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THE FOREST MELLIFEROUS FLORA IN THE VICINITY OF BLACE (SERBIA)

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Abstract — Melliferous plant species in the forests near Blace (South Serbia) were investigated in order to estimate the significance, contribution, quality, and ecological characteristics of representatives of the apiflora as potential nectar and pollen sources, the elements of bee pasturage.
The significance of melliferous plants was determined on the basis of nectar and pollen production intensity, as well as by following blooming periods. According to adaptations to moisture, light, and temperature, melliferous species can be relegated to eight groups and six subgroups. Out of the total number of melliferous species in the investigated area (223), the forest apiflora accounted for 82 species (36,77%). The species with highest nectar and/or pollen production are: *Alnus glutinosa*, *Corylus avellana*, *Paulownia tomentosa*, *Picea abies*, *Prunus tenella*, *Robinia pseudoacacia*, *species of the genera Salix*, *Tilia*, and *Campanula*, *Atropa bella–donna*, *Calamintha officinalis*, *Glechoma hederacea*, *Pulmonaria officinalis*, *Salvia glutinosa*, and *Valeriana officinalis*.

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INTRODUCTION

Blace is located in the northern part of South Serbia, between the mountains Jastrebac, and Kopaonik. Relief of the investigated area is hilly to mountainous.

The basic soil types in this region are eutric cambisol, vertisol, and terra rossa (Živković, 1991). The dominant trees in forests on the first soil type are *Quercus cerris* L., *Quercus frainetto* Ten., *Fraxinus ornus* L., *Acer campestre* L., and *Ulmus glabra* Huds. Vertisol is mainly located at 600 m a.s.l. Recent natural vegetation on vertisol is represented by forests of Turkey oak (*Quercus cerris* L.), and European hornbeam (*Carpinus betulus* L.). Terra rossa is located at different elevation above sea level and has an extrazonal character. With respect to its mechanical components, terra rossa belongs to the soil type with the greatest proportion of clay in our country. The xerophylous species *Quercus pubescens* Willd., and *Fraxinus ornus* L. dominate in forest communities on terra rossa.

The investigated area is located at 43° and 15' of N between 350 and 1050 m a.s.l. in a moderately continental climate zone. Biogeographically, it belongs to the Central European Region and Moesic Province (Stevanović, 1995). The greatest numbers of melliferous plant species were recorded in forests at the localities Javorac, Džurla, Crna čuka, Kondelova, Jankova klisura, and Žunje, as well as along the rivers Žunjska reka and Blatašnica. Investigations were performed in phytocoenoses, which can be grouped in Quercetum frainetto–cerris Rud. 1949, Quercetum montanum Čer. et Jov. 1953, Querco–Carpinetum serbicum Rudski (1945) 1949, Fagetum submontanum B. Jov., 1976, and Fagetum moesiaceae montanum B. Jov. 1953 (Jovanović *et al.*, 1997) associations.

MATERIALS AND METHODS

Field investigations of vegetation around Blace were carried out during the vegetation periods in 1998–2002. Determination of forest plant species was performed according to the following sources: The flora of Serbia (Josifović, 1970–1980), and Iconography of the Flora from the Southeastern Part of Central Europe (Javorka–Csapody, 1975).

Nectar (Inp) and pollen production (Ipp) indices of recorded plants were graded from 1 to 4 (1 is for a poor melliferous species with minimum nectar and pollen production; 2 for a good species; 3 for a very good species; and 4 for an excellent species). The melliferous quality of some plant species was assessed according to the methods of Jašmak (1980), and Umeljić (1999). Ecological requirements of melliferous species with respect to moisture, temperature, and light were determined according to Kojić *et al.* (1997). The blooming period of ascertained by observation, and also using data from The Flora of Serbia (Josifović, 1970–1980).

RESULTS

The geographical position of the investigated area is presented in Fig. 1. Melliferous plant species, together with indices of their nectar and pollen production, flowering times, and ecological properties, are presented in Table 1 (abbreviated terms for ecological groups are given).

According to temperature tolerance, plant species can be divided into two groups, mesotherms (50%), and thermophiles (12,2%), and two subgroups, a transitional group between frigoriphiles and mesotherms (1,22%), and a transitional group between mesotherms and thermophiles (36,58%). In regard to light regime of the habitat the forest apiflora can be divided into three groups, namely heliophytes or plants growing in an open habitat (3,65%), semisciophytes or semi–shade plants (61%), and sciophytes or shade plants (1,22%); and two subgroups, namely a transitional group between sciophytes and semisciophytes (12,2%), and a transitional group between semisciophytes and hellophytes (21,95%). With respect to water requirements, the forest apiflora can be divided into three groups, namely xerophytes (4,87%), mesophytes (17,07%), and hygro–helophytes (1,22%); and two subgroups, namely subxerophytes (20,73%), and submesophytes (56,1%).

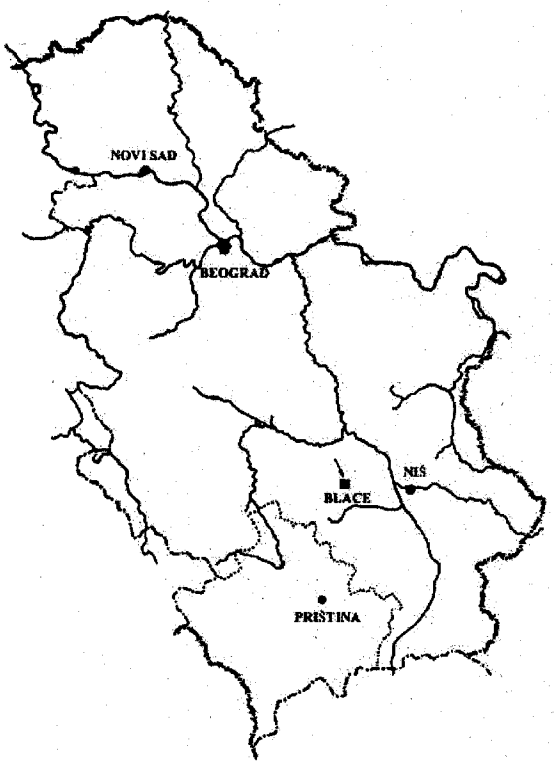

Fig. 1. Geographical position of investigated area.

DISCUSSION

Floristic research showed that the flora surrounding the town of Blace contains 488 vascular plant species. Among them, 223 species (45,7%) have a melliferous character. The forest apiflora includes 82 species (36,77%) from 34 families. The families with the most of melliferous species are as follows: *Rosaceae* (13), *Salicaceae* (9), *Fagaceae* (7), *Aceraceae* (4), *Lamiaceae* (4), *Oleaceae* (3), *Ranunculaceae* (3), and *Pinaceae* (3). The most melliferous forest species in the investigated area (species with Inp 4) are: *Alnus glutinosa* (L.) Gaertn., *Corylus avellana* L., *Paulownia tomentosa* (Thumb.) Sieb. et Zucc., *Picea abies* (L.) Karsten, *Prunus tenella* Batsch, *Robinia pseudoacacia* L., *Salix babilonica* L., *Salix fragilis* L., *Salix grandifolia* Ser., *Salix purpurea* L., *Tilia cordata* Mill., *Tilia platyphyllos* Scop., *Atropa belladona* L., *Calamintha officinalis* Mnch., *Campanula persicifolia* L., *Campanula trachelium* L., *Glechoma hederacea* L., *Pulmonaria officinalis* L., *Salvia glutinosa* L., and *Valeriana officinalis* L. Among the forest apiflora, plants with edible fruits (wild fruit trees) are of great significance. The most melliferous species from this group are: *Sambucus nigra* L., *Prunus avium* L., *Prunus cerasifera* Ehrh., *Prunus tenella* Batsch, *Malus sylvestris* Mill., *Sorbus domestica* L., *Castanea sativa* Mill., *Rosa canina* L., and *Cydonia oblonga* Mill.

With an early flowering period, hazel tree (*Corylus avellana* L., Inp 4, Ipp 4) offers the first bee pasturage on the investigated area (January–April). Bees use pollen powder from hazel flowers to feed the new brood (Mratinić and Kojić, 1998). Flowering in the February and March, *Cornus mass* L. (Inp 1, Ipp 2) is also significant for vernal bee development. Pollen and nectar of this plant accelerate brood development by stimulating greater activities of bees and queen. In April and May, the most significant bee pasturage is composed of walnut (*Juglans regia* L.) and species of the genera *Acer*, *Salix*, and *Populus*. *Juglans regia* L. (Inp 3, Ipp 4) grows in native forests at a lower elevation, but is more wide spread as a cultivated species. It optimally grows on deep soil in moist habitats. With a flowering period that comes a little before leaf formation, this species produces a great deal of pollen powder and slightly less nectar for bees.

Because it produces a great volume of pollen and enough nectar, the importance of cultivated chestnut tree (*Castanea sativa* Mill. Inp 2, Ipp 4) for bee pasture should be emphasized. It is a Mediterranean species that optimally grows up to 900 m a.s.l. and seeks a warm climate with fairly plentiful rainfall and enough humidity in the air. In relation to other woody forest species, it is characterized by a later blooming time (June), which corresponds to that of linden (*Tilia cordata* Mill., *Tilia platyphyllos* Scop.).

Table 1. Ecological characteristic and melliferous indices of investigated forest plants

Species	ECOLOGICAL GROUPS WITH RESPECT TO MELLIFEROUS INDICES					
	Moisture	Light	Temperature	Inp	Ipp	Flowering period
WOODY SPECIES						
Acer campestre L.	submes.	semisci.	mesoth.–thermo.	2	2	IV, V
Acer platanoides L.	submes.	sci.–semisci.	mesoth.	2	2	IV, V
Acer pseudoplatanus L.	submes.	sci.–semisci.	mesoth.	2	2	IV, V
Acer tataricum L.	subxer.	semisci.–helio.	thermo.	3	3	V, VI
Ailantus altissima (Mill.) Swing.	subxer.	semisci.–helio.	thermo.	2	2	V, VI
Alnus glutinosa (L.) Gaertn.	hyg.–hel.	semisci.	mesoth.	4	3	II, III
Betula pendula Roth	submes.	semisci.–helio.	mesoth.	2	2	IV, V
Carpinus betulus L.	submes.	sci.–semisci.	mesoth.–thermo.	2		IV
Castanea sativa Mill.	submes.	semisci.	mesoth.–thermo.	2	4	VI
Clematis vitalba L.	submes.	semisci.	mesoth.	1	1	VI–IX
Cornus mas L.	submes.	semisci.	mesoth.–thermo.	1	2	II–III
Cornus sanguinea L.	submes.	semisci.	mesoth.	2	2	V
Corylus avellana L.	submes.	semisci.	mesoth.	4	4	I–IV
Crataegus monogyna Jacq.	submes.	semisci.–helio.	mesoth.	1	1	V–VI
Cydonia oblonga Mill.	mes.	semisci.	mesoth.	1	2	IV–V
Evonymus europaeus L.	submes.	semisci.	mesoth.–thermo.	2		III–IV
Fagus sylvatica L.	mes.	sci.–semisci.	mesoth.	2		V
Fraxinus excelsior L.	submes.	semisci.	mesoth.	3		III–IV
Fraxinus ornus L.	subxer.	semisci.	mesoth.–thermo.	3		III–IV
Juglans regia L.	submes.	semisci.	mesoth.–thermo.	3	4	IV–V
Lonicera caprifolium L.	submes.	semisci.	mesoth.–thermo.	2		V
Malus sylvestris Mill.	submes.	semisci.	mesoth.	2	3	IV–V
Mespilus germanica L.	mes.	semisci.–helio.	mesoth.–thermo.	2		IV, V
Paulownia tomentosa (Thumb.) Sieb. et Zucc.	subxer.	semisci.–helio.	mesoth.–thermo.	4		IV, V
Picea abies (L.) Karsten	submes.	sci.	frigor.–mesoth.	4	2	IV–VI
Pinus nigra Arn.	subxer.	semisci.–helio.	mesoth.–thermo.	3		IV–VI
Pinus sylvestris L.	submes.	semisci.–helio.	mesoth.	3		IV–VI
Pirus domestica Medic.	xer.	helio.	thermo.	1	2	IV
Populus alba L.	submes.	semisc.–helio.	thermo.	3		III–IV
Populus nigra L.	mes.	semisci.	mesoth.–thermo.	3		III–IV
Populus tremula L.	submes.	semisci.–helio.	mesoth.	3		II–III
Prunus avium L.	mes.	semisci.	mesoth.	2	2	IV–V
Prunus cerasifera Ehrh.	subxer.	semisci.–helio.	thermo.	3	3	III–V
Prunus cerasus L.	subxer.	semisci.–helio.	mesoth.–thermo.	3	2	IV
Prunus domestica L.	mes.	semisci.	mesoth.–thermo.	1	2	IV–V
Prunus tenella Batsch	xer.	helio.	thermo.	4		IV
Quercus cerris L.	subxer.	semisci.–helio.	mesoth.–thermo.	2		V–VI
Quercus farnetto Ten.	subxer.	semisci.–helio.	mesoth.–thermo.	2		V–VI
Quercus petraea (Matt.)Liebl	submes.	semisci.	mesoth.	3	3	IV–V
Quercus pubescens Willd.	subxer.	semisci.	thermo.	2		V–VI
Quercus robur L.	submes.	semisci.	mesoth.–thermo.	3	3	IV–V
Robinia pseudoacacia L.	subxer.	semisci.	mesoth.–thermo.	4	1	V–VI
Rosa canina L.	submes.	semisci.	mesoth.	1	3	IV–VII
Salix alba L.	mes.	semisci.	mesoth.	2	3	III–IV
Salix babilonica L.	mes.	semisci.	mesoth.	4	4	III–V
Salix caprea L.	submes.	semisci.	mesoth.	2	4	III–IV
Salix fragilis L.	mes.	semisci.	mesoth.	4		III, IV
Salix grandifolia Ser.	mes.	semisci.	mesoth.	4		III, IV

Table 1. continued

Salix purpurea L.	submes.	semisci.–helio.	mesoth.	4		III, IV
Sambucus ebulus L.	submes.	semisci.–helio.	mesoth.–thermo.	1	1	VI, VII
Sambucus nigra L.	submes.	semisci.	mesoth.–thermo.	2		V, VI
Sorbus domestica L.	subxer.	semisci.	mesoth.–thermo.	2	2	IV, V
Sorbus torminalis (L.) Crantz	subxer.	semisci.	mesoth.–thermo.	2	2	V, VI
Spirea media F. W. Schmidt	subxer.	semisci.	mesoth.	1	2	V, VI
Staphyllea pinnata L.	submes.	semisci.	mesoth.–thermo.	2		V
Syringa vulgaris L.	submes.	semisci.	thermo.	1	1	IV, V
Thuja orientalis L.	xer.	helio.	thermo.	3	2	IV, V
Tilia cordata Mill.	submes.	sci.–semisci.	mesoth.	4	2	VI, VII
Tilia platyphyllos Scop.	submes.	sci.–semisci.	mesoth.–thermo.	4		V–VII
Ulmus glabra Huds.	mes.	sci.–semisci.	mesoth.	3		III, IV
Viburnum lantana L.	subxer.	semisci.	mesoth.–thermo.	2	2	IV–VII
HERBACEOUS SPECIES						
Adonis vernalis L.	xer.	semisci.–helio.	thermo.	2		III, IV
Angelica silvestis L.	mes.	semisci.	mesoth.	2	2	VI–IX
Atropa bella–donna L.	submes.	semisci.	mesoth.	4		VI
Calamintha officinalis Mnch	submes.	semisci.	mesoth.	4		VII–IX
Campanula persicifolia L.	submes.	semisci.	mesoth.–thermo.	4		VI, VII
Campanula trachelium L.	submes.	sci.–semisci	mesoth.	4		VII–IX
Corydalis solida L.	submes.	sci.–semisci.	mesoth.	2		III–IV
Eupatorium cannabinum L.	mes.	semisci.	mesoth.	3	1	VI–IX
Ficaria verna Huds.	submes.	semisci.	mesoth.	2		III–IV
Fragaria vesca L.	submes.	semisci.	mesoth.	2	2	IV–VI
Galanthus nivalis L.	submes.	semisci.	mesoth.–thermo.	1	1	I–V
Glechoma hederacea L.	submes.	semisci.	mesoth.	4		IV–VII
Helleborus odorus L.	submes.	semisci.	mesoth.–thermo.	1	1	I–IV
Lilium martagon L.	submes.	semisci.	mesoth.	2		VII, VIII
Origanum vulgare L.	subxer.	semisci.	mesoth.	2	1	VI–X
Pulmonaria officinalis L.	submes.	semisci.	mesoth.	4		III, IV
Salvia glutinosa L.	submes.	semisci.	mesoth.	4		VI–IX
Scilla bifolia L.	submes.	semisci.	mesoth.–thermo.	1	2	III–IV
Scrophularia nodosa L.	submes.	sci.–semisci.	mesoth.	2		VI–VIII
Valeriana officinalis L.	mes.	semisci.	mesoth.	4		V
Viola odorata L.	submes.	semisci.	mesoth.–thermo.	1	1	III – IV

Inp.: index of nectar production; **Ipp.**: index of pollen production
mes.: mesophyte ; **xer.**: xerophyte ; **submes.**: submesophyte ; **subxer.**: subxerophyte ; **hyg.–hel.**: hygro –helophyte; **sci.**: sciophyte; **semisci.**: semisciophyte; **helio.**: heliophyte; **sci.–semisci.**: transitional group between sciophytes and semisciophytes ; **semisci.–hello.**: transitional group between se misciophytes and heliophytes ; **mesoth.**: mesotherm ; **thermo.**: thermophile ; **mesoth.–thermo.**: transitional group between mesotherms and thermophiles; **frigor.–mesoth.**: transitional group between frigoriphiles and mesotherms.

Linden species represent the best melliferous plants. The most melliferous linden trees grow in valleys and hilly regions sheltered from wind. These species have good nectar secretion in habitats with increased air and soil humidity. During its blooming time (June and July), the locust tree (*Robinia pseudoacacia* L.) is frequently visited by bees because it produces a lot of nectar (Inp 4, Ipp 1). The beginning of its blooming depends on both the altitude where it grows and insolation of the habitat. Solitary and old trees are considerably more productive than young ones and those in forest complexes. Locust tree flowers have the greatest nectar secretion at a temperature above 16°C.

Forest herbaceous plants with a nectar production index of 4 (*Atropa bella–donna* L., *Calamintha officinalis* Mnch., *Campanula persicifolia* L., *Campanula trachelium* L., *Eupatorium cannabinum* L., *Glechoma hederacea* L., *Pulmonaria officinalis* L., *Salvia glutinosa* L., and *Valeriana officinalis* L.) represent exceptionally good bee pasturage.

Pollen powder is an important food source for pollinators, above all for insects, since it contains 16–30 % proteins, 1–7 % starch, up to 15% sugar and 3–10 % lipids, as well as macroelements (nitrogen, potassium, phosphorous, calcium, etc.), microelements (iron, boron), and vitamins (Stevanović and Janković, 2001). The dominant compounds of nectar are the sugars glucose, sucrose, and fructose (25–75%), but it also contains a myriad of other less abundant constituents such as amino acids, lipids, and other nutrients (Freitas *et al.*, 2001; Forcone *et al.*, 1997). Quantitative and qualitative nectar characteristics depend on internal (plant species–specific characteristics) and external (abiotic ecological characteristics: soil properties, air temperature and humidity, light, and wind) factors. Plants produce the greatest quantity of nectar in the time of blooming, during the pollination process. The most concentrated nectar is produced during hot and dry periods. The temperature optimum for nectar secretion in the majority of plants varies between 16 and 25°C (Belčić *et al.*, 1982). In the vicinity of Blace, the temperature regime best satisfies the requirements of mesothermal melliferous species (50%). Blooming phases are influenced by light. As far as light is concerned, semisciophytes (61%) are the most frequent ecological group of plants in the investigated area. The quantity and dynamics of nectar production and concentration depend on habitat humidity. Nectar secretion is the most optimal when air humidity is between 60 and 80%. Adapted to extremely dry and mesophytic phytocoenoses, submesophytes are the most significant ecological group (56,1%) in the investigated area.

Investigations of melliferous plants are mainly based on nectar production research (Verassin *et al.*, 2001; Pettersson and Knudsen, 2001). The melliferous flora in our country has been investigated mainly in meadow and pasture communities (Blaženčić *et al.*, 1994; Mačukanović *et al.*, 1996; Danon *et al.*, 1990).

Compared to the apiflora of Mt. Goč (Danon *et al.*, 1990), the investigated area around of Blace is characterized by a considerably greater number of melliferous species. In the case of Mt. Goč only 10 species have a nectar production index of 4, while in the Blace region there are 20 such species. It can be concluded that the forest flora near Blace is considerably more meliferous than that of Mt. Goč.

Mačukanović and Grabeljšek (1996) detected a high proportion (53,92 %), of apiflora in a Carpineto orientalis–Quercetum Jov., 1960 community on the Fruška gora mountain. This percentage is much greater than the proportion of apiflora in the Blace area. However, the proportion of forest apiflora in the Blace region is greater than it is in a Festuco montanae — Quercetum petrea M. Jank., 1974 community (38, 64%) on the indicated mountain.

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ШУМСКА МЕДОНОСНА ФЛОРА ОКОЛИНЕ БЛАЦА (СРБИЈА)

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Флористичким истраживањима околине Блаца (ливаде, пашњаци, шуме, рудерална и мочварна станишта), забележено је 488 врста, од којих су 223 (45,7%) медоносне, Од овог броја, шумску апифлору чине 82 врсте тј. 36,8% (61 дрвенаста и 21 зељаста). С обзиром на медни потенцијал (највећи индекси нектарске или поленске продукције), велику бројну заступљеност као и период цветања, највећи значај за пчелињу пашу имају следеће шумске врсте: *Acer tataricum*, *Alnus glutinosa*, *Castanea sativa*, *Corylus avelana*, *Juglans regia*, *Salix babilonica*, *Robinia pseudoacacia*, *Tilia cordata*, *Pulmonaria officinalis*, *Salvia glutinosa и Glechoma hederacea*. Анализом влажности станишта, може се закључити да највећи број врста са истраживаног подручја припада еколошкој групи субмезофита (56,1%). Према светлосним условима на стаништима у околини Блаца, већина медоносних шумских врста су полускиофите (61%), а у односу на температуру, 50 % су мезотермне врсте.