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BUMBLEBEES IN NATURAL AND AGRO-ECOSYSTEMS AT DIFFERENT ALTITUDES FROM MOUNT ETNA, SICILY (HYMENOPTERA APIDAE BOMBINAE): LONG-TERM FAUNISTIC AND ECOLOGICAL OBSERVATIONS

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Mazzeo G., Bella S., Seminara A.R., Longo S. – Bumblebees in natural and agro-ecosystems at different altitudes from Mount Etna, Sicily (Hymenoptera Apidae Bombinae): long-term faunistic and ecological observations.

The results of a ten-years study on bumblebee species of Mount Etna in eastern Sicily are given. The observations were carried out in natural and anthropized ecosystems at different altitudes in the Mediterranean Basal plan (0-1450 m a.s.l.) and Mountain-Mediterranean plan (1450-2100 m a.s.l.). Twelve species belonging to *Bombus* (2 spp.), *Melanobombus* (1 sp.), *Megabombus* (2 spp.), *Thoracobombus* (3 spp.) and *Psithyrus* (4 spp.) subgenera are recorded. In the Mountain-Mediterranean plan, rich in endemic plants from Etna and Sicily, 11 species have been recorded on plants characterised by the highest honey potential like *Astragalus*, *Rubus*, and *Senecio*. The most abundant species in this level are *B. lapidarius decipiens* and *B. lucorum lucorum*. In the Mediterranean Basal plan 12 species have been recorded. Among them, *Bombus terrestris terrestris* is always present, and *B. terrestris calabricus* has been recorded only at 1900 m a.s.l.

Data are given on surveyed bumblebee species and subspecies, their presence in Italy, the spread in Sicily, and the plants on which the bees were observed. These data are placed in relation to the altitudinal levels and the ecological quality of the areas where the specimens were found.

KEY WORDS: *Bombus*, Biodiversity, Ecosystems, Floral relationships, Italy.

INTRODUCTION

Studies of the biological diversity of the natural and anthropic ecosystems through surveys on the presence of indicator organisms are becoming increasingly important for their sustainable management. With this objective, as part of several projects of national and regional research from 1997 to 2007, observations were conducted on anthophilous insects detected on plants in bloom in different ecosystems in eastern Sicily. The surveys showed that of 20,751 specimens surveyed, including 190 taxa (species and subspecies), the majority belonged to the family Apidae (QUARANTA *et al.*, 2004; MAZZEO *et al.*, 2004, 2006, 2007a,b,c; SEMINARA *et al.*, 2009). Among them, besides *Apis mellifera* Linnaeus, 1758, present in all environments investigated in relation to the widespread beekeeping, an important role is played by bumblebees, especially in certain micro-climates and plant associations such as those that characterise the mountainous areas. The genus *Bombus* Latreille, 1802, includes about 240 species distributed mainly in temperate and cold regions of Europe, Asia and North America (WILLIAMS, 1998; BENTON, 2006), with the presence and spread especially affected by altitude (COMBA and COMBA, 2001; ISERBYT and RASMONT, 2012). Bumblebees are present at altitudes between sea level and 4000 m and vary considerably in size and density of pubescence that covers the body (MANINO *et al.*, 2010).

In Italy, studies of bumblebees are still unsatisfactory, although by the end of the last century in different regions, researchers studied their distribution, abundance, plant visits and seasonal appearance (INTOPPA *et al.*, 1995, 1999, 2009; MAZZEO *et al.*, 2010). The number and spread of

subspecies throughout the country has not been the subject of a comprehensive study; at present, 63 taxa (species and subspecies) are known, more or less present in different areas and showing a greater abundance in the regions of northern Italy (MANINO *et al.*, 2007). Some species, with the presence of several subspecies, are widely distributed, from the plains to the highest peaks, while others are found exclusively on islands (MANINO *et al.*, 2007; 2010). RASMONT and ISERBYT (2010-2012) reported 44 species for Italy, including 11 in Sicily.

This paper aims to increase knowledge about Sicilian bumblebees, reporting data on the species surveyed in ten years from sea level to the high slopes of the Etna volcano. Information about their presence in Italy, the spread in Sicily, the report notes for the island for the past 20 years, and the plants on which the bees were observed is also given. The recorded data are placed in relation to the altitudinal quotes and ecological quality of the areas where the specimens were found.

MATERIALS AND METHODS

THE INVESTIGATED TERRITORY

The Etna volcano, more than 3300 m high with a base of about 40 km, is located in eastern Sicily and is bordered to the east by the Ionian Sea, to the south by the Catania Plain, to the west by the Simeto River, and to the north by a mountain ridge. It derived from the overlapping of several volcanic structures formed at different times and subject to constant change in morphology. The soils are of sedimentary and volcanic type and are highly permeable, which are

distinctive of the xeric environment of Etna (COCUZZA SILVESTRI and RONISVALLE, 1990).

The protected area

Etna Park was established as a regional nature park in 1987 to protect unique and constantly changing natural landscapes. The mid-higher slopes of the volcano have been distinguished based on the value of the biodiversity into four zones at different levels of protection: A (integral reserve), B (general reserve), C (protection) and D (control). In 2013, UNESCO added Etna as a world heritage site.

The climate

The climate is Mediterranean, with significant differences in function of the slopes, altitude, and exposure: thermo-mediterranean (xerothermic-hot) in the basal plane, meso-mediterranean in the stations at medium altitude, and oro-xerotheric or xerotheric-cold in higher areas (POLI MARCHESE and PATTI, 2000). July is the hottest month, with averages exceeding 22 °C, and January is the coldest, with temperatures that generally do not fall below -4 °C. Average annual rainfall, concentrated in the winter months, ranges from 500-600 mm (basal plane) to over 1300 mm (high altitude); in summer it creates a state of dryness that lasts for 2-6 months. The climate is thermo-mediterranean on the coast, with average temperatures more than 16 °C, where the following survey sites are located: Torre Allegra, Spina Santa, Contrada Nespole, Motta Sant'Anastasia, Paternò, and Ramacca. The climate is meso-mediterranean in the hilly zone, with average temperatures between 12 and 16 °C and sites: Bronte and Milia. The climate is oro-mediterranean in the high mountain ranges, with average temperatures below 8 °C and the site of Piano Provenzana (SIAS, 2014).

The vegetation

The vegetation is influenced by human activity in the mid-baseline plane and by the activity of the volcano in the middle summit. Numerous plant groupings are followed at various altitudes, proceeding from the most xerophilous in the baseline, to the forests on the mountain slopes, to the xerotheric vegetation at high altitude, featuring "altitudinal plans" and "horizons", ecologically corresponding to bioclimatic zones (Table 1). The medium-baseline plan is characterised by cropland that include mainly citrus orchards, olive groves, vineyards, and orchards; oak groves

and pine forests are found at higher altitudes. Besides the upper altitudinal limit of the arboreal vegetation and to 2450 m, a characteristic group of species is present, dominated by *Astragalus siculus* Biv., characterised by a prostrate department and a deep root system capable of colonising the slopes of loose volcanic sand and providing shelter to other species, some endemic to the volcano, such as *Senecio squalidus* L. *aetnensis* (Jan in DC.) Fiori, *Viola aetnensis* Parl., *Anthemis aetnensis* Schouw., *Rumex aetnensis* (C. Presl), *Galium aetnicum* Biv., *Sclerantus aetnensis* Strobl, and *Saponaria sicula* Rafin. (POLI MARCHESE, 1991).

SAMPLING SITES

Observations in the field have been conducted during the years 1997-2007 in nine different areas representative of the main environments of eastern Sicily, from sea level to 1900 m. These, were divided into the following three types based on the complexity of flora, the degree of human and agronomic aspects: agro-ecosystem [AE], natural ecosystem [NE], and semi-natural ecosystem [SN].

Locality

In parenthesis municipalities where fall the surveyed areas; those marked with the symbol * are inside protected areas.

- [SN] *Torre Allegra (Catania), 37°24 N 15°04 E, 5 m a.s.l. The site is located within the nature reserve "Oasi del Simeto" in an area behind the dunes, cultivated with sulla and wheat and surrounded by large wetlands with characteristic natural vegetation.
- [AE] Spina Santa (Catania), 37°24 N 14°57 E, 18 m a.s.l. The area is intensively cultivated with cereals, sulla, and vegetables, with natural flora present in the residual zones.
- [AE] Contrada Nespole (Giarre), 37°44 N 15°10 E, 81 m a.s.l. Agro-ecosystem cultivated with avocado, citrus, mango, fejoia, loquat, and other fruits, with native flora in marginal areas.
- [AE] Motta Sant'Anastasia, 37°30 N 14°53 E, 70 m a.s.l. Area intensively cultivated with citrus and with little natural vegetation.
- [AE] Paternò, 37°33 N 14°54 E, 256 m a.s.l. Citrus groves in intensive culture with residual natural vegetation.
- [AE] Ramacca, 37°23 N 14°41 E, 200 m a.s.l. Agro-ecosystem cultivated with cereals and oilseeds; marginal areas with native flora.
- [AE] Bronte, 37°48 N 14°47 E, 625 m a.s.l. Large areas

Table 1 – Altitudinal zones of Mount Etna (modified from POLI MARCHESE, 2004).

PLANS	HORIZONS	ENVIRONMENTS	ALTITUDE m a.s.l.
HIGH MEDITERRANEAN PLAN	Volcanic desert	Pioneer vegetation with many endemic species	2950-3330
	Horizon top (<i>Rumici-Anthemidetum aetnensis</i>)		2450-2950
	Horizon lower (<i>Astragaletum siculi</i>)		2100-2450
MOUNTAIN MEDITERRANEAN PLAN	Horizon top (<i>Astragaletum siculi</i>)	Pine, beech and astragaletto	1450-2100
	Horizon lower (<i>Geranio-Fagion sylvaticae</i>)		
MEDITERRANEAN BASAL PLAN	Supramediterranean horizon (<i>Quercion pubescenti-petraeae</i>)	Crops, chestnut and deciduous oaks	1000-1450
	Mesomediterranean horizon (<i>Quercion ilicis</i>)		500-1000
	Thermomediterranean horizon (<i>Oleo-Ceratonion siliquae</i>)		0-500

cultivated with peach and pear, surrounded by oak forests.

- [SN] *Milia, Monte San Leo (Belpasso), 37°39' N 14°59' E, 1046 m a.s.l. The site is inside Etna Park; pome and stone-fruit orchards with an abundance of wild flowers.
- [NE] *Piano Provenzana, Monte Tanaurpi (Lingua-glossa), 37°47' N 15°02' E, 1845 m a.s.l. Area inside Etna Park (site Natura 2000 ITA 070009) located at the altitudinal limit of pioneer vegetation, rich in plants of high ecological value, and the presence of many endemic species.

SAMPLING METHODS

A transect of about 400-600 m, representative of native flora, was preliminarily defined in every area surveyed; the anthophilous insects, along the transect are detected, following the protocol developed within the Italian project AMA (Ape, Miele, Ambiente) (QUARANTA *et al.*, 2004).

Field observations were conducted on a monthly basis on wild plants, while the cultivated plants were observed three times during the flowering period (beginning, middle, and end of anthesis). Four samples were made over the course of the day, every three hours, from 9 am to 18. The bumblebees were surveyed, recording for each species the number of individuals intercepted; with the exception of those known, the specimens were taken for subsequent identification in the laboratory. The collected specimens were prepared dry and labelled with reporting date, location, plant visited, and time of pickup. Where necessary, preparations of male sexual structures have been carried out for the specific identification.

The classification at the level of genus and subgenus follows MICHENER (2007) and WILLIAMS *et al.*, (2008); identification of species and subspecies and their nomenclature are according to STOCH (2003) and INTOPPA *et al.*, (2009).

The collected material is preserved in the collection of the Dipartimento di Agricoltura, Alimentazione e Ambiente, sez. Entomologia applicata University of Catania.

RESULTS

In the ten years of investigation, 3,426 specimens of bumblebees were observed; they accounted for 16.45% of the total Apoidea observed in the decade and belonged to 12 species. They are listed below and briefly discussed, listed in alphabetical order within the respective subgenera.

DETECTED TAXA

Subgenus *Bombus* Latreille, 1802

Bombus lucorum (Linnaeus, 1761)

Distribution: widespread in Europe (RASMONT and ISERBYT, 2010-2012), in the East, and in North America (WILLIAMS, 2014). This taxon is present in Italy with two subspecies: *lucorum* and *ariztoensis* Krüger, 1951. The last subspecies only present in Sardinia (INTOPPA *et al.*, 2009). Throughout Italy, is diffused especially between 1300 and 2200 m.

Citations for Sicily - Messina: S. Stefano Camastra and Ucria (PRIORE, 1993). Catania: Mt. Tanaurpi (SEMINARA *et al.*, 2009) (as *Bombus lucorum lucorum*); Milia (as *B. lucorum lucorum*).

Bombus terrestris (Linnaeus, 1758)

Distribution: W-Palaeartic. Widespread throughout Italy, ubiquitous taxon, as a rule more diffuse below 1000 m.

This taxon is present in Italy with the following subspecies: *terrestris*, *dalmatinus* Dalla Torre, 1882, *calabricus* Krüger, 1958, *lusitanicus* Krüger, 1956 (= *ferrugineus* auct nec Schmiedeknecht, 1878), *sassaricus* Tournier, 1890, and *xanthopus* Kriechbaumer, 1870. The last subspecies is endemic to Corsica and the Tuscan archipelago (INTOPPA *et al.*, 2009).

Citations for Sicily - Sicily: STOCH, 2003; SINACORI *et al.*, 2002 (as *Bombus terrestris*). Palermo: Cefalù (PAGLIANO, 1994) (as *B. terrestris calabricus*); Campofelice di Roccella (GRENCI *et al.*, 1997) (as *B. terrestris*). Agrigento: Platani river (GRENCI *et al.*, 1997) (as *B. terrestris*); Santa Margherita Belice and Montevago (LO VERDE and LA MANTIA, 2011). Messina: Castel di Lucio, San Pietro Patti and Ucria (PRIORE, 1993) (as *B. terrestris dalmatinus*). Catania: Bronte and Milia (MAZZEO *et al.*, 2004; 2006; 2007c; QUARANTA *et al.*, 2004); Motta Sant'Anastasia and Paternò (MAZZEO *et al.*, 2006; QUARANTA *et al.*, 2004) (as *B. terrestris*); Torre Allegra (MAZZEO, 2002; MAZZEO and LONGO, 2002; MAZZEO *et al.*, 1999; 2002a,b; 2006; QUARANTA *et al.*, 2004); Contrada Spina Santa and Ramacca (MAZZEO *et al.*, 2006); Giarre (MAZZEO *et al.*, 1999; 2002a; 2004; QUARANTA *et al.*, 2004) (as *B. terrestris*); Etna park (LONGO *et al.*, 2001); Mt. Tanaurpi (MAZZEO *et al.*, 2007a,b; SEMINARA *et al.*, 2009) (as *B. terrestris terrestris*); Mt. Tanaurpi (SEMINARA *et al.*, 2009) (as *B. terrestris calabricus*). Siracusa: Mt. Iblei (PILATO, 1996; PILATO *et al.*, 2007) (as *B. terrestris calabricus*).

Subgenus *Melanobombus* Dalla Torre, 1880

Bombus lapidarius (Linnaeus, 1758)

Distribution: W-Palaeartic. Only two subspecies present in Italy: *lapidarius* and *decipiens* Pérez, 1879. Present throughout Italy except Sardinia.

Citations for Sicily - Sicily: (STOCH, 2003). Messina: Ucria (PRIORE, 1993) (as *Bombus lapidarius decipiens*). Catania: Milia (QUARANTA *et al.*, 2004) (as *B. lapidarius*); Mt. Tanaurpi (MAZZEO *et al.*, 2007b; SEMINARA *et al.*, 2009) (as *B. lapidarius decipiens*); Torre Allegra (QUARANTA *et al.*, 2004) (as *B. lapidarius*). Siracusa: Mt. Iblei (PILATO *et al.*, 2007) (as *Melanobombus lapidarius decipiens*).

Subgenus *Megabombus* Dalla Torre, 1880

Bombus hortorum (Linnaeus, 1761)

Distribution: Siberian-European. In Italy this species is present only with the nominal subspecies. Throughout Italy, especially above 500 m.

Citations for Sicily - Sicily: (STOCH, 2003). Palermo: Campofelice di Roccella (GRENCI *et al.*, 1997). Agrigento: Santa Margherita Belice and Montevago (LO VERDE and LA MANTIA, 2011). Messina: Ucria (PRIORE, 1993) (as *Bombus hortorum hortorum*); Taormina (BOLCHI SERINI and MARIANELLI, 1994). Catania: Bronte (QUARANTA *et al.*, 2004); Giarre (MAZZEO *et al.*, 2004) (as *Bombus* sp.); Ramacca (MAZZEO *et al.*, 2002a; 2006; QUARANTA *et al.*, 2004); Torre Allegra (QUARANTA *et al.*, 2004). Siracusa: Mt. Iblei (PILATO, 1996) (as *Megabombus hortorum*); (PILATO *et al.*, 2007) (as *M. hortorum*).

Bombus ruderatus (Fabricius, 1775)

Distribution: W-Palaeartic. Present in most of mainland Italy and the islands.

The subspecies present in Italy are: *atrocorbiculosus* Vogt, 1909, *autumnalis* (Fabricius, 1793) (= *eurynotus* Dalla Torre, 1882), *siculus* Friese, 1909, *sardiniensis* (Tournier, 1890) (INTOPPA *et al.*, 2009).

Citations for Sicily - Sicily: STOCH, 2003. Palermo: Petralia Sottana (PAGLIANO, 1994) (as *Bombus ruderatus ruderatus*). Agrigento: Platani river (GRENCI *et al.*, 1997) (as *Megabombus ruderatus autumnalis*). Messina: Castel di Lucio and Ucria (PRIORE, 1993) (as *B. ruderatus atrocorbiculosus*); Taormina (BOLCHI SERINI and MARIANELLI, 1994) (as *B. hortorum siculus*). Catania: Contrada Spina Santa (MAZZEO, 2002; MAZZEO and LONGO, 2002; MAZZEO *et al.*, 2002b; QUARANTA *et al.*, 2004) (as *B. ruderatus*); Bronte, Milia (MAZZEO *et al.*, 2007c); Piano Provenzana (SEMINARA *et al.*, 2009) (as *B. ruderatus eurynotus*); Paternò (QUARANTA *et al.*, 2004) (as *B. ruderatus*); Torre Allegra (MAZZEO, 2002; MAZZEO and LONGO, 2002; MAZZEO *et al.*, 2002a,b; 2006; QUARANTA *et al.*, 2004) (as *B. ruderatus*). Siracusa: Mt. Iblei (PILATO *et al.*, 2007) (as *M. ruderatus autumnalis*).

Subgenus *Thoracobombus* Dalla Torre, 1880

Bombus pascuorum (Scopoli, 1763)

Distribution: Siberian-European. Extremely variable taxon present in Europe and Asia with two dozen of subspecies. Italy has the following subspecies: *pascuorum*, *maculatus* (Vogt, 1909) (= ssp. *intermedius* Vogt, 1909), *melleofacies* (Vogt, 1909), *siciliensis* (Tkalcu, 1977) (= *fairmairei* Friese, 1887 *nec* Sichel, 1864), and *floralis* (Gmelin, 1790) (= ssp. *agrorum* (Fabricius, 1787)). Present throughout mainland Italy but not on Sardinia; the subspecies *siciliensis* is common in Sicily.

Citations for Sicily - Sicily: STOCH, 2003; SINACORI *et al.*, 2002 (as *Thoracobombus pascuorum siciliensis*); NOBILE, 1995 (as *T. pascuorum siciliensis*). Agrigento: Santa Margherita Belice and Montevago (LO VERDE and LA MANTIA, 2011) (as *Bombus pascuorum siciliensis*). Messina: Castel di Lucio and Ucria (PRIORE, 1993) (as *B. pascuorum melleofacies*). Catania: Torre Allegra (MAZZEO, 2002; MAZZEO and LONGO, 2002; MAZZEO *et al.*, 1999; MAZZEO *et al.*, 2002b) (as *B. pascuorum siciliensis*); (QUARANTA *et al.*, 2004) (as *B. pascuorum*); Giarre (MAZZEO *et al.*, 2004) (as *B. pascuorum*); Milia (QUARANTA *et al.*, 2004) (as *B. pascuorum*); (MAZZEO *et al.*, 2002a; 2007c) (as *B. pascuorum siciliensis*); Mt. Tanaurpi (MAZZEO *et al.*, 2007a,b; SEMINARA *et al.*, 2009) (as *B. pascuorum siciliensis*). Siracusa: Mt. Iblei (PILATO, 1996) (as *T. pascuorum siciliensis*); PILATO *et al.*, 2007 (as *T. pascuorum siciliensis*).

Bombus ruderarius (Müller, 1776)

Distribution: Species with Palaearctic distribution. It is present throughout Italy except Sardinia, with two subspecies: *ruderarius* and *montanus* Lepelletier, 1836 (INTOPPA *et al.*, 2009).

Citations for Sicily - Sicily: STOCH, 2003. Catania: Mt. Tanaurpi, Paternò, Spina Santa and Torre Allegra (MAZZEO *et al.*, 2007a, b) (as *Bombus ruderarius montanus*). Siracusa: Mt. Iblei (PILATO, 1996) (as *Megabombus ruderarius montanus*); PILATO *et al.*, 2007 (as *Thoracobombus ruderarius montanus*).

Bombus sylvarum (Linnaeus, 1761)

Distribution: W-Palaearctic. Present throughout Italy except Sardinia.

This taxon is present in Italy with two subspecies: *sylvarum* and *rogenhoferi* Dalla Torre, 1882 (INTOPPA *et al.*, 2009).

Citations for Sicily - Sicily: STOCH, 2003. Messina: Castel di Lucio (PRIORE, 1993) (as *Bombus sylvarum distinctus* Vogt,

1909). Catania: Ramacca and Giarre (MAZZEO *et al.*, 2002a), Milia and Piano Provenzana (SEMINARA *et al.*, 2009) (as *B. sylvarum rogenhoferi*); Mt. Etna (PAGLIANO, 1994) (as *B. sylvarum rogenhoferi*). Siracusa: Mt. Iblei (PILATO, 1996) (as *Megabombus sylvarum rogenhoferi*); (PILATO *et al.*, 2007) (as *Thoracobombus sylvarum rogenhoferi*).

Subgenus *Psithyrus* Lepeletier, 1832

Bombus barbutellus (Kirby, 1802)

Distribution: Palaearctic region. Present throughout Italy, including Sardinia and Sicily.

Bombus barbutellus and *B. maxillosus* Klug, 1817 were considered distinct species with remarkable morphological similarity and with both reported throughout Italy (STOCH, 2003), with a prevalence of *B. barbutellus* in alpine areas. They were deemed synonyms by LECOCQ *et al.*, (2011) as a result of genetic testing.

Citations for Sicily - Sicily: STOCH, 2003. Palermo: Polizzi Generosa (PAGLIANO, 1994) (as *Bombus maxillosus maxillosus*). Catania: Milia (MAZZEO *et al.*, 2004) (as *B. maxillosus italicus*); Mt. Tanaurpi (MAZZEO *et al.*, 2007b) (as *B. maxillosus maxillosus*); Giarre (MAZZEO *et al.*, 2004) (as *Bombus* sp.).

Bombus rupestris (Fabricius, 1793)

Distribution: Palaearctic region. Present throughout Italy except Sardinia.

The subspecies present in Italy are: *rupestris* and *siculus* Reinig, 1931.

Citations for Sicily - Sicily: STOCH, 2003. Messina: Ucria (PRIORE, 1993) (as *Bombus rupestris siculus*). Catania: Mt. Tanaurpi (MAZZEO *et al.*, 2007a,b; SEMINARA *et al.*, 2009) (as *B. rupestris siculus*).

Bombus sylvestris (Lepeletier, 1832)

Distribution: Palaearctic Region. Present in mainland Italy. This species in Italy has not subspecies.

Citations for Sicily - This species has been reported recently in Sicily (Mt. Etna): Milia (MAZZEO *et al.*, 2004) and later found on Mt. Tanaurpi.

Bombus vestalis (Geoffroy, 1785)

Distribution: W-Palaearctic. Present throughout Italy including Sardinia and Sicily.

In Italy this taxon has three subspecies: *vestalis* (Geoffroy, 1785), *obenbergeri* May, 1944, and *sorgonis* Strand, 1917.

Citations for Sicily - Sicily: STOCH, 2003; SINACORI *et al.*, 2002 (as *Ashthonipsithyrus vestalis*). Catania: Torre Allegra (MAZZEO, 2002; MAZZEO and LONGO, 2002; MAZZEO *et al.*, 2002b) (as *Psithyrus vestalis*), (QUARANTA *et al.*, 2004) (as *Bombus vestalis*); Mt. Tanaurpi (MAZZEO *et al.*, 2007b) (as *B. vestalis vestalis*).

FOOD SOURCES

All the bumblebees were observed on 46 *taxa* of plants, comprising a total of 41 plant genera within 17 plant families (Table 2, Fig. I). Some species are of considerable phytogeographic importance, particularly *Astragalus siculus* (Fabaceae) and *Senecio squalidus* subsp. *aetnensis* (Asteraceae), characteristic of high altitudes of the Etna, and *Erysimum bonannianum* C. Presl (Brassicaceae) endemic to Sicily, all present in the site of Piano Provenzana. The herbaceous and woody crop plants visited by bumblebees, included 8 species within the genera *Citrus*, *Malus*, *Prunus*, and *Pyrus* (spring flowering);

Table 2 – Bumblebees recorded in the years 1997-2007 and visited plants; the specimens were separated by altitudinal plans according to the scheme adopted in Table 1.

Bumblebees			Plants		Altitude	N° specimens
Subgenus	Genus and species	Subspecies	Family	Species		
<i>Bombus</i>	<i>Bombus lucorum</i>	<i>lucorum</i>	Rosaceae	<i>Amygdalus communis</i>	1000-1450	4
			Asteraceae, Fabaceae, Rosaceae, Scrophulariaceae, Onagraceae	<i>Senecio squalidus</i> var. <i>aetnensis</i> , <i>Astragalus siculus</i> , <i>Rubus aetnicus</i> , <i>Linaria purpurea</i> , <i>Potentilla calabra</i> , <i>Epilobium angustifolium</i>	1450-2100	410
	<i>Bombus terrestris</i>	<i>terrestris</i>	Boraginaceae, Asteraceae, Rutaceae, Fabaceae, Oxalidaceae, Rosaceae, Dipsacaceae, Verbenaceae	<i>Borago officinalis</i> , <i>Centaurea napifolia</i> , <i>Cbrysanthemum coronarium</i> , <i>Citrus sinensis</i> , <i>Dittrichia viscosa</i> , <i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Eriobotrya japonica</i> , <i>Galactites tomentosa</i> , <i>Hedysarum coronarium</i> , <i>Oxalis pes-caprae</i> , <i>Rubus ulmifolius</i> , <i>Scabiosa maritima</i> , <i>Vitex agnus-castus</i> , <i>Helianthus annuus</i>	0-500	352
			Apiaceae, Rosaceae, Fabaceae, Boraginaceae	<i>Daucus carota</i> , <i>Pyrus communis</i> , <i>Prunus persica</i> , <i>Vicia sativa</i> , <i>Rubus ulmifolius</i> , <i>Echium vulgare</i> var. <i>pustulatum</i>	500-1000	15
			Asteraceae, Boraginaceae, Rosaceae, Fabaceae, Iridaceae, Liliaceae, Brassicaceae, Boraginaceae, Labiatae, Lamiaceae	<i>Onopordum illyricum</i> , <i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Amygdalus communis</i> , <i>Spartium junceum</i> , <i>Anchusa hybrida</i> , <i>Senecio squalidus</i> var. <i>glaber</i> , <i>Romulea bulbocodium</i> , <i>Pyrus communis</i> , <i>Asphodeline lutea</i> , <i>Asphodelus microcarpus</i> , <i>Isatis tinctoria</i> , <i>Vicia sativa</i> , <i>Cynoglossum creticum</i> , <i>Satureja fruticosa</i> , <i>Marrubium vulgare</i>	1000-1450	212
			Fabaceae, Berberidaceae, Onagraceae, Brassicaceae, Scrophulariaceae, Rosaceae, Asteraceae	<i>Astragalus siculus</i> , <i>Berberis aetnensis</i> , <i>Epilobium angustifolium</i> , <i>Erysimum bonannianum</i> , <i>Linaria purpurea</i> , <i>Potentilla calabra</i> , <i>Rubus aetnicus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i>	1450-2100	378
<i>Bombus terrestris</i>	<i>calabricus</i>	Fabaceae, Brassicaceae, Onagraceae, Scrophulariaceae, Rosaceae, Asteraceae	<i>Astragalus siculus</i> , <i>Erysimum bonannianum</i> , <i>Epilobium angustifolium</i> , <i>Linaria purpurea</i> , <i>Rubus aetnicus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i>	1450-2100	219	
<i>Melanobombus</i>	<i>Bombus lapidarius</i>	<i>decipiens</i>	Asteraceae, Boraginaceae, Rosaceae, Lamiaceae	<i>Onopordum illyricum</i> , <i>Anchusa hybrida</i> , <i>Amygdalus communis</i> , <i>Micromeria graeca</i> , <i>Marrubium vulgare</i> , <i>Malus domestica</i> , <i>Echium vulgare</i> var. <i>pustulatum</i>	1000-1450	42
			Fabaceae, Rosaceae, Asteraceae, Brassicaceae	<i>Astragalus siculus</i> , <i>Rubus aetnicus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i> , <i>Erysimum bonannianum</i>	1450-2100	754
<i>Megabombus</i>	<i>Bombus hortorum</i>		Boraginaceae, Asteraceae, Rosaceae	<i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Centaurea napifolia</i> , <i>Helianthus annuus</i> , <i>Eriobotrya japonica</i>	0-500	34
			Lamiaceae	<i>Marrubium vulgare</i>	500-1000	2
	<i>Bombus ruderatus</i>	<i>autumnalis</i>	Boraginaceae	<i>Echium vulgare</i> var. <i>pustulatum</i>	500-1000	3
			Boraginaceae, Rosaceae, Lamiaceae	<i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Amygdalus communis</i> , <i>Marrubium vulgare</i>	1000-1450	28
			Fabaceae, Asteraceae	<i>Astragalus siculus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i>	1450-2100	30

(Continued)

Continued Table 2.

Bumblebees			Plants		Altitude	N° specimens	
Subgenus	Genus and species	Subspecies	Family	Species			
Thoracobombus	<i>Bombus pascuorum</i>	<i>siciliensis</i>	Verbenaceae, Rosaceae	<i>Vitex agnus-castus</i> , <i>Rubus ulmifolius</i> , <i>Eriobotrya japonica</i>	0-500	106	
			Scrophulariaceae, Boraginaceae, Labiatae, Lamiaceae	<i>Linaria purpurea</i> , <i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Linaria heterophylla</i> , <i>Satureja fruticosa</i> , <i>Marrubium vulgare</i>	1000-1450	11	
			Scrophulariaceae, Fabaceae, Rosaceae, Asteraceae	<i>Linaria purpurea</i> , <i>Astragalus siculus</i> , <i>Rubus aetniscus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i>	1450-2100	260	
	<i>Bombus ruderarius</i>	<i>montanus</i>	Boraginaceae, Fabaceae, Brassicaceae, Asteraceae	<i>Echium vulgare</i> var. <i>pustulatum</i> , <i>Hedysarum coronarium</i> , <i>Diploaxis eruroides</i> , <i>Centaurea napifolia</i>	0-500	34	
			Scrophulariaceae	<i>Linaria purpurea</i>	1450-2100	1	
	<i>Bombus sylvarum</i>	<i>rogenhoferi</i>	Asteraceae	<i>Helianthus annuus</i>	0-500	1	
			Lamiaceae, Rosaceae	<i>Micromeria graeca</i> , <i>Marrubium vulgare</i> , <i>Malus domestica</i>	1000-1450	4	
			Rosaceae, Asteraceae, Fabaceae	<i>Rubus aetniscus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i> , <i>Astragalus siculus</i>	1450-2100	97	
	Psithyrus	<i>Bombus barbutellus</i>		Rosaceae	<i>Eriobotrya japonica</i>	0-500	2
				Rosaceae	<i>Amygdalus communis</i>	1000-1450	1
Berberidaceae, Rosaceae				<i>Berberis aetnensis</i> , <i>Rubus aetniscus</i>	1450-2100	14	
<i>Bombus rupestris</i>		<i>siculus</i>	Asteraceae	<i>Centaurea napifolia</i>	0-500	12	
			Asteraceae, Scrophulariaceae, Fabaceae, Berberidaceae, Onagraceae	<i>Senecio squalidus</i> var. <i>aetnensis</i> , <i>Linaria purpurea</i> , <i>Astragalus siculus</i> , <i>Berberis aetnensis</i> , <i>Epilobium angustifolium</i>	1450-2100	362	
<i>Bombus sylvestris</i>			Rosaceae, Caryophyllaceae	<i>Amygdalus communis</i> , <i>Silene colorata</i>	1000-1450	3	
			Onagraceae	<i>Epilobium angustifolium</i>	1450-2100	1	
<i>Bombus vestalis</i>		<i>vestalis</i>	Fabaceae	<i>Hedysarum coronarium</i>	0-500	1	
			Fabaceae, Asteraceae, Berberidaceae	<i>Astragalus siculus</i> , <i>Senecio squalidus</i> var. <i>aetnensis</i> , <i>Berberis aetnensis</i>	1450-2100	33	

Hedysarum and *Helianthus* (summer flowering); and *Amygdalus* and *Eriobotrya* (winter flowering). Eight species of bumblebees (66%) were found on almond trees (to 1000 m) and loquat (to 81 m), in December-January and December-February, respectively (Table 2).

All *Bombus* species collected in the surveys are polylectic, as shown by the data of the visited plants (Table 2). Figure I shows the number of species of bumblebees observed on each botanical family of surveyed plants. Most species of bumblebees were found on Asteraceae, Rosaceae, and Fabaceae. As regards food preferences, in Fig. II it is evident that some bumblebees have visited a large number of plants belonging to different families (e.g. *B. terrestris*, *B. pascuorum*, and *B. lucorum*), while others have been attracted only by two or three botanical species (e.g. *B. maxillosus*).

DISCUSSION AND CONCLUSIONS

In the ten years of research, bumblebees accounted for 16.46% of all Apoidea detected. In total, we found 12 species of bumblebees, 4 of which belong to the subgenus *Psithyrus*,

2 to *Bombus*, 1 to *Melanobombus*, 2 to *Megabombus*, and 3 to *Thoracobombus*; among them, *B. sylvestris* was not previously known in Sicily and was reported during investigation (MAZZEO *et al.*, 2004). Each species is represented by a single sub-species, with the exception of *Bombus terrestris* represented by *B. terrestris terrestris* (34.33% of total) and *B. terrestris calabricus* (Table. 2). *B. terrestris terrestris*, ubiquitous and abundant, is predominant for number of specimens and range, and was found at all altitudes of Etna; *B. terrestris calabricus* was instead found only at 1900 m. *Bombus lapidarius decipiens* (23.23%) was found only in two localities above 1000 m (Milia and Piano Provenzana); *B. lucorum* (12.08%) was detected in the same location as *B. lapidarius*. *Bombus ruderarius* (1.02%), *B. vestalis* (0.99%), *B. barbutellus* (0.5%) and *B. sylvestris* (0.12%) were less frequent (Table 2).

The greatest number of species was found in the thermo-mediterranean and meso-mediterranean horizons, where their presence was abundant even in the coldest months of the year on winter-flowering crops such as almond and loquat.

In the mountain-mediterranean plan and in the supra-mediterranean horizon, *Bombus lapidarius decipiens* and *B. lucorum lucorum* were more abundant; *Bombus sylvestris*

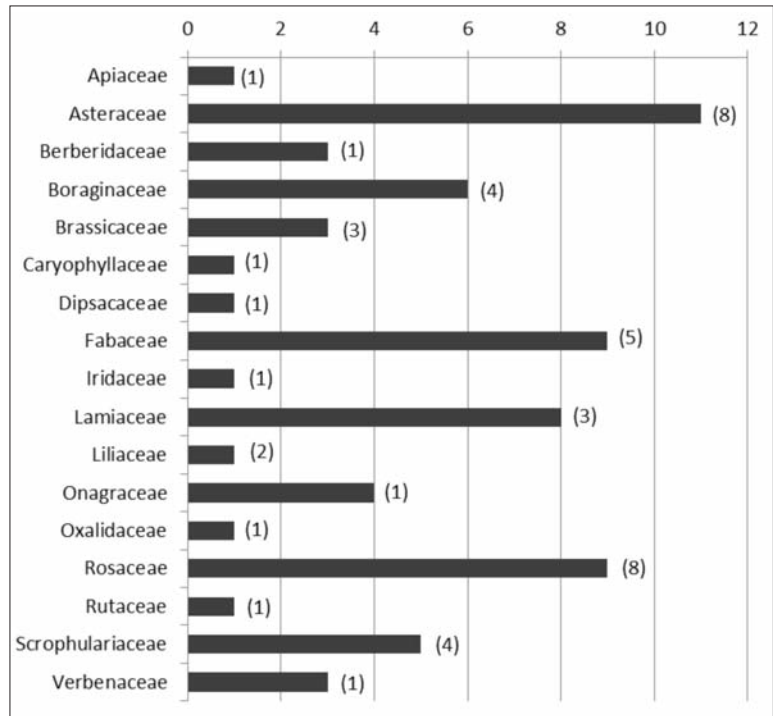


Fig. I – Number of bumblebees species recorded in the years 1997-2007 on plants in relation to botanical families (in brackets the number of plant taxa per family).

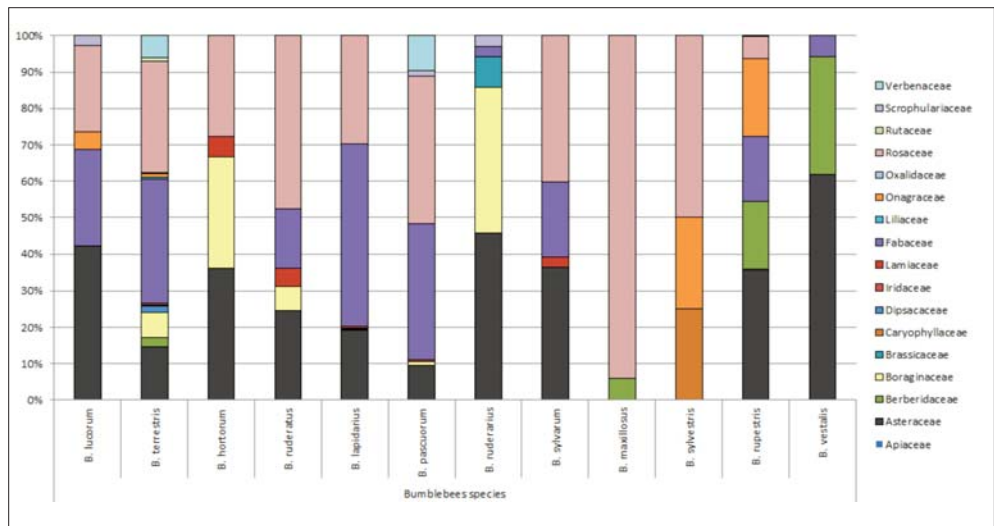


Fig. II – Species of bumblebees and botanical families visited in the years 1997-2007.

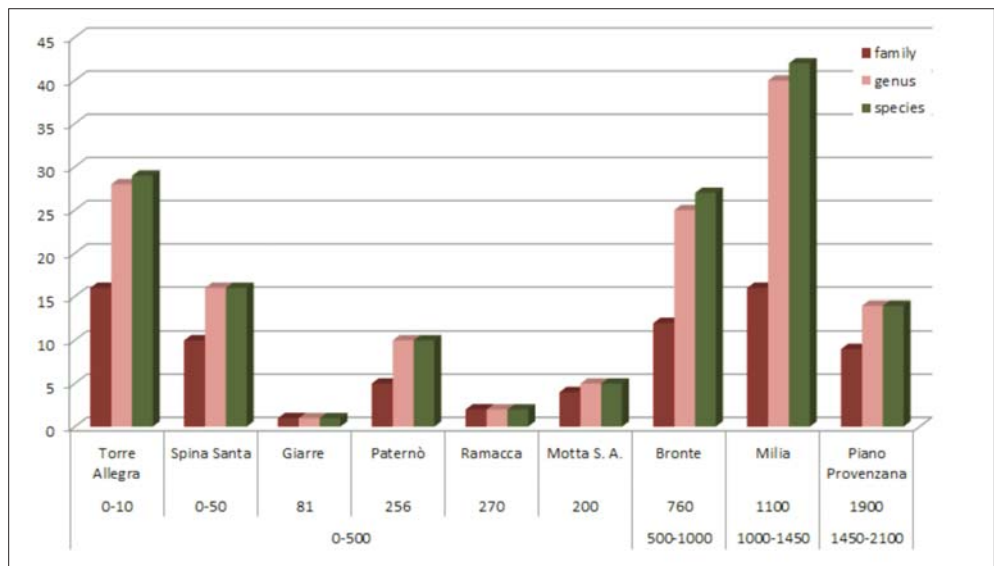


Fig. III – Number of families, genera, and species of visited plants in the years 1997-2007 in relation to the altitudinal zones.

was very rare in the years of the investigation, with only 4 specimens recorded.

The largest number of plant species was found in the two semi-natural ecosystems of Torre Allegra and Milia and in the agro-ecosystem of Bronte (Fig. III); the species of plants visited by bumblebees were less numerous in the Piano Provenzana area, although the largest number of species of *Bombus* was found here.

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