GAETANA MAZZEO ^a - SANTI LONGO ^a - ALICE R. SEMINARA ^b - SALVATORE BELLA ^c

FAUNISTIC AND ECOLOGICAL STUDIES ON APIDAE (HYMENOPTERA APOIDEA) IN NATURAL AND CULTIVATED ECOSYSTEMS IN SICILY

^a *Dipartimento di Agricoltura, Alimentazione e Ambiente, sez. Entomologia applicata. Università degli Studi di Catania, via S. Sofia 100 - 95123 Catania, Italy.*^b *PhD in "Tecnologie Fitosanitarie" – via N. Coviello 26 - 951030 Gravina di Catania (CT), Italy.*^c *(CREA) Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria. Centro di ricerca olivicoltura, frutticoltura e agrumicoltura. Corso Savoia 190 - 95024 Acireale (CT), Italy. E-mail: salvatore.bella@crea.gov.it.*

Corresponding Author: Gaetana Mazzeo, gamazzeo@unict.it

Mazzeo G., Longo S., Seminara A.R., Bella S. – Faunistic and ecological studies on Apidae (Hymenoptera Apoidea) in natural and cultivated ecosystems in Sicily.

The authors give the results from more than a decade of studies on Apidae (Hymenoptera, Apoidea) in eastern Sicily, carried out in natural and cultivated ecosystems at different altitudes in the Mediterranean Basal (0-1450 m a.s.l.), and Mountain-Mediterranean plans (1450-2100 m a.s.l.). Seven species are reported for the Mountain-Mediterranean plan at the highest altitude (Piano Provenzana, 1845 m, rich in endemic plants from Etna and Sicily, such as *Astragalus*, *Rubus* and *Senecio*): *Anthophora balearica* (Friese), *A. retusa* (L.), *Apis mellifera* L., *Ceratina chalybea* Chevrier, *Epeolus julliani* Pérez, *Eucera aterrima* Friese and *Xylocopa violacea* (L.). Thirty-one bee species were recorded in the Mediterranean Basal plan, with *Apis mellifera* and *Xylocopa violacea* ubiquitous and abundant in all sites surveyed. Overall, 35 species of Apidae belonging to 11 genera are reported here: *Amegilla* (2 species), *Anthophora* (6 species), *Apis* (1 species), *Ceratina* (7 species), *Epeolus* (1 species), *Eucera* (10 species), *Habropoda* (1 species), *Melecta* (1 species), *Nomada* (3 species), *Tetraloniella* (1 species), and *Xylocopa* (2 species). Data on the surveyed species are discussed in relation to the altitudinal level, the plants visited, and the ecological quality of the sites where the specimens were found.

KEY WORDS: Apidae; Biodiversity; Plants; Ecosystems; Sicily; Altitudinal plans.

INTRODUCTION

The evaluation of the biodiversity and quality of natural environments and agro-ecosystems is based on the knowledge of the organisms living there, particularly on the study of key species used as bioindicators. Insects are considered good bioindicators, particularly solitary and social bees, due to their relationships to the plants they visit for taking nectar and pollen (PORRINI *et al.*, 2002; CELLI and MACCAGNANI, 2003).

Bees contribute significantly to the pollination of crops and wild plants, and are of great importance for the protection of natural environments (LONGO *et al.*, 2002; BELLA, 2014; MARGIOTTA *et al.*, 2017). In Europe, this group is threatened by habitat loss from agricultural intensification, urban development, and a changing climate. Knowledge about bees and their ecological role is particularly poor in southern European countries. It is therefore essential to analyse recent data about the distribution, population trends, and ecology of the species living in a certain territory that is considered critical for the conservation of bee diversity and for the benefits associated with pollination (NIETO *et al.*, 2014; BALZAN *et al.*, 2016).

In order to know the ecological status of natural and anthropic ecosystems in Sicily, observations were conducted for a period of 11 years on anthophilous insects detected on flowers in different ecosystems. Some of the results regarding crops and some groups of anthophilous insects have already been published, and the data showed that the majority of the insects belonged to Hymenoptera and to the family Apidae (QUARANTA *et al.*, 2004; MAZZEO

et al., 2004, 2006, 2007a,b,c; SEMINARA *et al.*, 2009). This paper, is focused on Apidae (Hymenoptera, Apoidea) species recorded in 11 years of surveys, from sea level to the high slopes of the volcano Etna (eastern Sicily). Twelve species (13 taxa) of *Bombus* Latreille recorded in the same period of investigation, were treated in detail in MAZZEO *et al.* (2015) and were thus excluded from the discussion.

In this context, this paper represents a first step to the study of ecological traits of bees in a very particular area, the Mount Etna, by providing a list of species, with data on visited plants, altitudinal quotes and features of the areas where the specimens were found.

MATERIALS AND METHODS

THE INVESTIGATED TERRITORY

The surveys were carried out from 1997 to 2007 in nine sites representative of the main environments of eastern Sicily, from sea level to 1900 m a.s.l. on Mount Etna, in Catania province. The sites differed in climate and vegetational aspects. Overall, the climate is Mediterranean, with variations in slope, altitude, and exposure. In the basal plane on the coast, the climate is thermo-Mediterranean (xerothermic-hot), with average temperatures ≥ 16 °C; the following survey sites were located here: Catania (Torre Allegra, and Spina Santa), Giarre (Contrada Nespole), Motta Sant'Anastasia, Paternò and Ramacca. In the hilly zone, the climate is meso-mediterranean with average temperatures between 12 and 16 °C; the following sites were here: Bronte, and Milia (Monte San Leo, Belpasso). In the higher sites of

the high mountain ranges, the climate is oro-mediterranean with average temperatures $\leq 8^\circ\text{C}$ (SIAS, 2014; MAZZEO *et al.*, 2015; POLI MARCHESE and PATTI, 2000); the site of Piano Provenzana (Monte Tanaurpi, Linguaglossa) was here. The vegetational aspects characterising these sites are influenced both by human activity, especially in the mid-baseline plane, and by the activity of the volcano in the central summit. The bioclimatic zones (“altitudinal plans” and “horizons”) constituted by plant groupings at various altitudes, include a medium-baseline plan (0-1450 m a.s.l.) that is characterised by cropland (mainly citrus orchards, olive groves, vineyards, and orchards), oak and pine forests, a mountain plan (1450-2100 m a.s.l.) that comprise pine and beech forests and pioneer plants in upper altitudinal limit of the arboreal vegetation, a high plan (2100-2950 up to the volcanic desert at 3330 m a.s.l.) where a characteristic group of species is present. In this area, the predominant plants are *Astragalus siculus* Biv., capable of colonising the slopes of loose volcanic sand and providing shelter to other species, and some endemic to the volcano, such as *Senecio aetnensis* Jan ex DC., *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

The nine surveyed areas were divided into the following three types based on floristic complexity and the degrees of human and agronomic aspects: agro-ecosystems [AE]; natural ecosystems [NE]; and semi-natural ecosystems [SN]. The sites are described in Table 1.

SAMPLING METHODS

The protocol of the surveys was developed within the Italian project A.M.A. (Ape, Miele, Ambiente) (QUARANTA

et al., 2004) with some modifications. Anthophilous insects were recorded in each site along a transect of 400-600 m, representative of the spontaneous flora that were preliminarily defined in all surveyed areas. The wild plants were collected, prepared and identified in case of doubt by the specialist. The observations were conducted on wild plants once a month, while the cultivated plants were observed three times during the flowering period. The distribution, locality and date of capture, number and sex of examined specimens, number of observed specimens in brackets, and the plants visited are reported for each species. Each specimen was prepared dry and specifically identified after the observation of male sexual structures in cases of doubt.

The classification used in this paper followed MICHENER (2007) for supra-specific taxa, and their nomenclature was according to STOCH (2003) and POLASZEK (2013). Updated distributional data were taken from the online check-list by COMBA (2015), KUHLMANN *et al.* (2015) and RASMONT and HAUBRUGE (2018). The species were assigned to chorological categories according to LA GRECA (1964).

The collected material is preserved in the collection of the Department of Agriculture, Food and Environment, sect. Applied Entomology, University of Catania.

Acronyms used in the text for the collectors and determiners as follows: AS (Alice Seminara); SB (Salvatore Bella); VL (Vincenzo Lizzio); MQ (Marino Quaranta); MS (Maximilian Schwarz); VN (Vittorio Nobile).

RESULTS

FAUNISTIC DIVERSITY

Over the course of 11 years more than 14600 specimens of Apidae were collected or observed, belonging to 35 species.

Table 1 – Sites where the surveys were carried out in 1997-2007.

Sites	m a.s.l.	Ecological types	Geographic coordinates	Description	
				General info	Crops and plants
Torre Allegra	5	[SN]	37°24'N 15°04'E	Within the nature reserve “Oasi del Simeto”, behind the coastline	Sulla and wheat, surrounded by large wetlands with characteristic wild plants
Spina Santa	18	[AE]	37°24'N 14°57'E	Large cultivated areas	Cereals, sulla, and vegetables, with natural flora present in the residual zones
Motta Sant'Anastasia	70	[AE]	37°30'N 14°53'E	Large cultivated areas	Citrus and little natural vegetation
Giarre	81	[AE]	37°44'N 15°10'E	Large cultivated areas	Avocado, citrus, mango, fejoia, loquat, and other fruits, with native flora in marginal zones
Ramacca	200	[AE]	37°23'N 14°41'E	Agro-ecosystem	Cereals and oilseeds; marginal areas with native flora
Paternò	256	[AE]	37°33'N 14°54'E	Large cultivated areas	Citrus groves in intensive culture with residual natural vegetation
Bronte	625	[AE]	37°48'N 14°47'E	Large cultivated areas	Peach and pear, surrounded by oak forests
Milia	1046	[SN]	37°39'N 14°59'E	Within Etna Park	Pome and stone-fruit orchards with an abundance of wild flowers
Piano Provenzana	1845	[NE]	37°47'N 15°02'E	Within Etna Park (site Natura 2000 ITA 070009) at the altitudinal limit of pioneer vegetation	Rich in plants of high ecological value, with the presence of many endemic species

The species belonged to eleven genera: *Amegilla* (2 species), *Anthophora* (6 species), *Apis* (1 species), *Ceratina* (7 species), *Epeolus* (1 species), *Eucera* (10 species), *Habropoda* (1 species), *Melecta* (1 species), *Nomada* (3 species), *Tetraloniella* (1 species), and *Xylocopa* (2 species). Overall, the Apidae genera were represented as follows: *Amegilla* (12 specimens; 0.08% of the total number), *Anthophora* (94 specimens; 0.65%), *Apis* (13.666 specimens; 94.57%) *Ceratina* (124 specimens; 0.86%), *Epeolus* (1 specimen; 0.01%), *Eucera* (421 specimens; 2.91%), *Habropoda* (13 specimens; 0.09%), *Melecta* (1 specimen; 0.01%), *Nomada* (18 specimens; 0.12%), *Tetraloniella* (3

specimens; 0.02%), and *Xylocopa* (98 specimens; 0.68%). *Apis mellifera* Linnaeus, was the most numerous and common species, recorded in all environments investigated, due to the widespread practice of beekeeping.

Table 2 shows the recorded entities with the list of plants visited in relation to the altitudinal plans.

FOOD SOURCES

The surveyed Apidae were observed on 68 species of plants, comprising a total of 63 plant genera within 27 plant families (Tables 2, 3, and Fig. 1). Particularly interesting was the site of Piano Provenzana, where there were species

Table 2 – Taxa and related number of specimens of the bees (Apidae family, bumblebees excluded) recorded on Mount Etna in the period 1997-2007 on cultivated and wild plants at different altitudinal plans.

Bees		Plants		Altitude	No. specimens
Genus	Species/subspecies	Family	Species		
<i>Amegilla</i>	<i>albigena</i>	Verbenaceae	<i>Vitex agnus-castus</i>	0-500	5
	<i>quadrifasciata</i>	Asteraceae, Brassicaceae	<i>Helianthus annuus</i> , <i>Moricandia arvensis</i>	0-500	4
		Boraginaceae, Scrophulariaceae, Asteraceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Linaria purpurea</i> , <i>Onopordum illyricum</i>	1000-1450	3
<i>Anthophora</i>	<i>aestivalis</i>	Asteraceae	<i>Centaurea napifolia</i>	0-500	1
	<i>balearica</i>	Brassicaceae	<i>Erysimum aetnense</i>	1450-2100	1
	<i>balneorum</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	1000-1450	1
	<i>crinipes</i>	Asteraceae	<i>Onopordum illyricum</i>	1000-1450	10
	<i>plumipes squalens</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	0-500	67
		Boraginaceae, Rosaceae	<i>Anchusa hybrida</i> , <i>Pyrus communis</i>	1000-1450	8
	<i>retusa</i>	Brassicaceae	<i>Raphanus raphanistrum</i>	500-1000	2
		Rosaceae	<i>Rubus aetnensis</i>	1450-2100	4
<i>Apis</i>	<i>mellifera</i>	Apiaceae, Asteraceae, Boraginaceae, Brassicaceae, Convolvulaceae, Cucurbitaceae, Dipsacaceae, Euphorbiaceae, Fabaceae, Mirtaceae, Oxalidaceae, Resedaceae, Rosaceae, Rutaceae, Tamaricaceae, Verbenaceae	<i>Ammi visnaga</i> , <i>Anthemis arvensis</i> , <i>Borago officinalis</i> , <i>Brassica nigra</i> , <i>Calendula arvensis</i> , <i>Centaurea napifolia</i> , <i>Cerinth major</i> , <i>Chrozophora tinctoria</i> , <i>Citrullus lanatus</i> , <i>Citrus sinensis</i> , <i>Calystegia sepium</i> , <i>Diploaxis erucoides</i> , <i>Diploaxis tenuifolia</i> , <i>Dittrichia viscosa</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Eriobotrya japonica</i> , <i>Eucalyptus camaldulensis</i> , <i>Galactites tomentosa</i> , <i>Hedysarum coronarium</i> , <i>Helianthus annuus</i> , <i>Heliotropium europaeum</i> , <i>Knautia integrifolia</i> , <i>Melilotus officinalis</i> , <i>Oxalis pes-caprae</i> , <i>Reseda alba</i> , <i>Rubus ulmifolius</i> , <i>Scabiosa maritima</i> , <i>Sonchus oleraceus</i> , <i>Tamarix gallica</i> , <i>Vitex agnus-castus</i>	0-500	10.737
		Asteraceae, Brassicaceae, Onagraceae, Rosaceae	<i>Diploaxis erucoides</i> , <i>Dittrichia viscosa</i> , <i>Epilobium hirsutum</i> , <i>Malus domestica</i> , <i>Prunus spinosa</i> , <i>Pulicaria dysenterica</i> , <i>Pyrus communis</i> , <i>Rubus ulmifolius</i>	500-1000	400
		Asteraceae, Fagaceae, Geraniaceae, Labiatae, Lamiaceae, Rosaceae, Scrophulariaceae	<i>Amygdalus communis</i> , <i>Calamintha foliosa</i> , <i>Carlina nebrodensis</i> , <i>Castanea sativa</i> , <i>Erodium acaule</i> , <i>Linaria purpurea</i> , <i>Malus domestica</i> , <i>Micromeria graeca</i> , <i>Onopordum illyricum</i> , <i>Pyrus communis</i> , <i>Salvia verbenaca</i> , <i>Satureja fruticosa</i> , <i>Senecio glaber</i> , <i>Rubus ulmifolius</i>	1000-1450	448
		Asteraceae, Berberidaceae, Fabaceae, Onagraceae, Rosaceae, Rubiaceae, Scrophulariaceae	<i>Astragalus sculus</i> , <i>Berberis aetnensis</i> , <i>Epilobium angustifolium</i> , <i>Galium aetnensis</i> , <i>Linaria purpurea</i> , <i>Rosa canina</i> , <i>Rubus aetnensis</i> , <i>Senecio aetnensis</i> , <i>Tanacetum siculum</i>	1450-2100	2.081
<i>Ceratina</i>	<i>chalcites</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	500-1000	2
		Asteraceae	<i>Onopordum illyricum</i>	1000-1450	1
	<i>chalybea</i>	Asteraceae	<i>Senecio aetnensis</i> , <i>Tanacetum siculum</i>	1450-2100	7

(continued)

Continued Table 2

Bees		Plants		Altitude	No. specimens
Genus	Species/subspecies	Family	Species		
<i>Ceratina</i>	<i>cucurbitina</i>	Boraginaceae, Verbenaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Vitex agnus-castus</i>	0-500	9
		Asteraceae, Boraginaceae, Brassicaceae, Rosaceae	<i>Diploaxis erucoides</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Galactites tomentosa</i> , <i>Malus domestica</i>	500-1000	15
		Asteraceae, Boraginaceae, Rosaceae, Scrophulariaceae	<i>Bellis perennis</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Linaria purpurea</i> , <i>Malus domestica</i> , <i>Pyrus communis</i> , <i>Senecio glaber</i>	1000-1450	65
	<i>cyanea</i>	Asteraceae, Verbenaceae	<i>Dittrichia viscosa</i> , <i>Vitex agnus-castus</i>	0-500	15
	<i>dallatorreana</i>	Asteraceae, Boraginaceae, Verbenaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Helianthus annuus</i> , <i>Vitex agnus-castus</i>	0-500	7
	<i>dentiventris</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	500-1000	1
		Boraginaceae	<i>Heliotropium europaeum</i>	1000-1450	1
	<i>nigrolabiata</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	500-1000	1
<i>Epeolus</i>	<i>julliani</i>	Scrophulariaceae	<i>Linaria purpurea</i>	1450-2100	1
<i>Eucera</i>	<i>aterrima</i>	Fabaceae, Rosaceae	<i>Astragalus siculus</i> , <i>Rubus aetniscus</i>	1450-2100	7
	<i>caspica</i>	Boraginaceae, Fabaceae	<i>Anchusa hybrida</i> , <i>Vicia sativa</i>	1000-1450	3
	<i>eucnemidea</i>	Asteraceae, Boraginaceae, Fabaceae, Malvaceae	<i>Centaurea napifolia</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Galactites tomentosa</i> , <i>Glebionis</i> <i>coronaria</i> , <i>Hedysarum coronarium</i> , <i>Lavatera</i> <i>trimestris</i> , <i>Reichardia picroides</i>	0-500	364
		Asteraceae	<i>Galactites tomentosa</i>	500-1000	2
	<i>nigrescens</i>	Fabaceae	<i>Hedysarum coronarium</i>	0-500	1
		Boraginaceae, Fabaceae	<i>Borago officinalis</i> , <i>Vicia sativa</i>	500-1000	6
		Fabaceae	<i>Vicia sativa</i>	1000-1450	1
	<i>notata</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	0-500	3
		Asteraceae, Fabaceae	<i>Lathyrus grandiflorus</i> , <i>Onopordum illyricum</i>	1000-1450	5
	<i>numida numida</i>	Fabaceae	<i>Hedysarum coronarium</i>	0-500	2
	<i>oraniensis</i>	Asteraceae	<i>Galactites tomentosa</i>	0-500	9
		Rosaceae	<i>Amygdalus communis</i>	1000-1450	5
	<i>proxima</i>	Fabaceae	<i>Hedysarum coronarium</i>	0-500	3
	<i>seminuda</i>	Asteraceae, Rutaceae	<i>Citrus sinensis</i> , <i>Galactites tomentosa</i>	0-500	7
	<i>vulpes</i>	Asteraceae, Boraginaceae	<i>Centaurea napifolia</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i>	0-500	3
<i>Habropoda</i>	<i>tarsata</i>	Boraginaceae, Fabaceae, Rosaceae	<i>Anchusa hybrida</i> , <i>Lathyrus grandiflorus</i> , <i>Pyrus communis</i>	1000-1450	13
<i>Melecta</i>	<i>albifrons nigra</i>	Boraginaceae	<i>Echium vulgare</i> ssp. <i>pustulatum</i>	0-500	1
<i>Nomada</i>	<i>discrepans</i>	Asteraceae, Rosaceae	<i>Pulicaria dysenterica</i> , <i>Rubus ulmifolius</i>	0-500	9
	<i>distinguenda</i>	Asteraceae, Verbenaceae	<i>Pulicaria dysenterica</i> , <i>Vitex agnus-castus</i>	0-500	6
	<i>succincta</i>	Rosaceae	<i>Amygdalus communis</i> , <i>Pyrus communis</i>	1000-1450	3
<i>Tetraloniella</i>	<i>dentata fulviscopa</i>	Asteraceae, Lamiaceae	<i>Marrubium vulgare</i> , <i>Onopordum illyricum</i>	1000-1450	3
<i>Xylocopa</i>	<i>iris</i>	Verbenaceae	<i>Vitex agnus-castus</i>	0-500	14
		Lamiaceae, Rosaceae	<i>Amygdalus communis</i> , <i>Micromeria graeca</i>	1000-1450	2
	<i>violacea</i>	Boraginaceae, Rosaceae, Verbenaceae	<i>Borago officinalis</i> , <i>Eriobotrya japonica</i> , <i>Rubus</i> <i>ulmifolius</i> , <i>Vitex agnus-castus</i>	0-500	20
		Asteraceae, Boraginaceae, Rosaceae	<i>Borago officinalis</i> , <i>Dittrichia viscosa</i> , <i>Prunus</i> <i>persica</i> , <i>Pulicaria dysenterica</i>	500-1000	6
		Asphodelaceae, Asteraceae, Boraginaceae, Lamiaceae, Rosaceae	<i>Amygdalus communis</i> , <i>Anchusa hybrida</i> , <i>Asphodelus ramosus</i> , <i>Echium vulgare</i> ssp. <i>pustulatum</i> , <i>Marrubium vulgare</i> , <i>Pyrus communis</i> , <i>Senecio glaber</i>	1000-1450	41
		Caryophyllaceae, Fabaceae, Rosaceae	<i>Astragalus siculus</i> , <i>Rubus aetniscus</i> , <i>Saponaria sicula</i>	1450-2100	15

Table 3 – Species of Apidae and botanical families.

<div><div>Plant's family</div><div>Apidae species</div></div>	ASPHODELACEAE	APIACEAE	ASTERACEAE	BERBERIDACEAE	BORAGINACEAE	BRASSICACEAE	DIPSACACEAE	CARYOPHYLLACEAE	CONVOLVULACEAE	CUCURBITACEAE	EUPHORBACEAE	FABACEAE	FAGACEAE	GERANIACEAE	LABIATAE	LAMIACEAE	MALVACEAE	MYRTACEAE	ONAGRACEAE	OXALIDACEAE	RESEDACEAE	ROSACEAE	RUBIACEAE	RUTACEAE	SCROPHULARIACEAE	TAMARICACEAE	VERBENACEAE
<i>Amegilla albigena</i>																											5
<i>Amegilla quadrifasciata</i>			3		1	2																			1		
<i>Anthophora aestivalis</i>			1																								
<i>Anthophora balearica</i>						1																					
<i>Anthophora balneorum</i>					1																						
<i>Anthophora crinipes</i>			10																								
<i>Anthophora plumipes squalens</i>					74																	1					
<i>Anthophora retusa</i>						2																4					
<i>Apis mellifera</i>		2	1550	70	878	127	21		60	21	2	2690	50	1	40	100		154	386	37	2	4836	8	2194	43	365	29
<i>Ceratina chalcites</i>			1		2																						
<i>Ceratina chalybea</i>			7																								
<i>Ceratina cucurbitina</i>			8		7	1																67			1		5
<i>Ceratina cyanea</i>			3																								12
<i>Ceratina dallatorreana</i>			2		1																						4
<i>Ceratina dentiventris</i>					2																						
<i>Ceratina nigrolabiata</i>					1																						
<i>Epeolus julliani</i>																									1		
<i>Eucera aterrima</i>												5										2					
<i>Eucera caspica</i>					1							2															
<i>Eucera eucnemidea</i>			99		16							1					248										
<i>Eucera nigrescens</i>					2							6															
<i>Eucera notata</i>			2		3							3															
<i>Eucera numida numida</i>												2															
<i>Eucera oraniensis</i>			9																			5					
<i>Eucera proxima</i>												3															
<i>Eucera seminuda</i>			6																					1			
<i>Eucera vulpes</i>			2		1																						
<i>Habropoda tarsata</i>					5							7										1					

(continued)

Continued Table 3

Plant's family																											
	Asphodelaceae	Apiaceae	Asteraceae	Berberidaceae	Boraginaceae	Brassicaceae	Dipsacaceae	Caryophyllaceae	Convolvulaceae	Cucurbitaceae	Euphorbiaceae	Fabaceae	Fagaceae	Geraniaceae	Labiatae	Lamiaceae	Malvaceae	Myrtaceae	Onagraceae	Oxalidaceae	Resedaceae	Rosaceae	Rubiaceae	Rutaceae	Scrophulariaceae	Tamaricaceae	Verbenaceae
Apidae species																											
<i>Melecta albifrons nigra</i>					1																						
<i>Nomada discrepans</i>			6																			3					
<i>Nomada distinguenda</i>			3																								3
<i>Nomada succincta</i>																						3					
<i>Tetraloniella dentata fulviscopa</i>			2													1											
<i>Xylocopa iris</i>																1						1					14
<i>Xylocopa violacea</i>	1		3		4			6				7				4						45					12

Fig. I – Number of families, genera, and species of plants visited by bees in the period 1997-2007 in relation to the altitudinal plans.

of considerable phytogeographic importance, such as *Astragalus siculus* (Fabaceae) and *Senecio aethnensis* (Asteraceae), characteristic of high altitudes of Etna, and *Erysimum aetnense* Jord. (Brassicaceae), all endemic to Sicily. In this environment, most of the bees were recorded on plants with the highest potential of honey, such as *Astragalus*, *Rubus* and *Senecio*. Here, despite the position inside a protected area, the total number of plants was low (Fig. I) due to the extreme climatic conditions of this high mountain environment. 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. I). In this latter, this is explained with the presence of a large number of wild plants surrounding the agro-ecosystems. The herbaceous and woody cultivated plants visited by bees included 11 species within *Castanea*, *Citrus*, *Eucalyptus*, *Malus*, *Prunus*, and *Pyrus* (spring flowering); *Hedysarum* and *Helianthus* (summer flowering); and *Amygdalus* and *Eriobotrya* (winter flowering). Only five species of bees were found on almond trees (cultivated at an altitude of

1000 m) and loquat (81 m) in December-January and December-February, respectively (Table 2). In this adverse season, only the following species were noticed: *Apis mellifera*, *Eucera oraniensis* Lepeletier, *Nomada succincta* Panzer, *Xylocopa iris* (Christ) and *X. violacea* (L.).

Table 3 shows the number of species of bees observed on each botanical family of plants surveyed. Most of the species of the bees were found on Asteraceae (19 species), Rosaceae (11 species), and Fabaceae (10 species). As regards the food preferences, only a few bee species visited a large number of plants belonging to different families (polylectic bees, e.g. *Apis mellifera*, *Ceratina cucurbitina* and *Xylocopa violacea*), whereas the majority were attracted by only two or three botanical species (oligolectic bees) (Table 3).

DETECTED TAXA

Family Apidae Latreille, 1802

Genus *Amegilla* Friese, 1897

Amegilla (Zembramegilla) albigena (Lepeletier, 1841)

Distribution: Central-Asiatic, European-Mediterranean.

Examined specimens: Torre Allegra, 28.VII.1998, 1 ♂, (3), 23.VII.1999, 1 ♂, SB leg., MQ det.

Amegilla (Amegilla) quadrifasciata

(De Villiers, 1789)

Distribution: Palaearctic.

Examined specimens: Ramacca, 23.VI.1999, 1 ♀, 02.VII.1999, 2 ♀♀, 12.VII.1999, 1 ♂, SB leg., MQ det.; Milia, 21.IX.2004, (1), 16.VII.2005, 1 ♀, (1), SB leg. and det.

Genus *Anthophora* Latreille, 1803

Anthophora (Anthophora) crinipes Smith, 1854

(= *salviae* Panzer, 1804)

Distribution: Asiatic-European.

Examined specimens: Milia, 07.V.2003, 1 ♂, (9), SB leg., MQ det.

Anthophora (Anthophora) plumipes squalens

Dours, 1869

Distribution: South-central Europe, and Maghreb.

Examined specimens: Torre Allegra, 14.IV.1998, 5 ♀♀, 1 ♂, (12), 22.IV.1998, 5 ♀♀, (28), VL leg., 06.V.1998, 5 ♀♀, (10), 04.V.1999, 1 ♀, SB leg., MQ det.; Milia, 24.III.2000, 1 ♂, (6), 7.V.2003, 1 ♀, SB leg., MQ det.

Anthophora (Paramegilla) balneorum (Lepeletier, 1841)

Distribution: South-West Mediterranean.

Examined specimens: Milia, 30.V.2006, 1 ♂, SB leg., MQ det.

Anthophora (Pyganthophora) aestivalis (Panzer, 1801)

Distribution: Europe, Anatolia, and Caucasus.

Examined specimens: Torre Allegra, 26.V.1999, 1 ♀, SB leg., MQ det.

Anthophora (Pyganthophora) balearica (Friese, 1896)

Distribution: Spain and Baleari Islands, southern Italy (Apulia and Sicily), and Anatolia.

Examined specimens: Piano Provenzana, 19.VI.2007, 1 ♂, AS & SB leg., VN det.

Remarks: MAIDL (1922) reported this species for Spain, Italy and Anatolia.

Anthophora (Pyganthophora) retusa (Linnaeus, 1758)

Distribution: Palaearctic.

Examined specimens: Bronte, 13.IV.2000, 1 ♂, (1), SB leg., MQ det.; Piano Provenzana, 27.VII.2007, 1 ♀, (3), AS & SB leg., VN det.

Genus *Apis* Linnaeus, 1758

Apis mellifera Linnaeus, 1758

Distribution: Cosmopolitan.

Examined specimens: abundant in all sites surveyed (Table 2).

Remark: in relation to the widespread presence in the island territory of beekeeping activity, the specimens observed were mainly related to the two subspecies present in Sicily (*Apis mellifera siciliana* Dalla Torre, 1896 and *A. m. ligustica* Spinola, 1806) and their hybrids.

Genus *Ceratina* Latreille, 1802

Ceratina (Ceratina) cucurbitina (Rossi, 1792)

Distribution: W-Palaearctic.

Examined specimens: Torre Allegra, 28.VIII.1997, 1 ♀, (2), VL leg., 04.V.1999, 1 ♀, (3), 28.VI.1999, 2 ♀♀, SB leg., MQ det.; Bronte, 30.VI.2000, 1 ♀, SB leg., MQ det., 27.IV.2005, 1 ♂, 2 ♀♀, (9), 29.V.2006, 2 ♀♀, SB leg., VN det.; Milia, 30.V.2000, 1 ♀, 02.V.2003, 3 ♂♂, (52), SB leg., MQ det., 23.IV.2005, 2 ♂♂, (4), 24.IX.2005, 1 ♀, 11.IV.2006, 1 ♂, 30.V.2006, 1 ♂, SB leg., VN det.

Ceratina (Euceratina) chalcites Germar, 1839

Distribution: Europe and northern Asia (excluding China).

Examined specimens: Bronte, 19.VII.2005, 1 ♀, (1), SB leg., VN det.; Milia, 23.VI.2006, 1 ♀, SB leg., VN det.

Ceratina (Euceratina) chalybea Chevrier, 1872

Distribution: W-Palaearctic.

Examined specimens: Piano Provenzana, 16.VI.2007, 1 ♂, (4), 16.VIII.2007, 1 ♂, 28.VIII.2007, 1 ♀, AS & SB leg., VN det.

Ceratina (Euceratina) cyanea (Kirby, 1802)

Distribution: European.

Examined specimens: Spina Santa, 27.X.1998, 1 ♂ (2), SB leg., MQ det.; Torre Allegra, 28.VI.1999, 1 ♂, 23.VII.1999, 2 ♂, (9), SB leg., MQ det.

Ceratina (Euceratina) dallatorreana Friese, 1896

Distribution: Holarctic.

Examined specimens: Torre Allegra, 04.V.1999, 1 ♀, 28.VI.1999, 1 ♀, 1 ♂, (2), SB leg., VN det.; Ramacca, 02.VII.1999, 2 ♀♀, SB leg., MQ det.

Ceratina (Euceratina) dentiventris Gerstaecker, 1869

Distribution: Caucasus, southern Europe, Anatolia and the Maghreb.

Examined specimens: Bronte, 30.VI.2000, 1 ♂, SB leg., MQ det.; Milia, 20.VIII.2005, 1 ♂, SB leg., VN det.

Ceratina (Euceratina) nigrolabiata Friese, 1896

Distribution: Europe and northern Asia (excluding China).

Examined specimens: Bronte, 29.V.2006, 1 ♀, SB leg., MQ det.

Genus *Epeolus* Latreille, 1802

Epeolus julliani Pérez, 1884

Distribution: Southern Europe and Anatolia.

Examined specimens: Piano Provenzana, 16.VIII.2007, 1 ♀, AS & SB leg., VN det.

Genus *Eucera* Scopoli, 1770

Eucera (Atopeucera) seminuda Brullé, 1832

Distribution: Medium-South Europe, Anatolia and Maghreb.

Examined specimens: Spina Santa, 25.IV.1998, 2 ♀♀, (4), SB leg., MQ det.; Motta Sant'Anastasia, 10.V.2000, 2 ♀♀, SB leg., MQ det.

***Eucera (Eucera) proxima* Morawitz, 1875**(= *graeca* Radoszkowski, 1875)

Distribution: South-central Europe, Anatolia, and eastern Mediterranean.

Examined specimens: Spina Santa, 16.IV.1998, 1 ♂, (2), SB leg., MQ det.

***Eucera (Eucera) nigrescens* Pérez, 1879**

Distribution: Europe and Anatolia.

Examined specimens: Torre Allegra, 14.IV.1998, 1 ♀, SB leg., MQ det.; Bronte, 13.IV.2000, 1 ♂, 1 ♀, 26.IV.2000, 1 ♂, 1 ♀, (2), SB leg., MQ det.; Milia, 07.IV.2006, 1 ♂, SB leg., MQ det.

Eucera (Eucera) numida numida

Lepeletier, 1841

Distribution: South-West-Europe and Maghreb.

Examined specimens: Torre Allegra, 06.V.1998, 2 ♀♀, SB leg., MQ det.

Eucera (Hetereucera) notata

Lepeletier, 1841

Distribution: Mediterranean.

Examined specimens: Paternò, 27.IV.1998, 1 ♀, (2), SB leg., MQ det.; Milia, 29.III.2000, 1 ♂ (2), 27.VI.2000, (2), SB leg., MQ det.

Eucera (Hetereucera) oraniensis

Lepeletier, 1841

Distribution: South-West Europe, and northern African.

Examined specimens: Torre Allegra, 14.IV.1998, 1 ♀, (2), SB leg., MQ det.; Spina Santa, 23.III.1998, 1 ♀, (2), 16.IV.1998, 1 ♀, (2), SB leg., MQ det.; Milia, 26.III.2003, 1 ♂ (4), SB leg., MQ det.

***Eucera (? Pareucera) aterrima* Friese, 1896**

Distribution: Mediterranean.

Examined specimens: Piano Provenzana, 02.VII.2006, 1 ♀, 16.VII.2006, 1 ♀, (1), 19.VI.2007, 1 ♀, 27.VII.2007, 1 ♀, (2), AS & SB leg., VN det..

Remark: in this context and until the males are identified, we prefer to believe that *Eucera aterrima* is a good species and not a subspecies of *E. nigrata* Friese 1896, as in Risch (2001).***Eucera (Pareucera) caspica* Morawitz, 1873**

Distribution: Central-Asiatic, Europe, and Anatolia.

Examined specimens: Milia, 08.IV.2005, 1 ♂, 07.IV.2006, 1 ♀, (1), SB leg., VN det.

***Eucera (Pteneucera) eucnemidea* Dours, 1873**

Distribution: South-West Europe, and Maghreb.

Examined specimens: Torre Allegra, 06.V.1998, 10 ♂♂, (78), VL leg., MQ det.; Spina Santa, 16.IV.1998, 8 ♂, (34), 25.IV.1998, 15 ♂♂, (215), 28.V.1999, 1 ♂, (1), SB leg., MQ det.; Bronte, 31.V.2000, 1 ♂, (1), SB leg., MQ det.

***Eucera (Rhyteucera) vulpes* Brullé 1832**(= *parvula* Friese, 1896)

Distribution: South-Europe, and Anatolia.

Examined specimens: Torre Allegra, 04.V.1999, 2 ♀♀, (1), SB leg., MQ det.

Genus *Habropoda* Smith, 1854***Habropoda tarsata* (Spinola, 1838)**

Distribution: European extended to Anatolia.

Examined specimens: Milia, 17.IV.2000, 1 ♂ (4), 22.IV.2000, 1 ♂, (1), SB leg., MQ det., 07.V.2003, 1 ♀ (5), SB leg., VN det.

Genus *Melecta* Latreille, 1802***Melecta albifrons nigra* Spinola, 1806**

Distribution: South-West Europe.

Examined specimens: Torre Allegra, 14.IV.1998, 1 ♀, SB leg., MQ det.

Genus *Nomada* Scopoli, 1770***Nomada discrepans* Schmiedeknecht, 1882**

Distribution: South-Europe, Maghreb, and Macaronesia.

Examined specimens: Torre Allegra, 04.VIII.1997, 1 ♂, (2), 28.VIII.1997, 1 ♂, (5), VL leg., MQ det.

***Nomada distinguenda* Morawitz, 1874**

Distribution: Palaearctic.

Examined specimens: Torre Allegra, 04.VIII.1997, 1 ♂, (2), 28.VIII.1997, 1 ♂, (2), VL leg., MS det.

***Nomada succincta* Panzer, 1798**

Distribution: Asiatic-European.

Examined specimens: Milia, 29.III.2000, 1 ♀, 31.III.2006, 1 ♂, 04.IV.2006, 1 ♀, SB leg., MQ det.

Genus *Tetraloniella* Ashmead, 1899***Tetraloniella dentata fulviscopa* Hedicke, 1933**

Distribution: South-Europe, and Caucasia.

Examined specimens: Milia, 22.VI.2005, 1 ♂, 23.VI.2006, 2 ♂♂, SB leg., VN det.

Genus *Xylocopa* Latreille, 1802***Xylocopa (Coxoxyla) iris* (Christ, 1791)**

Distribution: Mediterranean and Central-Asiatic.

Examined specimens: Torre Allegra, 04.VIII.1997, 1 ♀, (2), 27.IX.1997, 1 ♂, (2), VL leg., 28.VII.1998, 1 ♂, (1), 28.VI.1999, 1 ♂, 23.VII.1999, 1 ♂, 1 ♀, (3), SB leg., MQ det.; Milia, 13.III.2003, 1 ♂, VN det., 16.VII.2005, (1), SB leg. and det.

***Xylocopa (Xylocopa) violacea* (Linnaeus, 1758)**

Distribution: Europe extended to the Maghreb and Anatolia.

Examined specimens: Torre Allegra, 28.VIII.1997, 3 ♂♂, 1 ♀, (8), 27.IX.1997, 1 ♂, (2), VL leg., MQ det.; Giarre, 14.XI.2000, (2); Paternò, 27.IV.1998, 1 ♂, (2), SB leg., MQ det.; Bronte, 07.IV.2005, (1), 27.IV.2005, (3), 26.IX.2005, (1), 28.IX.2006, (1); Milia, 24.III.2000, 2 ♂♂, (1), 20.IV.2000, 1 ♀, 5.III.2003, 1 ♂, (4), 13.III.2003, 1 ♂, (29), 19.III.2003, 1 ♂, (1), SB leg., MQ det.; Piano Provenzana, 19.VIII.2006, 1 ♂, (14), AS & SB leg., VN det.

DISCUSSION AND CONCLUSIONS

In the 11 years of investigation, more than 20000 specimens of Apoidea were collected and/or observed, more than 18000 of which belonged to the family Apidae, accounting for 88% of the total. Excluding bumblebees that accounted for 3426 specimens in 12 species (MAZZEO *et al.*, 2015), 14451 Apidae specimens in 11 genera and 35 species were detected. Overall, the Apidae family (*Bombus* genus included) was present with 48 taxa.

Apis mellifera, with 13666 specimens was the predominant species for number and range, having been found on Mount Etna at all altitudes. *Xylocopa violacea* was also very common and widely distributed. Only seven species were recorded for the site at the highest altitude, Piano Provenzana (1845 m a.s.l.): *Anthophora balearica*, *A. retusa*, *Apis mellifera*, *Ceratina chalybea*, *Epeolus julliani*, *Eucera aterrima* and *Xylocopa violacea*. The greatest number of species was found in the thermo-Mediterranean (0-500 m a.s.l.) and meso-Mediterranean (500-1000 m a.s.l.) horizons (Fig. II), where the

Fig. II – Number of Apidae genera and species (bumblebees excluded) per site recorded on cultivated and wild plants at different altitudinal plans.

presence of bees was abundant even in the coldest months of the year on winter-flowering crops, as in the case of almond (5 species) and loquat (2 species). In this horizons *Anthophora plumipes*, *Apis mellifera* and *Eucera eucnemidea*, were the most abundant species. In the mountain-mediterranean (1450-2100 m a.s.l.) plan and in the supra-mediterranean horizon (1000-1450 m a.s.l.), *Apis mellifera* and *Xylocopa violacea* were most abundant.

Anthophora aestivalis, *A. balearica*, *A. balneorum*, *Ceratina chalcites*, *C. dentiventris*, *C. nigrolabiata*, *Epeolus julliani*, *Eucera proxima*, *E. numida*, *E. parvula*, *Melecta albifrons nigra*, *Nomada succincta* and *Tetraloniella dentata* were very rare in the period of investigation, with only 1-3 specimens recorded for each species.

Most of the species were recorded inside the protected areas and in particular: *Amegilla albigena*, *Anthophora aestivalis*, *Apis mellifera*, *Ceratina cucurbitina*, *C. cyanea*, *C. dallatorreana*, *Eucera nigrescens*, *E. numida*, *E. oraniensis*, *E. eucnemidea*, *E. vulpes*, *Melecta nigra*, *Nomada discrepans*, *N. distinguenda*, *Xylocopa iris* and *X. violacea* from Torre Allegra; *Amegilla quadrifasciata*, *Anthophora crinipes*, *Anthophora plumipes squalens*, *Anthophora balneorum*, *Anthophora balearica*, *Anthophora retusa*, *Apis mellifera*, *Ceratina cucurbitina*, *C. chalcites*, *C. chalybea*, *C. dentiventris*, *Epeolus julliani*, *Eucera nigrescens*, *E. notata*, *E. oraniensis*, *E. aterrima*, *E. caspica*, *Habropoda tarsata*, *Nomada succincta*, *Tetraloniella dentata fulviscopa*, *Xylocopa iris*, and *X. violacea* from the Etna Park.

The qualitative and quantitative characterisations of the pollinators of a given area provide the “health status” of that territory and, through subsequent monitoring, show the environmental changes that have occurred and how much these have affected biodiversity.

The data from this study, together with those about the *Bombus* species in MAZZEO *et al.* (2015), analysed the biodiversity of the Apidae family in the cultivated, semi-natural, and natural ecosystems of the Etna territory, a wide area of eastern Sicily, placing it in relation to the

different human activities, altitudinal plans, plants visited, and ecological qualities of the areas.

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