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La flora visitata dalle Api e dagli altri Apoidei in Europa

CALDERINI
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EUROPEAN BEE FORAGE

INTRODUCTION

Traditionally, the relation between bees and food plants are often approached from two different directions. In general, agronomists and plant scientists are concerned with the role of bees as important pollinators for crops and wild plants. And beekeepers and bee ecologists are principally fascinated by the importance of plants as sources for nectar and pollen.

Concerning the pollination effect of bees it is generally known that we need bees to pollinate our crops. About 80 percent of our food plants are pollinated by the help of animals, and these are mainly bees. About one third of all what we eat and drink, is produced through service supplied by pollinators. Nowadays, we learn more about this role played by the bees. The pollination provided by bees is known to be important for the growing of traditional and well-known crops, but recent evidence confirms also the significance of pollinating bees for some very interesting tropical and less common crops. It is consequential to obtain more knowledge about the pollinator needs of such crops. Through improved pollination, production or quality could be further increased.

Through their pollination acts, bees appear essential for our own existence, and beekeepers should be rewarded for contributing in this respect. Modern beekeepers, of course, are mainly interested in the role of *Apis* bees. But for applied pollination purpose, it is also important to look into the specific pollinator role that is played in nature by non-*Apis* bees. The production of certain non- *Apis* bees, e.g. bumblebees, specifically for pollination in greenhouses, is already a big industry and some apiculturalists have become even large-scale bumblebee producers.

The developments in the study of the melliferous flora may seem to have been less revolutionary than in the recent applied study of insect pollination. But nowadays it is certainly realised that this study should receive more emphasis. Modern developments in the world honey market make study of special characteristics of honey types from certain regions of economic importance. The analysis of the botanical origin of honeys, pollen and propolis, is therefore an important field of applied ecological research. This makes the technique of melissopalynology (identification of pollen grains) a powerful tool for honey control procedures.

Recently however, through the increasing importance given to commercial bee pollination, the study of bee-food plant relations, including melissopalynology, is receiving much interest in agronomic studies. This results in a further integration of studies on pollination and on bee food plants.

The importance of bee diversity for the pollination of wild and cultivated plants is a topic of great concern. Focussing on the interest of the plants, we like to discuss the pollinator status of the various species/groups of bees. What is in this respect the importance of a diverse bee fauna in a certain area? What is the real pollinator impact of oligolectic species, and to what extent can their food plants also be pollinated by polylectic species?

Many reports state that the bee fauna is declining in actual number of bees, and also in species. Obviously, food resources and critical nest substrate conditions are of great importance for bee diversity, but the real limiting effect of these resource factors is not quantitatively studied.

This book by the naturalists G. Ricciardelli D'Albore and F. Intoppa, the first from the University of Perugia, the second from the Zoological Institute of Rome, forms an important contribution to the knowledge and study of the European bee flora. The most substantial part of the book consists of a comprehensive treatment of the bee food plants. An impressive series of about 600 colour illustrations of bee botany are included. This information is based on the previous works by Ricciardelli D'Albore and F. Intoppa on pollination, biodiversity of wild bees, bumblebees' ecology and bee botany (Ricciardelli has published various books about general melissopalynology and Mediterranean melissopalynology and one about Italian bee forage).

The plants (genera) are listed in this book under the families in alphabetical order. For a plant genus is indicated the type of plant, where it can be found, by which bee groups it is visited and if so, for what major food component. The honey potential is quantitatively indicated.

The introductory chapters of the book concern the systematics and the ecology of the group of the bees, as well as some remarks about the sociality of some bee species. Special attention is given to the foraging ecology of bees and to the environmental conditions of bee habitats. Habitat conditions receive also particular importance in this book through the comprehensive treatment of conservation programmes and recent projects.

Further chapters deal with the collection of pollen and nectar. This is followed by a discussion of the importance of the study of pollen for an analysis of bee food plant relations.

Prof. Ricciardelli's earlier book on Melissopalynology was published by APIMONDIA and it proved to be important for various practical fields and for related fundamental studies. I hope that this present book by Ricciardelli and Intoppa may serve to further stimulate the fundamental study of bee-plant relations and in the practical field to expand the work on bee pollination.

Dr. Marinus J. Sommeijer, President APIMONDIA Standing Commission on Melliferous Flora and Pollination

Utrecht, 31 January 2000

Chapter 1

RUDIMENTS OF SYSTEMATICS, ECOLOGY AND DEFENCE STRATEGY OF APOIDEA

Apoidea systematics

The characteristic making Apoidea pre-eminently pollinators is the special diet of their larvae, fed with pollen or mixture of pollen and nectar. The regular research for such food sources carried out by the adults put them in touch with a lot of flowerings, taking advantage of these specialized visits to reproduction aims.

Adult's morphology is fitted in order to make this dietetic specialization easier: the body is more o less covered with feathery hair, legs or other parts of the body own harvest systems allowing to gather and carry pollen; metatarsi of back legs are more o less extended and thickly pubescent, as a rule; mouthparts are stretched out and fit for collecting nectar; wings are full grown, well matched and for this reason suitable for an efficient flight.

Apoidea phylogenesis and systematics are rather discussed, at least as far as some groups of genera (and the rank of some super-species *taxa*) are concerned. At present the subdivision in two main groups is generally accepted: short tongue bees (defined as "primitive bees"), including Colletidae, Andrenidae, Halictadae families, and long tongue bees, with Melittidae, Megachilidae, Anthophoridae and Apidae families. In this work, the taxonomy indicated in figure 1 and table 1 will be followed.

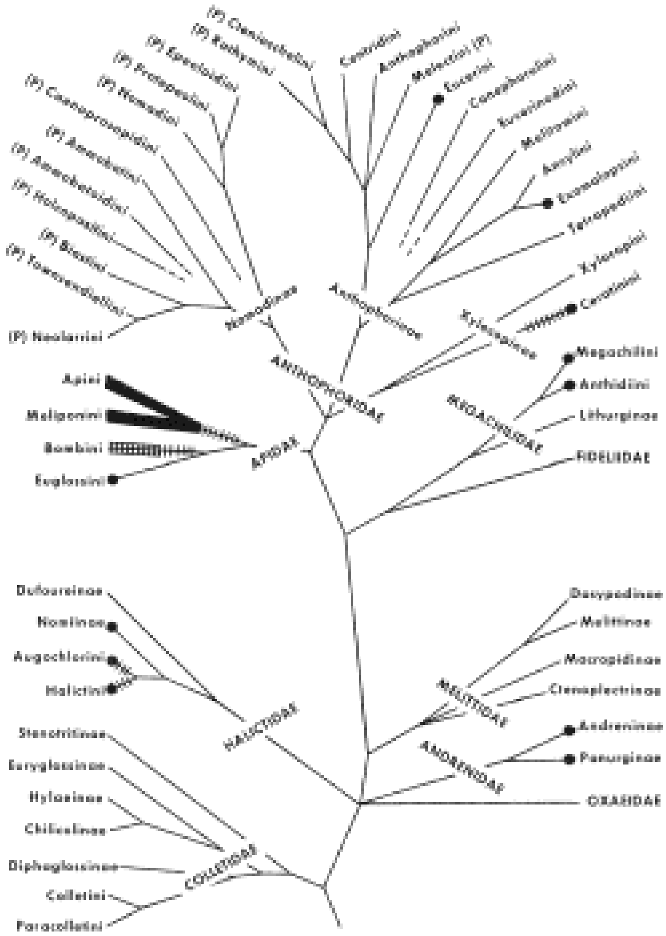

Figure 1. Phylogenetic relationship among the main groups of Apoidei.

Lines ending with a black dot represent taxa in which some species live in parasocial colonies; lines with transversal outline represent taxa with primitively eusocial species; if outlines are joined with sides (Bombini), all non parasite species are primitively eusocial; marked lines represent taxa in which all species are highly social; (P) is indicative of fully parasite tribes and therefore lacking in colonial species.

(from Michener, 1974; groups not containing European species have been eliminated).

Table I. Apoidea in Italian fauna (according Michener, 1944; it has been modified)

COLLETIDAE
Hylaeinae
Hylaeus Fabricius, 1793
Colletinae
Colletes Latreille, 1802

ANDRENIDAE
Panurginae
Camptopoeum Spinola, 1843
Panurginus Nylander, 1848
Panurgus Panzer, 1806
Melitturga Latreille, 1809
Andreninae
Andrena Fabricius, 1775

HALICTIDAE
Halictinae
Halictus Latreille, 1804
Lasioglossum Curtis, 1833
Sphecodes Latreille, 1804
Nomioides Schenck, 1867
Nomiinae
Pseudapis Kirby, 1900
Dufoureinae
Dufourea Lepeletier, 1841
Rhophitoides Schenck, 1859
Rophites Spinola, 1808
Systropha Illiger, 1806

MELITTIDAE
Melittinae
Melitta Kirby, 1802
Macropis Panzer, 1809
Dasypodinae
Dasypoda Latreille, 1802

MEGACHILIDAE
Lithurginae
Lithurge Latreille, 1825
Megachilinae
Megachilini
Creightonella Cockerell, 1908
Chalicodoma Lepeletier, 1841
Megachile Latreille, 1802
Coelioxys Latreille, 1809
Dioxys Lepeletier & Serville, 1825
Osmiini
Anthocopa Latreille & Serville, 1825
Hoplitis Klug, 1807
Osmia Panzer, 1806
Protosmia Ducke, 1900
Chelostoma Latreille, 1809
Heriades Spinola, 1808
Anthidiini
Trachusa Panzer, 1804
Anthidium Fabricius, 1804
Anthidiellum Cockerell, 1904
Icteranthidium Michener, 1948
Pseudoanthidium Friese, 1898
Exanthidium Pasteels, 1969
Rhodanthidium Isensee, 1927
Trianthidium Mavromoustakis, 1958
Stelis Panzer, 1806

ANTHOPHORIDAE
Anthophorinae
Habropoda Smith, 1854
Anthophora Latreille, 1803
Amegilla Friese, 1897
Melecta Latreille, 1802
Eupavlovskia Popov, 1955
Thyreus Panzer, 1806
Eucera Scopoli, 1770
Tetralonia Spinola, 1838
Xylocopinae
Xylocopa Latreille, 1802
Ceratina Latreille, 1802
Nomadinae
Nomada Scopoli, 1770
Tarsalia Morawitz, 1895
Pasites Jurine,1807
Ammobates Latreille, 1809
Ammobatoides Radoszkowski, 1868
Biastes Panzer, 1806
Epeolus Latreille, 1802
Triepeolus Robertson, 1901
Epeoloides Giraud, 1863

APIDAE
Bombinae
Bombus Latreille, 1802
Psithyrus Lepeletier, 1832
Apinae
Apis Linnaeus, 1758

Social life of Apoidei

The evolution process from which solitary bee leads to eusocial bee has been differently interpreted by Authors, according to the crucial passage taken into consideration by them: the relationship between adult and larva (the mother goes about with her brood and lives enough to take advantage of her daughters' co-operation when they reach the adult stage), or the co-operation among adult females, with the following division of roles.

Moreover, it is possible to mention shortly the most significant stages of the theoretical evolution phases:

- Solitary bees (i.e. *Colletes*, *Anthophora*, etc.). Each female makes one o more brood nests, supplies a cell with enough food to the whole development of a larva and lays an egg; at last, she seals with various material and makes other cells. Usually the mother dies before that her brood grows to maturity.
- Aggregation of solitary bees (a phenomenon common to all families, except Apidae). Nests have near entrances, without tunnels connecting them or areas reserved to brood. These clusters would be originated by the inclination to return to the birthplace or by a mutual attraction among individuals of the same species.
- Community bees (i.e. some *Andrena*, *Megachile*, etc.). They are groups of females (from two to over one thousand) which utilise only one common nest, even if each one of them makes and supplies her cells, with the obvious advantage of a better defence of the nest.
- Nearly social bees (i.e. some *Nomia*). Females make and watch entrance tunnels in mutual agreement and cooperate to make and supply brood cells, but without any work subdivision.
- Half-social bees (i.e. some American *Halictinae*). Females of the same generation cooperate in building and supplying the nest, but they are divided into two functional castes, since some females do not lay eggs, but only act as workers.
- Social bees. Eusociality is reached by superimposing more generations in the nest and by sharing out their reproductive work among castes. The distinction between primitively social bees and highly social bees is, above all, based on the presence among the last ones of structurally different females and on the survival only of sexual females during hibernating or at the end of the colony cycle. As far as it concerns European fauna of Apoidea, *Apis*, *Bombus* and some *Halictus* species are eusocial; a further valuation of several characters of the social behaviour places *Apis* colonies at the maximum evolutive grade.

Social parasitism in Apoidei

Parasite relations, frequent in Apoidea, also show different grades of behaviour ranging from the simple nest sack ("kleptoparasitism", widespread in several families, in which a female discovers food stored by an other female, usually belonging to a different family, and takes possession of it to rear her brood by sending away or killing the occupant) to the real "social parasitism", in which the outsider female becomes a part of the host society. *Psithyrus* can exemplify this kind of behaviour towards the colonies of *Bombus*.

The parasitic way of life involves the reduction of some morphologic characteristics associated to nest building and supplying and, on the other hand, to some defence adaptations necessary for intrusion ways in nests. Main characters relating to adaptation concern: loss of systems of pollen gathering and of basitibial and pigidial plates, sting development, integument thickening and formation of crests and thorns to protect neck and abdomen. Loss of pollen combs is the most significative element in this connection, since without such structures females are not able to lay in stores in pollen.

An outline of Apoidea bionomy

The Italian term *api* means domestic bees (or honey bees), but it is not the same of the English *bees*, applying to all Apoidea insects. In this work, to avoid confusion, the term *bee* will be utilised to mean honey bees and *Apoidea* to mean wild bees, that is all other Apoidea species as a whole. The term "bumblebees" will be indicative of all species belonging to *Bumbus* genus.

Everybody knows honey bee, from millennial tradition and from the benefit (honey) derived by men. On the contrary, insiders, naturalists and amateur fans know other Apoidea. Nowadays in the agro-ecosystem, bees, safeguarded and reared by man, warrant a valid pollination service towards a lot of cultivations in field and in greenhouse. In more o less natural environments, where bees can coexist with other insects, but more often they are only temporarily transferred by the practice of nomadism, volunteer species (80% of angiosperms, at least) would be destined to disappear in time, due to the lack of pollinators and first of all of Apoidea.

In order to better differentiate large and small environments where these insects live, it is useful to shortly recall the main components of an ecosystem: the geotope, represented by the mineral kingdom (soils, rocks, etc.), the climatope (meteors, gases, etc.), represented by the state of atmosphere surrounding and being part of the ecosystem, and the biocenoses (zoocenosis, phytocenosis and microbiocenosis). All these components interact and aim at establishing a more or less stable situation of balance, where autotrophic vegetables absorb inorganic components from soil and carry out chlorophyll photosynthesis, heterotrophic organisms of various grade (animals) consume and then the organic substance is attacked by destroyers (microbiocenosis) and led back to inorganic substance to conclude the cycle. This scheme, simply represented, can be found in all the environments, generically considered as agro-ecosystem, or in other anthropised systems and other more o less natural systems, with few or no anthropic action and with different degrees of mutual filtering among the elements.

Many large and small environments are fit for Apoidea survival: aquatic environments (marshes, banks of rivers, etc.), land environments (pastures, woods, forests, brushwoods, hedges, moors, bushes, steppes and, in particular, slopes, sides of roads, banks, rocky lands, embankments, caves, paths, dunes, other small structures used for shelters as walls, abandoned houses, rotten timber), at last gardens, parks and large cultivated grounds, the last ones often fully inhospitable for Apoidea (Linsley, 1958).

Apoidea nest in the most various places and ways. Small occasional recovers often meet the requirements of several Apoidea (rotten timber, hollow branches, small reeds, clefts between bricks and etc.). There are digger insects (*Andrena*, *Halictus*, etc.) nesting mostly in a variable texture ground digging typical tunnels connected to ramifications where progeny is lodged. Other insects (*Megachilidae*) gnaw or cut vegetable parts (leaves, above all) to cover the walls of cigar-shaped nests built within natural hollows (e.g., reeds). Many of them, exploiting already existing hollows or small canals (*Hylaeus*, *Bombus*, *Osmia*, etc.), collect different kinds of fragments (wool, fibres, earth, clay, etc.) to make or finish nests; they often live in particular hollows (e.g., shells), dividing cells with resin partitions; the most developed insects build nests utilising wax or wax mixed with other substances (*Apis*, etc.).

According to the number of biologic cycles performed in a year, species differ in monovoltine, bivoltine and polivoltine. For example, *Osmia cornuta* Latr. is monovoltine; some *Andrenidae* are polivoltine. Other monovoltine Apoidea (*B. terrestris* L.) in particular areas and conditions (Mediterranean bush) can become bivoltine (Westrich, 1990).

Since Apoidea can survive in nature, besides the presence of places fit for nesting and of flora apt for their nourishment, it is necessary that climate is propitious, that long periods of unfavourable climatic conditions (frosts, drought) do not take place and that biologic cycles can conclude.

As for food supplying (pollen and nectar), among Apoidea a sort of competition is established between different species and within a same species. As a rule, the competition keeps itself on pacific levels, turning into a kind of mutual tolerance. When this competition takes place among social insects, generally it ends with a division of pasture and latecomers (which would intercept the odour of the firsts to arrive) occupy a share of the pasture left vacant. If competition is established between solitary and social insects or between two solitary species, insect's food habits assume an important part, because, if they are different, they will allow a pacific division of the booty. When food is lacking, then aggressiveness explodes and often ends with the escape of the weaker insect, which leaves the place to the stronger one. A family or a nest of honey bees needs a lot of food, while a solitary insect will need it to a smaller extent. For this reason, human interference with beekeeping (nomadism) can temporarily cause unbalances in a natural environment: if bees are numerous, they take away food to the already present species, but if the last ones are themselves numerous, bees are in a sorry plight and produce very little. The warning to beekeepers is ever the same: not to be greedy (it is better one less beehive than one to much!) (Banaszak, 1980; Buchmann, 1996; Eickworth & Giusberg, 1980; Gramadzka & Trojan, 1967; Haman & Koller, 1956; Hedtke, 1995; Leconte, 1962; Ryszkowski & Karg, 1977; Westrich, 1990).

More detailed aspects about the competition among Apoidea and between Apoidea and honey bees will be investigated. As far as it concerns nesting places, the competition often ends in a sharing out of the territory on intraspecific and interspecific level. Honey bee has nothing to do with this competition, but only with food division. From this point of view, size, number of body hair and tongue length assume great importance in Apoidea: while small Apoidea supply with food on flowers with a very short corolla only, big Apoidea are able to force flower open, thanks to their weight. Tongue length (ranging from about 2 mm to 20 mm) is particularly important for gathering in field: as a rule, pollinators with a long tongue do not visit flowers with a short corolla, as a short tongue insect cannot have access to the nectar of flowers with a long corolla.

In this last case, it is well known the behaviour of some bumblebees piercing with their mandible the base of a long corolla to suck in the nectar; later these holes are exploited by other Apoidea and by bees, too. *Xylocopa violacea* L. can show a similar behaviour (e.g., on *Lonicera*) (Ricciardelli D'Albore, 1997m). Such insects are defined as "robber bees" since they make a supply of nectar without paying toll, that is, without carrying out the requested pollination in exchange for food.

Insect's speed and skill also plays a very important role in competition. *Halictus* insects usually are very slow when compared to *Anthidium* or *Anthophora*, which, in the same time, visit many more flowers. Distance of food from nests is also particularly important. Solitary Apoidea fly for short distances; beyond them flowerings are not accessible to these insects. Honey bee can instead fly at a distance of many kilometres and, for this reason, is widely favourite. The well known "flight cost" comes into play. It is expressed in quantity of consumed energy and subtracted from the quantity of collected and carried food, always calculated as energy. All Apoidea have to make a convenience calculation when confronted with more o less far flowerings (Comba, 1997; Corbet et al., 1991; Felicioli & Pinzauti, 1994; Hedtke, 1995; Herrera, 1990; Inonye, 1983; Käpila, 1974).

"Generalist" and "specialist" insects

As for their floral preferences, Apoidea show a wide range of behaviour: some of them hold fast to a given and unique vegetal species, or to one o more genera of the same family, while others gather pollen on plants belonging to different botanical families. Several terms have been used to describe this kind of behaviour: oligophagia and polyphagia, or oligotrophia and polytrophia (Baker & Hurd, 1968; Eickwort & Ginsberg, 1980; Haman & Koller, 1956); somebody else preferred to use the distinction between monophagia (one species visited), stenophagia (few species) and eurifagia (a lot of species of different families), or between monantic, stenantic and euriantic insects (Stoeckhert, 1933).

Now it is widely used the distinction of pollinators in strictly oligoleptic insects (e.g., *Melitta dimidiata* Mor. on *Onobrychis* Miller), when visit few species of only one botanical genus, in widely oligoleptic insects, if they visit more species of genera from only one family (e.g., *Heriades truncorum* L. on Composite) and in polyleptic insects, if they gather pollen on several plants from different families (honey bee is pre-eminently a polyleptic insect).

The problem of a right definition is, above all, connected to insect's behaviour; still today, although floral preferences of most pollinators have been thoroughly investigated, it is impossible to place some species into one category. Pollinators, considered loyal to one species, have been often found on another plant: for example, *Colletes succinctus* L., well-known for faithfully visiting Ericaceae, in particular *Calluna vulgaris* Salisb., has been often captured with considerable pollen harvesting from *Hedera helix* L. Similar cases are rather frequent and it is not clear to what degree one can speak of not exhaustive knowledge or of the insect's behaviour which sometimes, when necessary, is different from the fixed habits.

Moreover, when an Apoidea insect is specialised in gathering pollen on a particular nectarless species, it is forced to go to other plants for collecting glucides and, for this reason, in spite of its partial specialisation, it becomes a polyleptic insect. Occasional interest towards strange sources of food can also be temporary: as soon as optimum conditions are created again, the "trasgressive" insect comes back to its usual behaviour. In any case, in areas where food resources specific for a given insect are lacking, this one also is lacking. As a rule, the phenology of the flowers from a chosen plant is synchronised with the biologic cycle of the insect loyal to it. Oligolepsy and polylepsy are well distributed in the genealogical tree of Apoidea, from the most primitive ones to the social insects (bumblebees and bees). In pollinator's species of today, the polylepsy is widely prevailing (Westrich, 1990); i.e. in Europe, oligoleptic species are only 10% of all species.

In the economy of an ecosystem, the strong faithfulness of an insect towards a given plant is double-faced. It is an index of a specialisation, that is, of a remarkable advancement under the evolutive profile of the relationship between insect and plant, but it is also a limit discussing the survival of an insect: if the vegetal species is lacking, the insect cannot live in that ecosystem, while plant shows a clear and greater adaptability to the various phytocenosis and, for that reason, insect's survival is discussed only if all phytocenosis disappears from an ecosystem (i.e. a fire).

All this happens in more or less natural systems. In agro-ecosystem, instead, where the presence of single crop systems prevails and their flowering can be followed by no other flowering ("lacks of pasture"), pollinators can unlikely develop their long or short biologic cycles. This is the reason for Apoidea disappearance from such agro-ecosystems. Now the density of population of pollinators is due to many factors and, particularly, to those few strongly affecting their life (Banaszak, 1983, 1985, 1987; Unwin & Corbet, 1991).

Regulators

Food amount and competition act as regulators of population densities in a territory; in natural ecosystems it is then possible that populations of some species grow too much. The conservation of balance among populations is however assured by the intervention of the so-called regulators, that is, of those unicellular or multi-cellular organisms living at Apoidea expense and are therefore delegated to maintain reasonable densities of populations (*demographic regulators*) (Banaszak, 1996; Westrich, 1990).

Among fungi, mycoses of bees are to be mentioned (*Ascosphaera*, *Aspergillus*); among protozoans, nosemiases; among nematodes, the typical parasite is *Sphaerularia*, penetrating into genitals of bumblebee queens. Spiders often are cruel enemies of pollinators; genus *Misumena* can easily found on flowers; here the spider awaits for pollinator, which is immediately paralysed. For that reason Apoidea carcasses are seen hanging from flowers. Among acari, it is sufficient to mention *Parasitus* of bumblebees or the terrible *Varroa* of bees. Many other parasites, parasitoids, predators, etc., belonging to various orders (mostly Diptera and Hymenoptera), act as regulators of Apoidea. Other important regulators are also to be mentioned: many species of birds usually eat Apoidea larvae and adults; other natural enemies are moles, mice and porcupines.

Finally, among regulators, there is man. His careless interventions on nature are the most conditioning elements in Apoidea life and in many cases (i.e. in the boosted agro-ecosystem) can cause the disappearance of some pollinators, as we will see later (Westrech, 1990).

Strategies for Apoidea survival

As already said, Apoidea floral preferences are reflected on their food strategies. Plants, instead, are generally most favourite as for their own survival, because they can take advantage of the visits of several insects from different orders, too. In particular cases their flowers have structures needing the visit of specific insects; i.e., flowers with narrow and long corolla can be visited only by Apoidea species with long tongue. When an insect is polyleptic, its faithfulness on a given species is however important. honey bee, when chooses a pasture, remains faithful for days and this way assures cross-pollination.

Currently, factors for the decrease of Apoidea can be divided into natural and artificial ones. Among natural factors, sudden and lasting climate variations, the presence of predators and parasites, natural disasters (fires, floods, etc.) and the evolution of some phytocenoses (i.e. a wood or a bush degrading in pasture or cultivation, or, vice versa, reconstituted) can determine a reduction or a variation of many populations of pollinators.

Man is the main element of disturbance and the most important cause of balance alteration and therefore of reduction of Apoidea populations. He destroys nest by ploughing, devastates shores appointed for tourism where Apoidea which choose sandy soils build their nest (*Andrena*, etc); he takes care badly of wood and brushwoods, indiscriminately utilises plant protection products for agriculture and gardens; he does not make rotation of crops any more causing reduction or non-scalarity of flowerings; he burns slopes (fire-weeding); he dredges watercourses putting the balance of banks into disorder; he pollutes; he builds and with traffic kills many Apoidea in flight (Hedke, 1995; Schnaider, 1976).

The density of Apoidea pollinators depends on few, but fundamental, factors. They determine the reduction or the disappearance of these insects in the agro-ecosystem, but they compel workers to carefully value how many pollinators must be present on a cultivation to obtain an efficient pollination and to think over the right strategies in order to assure their survival. Plant protection products, for example, should be administered with extreme caution, supporting the use of the integrated and biologic struggle; biodiversity (in this case, flora variability) should be conserved and warranted; rotations of crop and a wiser wood management should be taken into consideration again, so as a reasonable flowering scalarity can be restored, assuring appetising flora and sufficient areas for nesting to Apoidea (Matheson *et al.*, 1996; Ricciardelli D'Albore, 1987a, 1987b).

The most careful naturalists have already understood that many species of Apoidea are at risk in ecosystems where anthropic action is stronger. In the last thirty years about 10% of insects died out, at least in the most adverse areas for them. Moreover a substantial percentage is at risk, since it survives in few and small surfaces. Little less than 50% of Apoidea have therefore no problem, while little more than 50% of pollinators are endangered species. Smaller percentages can be hardly found (rarefaction).

For that reason, it is necessary to put into effect all strategies, first of all because this situation, provoked by a foolish anthropic action, does not become worse, and then, if it is possible, to rescue Apoidea taking them back to more bearable conditions. Sandy or stony embankment grounds, banks, caves, old farmhouses should be left unchanged for years to save Apoidea. Widening natural surfaces, checking population dynamics of these insects, increasing artificial nests, rearing and then releasing insects caught by nest trapping, these are all useful actions to increase populations. Ornamental species and mixed meadows (i.e. not only meadows of Graminaceae, but mixed with *Bellis perennis* L., *Veronica persica* L. and *Trifolium repens* L., if it is possible) useful to Apoidea should be planted in the gardens, this way assuring the presence of exploitable flora (nectar and pollen). It will be useful to repair beds and banks of watercourses only if necessary. Woods should be wisely taken care of (Anon, 1986, 1991; Banaszak, 1992; Matheson *et al.*, 1996; Osborne *et al.*, 1991; Petanidou & Ellis, 1996; Peter, 1972; Williams *et al.*, 1991).

In conclusion, typical natural environments, where many Apoidea conclude their biologic cycle, must be absolutely preserved or, when possible, improved. Phytocenoses must satisfy Apoidea as regards available food, with areas and structures to build nests and, at last, as regards suitable conditions for a normal and complete genetic cycle. In particular, normal flora for oligoleptic insects will have to be assured. If many and various types of flora are at disposal, problems concerning survival and competition will decrease. The threat of some species reduction or extinction will be overcome by particular actions in natural ecosystems, by a return to a better management of the agro-ecosystem and by a careful supervision on populations. It is now time for man to learn how to manage the territory in a more responsible way. He must try to ease certain pressures preventing ecosystems from being in balance with obvious damage for all biocenoses. A recover of Apoidea will be possible by carrying out these and other strategies.

Researchers' continuous check and attention on these problems have aim at stopping "Apoidea red list". Moreover, the attempt to awaken one's own country and European Union to this problem aims at avoiding that many species are only a nostalgic memory in the near future (Westrich, 1990).

Tab. II Main European oligoleptic pollinators

Pollinator	Visited flora	Pollinator	Visited flora
Andrena agilissima Scopoli	Cruciferae	*Colletes cunicularius* Linnaeus	*Salix*
A. apicata Smith	*Salix*	*C.daviesanus* Smith	Compositae
A. barbareae Smith	*Polygonum*	*C. fodiens* Fourcroy	Compositae
A. clarckella Kirby	*Salix*	*C. halophilus* Verhoeff	Compositae
A. chrysopius Perez	*Asparagus*	*C. similis* Schenk	Compositae
A. curvungula Thomson	*Campanula*	*C. nasutus* Smith	*Anchusa*
A. distinguenda Schenk	Cruciferae	*C. succinctus* Linnaeus	*Calluna* (e *Hedera* ?)
A. erislinella Stoeckert	Cruciferae	*Dasypoda argentata* Panzer	Dipsacaceae
A. florea Fabricius	*Bryonia*	*D. suripes* Christ	Dipsacaceae
A. fulvago Christ	Compositae	*Eucera cinerea* Lepetier	Leguminosae
A. fuscipes Kirby	Ericaceae	*E. interrupta* Baer	Leguminosae
A. gebiae Vecht	Leguminosae	*E. longicornis* Linnaeus	Leguminosae
A. granulosa Perez	*Helianthemum*	*E. tuberculata* Fabricius	Leguminosae
A. hattorfiana Fabricius	Dipsacaceae	*Hylaeus punctulatissimus* Smith	*Allium*
A. humilis Imhoff	Compositae	*H. signatus* Panzer	*Reseda*
A. lathyri Alfken	Leguminosae	*Lasioglossum costulatum* Kriechb.	*Campanula*
A. marginata Fabricius	Dipsacaceae	*Megachile ericetorum* Lepetier	Leguminosae
A. nanula Nylander	*Daucus*	*M. lapponica* Thomson	*Epilobium*
A. nasuta Giraud	*Anchusa*	*M. nigriventris* Schenk	*Epilobium*
A. nychtemura Imhoff	*Asparagus*	*M. rotundata* Fabricius	*Epilobium*
A. potentillae Panzer	*Potentilla*	*Melitta dimidiata* Morawitz	*Onobrychis*
A. tarsata Nylander	*Potentilla*	*M. hemorroidalis* Fabricius	*Campanula*
A. rhenana Stoeckhert	*Taraxacum*	*M. leporina* Panzer	Leguminosae
A. rosae Panzer	Umbelliferae	*M. nigricans* Alken	*Lythrum*
A. symphyti Schmiedeknecht	*Symphytum*	*M. tricincta* Kirby	*Odontites*
A. taraxaci Giraud	*Taraxacum* e *Tuxilago*	*Osmia adunca* Panzer	*Echium*
A. tscheki Morawitz	Cruciferae	*O. anthocopoides* Schenk	*Echium*
A. viridescens Viereck	*Veronica*	*O. lepetieri* Perez	*Echium*
Anthophora furcata Panzer	Labiatae	*O. mitis* Nylander	*Campanula*
Bombus gerstaeckeri Morawitz	*Aconitum*		

Chapter 2

APOIDEA AND ENVIRONMENT

Biodiversity

Biodiversity is the complex of all living shapes in our planet with their various interactions in the environment. It represents the inheritance left to us by nature and cannot be recreated. For this reason, this wealth, when destroyed, will be lost forever. When the environment changes in a drastically way, some shapes do not survive and are substituted by others that are more suitable to changed conditions and to mutual interactions (coevolution). But, if diversity fails, this process is precluded and many living species will run the risk of dying out (Lorenzetti, 1994).

Biodiversity levels are substantially three: of ecosystem, of specific diversity and of genetic diversity. Biodiversity is based on some fundamental principles or rules concerning populations and species, with genetic exchange among various individuals, in a wonderful mechanism of combinations warranting variability. Variability allows individuals to face environmental conditions. Such principles are the result of millions of years of evolution and warrant system continuity. They concern ecosystem, which continuously assure species conservation or their substitution (Porceddu, 1996).

The number of species risking of dying out or already died out is considerably increased as a result of human society development. For a freak of fate, men became aware of these problems only when they already were a penalising factor above all for the production of agroalimentary resources, without ever taking into account the importance of biodiversity (Buiatti, 1996).

Agriculture in times past was founded on several species cultivation, since thousands of different varieties, warranting a sufficient biodiversity, were present. The reason of about 80% of this wealth disappearance is the widespread of an agriculture based on genetically uniform varieties and on high energetic inputs. Because of genetic improvement methods few varieties asserted themselves and the result is a progressive erosion (Lorenzetti, 1994). The boost aiming at maximising yields led to a specific and genetic selection of the most profitable crops and the result is that typical and traditional crops are disappeared, owing to political choices and to the importation of development models unfit for some countries or geographical areas (the coming of the single-crop system, the indiscriminate use of fertilisers, sanitary protections, population exodus, formation of fringe or derelict lands) (Pitzalis *et al.*, 1996).

In this complex situation the world of pollinators is also included, since they are obliged to pay for human economic and social logic in the use of territory. Pollinators warrant a crossed fertilisation, assuring a better remixing of vegetable genotype. They promote reproduction of about 80% of angiosperms that Nature - using genetic, morphologic, mechanic and structural strategies - made self-incompatible to assure the greatest genetic diversity. And now, as ever, they are compelled to passively suffer anthropic action (intensive agriculture, single-crop systems, plant protection products, pollution, etc.) negatively affecting their survival by making places inhospitable for their biologic cycle carrying out (Westrich, 1990).

In order to foster the coming of an agriculture taking care not only of production but also of productivity conservation and of environmental protection, culture, science and technology need to be consolidated. It is necessary to think to a sustainable agriculture, in the observance of biodiversity conservation at any level, preserving *in situ* and *ex situ* genetic heritages, in order to ascertain its erosion (Fowler & Mooney, 1993; Mc Neeley *et al.*, 1990; Pearce *et al.*, 1993).

Biodiversity conservation is therefore of essential importance for human being's future. To erode genetic heritage, indeed, means to make disappear a not renewable resource and the result will be that in the future of agriculture it will be difficult to improve crops against new biotic or abiotic adversities (Negri et al., 1996).

At the Convention of Rio de Janeiro in 1992 about biodiversity, the Agenda no. 21 looks upon signer countries as engaged in the sustainable use of biotechnology, in the conservation and use of genetic resources, including their conservation *in situ* (Buiatti, 1996).

In particular, the Convention of Rio identifies some strategies to come to concrete results. They are as follows:

- identification, checking and conservation of biodiversity main elements and exclusion of actions risking to have unfavourable impacts;
- conservation of habitats and natural ecosystems *in situ*, maintaining or establishing a-

gain peculiar species of natural and anthropized places (agro-ecosystems and city parks and gardens);

- conservation *ex situ* of genetic heritages;
- cooperation among signer countries, for an action aiming at positive results on the matter.

Further Conferences in Europe and elsewhere have been concerned with these problems. Biodiversity is decreased as time passed, also because the relation between economists and environmentalists in these last years has been lacking in cooperation and each of them remained stick to his own narrow principles. The new way to interpret the relation among economy, environment and territory is now based on three fundamental concepts: common property of environmental goods, private responsibility on decisions taken with regard to environment and new relations between State and citizens (Perrings, 1987). In particular, it is now clear that a sustainable use of biodiversity has a positive economic value and that the economic value of an environmental resource is made up of its usage value plus its non-usage value. Finally, from an economic and utilitarian valuation of resources a new concept of market is making itself known. This new concept must conciliate erosion, conservation, environmental defence and biodiversity (Ciani & Cocco, 1996). Recently European Union (04.02.98) - in accordance with the deliberations of the United Nations Convention on Biological Diversity (CBD) and within the Nature Network 2000 - set up a series of strategies to prevent biodiversity reduction, with the purpose of improving and preserving it. Among the numerous initiatives, a European network connecting national and regional parks, instituted and not already instituted protected areas, has been founded, promoting an active cooperation among countries. Pollinators surely will benefit by this interesting initiative aiming at protecting environment, because they will have places fit for nesting and will be able to carry out their biologic cycles undisturbed.

In conclusion, we hope that - after Rio Convention and the following ones - all interventions necessary to conciliate production requirements and the conservation of biological diversity and of all earthly environment will be carried out. The achievement of these objectives will warrant man a more sustainable use of resources and a less dramatic future.

If man, understanding the importance of biodiversity, comes to know how to use planet resources in a sustainable way, pollinators also will live in better environments; in exchange, they will go on with their inexhaustible and praiseworthy pollination work, not highly valued by man till now.

Agricultural income, quantifiable in some millions dollars as for pollinators' service, will to be still assured. Service made to spontaneous species, many of which are very interesting for man (medicinal herbs, edible plants, protected species, etc.) will be also safeguarded. This last type of income is not quantifiable, but it has an enormous value to preserve environment and biodiversity (Ricciardelli D'Albore, 1994d).

Bees and agro-environmental politics

Times when Europe was a continent covered of forests are far away. When man discovered that land could be cultivated, besides the first seeds sown to produce food the first seed of anthropic action was sown. It was the first human negative evidence by causing a slow and progressive unbalance and erosion of environment. Since then, an irreversible reduction in woodlands has been started. It is still taking place, above all in the big "lungs" represented by rain forests where the lands taken away from natural ecosystem are destined for an ever more unsustainable agriculture, urbanism, industrialisation. A mosaic of more or less exploited and polluted new systems arouses next to an uncontaminated nature. These new systems poisoned soils and also water-bearing strata, waters, seas and also the residual "natural" environments due to drift and acid rains.

The main actions responsible for deep alterations in territory can be summarised as follows:

- short-sighted policies and economy matched to maximum profit;
- urbanisation and industrialisation, with unpropitious polluting action;
- closed cycle zootechnical breeding, with the same consequences;
- introduction of models of agricultural development that are unsustainable for many populations. The consequence of this kind of situation is the land abandonment and the formation of unproductive and unstable fringe areas, with a precarious geotope continuously threatened by climatope;

- deforestation, with senseless cuts and still more senseless reforestation.

These ones and other side actions are unequivocal evidences of what and how much *Homo sapiens* was able to do till today as to the improvident exploitation of lands at disposal. After the passage from rotation of crops to single-crop systems, pollinators - very important for their pollination service on crops and on spontaneous species - found themselves to face an unfavourable environmental reality. When a rational scalarity of flowerings, warranting the normal and complete carrying out of the biologic cycle and places for nesting, came to an end, pollinators slowly distanced themselves from this unstable ecosystem. Nowadays in modern agriculture survives (if is not ever easily) honey bee, because it is protected and reared by man. Wild pollinators are by now lacking in agro-ecosystem; they instead maintained population densities in less anthropised environments almost unchanged. Man understood (not too late, we hope) that pursuing on this way he would come up against unsolvable problems, a real catastrophe for future generations. Politics and economists partly agreed on new programmatic lines reported below.

In 1984, with the agreement of Stuttgart at European level, a sharp turnabout of the community agricultural policy was planned. The application of physical shares of product and joint liability taxes marked the passage from a quantity production to a quality one. Brundtland Report (1987) defines the *sustainable development* as "the development allowing to satisfy current needs without compromising the possibility to satisfy future generations' needs". The development is here meant in a very complex way. It is aiming at economical and social aspects and at environmental safeguard objectives, at the same time. Many sectors are involved in this strategy and sustainable agriculture is an important part of it. Market of all agro-alimentary products is becoming ever more dynamic and complex. With respect to this, it has to be underlined that few years ago (11/04/1994) the General Agreement on Tariffs and Trade (GATT) was formally signed in Marrakesh (Morocco) and the General Trade Organisation (GTO) was established. Reference frameworks for agriculture and connected activities can be drawn from this treaty. It is characterised by the following points:

- complexity
- globality
- competitiveness
- market deregulation
- sustainable development strategy
- accentuation of environmental problems
- economy fall in Eastern countries
- defusing of traditional industry and shift of interests in innovative sectors towards Asiatic markets.

In U.S. for many years by now it has been speaking about LISA (Low Input Sustainable Agriculture) Programme. A right policy about natural resources cannot be given up in order to achieve a new model of development aiming at qualitative aspects in a stronger way than in the past. Within this reference framework the problem of biodiversity is assuming a remarkable weight.

As already said, EU promotes an ever more massive U-turn for the construction of a strategy of agricultural development aiming at quality of life, conservation of natural resources, market balance, sustainable development. It is therefore important to summarise contents and principles inspiring regulations aiming at achieving these objectives.

Some years ago European Union made a turn-about on some aspects of Community Agricultural Policy (PAC) with two important regulations (2078/92 and 2080/92). Main innovations (to be ascribed above all to the regulation 2078/92) are as follows:

- the intervention only in "sensible areas" (regulation 797/85) becomes an intervention involving the whole territory, by *regional programmes*; *preferential areas* are to be individuated within these *homogeneous areas*;
- each partner country is compelled to plan the system of assistance.

The general aims are the following:

- decrease of pollution provoked by man;
- recognition of farmer's function, in the public interest, as for management of space and of natural resources and as for the defence of nature;
- to contribute to ensure an adequate income to farmers.

Some specification has to be given about the last two points. The old PAC leaves its place to an Agro-environmental Policy, result of an evolution started by the middle of the Eighties. The regulation 1760/87 was the first to promote the withdrawal of sowable land from production and to keep lands set aside for more or less long periods. From that moment onwards the new password is *extensification*, with the double aim of reducing agricultural surplus and lowering pressure on environment. This produces a lesser income to be sustained by means of bounties for each hectare set aside or head of cattle taken away from production. With the new regulation, bounty amount per surface is considerably increased and it is established the possibility to cumulate on the same surface other bounties appropriated by other regulations for measures having positive effects on environment. Among the "accompanying measures" indicated by regulations 2978/92 and 2080/92 in order to achieve the said objectives, we identified those ones interesting for beekeepers and for the defenders of wild Apoidea from a careful examination of Pluriannual Regional Programmes of realisation, that is, Agroenvironmental Programme and the Afforestation Programme.

Regulation 2078/92	Regulation 2080/92
• Extensification of vegetable productions • Extensification of ovine and bovine zootechnics • Twenty year withdrawal of sowable land • Protection of abandoned agricultural land • Management of land for public access and leisure activities	• Afforestation as an alternative use of agricultural land • Improvement of woodlands

Single and associated beekeepers, farmers and not, will be able to perform an imaginative effort, to find some cooperation procedure with farmers determined to change their lands with public bodies or to let lands themselves and introduce autochthonal melliferous species, fit for hedges, enclosures, pastures, meadows and volunteer vegetable covering against the decay of abandoned lands, woods, etc.

In the light of these commitments taken also by EEC countries and till now only partially applied, some practices that could be put into effect in the immediate future for pollinators - first authors of the conservation of vegetable biodiversity, above all at a genetic level - will be examined (Cresso, 1991; Corbet *et al.*, 1991; Free *et al.*, 1975; Ricciardelli D'Albore, 1994d; Ricciardelli D'Albore & Quaranta, 1995b; Williams, 1993).

Lands set-aside

The lands set-aside must have a vegetable covering, otherwise nitrogen can filter more easily and end in water-bearing strata. Some time ago a mixture of seeds from yearly spontaneous flora (*Tübingen mixture*) was set up. It is wisely proportioned in seed percentages of each species and temporarily covering lands set-aside (two years) allows pollinators to feed. At the same time it causes an increase of humus in lands, allows birds to nest, decreases the impact of noxious insects, etc. A new mixture (BBA) was set up for land covering; it includes also perennial species so as to prevent the settlement of unwelcome infesting weeds. Two other mixtures are *mixture of Nentwig*, concerning the immission of shrubs and two-year grasses in long term lands set-aside, and the *hedge of Brandeburg*, consisting in the recover of stripes of land some metres wide, where spontaneous flora can develop next to dry timber (fascine of small reed would be better) with the aim to making pollinator nesting easier. These very clever practices are applied above all in central and northern Europe, while in the Mediterranean area the problem has only partly taken into account and a mixture of plants fit for solving for the main problem of these environments, the dryness, has not already put up. *Tübingen mixture*, indeed, is right only for the beginning of spring, but is non able to cover critical months (June-July-August) (Andrews, 1992; Bauer, 1983, 1985; Bauer & Engels, 1991, 1992; Engels et *al.*, 1994; Griesahn, 1984; Liebig 1998; Lutman *al.*, 1991; Manninger, 1973; Matheson, 1994; Raedle & Engels, 1993; Smith *al.*, 1992). It is therefore necessary that scientifical research faces and solves this serious problem.

Afforestation and side lands

Bodies charged with afforestation till now did not show a particular sensitivity towards connections between beekeeping and forestry, links already well known by beekeepers. It could be therefore useful let foresters know about the existence of numerous arboreal and shrubby species able to satisfy bees and afforestation requirements at the same time. The widespread of such plants could result in an increase of honey production, on condition that honey species are experimented in advance in suitable pilot-places strictly checked, above all for that concerns environmental impact.

In this connection, especially in the Mediterranean area (Italy), important studies to promote the immission of grassy, shrubby and arboreal flora in unstable lands have been carried out, and in some cases plants have been introduced in the farmhouses of some workers who have proved to be more sensible to this kind of problem (Ciani et *al.*, 1990, Ricciardelli D'Albore, 1987b, 1987c; Ricciardelli D'Albore, 1991e; Ricciardelli D'Albore, 1998i; Ricciardelli D'Albore & Ciani, 1996a,b).

Chapter 3

POLLEN GATHERING

Pollen is the only proteic food within the beehive; as a consequence, it plays a fundamental role in feeding the colony, whose biology is entirely conditioned by this factor. In fact, pollen is used for feeding the larvae and the young bees. It contributes to body growth in general and is a determining factor in the development and the functionality of certain organs such as adipose body, ovaries and in particular hypopharingal glands. These glands play an important role in "royal jelly" secretion; royal jelly is used for feeding the larvae for the first three days of their life and provides the queen bees with nourishment for their entire life.

Even if in several cases pollen and nectar are gathered at the same time - an almost frequent phenomenon in solitary and social Apoidea (bumblebees and Halictidae); they gather pollen mixing it to nectar and feeding the larva with this kind of "paste" - pollen gathering by bees is mostly left in charge of specialised gatherers and is carried out in two separate phases. The result is the formation, on bee's back legs, of loads made of pollen mixed with nectar or honey.

The first stage consists of pollen gathering from flower, carried out in different ways according to flower shape. On anemophilous plants, for example, bee climbs the inflorescence and clings to anthers by mouthparts, biting them and causing this way pollen flow. Then pollen sticks to mouthparts, head, leg hair, etc. When visiting one flower, like *Cistus*, *Papaver*, etc., bee shifts backwards and forwards attracting anthers and staining all body with pollen. If flowers are *Leguminosae*, bee, breaking the corolla open to find a passage, sets anthers free and these last ones place pollen on the body of the insect. Some plants show particular devices, like balance stamens of *Salvia*, or the spring mechanism in the staminal tube of *Medicago*, etc.

In the second stage bee, covered with pollen, leaves flower and, keeping in flight above it, begins to perform a complex series of motions in quick sequence to prepare pollen loads. This task is mainly carried out by legs, provided with a system of bristles and hair to gather and keep pollen. The first pair of legs gathers pollen sticking to mouthparts, head and neck; this pollen, partly already moistened during the first stage, is continuously mixed with nectar gathered on flower or with honey regurgitated from honey sac filled by bee in the beehive before the beginning of the flight. Pollen becomes therefore ready to be conglomerated. In other Apoidea, oil lining pollen surface is also utilised to this aim. The second pair of legs, always by means of cleaning combs, gathers powdery pollen on chest and mixes it to the moistened one received by the first pair. The third pair, finally, gathers pollen from abdomen and mixes it with the moistened one received by the second pair. Then, by means of a swift friction of back legs, pollen is transferred from a leg-cleaning comb to another "comb". Such a comb - also said "rake" - is located on the tibial distal side and is made of a series of hard bristles which, passing through the hair rows of brush, gather pollen in a dense mass. The mass then falls on a small lobe situated below, said "auricle", formed by the basitarsus. Then bee bends the tibial-tarsal joint, known as "pollen press", and this way pollen is crushed and pushed outside in the "pollen basket". It is constituted by the external and concave side of tibia and along edges is equipped with a series of crooked hair keeping back pollen mass; it is moreover sustained by a solitary hair, longer than the others, placed in the central part of the pollen basket. Little by little more pollen is added and loads increase till are carried into the hive, when they have reached a certain size. Here the gatherer frees itself from loads taking them off with the help of the second pair of legs, while young bees of the beehive arrange for their storage in cells after having moistened them with honey.

Many Apoidea also gather pollen from anthers with front legs and often use medium and back legs, too (*Chelostoma*, *Osmia*, *Systropha*, etc.) While only social Apidae (bees and bumblebees) carry all pollen gathered in pollen baskets, other Apoidea use several body parts, besides legs; these parts are often connected among them for a more complex gathering (Westrich, 1990). Like bee, also *Hylaeus*, *Andrena*, *Lasioglossum*, etc. are in the habit of using mandibles to rake pollen granules; *Xylocopa*, on the contrary, is accustomed to take pollen with mouthparts, to swallow it and to carry it to the nest this way. Colletidae, also, unprovided with any gathering system, swallow pollen and then regurgitate it. *Rophites* and other species are provided with sharp hair on head and hoard pollen by means of them. It is then transferred to back legs through medium legs. Some *Osmia* have on front head a small basket lined with hair where the first phase of pollen gathering takes place, by head friction. Afterwards (as for all non parasite *Megachilidae*) the real gathering and hoarding take place by an abdominal pollen comb formed by parallel hair fringes along ventral plates (sternites), while abdomen is ritmically beated against flower anthers, like a drum.

Besides pollen carriage in the ingluvies or on various specialized structures, a whole series of adjustments can be found. *Panurgus* and some *Andrena*, for example, carry pollen on coxa only; other *Andrena*, *Halictus* and *Lasioglossum* make use of the coxa, trochanter and thigh bone complex; *Anthophora*, *Eucera*, *Melitta*, etc. make also use of a kind of tibial comb. In some *Andrena* propodeum also, unprovided with side hair, is used in pollen gathering. *Systropha* is equipped with hair for gathering on dorsal plates (tergites).

Generally, after having choosen a flowering, bees keep on gathering pollen on it until stocks are finished or until they do not find other more appetizing flowerings. Bee loads are therefore made of more or less omogeneous pollen and have particular colour, shape and consistence, according to the visited species.

On the other hand, it is possibile that pollen loads of similar colour come from different species: the various shades of yellow are very common. The kind of brightness, grain and shape of pollen load can be distinguishing elements in the case of mixed loads, consisting of two, three or four different pollens, but this case is an exception.

As for consistence, loads coming from anemogamic plants are generally more friable and stronger than the ones coming from entomogamic plants. But some exceptions are known: the anemogamic *Zea* produces very thick loads. The average weight of a load is of about 7.5 mg. After each trip, therefore, a bee carries to the hive 15 mg of pollen.

Special devices can be set up in the beehive to enable a careful, both quantitative and qualitative analysis of the pollen collected. These devices, known as “pollen traps”, can be of two different types, but all are based on the same mechanism: the beehive entrance is closed with a grill whose small holes are dimensioned in such a way that the bees can pass through, but a portion of the pollen loads they are carrying falls off into a little box situated below the entrance to the hive. To avoid an excessive crowding at the trap entrance, a hole on a side of the beehive is opened; when, after some days, bees have been got used to the new passage, this one is closed and another one is opened at the opposite side. The most commonly used trap today is collocated below the floor of the beehive.

In the period immediately after the grill is installed, almost all the pollen gathered ends up in the trap, but after some days, the gatherers learn how to enter the hive without losing their entire pollen load. So the trap yield settles at about 10%; this means the trap can be used, at least for a certain period of time, without substantially damaging the colony, especially as the colony makes up for its losses by working more intensely.

The contents of the trap are removed at regular intervals (usually, each evening). Then they are analysed, dried and stored for the sale. Pollen quantity obtained in a year by a colony by means of the use of the trap is of 2-3 kg on an average. They correspond to 20-40 kg carried to the beehive, estimating a yield of about 10%. Actually, this is the quantity necessary to cover pollen needs in a colony of average size. Bees gather more pollen than their real requirements, when they can do it. This phenomenon takes place above all in those areas where botanical species abound in pollen; the result is a greater development of brood and therefore an increase in family, which will inclined to swarm. This is greatly due to the instinct of storing stocks against shortage periods.

Among internal factors of the beehive, the fundamental one for gathering is the presence of an uncapped brood. Colonies with a more consistent brood gather more pollen than others with a smaller brood. Orphan colonies, without brood, stop gathering. They begin to gather again when frames with an uncapped brood are introduced in the beehive. During the year the ponderal curve of pollen gathering follows laying course: the activity of the queen bee is stronger in spring, taking to family growth; it slows during summer and almost stops in autumn; the brood reared in this period gives origin to bees destined to pass winter.

The main external factors are represented by biotic (presence and abundance of flora) and abiotic (climate) conditions. As for weather, temperature is the main limiting factor at the end of winter, since below 10°C bees do not gather anything, while other Apoidea (*Osmia cornuta* Latr., *Bombus* spp., etc.) can gather at temperatures below 10°C; other pollinators, instead (*Lasioglossum*, *Andrena*, etc.), work only at temperatures higher than 15°C.

Bees and other Apoidea prefer to gather pollen on entomophilous plants, with viscous pollen (presence of fats on pollen granule surface). Honey bees do not disdain anemophilous pollens, sometimes gathered in big amounts (*Quercus*, *Zea*, etc.), but more often treated as occasional gatherings or as a makeshift (*Pinus*, *Cupressus*, *Rumex*, etc.). Maybe, in the choice, biologic value of pollen is very important, because it has repercussions on bee physiological state and longevity and it is not the same for all pollens. Maurizio (1954) classified three pollen groups on this subject: very active pollens, few active pollens and inactive pollens. The last ones, that in some cases can be noxious, include most anemophilous pollens and they are not so favourite by bees.

It is not yet completely known which of the several components of pollen are responsible for its more or less high biologic value. An essential role is surely played by proteic constituents (present for 15-30%). This can be valid for solitary bees also, except the oligoleptic ones that established a synecologic relationship between bee and plant and for this reason are joined to that particular kind of food. It is possible anyway that proteic content is not the only factor to determine pollen biologic value: there are in it also numerous vitamins - of fundamental importance according to some Authors - and other substances of different chemical nature, with a not already precisely individuated function.

It is however to be specified that unifloral gatherings are rare. It is possible that the colony needs a various diet to reach a balance in nutritional contributions. Moreover it seems proved that some beehive diseases depend on the lack of some fundamental element in the diet. It is known that noxious pollens (*Aesculus*, *Ranunculus*, etc.), when mixed with others, are innocuous, while at the unifloral state they can cause severe damage to bees. In other Apoidea, unifloral gatherings, registered in the case of strictly oligoleptic insects, are very rare, in comparison to the widely oligoleptic or polyleptic ones.

A short account deserves the sometimes-determining anthropic action on gathering chances by Apoidea. It is carried on through more or less radical changes in the environment where insects live. The introduction of single crop systems assures, even if for a short time, abundant food, but the drastic reduction of surface at the disposal of the spontaneous flora, further impoverished by the use of herbicides, deprives pollinators of many resources. It is sufficient to give the example of *Papaver rhoeas*. Till some years ago, it was the main component in May gatherings, while now keeps this role in few places only. Single crop systems caused strong unbalances in quality and quantity of plant at disposal in agro-ecosystems. Nowadays, flowering variety and scalarity, otherwise than in more or less natural ecosystems, are severely compromised. For this reason in anthropised environments bees survive better than other Apoidea, since they are safeguarded by man, who raises them for his own advantage (Ricciardelli D'Albore & Persano Oddo, 1978).

Chapter 4

NECTAR SECRETION

Nectar is a sugary solution secreted by particular organs of plants, defined as nectaries. Nectaries can be located on flower and on other parts of the plant. In the first case, they can be situated inside and outside flower, and their role is much discussed. Delpino (1868-1874), the first to propose the definition “wedding and extrawedding nectaries”, deemed the first ones only as apt to attract pollinators. Nowadays the distinction between floral nectaries and extrafloral nectaries is widely accepted. Both types, moreover, can be or cannot be morphologically differentiated and are defined as “histoids” if they consist of tissues, or “organoids”, if resulting from more or less modified organs. Moreover, histoids can be flat, concave, structured in cavities, scaly and raised (Zimmermann, 1932; Springensguth, 1935; Ziegler, 1968). Such distinctions are very important to study nectar secretion, because to pipette nectar it is necessary to know nectary shape and position.

Carbon hydrates are the most important share in nectar composition. Their concentration also depends on climatic conditions. In some cases, nectar can even crystallize, becoming an hardy extractable food by pollinators. Nectar can contain also small percentages of organic acids, amino acids, peptides, albumins, vitamins and aromatic substances, and also some inorganic compounds (Ziegler, 1968).

According to sugar content, there are three types of nectar :

- with predominating saccharose
- with almost the same share of saccharose, fruttose and glucose
- with dominance of fruttose and glucose, even if the ratio of the first to the second is extremely changeable.

The presence of enzymes can modify sugar concentration and type, characterising this way the specific nectar. In any case, nectary morphology and nectar sugar content are peculiar of this vegetal species.

For some time nectar secretion of plants has been studied by various Authors (Agtha, 1951; Bertsch, 1983; Bolter *et al.*, 1973; Bähneker, 1917; Burquez & Corbet, 1991; Cammerloher, 1929; Corbet, 1978a, b, 1979; Corbet *et al.*, 1979; Cruden & Hermann, 1983; Cruden *et al.*, 1983; Czarnowski, 1952; Ewert, 1932; Fahn, 1952; Harder, 1985; Harder & Cruzan, 1990; Herrera, 1985; Lüttge, 1961 and 1962b; Mc Kenna & Thomson, 1988; Percival, 1961; Pflumm, 1985; Schnepf, 1977; Shuel 1964). Among them, Andrejev (1927), Rozov (1933-1963), Bogojavlenskij & Tereschenko (1936), Maurizio (1954), Demianowicz (1963), in particular, gave their contribution to the set up of a method, now retained by most researches as the most reliable from a statistical point of view. Thanks to this method it is possible to assess nectar amount produced by the single crop system of a given vegetal species.

To assess the “honey potential” of a plant is important for two reasons:

1. beekeeper can individuate species with higher honey potential in a given area and can therefore locate beehives in more productive floral areas;
2. in normal agronomic and forestry practices some species interesting for bees can be included, besides the commonly used ones.

On the basis of the numerous researches carried out, it is possible to affirm that the amount of nectar secreted:

- is minimum when the ratio of air temperature to soil temperature is equal to 1; increases if this ratio is lesser than 1 and is maximum if it is higher than 1 (Dietz, 1966);
- is in direct function of light (Schnel, 1963; Dietz, 1966);
- depends on soil composition (Bogojavlenskij, Rozov, Tereschenko, 1936); but opinions in this respect are disagreeing and the matter is far from being resolved;
- is higher, in a same species, when altitude increases (Bonnier, 1878);
- depends on flower phenology; increases during anthesis, being extended following insect visits, and then progressively decreases. There are however exceptions to this kind of behaviour and, in some cases, at the beginning of the flowering of a species, there is an increase (Boetius, 1948);
- depends on flower position on plant (Andrejev, 1927);
- is influenced by reabsorption by means of plant (Ziegler, 1968).

The percentage of sugars present in nectar is also influenced by various factors:

- the amount of sugar secreted is inversely proportional to the humidity percentage in air (Dietz, 1966);
- the air temperature directly acts on sugar concentration ratio in nectar (Rozov, 1936; Dietz, 19966), although some experiences are in contrast with such a statement (Beutler, 1940);
- in airy environment nectar is inclined to concentrate: this phenomenon is connected also with nectary shape and position (Dietz, 1966);
- nectar is more concentrated at the end of the flowering of a species, even if its amount decreases (Boetius, 1948).

Factors qualitatively and quantitatively influencing nectar production by plants are so numerous that they can considerably widen the variability field of the phenomenon. For this reason, to obtain a higher number of data, it is necessary that inquires follow each species for at least three years, and always in the same place, being sure that variations, followed one another in the environment during the period of time taken into consideration, can offer a sufficiently mediate appearance.

It is moreover necessary to specify that in researches carried out in full field it is necessary to prescind from the single action of each of the above-said factors and to accept as representative the medium value obtained by their concomitant influence. The obtained data are considered as sufficiently valid to express medium nectar productivity of a vegetal species and to attribute a certain honey potential to this species.

Vegetal species are generally studied according to the following methodologies:

a. *Flower phenology*: by marking 10 flowers before anthesis, average life of a flower is calculated from the opening of the corolla till to the fall of petals or the withering of its organs.

b. *Investment calculation per hectare*: in the case of a wooden perennial species, when average dimensions are established, the average number of flowers present during the whole flowering period for a plant and then the number of plants per hectare of a single crop system are calculated. For herbaceous plants, data are obtained by marking the boundary of five lots of one square metre where flowers are counted, calculating then the average value per hectare.

c. *Nectar secretion investigation*: a group of flowers for each plant is covered with tulle small sacs. After 24 hours the secreted nectar is collected from these flowers by means of a Jablonski pipette (Figure 2) (Nowadays calibrated, expensive and exact microcapillars are used. They allow to get over Mc Kenna & Thomson's (1988) and Harder & Cruzan's (1990) methodologies).

This technique, used for very small flowers, lies in diluting nectar with distillate water, with the addiction of few drops of phenol at 5% and of 1 ml of concentrated H_2SO_4. This solution, in presence of sugars, becomes orange (Schemske *et al.*, 1978) and is subjected to further laboratory treatments (HPLC) (Petanidou & Smets, 1995) after being weighed. Nectar weigh is then calculated making the difference and the obtained datum is divided by the number of flowers pipetted to establish the average value for each flower. Finally, sugary concentration of nectar is determined by refractometer.

Every 24 hours, for the whole period of flowering, the small sacs are transferred to other groups of flowers at different development stages, previously also visited by insects. It is possible to assess nectar secretion in every phase of flower life and in relation to the presence of entomofauna. At the end of observations, the average amount of nectar produced in 24 hours from a flower is multiplied by its life (mg x no. of days).

d. *Honey potential calculation*: by knowing the number of flowers present in an hectare and the amount of nectar produced by a flower in its life, and by taking into consideration the fact that sugars take part of honey average composition for about 80% (that is, 0.8 kg of sugars = 1 kg of honey), the following formula is applied:

kg of honey/ha = kg of sugar/ha x 100/80

The so calculated value does not take into consideration all negative factors trending to lower it (unfavourable climatic conditions, etc.) and does not give indications about the amount of honey that can really be obtained by the beekeeper. Actually, factors as species desirability, competition with other (diurnal and nocturnal) pollinators, honey consumption by the colony for its own feeding, more or less shrewd exploitation of crop (number of hives per hectare and their disposition) have repercussion on the amount of honey produced.

However, on the basis of the obtained data, it is possible to group the various species studied according to productivity classes, as follows:

Class	I	less	than	25	kg/ha honey
“	II	from 26	to	50	“ “ “
“	III	from 51	to	100	“ “ “
“	IV	from 101	to	200	“ “ “
“	V	from 201	to	500	“ “ “
“	VI	over		500	“ “ “

When there is a single crop system and the honey potential of a territory with mixed vegetal covering has to be assessed, Braun-Blanquet method can be adopted for phytosociological studies, by establishing as far as one can judge the percentage of nectar plants present on surfaces of 0.5-1 sqm and carrying out some repetitions. An alternative method is based on the use of a circle with a known area that is thrown again and again on soil. By putting non nectariferous plants aside, the real number of nectariferous species in an hectare of a given floral system is deduced (Ricciardelli D’Albore, 1990d).

In this work, the maximum value indicated by researchers has been reported, that is the maximum theoretical quantity of honey that can be obtained by an hectare of crop. When this datum is not known, for each species are indicated the mg of nectar produced by the single flower. From this value, by means of the described calculations, it is possible to go back to honey potential/ha (Ricciardelli D’Albore & Intoppa, 1979).

Chapter 5

NECTAR GATHERING AND HONEY

Honey has been defined as "the sugary substance produced by bees from nectar, honeydew and other sugar substances gathered by these insects on living vegetables. They enrich this material with substances coming from their body, transform and store it in combs and make it mature".

As stated by this definition, raw material from which honey originates are mainly nectar and honeydew. The amount of honey bees can obtain from a flowering, besides from the extension of the flowering itself, depends on the quantity of nectar produced and on its sugary concentration. Both are factors greatly varying according to species: the quantity can range from less than 0.1 mg (a single flower of clover) to over 1 g (*Liriodendron* L.) and sugary concentration from 2% to over 60%. Bees prefer species offering a higher nectar quantity, but require also that concentration is quite high, at least over 15%. Nectaries accessibility is also important. Some species, indeed, even though they are nectariferous, own a floral shape that not makes gathering easy. If a flower has a long tubule, bee tongue cannot reach the bottom of the calyx where nectar is gathered, while the tongue of several species of bumblebees and Anthophoridae can do it.

The amount of honey produced in a beehive is greatly varying: from the honey-extraction of a permanent hive an average of 10-15 kg of honey in a year can be obtained, with peaks over 40 kg, while in nomadic beekeeping the value of 60 kg can be exceeded. As for pollen, for nectar also the extent of gathering is, as a rule, proportional to colony strength and numerical consistence and, during the year, follows a course related to climatic and floral situation. And in this case, "climate" is still more relevant, since it directly influences nectar secretion, as already said. If, for example, humidity values increase over a certain limit, nectar production is high, but it is more diluted and to obtain the same amount of honey bees must perform much more work.

The radius of action of nectar gatherer is wider than the pollen gatherer. The insect can fly at a distance of three kilometres and, under particular conditions, this gatherer can go over. The fight radius of other Apoidea, save bumblebees, is generally limited at a little distance from nest and can go from few decades of metres to 200-300 metres.

Now we will examine, in detail, nectar and honeydew gathering mechanism and the transformation of these raw materials in honey.

Bee can suck in sugary liquids, thanks to the particular conformation of its highly specialized mouthparts: maxillary palps and lower labial palps can join to form a tube through which food passes inside. The tongue, provided with thick hair and with a duct for saliva, moves inside this tube. Such structures, as a whole, are called "proboscis". Pharynx muscles assure liquid ingestion and regurgitation. They compress or stretch preoral cavity (*cibarium*), making it function as a pump. The liquid sucked through the proboscis, after its passage in pharynx and oesophagus, arrives in the "honey sac", where it remains as long as gatherer, completed its burden, returns in the beehive. The honey sac is a sac-shaped dilatation of oesophagus, can contains about 50-60μl and is separated from the food duct by a particular funnel-shaped valve leaning forward inside it. This valve, called "proventricule" is formed by four lobes closing like a cross and has the function to keep the liquid in the sac. Moreover, it has the task to filter nectar to be stored, by removing polluting substances (nosema and plague spores) and by greatly reducing the number of pollen granules present in nectar. Since the whole operation is performed during the re-entry flight of gatherer, pollen amount excluded from nectar will be more or less great, according to the distance of the nectariferous source from the beehive. This explains the considerable differences that can be found in pollen content of honeys with the same botanical origin.

The most important transformation processes of nectar in honey take place in beehive, but some change begins to verify already during gathering activity and re-entry flight. Bee, indeed, sucking nectar, added to it the secretion of its own salivary glands, diluting and enriching nectar with enzymes which act on sugars contained in it.

After its return to beehive, gatherer regurgitates the content of the honey sac and entrusts it to house bees, then they pass it from one to another, again and again. The number of these transits depends on work rate in the beehive. If the amount of nectar arriving in the hive is high, all operations concerning its elaboration are more rushed and the number of transits from a bee to another is reduced. If, on the contrary, gathering is moderate, house bees can longer handle liquids given to them. Nectar is enriched of substances elaborated by bees - in particular, enzymes - in proportion to the number of transits.

Before being stored, honey undergoes a “maturation” process, implying a series of transformations. The most important is the gradual loss of water. To be conserved without fermentation risks, honey needs that its water content is not higher than 20%, while in the gathered nectar the percentage is much higher. This progressive concentration is carried out through two different phases: during the first phase, the bee which received nectar pumps it outside forming a drop at the base of proboscis and then suck it again, quickly repeating the sequence for numerous times, in 15”-20”. Exposed to the dry and warm air in the hive, the drop loses a certain amount of water, up to reach a moisture value of 40-50%. At this point, the second phase begins. Drop is located inside a cell where evaporation continues spontaneously, helped by air movement due to “ventilators” bees. First cells are filled for a fourth or a third of their capacity. When water content drops below 20%, the cell is filled and capped with a layer of waterproof wax.

Modifications underwent by honey during its maturation do not imply a water loss only, but also real chemical transformations. We have seen that, by passing from a bee to another, honey enriches in enzymes worked out by the same bees: these enzymes act mainly on complex sugars (di- tri- polysaccharides) transforming them in simple sugars. In particular, saccharose disaccharide, often present in nectar in high percentages, is resolved in fructose and glucose, the main components of mature honey. The percentages of sugars depend on honey botanical origin. Each honey, according to its place of origin, owns peculiar odour and flavour and also the gamut of colours changes from the almost colourless light yellow to dark brown, with all intermediate shades of yellow and amber.

Honey, at room temperature, is a solution oversaturated of sugars and for this reason is inclined to crystallize. This phenomenon mainly interests glucose, less soluble in water than fructose. The relationship between glucose and water is then the conclusive factors for a more or less quick crystallization and, if it is lower than a certain value, honey does not crystallize, like in some particular cases (acacia honey, where the prevailing sugar is fructose).

For the beginning of the process, solid particles contained in honey (pollen, dust granules, wax fragments, etc.) or small crystals of the same glucose (primary crystals) act as crystallization cores. If in a honey there are many of these cores, crystallization is quick and fine. On the contrary, if cores are few, crystallization is slower and crystals are gross. Since glucose crystals are white, honey, by crystallizing, assumes a lighter colour.

As for other Apoidea, bumblebees gather nectar and, when it is mature, lay it down in particular small cups. Some Anthophora fill their cells with a very fluid honey on which the laid egg is floating. The remaining solitary bees usually lay a mixture of pollen and nectar (pollen paste) in each cell of pedotrophic nest (Westrich, 1990).

Chapter 6

HONEYDEWS

Honeydews are excretions made by piercing and suction insects (*Rinchota Homoptera*), which use their piercing oral apparatus to attack plants and suck out the phlohematic liquid which is rich in nourishing substances, especially aminoacids. To satisfy their protein needs, these insects are compelled to suck large amounts of this phlohematic liquid, which contains only 1-2% of proteins and is rich in water and sugars. Some Rinchota (for example Coccides) have a complex digestive tract, with a filtering chamber, which connects the ingluvies to the rectum. Most of their food passes across this filter and, as a consequence, their excretions become richer in water and saccharose (the carrier sugar in plant sap) (Ricciardelli D'Albore & Battaglini, 1991). In most other piercing and suction insects (for example Aphids), there is no filtering chamber in the digestive tract; as a result, their food passes through the entire abdominal duct, which digests, absorbs and transforms most of the sugars. The chemical composition of the honeydew produced by these insects differs considerably from that of the insects whose digestive tract has a filtering chamber.

Many other factors, related to insect and plant biology, affect the quantity and the quality of the honeydew produced. Microscopic fungi and algae develop on these nectar excretions. These fungi imperfecti can then be found in the honeydew sediment.

One often hears of the damages that piercing and suction insects inflict on plants are less than is commonly thought. Even though an insect attack may be harmful (for example fumagines can develop), it is equally true that plants recover quite well by themselves (in agriculture the situation is different, because production quantity and quality have to be taken into account). Moreover, in a forestry ecosystem hundreds of useful insect species feed on honeydews, which consequently play an important role in the food chain. In a forestry environment, insects are classified as "useful", "noxious" and "indifferent". Experts in this field usually include Rinchota in the "indifferent" ones class.

Bees use these honeydews to produce large amounts of honey, which is often greatly appreciated by consumers. Experts usually use the plant name to classify honeydews (fir-tree honey, larch honey, lime-tree honey, etc.); this explains why many people think that honeydew is a substance directly secreted by the plant (exudate). Even though particular physiological conditions or shocks can induce a plant to excrete a sort of "vegetable honeydew", in 99% of cases honeydew is of animal origin, i.e. produced by piercing and suction insects (Kloft & Kunkel, 1985; Wellenstein, 1961, 1966).

Honeydew production depends directly on the population trends of these insects and these vary greatly from one species to another. A large quantity of honeydew can only be produced when the insect population density is very high; it should be noted that even when the insect population is at its maximum, very adverse meteorological conditions could totally ruin honeydew production. It is not advisable to practise beekeeping in a forest if there is no possibility of obtaining a prognosis of the honeydews likely to be produced in the immediate future. Experts know which techniques to use to obtain a reliable prognosis. Basic entomological knowledge is required in this field: insects in every development phase can be quantified per surface unit (for instance a 1 meter branch, etc.) or by the number of drops of honeydew which fall onto a plastic sheet per surface unit and per time unit. Therefore meticulous observations in the field are requested to enable a beekeeper to estimate how many bee colonies can be transferred into any given area.

Some honeydews are produced in large quantities in a short time (conifers or *Metcalfa pruinosa* (Say) honeydews), but one generally obtains an abundant honeydew production every four years (honeydew of many broadleaves). Sometimes the Rinchota population explosion happens over very long periods of time (6-8 years, Chestnut honeydew); however, since Rinchota trends depend on numerous biotic and abiotic factors no fixed guide-lines can be laid down for any of the species, so a reliable prognosis can only predict whether there will be a large production of honeydew in a given year (Liebig, 1977; Pechhacker, 1976; Rihar, 1971).

The main types of honeydew

This paragraph provides a description of those honeydews that are more or less constantly produced in large quantities and which contemporaneously attract bees.

- Silver fir (*Abies alba* Miller) honeydew. It is considered as one of the best honeydew varieties in Europe. In Italy this honeydew variety comes from the Alps and the Tusco-Emilian Apennines area. The insects responsible for its production belong to the *Cinara* genus (*Cinara pectinatae* (Nördlinger) plays a particularly important role). Mention should also be made of the so-called silver fir honeydew (*A. cephalonica* Loudon), produced in Greece and Turkey. Silver fir honeydew production is widespread in Central Europe.

- Spruce (*Picea abies* Karstern) honeydew. It is an excellent honeydew, mainly produced in Europe. In Italy this honeydew comes prevalently from the Alps area (Schmutterer, 1965). The piercing and suction insects most involved in the production of this honeydew belong to *Cinara costata* (Zetterstedt), *C. piceae* (Panzer), etc.) and *Physokermes hemicryphus* (Dalman).

- Oak-tree (*Quercus* spp.) honeydew. It is obtained periodically in good quantities. Its quality is inferior to spruce and silver fir honeydew from the organoleptic point of view. Honey made with oak-tree honeydew does not remain liquid for long; it crystallizes firmly, forming large crystals. Oak-tree honeydew is quite common in central and southern Italy. Hole-oak (*Quercus ilex* L.) honeydew is probably the worst of the oak honeydews. The insects, which play the largest role in oak-tree honeydew production, are *Tuberculatus annulatus* (Hartig). and *T. borealis* (Krzywiec).

- Lime-tree honeydew (*Tilia* spp.). Its quality is superior to that of oak honeydew and it has a typical grape aftertaste which consumers usually appreciate. The most important piercing and suction insect which makes lime-tree honeydew belongs to *Eucallypterus tiliae* (L.). In Italy there are no forest areas with lime-trees, or only a few very limited areas, so lime-tree honeydew is produced near built-up areas (avenues, parks, estates, etc.).

- Chestnut (*Castanea sativa* Miller) honeydew. Given the diffusion of this species in Italy, one would expect a high production of chestnut honeydew honey. This does not happen for two reasons. Firstly, bees are not greatly attracted by this glucidic source, and secondly high production rates can only be reached after a long period of time. The most important piercing and suction insect for chestnut trees is *Myzocallis castanicola* Baker; this insect only reaches a high population density after quite a few years (Serini, 1973).

- Willow-tree (*Salix* spp.) honeydew. It is excellent, but not widespread in Italy; there is small-scale production in Piedmont, Tuscany and Umbria. In Eastern Europe (ex-Yugoslavia, Rumania, etc.) this kind of honey is produced in very substantial quantities. The piercing and suction insect is *Tuberolachnus salignus* (Gmelin).

- Larch (*Larix decidua* L.) honeydew. Beekeepers prefer to avoid this kind of honeydew because it crystallizes within the honeycombs, forming the so-called “concrete honey”. It is produced in the Alpine areas (its main piercing and suction insects are *Cinara laricis* (Hartig) and *C. cuneomaculata* (Del Guercio)) and usually coincides with Rhododendron flowering; in this case the nomadism on this heather species does not result in a good quality honey, but represents a real damage for beekeeping.

- Pine (*Pinus halepensis* L.) honeydew. In Greece only large amounts of this type of honey are obtained, thanks to the activity of piercing and suction insects belonging to the *Marchalina hellenica* (Gennadius) species.

- Wheat (*Triticum* spp.) honeydew. Cereals are generally well controlled by man but under certain conditions they can be strongly attacked by piercing and suction insects, such as *Sitobion avenae* (Fabricius). When this does happen bees gather a very tasty honeydew, while farmers have to assess whether they should adopt expensive treatments or not; usually the resulting wheat weight loss is not such as to justify these treatments because they result uneconomical. In Umbria (Italy) this phenomenon occurred ten years ago and the head of the Institute of Agrarian Entomology in that moment, the lamented professor G. Fiori, ascertained, by precise inquires, that the cost for treatments, which would compel beekeeper to transfer their bees to save them, was higher than the damage foreseen for the attack of piercing and suction insects.

- Citrus fruits (*Citrus* spp.) honeydew. Farmers also control these crops. However various Rinchota (such as *Aleurothrixus* Quaitance & Baker, *Planococcus* Ferris, I*cerya* Signoret, etc.) produces a very tasty honeydew in abandoned Citrus groves. About ten years ago researchers found some Citrus fruit honeydew honey which came from Calabria and Sicily and from Tunisia.

- *Metcalfa pruinosa* (Say) honeydew. It is one of the few honeydews whose name comes from the insect which produces it. This insect was introduced into Italy recently and quite by accident.

It is polyphagous, i.e. it feeds on many spontaneous plants and also on plants cultivated for agricultural and ornamental purposes. Generally honey made from this honeydew is of poor quality (it has a typical molasses flavour); if, however, these insects also attack lime or maple-trees, its quality can improve. *M. pruinosa* is widespread in Veneto and is quickly spreading to nearby regions (it has been recorded as far away as Tuscany, Marche and Umbria) (Kloft & Kunkel, 1985; Ricciardelli D'Albore & Vorwohl, 1980).

Occasional honeydews

This paragraph deals with honeydews that do not strongly attract bees, even though produced in large amounts, and with others that attract bees but do not give rise to a unifloral honey, because the vegetative species is relatively scarce in a given area.

- Maple trees (*Acer* spp.) honeydew. Only *Acer pseudoplatanus* L. honeydew is of some interest to bees. The piercing and suction insect responsible for its production is *Peryphyllus acericola* (Walker).

- Birch (*Betula* sp.) honeydew. In the northern zones or wherever birches grow, it is not rare to see birch leaves literally shining because of the abundant honeydew produced by piercing and suction insects belonging to the genus *Betulaphis* Glendenning. Bees, however, are not often seen visiting these honeydews.

- Judas tree (*Cercis siliquastrum* L.) honeydew. Produced by *Cacopsylla pulchella* (Löw), this kind of honeydew greatly attracts bees, especially in parks and in certain central Italian valleys where it forms spontaneously (for example Valle del Nera in Umbria). It should be noted that this is one of the relatively infrequent cases where the piercing and suction insect not only attacks the lower blade of the leaf (typical in the broadleaves), but also the upper one and it then attacks the siliquae produced by flower fecundation.

- Fig tree (*Ficus carica* L.) honeydew. The piercing and suction insect *Homotoma ficus* (L.) produces an abundant honeydew which attracts bees, but it is of only relative and sporadic interest in the Mediterranean area.

- Poplar (*Populus* spp.) honeydew. Bees visit poplar-woods in spring to gather pollen and in summer to collect propolis; they are not attracted by the honeydew produced by piercing and suction insects as *Chaitophorus populeti* (Panzer) and *C. tremulae* Koch.

Certain honeydews, such as *Corylus avellana* L. (hazel) (*Myzocallis coryli* (Goeze)), *Fagus silvatica* L. (beech) (*Phyllaphis fagi* L.), *Fraxinus excelsior* (ash-tre) L. (*Parthenolecanium corni* (Bouché)), *Prociphilus fraxini* (Fabricius), *Juglans regia* L. (walnut-tree) (*Callaphis juglandis* (Goeze)), *Juniperus communis* L. (juniper) (*Cinara juniperi* (De Geer)), *Robinia pseudacacia* L. (false acacia) (*Aphis craccivora* Koch), *Thuja occidentalis* (thuja) (*Cinara cupressi* (Buckton)), *Ulmus campestris* L. (elm) (*Eriosoma ulmi* L.), and many others, usually of herbaceous species but also arboreal and shrubby ones, both spontaneous and cultivated for food or for decorative purposes, do not seem to attract bees, partly because only small amounts of honeydew are to be found on them (Kloft & Kunket, 1985).

In forestry ecosystem the concept of honeydew seen as cause of damage for plants should be reduced in the light of the recent experiences; honeydew, indeed, is a huge reservoir of glucide and many insects feed with them. The attacked plants, in most cases, do not greatly feel the effect of the action by Rinchota and recover easily;

although the taste is subjective, it is to be recognised that honeydew honey has a more tonic and less nauseating flavour, since it has less sweetening power (Binazzi, 1978; Borner, 1952; Cirnu, 1971; Kloft, 1968; Kloft & Kunkel, 1985; Patetta *et al.*, 1983; Ricciardelli D'Albore & Quaranta, 1992a).

Chapter 7

MELISSOPALYNOLOGY NOTES

Melissopalynology is the branch of palynology which studies the botanical and geographical origin of honey by subjecting honey sediment, and therefore pollen and the other fungi imperfecti contained therein, to microscopic analysis. The earliest research on the pollen analysis of honey was undertaken by Pfister in 1895; since then various other researchers have devoted themselves to this subject (Fehlman, 1911; Armbruster & Oenike, 1929, Armbruster & Jacobs, 1934-35; Griebel, 1930-31). The most authoritative of these researchers is certainly Zander, whose works (1935, 1937, 1941, 1949, 1951) are still the main reference point for whoever is interested in this subject. These studies have made it possible to ascertain, on a rigorous, scientific basis, the apicultural importance of the different botanical species, whereas previously this evaluation was the fruit of general field observations.

Even though melissopalynological analysis is not error proof, it does provide, together with organoleptic and physical-chemical analyses, a valid means for formulating an objective opinion about the botanical origin of any type of honey. Flower nectar always contains greater or lesser quantities of pollen and this pollen can then be traced in the honey sediment. Identification of these pollens, estimation of the percentage in which they are present and the eventual identification of elements probably indicative of honeydew, make it possible to trace the botanical species gathered with far greater precision than can be obtained with direct observations. With direct observation it is only possible to ascertain whether a species is more or less intensely visited by bees, but not the extent to which it contributes to honey production.

Through melissopalynology it is also possible to trace the geographical origin of a particular type of honey, since its pollen spectrum, i.e. pollens in the sediment as a whole, reflects the floral situation of the place where that particular honey was produced. Different geographical areas present particular floral associations and the greater the climatic difference the more conspicuous the variation in the floral association. The pollen spectrum of a tropical honey is quite different from that of a Mediterranean honey; even varieties of honey produced in areas close to each other or with a similar climate show differences: the rare pollens present in honey vary as does the percentage value of each pollen.

The identification of the geographic origin is generally based upon the presence of a combination of pollens typical of that particular area: only in some cases it is possible to find particular pollens, which are characteristic of a certain territory and are not found elsewhere; these marker pollens, if present, are sufficient to indicate the origin of the variety of honey in which they are found.

It would therefore seem feasible to utilise certificates of origin to distinguish among the different types of honey. This fact is of great practical importance, especially in those countries where laws protecting national beekeeping and honey products are in force, because it preserves dealers from purchasing foreign honey at a low price and then passing it off as nationally produced honey and selling it at an increased prize, to the obvious detriment of local beekeepers.

A microscopic examination of honey brings to light possible impurities, such as insect fragments, dust, etc. The laws regulating the sale of this product forbid the presence of these substances in honey.

It should be noted that the pollen content of honey can be influenced by numerous factors, some relating to the morphological characteristics of flowers and pollens, and others relating to the operations successively carried out on nectar and on honey. The pollen can contaminate the nectar at various times. There are three pollution categories: primary, secondary and tertiary.

Primary pollution occurs in the flower as a result of the mechanical action of insects, wind, etc. These agents shake the anthers and the pollen becomes detached and falls into the nectar of the same flower. The quantity of pollen, which falls into the nectar, varies. Both the shape and the position of the flower can facilitate or limit the extent of this pollution; for example, the larger the pollen granules are, the less likely they are to be found in the nectar. Pollen content can also be limited by the following factors: the presence of extrafloral nectaries, the lack of synchronism between anther dehiscence and the moment of maximum nectar secretion, partial or total sterility of the stamina, unisexuality of the species. All the elements responsible for primary pollution are closely related to plant characteristics and are relatively constant in any one single species so it is possible to assess them fairly exactly; if these elements taken together lead to an abundance of pollen in nectar, pollen is classified as overrepresented; on the contrary, if these factors obstruct pollution, pollen is classified as underrepresented; in intermediate cases pollen is classified as normally represented.

Secondary pollution takes place from the moment when the nectar arrives in the hive to the moment when the cell, overflowing with honey, is operculated. However it should be mentioned that some alterations to the pollen content take place during the transport of the nectar to the hive. During the gatherer re-entry flight nectar is filtered by the proventricular valve, which retains a part of the pollen. The longer the nectar remains in the crop the better it is filtered. This filtering operation is more effective for the larger pollens, so their number, already inferior to that of the smaller pollens, is reduced even more. In the hive, during nectar transit from one bee to another and later, while the cells are being filled up, nectar and honey are enriched with pollen adhering to the bees hair; this pollen can come from either the nectariferous species gathered or from the stores of pollen, used to feed the young bees and larvae. The stronger the pollen gathering and hive activities are, the greater this kind of pollution is. It mainly affects the anemophilous pollens, which are less sticky and more easily dispersed than the entomophilous ones. This secondary pollution, therefore, although less easily verifiable than the primary type, can be partly revealed using microscopic analysis.

Lastly there is a tertiary pollution which takes place during honey-extraction operations and is caused by pollen reserves stored in the hive, especially in the honeycomb, and by pollen dispersed on the honeycomb surface.

This pollution is negligible if honey is obtained by centrifugation and if simple sanitary measures, such as washing the honeycombs with warm water before disoperculature and not drawing brocel honeycombs for honey-extraction, are observed.

From what has been said, it is clear that the results of melissopalynological analyses, however reliable, cannot guarantee absolute precision. In conclusion, melissopalynology, like other sciences investigating biological phenomena, where it is often difficult to assess the variables, can make no claim to be a mathematical science (Ricciardelli D'Albore & Persano Oddo, 1978). Methods used in melissopalynology concern qualitative and quantitative analysis.

Qualitative melissopalynological analysis

This kind of analysis consists in recognising the different fungi imperfecti contained in the sediment and in evaluating the respective percentages of each element. In most cases this is sufficient to determine the botanical and geographical origin of honey. It is impossible to discover the botanical origin of honey obtained by pressing, because the sediment is enriched with the contents of the pollen cells. Caution is needed when identifying the botanical origin of *Calluna* honey, because the extraction technique used for this honey results in an abundant sediment (Ricciardelli D'Albore, 1997q).

Quantitative melissopalynological analysis

This kind of analysis involves the evaluation of two different parameters: the total sediment volume and the quantity of fungi imperfecti per honey weight unit. The determination of the total quantity of sediment per weight unit makes it possible to ascertain how a type of honey was produced and whether or not it contains any foreign matter; it can also be useful in identifying adulterated honey. The methods used in quantitative analysis are those ones by Maurizio, Demianowicz and Louveaux examined in detail in Ricciardelli D'Albore, 1997q.

Tab. III European Unifloral Honeys

Genus	Northern Europe	Central Europe	Southern Europe
Abies *		X	X
Acer	X		
Aesculus	X	X	
Ailanthus	X	X	
Amorpha			X
Anthyllis			X
Arbutus			X
Asphodelus			X
Astragalus			X
Brassica	X	X	X
Calluna	X	X	
Carduus			X
Carthamus			X
Castanea **	X	X	X
Centaurea ***	X	X	X
Ceratonia			X
Citrus ** ***			X
Diplotaxis			X
Dorycnium			X
Echium			X
Eryngium			X
Eucalyptus ***			X
Fagopyrum		X	X
Genista			X
Gossypium			X
Hedera		X	X
Hedysarum			X
Helianthus		X	X
Impatiens		X	
Larix *		X	
Lavandula ***		X	X
Lythrum	X	X	
Lotus		X	X
Malus	X	X	X
Medicago	X	X	X
Metcalfa *			X
Muscari			X
Myrtus			X
Myosotis		X	X
Onobrychis		X	X
Ononis			X
Phacelia		X	X
Picea *		X	
Pinus *			X

Genus	Northern Europe	Central Europe	Southern Europe
Prunus	X		X
Punica			X
Quercus *		X	X
Robinia		X	X
Rhododendron ***		X	X
Rosmarinus			X
Rubus ***	X	X	X
Salix **	X		X
Salvia			X
Satureja			X
Sesamum			X
Sideritis			X
Sinapis	X	X	
Solidago	X	X	X
Sophora			X
Taraxacum	X	X	X
Teucrium	X	X	
Thymus ***			X
Tilia	X	X	X
Trifolium ***	X	X	X
Triticum *			X
Vicia			X

* Honeydew honey
** Nectar and honeydew honey
*** More nectariferous species

Chapter 8

HONEY ORGANOLEPTIC ANALYSIS

To complete microscopic analysis (melissopalynology), able in most cases to define the botanical and geographical origin of honey, organoleptic analysis and, if necessary, physical and chemical analyses, are taken into consideration. An expert analyst always begins with organoleptic analysis and by means of it he gets the general idea of honey botanical origin and of its quality (authenticity, healthfulness, etc.). Then he proceeds to microscopic analysis (qualitative and quantitative pollen analysis). On the basis of pollens found, of percentages and of the number of pollen granules per weight unity, he will be able to give a further opinion about the botanical and geographical origin of the sample. Finally he repeats organoleptic analysis to confirm the former valuations.

In routine analyses, these three valuations (first organoleptic analysis, microscopic analysis, and second organoleptic analysis) should agree exactly and in this case only the analyst can be satisfied with his work. In most difficult cases (when, for example, there can be frauds and honey adulteration) the mentioned analyses could not be sufficient to give a reliable valuation. Then physical and chemical analyses are performed, while generally they merely define enzymatic charge, honey moisture and product freshness (that is, if it has been warmed at wrong temperatures and if particular syrups have been added - isomerous honey).

However, what is honey organoleptic or sensorial analysis? In this type of analysis sensorial organs assess the characteristics of the product. Honey colour, presence or absence of impurities, physical state (fluidity, solidity, viscosity, etc.), presence of marbling in mass, foam or bubble on the surface and (above all in Germany) possible flaws in the container (traces of rust on lid, not regular label, etc.) can be assessd by sigh. Honey peculiar odours and flavours unrelated to honey can be perceived by olfaction, when applied on a honey sample set in a glass and kept covered for a few hours.

As for taste, a little quantity of honey taken from the same glass is kept between tongue and palate the time necessary for feeling the flavour. Then it is swallowed up so as to feel the aftertaste, too. In this stage of sensorial analysis, touch also is used. It give useful indications about honey physical state (in case of fluidity, it will be viscosous; in case of solidity, it will be with a sandy or gross crystallization).

At the end of the sensorial analysis, a table sums up scores assigned to the product for each sense put into action. To carry out this work, special judges, chosen among expert tasters registered in a National Register, are formed.

In Europe two methods of sensorial analysis are used: the French method and the German method. The first, taking as starting point standards utilised in wine organoleptic analysis, would be effective, but - according to an authoritative judgement (Ricciardelli D'Albore, 1995a) - its lack is a too high subjectiveness, with a too complex terminology. The second, from the German Association of Beekeepers (DIB), was set up several decades before the French one. It is very impartial and limits itself to verify if a product is or not in conformity with the judgement given by melissopalynologic analysis, that is, if microscopic analysis of a colza honey shows a very high percentage of *Brassica* pollen and the analyst says that honey is unifloral from this species, the said honey must be in conformity with its typical requisites: white colour, turnip or cabbage odour and flavour, sandy crystallization. If one or more characteristics are not in accordance with these ones, honey is penalised by taster judges for its defects.

Both methods allow to give a final judgement awarding a prize or not to the product, by the drawing up of valuation tables.

In the last years these tables have been often changed to make them easier, with numerically different scores, but without falsifying the judgement content.

A final note: who tastes honey should do that in a quiet and odourless environment, should not use cosmetics, should not smoke and not drink very aromatic beverages (like coffee) before tasting. Small pieces of green apple, wholemeal bread or cucumber swallowed between a honey sample and the other are fundamental to remove organoleptic substances of the previously tasted product.

Chapter 9

ENTOMOPALYNOLOGY

A new research branch recently opened in Actuopalynology with unexpected possibilities of application: Entomopalynology, concerning the study of diet of all pollinators to know their ethology. Researchers from all over the world understood that the knowledge of Apoidea diet is very important to understand whether they are monoleptic, oligoleptic or polyleptic.

On the basis of this knowledge it is possible to pick out insect species specialised to pollinate a crop, rearing and propagating them, carrying out, then, a specialised pollination service. To this purpose the nest-trapping technique has been set up. It consists in putting artificial shelters at Apoidea disposal (especially hollow reeds of *Bambusa* Schreb., *Arundo* L., *Phragmites* Adanson and elder branches, after pith has been removed) (Figure 3).

The classic nest-trapping consists in dividing in two halves the artificial shelter/nest. When an insect stores food in pedotrophic nest and closes it with various material, after eggs have been laid in each cell, the researcher can open the two halves joined with a rubber band, can withdraw a portion of food in each cell - subjected to microscopic examination - and then can close again the two halves, rearing the content in climatic cells with conditioning temperature, humidity and light, or leaving it under natural conditions, so that it can complete its cycle. The following results will be observed: the multiplication of the studied insect. From a female founder, for example, a reed nesting is obtained (about 12 subjects). When born, they will become founders and, by coupling with males, they will give life to a new generation nesting in places located by man in the vicinity for this purpose. If a female founder can produce over 10 living beings, it can be deduced that insect multiplication is quite easy, in spite of demographic regulators. Now, besides the material described, nests assembled in faesite with holes of different diameters are prepared (Figure 4) (Ricciardelli D'Albore *et al.*, 1994, 1997). From pollen analysis it is possible to go back to which and how many plants have been visited. If these ones are few or only one, insect can be utilised as pollinator of a particular plant.

Methods

Pollen analysis, allowing to go back to the plants visited by a pollinator, can be performed directly on insect or indirectly.

In the first case the direct collection of pollen on an insect body is normally carried out using a needle. Pollen is diluted with few drops of distilled water, set on a slide and examined at the microscope. Only one type of pollen is generally observed. Some Apoidea, however, gather more pollens in only one trip, as bumblebees.

When an insect is lacking in pollen burden, pollen sticking to the body and to hair is collected, by washing the insect with ethyl oxide on a watch glass. A very substantial system to know what pollinator ate in the last 24 hours is the extraction of intestine, then prepared on a slide to examine the ingested pollens. This method is almost complex and requires a good manual dexterity. It has the merit to give complete information about the diet of the insect for a longer time and, at the same time, about nectar and pollen. The examination of honey sac also makes known with precision nectar sources visited short before the capture.

The indirect method is based on examination of pollen collected before and after storing by field bee. As for bees, the well known method of pollen traps is used. This way some pollen loads are taken away from the beehive. First, these loads are selected on the basis of colour and then are examined at the microscope (Ricciardelli D'Albore & Persano Oddo, 1978). Another method consists in examining pollen collected from nest cells. As for solitary insects, the hardly finished pedotrophic nests are opened and a small amount of food is taken by carrying out a selection on the basis of colours (solitary insects lay in a single cell also 5-6 different pollens) (Figure 5).

As for bees, melissopalynologic analyses allow to individuate nectar sources of honey.

When it is settled that an insect can be utilised, it is multiplicated in nature or in laboratory. This way in a few years thousands of selected insects are at disposal. Hibernating nymphs under controlled temperature and making them emerge short before the flowering of crops to be fertilised can adjust their biologic cycle. An example of this is given by *Osmia cornuta* Latr.; kept for some months at 4 degrees, it can emerge within 10 days, if temperature is made higher (10 degrees) (Figure 6) and then it is used for pollination of fruitful trees, by previous careful planning of times. *Osmia rufa cornigera* Rossi, *Xylocopa violacea*, *Magachile rotundata* L., etc., are already utilised on industrial level.

Thanks to pollen analysis, we are therefore able to know the kind of behaviour assumed by an insect and to assess whether it is worth being reared to be released, or not (Free, 1993; Ricciardelli D'Albore, 1993b; 1997n; Ricciardelli D'Albore *et al.*, 1994, 1997).

Currently, the best specialists in this field undertook upon themselves the not easy task to study the most of Apoidea to be reared.

Besides the nest-trapping carried out by means of the above-said methods (and by pots filled with clayey and sandy earth, if insects nest in the ground), to know if a pollinator is oligoleptic or polyleptic, during the flowering of a given botanical species it is convenient to capture many of them, to examine their intestine and check if pollen contained there is only of that species or also of other ones.

In our researches we verified that *Andrena florea* F. is only specialised in the pollination of *Bryonia* officinal species, that *A. hattorfiana* F. gathers pollen on Dipsacaceae only and that *Melitta dimidiata* visits *Onobrychis* species only. We also studied the behaviour of *Heriades truncorum*, known for visiting Compositae only, that perhaps can be used for sunflower and safflower pollination (Ricciardelli D'Albore *et al.*, 1997).

Another area of application for Entomopalynology is environmental monitoring. For some time bee has been used as test-insect to check health status of a territory: bee flies within a radius of some kilometres, gathers pollen, nectar, propolis and water and can therefore give useful indications about the poisoning of an orchard or the pollution of a river. A too high bee murrain in a given time (a week) allows research chemist to find the toxic molecule that killed the insects and palynologist to locate where they met the lethal molecule (on which plants, ditches, rivers, etc.), thanks to the analysis of pollen found on insect or into its intestine (Celli, 1983; Celli *et al.*, 1985; Ricciardelli D'Albore *et al.*, 1993). It has then to be remembered that the use of test-bee is cheaper than the utilise of other mechanical detectors set up in field.

Research field is extremely wide, since thousands of Apoidea behaviour have to be studied and their ethology is only partially known. Moreover, knowledge acquired by Entomopalynology - at first of merely scientific interest - can now have a practical application. Biofirms, indeed, in addition to insect rearing for biocontrol, can rear others for pollination (as for some time it has been done with bumblebees).

Laboratory activities and researches in co-operation with entomologists, palynologists, botanists, systematical researchers and ethologists would allow to optimise knowledge about pollinator and plant interaction, both in agrarian and in natural field. In conclusion, we have to remember that about 80% of angiosperms is auto-incompatible, that to defend environment means keep biodiversity high, that vegetal world conservation depends also on genotype continuous remixing. Entomopalynology can therefore give very useful information for the defence of territory and for the reproduction of several crops.

Chapter 10

ORNAMENTAL FLORA VISITED BY APOIDEA

To embellish a garden or public parks and gardens can be considered as the pride of who plans and realizes the project and satisfies the eye of those ones loving nature and flora. Nowadays, private citizens have their own way to give their gardens an enviable aesthetics. At the same time, public works are given to sector experts and in some cases to architects.

Till now research did not investigate relations between Apoidea and gardening. If we exclude some isolated allusion on beekeeping magazines, a work about the most important flora in private gardens and in public parks and gardens, visited by honey bees and by other pollinators for nectar and pollen gathering, is lacking. It has also to be remembered that in town bees do not find a favourable environment to carry out their biologic cycle and collecting activity, because of the severe pollution.

It seems therefore a nonsense to speak about beekeeping in town. Honey produced near built-up or industrial areas is ever a carrier of dangerous residual products for human health, even if rarely in an alarming way. Bees often gather pollen on tailings from confectionery industry. Products deriving from this action are innocuous, but law does not allow their organoleptic characteristics.

Nevertheless, flora can be situated also in wide urban areas representing real oases for insects and in private gardens far from urban pollution (residential areas with less traffic). In these areas, to be considered as real green lungs for towns, beekeeping could be practised, even if like a hobby. On the other hand, the pollution levels in these environment is very changeable. In some urban areas, like public parks and gardens far from traffic and industries, pollution is very low. In areas near autoroutes or industries, the situation is rather different. Finally, speaking of gardens, we do not forget the ones located in the country (villas, country-houses, beekeeper's domestic areas, etc.) where urban pollution is absent. There is perhaps the problem of environmental pollution (use of plant protection products), but this is a problem now involving almost all ecosystems. Besides, in gardens rich in ornamental flora, Apoidea can nest and carry out their biologic cycle. The knowledge of ornamental flora, performing a useful role in insect survival, is therefore very important, since it can stimulate to cultivate some more interesting plants for bees.

From the lists below, it can be seen that plants more or less recently introduced are clearly prevailing compared to the European ones (Tables II, III and IV). The listed species are a good share (not the whole) of the most cultivated ornamental flora. In most cases it can be used everywhere in Europe, following nurserymen indications, climatic limitations excepted. The main problem is to succeed in warranting pollinator plants suitable to each stage of their biologic cycle. Every time food is lacking, in particularly during critical periods (end of winter, late summer and autumn), ornamental flora can bring help to needy field bees. Apoidea will be able to find these small food sources and to take advantage of them. However, also in parks and gardens essences useful to pollinators for their flowering scalarity should be planted. We hope that the list of plants below (even if it is not complete) can be useful to improve private and public parks and gardens, thinking at the same time to useful insects. In this world going so quickly and causing severe unbalances in ecosystems, maybe the solution is to love and respect nature.

Tab. IV Genera of ornamental plants visited by Apoidea.

Genus	**Family**	**Existing species No.**	**More cultivated species No.**	**Flowering period**	**Harvest**	**Visits**
Acacia	Leguminosae	350	8	II-III	P	A
Acer	Aceraceae	100	6	IV-V	NP	AB
Aesculus	Ippocastanaceae	25	8	IV-V	NP	AB
Ailanthus	Simaroubaceae	9	3	VI-VII	NP	A
Albizzia	Leguminosae	25	4	VI-VIII	N	A
Bauhinia	Leguminosae	150	3	IV-VI	NP	A
Callistemon	Myrtaceae	12	3	VI-VIII	NP	A
Cassia	Leguminosae	400	4	VI-X	NP	A
Castanea	Fagaceae	12	3	VI-VII	NP	AB
Catalpa	Bignoniaceae	12	5	VI-VII	N	A
Ceratonia	Leguminosae	1	1	IX-X	NP	A
Cercis	Leguminosae	7	2	IV-V	NP	AB
Citrus	Rutaceae	10	10	IV-V	NP	AB
Eriobotrya	Rosaceae	10	1	XI-I	NP	AB
Erythrina	Leguminosae	30	6	V-VIII	N	A
Eucalyptus	Myrtaceae	500	10	III-VIII	NP	AB
Fraxinus	Oleaceae	50	8	III-V	P	A
Gleditsia	Leguminosae	12	6	V-VI	NP	A
Ilex	Aquifoliaceae	295	2	IV-V	NP	A
Jacaranda	Bignoniaceae	50	3	VI-VIII	NP	A
Lagerstroemia	Lytrhaceae	30	3	VII-IX	NP	A
Laurus	Lauraceae	2	2	IV-V	NP	A
Liriodendron	Magnoliaceae	2	2	VI-VII	N	AB
Magnolia	Magnoliaceae	80	11	IV-VIII	P	A
Malus	Rosaceae	30	10	IV-V	NP	AB
Paulownia	Bignoniaceae	17	1	V-VI	N	AB
Poinciana	Leguminosae	2	1	VI-VIII	N	A
Prunus	Rosaceae	200	8	IV-V	NP	AB
Robinia	Leguminosae	20	4	V-VI	N	AB
Schinus	Anacardiaceae	17	3	V-VI	NP	A
Sophora	Leguminosae	10	5	VII-VIII	NP	A
Sorbus	Rosaceae	60	13	V-VI	NP	AB
Tamarix	Tamaricaceae	60	7	IV-V	N	A
Tilia	Tiliaceae	30	9	VI-VII	N	AB

Legenda: N= nectar, P = pollen, A= honey bees and solitary bees, B= bumblebees

Tab. V Genera of ornamental shrubby plants visited by Apoidea.

Genus	Family	Existing Species No.	More cultivated species No.	Flowering period	Harvest	Visits
Abelia	Caprifoliaceae	20	3	VI-IX	NP	AB
Actinidia	Actinidiaceae	40	3	V-VI	P	AB
Arbutus	Ericaceae	12	4	X-II	NP	AB
Berberis	Berberidaceae	200	13	IV-V	N	A
Buxus	Buxaceae	30	3	III-IV	P	AB
Capparis	Capparidaceae	150	5	VI-VII	N	A
Ceanothus	Rhamnaceae	50	7	V-VIII	P	A
Cistus	Cistaceae	20	5	IV-VI	P	A
Clematis	Ranunculaceae	400	4	V-VIII	NP	A
Cobaea	Polemoniaceae	10	1	VII-IX	NP	AB
Colletia	Rhamnaceae	20	3	IV-VI	NP	A
Colutea	Leguminosae	10	4	IV-VI	NP	AB
Cornus	Cornaceae	40	5	IV-VI	NP	A
Cotoneaster	Rosaceae	40	22	V-VII	NP	A
Crataegus	Rosaceae	800	2	IV-VI	NP	A
Cuphea	Lythraceae	200	4	VII-VIII	NP	B
Dahlia	Compositae	10	3	VII-IX	NP	AB
Diervilla	Caprifoliaceae	12	8	VI-VIII	NP	AB
Erica	Ericaceae	600	14	III-II	NP	AB
Escallonia	Saxifragaceae	50	8	IV-VI	N	A
Euonymus	Celastraceae	120	8	V	NP	A
Genista	Leguminosae	100	15	IV-VI	P	A
Hedera	Araliaceae	7	5	IX-X	NP	A
Hibiscus	Malvaceae	200	14	VI-IX	N	A
Indigofera	Leguminosae	300	5	V-VIII	NP	A
Jasminum	Oleaceae	200	9	III-VII	NP	AB
Kalmia	Ericaceae	8	5	V-VI	NP	AB
Lavandula	Labiatae	25	6	VI-VIII	N	AB
Lonicera	Caprifoliaceae	346	12	IV-V	NP	AB
Mahonia	Berberidaceae	50	4	IV-V	N	A
Myrtus	Myrtaceae	100	6	VI-VIII	NP	AB
Parthenocissus	Vitaceae	10	5	VII-VIII	N	A
Passiflora	Passifloraceae	300	8	VII-IX	N	A
Pittosporum	Pittosporaceae	80	4	IV-VI	N	A
Rhamnus	Rhamnaceae	100	5	V-VI	N	A
Rhododendron	Ericaceae	700	24	V-VII	N	A
Rhus	Anacardiaceae	150	3	VI-VII	NP	AB
Ribes	Grossulariaceae	150	5	IV-V	N	AB
Rubus	Rosaceae	400	2	V-VI	NP	AB
Symphoricarpos	Caprifoliaceae	20	7	V-VII	N	A
Syringa	Oleaceae	30	7	IV-V	N	A
Tecoma	Bignoniaceae	6	6	VII-VIII	N	A
Viburnum	Caprifoliaceae	120	19	IV-VI	NP	A
Wistaria	Leguminosae	7	3	IV-V	N	AB

Legenda: N= nectar, P = pollen, A= honey bees and solitary bees, B= bumblebees

Tab. VI Genera of ornamental herbaceous plants visited by Apoidea.

Genus	Family	Existing Species No.	More cultivated species No.	Flowering period	Harvest	Visite
Abutilon	Malvaceae	90	4	V-VIII	N	AB
Adonis	Ranunculaceae	20	3	IV-VI	P	A
Agave	Amaryllidaceae	350	9	VII-VIII	NP	A
Ageratum	Compositae	30	3	VI-IX	NP	A
Agrimonia	Rosaceae	10	2	V-VII	N	A
Ajuga	Labiatae	30	3	IV-VI	N	AB
Allium	Liliaceae	280	9	IV-VI	NP	AB
Aloe	Liliaceae	180	9	V-VIII	P	AB
Althaea	Malvaceae	15	4	VI-IX	N	A
Alyssum	Cruciferae	100	7	V-VIII	NP	A
Anchusa	Boraginaceae	60	4	V-VII	N	AB
Anemone	Ranunculaceae	100	11	IV-V	P	A
Antirrhinum	Scrophulariaceae	40	3	V-IX	NP	AB
Aquilegia	Ranunculaceae	70	4	V-VII	P	A
Arabis	Cruciferae	100	4	IV-VI	NP	A
Arctotis	Compositae	30	5	VI-IX	NP	A
Armeria	Plumbaginaceae	50	7	VI-VIII	N	A
Asphodelus	Liliaceae	6	4	IV-VI	NP	A
Aster	Compositae	200	8	IV-IX	NP	A
Aubrieta	Cruciferae	12	3	IV-VI	NP	A
Calendula	Compositae	20	2	III-V	NP	A
Campanula	Campanulaceae	300	18	V-VIII	N	AB
Carduus	Compositae	80	4	V-IX	NP	AB
Carlina	Compositae	20	4	VIII-IX	NP	AB
Centaurea	Compositae	500	5	VI-VII	NP	AB
Cerastium	Caryophyllaceae	60	4	VI-VII	P	A
Cheiranthus	Cruciferae	10	4	IV-V	NP	AB
Commelina	Commelinaceae	100	5	VI-VIII	NP	A
Convolvulus	Convolvulaceae	200	9	IV-IX	NP	A
Coreopsis	Compositae	100	9	VII-IX	NP	A
Cosmos	Compositae	20	4	VII-IX	NP	AB
Crocus	Iridaceae	70	14	IX-IV	NP	AB
Crysanthemum	Compositae	150	15	VII-XI	NP	A
Dahlia	Compositae	10	3	VII-IX	NP	AB
Datura	Solanaceae	20	8	VII-IX	NP	AB
Delphinium	Ranunculaceae	200	9	VI-IX	NP	AB
Digitalis	Scrophulariaceae	20	8	V-VII	NP	AB
Dimorphoteca	Compositae	20	7	VI-VIII	NP	A
Doronicum	Compositae	30	3	V-VI	NP	A
Echinops	Compositae	60	2	VII-IX	NP	AB
Echium	Boraginaceae	40	8	VI-VIII	NP	AB
Eremurus	Liliaceae	30	8	V-VI	NP	A
Eryngium	Umbelliferae	200	6	VII-IX	N	AB
Eschscholtzia	Papaveraceae	?	4	IV-VI	P	A

(Tab VI)

Genus	**Family**	**Existing Species No.**	**More cultivated species No.**	**Flowering period**	**Harvest**	**Visits**
Gaillardia	Compositae	20	2	VI-VIII	NP	A
Gazania	Compositae	25	5	V-IX	NP	A
Godetia	Oenotheraceae	20	4	VI-VIII	P	A
Helenium	Compositae	30	5	VII-IX	NP	A
Helianthus	Compositae	50	7	VII-X	NP	AB
Heliotropium	Boraginaceae	200	2	V-IX	NP	AB
Helleborus	Ranunculaceae	20	5	III-IV	NP	AB
Iberis	Cruciferae	40	7	IV-VI	NP	A
Impatiens	Balsaminaceae	500	3	V-VIII	NP	A
Jacobinia	Acanthaceae	40	4	VI-VIII	NP	AB
Lavatera	Malvaceae	25	3	IV-VI	N	A
Limonium	Plumbaginaceae	200	4	VI-VIII	N	A
Linaria	Scrophulariaceae	125	8	VII-IX	N	AB
Matthiola	Cruciferae	50	4	IV-VI	N	A
Meconopsis	Papaveraceae	40	11	V-VI	P	A
Monarda	Labiatae	10	3	VI-VIII	N	AB
Narcissus	Amaryllidaceae	40	15	III-IV	N	B
Oenothera	Oenotheraceae	200	18	VI-VIII	NP	AB
Opuntia	Cactaceae	200	4	VII-VIII	N	A
Paeonia	Ranunculaceae	25	6	V-VI	P	AB
Papaver	Papaveraceae	100	7	V-VII	P	AB
Polemonium	Polemoniaceae	30	8	VI-VII	N	A
Rudbeckia	Compositae	30	8	VI-IX	NP	A
Salvia	Labiatae	500	10	VI-IX	N	AB
Saxifraga	Saxifragaceae	300	9	V-VII	N	A
Scabiosa	Dipsacaceae	80	4	V-VIII	NP	AB
Sedum	Crassulaceae	20	5	VI-VII	N	A
Sempervivum	Crassulaceae	25	9	VII-VIII	N	A
Senecio	Compositae	1300	22	V-VII	NP	A
Solidago	Compositae	130	7	IX-X	NP	A
Stachys	Labiatae	50	8	VI-IX	N	AB
Tagetes	Compositae	30	6	VII-IX	N	A
Teucrium	Labiatae	100	4	VII-VIII	N	AB
Thunbergia	Acanthaceae	100	2	VII-IX	N	A
Tropaeolum	Tropaeolaceae	50	7	VI-VIII	NP	AB
Valeriana	Valerianaceae	150	9	VI-VIII	N	A
Verbascum	Scrophulariaceae	300	9	V-VIII	P	AB
Verbena	Verbenaceae	200	12	VI-VIII	N	A
Veronica	Scrophulariaceae	250	16	III-VI	NP	AB
Viola	Violaceae	400	8	IV-VI	N	AB
Zinnia	Compositae	15	2	VII-IX	NP	A

Legenda: N= nectar, P = pollen, A= honey bees and solitary bees, B= bumblebees

Chapter 11

EUROPEAN BEE FORAGE

This chapter is an attempt to form a list of the most interesting plants for bees and other Apoidea. The base source is extracted from the melissopalynologic and organoleptic analyses personally performed by the Authors on many honey samples collected for years from all over Europe (see Ricciardelli D'Albore, 1997q, 1998n) and on the pollen gathered by bees and other Apoidea. These data are combined with the results of several field observations. Among them some species visited by gatherers, absent in the honey sediment and in the collected pollen, were observed. Lastly, a rich international bibliography on the subject was consulted.

Significantly interesting field observations were carried out on some species whose nectar, even if gathered in great quantities by bees, is used for feeding the colony. For this reason it is not available inside the honeycomb during honey-extraction. A nectariferous species can be important from two different points of view: honey production and development of a colony. Nectar gathered in some periods of the year (critical periods as the end of the winter and the beginning of the autumn) and immediately used by bees to feed colony plays a fundamental role (help flora) making it stronger and able to carry on an intense activity in storing honey.

It is also to be remarked that the data obtained from the materials collected by bees and Apoidea, even if showing the practical relevance of the different botanical species, not always accord with the quantity of nectar and pollen produced by a given species; even if producing a great quantity of nectar and pollen, many plants are indeed so scarcely diffused that they result actually not interesting.

The most species observed, amounting to one thousand about (even if the total number of the visited species is higher), are listed below in an alphabetical order. Those families revealing themselves not interesting were ignored.

In the species description the following data have been reported:

interest to bee: it is indicated if, and how frequently, a species is visited for its nectar or pollen;

the melliferous value (m.v. of sugar expressed in kg/ha or mg/flower);

the gathered quantity of nectar, whose evaluation is obtained taking into account the maximum representativeness of pollen coming from this species as it is found in honey (less than 3%: low representativeness; from 4 to 15%: quite good representativeness; from 16 to 45%: good representativeness);

the organoleptic characteristics of unifloral honey (pollen percentage higher than 45%);

the quantity of the gathered pollen and the colours of the pollen loads.

If not expressively remarked, the collected data are referred to the bees activity. As far as the other Apoidea only those that frequently visit a given species are cited, especially the oligoleptic ones. As above said, these data are obtained from field observations combined with entomopalynological methods. Table VII shows the species interesting to bees and their melliferous value.

ACANTHACEAE

Acanthus mollis L. (Acanthus), an ornamental herb frequently growing wild in parched and shrubby lands, flowers in spring. It is rarely visited by bees, but constantly by *Bombus* and *Xylocopa*.

ACERACEAE

Acer L. includes some woody species as *A. campestre* L. (Maple), widespread in woods and shrubs, *A. ginnaba* Maxim (m.v. 73 kg/ha), *A. negundo* L. (Box elder), ornamental, *A. platanoides* L. (Norway maple) (m.v. 40 kg/ha), *A. pseudoplatanus* L. (Sycamore maple) and *A. tataricum* L. (m.v. 100 kg/ha). Maple trees flower in spring. They are quite frequently visited by bees searching for their pollen and nectar. Pollen, collected in large quantities, gives greenish pollen loads. Remarkable rates of pollen deriving from these species can be found in honey coming from the Alps and northern and central Europe. *Acer* honeydew, as a result of attacks by *Peryphyllus acericola*, is also known. Maple trees are frequently visited by many polyleptical *Andrena*, *Bombus* and *Osmia cornuta*, too.

ADOXACEAE

Adoxa moschatellina L. (Moschatel) is an underwood herb flowering in spring. It is sometimes visited by *Lasioglossum* searching for its grey pollen.

AGAVACEAE

Agave americana L. (Agave), native to Mexico, became naturalized in the Mediterranean area, where it now represents one of the most typical elements. This species flowers each ten years during summertime and dies after flowering. Its flowers give large quantities of nectar, collected by bees, wasps and even by bats (in the night). The percentage of pollen in honey is lower than 1% because of its huge dimensions, making it exceptionally underrepresented.

AIZOACEAE

Carpobrotus acinaciformis (L.) L. Bolus (Hottentots' fig) is a fleshy herb diffused along the coasts. It grows well in sandy and rocky areas and is also cultivated in rock gardens. It flowers in spring and is visited by bees and bumblebees searching for its pollen, however gathered in modest quantities. Pollen loads are orange-yellow and their representativeness in honey is very low. This family includes the genus *Mesembryanthemum* L., whose numerous varieties are cultivated as ornamentals, resulting not very interesting to Apoidea.

ALISMATACEAE

This family includes aquatic plants only. *Alisma plantago-aquatica* L. (Water-plantain), flowering in summer near ponds and marches, is quite interesting to bees looking for nectar and pollen, whose colour is brown-grey. The representativeness of pollen in honey is very low, but it is hyporepresented.

AMARANTHACEAE

These plants are not too interesting to bees. Only the genus *Amaranthus* L. (Amaranth) is visited by bees in summer. Species as *A. retroflexus* L. and *A. chlorostachys* Willd. grow on ruins and uncultivated grounds. Pollen, whose colour is light yellow, is gathered in small quantities.

AMARYLLIDACEAE

Galanthus L.
It grows in wet and underwood areas, where it flowers at the end of the winter. *G. nivalis* L. (Snowdrops) is an important early source of nectar for bees and bumblebees; it also gives an opaque orange pollen. Its representativeness in honey is very low because of the flowering period and the recurved backwards flowers.

Narcissus L.
The most interesting plants are *N. jonquilla* L. (Jonquil), *N. poëticus* L. (Pheasant's eye), *N. pseudonarcissus* L. (Yellow daffodil) and *N. tazetta* L. (Polyanthus), some of which are also cultivated as ornamentals. They flower at the beginning of the spring on pasture lands and are visited exclusively for their pollen; in most species, indeed, the flowers shape prevents bees from reaching nectaries. The yellow-orange pollen loads can be gathered in spring. The representativeness in honey is always very low. This genus is also visited by Anthophoridae and bumblebees.

Sternbergia W. et K.

Only the *S. colchiciflora* W. & K. and *S. lutea* (L.) Ker-Gawl species are to be noted. Their flowers, common on the mountain grasslands and woods, are visited in September chiefly by bees. They predominantly gather a yellow pollen.

ANACARDIACEAE

Cotinus Miller

This genus, including one species only (*C. coggygria* Scop. (Smoke tree)), is diffused in the Mediterranean area as well as in some internal zones whose climate is quite mild. It grows in shrubby and rocky soils and flowers from May to July. It is visited for its nectar, but low percentages of its pollen may be found in the honey sediment. This species is frequently visited by the genus *Lasioglossum*.

Pistacia L.

Three not nectariferous woody species common in the Mediterranean area, *P. lentiscus* L. (Mastic tree), *P. terebinthus* L. (Turpentine), *P. vera* L. (Pistacio), belong to this genus. They flower from April to June and are quite frequently visited by bees searching for their pollen. Pollen loads are grey-green.

Rhus L.

It includes four woody species. *R. coriaria* L. (Sicilian sumac), cultivated in the Mediterranean area as a principal source of resins and tannins and growing spontaneous in poor soils, flowers in June-July. *R. thyphina* L. (Stagorn sumac) is cultivated as ornamental and flowers at the beginning of the summer. *Rhus* is quite frequently visited for its nectar, but its representativeness in honey is low.

Schinus L.

S. molle L. (Peruvian) is an ornamental plant that grows in warm climates, flowers in summer and is sporadically visited by bees searching for its nectar and pollen. Its representativeness is low.

APOCYNACEAE

Nerium oleander L. (Oleander) is an evergreen shrub flowering in summer, spontaneous in warm climates and diffusely cultivated as ornamental. Bees visit this species searching for nectar, but its pollen is so underrepresented that a diagnosis about the honey coming from it is impossible. A microscopic observation on it, without using organoleptic and chemical analyses, is indeed not enough. There is also an oleander honeydew as a result of attacks by *Saissetia oleae* Olivier, yet not visited by bees. We remember also *Vinca major* L. and *V. minor* L. (Periwinkle), growing in woods and thickets, flowering in spring and frequently visited by Anthophoridae belong to this family.

AQUIFOLIACEAE

This family is represented by *Ilex aquifolium* L. (Holly), tree or shrub not too diffused in woods and cultivated as ornamental. It flowers from April to June and is frequently visited by bees searching for its nectar as well as pollen, whose loads are light yellow. If cultivated, holly can grow upwards to a great height (England, Gargano - Italy, etc.). This species is also visited by many polyleptical *Andrena*, by *Osmia cornuta* and by *O. rufa cornigera* insects. The representativeness in honey is very low.

ARACEAE

The genera *Arisarum* Targ.-Tozz., in particular *A. vulgare* Targ.-Tozz., and *Arum* L., especially *A. italicum* Miller, are quite important. The last one is common in bushy areas and frequently grows as infesting weed in vineyards and olive-grove. This species flowers in spring and bees gather from it small quantities of light yellow pollen. The representativeness in honey is very low.

ARALIACEAE

The only species interesting all over Europe is *Hedera helix* L. (English ivy), a woody climbing plant spontaneously growing in woods, but also cultivated for ornamental purposes. It flowers at the end of the summer (m.v. 500 kg/ha). This species is very important for bees, that collect from it large quantities of nectar and pollen. Its representativeness in honey is yet conditioned by climate. Since flowering lasts until late October, forager bees are permitted to visit these plans only where the climate is fit for it, that is where a late honey-extraction can be carried out. The representativeness of pollen in honey may be remarkable in the Mediterranean area. The ivy unifloral honey is greyish-white in colour, delicate in odour, bitterish in flavour and quite creamy in consistence. In those areas where the honey-extraction is not possible, this species is nevertheless a good source of food for the bees colonies. As far as pollen, ivy represents the most remarkable source in autumn; all the gathered material contains it, very frequently as unifloral pollen. Pollen loads are variable in shape and light orange with pink nuances in colour.

ASCLEPIADACEAE

Asclepias incarnata L., *A. syriaca* L. (Common milkweed) (m.v. 500 and 580 kg/ha respectively) and *Vincetoxicum hirundinaria* Medicus (m.v. 290 kg/ha) flower in late spring on the woods and shrubs margins. Low representativeness.

BALSAMINACEAE

Impatiens noli-tangere L. (Balsam) is rather diffused in woody and shadowy areas, while *I. glandulifera* Royle (m.v. 740 kg/ha) is common on uncultivated soils. The last one is frequently visited by bumblebees, as *I. parviflora* DC. Generally imported from the East, these plants usually flower at the end of the spring and in summer. Very few unifloral honeys were found in central Europe.

BEGONIACEAE

Genus *Begonia* L., whose species are commonly cultivated for ornamental purposes, has to be mentioned. Bees visit these plants searching for their light yellow pollen. Bumblebees and *Anthophora plumipes* Pallas visit these plants very rarely.

BERBERIDACEAE

This family includes some shrubby genera (*Berberis* L., *Epimedium* L. and *Mahonia* Nutt.). *Berberis vulgaris* L. (Common barberry) flowers in spring on poor slopes and in degraded woods. *Mahonia aquifolium* (Pursh) Nutt. (Barberry) is cultivated for ornamental purposes and flowers in early spring. These plants are visited by bees principally searching for nectar, while bumblebees and some *Andrena* visit them only sometimes. Low representativeness in honey.

BETULACEAE

This family includes the genera *Alnus* Miller and *Betula* L., trees native to cold climates, whose pollination is anemophylous.

Alnus Miller

The most common species is *A. glutinosa* (L.) Gaertn. (Black alder), a tree growing spontaneously in wet sites and used for ornamental planting. Its aments flower at the end of the winter. *A. incana* (L.) Moench. (Grey alder) and *A. viridis* (Chaix) DC. have also to be taken into consideration. Bees gather small quantities of pollen from *Alnus*, making yellow loads.

Betula L.

The production of abundant honeydew by *Betulaphis* is noteworthy. It is not know if bumblebees visit this genus. It includes *B. pendula* Roth. (European white birch), growing in the wet subalpine woods and flowering in spring. It is rarely visited for its light yellow pollen. Low representativeness in honey coming from northern and central Europe.

BIGNONIACEAE

The European members of this family are ornamentals coming from tropical zones: *Tecoma radicans* (L.) Juss. (Bignonia), a woody climber flowering in summer (m.v. > 500 kg/ha); *Paulownia tomentosa* (Sprengel) Steudel (Princess tree), a tree flowering in spring and quite frequently visited by bees searching for nectar; *Catalpa bignonioides* Walter (Catalpa), a tree flowering in May-June (m.v. > 500 kg/ha), whose main feature is the presence of extrafloral nectaries on sepals. *Catalpa* Scop. is frequently visited by *Xylocopa*, too. Low representativeness in honey.

BORAGINACEAE

Anchusa L.

A. italica Retz. grows on uncultivated soils and fields and on the sides of the roads. It is a biennial plant flowering from April to August and predominantly visited by bees, bumblebees, *Anthophora* and *Osmia*. *A. officinalis* L. (m.v. 500 kg/ha) (Common bugloss), *A. sempervirens* L. (coming from the Iberian peninsula), *A. variegata* Lehm and *A. barrelieri* Vitman are also to be mentioned. *Anchusa* plants are also visited by the oligoleptic *Andrena nasuta* Giraud and *Colletes nasutus* Smith. Quite good representativeness in the honey coming from the eastern Europe.

Borago L.

B. officinalis L. (Borage) is widely diffused on uncultivated soils and ruins. It is an annual plant whose flowering period is long (m.v. > 500 kg/ha). Its pollen is widely underrepresented because flowers are recurved backward, preventing pollen from contaminating nectar. Bumblebees frequently visit these plants. In the past years a rare white unifloral honey, with a delicate flavour and a fine crystallization, was found in Italy.

Buglossoides Moench.

B. purpurocaerulea (L.) Johnston can easily be found on uncultivated grounds; it flowers in spring and is frequently visited by Anthophoridae, bumblebees and quite frequently by bees searching for its nectar. Low representativeness.

Cerinthe L.

C. major L. and *C. minor* L. (Lesser honeywort) belong to this genus. They flower in spring on uncultivated grounds and are visited by bees as well as by Anthophoridae and by the oligoleptic *Osmia cerinthidis* Mor. Low representativeness.

Cynoglossum L.

C. officinale L. (Dog's tongue) grows on uncultivated grounds and on hill and mountain pasture lands. It is a biennial herb flowering from June to August (m.v. 160 kg/ha). It is frequently visited by bees searching for nectar; the light grey pollen is gathered in lower percentages. Quite good representativeness in mountain honey. *C. magellense* Ten is also to be mentioned; it flowers in spring on the mountainous pasture lands and is chiefly visited by bumblebees.

Echium L.

E. italicum L., *E. plantagineum* L. and *E. vulgare* L. (Viper's bugloss) are widespread on uncultivated grounds and arid pasture lands, where they flower from April to September (m.v. 500 kg/ha). This genus represents a good source of nectar for bees, especially in case of dry summers. In the Mediterranean area it is possible to find an *Echium* white unifloral honey, with delicate odour and flavour and pasty crystallization. Notwithstanding the small size of the granules, pollen belongs to the "normal" group because of the flower morphology, able to reduce the level of primary pollution. They are relevant nectariferous plants; good quantities of violet pollen can be found in the loads. *E. vulgare* is visited by many Apoidea, among which there are bumblebees, as well as by the oligoleptic *Osmia adunca* Panz., *O. anthocopoides* Schenk. and *O. lepetieri* Lens.

Heliotropium L.

H. europaeum L. (Common eliotrophe) and *H. hirsutissimus* Grauer are not too important because of their low potential (m.v. 0.03 mg/flower). They are chiefly visited by genus *Lasioglossum* at the end of the spring.

Myosotis L.

M. alpestris F. W. Schmidt is a perennial species widespread on Alpine pasture lands, where it flowers at the end of the spring, while *M. scorpioides* L. (Forget-me-not) can be found in wet areas. As far as bees, the most important is the mountain species, giving a light yellow unifloral honey showing a fine and regular cristallization. It exhales a strong floral flavour. The *Myosotis* pollen is the smallest (6-8 microns) and the most underrepresented one. In order to be defined as unifloral, the *Myosotis* honey sediment must contain the 100% of the species pollen. It depends on the small size of the pollen granules and on the flower morphology causing a severe primary pollution.

Nonea Medicus

N. lutea (Desr.) DC. and *N. vesicaria* (L.) Rchb., growing on uncultivated soils and on the shores respectively, are visited in spring chiefly by Anthophoridae and by bumblebees.

Onosma L.

O. echioides L. (m.v. 200 kg/ha) grows in spring on calcareous slopes and on rocks and is visited chiefly by bumblebees.

Pulmonaria L.

P. officinalis L. (Lungwort) is a quite common perennial plant flowering in spring in woods; it is frequently visited by Anthophoridae insects and bumblebees. *P. obscura* Dumort. (m.v. 50 kg/ha) is also to be mentioned.

Solenanthus Ledeb

Nectar coming from *S. apenninus* (L.) Fischer et C.A. Meyer is frequently gathered by bees and bumblebees. This plant flowers at the end of the spring in bushes and on arid pasture lands. Quite good representativeness in honey coming from southern Europe.

Symphytum L.

S. officinale L. (Comfrey) flowers in spring on meadows and wet woods; it is visited by Anthophoridae, bumblebees and by the oligoleptic *Andrena symphyti* Schm. *S. tuberosum* L., a perennial plant growing into underwood and flowering in spring, is also common. It is visited by the above mentioned Apoidea searching predominantly for nectar. This genus is not so important for bees. Quite good representativeness in honey coming from Eastern Europe.

BUDDLEJACEAE

Buddleja davidii Franchet is an ornamental plant, frequently growing wild along the watercourses. It is not too interesting for bees, visiting it for nectar only sometimes.

BUTOMACEAE

Butomus umbellatus L. (Flowering-rush) only sometimes is visited by bees searching for nectar and pollen. It flowers at the end of the spring along ditches and canals.

BUXACEAE

This family is represented by *Buxus balearica* Lam. and *B. sempervirens* L. (Common box), growing as ornamental plants but also widespread in woods. Both of them flower at the beginning of the spring and are very interesting for bees thanks to their pollen (yellow loads). These monoecious plants have unisexual flowers, whose nectar secretion is not known.

CACTACEAE

Opuntia ficus-indica (L.) Miller (Indian fig), whose fruits are edible, is the most common imported genus of the Mediterranean area. Here it grows both spontaneous and cultivated. It flowers in summer and is visited by bees searching for nectar, but also by bumblebees and Apoidea. Its pollen is very underrepresented because of the large size of the granule. It can be found in the honey sediment in very low percentages.

CALYCANTHACEAE

Chimonanthus praecox Link (Japan allspice) is a shrubby species cultivated for ornamental purposes. It flowers at the end of the winter, that is in coincidence with the most extent of the bees inactivity period. For this reason it is visited only sometimes, even if it is a nectariferous plant.

CAMPANULACEAE

Campanula L.

C. barbata L., *C. drabyfolia* Sibth & Sm. (m.v. 0.02 mg/flower), *C. glomerata* L., *C. medium* L. (Canterbury bell) (m.v. 400 kg/ha), *C. napulifera* Schr. (m.v. 34 kg/ha), *C. patula* L. (m.v. 0.14 mg/flower), *C. persicifolia* L. (Peach-leaved bellflower) (m.v. 0.39 mg/flower), *C. rapunculoides* L., *C. rapunculus* L. (Rampion), *C. rotundifolia* L., *C. scheuchzeri* Vill and *C. trachelium* L. are to be mentioned. These species are widespread on pasture lands, rocks, hilly and mountainous grounds, while some of them grow on uncultivated areas and on shrubby slopes. They flower in spring-summer and provide bees with large quantities of nectar; for this reason the Campanula pollen is the typical component of the Alpine honey sediment. This genus is visited by many “specialised” pollinators, as *Andrena curvuncula* Thomson, *A. pandellei* Pérez, *A. rufizona* Imh., *Chelostoma campanularum* Kirby, *C. distinctum* Stoeckert, *C. fuliginosum* Panz., *Dufourea dentiventris* Nylander, *D. inermis* Nylander, *D. minuta* Lep., *Melitta hemorroidalis* F. and *Osmia mitis* Nylander. Furthermore, these plants are visited by many other Apoidea, bumblebees included. Low representativeness in honey.

Jasione L.

J. montana L. (Sheep’s bit) (m.v. 237 kg/ha) is a spring species important in Spain and on the Alps. It grows on rocks and uncultivated grounds and is very frequently visited by bees. Quite good representativeness.

Legousia Durande

L. speculum-veneris (L.) Chaix. (Venus’ looking-glass) is widespread on cereal fields as infesting weed and on uncultivated grounds. It flowers from April to July. Its importance for bees is limited to the pollen collection, whose colour is light yellow.

Phyteuma L.

Among the most common species there is *P. betonicifolium* Vill., a plant flowering at the end of the spring on the Alpine pasture lands. It is a good source of pollen for bees. The pollen loads are violet coloured and the pollen granules can be found in quite high percentages in the Alpine honey.

CANNABACEAE

Cannabis sativa L. provides bees with small quantities of light yellow pollen. This plant is cultivated for its fibre but grows wild in some sites, too.

CANNACEAE

The only interesting species is *Canna indica* L. (Canna), an ornamental plant flowering in summer and visited almost exclusively by bumblebees.

CAPPARIDACEAE

The most interesting species is *Capparis spinosa* L. (Caper bush), flowering in spring-summer on rocky areas in the Mediterranean area. It is visited by bees and bumblebees. Low representativeness in honey.

CAPRIFOLIACEAE

Lonicera L.

L. caprifolium L. (Honeysuckle) is a climbing shrub widespread on woods and bushes. It flowers from April to July. Bees gather from it quite good quantities of nectar. The following species are to be mentioned: *L. alpigena* L., *L. coerulea* L., *L. etrusca* Santi, *L. implexa* Aiton, the ornamental *L. japonica* Thunb., *L. periclymenum* L. (Honeysuckle) and *L. tatarica* L. (m.v. 50 kg/ha), the last one important especially in northern and central Europe. Underrepresented pollen. Plants belonging to genus *Lonicera* are frequently visited by *Xylocopa* and bumblebees, having a “robber” behaviour; *Halictus scabiosae* Rossi visits this genus, too.

Sambucus L.

S. ebulus L. (Danewort) is widespread on shrubby and uncultivated grounds. It is a perennial herb flowering from June to August. Bees gather small quantities of nectar and grey pollen. On the mountains this species is also visited by bumblebees. *S. nigra* L. (Elder) is native to woods and shrubs, where flowers from May to July. It is not known why this species is completely ignored by Apoidea.

Symphoricarpos Duhamel

S. rivularis Suksd. is the most common species, cultivated for ornamental purposes as well as growing wild in wet woods. It flowers in spring-summer and is frequently visited by bees searching for its nectar (m.v. 240 kg/ha). Low representativeness of pollen in honey.

Viburnum L.

V. lantana L. (Wayfaring tree) is widespread on woods and wild grounds, flowers from April to June and is visited by bees gathering quite large quantities of nectar and pollen. A rare white unifloral honey, exhaling a very delicate odour and flavour and showing a sandy crystallization, is produced in central Italy. *V. tinus* L. (Laurustine) grows spontaneously in woods, but it is also cultivated for ornamental purposes. It flowers from January to April and it is as important for bees as the above described species.

Weigela Thunb.

W. florida (Bunge) DC. is cultivated for ornamental purposes. It flowers in spring and is visited predominantly by bees and bumblebees searching for nectar. Low representativeness in honey.

CARYOPHYLLACEAE

The most species are important for bees providing them with good quantities of pollen, but preventing them from reaching nectaries because of the length of the corolla tube. The pollen representativeness in honey is generally low.

Agrostemma L.

It includes one species only, *A. githago* L. (Corn cockle), a weed infesting cereal field and flowering at the end of the spring. Pollen can easily be found in the sediment of Alpine honey, but always in low quantities.

Cerastium L.

C. arvense L., *C. semidecandrum* L. and *C. tomentosum* L. (Dusty miller) can easy be found on pasture lands and uncultivated grounds at different altitudes. They flower in spring and are visited by bees and Andrenidae predominantly searching for their greenish-grey pollen.

Dianthus L.

Among the spontaneous species there are *D. armeria* L. (Deptford Pink), *D. carthusianorum* L. (Carthusian Pink), *D. caryophyllus* L. *s.l.* (Carnation) and *D. monspessulanus* L., flowering in late spring on pasture lands and in woods. *Dianthus* is important for bees providing them with good quantities of pollen (grey-green loads). This genus is frequently visited by *Andrena* and *Ceratina*, too.

Drypis L.

D. spinosa L. is widespread on rocks and uncultivated grounds and flowers in summer on the mountains. It is visited by bees, bumblebees and *Xylocopa* searching predominantly for nectar. Low representativeness.

Lychnis L.

The most common plant is *L. flos-cuculi* L. (Ragged robin), native to meadows and woods margins and flowering in spring. Its pollen makes up grey-green loads. This species is also visited by *Andrena bicolor* F. and Halictidae.

Silene L.

Among the most common plants there are *S. alba* (Miller) Krause, *S. vulgaris* (Moench) Garcke (Bladder-campion) and *S. gallica* L. (Small-flowered catchfly), flowering in spring-summer. Bees gather modest quantities of grey pollen.

Spergularia (Pers.) Presl

S. rubra (L.) Presl (Sand spurrey) is widespread on sandy and arid uncultivated grounds, where it flowers from March to August. It is visited by bees searching for its nectar and grey pollen.

Stellaria L.

The most common species is *S. media* (L.) Vill. (Starwort), an infesting weed flowering in spring. It is one of the few species belonging to *Cariofillaceae*, frequently visited for nectar; the percentage of pollen in the honey sediment is indeed quite good. *Stellaria* is frequently visited because of its brown pollen, too, and among its forager insects there are *Andrena* and *Lasioglossum*.

CELASTRACEAE

The most common species belonging to genus *Euonymus* L. is *E. europaeus* L. (Bittersweet), flowering in spring. It is not too interesting for bees, gathering from it only small quantities of nectar and green pollen. Small quantities of pollen can be found in honey. *Euonymus* is also visited by the genus *Lasioglossum*.

CHENOPODIACEAE

Being not nectariferous plants, the species belonging to this family are frequently visited by bees and by genera *Andrena* and *Lasioglossum* only for their pollen.

CISTACEAE

This family provides bees with good quantities of pollen; its species are indeed considered as not nectariferous even if the representativeness of their pollen in honey is remarkable. It can be explained on the basis of some observations carried out by the Authors, who realised that genus *Cistus* is visited early in the morning by insects searching for nectar. Furthermore, the good representativeness could depend on the adopted honey-extraction (tertiary pollution). Anyway this problem should be further investigated.

Cistus L.

Among the most common plants there are *C. albidus* L., *C. crispus* L., *C. clusii* Dunal, *C. incanus* L. (Rockrose), *C. ladanifer* L., *C. libanotis* L., *C. monspeliensis* L., *C. parviflorus* Lam. (m.v. 0.04 mg/flower), *C. salvifolius* L. and *C. various* Pourret. They are native to shrubs and flower in spring. This genus is very interesting as source of pollen, gathered even in high percentages. Loads are brick red coloured. The large quantities of pollen coming from Galicia to be commercialized is mostly produced by *Cistus*. These plants are also visited by Andrenidae and Halictidae, as well as by the oligoleptic *Andrena granulosa* Perez.

Halimium (Dunal) Spach

H. ocymoides Willk., *H. viscosum* P. Silva and *H. umbellatum* Spach. are good sources of pollen in the Spanish bush.

Helianthemum Miller

H. apenninum (L.) Miller and *H. canum* (L.) Bung. are native to mountainous rocky grounds, while *H. nummularium* (L.) Miller is widespread on arid meadows and rocks. All of them flower in spring. This genus is a good source of pollen for bees; loads are orange coloured.

COMPOSITAE

Flowers can be distinguished into two types: regular, with a pentamerous tubular corolla (tubulous flowers), or zygomorphous, with a unilabiate corolla (ligulate flowers). The division into two families, Asteroideae (or Tubuliflorae) and Cichorioideae (or Liguliflorae), depends on the presence of flower heads in the first or in the second type. As far as bees, Compositae are very important because of their worldwide distribution. Bees collect predominantly pollen, but the quantities of gathered nectar can also be remarkable; moreover some species produce a unifloral honey. The pollen granules of the different species are sometimes very similar each other: a dozen of main kinds of pollen, whose source species or genus is very difficult to be found, are described in palinology. All the Compositae are visited by bees, but we shall confine ourselves describing those species providing the most conspicuous harvests. Compositae are visited by all the Apoidea, perhaps with the exception of the most Anthophoridae. The following oligoleptic species are also to be mentioned: *Andrena denticulata* Kirby, *A. fulvago* Christ., *A. humilis* Imh., *A. polita* Smith, *A. taraxaci* Giraud, *Anthidium lituratum* Panzer, *Colletes davisianus* Smith, *C. fodiens* Geoffroy in Fourcroy, *C. halophilus* Verhoeff and *C. similis* Schenk, *Dasypoda hirtipes* Fabricius, *Heriades crenulatus* Nylander, *H. truncorum* L., *Hylaeus nigritus* Fabricius, *Osmia fulviventris* Panzer, *O. leaiana* Kirby, *O. villosa* Schenk., *O. spinulosa* Kirby, *Panurgus banksianus* Kirby, *P. calcaratus* Scopoli, *P. dentipes* Latreille, *Tetralonia dentata* Klug. Compositae are generally preferred by Halictidae, too.

ASTEROIDEAE

Achillea L.

Besides the species cultivated for ornamental purposes, the following ones are to be mentioned: *A. macrophylla* L., *A. millefolium* L. (Yarrow) and *A. ptarmica* L. (Snelzewort) (m.v. 0.82 mg/flower). All of them flower in summer on pasture lands. This genus is visited by *Andrena, Colletes, Halictus* and *Lasioglossum* rather than bees. Low representativeness in honey.

Adenostyles Cass.

A. australis (Ten) Nyman (Lunaria) is widespread on beech-woods and rocky grounds, flowers at the beginning of the summer and is visited by small Apoidea, bumblebees and bees (less frequently) searching for nectar. Low representativeness.

Anthemis L.

It includes *Anthemis arvensis* L. (Corn camomile) and *Anthemis tinctoria* L. (Dyer's camomile). The first one is very similar to the true camomile and is widespread on cereal fields and pasture lands. The second one grows on arid slopes. Both of them flower in spring-summer. This genus is visited predominantly by *Heriades truncorum* and Colletidae. *A. maritima* L. grows along the shores and on the sand dunes; it is a strongly aromatic perennial plant flowering from May to October. *Anthemis* are sporadically visited by bees, too, gathering pollen (orange loads). Low representativeness in honey.

Arctium L.

A. lappa L. and *A. minus* (Hill) Bernh. (Common burdock) are biennial plants widespread on uncultivated grounds and bushes, where their flowers from July to September. They are quite important for bees searching from nectar and pollen, that somewhere can be found in large quantities. Some unifloral honeys, indeed, have been reported in Sardinia. *A. tomentosum* Miller, widespread on ruins and bushes, is an important source of nectar in summer in northern Europe.

Artemisia L.

A. vulgaris L. (Sagebrush) is a synanthropic perennial species, widespread on uncultivated grounds, flowering from August to September. Bees frequently visit this species only searching for pollen, making up light yellow loads. Representativeness is frequently quite good, especially in honeydew honey.

Aster L.

A. alpinus L. is a perennial plant growing on Alpine pasture lands and rocks and flowering in July-August. *A. dumosus* L., important in northern Europe (m.v. 64 kg/ha), *A. novae-angliae* L. (New England aster) (m.v. 100 kg/ha), *A. linosyris* (L.) Bernh and *A. novi-belgii* L. (Aster) are also to be mentioned. The last one, flowering in autumn, is widespread along the water courses but is also cultivated. Bees frequently visit this genus searching for nectar and pollen; it makes up brown loads. *A. tripolium* L., native to the Atlantic coasts, flowering in summer and producing a salt yellow unifloral honey, is also noteworthy.

Balsamita Miller

Balsamita major Desf. (Balsamic bitter herb) (m.v. 0.003 mg/flower) is cultivated as a spice, but it sometimes grows wild. It is visited in summer by small Apoidea, especially by *Hylaeus* and *Lasioglossum*.

Bellis L.

B. perennis L. is the well-known Daisy. It is a synanthropic perennial plant flowering all the year long. It is quite frequently visited by bees searching for pollen, especially in spring, when this plant flowers abundantly on lowland and mountain meadows. This species is frequently visited by Andrenidae and Halictidae, too. Low representativeness.

Buphtalmum L.

B. salicifolium L. (Yellow ox-eye) is a ubiquitous species widespread on arid and sunny slopes. It is visited in spring by bees and small Apoidea.

Calendula L.

C. arvensis L. (Marigold) is very common on fields and uncultivated grounds. It is an annual infesting weed, flowering nearly all the year long (from September to July) (m.v. 0.004 mg/flower). At the end of the winter, when the colony activity begins again, it provides bees with large quantities of orange pollen. It is frequently visited by Andrenidae and Halictidae, too. Low representativeness in honey.

Cardopatum Pers.

C. corymbosum (L.) Pers., widespreade on the Mediterranean waste clayey lands, where it flowers in summer, is assiduously wisited by bees, bumblebees and others Apoidea.

Carduus L.

Among the most common species the following ones are noteworthy: *C. acanthoides* L., *C. carlinaefolius* Lam., visited by bumblebees especially on the mountains, *C. carlinoides* Gouan and *C. crispus* L. (Curled thistle), defined as “important” in northern Europe, and *C. nutans* L. (Musk thistle), a biennial plant flowering from June to August and visited by almost all the Apoidea. *C. pycnocephalus* L. flowers from May to July on uncultivated grounds and on the sides of the roads.

In spring-summer thistles represent a rich source of nectar and pollen, grey-violet coloured, especially on arid soils. Unifloral honeys were recorded in Sicily and Sardinia; they derive from another Composita (*Galactites tomentosa* Moench) and are characterized by a light yellow colour, a delicate odour, a slightly strong aftertaste and a fine crystallization.

Carlina L.

C. acaulis L. (Carline thistle) is a perennial herb growing on mean and high altitudes mountains, where it flowers from August to September and is visited by bees searching predominantly for its whitish pollen. During famine years bees gather from it large quantities of nectar, too, moving from lowlands to mountains. *C. corymbosa* L. and *C. utzka* Hacq., flowering in summer, are widespread on the same environments, while *C. vulgaris* L. (Carline thistle), a biennial or perennial species flowering from July to September (m.v. 0.11 mg/flower), grows on uncultivated grounds and arid pasture lands. On the mountains these plants are preferred by bumblebees. Low representativeness.

Carthamus L.

C. lanatus L. is an annual or biennial plant widespread on arid uncultivated grounds, where it flowers from July to September. It represents a quite good source of nectar for bees. *C. tinctorius* L. (Safflower), cultivated commercially for the oil in the warmest regions but also widespread on uncultivated grounds and on the sides of the roads, flowers in summer and is frequently visited by bees. Quite good representativeness in honey coming from eastern Europe.

Centaurea L.

Among the principal species the following ones are to be mentioned. *C. cyanus* L. (Cornflower), an annual or biennial plant flowering at the beginning of the summer, is a weed infesting cereal fields especially in hilly and mountainous zones, but is also cultivated for ornamental purposes (m.v. 450 kg/ha). *C. jacea* L. (Brown knapweed) is a ubiquitous plant (m.v. 450 kg/ha) flowering in spring-summer and visited by many Apoidea. *C. soltitialis* L. (Yellow star-thistle) is a sharply thorny biennial species widespread on uncultivated grounds and flowering from July to September; this species is likely to give rare unifloral honey. The following species are also noteworthy: *C. montana* L. (Perennial cornflower) (m.v. 450 kg/ha), *C. nigra* L. (Common knapweed), *C. rhenana* Boreau (m.v. 885 kg/ha), *C. scabiosa* L. (Greater knapweed) (m.v. 880 kg/ha), *C. micrantha* Gren & Godron, chiefly important in Spain, *C. phrygia* L., important in northern Europe, *C. orphanidea* Heldr & Sart (m.v. 0.01 mg/flower) and *C. raphanina* Runemark (m.v. 0.13 mg/flower) important in Greece. All the Centaureae are frequently visited by bees and provide them with very large quantities of nectar and pollen. Among the Apoidea the most regular visitors are bumblebees.

Chrysanthemum L.

C. praecox Horvatiç is widespread on meadows and flowers in spring-summer on shrubs and on the sides of the roads. It provides bees with quite large quantities of pollen. Low representativeness.

Cirsium Miller

C. acaule (L.) Scop., *C. arvense* (L.) Scop. (Canadian thistle) and *C. vulgare* Ten. (Common thistle) are infesting weeds widespread on fields and on the sides of the roads and flowering from May to September. *C. eriophorum* (L.) Scop. and *C. montanum* (W. et K.) Sprengel are frequently visited by bumblebees and Megachilidae on the mountains pasture lands in summer. *C. erisithales* (Jacq.) Scop., *C. helenioides* (L.) Hill, *C. oleraceum* (L.) Scop. and *C. spinosissimus* (L.) Scop. (Yellow thistle) are widespread on the mountains; the last one can be found on the Alps "malgae". Genus *Cirsium* is frequently visited by bees gathering nectar and pollen and represents a good source of food in summer, especially in arid zones. Representativeness can be even high.

Cnicus L.

C. benedictus L. (Blessed thistle) is chiefly visited by bees. It is an officinal herb flowering in spring, both widespread on uncultivated grounds and cultivated. Low representativeness.

Cynara L.

C. cardunculus L., growing wild on pasture lands and uncultivated grounds, includes two subspecies, *cardunculus* (Thistle) and *scolymus* (L.) Hayek (Artichoke), both of which cultivated as table vegetables: the ribs of the leaves and the big flowers heads are used, respectively. Artichoke is a perennial plant flowering from June to August. Being excellent nectariferous plants, they are frequently visited by bees; anyway their importance for bees is limited because they are not widely distributed and are cut too early. Artichokes are frequently visited by Halictidae, Megachilidae and *Xylocopa*, too.

Doronicum L.

D. columnae Ten. flowers in spring-summer in damp woods and on rocks, where it is visited by many Apoidea.

Echinacea Moench

E. purpurea Moench is a summer officinal plant, chiefly visited by bees and bumblebees. Low representativeness.

Echinops L.

E. sphaerocephalus L. (Globe thistle) is widespread on rocky uncultivated grounds and arid meadows (m.v. 1100 kg/ha), while *E. ritro* L. is a perennial herb sometimes cultivated for ornamental purposes in many varieties. They flower in summer and represent a nectar and pollen source, sometimes remarkable. Other noteworthy species are *E. exaltatus* Schrader (m.v. 170 kg/ha), important in central-eastern Europe, *E. microcephalus* Sibth & Sm. (m.v. 0.11 mg/flower) and *E. spinosissimus* Turra (m.v. 0.13 mg/flower), important in the Mediterranean area. Pollen is under-represented (large-sized granule).

Erigeron L.

E. alpinus L. (Alpine daisy) can easily be found in Alpine pasture lands. It flowers in summer and is visited by many Apoidea. Low representativeness in honey.

Eupatorium L.

E. cannabinum L. (Hemp-agrimony) is the only species belonging to this genus. It is widespread on wet grounds and on ruins, flowers in summer and may have a great importance for bees. It is also visited by small Apoidea searching for its white pollen and nectar. Quite good representativeness.

Galactites Moench

G. tomentosa Moench (Holy thistle) is an important Mediterranean species flowering in spring-summer on uncultivated grounds and on the sides of the roads. It takes part in the composition of thistle unifloral honey.

Helianthus L.

It includes two species: *H. annuus* L. (Sunflower) and *H. tuberosus* L. (Jerusalem artichoke). The first one is cultivated commercially for oil and oilcakes, flowers in summer and is practically widespread all over central and southern Europe, providing large quantities of unifloral honey. The honey potential is generally low, very variable and equal to 40 kg/ha on the average. Honey is yellow, with a strong odour and flavour and a fine crystallization. Jerusalem artichoke flowers in autumn on uncultivated grounds and along the water courses and has some importance as a source of nectar and pollen for bees and other Apoidea.

Helichrysum Miller

H. stoechas (L.) Moench, flowering in summer in bushes (m.v. 0.02 mg/flower) and chiefly visited by Colletidae and Halictidae and only sometimes by bees, is to be mentioned.

Inula L.

I. helenium L. (Elecampane) flowers in summer and is visited by bees, bumblebees, Andrenidae, Halictidae and Megachilidae searching for its nectar and orange pollen. Low representativeness. *I. viscosa* Gren & Godron, a perennial infesting weed, is commonly widespread; it flowers in autumn and is frequently visited by bees searching for its brick red pollen that in autumn can be found as unifloral. *Inula* has some importance for late cycle Apoidea, too. Even good representativeness.

Matricaria L.

The most common species is *M. chamomilla* L. (Camomile), a weed predominantly infesting cereals fields. It flowers in spring-summer and is sometimes visited by bees searching for pollen and nectar, but more frequently by many Andrenidae, Halictidae and Megachilidae. Quite good representativeness.

Onopordum L.

O. acanthium L. flowers in summer on uncultivated grounds and along the roads; in the mountains it is assiduously visited by *Bombus*, *Xylocopa* and others Apoidea.

Pallenis Cass.

P. spinosa (L.) Cass. (m.v. 0.12 mg/flower), a herb native to the Mediterranean area, flowering in spring-summer and visited by a high number of Apoidea, has some importance.

Petasites Miller

P. albus (L.) Gaertn. and *P. hybridus* (L.) Gaertn., Meyer & Scherb. (Butterbur) are to be mentioned among the most common species. They are perennial plants flowering in spring and growing along the water courses and within wet environments. They provide bees with large quantities of pollen and nectar and represent a good source of food for queens and bumblebees coming from the winter lethargy. Low representativeness.

Senecio L.

In addition to *S. doronicum* L. and *S. erucifolius* L., widespread on meadows and uncultivated grounds, where flower from June to September, and *S. vulgaris* L. (Common groundsel), an annual infesting weed common on fields and uncultivated grounds, whose flowering lasts all the year long, the following species are to be mentioned: *S. jacobaea* L. (Common ragwort), widespread in England and providing for very aromatic, bitter unifloral honeys, *S. nemorensis* L. and *S. paludosus* L., native to wet grounds in central Europe. Bees and small Apoidea gather large quantities of pollen and nectar from these plants.

Silybum Adanson

The only species belonging to this genus is *S. marianum* (L.) Gaertn. (Milk thistle), a thorny biennial plant widespread on uncultivated grounds and on the sides of the roads and flowering from June to August. It is a good nectariferous plant and its pollen is frequently found in the sediment of summer honey. It is also important for its violet-greyish pollen. *S. marianum* is frequently visited by Halictidae and Megachilidae, too.

Solidago L.

S. virgaurea L. (Goldenrod) (m.v. 840 kg/ha) is widespread on woods and pasture lands. It is a perennial herb flowering from July to October and frequently visited for its nectar. Unifloral honey coming from different European zones, light brown coloured, irregularly crystallizing and easily fermenting, are known. *S. canadensis* L. (m.v. 900 kg/ha) and *S. gigantea* Aiton (m.v. 800 kg/ha) (Early goldenrod), native to Spain, are also important for bees as well as for small Apoidea.

Tanacetum L.

T. vulgare L. (Common tansy) is a perennial aromatic plant growing on uncultivated grounds and along water-courses and flowering from July to September. It is visited by small Apoidea rather than bees.

Tussilago L.

This genus is represented by one species only, *T. farfara* L. (Coltsfoot), a perennial plant very common on uncultivated grounds and wet clayey sites and flowering very early (from February on). It has a great importance for bees, being one of the few nectar and pollen sources available during the late winter first flights. Low representativeness in honey. This species is frequently visited by *Lasioglossum*, especially in northern Europe.

Xanthium L.

The species belonging to this genus are annual monoecious plants growing on sandy uncultivated grounds. Among the principal ones, *X. strumarium* L. (Cocklebur) flowers from June to November and is visited by bees only, gathering modest quantities of pollen.

CICHORIOIDEAE

Chondrilla L.

C. juncea L. is widespread on arid grounds and slopes. It is a herb flowering in summer. It is frequently visited by Andrenidae and Halictidae searching for its nectar and orange pollen and very seldom by bees. Low representativeness.

Cicerbita Wallr.

C. alpina (L.) Wallr. is visited by bumblebees in the mountains, where it flowers in summer in the woods.

Cichorium L.

C. endivia L. (Endive) and *C. intybus* L. (Chycory) are cultivated as table vegetables. The second one, also growing wild, is a ubiquitous perennial plant flowering from June to September and in summer represents a good source of nectar and white pollen. This species is visited by bees and by Andrenidae and Halictidae; it is also visited by bumblebees on the mountains. The representativeness in honey can be even quite good.

Crepis L.

C. sancta (L.) Babcok is widespread on uncultivated grounds and pasture lands; it flowers in spring and is very important for the collection of pollen (orange loads), gathered in large quantities. This plant is also visited by Andrenidae and Halictidae. Also *C. vesicaria* L. (Beacked hawk's-beard), widespread on uncultivated grounds and on the sides of the roads, has some importance. Its flowering period is very long and its representativeness is generally low.

Hieracium L.

It includes perennial species, the principal of which is *H. pilosella* L. (m.v. 0.45 mg/flower), widespread on arid meadows and rocky slopes and flowering at the end of the spring. Bees visit these plants searching predominantly for their pollen, often available in large quantities in the loads. *H. umbellatum* L. (Hawkweed) (m.v. 0.37 mg/flower) and *H. autumnale* L. (m.v. 560 kg/ha) are also to be mentioned. This genus is visited by Andrenidae and Halictidae.

Hypochoeris L.

H. achyrophorus L. (m.v. 0.002 mg/flower), a Mediterranean species growing on uncultivated and arid grounds, is quite important because it flowers in spring, while *H. radicata* L. (Rough cat's-car) is an edible herb. Low representativeness in honey.

Leontodon L.

Bees and other Apoidea frequently visit *L. autumnalis* L. (Wild chycory) (m.v. 0.49 mg/flower), native to mown meadows, and the ubiquitous *L. hispidus* L., both of them flowering in summer-autumn. Low representativeness.

Picris L.

P. echioides L. (British oxtongue) and *P. hieracioides* L. (Hawkweed oxtongue) are widespread on fields and uncultivated grounds and flower in summer. These species are frequently visited by bees searching for pollen, that gives considerable loads in central Italy. They are also visited by other Apoidea. Representativeness in honey is often quite good.

Prenathes L.

P. purpurea L. flowers in summer in mountainous woods. It is frequently visited by bumble-bees and more rarely by bees searching for nectar. Low representativeness.

Reichardia Roth

R. picroides (L.) Roth is an edible plant flowering in spring-summer on uncultivated grounds and on the walls. It is frequently visited by Apoidea, more rarely by bees. Low representativeness.

Scolymus L.

S. hispanicus L. (Spanish salsify) can easily be found on arid grounds. It flowers in summer and is frequently visited by a high number of Apoidea searching for its nectar and its dark yellow pollen. Quite good representativeness.

Scorzonera L.

S. austriaca Willd, a summer herb widespread on meadows, is native to central Europe. It has some importance for bees and small Apoidea. *S. deliciosa* Guss. (Black salsify), flowering in summer on pasture lands, has the same role for Apoidea in the Mediterranean area.

Sonchus L.

S. asper (L.) Hill (Pricked sow thistle), an edible herb flowering in spring, and *S. oleraceus* L. (Sow thistle) have some importance all over Europe, where they grow on the ruins. Quite good representativeness.

Taraxacum Weber

T. officinale Weber (Common dandelion) is the principal species. It is a perennial plant growing on lowland and mountain pasture lands and flowering in spring (m.v. 200 kg/ha). It has a great importance for bees as a source of nectar and pollen, in some sites giving rise to a unifloral honey. Honey is light yellow, its crystallization is very fine and regular and its flavour is strong, not pleasing everybody. The orange pollen is chiefly gathered, even in large quantities, by Andrenidae, Halictidae and Megachilidae.

Tragopogon L.

T. dubius Scop., *T. porrifolius* L. (Salsify) (m.v. 0.01 mg/flower) and *T. pratensis* L. (Goat's beard) are widespread on meadows and uncultivated grounds, both on lowlands and on the mountains. In spring they are rarely visited by bees, but frequently by Andrenidae and Halictidae.

Urospermum Scop.

U. dalechampii (L.) Schmid is widespread on meadows and uncultivated grounds. It is a perennial plant flowering in spring-summer, frequently visited by small Apoidea and less often by bees. The last ones gather quite large quantities of light yellow pollen.

CONVOLVULACEAE

Calystegia R. Br.

C. sepium (L.) R. Br. (Hedge bindweed) is a voluble plant widespread on bushes and in woods.

It flowers in summer and is visited by bees searching for nectar. The pollen representativeness in honey is lower than 2% (it is underrepresented) because of the large-sized granules. This species is frequently visited by bumblebees, too.

Convolvulus L.

C. arvensis L. (Common bindweed) and *C. cantabrica* L. (m.v. 0.04 mg/flower) are widespread on uncultivated grounds and often act as infesting weeds. These herbs flower all the summer long and are visited for their nectar and their white pollen. Convolvulus is visited by the oligoleptic *Systropha curvicornis* Scop. and *S. planidens* Giraud, as well as by numerous species belonging to Andrenidae and Halictidae. Visitations by bumblebees are not frequent.

CORNACEAE

Cornus alba L. (Coral dogwood), flowering in summer, *C. mas* L. (Cornelian cherry), flowering at the end of winter/beginning of the spring, and *C. sanguinea* L. (Blood-twig dogwood), flowering in late spring, are widespread in broadleaf woods and on shrubs. All these species have some importance. This genus produces quite large quantities of nectar, but bees visit it predominantly searching for pollen; it is yellow coloured in Cornelian cherries and brown coloured in Blood-twig dogwoods. The representativeness in honey can be even quite good.

CORYLACEAE

They are shrubs or trees flowering at the end of the winter/beginning of spring. Being not nectariferous plants, their importance only refers to the pollen collection. The following species are to be mentioned: *Carpinus betulus* L. (Hornbeam), *Corylus avellana* L. (Hazel) and *Ostrya carpinifolia* Scop. They make light yellow friable pollen loads. Honeydew is produced by horbeam (*Myzocallis carpini* (Koch)) and sometimes by hazel (*Myzocallis coryli* (Goeze)), which is not visited by bees.

CRASSULACEAE

Sedum L.

S. acre L. (Mossy stonecrop) (m.v. 0.12 mg/flower), *S. album* L., *S. reflexum* L., *S. sexangulare* L. (Tasteless stonecrop), *S. spurium* Bieb. (Caucasian stonecrop) and *S. telephium* L. (Live-forever stonecrop) (important in northern Europe) are widespread on rocky and uncultivated grounds. They predominantly flower in summer. Even if they are quite good nectariferous plants, the representativeness of their pollen is low.

Sempervivum L.

S. arachnoideum L., *S. montanum* L. and *S. tectorum* L. (Sengreen) have to be mentioned among the principal species. They flower in summer on rocky grounds and are chiefly visited for their nectar; bumblebees frequently visit them on the mountains. Low representativeness.

Umbilicus DC.

U. erectus DC. is widespread on rocky grounds and is visited by a high number of Apoidea, rarely by bees.

CRUCIFERAE

Numerous species have great importance from an economic point of view, being used as table vegetables or fodder; they are often cultivated commercially for the oils (in the food form or as industrial products) but also for ornamental purposes. Cruciferae are nectar and pollen-carriers. They are generally visited by bees, but their importance varies depending on the flowering intensity and the quantity of nectar produced. The species that provide for unifloral honey are *Brassica napus* var. *oleifera* Del. and *Diplotaxis erucoides* (L.) DC., only. From a melissopalynological point of view, pollen obtained from Cruciferae can be divided into two main forms: R (*Brassica*), finely reticulated and S (*Sinapis*), reticulate. Cruciferae are generally visited by the most Apoidea, among which the following oligoleptic species: *Andrena agilissima* Scop., *A. brevicornis* F., *A. distinguenda* Schenk, *A. niveata* Friese, *A. suerinensis* Friese and *Osmia brevicornis* F.

Alliaria Scop.

A. petiolata (Bieb.) Cavara et Grande (Garlic mustard) is widespread on uncultivated grounds. It flowers in spring and is chiefly visited by bees searching for nectar. Low representativeness.

Alyssum L.

A. montanum L. is widespread on arid meadows, flowers in spring-summer and is visited by bees searching chiefly for pollen, that can be found in the loads in modest quantities.

Arabis L.

Some species are widespread on the mountains, as *A. caerulea* All., while others are common on fields and in woods, as *A. turrita* L. (Tower cress), or on rocky grounds, as *A. alpina* L., important in northern Europe. All of them provides bees with small quantities of pollen in spring.

Aubrieta Adamson

A. columnae Guss. can be found on calcareous rocks, but it is also cultivated as ornamental. It flowers in spring and is chiefly visited by bees searching for nectar and by Anthophoridae. Low representativeness.

Barbarea R. Br.

B. vulgaris R. Br. (Rocket) has some importance being a spring nectariferous plant. It is generally widespread along the ditches (m.v. 150 kg/ha). Low representativeness in honey.

Biscutella L.

B. laevigata L. is widespread on arid rocks and meadows. It flowers in spring and is visited chiefly by small Apoidea.

Brassica L.

Among the cultivated species, the following ones are to be mentioned as good nectariferous plants: *B. nigra* (L.) Koch (Black mustard), *B. napus* L. var. *oleifera* Del. (Colza), *B. oleracea* L., giving rise to the varieties of cabbage, *B. rapa* L., with its subspecies *rapa* (Rape) and *sylvestris* (L.) Janchen (Cole). All these species flower in spring (m.v. 100 kg/ha) and *B. nigra* only has a low importance as melliferous plant (m.v. 40 kg/ha). Colza is the most important species for bees. It is largely cultivated all over Europe, even on set-aside grounds. Its abundant flowering provides for large quantities of honey, whose sediment can contain until 90% of Colza pollen. It is white, rape odoured and flavoured and its crystallization is fine and regular. This honey is also used for inseminating honey with an imperfect crystallization.

Cakile Miller

C. maritima Scop. (Sea rocket) is a halophilous species widespread on shores and flowering in spring-summer. It can provide for quite good quantities of pollen and nectar. Low representativeness.

Capsella Medicus

C. bursa-pastoris (L.) Medicus (Shepherd’s purse) is an infesting weed whose flowering is prolonged. It is predominantly visited by small Apoidea.

Cardamine L.

C. hirsuta L. (Hairy bitter-cress) is a very common infesting weed flowering in spring and visited by small Apoidea, only. *C. bubifera* (L.) Crantz, native to shrubs, flowering in spring and visited by small Apoidea, is also noteworthy.

Cardaria Desv.

C. draba (L.) Desv. (Hoary cress) is an infesting weed common on uncultivated grounds and on the sides of the roads; it flowers in spring-summer, providing bees and other Apoidea with good quantities of light yellow pollen.

Cochlearia L.

C. officinalis L. (Scurvy grass) is an ubiquitous plant flowering in spring. It is visited by bees and many Apoidea. Its representativeness is low.

Diplotaxis DC.

D. erucoides (L.) DC. is a very common weed infesting vineyards and olive-grow. It is characterized by prolonged and spread flowerings. It is visited by bees and Apoidea gathering large quantities of yellow-greenish pollen and nectar. Honey coming from this species has the same features as that one obtained by Colza. This genus includes other two species, *D. muralis* (L.) DC. (Annual wall-rocket) and *D. tenuifolia* (L.) DC. (Perennial wall-rocket), less important than the above mentioned ones; they are widespread on uncultivated grounds and ruins and flower from May to October. They are frequently visited by small Apoidea and only sometimes by bees.

Draba L.

D. aizoides L. is widespread on uncultivated grounds and flowers in spring. It is visited by small Apoidea gathering nectar and the green-yellow pollen.

Eruca Miller

E. sativa Miller (Garden rocket) is cultivated as table vegetable. It is visited by bees and Anthophoridae searching for nectar and the orange pollen. Low representativeness.

Erysimum L.

It includes one species only, *E. cheiri* (L.) Crantz (Wallflower), growing spontaneously on walls but also cultivated for ornamental purposes. It flowers in spring. Bees visit it gathering modest quantities of pollen and nectar.

Iberis L.

I. umbellata L. (Globe candytuft) is cultivated for ornamental purposes but is also widespread along the shores, where it flowers in spring and is visited by bees searching for pollen and nectar. Low representativeness in honey.

Isatis L.

I. tinctoria L. is very common on rocky grounds. It flowers in spring and is only visited by small Apoidea searching for nectar and pollen.

Lobularia Desv.

This genus includes one species only, *L. maritima* (L.) Desv., growing on the shores; it can be found on rocks and walls and flowers in summer, providing for quite good loads of light yellow pollen.

Lunaria L.

L. annua L. (Satin flower) is widespread on uncultivated grounds and embankments. It flowers in spring and is visited by bees and Anthophoridae searching for nectar. Low representativeness.

Matthiola R. Br.

M. incana (L.) R. Br. (Gillyflower) grows spontaneously on the Mediterranean shores, flowers in spring and is sporadically visited by bees and other Apoidea.

Moricandia DC.

M. arvensis (L.) DC., flowering in spring on uncultivated grounds and pasture lands, is quite well-known. It is visited by bees and small Apoidea.

Nasturtium R. Br.

N. officinale R. Br. (Watercress) is widespread on the still and running waters shores. It flowers in spring and is cultivated as table vegetable. It is sporadically visited by bees, frequently by small Apoidea.

Raphanus L.

R. raphanistrum L. (Wild radish), a spontaneous infesting weed, and *R. sativus* L. (Garden radish), a cultivated species, flower in spring (m.v. 46 kg/ha). As all the Cruciferae, their representativeness in honeys is low (with the exception of the above mentioned unifloral honeys).

Rapistrum Crantz

R. rugosum (L.) All. (Radish) is the most common species. It is an infesting weed flowering at the beginning of the spring and frequently visited by bees and Andrenidae. Quite good representativeness in honey.

Sinapis L.

The most common species are *S. alba* L. (White mustard) and *S. arvensis* L. (Charlock), infesting weeds growing on fields and uncultivated grounds (m.v. 35 kg/ha). They are important species in Europe. Quite good representativeness.

Sisymbrium L.

S. austriacum Jacq. and *S. irio* L. (London rocket) are important in central Europe and in Spain, respectively. They grow on rocks and are chiefly visited for their dark yellow pollen. *S. orientale* L. (m.v. 0.01 mg/flower) is also interesting.

Thlaspi L.

T. alpestre L. has some importance for bees both for pollen and for nectar. It flowers at the beginning of the summer on the northern European arid pasture lands.

CUCURBITACEAE

Bryonia L.

B. dioica Jacq. (Bryony) is widespread on bushes and woods. It flowers at the last of the spring. A unifloral yellow honey, odourless and with an acrid flavour, was recently found out. It should be convenient to investigate the presence in nectar of the bryonine and bryonidine alkaloids, typical of this toxic officinal plant. Genus *Bryonia* is also visited by bumblebees and by the oligoleptic *Andrena florea* F.

Citrullus Schrader

C. lanatus (Thunb.) Mansf. (Watermelon) is cultivated for its fruits; it flowers at the beginning of the summer and is frequently visited by bees searching for nectar. Low representativeness.

Cucumis L.

C. melo L. (Muskmelon) and *C. sativus* L. (Cucumber) are cultivated in market-gardens. They flower in summer and are visited chiefly for nectar (m.v. 30 kg/ha), less frequently for the orange pollen. The *Cucumis* pollen is often found in honey even in quite large quantities.

Cucurbita L.

C. maxima Duchesne in Lam. (Gourd), *C. moschata* Duchesne ex Poiret (Winter crookneck squash) and *C. pepo* L. (Summer squash) flower at the end of the spring and are frequently visited by bees searching for nectar. Its representativeness is very low because of the large sizes of the pollen granule.

Ecballium A. Rich.

E. elaterium (L.) A. Rich (Squirting cucumber), native to embankments, uncultivated grounds and slopes and flowering in summer, is noteworthy. It is visited by bees. Low representativeness.

CUPRESSACEAE

This family includes the following shrubs: *Juniperus communis* L. (Juniper), *Thuja* L. (Thuja) and *Cupressus sempervirens* L.(Cypress). The last one flowers at the end of the winter and produces large quantities of pink pollen, actively gathered by bees. Juniper produces honeydew, too, as a result of attacks by *Cinara juniperi* (De Geer). Honeydew is not gathered by bees.

CYPERACEAE

Two herbs only, *Carex* L. and *Cyperus* L., are interesting for bees, providing them with small quantities of friable yellow pollen.

DIOSCOREACEAE

Tamus communis L. (Black bryony) is widespread in woods, flowers in spring and is visited by Andrenidae and Halictidae.

DIPSACACEAE

Plants belonging to this family have great importance for bees as a source of nectar, especially in summer. They are also visited for their pink pollen, gathered in large quantities because of the direct consumption of honey and the large size of pollens. Low representativeness in honey. All the Dipsacaceae are visited by bumblebees, other Apoidea and oligoleptic pollinators as *Andrena hattorfiana* F., *A. marginata* F., *Dasypoda argentata* Panz. and *D. suripes* Christ.

Cephalaria Schrader
The following species are quite common: *C. leucantha* (L.) Schrad., native to arid and rocky meadows, and *C. transsylvanica* (L.) Schrad., widespread on uncultivated grounds; both of them flower in summer and are visited by bees and bumblebees for nectar and pollen.

Dipsacus L.
D. fullonum L. (Fuller's teasel) (m.v. 770 kg/ha) is a very high herb flowering in summer on uncultivated grounds and ruins. It is frequently visited by bumblebees and *Xylocopa*. It is very important in central-eastern Europe.

Knautia L.
The most common species is *K. arvensis* (L.) Coulter (Field scabious), widespread on pasture lands and uncultivated grounds. It flowers in summer and provides bees with large quantities of pollen and nectar. It is visited by many Apoidea, too.

Scabiosa L.
S. atropurpurea L. and *S. columbaria* L. (Small scabious) are widespread on uncultivated grounds, flower at the end of the spring and provide bees with quite good quantities of nectar and pollen. They are visited by bumblebees and other Apoidea, too. *S. crenata* Cyr. flowers in summer in Mediterranean gravelly soils and is visited by bumblebees and others Apoidea.

Succisa Necker
S. pratensis Moench is as important as the above mentioned species. It flowers in summer on wet meadows.

EBENACEAE

The only species interesting for bees is *Diospyros kaki* L. (Japanese persimmon), a monoecious plant cultivated for its fruits. It is noteworthy because it is visited by bees at the beginning of the summer. Its pollen can be found in honey only rarely.

ELAEAGNACEAE

Elaeagnus angustifolia L. is cultivated for ornamental purposes and flowers in spring. It has some importance as a source of nectar, providing for strongly odoured unifloral honey only rarely (m.v. 100 kg/ha). Low representativeness of pollen in honey (underrepresented pollen).

ERICACEAE

Arbutus L.

A. andrachne L. and *A. unedo* L. (Arbutus) are native to the Mediterranean bush and flower in winter. A unifloral honey is produced from them in Sardinia, Albania and Greece. It is light grey, strong in odour and bitter in flavour and ferments quite easily. Pollen is underrepresented because of the large size of the granule and the position of the flowers (recurved backward), making difficult a primary pollution of nectar. Arbutus has some importance as pollen (white loads) carrier, too. It is also visited by bumblebees.

Arctostaphylos Adanson

A. alpinus (L.) Sprengel and *A. uva-ursi* Sprengel (Bearberry), quite good nectariferous plants native to the European mountainous grounds, flowering in spring-summer, are noteworthy.

Calluna Salisb.

The only species belonging to this genus is *C. vulgaris* (L.) Hull (Ling). It flowers from August to November (m.v. 30 kg/ ha) and forms heaths, habitats typical of the poor grounds chiefly located in central-northern Europe and on the Atlantic coasts. In these environments large quantities of *Calluna* unifloral honey are produced; it is orange coloured, shows a very particular odour and flavour and crystallizes inside the honeycombs ("tixotropy"); for this reason honeycombs have to be perforated by means of suitable forks before centrifugation. Pollen (pink loads) is abundantly gathered. This species is also visited by bumblebees and by the oligoleptic *Andrena fuscipes* Kirby and *Colletes succinctus* L.

Erica L.

E. arborea L. (Heather) (m.v. 40 kg/ha), *E. australis* L., *E. ciliaris* L., *E. cinerea* L., *E. herbacea* L., *E. scoparia* L., *E. tetralix* L. (Cross-leaved heath), *E. umbellata* L. and *E. vagans* L. are widespread on woods and bushes (some of them are very common in Spain) and flower predominantly in spring. Orange unifloral honeys, aromatic, slightly bitter and with gross granules, can be obtained from these species. *E. manipuliflora* Salisb. and *E. multiflora* L., flowering from the late summer on and providing for unifloral honey, can be found in the central and eastern Mediterranean area. All these species also provide bees with large quantities of pink pollen.

Ledum L.

L. palustre L. (Labrador tea), having a great importance for bees in northern Europe (m.v. 65 kg/ha), is the only noteworthy species.

Rhododendron L.

R. ferrugineum L. and *R. hirsutum* L. (Rhododendron) belong to this genus. The *R.* x *intermedium* Tausch. hybrid is widespread in those grounds where the two above mentioned species can be found together. Rhododendrons grow almost exclusively on the Alps, where they flower from May to the end of July. They give a white unifloral honey, exhaling a very delicate odour and flavour and showing a very fine crystallization. Pollen is underrepresented. Being interesting for the production of white pollen, rhododendrons are frequently visited by bumblebees, too.

Vaccinium L.

This species has some importance for the production of edible berries, used for making jellies. *V. myrtillus* L. (Bilberry), *V. vitis idaea* L. (Mountain cranberry), *V. oxycoccos* L. (Small cranberry) and *V. uliginosum* L. are widespread on pasture lands, woods and heaths. They flower from the end of the spring on and rarely produce unifloral honeys, very similar to those ones obtained from Rhododendron (m.v. 75 kg/ha). Bilberries are frequently visited by bumblebees, other Apoidea and above all by the oligoleptic *Andrena lapponica* Zetter.

ESCALLONIACEAE

Genus *Escallonia* Mutis ex L. fill. includes shrubs very important as melliferous plants. *E. macrantha* Hooker & Arnott and *E. rubra* (Ruiz e Pavon) Pers., cultivated for ornamental purposes in western Europe, are frequently visited by bees searching for nectar. The representativeness in honey is very low because of the species rarity.

EUPHORBIACEAE

Chrozophora Juss.
C. tinctoria (L.) Juss. (Officinal croton) is widespread on arid grounds, flowers in summer and provides bees with yellow pollen. Low representativeness.

Euphorbia L.
Among the most common species the following ones are to be mentioned: *E. dendroides* L., a typical coastal shrub, *E. characias* L., *E. cyparissias* L., *E. helioscopia* L. (Sun spurge), widespread on uncultivated grounds, and *E. acanthothamnos* Heldr & Sart. (m.v. 0.02 mg/flower), generally flowering in spring. They are not too important for bees, gathering from them small quantities of nectar and pollen. Low representativeness.

Mercurialis L.
M. annua L. (Annual mercury), an infesting weed flowering all the year long, and *M. perennis* L. (Dog's mercury), a rarer species native to woods and flowering in late spring, are dioecious plants. In all probability they are not nectariferous plants. They are visited by bees searching for their brown pollen.

Ricinus L.
This genus is represented by *R. communis* L. (Castor-oil plant), only. It is a cultivated or wild monoecious plant, flowering from the end of the spring on and providing for small quantities of white pollen. This plant gives visible extrafloral nectaries frequently gathered by bees and ants.

FAGACEAE

This family includes very important forestal trees as Chestnut, Beech and Oaks, making up large woody habitats.

Castanea Miller
This genus is represented by one species only, *C. sativa* Miller (Chestnut), a tree flowering at the beginning of the summer and providing for large quantities of unifloral honey (m.v. 250 kg/ha). Chestnut honey is dark red coloured; its odour is strong and its flavour quite bitter; it crystallizes after a long time. A honeydew, as a result of attacks by *Myzocallis castanicola*, is also produced. Chestnut pollen is overrepresented; to be sure that honey is unifloral the percentage of pollen in the sediment has to be higher than 90% and granules has to be more than 200,000 units each 10 g of honey. Chestnut is often visited for its yellow pollen. Frequent visitations by bumblebees were also recorded.

Fagus L.
This genus is represented by one species only, *F. sylvatica* L. (Beech), a tree not too important for bees and giving a light yellow pollen. A honeydew, as a result of attacks by *Phyllaphis fagi*, is produced and sometimes gathered by bees.

Quercus L.
Q. ilex L. (Ilex) and *Q. suber* L. (Corn-oak), widespread in the Mediterranean area, are evergreen species. Among the deciduous ones (i.e. losing their leaves in the fall), there are *Q. cerris* L.

(Turkey oak), *Q. coccifera* L. (Scarlet oak), *Q. petrea* (Mattuschka) Liebl. (Bay oak), *Q. pubescens* Willd., *Q. pyrenaica* Willd., *Q. robur* L. (British oak) and *Q. rotundifolia* Lam. Oaks are of some importance in the pollen collection, that is yellow coloured. It is frequently gathered by *Osmia cornuta* and *O. rufa cornigera*, too. A honeydew, as a result of attacks by many piercing and suction insects, among which *Tuberculatus annulatus*, is also produced.

GENTIANACEAE

Gentiana lutea L. (Gentian) is quite common on mountainous meadows, flowers in July (m.v. 180 kg/ha) and shows a quite low representativeness of pollen in honey. Gentian is visited by bumblebees, Andrenidae, Halictidae and Megachilidae. *G. punctata* L., *G. kochiana* Perr. e Song. and *Gentianella amarella* (L.) Börner are frequently visited by bumblebees on the Alpine pasture lands.

GERANIACEAE

Among the well-known species the following ones are to be mentioned: *Geranium phaeum* L., *G. pratense* L. (m.v. 80 kg/ha) (Meadow crane's-bill), *G. pyrenaicum* Burm. f., *G. reflexum* L., *G. robertianum* L. (Herb Robert) and *G. sylvaticum* L. (m.v. 0.49 mg/flower), this one particularly important in northern Europe. They generally flower in spring on pasture lands and uncultivated grounds. All the species are visited by bees and bumblebees. Also *Erodium cicutarium* (L.) L'Hér. (Stork's-bill) (m.v. 0.01 mg/flower) and *E. malacoides* (L.) L'Hér are noteworthy species. Low representativeness.

GLOBULARIACEAE

They are herbaceous or suffrutticose plants, among which *Globularia alypium* L. (m.v. 0.007 mg/flower), *G. cordifolia* L. and *G. punctata* Lapeyr. are to be mentioned. They flower at the end of the spring on pasture lands, arid meadows and rocks. They have some importance as sources of a grey pollen. Nectar is also gathered, but its representativeness in honey is low.

GRAMINEAE

They represent one of the principal families, including species widespread all over the world on pasture lands, grass-lands, steppes and savannahs. Many species, as cereals, are cultivated and have great importance in the human and animal diet. They are not nectariferous plants; for this reason they are interesting for bees as far as the pollen collection only. A honeydew, as a result of attacks by *Sitobion avenae*, is also produced.

Zea L.

Z. mays L. (Maize), a monoecious species flowering in summer, is well-known. It is very important for bees as source of pollen (pale yellow, flat and solid loads). Representativeness in honey can be high, but in this case it is caused by a secondary pollution.

GROSSULARIACEAE

Ribes L., a shrubby genus often cultivated for the production of small fruits, belongs to this family. *R. uva-crispa* L. (Goosberry), *R. nigrum* L. (Black currant) and *R. rubrum* L. (Ribes) can grow wild in woods, flower in spring (m.v. 50 kg/ha) and are visited by bees, bumblebees, Andrenidae, especially by the oligoleptic *Andrena fulva* Mueller and *A. hemorroa* F., searching for nectar.

GUTTIFERAE

Hypericum perforatum L. (Saint John's wort) is to be mentioned among the well-known species. It flowers in summer on arid meadows, shrubs and uncultivated grounds. Its importance for bees is limited to the collection of small quantities of light brown pollen. It is frequently visited by bumblebees on the mountains.

HIPPOCASTANACEAE

This family includes some ornamental trees as *Aesculus californica* Spach., *A. hippocastanum* L. (Horse-chestnut), *A. octandra* Marsh. and *A. pavia* L. These species produce a nectar containing high levels of sugar and saponines. They are often visited by bees, but in general their pollen is rarely found in honey. Anyway, white, odourless and flavourless unifloral honeys were found in some towns in central Europe. Pollen, appearing in the form of purple loads and gathered in quite high percentages, is probably toxic for bees if eaten in large quantities (“may sickness”).

HYDROCHARITACEAE

Hydrocharis morsus-ranae L. (Frogbit) has some importance for bees. In summer it flowers in marches. Bees gather small quantities of nectar from it. Low representativeness.

HYDROPHYLLACEAE

Phacelia tanacetifolia Benth. is native to California and is more and more diffused in Europe, where it is cultivated to produce fodder and to cover set-aside grounds. It flowers in spring-summer (m.v. 1,000 kg/ha) and produces an amber-coloured unifloral honey, with strong odour and flavour and fine crystallization. This species is frequently visited by bumblebees, too.

IRIDACEAE

Crocus L.

C. albiflorus Kit., *C. biflorus* Miller (widespread on arid pasture lands and on meadows at the beginning of the spring), *C. cancellatus* Herb. (m.v. 0.05 mg/flower), *C. napolitanus* Mord et Loisel (important in northern Europe) and *C. sativus* L. (Saffron) (both cultivated and growing wild and flowering in autumn) are to be mentioned among the most common species. Bees gather from them red-orange pollen. This genus is frequently visited by bumblebees, too. Low representativeness.

Gladiolus L.

G. italicus Miller (Sword-lily) is an infesting weed widespread on cereals fields; it flowers at the end of the spring and is visited predominantly for its light-yellow pollen.

Romulea Medicus

R. linaresi Parl. flowers in spring on the meadows placed along the Mediterranean shores (m.v. 0.04 mg/flower) and is visited predominantly for nectar. Low representativeness.

JUGLANDACEAE

The only species growing spontaneously in Europe is *Juglans regia* L. (Walnut-tree), cultivated for producing fruits and prized wood. *J. nigra* L. is cultivated for ornamental purposes. These plants flower in spring and provide for quite large quantities of opaque yellow pollen. A honeydew, as a result of attacks by *Callaphis juglandis*, is also produced. The walnut-tree amenths are also visited by *Osmia*.

JUNCACEAE

Juncus L. and *Luzula* Lam. et DC. are the principal genera. Small quantities of yellow pollen are gathered on both of them. Low representativeness.

LABIATAE

Many species contain essential oils and are used in medicine, perfumery, as seasonings for food, in liqueurs, etc.; some of them are cultivated for ornamental purposes. Labiatae constitute one of the most interesting families for bees, especially for their nectar, and include species frequently visited by bees and other Apoidea and able to give unifloral honey. On the other hand they are not too interesting as far as pollen. Two main types of pollen can be distinguished from a melissopalynological point of view: tricolpate (*Stachys* type) and stephanocolpate (*Mentha* type).

Acinos Miller

A. alpinus (L.) Moench is widespread in the mountains pastures where it flowers in summer and is visited by bumblebees.

Agastache O. Kuntze

A. foeniculum Kuntze and *A. rugosa* Kuntze are essence herbs recently imported from the United States. They flower in late spring (m.v. 1300 kg/ha and 600 kg/ha respectively) and are visited by bees and *Lasioglossum*. Quite good representativeness.

Ajuga L.

A. reptans L. (Bungleweed) is widespread in woods and grass-lands. It is a perennial herb flowering in spring (m.v. 50 kg/ha) and providing bees with quite large quantities of nectar. Low representativeness of pollen in honey. This species is frequently visited by *Anthophora* and *Osmia*.

Ballota L.

B. acetabulosa (L.) Benth. (m.v. 2.65 mg/flower) and *B. nigra* L. (Fetid horehound) are fetid herbs flowering in summer on ruins and uncultivated grounds. They are not often visited by bees, but very frequently by *Anthidium* and bumblebees. Low representativeness.

Calamintha Miller

C. nepeta (L.) Savi and *C. sylvatica* Bromf. are the principal species. They are widespread on arid meadows, uncultivated grounds and walls and flower in summer. They are quite often visited by bees searching for nectar and frequently by bumblebees on the mountains. Low representativeness.

Dracocephalum L.

D. moldavica L. is one of the best nectariferous plants. It is cultivated for its fibre and flowers in spring-summer (m.v. >500 kg/ha). It is frequently visited by bees and other Apoidea. Representativeness can be even high in eastern Europe.

Galeopsis L.

G. angustifolia Ehrh. is quite common on bare patches. It flowers in spring and is chiefly visited by bumblebees; visitations by other Apoidea are rarer.

Glechoma L.

G. hederacea L. (Ground ivy) is the most common species. It is an ubiquitous herb flowering in spring, sometimes visited by bees but predominantly by *Anthophora plumipes* and bumblebees. Low representativeness.

Horminum L.

H. pyrenaicum L. is a perennial herb widespread on Alpine pasture lands. It flowers in summer and is visited by bees and bumblebees searching for nectar. Low representativeness.

Hyssopus L.

H. officinalis L. (Hyssop) is an important shrub used in medicine. It is cultivated for its properties, but grows spontaneously on rocky pasture lands and into underwood, too. It flowers in summer (m.v. 450 kg/ha) and is frequently visited by bees, Anthophoridae, Megachilidae and Halictidae. Quite good representativeness.

Lamiastrum Fabr.

Lamiastrum galeobdolon (L.) Ehrend. et Polatschek (m.v. 200 kg/ha) is particularly important in central Europe, where it is widespread into underwood and brushes. It flowers in spring-summer and is visited by bees and bumblebees. Quite good representativeness.

Lamium L.

L. album L. (White dead-nettle) (m.v. 725 kg/ha), *L. amplexicaule* L. (m.v. 600 kg/ha), *L. bifidum* Cyr., *L. garganicum* L., *L. maculatum* L. (Spotted dead-nettle) (m.v. 190 kg/ha), *L. orvala* L. and *L. purpureum* L. (Red dead-nettle) are important for bees and bumblebees. They are widespread in woods, meadows and uncultivated grounds, flower generally in spring and have a great importance as nectariferous plants. Nectar is indeed a fundamental food for the bumblebee queens and for Anthophoridae and *Xylocopa*. Representativeness can be even quite good.

Lavandula L.

L. angustifolia Miller (Common lavender), often cultivated as ornamental, *L. dentata* L. and *L. stoechas* L. (French lavender), widespread on bushes, *L. peduncolata* Cav. and *L. sanpaioana* Rodz. are the principal species. They generally flower in spring and are visited chiefly for nectar, providing for unifloral honey, very odorous, amber-coloured and showing a pasty crystallization. Pollen is underrepresented; therefore low percentages of it are sufficient to define honey as unifloral. Another typical honey is obtained by “Lavandino”, an hybrid cultivated to produce essence; being sterile, it prevents pollen from being found in its own honey sediment. Lavenders are frequently visited by bumblebees, especially on the mountains.

Leonurus L.

L. cardiaca L. (Cardiaca) and *L. villosus* Desf. are very good nectariferous plants. They flower in spring on uncultivated grounds and along the ditches (m.v. > 600 kg/ha). They are frequently visited by Megachilidae and *Xylocopa*. Quite good representativeness.

Lycopus L.

L. europaeus L. (Bungleweed) can easily be found along the ditches. It flowers in summer and is visited by bees and Halictidae searching for nectar.

Marrubium L.

M. incanum Desr. is widespread on the mountains, while the most common species is the perennial *M. vulgare* L. (Horehound). Both of them flower in summer on arid pasture lands and uncultivated grounds (m.v. 390 kg/ha). They are of some importance as sources of nectar for bees and bumblebees during the dry summers. Low representativeness.

Melissa L.

M. officinalis L. (Balm) is a well-known aromatic plant flowering at the end of the spring. It is rarely visited by bees, more frequently by genus *Anthidium*.

Melittis L.

M. melissophyllum L. is widespread in broadleaf woods. It flowers in spring and is frequently visited by bumblebees and Anthophoridae.

Mentha L.

M. aquatica L. (Water minth), *M. longifolia* (L.) Hudson, *M. rotundifolia* Hudson and *M. pulegium* L. (Pennyroyal) are widespread on wet uncultivated grounds or along the ditches. They flower in summer and are frequently visited by bees and small Apoidea. Quite good representativeness.

Nepeta L.

N. cataria L. (Catnip) (m.v. 165 kg/ha), frequently visited by bumblebees, and *N. nepetella* L. (Field balm), visited by all the Apoidea, flower on uncultivated grounds and ruins. Quite good representativeness.

Ocimum L.

This genus is represented by one only cultivated species, *O. basilicum* L. (Basil), aromatic plant and good nectariferous plants. It is chiefly visited by bees. Its pollen is found only sometimes in honey, because of the large size of the granule.

Origanum L.

O. majorana L. (Sweet marjoram) (m.v. 970 kg/ha) and *O. vulgare* L. (Wild marjoram) are well-known as seasonings for food. They grow on brushes and uncultivated grounds, flower in summer and are visited by bees and small Apoidea. Pollen is underrepresented.

Phlomis L.

P. fruticosa L. and *P. herba-venti* L. are widespread on the rocks, brushes and arid pasture lands of the Mediterranean area. They flower in spring (m.v. 1.83 mg/flower) and are chiefly visited by bumblebees and *Xylocopa*.

Prunella L.

P. vulgaris L. (Self-heal) is the principal species. It flowers in spring on uncultivated grounds, edges and brushes (m.v. 180 kg/ha). It is frequently visited by bees and bumblebees searching for nectar. Low representativeness.

Rosmarinus L.

This genus includes one only species, *R. officinalis* L. (Rosemary), an aromatic shrub with a prolonged flowering (m.v. > 500 kg/ha). It is frequently visited by bees and provides for a clear unifloral honey, with delicate odour and flavour and fine crystallization in the Mediterranean area. This plant is not very important for pollen, dark brown coloured. Rosemary is also visited by bumblebees, *Osmia* and other Apoidea.

Salvia L.

S. glutinosa L., *S. nemorosa* L. (m.v. 240 kg/ha), *S. pratensis* L. (Meadow clary), *S. officinalis* L. (Common sage), *S. verbenaca* L. (m.v. 200 kg/ha), *S. verticillata* L. (m.v. 200 kg/ha) and the aromatic *S. sclarea* L. (Clary) (m.v. 175 kg/ha) are to be mentioned. All of them, with the exception of the last one, flower in spring on pasture lands and are frequently visited by bees, bumblebees and other Apoidea, while Clary does not accept bees but attracts bumblebees, *Anthidium* and *Xylocopa*. Sage unifloral honeys with a strong odour come from Dalmatia and rarely from Alps.

Satureja L.

S. hortensis L. (Garden savory), cultivated as aromatic plant and flowering in summer (m.v. 380 kg/ha), and *S. montana* L., growing on rocky grounds and dry meadows and flowering at the end of the summer, are well-known. *S. intricata* Lange and *S. thymbra* L. (m.v. 0.15 mg/flower) are native to the Mediterranean area. Garden savory, frequently visited by bumblebees, gives rise to a light yellow unifloral honey, with delicate odour and flavour and fine crystallization. It is not interesting as far as pollen, light grey coloured.

Sideritis L.

S. syriaca L. has some importance as nectariferous plant. It flowers in summer on arid grounds and in the Mediterranean area gives rise to clear unifloral honeys with delicate odour and flavour.

Stachys L.

S. annua (L.) L. (Annual yellow-woundwort), a herb flowering on corn stubbles and market-gardens, *S. arvensis* (L.) L. (Field woundwort), *S. byzantina* Koch, important in northern Europe, *S. cretica* L. (m.v. 0.37 mg/flower), *S. heraclea* All., *S. officinalis* (L.) Trevisan (Betony), native to grass-lands and woods, *S. palustris* L. (Marsh woundwort) (m.v. 250 kg/ha) and *S. sylvatica* L. (Hedge woundwort) are noteworthy. These species generally flower in spring-summer and represent a fundamental source of nectar for bees and other Apoidea. The diffusion of *S. annua*, that in the past provided for large quantities of unifloral honeys, is nowadays limited by the utilisation of herbicides and early plowings. Honey is white, with an intense odour and a regular crystallization. The *Stachys* genus is visited by *Anthophora furcata* Panz., *Rophites quinquespinosus* Spin., *R. algirus* Perez and *Osmia andrenoides* Spin., considered as “specialized” Apoidea.

Teucrium L.

T. chamaedrys L. is a very common species widespread on arid meadows and the woods margins, where it flowers at the end of the spring and is chiefly visited for nectar. *T. fruticans* L., widespread in the Mediterranean bush and flowering in spring, *T. polium* L. (m.v. 0.05 mg/flower), *T. montanum* L., *T. scordium* L. (m.v. 1300 kg/ha) and *T. scorodonia* L. are frequently visited by bees and bumblebees. Quite good representativeness in central Europe.

Thymus L.

T. pulegioides L. (Wild thyme) is the most common species. It is an aromatic plant widespread on arid meadows, where it flowers in spring (m.v. 160 kg/ha). *T. vulgaris* L. (Garden thyme) is cultivated and grows spontaneously on arid grounds. It is very similar to the previous one, but its size is larger (m.v. 185 kg/ha). *T. capitatus* (L.) Hoffmgg. et Lk. (p. m. 0.07 mg/flower) has great importance in the warmest areas of the Mediterranean area and *T. mastichina* L., *T. mastigophorus* Lacaita and *T. spinulosus* Ten. are very important in Spain. All these species are very often visited by bees and give rise to large quantities of unifloral honey, amber-coloured and exhaling a typical intense odour. Thyme is frequently visited by short tongue bumblebees and some small Apoidea.

LAURACEAE

This family is represented in the southern Europe by one only tree, *Laurus nobilis* L. (Laurel), flowering at the beginning of the spring in the Mediterranean bush and frequently visited for its pollen, nectar and propolis. Nectar is mostly utilized to support the colony. Pollen forms orange loads. Its representativeness in honey is very low.

LEGUMINOSAE

This family is worldwide in distribution and includes some thousands of species. It is also very important economically because some of its species contain high percentages of proteins, fundamental elements of the human diet. It includes the main fodder species as clover, lucerne, sainfoin, sulla, etc., as well as legumes as beans, broad beans, peas, lentils, grams, etc. This family is formed by trees, shrubs, lianes, annual or perennial herbs, sometimes climbing, whose hermaphrodite flowers generally appear as inflorescences. Their corolla is formed by five petals: one of them, upward, is broader than the others and is named “standard petal”; other two, disposed laterally, are named wings; the remaining ones, downward, are sealed along one margin forming the so-called “keel”. Fruit is a typical legume, variable in shape; this difference can be very important from a systematical point of view. A common feature in the family is the presence of root nodules containing bacteria of the genus *Rhizobium leguminosarum*, capable of converting atmosphere nitrogen. For this reason these species are cultivated to enrich nitrogen-poor soils. Leguminosae have great importance for bees as far as nectar; unifloral honeys are also produced. The pollen granules of many species are so similar each others that it is very difficult to recognize them during the observations at the microscope. For instance, most of the clovers with white flowers are provided with the same kind of pollen; for this reason melissopalynology considers them as belonging to the *Trifolium repens* group, without making any further distinction. Likewise, *Trifolium pratense* Gr. is referred not only to the red clover, but also to those species having this kind of pollen. Furthermore, other very similar pollens are distinguished on the basis of the “shape” criterion only (*Genista*, *Lupinus*, *Galega*, etc.). Leguminosae have a great importance for Apoidea also as a source of pollen.

Acacia Miller

A. dealbata Link (Mimosa) is well-known. It flowers very early and represents a very important source of nectar and pollen. Nectar is gathered on the leaf extrafloral nectaries; pollen loads are yellow. Its presence allows to distinguish the Mediterranean honeys from those obtained in other European countries. Low representativeness.

Albizzia Durazzo

A. julibrissin (Willd.) Durazzo (False acacia) is cultivated for ornamental purposes. It flowers in summer and is visited by bees searching for nectar. Representativeness in honey is low because of the size of the pollen granule, too.

Amorpha L.

It includes one only species, *A. fruticosa* L. (Amorfa), flowering at the end of the spring. It is cultivated for ornamental purposes, but in northern Italy and in Yugoslavia it became an infesting weed growing along the flowers shores. Unifloral honeys amber-coloured and with delicate odour and flavour are rarely obtained by this species. It is frequently visited by bumblebees, too.

Anthyllis L.

A. cytisoides L. and *A. lotoides* L. are herbaceous plants flowering in spring and giving rise to unifloral honeys in Spain; the *A. hermanniae* L. (m.v. 0.09 mg/flower) pollen can frequently be found in honeys coming from Corsica, forming the typical feature of their sediment. *A. vulneraria* L. (Kidney-vetch), *A. vulneraria* L. subsp. *alpestris* (Kit.) Asch. et Gr. e subsp. *praepropera* (Kerner) Born. and *A. montana* L., flowering at the end of the spring on mountainous meadows and rarely visited by bees but frequently by bumblebees and Anthophoridae, are also to be mentioned. Representativeness is generally low and sometimes quite good.

Astragalus L.

A. danicus Retz, *A. depressus* L., *A. echinatus* Murray, *A. glycyphyllos* L. (Locoweed), *A. monspessulanus* L., *A. sempervirens* Lam. and *A. sirinicus* Ten. are to be mentioned. They flower in spring-summer on pasture lands and uncultivated grounds. Bees gather from them large quantities of nectar and pollen. On the mountains this genus is frequently visited by Anthophoridae and bumblebees. Quite good representativeness.

Caragana Lam.

C. arborescens Lam. is a melliferous plant important in northern Europe (m.v. 35 kg/ha), where it flowers at the end of the spring.

Ceratonia L.

C. siliqua L. (Carob) grows spontaneously but is also cultivated for the siliques production. It is a polygamous dioecious species native to the Mediterranean warm zones, where it flowers in late autumn. Yellowish unifloral honeys with a delicate odour and a bitterish flavour are rarely obtained. Small quantities of light yellow pollen are also gathered.

Cercis L.

C. siliquastrum L. (Juda's tree) is cultivated for ornamental purposes, but it also grows spontaneously in the thermophilous woods of the Mediterranean area. It flowers in spring before the development of leaves and is visited by bees searching for its nectar and light grey pollen. A honeydew, as a result of attacks by *Psylla pulchella* Loew, is also gathered. Low representativeness.

Chamaecytisus Link.

C. hirsutus (L.) Link. (m.v. 400 kg/ha) is widespread on bare patches and rocky grounds. It flowers in spring and is frequently visited by bees and bumblebees.

Cicer L.

C. arietinum L. (Gram) is cultivated to obtain grains. It flowers in spring and is visited by bees, bumblebees, *Anthidium* and other Apoidea. Low representativeness.

Colutea L.

The only species belonging to this genus is *C. arborescens* L., a shrub widespread on the submediterranean bush and flowering in spring. Notwithstanding its high honey potential (> 500 kg/ha), this plant is not very important for bees. Low representativeness. This species is frequently visited by bumblebees and *Xylocopa*.

Coronilla L.

C. emerus L., a shrub flowering in spring, is widespread in bushes. It is frequently visited by bees, bumblebees, Anthophoridae and *Xylocopa*. *C. varia* L. (Crown vetch), a synanthropic species widespread on grass-lands and flowering in spring-summer, is unimportant for bees. Quite good representativeness.

Cytisus L.

C. grandiflorus DC. and *C. scoparius* (L.) Link (Scottish broom) are the best known species. They flower on bare patches and shrubs and give a brick red pollen. These species are also visited by bumblebees searching for nectar. Low representativeness.

Dorycnium Miller

D. hirsutum (L.) Ser., *D. pentaphyllum* Scop. and *D. rectum* (L.) Ser. flower at the end of the spring and give rise to clear and slightly odoured unifloral honeys in Spain and in Italy. The grey pollen is also gathered. This genus is frequently visited by bumblebees, too.

Galega L.

G. officinalis L. is the only species belonging to this genus. It flowers at the beginning of the summer on uncultivated grounds and along the ditches. Being not a nectariferous plant, it is frequently visited for its grey-pink pollen. *Galega* is also visited by *Lasioglossum* and *Megachile*, more rarely by bumblebees.

Genista L.

G. tinctoria L. (Dyre's greenwood), *G. germanica* L. (German greenwood), *G. scorpius* (L.) DC., *G. falcata* Brot. and *G. florida* L. are the principal species. They flower in spring on uncultivated grounds and woods and give rise to unifloral honey in Spain. Their grey pollen is also gathered. *Andrena similis* Smith is an oligoleptic pollinator on *Genista*.

Gleditsia L.

It includes the only ornamental tree known as *G. triacanthos* L. (Christ's thorn), flowering in spring and providing for small quantities of nectar and pollen. It has a modest importance for bees. Low representativeness.

Glycine Willd.

G. max (L.) Merr (Soy) is cultivated to obtain seeds. It flowers in summer and is visited by bees gathering chiefly nectar. Low representativeness.

Glycyrrhiza L.

It includes two species, *G. echinata* L. and *G. glabra* L. (Liquorice), flowering in spring and cultivated in some places to extract liquorice from roots. Bees gather on them modest quantities of nectar. Low representativeness.

Hedysarum L.

Cultivated as fodder species, *H. coronarium* L. (Sulla) flowers in spring predominantly on clayey grounds. It is an important nectariferous plant: unifloral honey is produced in Italy in large quantities and, to a smaller extent, in Spain. Honey is whitish and is characterized by very delicate odour and flavour and a regular crystallization. The grey pollen is also gathered. Sulla is frequently visited by *Bombus*, *Megachile* and *Osmia*. *H. hedysaroides* (L.) Sch. & Th., widespread on the Alpine pasture lands of the central Europe, and *H. humile* L., common on the Mediterranean area, are also to be mentioned.

Hippocrepis L.

H. comosa L. is the best known species. It is widespread on pasture lands and uncultivated grounds, where it flowers in spring-summer. It is visited for pollen and nectar and provides for rare unifloral honeys, white in colour and delicate in odour and flavour.

Hymenocarpus Savi

H. circinnatus (L.) Savi is a quite good nectariferous plant widespread on the pasture lands and cultivated grounds of the Mediterranean area (m.v. 0.02 mg/flower).

Indigofera L.

I. dosua Buch-Ham ex D. Don, an ornamental tree imported in Europe, flowers in summer (m.v. 200 kg/ha). It is frequently visited by bees searching for nectar. Low representativeness.

Lathyrus L.

L. odoratus L. (Sweet pea) is cultivated for ornamental purposes, while *L. sativus* L. (Chickling) is cultivated to obtain grains. *L. pratensis* L. (Vetchling) and *L. sylvestris* L. are very common as spontaneous species flowering in spring. Lastly *L. occidentalis* (Fisch et N.) Fritscand, *L. vernus* (L.) Bernh (m.v. 150 kg/ha) are also to be mentioned. These plants are not very interesting for bees. The green-grey pollen is also gathered. Representativeness in honey is very low. Genus *Lathyrus* is frequently visited by Anthophoridae, bumblebees and by the oligoleptic *Andrena lathyri* Alfken. Low representativeness.

Lens Miller

L. culinaris Medicus (Lentil) is cultivated for table use. It flowers at the end of the spring and grows on all kinds of soil. This species is sporadically visited for its nectar.

Lotus L.

The principal species are *L. corniculatus* L. (Common bird's-foot trefoil) and *L. tenuis* W. et K., cultivated as fodder plants and spontaneous synanthropic species on grass-lands. They flower in spring-summer (m.v. 37 kg/ha). *L. cytisoides* L., native to rocky shores, *L. angustissimus* L., *L. parviflorus* Desf. and *L. uliginosus* Schkuhr are also to be mentioned. This genus is frequently visited by bees and provides for clear unifloral honey characterized by light odour and flavour. The light grey pollen is also gathered. *Lotus* is frequently visited by oligoleptic Apoidea as *Eucera interrupta* Baer., *E. longicornis* L., *E. tuberculata* F., *Megachile ericetorum* Lep., *Melitturga clavicornis* Latr., *Osmia acutiformis* Dufour & Perris, *O. gallarum* Spin., *O. loti* Mor., *O. ravonxi* Perez, *O. tridentata* Dufour & Perris, *O. xanthomelana* Kirby and by *Anthidium*, *Bombus* and *Trachusa byssina* Panz. on the mountains.

Lupinus L.

L. albus L. (Lupine), *L. angustifolius* L., *L. luteus* L. are quite well-known and sometimes cultivated. *L. polyphyllus* Lindley is known especially in northern Europe. They flower in spring and are visited by bees and bumblebees searching exclusively for pollen.

Medicago L.

M. sativa L. (Alfalfa) (m.v. 135 kg/ha) is widely cultivated as fodder plant. Its subspecies *falcata* (L.) Arcangeli is common on uncultivated grounds and arid meadows. *M. arabica* Hudson, *M. lupulina* L. (Hop clover) and *M. marina* L. are also to be mentioned. They flower in spring-summer. *M. arborea* L. is native to the Greek bush, while *M. media* Martyn. (m.v. 83 kg/ha) is typical of fresher zones. Alfalfa provides for unifloral honeys in fresh temperate zones. Its white honey is characterized by delicate odour and flavour and a strong aftertaste. Its pollen is definitely underrepresented, since bees are used to visit the flower laterally, preventing pollen from adhering to them. A honeydew, as a result of attacks by *Aphis craccivora* Koch., is also produced. *Megachile rotundata* F., *M. apicalis* Spin. and *Melitta leporina* Panz. are oligoleptic visitors. Bumblebees visit these plants chiefly on the mountains.

Melilotus Miller

M. alba Medicus (White sweet clover), flowering in summer (m.v. 640 kg/ha), and *M. officinalis* (L.) Pallas (Yellow sweet clover), flowering in spring-summer (m.v. 25 kg/ha) are widespread on uncultivated grounds. They give rise to rare unifloral honey, white in colour, delicate in odour and flavour and showing a gross crystallization. This genus is visited by small Apoidea and by the oligoleptic *Colletes marginatus* Smith.

Onobrychis Miller

O. viciifolia Scop. (Sainfoin) is the most important fodder plant for bees. It is native to fresh temperate zone, flowers in late spring (m.v. 200 kg/ha) and provides for unifloral honeys light yellow in colour and delicate in odour. The dark brown pollen is also gathered. Sainfoin is visited by the oligoleptic *Melitta dimidiata* Mor. and many other Apoidea. Lastly, *O. arenaria* (Kit.) DC. (m.v. 186 kg/ha), widespread on arid grounds, is to be mentioned.

Ononis L.

O. cristata Miller, *O. natrix* L., *O. pusilla* L., *O. spinosa* L. (Spiny restharrow) and *O. variegata* L. are some of the most common species. They flower in spring on arid grounds and are visited chiefly for their brick red pollen. They are also visited by Megachilidae. Lastly *O. tridentata* L., native to the Iberian peninsula, is to be mentioned. Quite good representativeness in honey.

Phaseolus L.

P. multiflorus Lam. (m.v. 320 kg/ha) is widespread in central-eastern Europe. It has a great importance for bees and *Xylocopa* and flowers at the beginning of the summer. Low representativeness.

Poinciana SW.

P. gilliesii Hook is an imported shrub cultivated for ornamental purposes. It flowers in summer (m.v. 50 kg/ha) and is frequently visited by bees searching for its nectar.

Pisum L.

P. sativum L. (Pea) is cultivated as table vegetable. It flowers in spring and is scarcely interesting for bees, providing them with small quantities of nectar and grey pollen. Quite good representativeness.

Psoralea L.

P. bituminosa L. is a herb widespread on uncultivated grounds and arid pasture lands and flowering in spring-summer. It is rarely visited by bees, more frequently by bumblebees and Megachilidae. Low representativeness.

Retama L.

Above all important is *R. sphaerocarpa* (L.) Boiss. tipical of the arid and stony soils of Spain; it is flowering in spring and assiduously visited for nectar by honeybees.

Robinia L.

R. pseudacacia L. (Black locust) (m.v. 500 kg/ha) is an imported tree cultivated for ornamental purposes and for its wood. It has become in a short time an infesting weed flowering in spring. Remarkable nectariferous varieties were selected in Hungary; they are today widespread on the territory of this country as a substitute for the true Black locust, this way triplicating the honey production. An excellent unifloral honey ("Acacia honey") is obtained from these species. If completely pure, this honey is transparent as water; otherwise it shows various shades of yellow. Thanks to the large percentage of fructose, honey keeps fluid for more than one year. Being gathered by bees only sometimes, pollen is definitely underrepresented: it can be found in honey in varying percentages.

Securigera DC.

S. securidaca (L.) Degen et Doerfl. is widespread on meadows. It flowers in spring and is visited by bees, bumblebees and other small Apoidea searching for nectar.

Sophora L.

S. japonica L. (Sophora) is an ornamental plant flowering at the beginning of the summer (m.v. 2.7 mg/flower); even if it is frequently visited by bees searching for nectar, is it scarcely important for bees. Low representativeness.

Spartium L.

Contrary to the common opinion *S. junceum* L. (Broom) is not interesting for bees and is visited by small Apoidea only rarely.

Trifolium L.

Many species are cultivated as fodder plants: *T. alexandrinum* L. (m.v. 160 kg/ha), *T. hybridum* L. (Alslike clover) (m.v. 127 kg/ha), *T. incarnatum* L. (Crimsom clover) (m.v. 160 kg/ha) and the subsp. *molinerii* Syme in Sowerby, *T. pratense* L. (Red clover), *T. repens* L. (White clover) (m.v. 127 kg/ha) and *T. squarrosum* L. (Sea clover). White clover is predominantly cultivated in central-northern Europe. Other clovers, most of which grow spontaneously, represent a good source of nectar and pollen in Europe: *T. alpestre* L. (Mountain zig-zag clover), *T. alpinum* L., *T. badium* Schreber, *T. campestre* Schreber, *T. fragiferum* L. (Strawberry clover), *T. medium* L. (Zig-zag clover), *T. ochroleucum* Hudson (Sulphur clover), *T. pannonicum* Jacq., *T. purpureum* Loisel, *T. resupinatum* L. (m.v. 750 kg/ha) and *T. rubens* L. Clovers generally flower at the end of the spring and, if mown, also in summer. In palinology clover pollen can be divided into two main groups: "B group" (White clovers) and "R group" (Red clovers). Unifloral honeys are mostly obtained by red clover and white clover: they are white coloured and exhale a very light odour and flavour. Clovers represent an excellent food for almost all the Apoidea.

Trigonella L.

T. foenum-graecum L. (Fenugreek) is cultivated as fodder plant, grows spontaneously on uncultivated grounds and flowers in spring. Honey obtained from its nectar are characterized by a liquorice odour. *T. coerulea* (L.) Ser. (m.v. 110 kg/ha) is also noteworthy.

Ulex L.

U. europaeus L. (Furze) and *U. parviflorus* Pourret are shrubs common on Mediterranean brushes. They flower in spring. Being not nectariferous, they are visited for their light yellow pollen only. Pollen is the typical marker of the Spanish honeys, with a low representativeness.

Vicia L.

V. faba L. (Broad bean) is a herb cultivated in numerous varieties. It flowers in spring and is frequently visited by Anthophoridae and bumblebees. Bees gather pollen and can reach nectar only after a visitation by "robber" bumblebees (m.v. 27 kg/ha). Other important species are: *V. angustifolia* Grufb., *V. cracca* L. (Tufted vetch) (m.v. 0.11 mg/flower), *V. sativa* L. (Spring vetch) (m.v. 30 kg/ha), *V. sepium* L. (Wild vetch), *V. tetrasperma* (L.) Schreber and *V. villosa* Roth (m.v. 30 kg/ha). This genus is frequently visited by bees, but clear unifloral honeys, with light odour and flavour, are obtained only rarely. The grey-green pollen is also gathered. *Vicia* is frequently visited by bumblebees, Anthophoridae, Megachilidae and by the oligoleptic *Andrena lathyri* Alfken, too. A honeydew, as a result of attacks by *Aphis fabae* Scop., is obtained from Broad bean.

LILIACEAE

Allium L.

Among the species cultivated as table vegetables the following ones are to be mentioned. *A. cepa* L. (Onion) (m.v. 170 kg/ha), *A. porrum* L. (Leek), *A. sativum* L. (Garlic). Among the spontaneous ones, *A. ampeloprasum* L. (Common leek), *A. ericetorum* Thore, *A. roseum* L. (Rose garlic), *A. schoenoprasum* L. (Chive) (m.v. 1.46 mg/flower), *A. subhirsutum* L. (Moly) (m.v. 0.02 mg/flower), *A. triquetrum* L., *A. ursinum* L.(Ramson) (m.v. 80 kg/ha) and *A. viminalis* L. are important. All these species flower in spring and have some importance as source of nectar and pollen, whose colour is violet-grey. Unifloral honeys, onion- or garlic-flavoured, are sometimes found on the Swiss Alps. This genus is frequently visited by many Apoidea and particularly by the oligoleptic *Hylaeus punctulatissimus* Smith.

Asparagus L.

A. acutifolius L. (Wild asparagus), flowering in summer, infesting nearly all the Mediterranean bushes and woods and frequently visited for its nectar, as well as *A. officinalis* L. (Asparagus), cultivated as table vegetable, are interesting for bees. Unifloral honeys, almost white in colour and very delicate in odour and flavour, are sometimes obtained from *Asparagus*. Pollen can be considered as overrepresented. Wild asparagus is also important for its pale yellow pollen and is visited by the oligoleptic *Andrena chrysopus* Perez.

Asphodelus L.

Known as Asphodel, *A. cerasifer* Gay and *A. microcarpus* Salzm. & Viv., widespread on the degraded grounds of the Mediterranean area, flower in spring. Unifloral honeys, yellow coloured, with a very delicate odour and flavour and a fine crystallization, are obtained in some areas. Pollen is definitely underrepresented because of the dimensions of the granules and the hidden position of the nectaries. *A. aestivus* Brot. (m.v. 1.99 mg/flower) and *A. albus* Miller, native to the mountainous pasture lands, are also to be mentioned.

Bellevalia Lapeyr.

The most common species is *B. romana* (L.) Sweet., flowering in spring on fields and meadows; it is frequently visited for the violet pollen and the nectar; pollen is underrepresented. This species is often visited by bumblebees and Megachilidae, too.

Bulbocodium L.

B. vernum L. (Spanish meadow saffron) flowers very early on mountainous meadows and has some importance as one of the first plants to be visited by bumblebees when they reawaken from lethargy.

Colchicum L.

C. autumnale L. (Meadow saffron), flowering in autumn (m.v. 30 kg/ha), is of some importance for bees. It is visited by bees and bumblebees gathering predominantly nectar. Low representativeness.

Convallaria L.

C. majalis L. (Lily of the valley) is widespread in woods and flowers in spring. It is quite often visited by bees searching for nectar. Low representativeness.

Fritillaria L.

F. graeca Boiss & Spruner flowers in spring (m.v. 0.05 mg/flower) in the Mediterranean area. Low representativeness.

Gagea Salisb.

G. fistulosa (Ramond) Ker-Gawler, native to the mountainous pasture lands, and *G. villosa* (Bieb.) Duby, widespread on fields and uncultivated grounds, are to be mentioned among the principal species. Bees gather from them small quantities of pollen.

Hemerocallis L.

They are cultivated and spontaneous plants widespread on wet woods and along the ditches, as *H. lilio-asphodelus* L. and *H. fulva* L. (Day lily), providing for a dark yellow pollen.

Leopoldia Parl.

L. comosa (L.) Parl. is of some interest for bees. It is widespread on fields and arid uncultivated grounds and flowers in spring. Bees gather nectar, but pollen representativeness in honey is low. This species is frequently visited by Anthophoridae.

Leucojum L.

L. vernum L. (Spring snowflakes) flowers at the beginning of spring on pasture lands and is sporadically visited for nectar.

Lilium L.

The most species are cultivated for ornamental purposes; among the spontaneous ones, *L.*

bulbiferum L. (Orange lily) and *L. martagon* L. (Turk's cap) grow on the mountains and flower at the end of the spring. They are predominantly visited by bumblebees. Low representativeness.

Muscari Miller

M. botryoides (L.) Miller (Small grape hyacinth) and *M. atlanticum* Boiss et Reuter (Grape hyacinth) flower in spring and represent a quite good source of violet pollen. They are sporadically visited for their nectar, too. Low representativeness. *M. commutatum* Guss. (m.v. 0.02 mg/flower) and *M. neglectum* Guss. (m.v. 0.04 mg/flower), native to the Mediterranean area, are also visited.

Narthecium Moehr.

N. ossifragum Huds. has some importance because its pollen allows the distinction between the northern and the central Europe *Calluna* honeys.

Ornithogalum L.

O. excapum Ten. (m.v. 0.02 mg/flower) and *O. umbellatum* L. (Star of Bethlehem) are infesting weeds very common on meadows, where they flower in spring. The light yellow pollen and small quantities of nectar are gathered. Low representativeness in honey. This genus is frequently visited by Halictidae.

Polygonatum Miller

P. multiflorum (L.) All. (Salomon's seal), growing into underwood, flowering in spring and visited by Anthophoridae, is to be mentioned.

Scilla L.

Among the principal species there are *S. autumnalis* L. (m.v. 0.08 mg/flower), flowering on arid grounds at the end of the summer, *S. bifolia* L., widespread into the mountainous underwood and flowering in spring, and *S. siberica* Andr., important for pollen in Europe. The first one is also visited for its violet pollen. Low representativeness in honey.

Smilax L.

It includes *S. aspera* L. only, a dioecious shrubby climber flowering in autumn. It has some importance as a source of small quantities of nectar and white pollen. Its pollen is characteristic of the honey coming from the Mediterranean area.

Tulipa L.

T. australis Link. is a protected species easy to be found on the mountainous pasture lands. It flowers in spring and is visited by Andrenidae and Halictidae searching for its yellowish pollen.

Urginea Steinh

Quite common on the Mediterranean coasts, *U. maritima* Baker flowers in summer (m.v. 0.43 mg/flower) and is rarely visited by bees and small Apoidea.

LINACEAE

Linum usitatissimum L. (Flax), flowering at the end of the spring, is widely cultivated, since it provides for oil and a valuable textile fibre. *L. catharticum* L. (Fairy flax) and *L. tenuifolium* L., both widespread on arid meadows, as well as *L. viscosum* L., common on hilly and mountainous meadows, are also to be mentioned. They have some importance as source of nectar. Their pollen is rarely found in the honey sediment.

LORANTHACEAE

Loranthus europapeus Jacq., parasiting oaks, flowering in spring and providing for small quantities of yellow-greenish pollen, is quite interesting for bees. Pollen granules may rarely be found in honey. *Viscum album* L. (Mistletoc), parasiting Rosaceae, flowers in summer and provides for pollen.

LYTHRACEAE

Lythrum salicaria L. (Purple loosestrife), widespread along the ditches, is the most interesting species. Its main characteristic is eterostyling, in correspondence with a pollen dimorphism. It flowers in summer. Bees gather from it nectar and brown pollen. Representativeness in honey is quite good and the production of unifloral honey is frequent on the Atlantic coasts (Holland and Belgium). This species is visited by the oligoleptic *Melitta nigricans* Alfken and *Tetralonia salicariae* Lep. *Lagerstroemia indica* L., an ornamental small tree flowering in summer, is also noteworthy. It is visited for its nectar and pollen, that may be found in the honey coming from northern Italy.

MAGNOLIACEAE

The principal species are represented by two ornamental trees: *Liriodendron tulipifera* L. (Tulip tree), flowering in spring (m.v. >500kg/ha), and *Magnolia grandiflora* L. (Magnolia), flowering at the end of the spring and visited for its white pollen. It is often found in the honey coming from northern Italy, especially in that one obtained from *Metcalfa* honeydew.

MALVACEAE

All genera are predominantly made up by nectariferous plants: *Abutilon* Miller, *Alcea* L., *Althaea* L., *Gossypium* L., *Hibiscus* L., *Malva* L. and *Lavatera* L. Among the most interesting species there are: *Abutilon theophrasti* Medicus, *Alcea rosea* L. (Hollyhock) (m.v. 200 kg/ha), *Althaea officinalis* L. (Marchmallow) (m.v. 110 kg/ha), *Hibiscus rosa-sinensis* L. (Rosemallow), the cultivated plant *Gossypium hirsutum* L. (Cotton), *Lavatera arborea* L. (m.v. 110 kg/ha), *L. trimestris* L. (m.v. 57 kg/ha), *Malva mauritiana* L. (m.v. 186 kg/ha), *M. moschata* L. (m.v. 1.80 mg/flower), *M. neglecta* Wallr., *M. pallida* Salisb. (m.v. 1.70 mg/flower), *M. pusilla* Sm. (m.v. 1.90 mg/flower) and *M. sylvestris* L. (Mallow) (m.v. 500 kg/ha). Pollen adhering to forager bees during their visitations is systematically removed from their bodies; this is one of the reasons why it is underrepresented. The above mentioned species are visited by many Apoidea, the oligoleptic *Tetralonia macroglossa* Ill. included.

MARTYNIACEAE

These plants are not very interesting for bees because they provide for small quantities of greyish pollen, especially on *Proboscidea lousitanica* Thell, quite common in Portugal and Russia.

MELIACEAE

Melia azedarach L. (Chinaberry tree) is an ornamental tree imported from warm regions. It flowers in spring and is sporadically visited for its nectar.

MENYANTHACEAE

Menianthes trifoliata L. has some importance for bees. It flowers in spring inside ponds and marshes and is sporadically visited for its nectar and light grey pollen.

MUSACEAE

Musa paradisiaca L. (Banana tree) grows in the Mediterranean warmest zones; here it is cultivated for its fruits and flowers in spring (m.v. > 500 kg/ha). Representativeness is always low, owing to the large size of the pollen granule.

MYOPORACEAE

Myoporum acuminatum R. Br. and *M. tenuifolium* G. Forster are ornamental species sometimes naturalized. These shrubs or trees flower in spring and are frequently visited by bees for nectar.

MYRICACEAE

This genus is not very interesting for bees, providing for modest quantities of nectar and light yellow pollen on *Myrica gale* L. (Bog myrtle), *M. faxa* Aiton and *M. caroliniensis* Miller.

MYRTACEAE

Eucalyptus L'Hér.
Among the principal species there are: *E. amygdalinus* Labill., *E. camaldulensis* Dehnh. (m.v. 200 kg/ha), *E. globulus* Labill., *E. robusta* Smith, *E. saligna* Smith and *E. viminalis* Labill. They flower in different periods of the year and are generally defined as Eucalyptus. Large quantities of light brown unifloral honey, with particular odour and flavour, are produced in many countries of the Mediterranean area. This genus is frequently visited also for pollen, brown-grey in colour; in some species it is overrepresented in honey. *Eucalyptus* is also visited by bumblebees.

Myrtus L.
The only species belonging to this genus is *M. communis* L. (Myrtle), a shrub native to the Mediterranean bush, providing in Sardinia for a unifloral honey, exhaling the typical odour of the plant flower. Pollen is overrepresented. *Myrtus* is also important for its grey pollen. It is also visited by Andrenidae, Halictidae and bumblebees.

NYMPHAEACEAE

Nuphar lutea (L.) Sibth. & Sm. (Nenufhar) and *Nymphaea alba* L. (Water-lily) are aquatic plants sporadically visited for their nectar and yellow-orange pollen. Low representativeness. The interest for bees is restricted to the collection of yellow pollen on *Nelumbo nucifera* Gaertn. (Lotus), native to marshes, where it flowers at the end of the spring. It is cultivated for ornamental purposes and for the extraction of edible seeds.

OLEACEAE

Forsythia Vahl
F. suspensa Vahl is a shrub cultivated for ornamental purposes; it flowers at the beginning of the winter. Bees gather from it modest quantities of yellow pollen.

Fraxinus L.
F. ornus L. (Manna-ash) is a tree widespread in submediterranean bushes and woods and cultivated for the "manna" (used in pharmaceutics) extraction. It flowers in spring and provides for large quantities of greenish pollen. *F. excelsior* L. (Ash-tree) is as important in woods and wet grounds. It flowers in February. Attacks by *Prociphilus* Koch spp. produce honeydew, but it does not seem to be gathered by bees. The representativeness of this pollen in the Acacia honey, as polluting agent, may be even good.

Jasminum L.
J. fruticans L., *J. nudiflorum* L. and *J. officinale* L. (Jasmin) are imported and generally cultivated for ornamental purposes. They flower in spring. Bees gather from them small quantities of nectar and the representativeness in honey is generally low.

Ligustrum L.
L. lucidum Aiton fil. and *L. vulgare* L. (Privet) are trees growing spontaneously in edges and woods or cultivated for ornamental purposes. They flower in spring and are visited by bees gathering small quantities of nectar and green pollen. Low representativeness.

Olea L.

This genus includes a tree very important from an economical point of view, *O. europaea* L. (Olive tree), flowering in June. A wild variety, *O. oleaster* Hoffmgg et Link (Wild olive), is also known. Olive tree is native to the Mediterranean area and is visited by bees gathering its yellow pollen.

Phillyrea L.

The two species, *P. angustifolia* L. and *P. latifolia* L., are shrubs native to the Mediterranean bush. They flower in spring and are visited by bees, gathering modest quantities of green-yellow pollen.

Syringa L.

S. vulgaris L. (Lilac) is a shrub cultivated for ornamental purposes and sometimes growing wild. It flowers in spring. Bees gather from it modest quantities of pollen, although in northern Europe this species is made up by important nectariferous plants (m.v. 200 kg/ha). Low representativeness. Lilac is chiefly visited by the long tongue Apoidea as Anthophoridae and bumblebees.

ONAGRACEAE

Among the principal species making up genus *Epilobium* L. there are *E. angustifolium* L. (Fireweed) (m.v. 148 kg/ha), widespread on woods and wet slopes, *E. dodonei* Will and *E. fleischeri* Hochst., diffused on rocky grounds, and *E. hirsutum* L. (Water fireweed), common along the ditches. These species flower in summer and are visited by bees exclusively for nectar, from which unifloral honeys are sporadically extracted in central and eastern Europe. The representativeness in honey is low, owing to the large size of the granule. *E. montanum* L., native to woods and wet grounds, is also noteworthy. This genus is very interesting for bumblebees and Megachilidae. *Oenothera biennis* L. (Evening primrose), cultivated for ornamental purposes and growing spontaneously in different habitats, is also to be mentioned. It flowers in spring-summer in wet grounds (m.v. > 500 Kg/ha) and is visited by bees chiefly for its nectar. It is frequently visited by bumblebees on the mountains. Low representativeness.

ORCHIDACEAE

These herbs have particularly shaped hermaphrodite flowers: a pistil portion is sealed with stamens making up one only body (*gynostemium*); at the base of it there is the stigma surface, while pollen granules are aggregated into masses named *pollinii*, provided with a viscous appendix. The largest petal (*labellum*) may be provided with a tubular structure generally containing nectar. When an insect visits a flower searching for nectar, the pollen masses adhere to its head and are subsequently left on the stigma of another flower. Bees and bumblebees generally visiting some Orchids (*Dactylorhiza maculata* (L.) Soó, *Orchis simia* Lam., etc.) were often found with these *pollinii* adhering to their bodies. Shape, colour and hairiness of the *labellum* belonging to the flowers of some *Ophrys* L. are very similar to the pollinators' female; flowers are therefore visited by the male insects trying to copulate with the "female" ones (*pseudocopulation*) acting as *pollinii*-carriers. *Eucera*, *Osmia* and *Anthidium*, belonging to Apoidea, are the most frequent visitors of Orchids.

OROBANCHACEAE

Rare visitations by bumblebees in spring on *Orobanchaceae* were recorded.

OXALIDACEAE

Oxalis acetosella L. (Wood sorrel) and *O. cernua* Thunb. are modest melliferous plants. They flower in spring and grow spontaneously in woods, on uncultivated grounds and market-gardens. They are also cultivated for ornamental purposes (edges). *O. pes-caprae* L. is widespread in the Mediterranean bush. Representativeness may be even quite good.

PAEONIACEAE

Numerous ornamental varieties were isolated from *Paeonia officinalis* L. (Peony), a herb widespread in broadleaf woods placed above 800 m. The spontaneous species, flowering in May, is chiefly visited by bumblebees searching for its yellow pollen, while the varieties growing in gardens are visited by bees, also searching for pollen.

PALMAE

Palms are native to tropical zones. *Chamaerops humilis* L. and *Phoenix dactylifera* L. (Date-palm) grow spontaneously in the Mediterranean area, while *Trachycarpus fortunei* (Hooker) Wendl is commonly cultivated for ornamental purposes. The above mentioned species flower in spring and are visited for the light yellow pollen, while the nectar excretion is not sure. The palm pollen can be easily found in the sediment of spring honey.

PAPAVERACEAE

Corydalis Vent.
They are perennial herbs flowering in spring in broadleaf woods. Among the most common plants, *C. cava* (L.) Schweigg et Koerte and *C. solida* (L.) Swartz are visited by bees searching for their yellowish-white pollen. They are more frequently visited by Anthophoridae and bumblebees; the last ones can behave in a regular way or act as “robbers”.

Chelidonium L.
C. majus L. (Celandine) is an infesting weed growing on slopes and flowering in spring. It is rarely visited by bees, more frequently by bumblebees searching for its light yellow pollen.

Eschscholzia Cham.
E. californica Cham. belongs to this genus. It is cultivated for ornamental purposes and flowers in spring. It is visited by bees searching for its orange pollen.

Fumaria L.
F. capreolata L. (White ramping-fumitory) and *F. officinalis* L. (Fumitory) are infesting weeds flowering in spring. Bees gather from them modest quantities of nectar and yellow-brown pollen. Low representativeness.

Glaucium Miller
The most common species is *G. flavum* Crantz (Yellow horned-poppy), widespread along the shores (especially on ruins) and flowering in spring. Bees gather modest quantities of orange pollen.

Hypecoum L.
H. imberbe S. et S. and *H. procumbens* L. are herbs widespread on Mediterranean uncultivated grounds and ruins. Bees gather their light yellow pollen in spring. The pollen granule is typical of the sediment of the Spanish honey.

Papaver L.
Among the principal species the following ones are noteworthy: *P. somniferum* L. (Opium poppy), cultivated for its edible seeds and opium, *P. rhoeas* L. (Corn poppy), no doubt the most common infesting weed, *P. argemone* L. (Wild poppy), *P. croceum* Ledeb, *P. hybridum* L., *P. rhaeticum* Leresche. Poppies flower in spring-summer and are visited by bees and many other Apoidea (especially Anthophoridae and bumblebees) gathering large quantities of brown-green pollen.

Roemeria Medicus
R. hybrida (L.) DC. is a herb frequently visited for its pollen in Spain.

PASSIFLORACEAE

Passiflora coerulea L. (Passion flower) is very interesting for bees as nectar source. It is an ornamental climber flowering in spring. It is visited by *Xylocopa* to a smaller extent. Pollen is practically absent in honey.

PEDALIACEAE

Sesamum indicum L. (Sesame) is the only interesting plant. It is cultivated in some places for the production of seeds and oil and is very often visited by bees. Low representativeness in the eastern Mediterranean area.

PHYTOLACCACEAE

Phytolacca dioica L. (Amaranth) is interesting in spring. It is widespread on uncultivated grounds and is visited by *Hylaeus* and *Lasioglossum* insects, gathering small quantities of nectar.

PINACEAE

It includes some of the most remarkable forest species, important for lumbering and paper production. They are also intensively cultivated for ornamental purposes. They are interesting for bees especially for the production of honeydew, but some of them give quite large quantities of pollen, too.

Abies Miller

A. alba Miller (Silver fir), *A. bornmuelleriana* Mattg., *A. cephalonica* Loudon, *A. pinsapo* Boiss. are very important plants. Honeydew provided by the first species gives dark greenish honeys in central Europe and in Italy; the second species provides for a honeydew in Turkey as a result of attacks by *Cinara pectinatae*.

Larix Miller

L. decidua Miller (Larch) grows spontaneously on the Alps (over 1,000 m.) and produces a typical honeydew crystallizing directly inside honeycombs (the so-called “concrete-honey”). *Cinara laricis* is to be mentioned as one of the parasites making this honeydew.

Picea A. Dietr.

P. excelsa (Lam.) Link is the main component of the subalpine coniferous forest. It produces small quantities of light brown honeydew as a result of attacks by *Cinara* Curtis spp. and *Physokermes hemicryphus*; honeydew is also gathered by bumblebees.

Pinus L.

Pinus includes *P. brutia* Ten. (Spruce), *P. cembra* L. (Stone pine), *P. halepensis* Miller, *P. mugo* Turra (Swiss mountain pine), *P. nigra* Arnold (European black pine), *P. pinaster* Aiton (Cluster pine), *P. pinea* L. (Stone pine) and *P. sylvestris* L. (Scotch pine). All these species are visited by insects gathering small quantities of light yellow pollen, but are more important for their honeydew. It is produced in large quantities in Greece and Turkey as a result of attacks by *Marchalina hellenica* especially on *P. halepensis* and *P. brutia*. Honey, whose colour is very dark, contains in its own sediment very showy spores and hyphae different than those ones that can be found in other European honeydews.

PITTOSPORACEAE

Commonly cultivated for ornamental purposes (edges), *Pittosporum tobira* (Thunb.) Aiton fil. is very often visited by bees in spring. They gather nectar while the plant aborted anthers do not produce pollen.

PLANTAGINACEAE

Genus *Plantago* L. is the only one interesting for bees. *P. lanceolata* L. (Ribwort plantain), *P. major* L. (Plantain) and *P. media* L. (Horay plantain) are to be mentioned as some of the most common species. They are infesting weeds flowering in spring-summer. Being not nectariferous plants, they are visited for their light yellow pollen only.

PLUMBAGINACEAE

Armeria Willd.

The most common species are *A. majellensis* Boiss and *A. plantaginea* (All.) Willd., native to mountain pasture lands and visited for their nectar. Pollen is underrepresented. Clear and very sweet unifloral honeys, coming from the Atlantic and Mediterranean coasts, were reported, even if not directly observed by the Authors.

Limonium Miller

L. sinuatum (L.) Miller grows spontaneously on the shores and is cultivated for the flowers commercialization, while *Limonium serotinum* (Rchb.) Pign. is widespread on salt marshes. Both of them flower in summer, are quite often visited by bees searching for nectar and, to a smaller extent, pollen. Its colour is light yellow and its representativeness is low.

POLEMONIACEAE

Polemonium coeruleum L. (Jacob’s ladder) is important in central-northern Europe. It flowers in spring-summer on wet meadows and is visited for nectar (m.v. 85 kg/ha). Low representativeness.

POLYGALACEAE

Polygala chamaebuxus L., *P. major* Jacq., *P. vulgaris* L. (Common milkwort) are very common on grass-lands and woods; they are perennial herbs flowering in spring and are visited by bees and bumblebees searching for nectar. Taking into account the flower shape, pollen results as exceptionally underrepresented.

POLYGONACEAE

Fagopyrum Miller

F. esculentum Moench (Buckwheat) is particularly interesting. It is cultivated and widespread in central-eastern Europe, where brown and strongly odoured unifloral honeys are obtained. This species flowers in spring (m.v. 500 kg/ha) and is heteroanthic, giving rise to pollen dimorphism.

Polygonum L.

P. amphibium L., *P. cuspidatum* Sieb. et Zucc. and *P. lapathifolium* L. are aquatic plants; *P. bistorta* L. and *P. viviparum* L. are native to higher zones; *P. alpinum* All. and *P. mite* Schrank. are also to be mentioned. These plants are sporadically visited by bees, Andrenidae and bumblebees gathering modest quantities of nectar. Small quantities of grey pollen are also gathered. Low representativeness.

Reynoutria Houtt.

R. japonica Houtt. was recently and casually imported in Europe, where it has become an infesting weed widespread along ditches and torrents. It is a shrub flowering in summer. Having pollen-less flowers, these plants are visited by bees searching for nectar.

Rheum L.

R. rhaponticum L. (Garden rhubarb) is a herb cultivated for its healing properties, flowers in summer and is visited by bees gathering its whitish pollen.

Rumex L.

This genus includes numerous species, among which *R. acetosa* L. (Garden sorrel) and *R. acetosella* L. (Sheep sorrel), in spring interesting for bees gathering modest quantities of white pollen. High percentages of this pollen can be found in the honey sediment, especially in the Acacia one.

PORTULACACEAE

Genus *Portulaca* L. is the only one interesting for bees and includes *P. grandiflora* Hooker, cultivated for ornamental purposes, and *P. oleracea* L. (Common purslane), widespread on fields and uncultivated grounds. Both of them flower in summer and are visited by bees gathering modest quantities of nectar and pollen, brick red coloured. Low representativeness.

PRIMULACEAE

Lysimachia vulgaris L. (Loosestrife) is the only species interesting for bees. It is visited by the oligoleptic *Macropis fulvipes* F. and *M. labiata* F. Genus *Primula* L. is sometimes visited by Anthophoridae, bumblebees and *Xylocopa*. *P. veris* L. (European primrose) and *P. vulgaris* Hudson (Common primrose), flowering at the beginning of the spring on pasture lands and into underwood, belong to this genus. *Vitaliana primulaeflora* Bertol. is common on rocks and alpine pastures, where it flowers in spring and is a good food for the bumblebee' s queens appearing from hibermation.

PROTEACEAE

Grevillea robusta A. Cunn., *Hakea salicifolia* B. L. Burtt. and *H. sericea* Schrader are quite common on the arid soils of Spain and Portugal. They give modest quantities of nectar and yellow pollen. Low representativeness.

PUNICACEAE

Punica granatum L. (Pomegranate), flowering in spring, has some importance for bees and bumblebees as a nectar source. Low representativeness.

RAFFLESIACEAE

Cytinus hypocistis (L.) L. is scarcely interesting for bees. It is a herb flowering in spring, without chlorophyll and parasiting *Cistus*. It gathers from these plants small quantities of nectar and pollen, that can be found in low percentages in honeys coming from Corsica.

RANUNCULACEAE

Aconitum L.

A. lamarckii Rchb. (Wolf's bane), *A. napellus* L. (Aconite) and *A. vulparia* Rchb. are to be mentioned. They are widespread on mountainous pasture lands (until 2,000 m.), flower in summer and are visited chiefly by bumblebees.

Adonis L.

The most common species is *A. annua* L. (Pheasant's-eye), widespread on cultivated grounds, where it flowers in spring. It provides bees with quite large quantities of purple pollen.

Anemone L.

A. apennina L., *A. nemorosa* L. (European wood anemone) and *A. ranunculoides* K. are among the most common species, widespread on broadleaf woods. *A. coronaria* L. (Poppy anemone) and *A. hortensis* L. are widespread on fields and flower in spring. Bees gather from them large quantities of purple-black pollen.

Aquilegia L.

A. vulgaris L. (Columbine) is the best known species. It flowers in spring-summer and gives small quantities of light yellow pollen. Bumblebees typically gather nectar, too, keeping themselves on the corolla sides.

Caltha L.

C. palustris L. (Marsh marigold) is an aquatic plant flowering in spring and visited by small Apoidea and bees searching for its strong yellow pollen.

Clematis L.

C. vitalba L. (Traveller's-joy) is widespread on shrubs and edges; *C. alpina* (L.) Miller, *C. flammula* L. and *C. recta* L. (Erect clematis) are also diffused. They flower in summer. This genus is frequently visited for its nectar (quite good representativeness) and its grey pollen. *Vitalba* is visited by bumblebees, too.

Consolida (DC.) S. F. Gray

C. regalis S. F. Gray (Forking larkspur) is the most common species. It is an infesting weed widespread on cereals fields and in summer is visited also by bumblebees gathering modest quantities of pollen.

Delphinium L.

D. peregrinum L. (Larkspur) and *D. staphysagria* L. (Stavesacre) are cultivated for ornamental purposes and grow spontaneously on uncultivated grounds. They flower in spring and are visited by bees and bumblebees gathering light yellow pollen.

Eranthis Salisb.

This genus includes one species only, *E. hiemalis* Salisb., widespread on fields and edges and flowering at the end of the winter. It represents a good source of nectar and pollen for bees. Low representativeness.

Helleborus L.

H. foetidus L., *H. niger* L. (Black hellebore) and *H. viridis* L. (Green hellebore) are among the most common species. They flower at the beginning of the spring and are widespread on meadows and in woods. They are visited by bees and bumblebees searching for nectar and a pale green pollen. Low representativeness. This genus constitutes an essential food for the bumblebee queens when they reawaken from winter lethargy.

Hepatica Miller

H. nobilis Miller (Roundlobe hepatica) is widespread in beech-woods, flowers in spring and is visited by bees and small Apoidea searching for its white pollen.

Nigella L.

N. damascena L. (Love-in-the-mist) is the best known species. It is widespread on fields and uncultivated grounds. *N. arvensis* L. (m.v. 0.25 mg/flower), *N. gallica* Jordan and the ornamental *N. sativa* L. are also to be mentioned. All of them flower in spring and are good nectariferous plants. The representativeness in honey is generally quite good. The greenish-yellow pollen is also gathered.

Pulsatilla Miller

P. alpina (L.) Delarbre (Pulsatilla) is native to Alpine and sub-alpine pasture lands. In summer bees gather from it quite large quantities of pollen.

Ranunculus L.

Some species as *R. aquatilis* L. prefer marshy areas, while others are native to meadows and pasture lands, as *R. arvensis* L., *R. bulbosus* L., *R. ficaria* L. (Lesser celandine) and *R. repens* L. (Creeping buttercop), *R. acris* L. (m.v. 0.10 mg/flower), *R. auricomus* L. (m.v. 0.20 mg/flower), *R.*

spruneanus Boiss (m.v. 0.06 mg/flower) and *R. montanus* Willd. are also to be mentioned. Buttercups flower in spring and are visited chiefly for their bright yellow pollen. Low representativeness in spring honey. This genus is also visited by Andrenidae, Halictidae and Megachilidae. *Chelostoma florisomne* L. is highly specialized for genus *Ranunculus*.

Trollius L.

It includes one species only, *T. europaeus* L. (Globeflower), native to Alpine pasture lands. It flowers in summer and is visited for its gold yellow pollen.

RESEDACEAE

Reseda alba L. (White mignonette), native to sandy uncultivated grounds, *R. lutea* L. (Yellow mignonette), widespread on uncultivated grounds and ruins, *R. luteola* L. (Wild woad) (m.v. 310 kg/ha), growing on rocks, and *R. odorata* L. (m.v. 170 kg/ha), cultivated for ornamental purposes, are interesting for bees. These species flower at the end of the spring and are also visited by many small Apoidea, among which the oligoleptic *Hylaeus signatus* Panz, searching for their nectar and yellow pollen. Low representativeness.

RHAMNACEAE

Frangula Miller

F. alnus Miller (Alder dogwood) is a shrub flowering in spring in woods (m.v. 80 kg/ha) and visited by bees searching for nectar. Low representativeness.

Paliurus Miller

P. spina christi Miller (Christ's-thorn) is a shrub growing spontaneously in bushes and sometimes cultivated for ornamental purposes. It flowers at the end of the spring and gives sometimes unifloral honey orange in colour and very delicate in odour and flavour.

Rhamnus L.

One of the most common shrubs is *R. alaternus* L., native to the Mediterranean bush. It flowers at the beginning of the spring and is visited for its nectar and greenish pollen. *R. catharticus* L. (Common buckthorn) and *R. saxatilis* Jacq. are as important for bees as the preceding one. Lastly *R. alpinus* L., native to mountainous soils, is also to be mentioned. Quite good representativeness.

ROSACEAE

This family is very important. It includes trees, shrubs and herbs, both spontaneous and cultivated, most of which (the so-called "orchards") are economically remarkable. They also produce unifloral honey. Numerous species are visited by bees as well as by many Apoidea.

Agrimonia L.

The most common species is *A. eupatoria* L. (Common agrimony), a perennial ubiquitous herb flowering in spring. It is visited by small Apoidea rather than bees.

Crataegus L.

This genus includes shrubs and small trees native to wood. Among them *C. divaricatus* Rhed. e Wils. (m.v. 231 kg/ha), *C. lucida* Schlecht. (m.v. 250 kg/ha) and *C. melanocarpa* Bieb. (m.v. 373 kg/ha), very important plants in central and eastern Europe, *C. intricata* Lange, important in northern Europe, *C. pentagyna* W. et K. (m.v. 242 kg/ha) and *C. monogyna* Jacq. (Hawthorn) are to be mentioned. These species are often visited for their nectar and yellow pollen. Quite good representativeness.

Cydonia Miller

It is represented by one only species, *C. oblonga* Miller (Quince), spontaneously growing in wood and cultivated in the Mediterranean area. Here it gives fruits for the production of jams and jellies. This species flowers in spring and is visited almost exclusively by bees. Quite good representativeness in honey.

Dryas L.

D. octopetala L. (Mountain avens) is a dwarf shrub flowering at the beginning of the summer and growing on the mountainous detrital soils. It has some importance for bees and small Apoidea. Quite good representativeness in honey.

Eryobotrya Lindley

This genus is made up by one only tree species, *E. japonica* (Thunb.) Lindley (Loquat), cultivated for economical and ornamental purposes. It flowers in late autumn. It is an excellent nectariferous plant giving a white unifloral honey, with a delicate flavour and a pasty crystallization. It is often visited by *Bombus terrestris* L., too.

Filipendula Miller

F. ulmaria (L.) Maxim. (Meadowsweet), a herb native to wet soils, and *F. vulgaris* Moench (Dropwort), widespread on arid grounds, belong to this genus. They flower in spring and are visited for nectar and pollen. Quite good representativeness.

Fragaria L.

F. x *ananassa* Duchesne (m.v. 0.10 mg/flower) and *F. vesca* L. (Strawberry) are economically important; the first one is cultivated, while the other one is native to underwood. Both of them flower in spring, but they are not interesting for bees, even if strawberry is quite important for bees in northern Europe. Low representativeness.

Geum L.

G. rivale L. (Water avens), widespread on wet soils, and *G. urbanum* L. (Bennet), growing on uncultivated grounds, are perennial herbs flowering at the end of the spring (m.v. 80 kg/ha). Bees gather quite large quantities of nectar and yellow pollen. *Geum* is often visited by Andrenidae and Halictidae, too. A unifloral honey amber-coloured, with delicate odour and flavour and a fine crystallization, was recently found in Veneto (Italy).

Malus Miller

Cultivated in numerous varieties, *M. domestica* Borkh. (Apple tree) flowers in spring and gives unifloral honey, with a clear colour and delicate odour and flavour (m.v. 10 kg/ha). The grey pollen is also gathered. A honeydew, as a result of attacks by *Aphis pomi* De Geer and *Cacopsylla mali* Schmid, is also produced.

Potentilla L.

P. argentea L. (White cinquefoil) (m.v. 0.01 mg/flower), *P. erecta* Räuschel, *P. hirta* L., *P. reptans* L. (Cinquefoil) and *P. palustris* (L.) Scop., important in northern Europe, are be to mentioned among the numerous species. All of them flower in spring, especially on meadows and uncultivated grounds. Insects visit them gathering nectar and orange pollen. Quite good representativeness in honey. This genus is visited by a high number of Apoidea and by the oligoleptic *Andrena potentillae* Panz. and *A. tarsata* Nylander.

Prunus L.

P. armeniaca L. (Apricot tree), *P. avium* L. (Cherry tree), *P. cerasus* L. (Wild-cherry tree), *P. domestica* L. (Plum tree), *P. dulcis* (Miller) D. A. Webb (Almond tree), *P. mahaleb* L. (Perfumed cherry) (m.v. 40 kg/ha), *P. padus* L. (Bird cherry), *P. persica* Batsch (Peach tree) (m.v. 50 kg/ha), the ornamental *P. laurocerasus* L. (Cherry laurel) and *P. spinosa* L. (Sloe) (m.v. 20 kg/ha) are the best known species. Genus *Prunus* is interesting for bees, producing sometimes unifloral honey with light colour and delicate flavour (almond and cherry tree). A greenish pollen is also gathered. A honeydew, as a result of attacks by *Myzus cerasi* (Fabricius), *M. persicae* (Sulzer) and *Hyalopterus pruni* (Geoffroy) is also produced. These plants are visited by *Bombus*, *Osmia* and *Xylocopa*, too.

Pyracantha M. J. Roemer

P. coccinea M. J. Roemer is widespread in woods and ilex groves, but it is also cultivated for ornamental purposes (edges). It flowers in spring, providing bees with a large quantities of nectar. A greenish pollen is also gathered. Quite good representativeness in honey.

Pyrus L.

P. communis L. (Pear tree) flowers in spring (m.v. 6 kg/ha) and is widely cultivated for its fruits. It is sporadically visited for its nectar and its brown pollen. A low-grade honeydew, as a result of attacks by *Cacopsylla piri* (L.), is also produced.

Rosa L.

R. canina L. (Wild rose), *R. gallica* L. and *R. sempervirens* L. are the best known wild species. They flower in spring in woods and uncultivated grounds (m.v. 0,07 mg/flower). This genus is predominantly visited by insects searching for the orange pollen.

Rubus L.

Among the well-known weeds infesting woods, shrubs and uncultivated grounds there are: *R. chamaemorus* L., *R. idaeus* L. (Raspberry), *R. ulmifolius* Schott. (Brambee), *R. saxatilis* L. (Stone bramble) and *R. arcticus* L. They flower in spring-summer (m.v. 150 kg/ha) and produce amber-coloured and delicately flavoured unifloral honey. A greenish pollen is also gathered. *Rubus* is also visited by many Apoidea, with the exception of Anthophoridae.

Sanguisorba L.

S. minor Scop. (Salad burnet) and *S. officinalis* L. (Great burnet) are very common herbs. They flower in spring on pasture lands and uncultivated grounds, but they are unimportant for bees. Low representativeness.

Sorbus L.

S. aria (L.) Crantz., *S. aucuparia* L. (Mountain ash), *S. domestica* L. (Sorb) and *S. torminalis* Crantz. are cultivated or grow spontaneously in woods (m.v. 14 kg/ha). They are quite often visited for their nectar and grey-green pollen. Low representativeness.

RUBIACEAE

Herbs belonging to genera *Asperula* L. and *Galium* L. are noteworthy. Particularly *A. taurina* L. flowers in spring on woods; in the mountains it is modesly visited by some Apoidea. They are ubiquitous, but unimportant for bees. Low representativeness.

RUTACEAE

Citrus L.

This genus is prevalently made up by species cultivated for producing fruits: *C. aurantium* L. (Orange tree), *C. bergamia* Risso & Poiteau (Bergamotto), *C. deliciosa* Ten. (Mandarine), *C. paradisi* Mcfayden (Grape-fruit tree), *C. limetta* Risso , *C. limon* (L.) Burm. fill. (Lemon tree), *C. medica* L. (Citron) and *C. sinensis* (L.) Osbeck (Sweet orange tree). Many varieties and hybrids were obtained from these species, among which the "Clementina" variety is to be mentioned. *Citrus* trees, widespread in the Mediterranean area, are of modest dimensions, flower in spring and are interesting for bees (m.v. 50 kg/ha). They give large quantities of unifloral honey white in colour and delicate in odour. Representativeness depends on the extent of the flowers sterility; pollen is yet normally underrepresented. *Citrus* is also visited for its brown pollen. Sometimes a honeydew, as a result of attacks by *Aleurothrixus*, *Yceria* and *Planococcus*, is produced.

Dictamnus L.

D. albus L. (Dittany) is widespread in arid meadows and bushes; it flowers in spring and is visited by bees and other Apoidea searching for nectar.

Evodia Forst.

E. velutina Rehd, an imported tree often visited in summer by bees (m.v. 243 kg/ha), is to be mentioned.

Poncirus L.

P. trifoliata L. is an ornamental thorny plant used for planting thick edges. It flowers at the beginning of the spring and is often visited by bees. Low representativeness.

Ruta L.

The best known species is *R. graveolens* L. (Rue), growing on arid and rocky slopes. It flowers in spring-summer (m.v. 458 kg/ha). Even if it is often visited by bees, its small size makes it unimportant for them. Low representativeness.

SALICACEAE

Populus L.

Growing spontaneously in wet grounds and cultivated for producing cellulose, *P. alba* L. (White poplar), *P. nigra* L. (Black poplar) and *P. tremula* L. (Trembling poplar) flower at the beginning of the spring and are visited by insects gathering small quantities of pollen. A rarely gathered honeydew is also produced as a result of attacks by *Chaitophorus populeti* and *C. tremulae*. Bees gather large quantities of propolis on the poplar buds.

Salix L.

They are tree or shrubs sometimes growing in woods and pasture lands, but they are more common along watercourses. *S. alba* L. (White willow), *S. atrocinerea* Brot., *S. aurita* L., *S. babylonica* L. (Weeping willow), *S. cantabrica* Rech e fill., *S. caprea* L. (Goat willow), *S. cinerea* L. (Grey willow), *S. elaeagnos* Scop., *S. fragilis* L. (Crack willow), *S. hastata* L., *S. myrsinifolia* Salisb. (Dark-leaved willow), *S. repens* L., *S. reticulata* L. (Net-leaved willow), *S. triandra* L. (Almond willow) (m.v. 50 kg/ha) and *S. viminalis* L. (Common osier) are often visited in Europe. Willows flower at the beginning of the spring (m.v. 40 kg/ha) and produce rare light yellow unifloral honey, with an intense and a good odour. The pink-yellow pollen is gathered in high percentages. A honeydew as a result of attacks by *Tuberolachnus salignus* is frequently gathered in eastern Europe. Willows are visited by many Apoidea, among which the so-called “specialists”, as *Andrena apicata* Smith., *A. clarckella* Kirby, *A. mitis* Schm., *A. nychtemera* Imh., *A. praecox* Scop., *A. ruficrus* Nylander, *A. sericata* Imh., *A. vaga* Panz., *A. ventralis* Imh. and *Colletes cunicularius* L.

SANTALACEAE

Osyris alba L. (Greenwed) is the only interesting plant. It is a semiparasitic shrub growing in the Mediterranean bush. It flowers in spring and is visited by bees and small Apoidea gathering quite good quantities of nectar. Low representativeness.

SAXIFRAGACEAE

Saxifraga aixoides L. and *S. bulbifera* L., widespread on meadows and rocky slopes, *S. paniculata* Miller and *S. rotundifolia* L., growing in mountainous woods and flowering in spring, are to be mentioned.

Parnassia palustris L. (Grass-of-Parnassus) is widespread on wet grounds and flowers in spring. It is important for bees to the extent that bees gather modest quantities of yellow pollen. Its representativeness in honey is very low.

Philadelphus coronarius L. (Mock orange) is an interesting shrub. It flowers in late spring in gardens and, even if ignored by bees, it is often visited by other Apoidea (*Andrena*, *Halictus*, *Hylaeus*, *Lasioglossum*, etc.).

SCROPHULARIACEAE

Anarrhinum Desf.

A. bellidifolium (L.) Desf. and *A. duriminium* Pers. flower in spring on pasture lands and arid slopes and are quite often visited by bees searching for their nectar. Low representativeness.

Antirrhinum L.

The most common species is *A. majus* L. (Snapdragon), spontaneous on rocks and walls and cultivated for ornamental purposes. It flowers from March to October. Bees gather its pink pollen and small quantities of nectar, but its flower is more suitable for visitations by bumblebees and *Xylocopa*. Quite good representativeness.

Bartsia L.

B. alpina L. (Bartsia) grows on Alpine pasture lands and flowers in summer. It is visited by bees and bumblebees. Low representativeness.

Digitalis L.

D. ferruginea L., *D. lutea* L. (Straw foxglove), *D. micrantha* Roth and *D. purpurea* L. (Common foxglove) are widespread on mountainous woodlands, while *D. lanata* Ehrh. is cultivated as medicinal herb. All these plants flower in summer and are visited by bees, bumblebees and *Anthidium* searching for nectar. Low representativeness.

Linaria Miller

L. purpurea (L.) Miller and *L. vulgaris* Miller (Common toadflax) are perennial infesting herbs widespread on uncultivated grounds, sides of the roads and ruins. They flower in summer-autumn. *L. alpina* Miller is native to the mountainous screes and flowers in summer. *Linaria* is visited by bees, bumblebees and *Xylocopa* searching for nectar. Quite good representativeness.

Melampyrum L.

M. pratense L. (Common cow-wheat) grows into underwood, especially on the mountains, and flowers in summer (m.v. 100 kg/ha). It is chiefly visited by bumblebees.

Odontites Ludwig

O. lutea Clairv. and *O. verna* Dumort. are hemiparasitic herbs widespread on arid pasture lands and paths. They flower in autumn and give very small quantities of yellow, creamy and slightly aromatic unifloral honey. A dark yellow pollen is also gathered. These plants are visited by the oligoleptic *Melitta tricincta* Kirby, but also by bumblebees.

Parentucellia Viv.

It includes two species widespread on fields and uncultivated grounds, *P. latifolia* (L.) Caruel and *P. viscosa* (L.) Caruel, flowering in spring and visited for their grey pollen.

Pedicularis L.

P. verticillata L. is an interesting plant flowering at the end of the spring and chiefly visited by bumblebees searching for nectar.

Pseudolysimachion Opiz

P. spicatum (L.) Opiz (m.v. 1.20 mg/flower), widespread on mountainous arid meadows, flowering in summer, visited by several Apoidea (*Xylocopa* included), is noteworthy.

Rhinanthus L.

R. alectorolophus (Scop.) Pollich and *R. aristatus* Celak. are native to meadows, flower at the beginning of the summer and give nectar and white pollen in abundance. Low representativeness in the Alpine honey. This genus is often visited by bumblebees on the mountains.

Scrophularia L.

S. umbrosa Dumort., *S. canina* L. (m.v. 1,100 kg/ha), *S. nodosa* L. (Common figwort) (m.v. 2,350 kg/ha) and *S. vernalis* L. are interesting for bees. They flower at the end of the spring on uncultivated soils and rocks and are often visited by other Apoidea, too, in particular by bumblebees. Quite good representativeness.

Verbascum L.

V. blattaria L. (Moth mullein), *V. phlomoides* L. (Orange mullein) and *V. thapsus* L. (Great mullein) are widespread on uncultivated grounds and ruins. They flower in summer and in the same period represent an important source of brick red pollen for bees and bumblebees.

Veronica L.

Widespread on meadows and on the sides of the roads, *V. chamaedrys* L. (Germander speedwell) flowers in spring. *V. persica* Poiret (Buxbaums speedwell), an infesting weed growing on meadows and market-gardens, is also important. *V. arvensis* L. (Wall speedwell), widespread on ruins, *V. dillenii* Crantz, *V. orsignana* Ten. and *V. serpyllifolia* L. common on arid and sunny slopes, are also to be mentioned. This genus is chiefly visited because of its white pollen; another visitor is the oligoleptic *Andrena viridescens* Viereck.

SIMAROUBACEAE

It includes one species only, *Ailanthus altissima* (Miller) Swingle (Tree of heaven), a tree imported from China to breed silkworms and then become an infesting weed. It flowers at the end of the spring and is visited for its nectar and pollen. A green-brown unifloral honey exhaling a typical muscat odour is sometimes produced in several European towns.

SOLANACEAE

Atropa L.

A. belladonna L. (Belladonna) is a herb growing into underwood and bearing poisonous fruits. It flowers in spring-summer and is chiefly visited by bumblebees.

Capsicum L.

Commonly cultivated in many varieties, *C. annuum* L. (Guinea pepper) flowers in summer and provides bees with grey pollen in abundance. Low representativeness.

Cestrum L.

C. parqui L'Hèr. (m.v. 300 kg/ha) is a cultivated and naturalized tree flowering in summer on the ruins and along the ditches in the Mediterranean area. Taking into account the elongation of the corolla, this plant can be only visited by Apoidea acting as "robbers".

Datura L.

D. stramonium L. (Jimsonweed) is a poisonous herb flowering in summer on ruins, while *D. metel* L. is used for ornamental planting. Bees gather small quantities of white nectar and pollen from these plants. Low representativeness.

Hyosciamus L.

H. albus L. and *H. niger* L. (Henbane) are poisonous herbs growing on ruins and flowering in spring. Bees gather from them small quantities of white nectar. Low representativeness.

Lycium L.

L. europaeum L. is a shrub widespread along the shores, where it flowers at the end of the spring. It is a quite good source of nectar. Low representativeness.

Nicotiana L.

N. tabacum L. (Tobacco-plant) and *N. rustica* L. (Tobacco-plant) are well-known cultivated herbs. They are interesting for their grey pollen, but not for their nectar. Their elongated flowers are indeed inaccessible to insects, Lepidoptera and “robbers” excluded.

Salpichroa Miers

S. origanifolia Baillon is an infesting weed flowering in summer-autumn on shrubby and uncultivated grounds. It is a nectariferous plant remarkable for bees and bumblebees in the Mediterranean area.

Solanum L.

S. dulcamara L. (European bittersweet) is the only interesting plant. It is a poisonous infesting weed widespread in wet woods and uncultivated grounds and flowering in spring. It has some importance for bumblebees as a source of pollen and nectar.

STAPHYLEACEAE

Staphylea pinnata L. is a tree widespread into underwood but it is also cultivated for ornamental purposes. It flowers in spring and is often visited by bees and other Apoidea searching for nectar. Low representativeness.

TAMARICACEAE

Tamarix africana Poiret and *T. gallica* L. (Tamarisk) have some importance for bees. These trees or shrubs are widespread along the shores, but they are also cultivated for ornamental purposes. They flower in spring and give large quantities of nectar. Tamarisks also produce honeydew as a result of attacks by *Stigmaphalara tamaricis* and *Colposcenia aliena*. Quite good representativeness.

TAXACEAE

Taxus baccata L. (Yew) is a tree widespread in beech-woods and cultivated for ornamental purposes. It is of some importance for bees. It is visited in spring for its whitish pollen.

TAXODIACEAE

Pseudotsuga menziesii Franco is the only interesting plant. It gives very small quantities of honeydew as a result of attacks by *Cynara* L.

THYMELAEACEAE

Widespread in the Mediterranean bush, *Daphne sericea* Vahl and *D. gnidium* L. flower in spring and in summer, respectively. *D. laureola* L. (Spurge laurel) and *D. mezereum* L. (Mezereon) are widespread in the broadleaf woods and flower at the beginning of the spring. They are more interesting for bumblebees than bees. Lasly *D. striata* Tratt. is tipical on alpine pastures, where it flowers in summer and is visited by bumblebees.

TILIACEAE

Tilia americana L. (Bass-wood), *T. cordata* Miller, *T. platyphyllos* Scop. (Large-leaved lime) and *T. tomentosa* Moench are well-known species. These trees are widespread in woods and cultivated for ornamental purposes. They are excellent melliferous plants (1,000 kg/ha) and are visited by bumblebees. Honey is greenish-yellow and exhales an intense odour typical of the flower, has a delicate flavour and a mint aftertaste. Pollen is underrepresented because of the position of the flowers and the cultivation of sterile varieties. Modest quantities of grey pollen are also gathered. A honeydew as a result of attacks by *Eucallypterus tiliae* is often produced; the obtained honey has the “uva fragola” typical aftertaste.

TROPAEOLACEAE

This family is made up by the genus *Tropaeolum majus* L. (Nasturtium), native to southern America and flowering in summer. Bees and bumblebees gather modest quantities of bright yellow nectar and pollen.

ULMACEAE

Ulmus glabra Hudson, *U. laevis* Pallas and *U. minor* Miller. are interesting for bees. Elms flower at the beginning of the spring and bees gather large quantities of pink pollen from them. A honeydew as a result of attacks by *Eriosoma ulmi* L. and *Cacopsylla ulmi* (Förster) is also produced.

UMBELLIFERAE

These plants are often visited by bees, resulting very interesting especially in dry seasons. Their pollen can be often found in honey with a very low representativeness. Honey is generally grey, with a pasty consistence and a typical odour of coumarin. Palynology divides honeys into two groups: "A-shaped" (*Astrantia*) and "H-shaped" (*Heracleum*), even if there are some intermediate forms making the botanical species very difficult to be detected. Umbelliferae are also visited by small Apoidea (Andrenidae, Colletidae, Halictidae and Megachilidae), rarely by bumblebees. Visitations by Anthophoridae and Melittidae were not recorded.

Aegopodium L.
Widespread in broadleaf woods, *A. podagraria* L. (Ground-elder) flowers in spring and is remarkable in central Europe. Quite good representativeness in honey.

Ammi L.
A. majus L. (Bullwort) and *A. visnaga* (L.) Lam. (Greater ammi) are widespread on uncultivated clayey soils and are considered as good nectariferous plants by some researchers.

Angelica L.
Growing spontaneously in woods, but also cultivated in market-gardens, *A. sylvestris* L. (Angelica) and *A. archangelica* L. flower in spring and summer (m.v. 253 kg/ha). They are chiefly visited by many small Apoidea searching for nectar. Low representativeness.

Anthriscus Pers.
A. cerefolium (L.) Hoffm. (Cervil), a herb flowering in spring (m.v. 0.10 mg/flower), both cultivated and growing spontaneous in market-gardens, has some importance for bees. *A. sylvestris* (L.) Hoffm., an infesting weed flowering in summer, is remarkable in northern Europe for its grey pollen. This species is made up by important nectariferous plants. Quite good representativeness.

Astrantia L.
A. bavarica F. W. Schultz, *A. major* L. (Great masterwort) and *A. minor* L. are widespread in mountainous woods and pasture lands. They flower in summer and their pollen can easily be found in Alpine honey. The pink pollen is also gathered. Quite good representativeness.

Bupleurum L.
B. lancifolium Hornem., weed on wheat and also present in the Mediterranean arid grounds, is a modest spring nectar source.

Carum L.
C. carvi L. (Caraway) is widespread on mountainous pasture lands, flowers in summer and is often visited by bees searching for pollen. On the Alps it can give unifloral loads.

Crithmum L.

C. maritimum L. (Sea fennel), common on cliffs, flowers all the summer long and is visited by small Apoidea searching for nectar only.

Coriandrum L.

C. sativum L. (Coriander) is an excellent melliferous plant. It is cultivated for its aromatic seeds. Growing wild as infesting weed in cereal fields and flowering in spring (m.v. 250 kg/ha), this species is important in central Europe, where rare unifloral honeys, with a clear colour and an intense odour, are produced.

Daucus L.

D. carota L. is well-known. Its subspecies *sativus* Arcangeli (Carrot) is commonly cultivated. It flowers in summer providing bees with large quantities of pollen and nectar. Carrot is visited by the oligoleptic *Andrena nitidiuscula* Schenk and other small Apoidea. Good representativeness in honey.

Eryngium L.

E. amethystinum L. and *E. campestre* L. are widespread on arid pasture lands, while *E. maritimum* L. is common along the shores. These species flower in summer and have great importance as a source of nectar, especially during dry periods. *E. giganteum* L. (m.v. 520 kg/ha), *E. palatum* L. (m.v. 1,000 kg/ha) and *E. planum* L. (m.v. 550 kg/ha) are also to be mentioned. This genus is often visited by Andrenidae, Halictidae, Megachilidae and bumblebees, especially on the mountains. Quite good representativeness.

Ferula L.

It includes *F. communis* L., a species native to the arid grounds of the Mediterranean area. It flowers in spring and provides for large quantities of light yellow pollen and nectar. Quite good representativeness.

Ferulago Koch

F. campestris (Besser) Grec., native to the Mediterranean area, flowers in spring. It is as important for bees as the preceding species. Quite good representativeness.

Foeniculum Miller

This genus is made up by one only species, *F. vulgare* Miller (Fennel), spontaneously growing on uncultivated grounds and arid lands in the Mediterranean area. It is also cultivated as table vegetable. It flowers in summer and is important for bees to a small extent, while is quite frequently visited by small Apoidea.

Heracleum L.

H. sphondylium L. (Cow parsnip) (m.v. 30 kg/ha) is widespread on meadows up to the mountainous lowlands, where it flowers at the end of the spring. It is visited by bees and small Apoidea searching for pollen. Quite good representativeness.

Levisticum Miller

Spontaneous or cultivated in the mountainous market-gardens, *L. officinale* Koch. (Lovage) flowers in summer (m.v. 545 kg/ha) and is visited for its nectar as well as for its yellow pollen. Low representativeness.

Pastinaca L.

P. sativa L. (Parsnip) is an infesting weed widespread on market-gardens and mown meadows. It flowers in summer and is a good source of unifloral honey, grey in colour and strong in odour.

Peucedanum L.

P. cervaria (L.) Lapeyr. is a noteworthy herb flowering in summer in woods and on uncultivated grounds. It has some importance as a source of nectar. Low representativeness.

Pimpinella L.

P. anisum L. (Anise) is an aromatic plant widespread on uncultivated grounds; it is sometimes cultivated. It flowers at the beginning of the summer and gives a clear and aromatic unifloral honey, especially in Spain.

Scandix L.

S. australis L. is a weed infesting cereal fields and widespread in Greece. It flowers in spring (m.v. 0.02 mg/flower) and gives large quantities of nectar. Low representativeness.

Smyrnium L.

S. olusatrum L. is a common infesting weed flowering at the beginning of the spring and visited by bees and many small Apoidea.

Thapsia L.

T. garganica L., native to Greece, has a honey potential equal to 0.01 mg/flower.

Tordylium L.

T. apulum L. and *T. maximum* L. are widespread on fields and uncultivated grounds. They flower in spring-summer, giving modest quantities of nectar and large quantities of grey pollen. Quite good representativeness.

VALERIANACEAE

Centranthus DC.

C. ruber (L.) DC. is a herb flowering on ruins and walls in spring-summer. Bees visit it gathering small quantities of nectar. Low representativeness.

Valeriana L.

V. montana L., *V. officinalis* L. (Valerian) and *V. tuberosa* L. are widespread on the mountains. These herbs flower at the end of the spring and are rarely visited by bees and more often by other Apoidea. Low representativeness.

VERBENACEAE

Lippia L.

Cultivated for ornamental purposes and subspontaneous, *L. triphylla* (L'Hér.) O. Kuntze (Lemon verbena) is a shrub flowering in summer. It is often visited by bees searching for its nectar and only sometimes by the other Apoidea. Low representativeness.

Verbena L.

V. officinalis L. (Vervani) is a herb widespread on uncultivated grounds and on the sides of the roads. It flowers in summer and is often visited by bees searching for nectar. Quite good representativeness.

Vitex L.

V. agnus-castus L. is a shrubby species widespread in the Mediterranean bush. It flowers in summer and is visited by bees and bumblebees searching for nectar. The other Apoidea visit it less frequently.

VIOLACEAE

Viola odorata L. (Violet), *V. reichenbachiana* Jordan ex Boreau (m.v. 1 kg/ha) and *V. tricolor* L. (Pansy) are the most common species. They are predominant into underwood, flower in spring and are often visited by bees searching for nectar. Its representativeness in honey is low because of the large size of the pollen granule. It is therefore underrepresented. Violets are frequently visited by Anthophoridae; less often by bumblebees.

VITACEAE

Vitis vinifera L. (Vine) is an economically remarkable species. It is cultivated in many varieties and flowers at the end of the spring. Being not a nectariferous plant, it is visited by bees gathering quite large quantities of a yellow-greenish pollen. *Parthenocissus quinquefolia* (L.) Planchon (Virginia creeper) is an ornamental plant, somewhere growing wild, flowering in summer (m.v. 260 kg/ha) and often visited by insects all over the Europe. Pollen representativeness in honey is always low.

ZYGOPHYLLACEAE

Tribulus terrestris L. (Caltrop) has some importance for bees. It grows on sandy uncultivated grounds and flowers in summer. Bee gather quite large quantities of yellow pollen, but this species is also visited by small Apoidea.

Aknowledgements

Authors are grateful to Profs J. Banaszak (Poland), M. J. Battesti (Corsica), B. Jablonski (Poland), M. Käpilä (Finland), A. Matheson (New Zeland), T. Petanidou (Grecia), J. Sanchez Sanchez (Spagna), K. Szklanowska (Polonia), G. Vorwohl (Germany), I. Williams (United Kingdom) and M. Cagiotti (Italy) for their helpful advice, as well as Drs N. Palmieri and C. Piatti and the technicians D. Fortini and M. Troni.

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