EUR |
| *Drassodes lopidaus* (Walckenaer, 1802)     |   | EUR |
| *Gnaphosa alaris* Simon, 1878               |   | EUR |
| *Gnaphosa lucifuga* (Walckenaer, 1802)      |   | EUR |
| *Haplopodes dalmatisensis* (L. Koch, 1866)  |   | EUR |
| *Haplopodes maccalinus* (Thorell, 1871)     |   | EUR |
| *Leptodrassus femineus* Simon, 1873         |   | EUR |
| *Marinorhelotes barbatus* (L. Koch, 1866)   |   | EUR |
| *Micaria albivittata* Lucas, 1846           |   | EUR |
| *Micaria coarctata* Lucas, 1846             |   | EUR |
| *Nomisia exornata* (C. L. Koch, 1839)       |   | EUR |
| *Scatiphis carperti* (O. Pickard-Cambridge, 1872) |   | EUR |
| *Trachyzelotes pedestrin* (C. L. Koch, 1837) |   | EUR |
| *Zelotes aeneus* Simon, 1878                |   | EUR |
| *Zelotes fulvaster* Simon, 1878             |   | EUR |
| *Zelotes hermani* Chyzer, 1897              |   | EUR |
| *Zelotes oblongus* (C. L. Koch, 1833)       |   | EUR |
| *Zelotes parocalus* Simon, 1914             |   | EUR |
| *Zelotes tenuis* (L. Koch, 1866)            |   | EUR |
| Species                                      | A | B |
|---------------------------------------------|---|---|
| *Heliophanus kochii* Simon, 1868            | 3 | EUM |
| *Heliophanus tribulus* Simon, 1868          | 21 | SIE |
| *Icius hamatus* (C. L. Koch, 1846)          | 12 | MED |
| *Leptorechtes herodtenis* (C. L. Koch, 1846) | 2 | EUM |
| *Mauroeris nidicolens* (Walckenaer, 1802)   | 10 | SEU |
| *Pellenes genericus* Simon, 1868            | 4 | CAM |
| *Philaeus chrysops* (Poda, 1761)            | 1 | PAL |
| *Philergia brevicolli* Lucas, (1846)        | 5 | AFM |
| *Pseudicius encarpatus* Walckenaer, 1802    | 1 | EUR |
| *Saltas bistipes* Simon, (1868)             | 1 | MED |
| *Saltas mutabilis* Lucas, 1846              | 5 | TUE |
| *Saltas tricolor* (C. L. Koch, 1837)        | 4 | PAL |
| *Scytodidae*                               |   |   |
| *Scytodes thoracica* Latreille, 1802        | 194 | OLA |
| *Sparassidae*                               |   |   |
| *Olios argelasius* Walckenaer, 1806         | 18 | MED |
| *Tetragnathidae*                            |   |   |
| *Metellina segmentata* Clerck, 1757         | 6 | OLA |
| *Pachygnatha degeeri* Sundevall, 1830       | 2 | PAL |
| *Theridiidae*                               |   |   |
| *Argyrodes argyrodes* Walckenaer, 1841      | 35 | MED |
| *Abania atima* Knoflach, 1996               | 11 | PAL |
| *Crustularia gutta* Wider, (1834)           | 7 | SIE |
| *Epineus angustatus* (Blackwall, 1836)      | 1 | MED |
| *Euryopes episina* (Walckenaer, 1847)       | 6 | TEM |
| *Euryopes laeta* Westring, (1861)           | 9 | PAL |
| *Heterotheridion nigrovariegatum* Simon, 1873 | 10 | TUM |
| *Kochiura aulica* (C. L. Koch, 1838)        | 57 | SEU |
| *Lasaeola convexa* Blackwall, (1870)        | 5 | PAL |
| *Parasteatoda lunata* Clerck, 1757          | 3 | COS |
| *Phorididae*                                |   |   |
| *Phorididae*                                |   |   |
| *Platnickina tintac* Walckenaer, 1802       | 14 | MED |
| *Robberphora nica* (Simon, 1873)            | 7 | MED |
| *Robertus mediterraneus* Eskov, 1987        | 1 | WME |
| *Spartoctonella* (Walckenaer, 1806)         | 1 | OA |
| *Theridion pinastri* L. Koch, 1872          | 2 | PAL |
| *Theridion varians* Hahn, 1833              | 1 | OLA |
| *Thomisidae*                                |   |   |
| *Bassaniodes bufo* Dufour, 1820              | 5 | MED |
| *Bassaniodes robustus* (Hahn, 1832)         | 2 | CAE |
| *Missanae varia* Clerck, 1757               | 1 | OLA |
| *Ozyptila conspersa* (C. L. Koch, 1841)     | 9 | SEU |
| *Ozyptila pullata* Thorell, (1875)          | 1 | EUR |
| *Ozyptila salusuri* Wunderlich, 2011        | 3 | APPC |
| *Ozyptila sanctaria* O. Pickard-Cambridge, 1871 | 1 | EUR |
| *Runcinia gramatica* (C. L. Koch, 1837)    | 23 | SCO |
| *Syneira globosa* Fabrícius, 1775           | 28 | PAL |
| *Thomisus benus* Walckenaer, 1805           | 1 | PAL |
| *Xysticus kochi* Thorell, 1872              | 6 | SIE |
| *Titanocidae*                               |   |   |
| *Nursia albomaculata* Lucas, (1846)         | 3 | TUE |
| *Uloboridae*                                |   |   |
| *Hyptiotes paradoxus* (C. L. Koch, 1834)    | 1 | PAL |

### Tab. 3: List of spider species (alphabetical order) collected in the case studies of 2010, 2013 and 2014 in olive groves (OL). For each species the number of specimens per microhabitat type is reported (Ground: species collected by pitfall traps; canopy: species collected by hand or beating) and the total number of specimens

A = OL_Ground; B = OL_Canopy; C = Total OL

| Species                                      | A | B |
|---------------------------------------------|---|---|
| *Agelenidae*                                 |   |   |
| *Agelenetae redii*                           | 0 | 3 |
| *Araneus angulatus*                          | 0 | 13 |
| *Araneus diadematus*                         | 0 | 37 |
| *Araneus marmoreus*                          | 0 | 2 |
| *Araneus sturmi*                             | 0 | 1 |
| *Cyclosa cf. oculata*                        | 0 | 1 |
| *Cyclosa conica*                             | 0 | 3 |
| *Cyrtarachne ixoides*                        | 0 | 6 |
| *Cytotophora citrata*                        | 0 | 16 |
| *Mangora acalypha*                           | 0 | 25 |
| *Nesiosa adianta*                            | 0 | 2 |
| *Zilla diadema*                              | 0 | 1 |
| *Zygella x-notata*                           | 0 | 77 |
| *Clubionidae*                                |   |   |
| *Clubiona brevipes*                           | 0 | 1 |
| *Dictynidae*                                 |   |   |
| *Argenna subnigra*                            | 1 | 0 |
| *Dictyna arundinacea*                        | 0 | 1 |
| *Dysderidae*                                 |   |   |
| *Dysdera cf. andreinii*                       | 1 | 0 |
| *Dysdera crocata*                             | 27 | 0 |
| *Dysdera erythrina*                           | 1 | 0 |
| *Harpactea arguta*                            | 27 | 0 |
| *Filotatidae*                                |   |   |
| *Filotata insidiatrix*                        | 1 | 0 |
| *Gnaphosidae*                                |   |   |
| *Aphantaulax cincta*                          | 4 | 0 |
| *Civiseolutes dentatidens*                   | 2 | 0 |
| *Drosis aephasa*                              | 1 | 0 |
| *Gnaphosa alavaria*                           | 6 | 0 |
| *Gnaphosa lucifuga*                           | 11 | 0 |
| *Haplodrassus dalmatensis*                   | 27 | 0 |
| *Haplodrassus macellinus*                    | 1 | 0 |
| *Leptodrassus femoralis*                     | 1 | 0 |
| *Marinarozelotes bartholus*                  | 28 | 0 |
| *Micaria alhovittata*                        | 3 | 0 |
| Species                  | A  | B  | C  |
|--------------------------|----|----|----|
| Micaria coarctata        | 1  | 0  | 1  |
| Nomisia exornata         | 45 | 0  | 45 |
| Setaphis carmieli        | 16 | 0  | 16 |
| Zeoltes fulvaster        | 2  | 0  | 2  |
| Zeoltes harnani          | 9  | 0  | 9  |
| Zeoltes oblongus         | 14 | 0  | 14 |
| Zeoltes paroculus        | 7  | 0  | 7  |
| Zeoltes tenuis           | 46 | 0  | 46 |
| **Linnyphiidae**         |    |    |    |
| Agyneta rarestris        | 4  | 3  | 7  |
| Crematoneeta mutinensis  | 0  | 1  | 1  |
| Diploleonius gracius     | 5  | 0  | 5  |
| Erigone automalis        | 5  | 2  | 7  |
| Erigone dentitpalpis     | 2  | 0  | 2  |
| Frontinellina frutetorum| 0  | 1496| 1496|
| Gonatium biimpressum     | 0  | 2  | 2  |
| Linyphia triangularis    | 0  | 10 | 10 |
| Palliduphantes cf. pallidus | 0 | 1 | 1 |
| Palliduphantes istrianus | 150| 0  | 150|
| Styloteter romanus       | 1  | 0  | 1  |
| Tenuiphantes herbicola   | 20 | 2  | 22 |
| Trichoncus affinis       | 2  | 1  | 3  |
| Trichoncus haekmani      | 0  | 1  | 1  |
| Trichoncus sordidus      | 8  | 0  | 8  |
| Walkenaeria antica       | 1  | 0  | 1  |
| **Lycosidae**            |    |    |    |
| Agraecina lineata        | 3  | 0  | 3  |
| Agroeca proxima          | 2  | 0  | 2  |
| Cybaecidae marinae       | 1  | 0  | 1  |
| **Lycosidae**            |    |    |    |
| Alopecosa albofasciata   | 364| 0  | 364|
| Arctosa personata        | 13 | 0  | 13 |
| Hogna radiata            | 26 | 0  | 26 |
| Trochosa ruicola         | 76 | 0  | 76 |
| **Miturgidae**           |    |    |    |
| Zora silvestris          | 1  | 0  | 1  |
| **Oonopidae**            |    |    |    |
| Silhouettella loricatula | 3  | 0  | 3  |
| **Oxypodidae**           |    |    |    |
| Ozyopes lineatus         | 0  | 6  | 6  |
| **Phidodromidae**        |    |    |    |
| Phidodromus cf. rufus    | 0  | 1  | 1  |
| Phidodromus lividus      | 0  | 5  | 5  |
| Phidodromus longipalpis  | 0  | 3  | 3  |
| Pulchellodromus bistigma | 1  | 0  | 1  |
| Thanatus atratus         | 1  | 0  | 1  |
| **Phurulithidae**        |    |    |    |
| Liocephrillus flavicollis| 11 | 0  | 11 |
| Phurulithus festivus     | 3  | 0  | 3  |
| **Salticidae**           |    |    |    |
| Chalcocisitrus insignus   | 2  | 0  | 2  |
| Euphrosyntis frontalis   | 7  | 0  | 7  |
| Euphrosyntis herbigrada  | 43 | 0  | 43 |
| Evarcha jucunda          | 0  | 2  | 2  |
| Heliophasus cupreas      | 1  | 0  | 1  |
| Heliophasus kochii       | 3  | 0  | 3  |

| Species                  | A  | B  | C  |
|--------------------------|----|----|----|
| Heliophanus tribulosus   | 0  | 14 | 14|
| Ilius hamatus            | 0  | 12 | 12|
| Leptorhous berolinensis  | 1  | 1  | 2  |
| Macarorhis ridiculens    | 0  | 10 | 10|
| Philaeus chrysoeps       | 0  | 1  | 1  |
| Phtegra brenieri         | 5  | 0  | 5  |
| Pseudicius encarpatus    | 0  | 1  | 1  |
| Salticus mandibularis    | 0  | 1  | 1  |
| Salticus mutabilis       | 0  | 5  | 5  |
| Salticus zebraneus       | 0  | 4  | 4  |
| **Sicyotidae**           |    |    |    |
| Sicyotes thoracica       | 156| 0  | 156|
| **Sparassidae**          |    |    |    |
| Olios argelasius         | 1  | 7  | 8  |
| **Tetragnathidae**       |    |    |    |
| Metellina segmentata     | 0  | 2  | 2  |
| Patchyntana degerei     | 0  | 1  | 1  |
| **Theriidae**            |    |    |    |
| Argyrodes argyrodes      | 0  | 26 | 26 |
| Asagenia italicita       | 9  | 0  | 9  |
| Crustodina gutata        | 7  | 0  | 7  |
| Epinisus cf. angulatus   | 0  | 1  | 1  |
| Euryops episinoidea      | 3  | 2  | 5  |
| Euryops laeta            | 9  | 0  | 9  |
| Heterothroidis nigrovariegatum | 0 | 10 | 10
| Kockière aulica          | 0  | 35 | 35 |
| Lasaelea convexa          | 0  | 5  | 5  |
| Parasteatoda lunata      | 0  | 3  | 3  |
| Parasteatoda tepidariorum| 0  | 4  | 4  |
| Phorosilia paradoxa      | 0  | 1  | 1  |
| Platnickia tincta        | 0  | 9  | 9  |
| Rhomphura nasica         | 0  | 5  | 5  |
| Robertus mediterraneus   | 1  | 0  | 1  |
| Steatoda paykultiana     | 1  | 0  | 1  |
| Theridion pinastri       | 0  | 1  | 1  |
| Theridion varians        | 0  | 3  | 3  |
| **Thomisidae**           |    |    |    |
| Bassaniodes bufo         | 3  | 0  | 3  |
| Bassaniodes robustus     | 1  | 0  | 1  |
| Misumena sutia           | 0  | 1  | 1  |
| Ozyptila confluens       | 5  | 0  | 5  |
| Ozyptila pullata         | 1  | 0  | 1  |
| Ozyptila salustri        | 0  | 3  | 3  |
| Ozyptila sanctuaria      | 1  | 0  | 1  |
| Runicnia grammica        | 0  | 19 | 19 |
| Synema globosum          | 0  | 21 | 21 |
| Thomusius onustus        | 0  | 1  | 1  |
| Xysticus kochi           | 6  | 0  | 6  |
| **Uloboridae**           |    |    |    |
| Hyptiotes paradoxus      | 0  | 1  | 1  |
| **Zodaridae**            |    |    |    |
| Zodarion elegans         | 7  | 0  | 7  |
| Zodarion italicum        | 1  | 0  | 1  |
| Zodarion fusio           | 7  | 0  | 7  |
| Zodarion vicinus         | 21 | 0  | 21 |

**Total number of specimens**

|              | A  | B  | C  |
|---------------|----|----|----|
| Species number| 1294| 1934| 3228|

**Species number**

|              | 76 | 60 | 129 |
Tab. 4: List of spider species (alphabetical order) collected in the case studies of 2013 and 2014 in woods (WA). For each species the number of specimens per microhabitat type is reported (Ground: species collected by pitfall traps; canopy: species collected by hand or beating) and the total number of specimens.

| Species | A | B | C |
|---------|---|---|---|
| Agelenidae | 0 | 1 | 1 |
| Agelena labyrinthica | 0 | 2 | 2 |
| Eratigena fuesslini | 0 | 1 | 1 |
| Tegenaria hasperi | 0 | 1 | 1 |
| Araneidae | 0 | 1 | 1 |
| Araneus angulatus | 0 | 1 | 1 |
| Araneus diadematus | 0 | 1 | 1 |
| Araneus marmoreus | 0 | 1 | 1 |
| Araniella cucurbitina | 0 | 1 | 1 |
| Argiope bruennichi | 0 | 1 | 1 |
| Cyclosa conica | 0 | 1 | 1 |
| Cyrtophora citricola | 0 | 1 | 1 |
| Gambiana bituberculata | 0 | 1 | 1 |
| Hypsosinga sanguinea | 0 | 1 | 1 |
| Mangora acalypha | 0 | 1 | 1 |
| Nesocosa adiata | 0 | 1 | 1 |
| Zilla diadia | 0 | 1 | 1 |
| Zygiella x-notata | 0 | 1 | 1 |
| Clubionidae | 0 | 1 | 1 |
| Clubiona brevipes | 0 | 1 | 1 |
| Dictynidae | 0 | 1 | 1 |
| Brigitta clevia | 0 | 1 | 1 |
| Dysderidae | 0 | 1 | 1 |
| Hapacte a arguta | 0 | 1 | 1 |
| Gnaphosidae | 0 | 1 | 1 |
| Gnaphosa alacris | 0 | 1 | 1 |
| Haplodrassus macellinus | 0 | 1 | 1 |
| Micaria albovittata | 0 | 1 | 1 |
| Nomisua exornata | 0 | 1 | 1 |
| Setophis carmeli | 0 | 1 | 1 |
| Trachyzelotes pedestris | 0 | 1 | 1 |
| Zelotes aeneus | 0 | 1 | 1 |
| Zelotes bermani | 0 | 1 | 1 |
| Zelotes oblongus | 0 | 1 | 1 |
| Zelotes parochus | 0 | 1 | 1 |
| Zelotes tenuis | 0 | 1 | 1 |
| Linyphiidae | 0 | 21 | 21 |
| Frontinellina frutetorum | 1 | 15 | 16 |
| Gonatium biimpressum | 0 | 14 | 14 |
| Linyphia triangularis | 2 | 0 | 2 |
| Styloctetor romanus | 1 | 0 | 1 |
| Tapinocyba praecox | 0 | 1 | 1 |
| Tenuiphantes herbicola | 0 | 3 | 3 |
| Tenuiphantes tenuis | 0 | 3 | 3 |
| Tramboncus backmani | 0 | 1 | 1 |
| Tramboncus sordidus | 0 | 3 | 3 |
| Wallemena antica | 1 | 0 | 1 |
| Lycosidae | 0 | 1 | 1 |
| Alopecosa albofasciata | 0 | 1 | 1 |
| Arctosa personata | 0 | 1 | 1 |
| Hogna radiata | 0 | 1 | 1 |
| Mimicidae | 0 | 1 | 1 |
| Mimetus lacvigatus | 0 | 1 | 1 |
| Philodromidae | 0 | 1 | 1 |
| Philodromus lividus | 0 | 1 | 1 |
| Philodromus longipalpis | 0 | 2 | 2 |
| Salticidae | 0 | 3 | 3 |
| Chalcisritus infimus | 0 | 4 | 4 |
| Euphryx frontalis | 0 | 1 | 1 |
| Euphryx petrensis | 0 | 1 | 1 |
| Evarcha juundu | 0 | 2 | 2 |
| Heliothulus tribulus | 0 | 1 | 1 |
| Pellenes gelicaulatus | 0 | 2 | 2 |
| Saitis barbipes | 0 | 1 | 1 |
| Scytodidae | 0 | 38 | 38 |
| Scytodes thoracica | 0 | 38 | 38 |
| Sparassidae | 0 | 1 | 1 |
| Olios argelserius | 0 | 1 | 1 |
| Tetragonitidae | 0 | 2 | 2 |
| Metelina segmentata | 0 | 2 | 2 |
| Pachygnatha degerei | 0 | 2 | 2 |
| Therididae | 0 | 1 | 1 |
| Argyrodus argyodes | 0 | 1 | 1 |
| Asagenia italicla | 0 | 3 | 3 |
| Platsinchina tincta | 0 | 4 | 4 |
| Eurypis episinosides | 0 | 4 | 4 |
| Rhamphaea nasica | 0 | 4 | 4 |
| Tetrarchia pinastri | 0 | 4 | 4 |
| Tetrarchia varian | 0 | 4 | 4 |
| Thomisidae | 0 | 1 | 1 |
| Bassaniodes roubus | 0 | 1 | 1 |
| Ozypilus confliens | 0 | 1 | 1 |
| Runcinia grammica | 0 | 1 | 1 |
| Symplocus globosum | 0 | 1 | 1 |
| Titanococidae | 0 | 3 | 3 |
| Nusria albomaculata | 0 | 3 | 3 |
| Zodriadae | 0 | 14 | 14 |
| Zodaria vicinum | 0 | 14 | 14 |
| Total number of specimens | 141 | 110 | 251 |
| Species number | 41 | 32 | 71 |

Tab. 5: List of spider species (alphabetical order) collected in the case studies of 2013 and 2014 in the Mediterranean garrigue (GA). For each species the number of specimens per microhabitat type is reported (Ground: species collected by pitfall traps; canopy: species collected by hand or beating) and the total number of specimens.

| Species | A | B | C |
|---------|---|---|---|
| Araneidae | 0 | 1 | 1 |
| Aculepeira arnida | 0 | 1 | 1 |
| Agalenatae redii | 0 | 1 | 1 |
| Araneus diadematus | 0 | 1 | 1 |
| Cyrtophora citricola | 0 | 1 | 1 |
| Zygiella x-notata | 0 | 4 | 4 |
| Dictynidae | 0 | 1 | 1 |
| Brigitta clevia | 0 | 1 | 1 |
| Gnaphosidae | 0 | 1 | 1 |
| Gnaphosa alacris | 0 | 1 | 1 |
| Gnaphosa lucifuga | 0 | 3 | 3 |
| Nomisua exornata | 0 | 1 | 1 |
Zelotes fulvaster (Simon, 1878) ( Gnaphosidae) (Fig. 2a-b)

Material examined. ITALY: Tuscany, Monte Pisano, olive groves: Avane (Pisa), 43.79444°N, 10.39905°E, 117 m a.s.l., 1 ♀, pitfall trap (20.–24. Sep. 2013); Pozzuolo (Lucca), 43.81887°N, 10.47096°E, 135 m a.s.l., 1 ♀, pitfall trap (20.–24. Sep. 2013); leg. M. S. Picchi, det. P. Pantini.

Distribution. France, Bulgaria, North Macedonia, Greece, Iran (Jézéquel 1962, Komnenov 2014, Nentwig et al. 2019, Senglet et al. 2011), new record for Italy, and confirmed in the southern part of the Balkans (Greece and Macedonia), in Corsica (France) and, outside Europe, in Iran (Senglet et al. 2011). Since this is a new species report for Italy, its known distribution range is extended here to the West-Mediterranean part of Southern Europe, consistent with its Mediterranean chorotype. Previous reports of this species come from xeric habitats (Komnenov 2014) and this preference for arid habitats partially matches the microclimate of olive orchards.

Pimoa rupicola is a troglobiotic species with some reports from central Apennine regions (Mammola et al. 2016), where it was found in pitfall traps in a rock, contrary to G. biimpunctatum, of which more specimens were found in the foliage of the forest trees, whereas D. andreinii and E. comosus were collected at the ground level of olive orchards. Cybaeodes marinae was sampled with pitfall traps on the ground of one olive orchard. This night-active species is typical of Mediterranean woods and it is probably related to a warm and dry environment (Di Franco 1989). Three endemic species were described from Tuscany: Zodarion vicinum was originally described by Denis (1935) from individuals collected on the island of Giglio (Tuscany), whereas D. andreinii was described by di Caporiacco (1928) from the island of Capraia (Tuscany). Ozyptila salustri was described based on samples collected in Grosseto (Tuscany) by Wunderlich (2011).

Considering the chorotype profiles, it is suggested here that besides common species (11% OLA: 16 species and 21% PAL: 31 species), the Mediterranean chorotype is represented by a high number of species (15.6%; 23 species). This is an expected result since Tuscany is typically associated with Mediterranean climatic conditions and vegetation associations. Generally, species in traditional olive landscapes are mesophilic species, often associated with garrigue or sunny localities (Gaymard & Lecigne 2018), e.g. Kochiura aulica (canopy) and Nomisia exornata (ground).

The most abundant species in olive canopies was the linyphiid Frontinellina frutetorum, also observed by Gaymard & Lecigne (2018) in mesophile woods. In fact, this species was numerous in the samples from woods and garrigue next to olive groves, despite previous analyses highlighting a lower number of F. frutetorum in garrigue-dominant landscapes (Picchi et al. 2016), probably due to the risk of desiccation (Pékár 2013). Likewise, Frontinellina frutetorum was dominant among 48 species in Italian olive groves (Ghavami 2006).

On the ground, among olive trees sampled in 2010, the most abundant spider was the lycosid Alopecosa albifasciata, already known to be common in olive groves (Thaler et al. 2000), in grass and in the garrigue. It has been regularly found in open sunny and arid places (Lugetti & Tongiorgi 1969). These results suggest that olive groves qualify as a mesophile habitat with species typical of drier habitats.

Considering species numbers in olive landscapes, Linyphiidae and Salticidae were represented by 20 species each.
Gnaphosids are common in all Mediterranean areas (Cardoso et al. 2007). The present results confirm those from the other studies (Cárdenas et al. 2012, Dinis et al. 2015). Jumping spiders are one of the richest families in dry shrubland, and most species collected were usually associated to garrigue. Nyffeler & Sunderland (2003) suggested that jumping spiders usually have a higher abundance in warmer regions because at low temperatures they are less active and their hunting efficiency is lower. Salticids were also one of the most abundant families found by Morris et al. (1999) in olive groves of Spain.

Olive groves provide spiders with more habitats for overwintering and food resources than the annual crops, therefore spiders are less dependent on adjacent non-crop and semi-natural vegetation (Picchi et al. 2016). In fact, olive groves have higher stability and are structurally and vegetationally more diverse (Maloney et al. 2003, Öberg et al. 2008) than annual crops and thus provide a high diversity of niches (Arambourg 1986), including for instance dry-stone walls and stones on the ground (Benhadi-Marin et al. 2018) that influence the occurrence of spiders (Samu et al. 1999).

Such a hypothesis was also supposed for vineyards by D’Alberto et al. (2012). They suggested there were only weak relationships between woody vegetation and the abundance of spiders in vineyards at all spatial scales and that this could be due to differences in the crop structure. Remarkably, perennials (type of crop) have a greater structural and compositional complexity than annuals (Lelevre et al. 2016). At the same time, other authors showed the importance of vineyards for the conservation of endangered or rare species of spiders (Košulić & Hula 2013, 2014, Košulić et al. 2014). The same conclusion could be applied to olive groves in the light of the presence of endemic species.

In olive groves of other Mediterranean countries, the species richness was similar. In research conducted in Spain 142 species of spiders were collected (Cárdenas & Barrientos 2011) with 33 species in common to Monte Pisano’s area, while in southern Portugal 144 spider species were sampled (Sousa Da Silva 2013) and 36 species were shared with the present study. In the northern part of Portugal, knowledge of the spider assemblages of olive groves increased recently (Benhadi-Marin et al. 2018, 2020) – the authors found 24 species common to the list of spiders in Monte Pisano’s olive groves. Considering these three countries, European olive groves share 12 species, and among them, many have a Mediterranean distribution. For instance, Spiders of Mediterranean geographical distribution, and even endemics. Although it is a perennial agroecosystem with periodic human intervention, olive groves appear to represent a stable and elaborate crop able to host many spider species. Application for environmentally friendly solutions to pest control issues through conservation biological control and conservation aims should encourage the study of this group of predators.

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