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Plant communities growing on marble slopes of North Pirin Mts (SW Bulgaria) - blossom morphology and bee visitors of a complex midsummer flowering entomophylus plants

Abstract

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The complex of plants flowering in mid summer on the marble slopes of Pirin Mts. were classified according to the morphology of their "blossoms" (flower or compact inflorescence) in the following basic classes: 1) "dish/bowl" - free access to the nectar and pollen, 2) "bell" and "funnel" - more or less hidden nectar, 3) "flag" (sternotribic pollination) and 4) "gullet" (nototribic pollination). The highest number of plant species have "gullet", "dish/bowl + funnel/tube" and "dish/bowl" shaped blossoms. Yellow and purple colours are equally presented by highest number of species. Next highest number of plant species have white blossoms. On Pirin marbles "gullet" morph is usually combined with purple colour. The "dish/bowl + funnel/tube" blossoms are usually purple while those shaped as "dish/bowl" are usually yellow. Also high is the number of plant species with "flag" blossoms which are usually bright or pale yellow. Most abundant are plant species with yellow and purple blossoms from different structural classes. Bumblebees were the most frequent bee visitors. All of them showed preference to "flag" and "gullet" blossom morph, mainly purple and yellow. Highest average visitation rate (number of visitors per minute) showed workers *Bombus pratorum*. Next most active bumblebees were *B. lapidarius* and *B. mastrucatus*.

Introduction

The awards pollen and nectar are in themselves inefficient unless accompagned by advertisement. Thus very important is visual attraction as a complex effect of shape, symmetry, size and colour of the flower (Faegri & van der Pijl 1971; Dafni 1992). From evolutionary point of view particular complex of flower characteristics could be referred as adaptation to different pollinating agents (Grant & Grant 1965; Faegri & van der Pijl 1971; Stebbins 1974; Grinfeld 1978; Richards 1990; Dafni 1992).

Many different methods have been used to qualify and quantify floral characters and many hypotheses have been proposed (Leppik 1956, 1957, 1958; Dafni 1992; Herrera 1996; Proctor & al. 1996; Dafni & Kevan 1996; Dafni & Neal 1997; Dafni & al. 1997; Neal & al. 1998; Giufra & al. 1999; Wolfe & Krstolic 1999; Endress 2001).

Floral characters of the members of particular plant communities or floras of certain

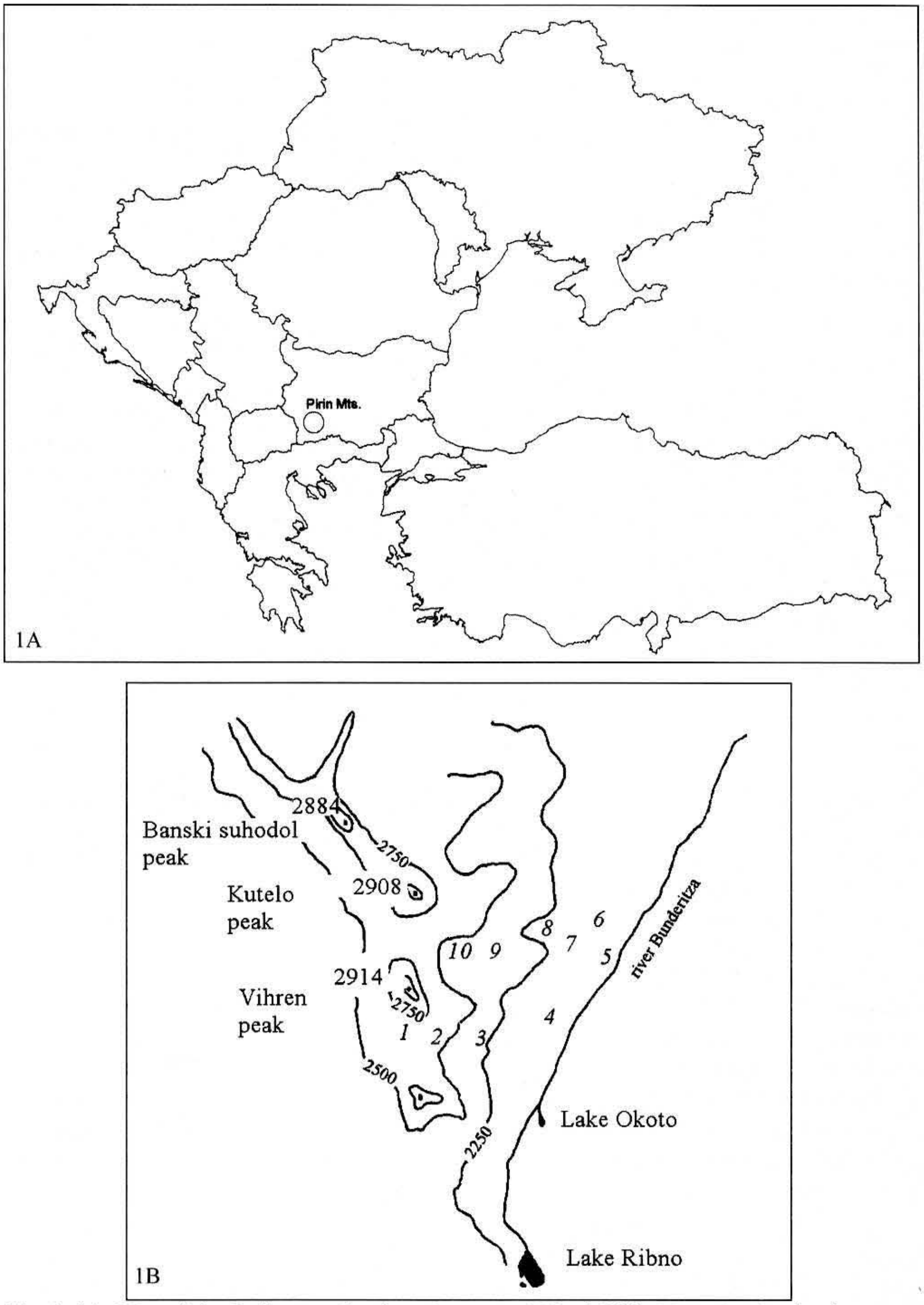

Fig. 1. 1A. Map of the Balkan peninsula and a part of North Pirin Mts.; 1B. Study sites: 1-10 waypoints recorded with Garmin GPS 12.

regions have been investigated often together with their pollinators (Kevan 1972; Ostler & Harper 1978; Pleasants 1980; Diamantopolos & Margaris 1981; Arroyo & al. 1982, 1985; Douglas 1983; Bowers 1985a, b; McCann 1986; Hartmann 1988; Inouye & Pyke 1988; Herrera 1987; Menzel & Shmida 1993; Petanidou 1993; Dafni & O'Toole 1994; Kozuharova 1997, 2000a). Pollinator guilds offer new means of assessing ecosystemic health because the species diversity and abundance relationship is changed from the log-normal standard expected from ecological principles and niche theory (Kevan 1999).

This study deals with the functional blossom morphology of a complex of plants flowering in mid summer on the marble slopes of North Pirin Mts. and the most frequent bee visitors in the region of investigation.

Material and methods

Observations were carried out in August 1995 and July 1996 on the marble part of North Pirin Mts. – the Eastern slopes of Vichren peak (2919 m). Ten study sites in subalpine meadows and in the ecotone zones to the coniferous forest belt as well as to the alpine belt were chosen (altitude between 1900 m and 2650 m, Fig. 1). The most conspicuous entomophylous plant species at these sites flowering during that period were listed after Flora of PR Bulgaria (Jordanov 1963-1995), "Guidebook of the higher plants" (Kozuharov 1992). Approximate abundance evaluation of the flowering plant species was done after Drude scale (Jaroshenko 1961).

The term "blossom" is accepted in this study. It refers both individual flowers and compact inflorescences (e.g. capitulum of *Asteraceae* and *Dipsaceae* assuming that such inflorescences function as single flower, see Faegri & van der Pijl 1971). According to their blossom morphology the plant species were classified after the scheme of Faegri and van der Pijl (1971) with some modifications as follows: 1) dish/bowl - free access to the nectar and pollen, radial symmetry of the "blossom"; (here is included capitulum which combines dish/bowl with the funnel/tube effect of its single flower; 2) bell and funnel - more or less hidden nectar, radial symmetry to slight zygomorphy; 3) flag (sexual organs are found in the lower part, pollen is deposited on the abdominal side of the insect, sternotribic pollination) and 4) gullet (sexual organs are restricted to the functionally upper side, pollen is deposited on the abdominal side of the insect back and upper part of the head, nototribic pollination); more or less hidden nectar, medial zygomorphy. These categories correspond to those accepted by Leppik (1956, 1957, 1958) as follows: actinomorphic, stereomorphic and zygomorphic, that we have used in other papers on similar topic (Kozuharova 1997a, b).

The most frequent bee visitors and their behaviour were recorded on transects along the study sites. Flies (Diptera) were recorded also where they have been frequent flower visitors and especially when bees lacked in these flowers. The observations on pollinators were conducted in these 2 years – totally for 10 days and 73 hours.

Results

The highest number of plant species have "gullet", "dish/bowl+funnel/tube" and "dish/bowl" shaped blossoms (Table 1; Fig. 2, see the "total" series).

Table 1. The complex of plants flowering at midsummer on the marble slopes of Pirin Mts. [1]*Centaurea triumfetti* All. subsp. *achtarovii* (Urum.) Koz. et Andr., [2]*Scorconera purpurea* L. subsp. rosea(W. et K.) Nym., [3]*Jasione laevis* Lam. subsp. *orbiculata* (Grsb. ex Vel.) Tutin, [4]*Onobrychis pindicola* Hausskn. subsp. *urumovii* Deg. et Dren., [5]*Alyssum cuneifolium* Ten. subsp. *pirinicum* Stoj. et Acht. [6]*Cerinthe glabra* Mill subsp. *pirinica* (Stoj. et Acht.) N Andr. Et Peev.; *cyan+purple. Approximate abundance evaluation of the flowering plant species was done after Drude scale descendingly as follows: Soc. (sociales), Cop.$_{-3}$ (copiosae$_3$), Cop.$_{-2}$ (copiosae$_2$), Cop.$_{-1}$ (copiosae$_1$), Sp. (sparsae), Sol. (solitariae).

	purple	cyan	yellow	white	purple+yellow
Dish/bowl	*Geranium macrorrhizum* L. **Cop.$_{-2}$**		*Helianthemum nummularium* (L.) Mill. **Cop.$_{-3}$**	*Galium gr. molugo* **Cop.$_{-1}$**	
	Geranium sylvaticum L. **Cop.$_{-2}$**		*Rhodax canus* (L.) Fuss. **Cop.$_{-3}$**	*Rubus idaeus* L. **Cop.$_{-2}$**	
			Alyssum cuneifolium Ten.[5] **Cop.$_{-1}$**	*Sedum album* L. **Sp.**	
			Sedum alpestre Vill. **Cop.$_{-1}$**		
			Verbascum longifolium Ten. **Cop.$_{-1}$**		
			Verbascum davidoffii Murb. **Sp.**		
Dish/bowl+funnel/tube	*Centaurea triumfetti* All.[1] **Sp.**		*Hieratium naegelianum* Panc.. **Sp.**	*Antennaria dioica (L.) Gaertn.* **Sp.**	*Aster alpinus* L. **Sp.**
	Scorconera purpurea L.[2] **Sol.**		*Hieratium hoppeanum* Schult. **Sp.**	*Achillea ageratifolia* (S. et S.) Boiss. **Sp.**	
	Carduus sp. **Sol.**				
	Centaurea rhenana Boreau **Sp.**				
	Scabiosa lucida L. **Sol.**				
		Jasione laevis Lam.[3] **Cop.$_{-1}$**			
Funnel shallow	*Armeria alpina* Willd. **Sol.**		*Linum capitatum* Kit. ex Shult **Cop.$_{-3}$**	*Cerastium alpinum* L. **Sp.**	
	Daphne cneorum L. **Cop.$_{-3}$**			*Daphne oleoides* Schreb. **Sp.**	
Funnel deep	*Dianthus cruentus* Grsb. **Sp.**	*Gentiana verna* L. **Sp.**		*Dianthus petraeus W. et K.* **Sp.**	
Bell		**Campanula cochlearifolia* Lam. **Sol.**	*Cerinthe glabra Mill.*[6] **Sol.**		
		Campanula velebitica* Borbas. **Cop.$_{-1}$			
		Campanula alpina* Jacq. **Cop.$_{-1}$			
Flag	*Onobrychis pindicola* Hausskn.[4] **Cop.$_{-3}$**		*Anthylis vulneraria* L. (s.l.) **Cop.$_{-3}$**		
	Trifolium medium L. **Sol.**		*Oxytropis urumovii* Jav. **Sp.**		
	Polygala major Jacq. **Cop.$_{-2}$**		*Oxytropis campestris* (L.)DC. **Cop.$_{-3}$**		
			Genista depressa Bieb. **Cop.$_{-3}$**		
			Chamaecytisus absinthioides (Janka) Kuzm.**Cop$_2$**		
Gullet	*Clinopodium vulgare* L. **Sol.**	*Ajuga genevensis* L. **Sp.**	*Teucrium montanum* L. **Cop.$_{-1}$**		
	Acinos alpinus (L.) Moench **Cop.$_{-2}$**		*Rhinanthus javorkae* Soo. **Sol.**		
	Scutellaria alpina L. **Cop.$_{-3}$**		*Digitalis viridiflora* Lindl. **Sol.**		
	Stachys alpina L. **Sp.**		*Linaria genistifolia* (L.) Mill. **Sol.**		
	Thymus perinicus (Vel.) Jalas **Cop.$_{-2}$**				
	Thymus moesiacus Vel. **Cop.$_{-2}$**				

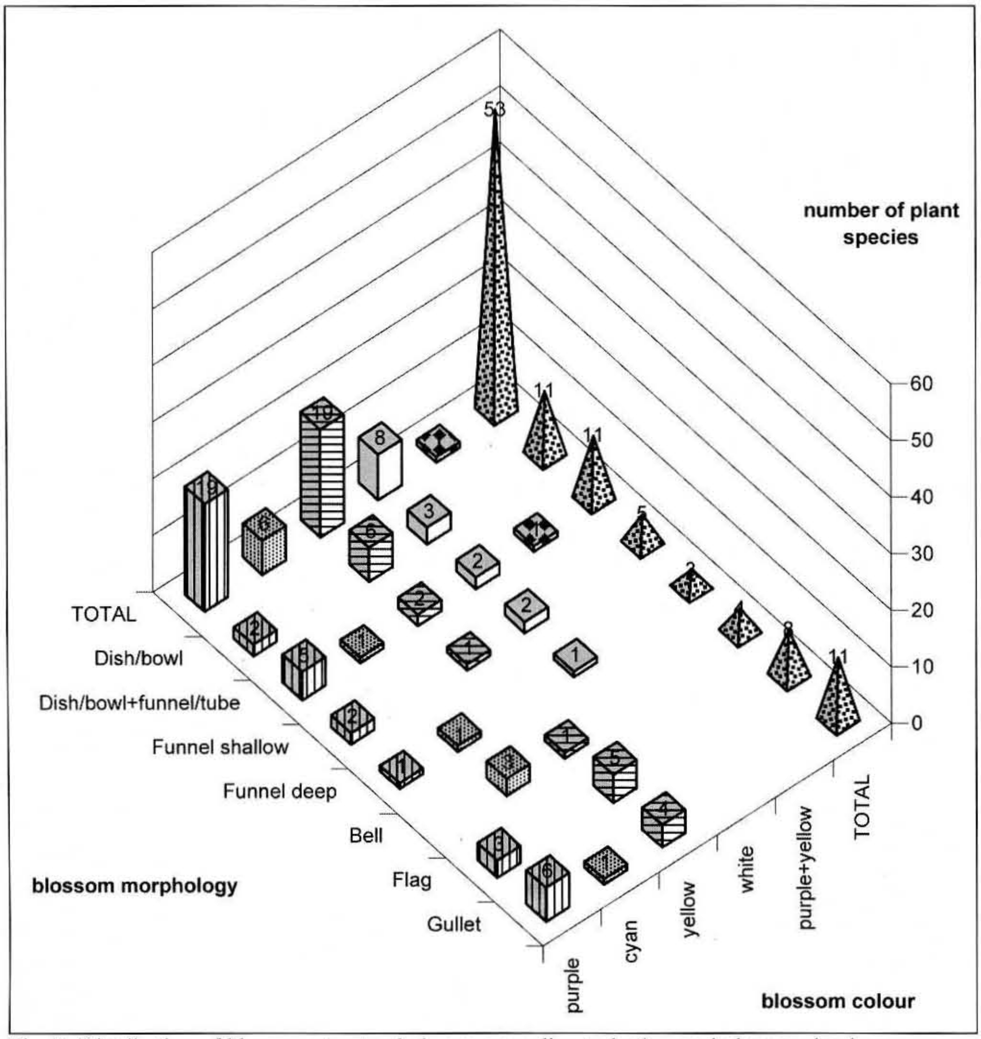

Fig. 2. Distribution of blossom structural classes according to both morphology and colour.

In the investigated plant communities yellow and purple colours are equally presented by highest number of species. Next highest number of plant species have white blossoms (Table 1, Fig. 2, see the "total" series).

On Pirin marbles "gullet" morph is usually combined with purple colour. The "dish/bowl + funnel/tube" blossoms are usually purple while those shaped as "dish/bowl" are usually yellow. Also high is the number of plant species with "flag" blossoms which are usually bright or pale yellow (Table 1, Fig. 2).

Most abundant are plant species with yellow and purple blossoms. Most abundant yellow coloured plant species have either "flag" shaped blossoms (e.g. *Anthylis vulneraria* L. (s.l.), *Genista depressa* Bieb. and *Oxytropis campestris* (L.) DC.) or "dish/bowl" shaped

Table 2. Visitation rate of bees (number of visits per minute) on plant species with purple blossoms; [1]*Centaurea triumfetti All.* subsp. *achtarovii* (Urum.) Koz. et Andr., [2]*Scorconera purpurea* L. subsp. rosea (W. et K.) Nym., [4]*Onobrychis pindicola* Hausskn. subsp. *urumovii* Deg. et Dren.

PURPLE	*B. lapidarius + B. mastrucatus*	*B terrestris*	*B. pratorum*	*B. pyrenaeus*	*B. hortorum*	*Halictidae*	*Megachillidae*
DISH/BOWL							
Geranium macrorrhizum L.	0.15			0.10			
Geranium sylvaticum L.							
DISH/BOWL+FUNNEL/TUBE							
Centaurea triumfetti All. [1]							
Scorzonera purpurea L.[2]							
Carduus sp.	0.10		0.20				
Centaurea rhenana Boreau	0.20						
Scabiosa lucida L.	0.18						
FUNNEL SHALLOW							
Armeria alpina Willd.							
Daphne cneorum L.							
FUNNEL DEEP							
Dianthus cruentus Grsb							
FLAG							
Onobrychis pindicola Hausskn.[4]	0.10	0.06	0.06	0.24			
Trifolium medium L.	0.03				0.01		
GULLET							
Polygala major Jacq.							
Clinopodium vulgare L.							
Acinos alpinus (L.) Moench.	0.02						
Scutellaria alpina L.	0.03				0.03		
Stachys alpina L.	0.03		0.01		0.01		
Thymus perinicus (Vel.) Jalas				0.02			
Thymus moesiacus Vel.	0.03		0.20	0.15			

blossoms (e.g. *Helianthemum nummularium* (L.) Mill. and *Rhodax canus* (L.) Fuss.). Most abundant purple coloured plant species fall in different structural classes: "funnel shallow" (e.g. *Daphne cneorum* L.), "flag" (e.g. *Onobrychis pindicola* Hausskn.) and "gullet" (e.g. *Scutellaria alpina* L., Table 1).

Bumblebees were the most frequent bee visitors (Tables 2-5). All of them showed preference to "flag" and "gullet" blossom morph, mainly purple and yellow (Table 6). At the average highest visit rate (number of visitors per minute) showed workers *Bombus pratorum*. They restricted their visits to 10 plant species from different structural blossom classes (Fig. 3, Tables 2-5). Next most active bumblebees were *B. lapidarius* and *B. mastrucatus*. Their foraging choice was wider – up to 19 plant species, that were mainly "flag" or "gullet" shaped, but also "dish/bowl" and "dish/bowl+funnel/tube" shaped (Fig. 3). Most restricted in their choice, only to 4 plant species, were *B. hortorum* workers. At the same time they showed relatively high visit rate (Fig. 3, Tables 2-5). These long tongued bumblebees chose only purple or yellow "flag" or "gullet" blossoms. *Megachilidae* bees as well as *Halictidae* bees and flies preferred cyan "bell" shaped and to lower extent yellow "dish/bowl+funnel/tube" or purple "dish/bowl" blossoms (Fig. 3, Tables 2-5).

Bombus pratorum workers showed highest visit rate in the blossoms of *Rubus* sp., *Carduus* sp. and *Thymus moesiacus* Vel. (Tables 2-5). All these relationships were located more or less at lower altitude. *B. lapidarius* and *B. mastrucatus* showed highest visit rate in the blossoms of *Centaurea rhenana* Boreau, *Scabiosa lucida* L., *Oxytropis campestris* (L.) DC. and *Anthylis vulneraria* L. (s.l.) (Tables 2-5). Highest visit rate *B. pyrenaeus* showed in the flowers of *Onobrychis pindicola* Hausskn. (Tables 2-5). *B. hortorum* workers showed highest visit rate in the blossoms of *Chamaecytisus absinthioides* (Janka) Kuzm. (Tables 2-5).

Some peculiarities worth to be pointed out. The flowers of *Geranium sylvaticum* belong to the typical "dish/bowl" class (Fig. 4). They are often visited for nectar by *Empididae* (Diptera, Table 6). The flowers of *Geranuim macrorrhizum* have corolla ("advertisement" according to Dafni 1992) that should be classified as "dish/bowl" (radially symmetric, actinomorphic). However the generative organs have slight bilateral symmetry and function as "flag" (Fig. 5). They are sternotribicaly pollinated by bumblebees (Tables 2, 6). The flowers of *Rubus idaeus* belong to the typical "dish/bowl" (radially symmetric, actinomorphic) class. They function like "buzz' pollinated flowers as bumblebees vibrate them downwards to collect their pollen. This is also the pollination mechanism of *Cerinthe glabra* which belongs to the "bell" class and in some cases of *Rhinanthus javorkae* which belongs to "gullet" class.

Discussion

According to the syndrome concept (Faegri and van der Pijl 1971; Proctor & al. 1996) presence of high number of plant species with purple "gullet", purple "dish/bowl (funnel/tube)" and yellow "flag" blossoms indicate the important role of the bees as pollinating agents in the investigated plant communities. This hypothesis correspond to the observed high bumblebee activity.

Bumblebees have specificity in their response and ability to learn flower traits (Laverty

Table 3. Visit rate of bees (number of visits per minute) on plant species with blue (cyan) blossoms; [3]*Jasione laevis* Lam. subsp. *orbiculata* (Grsb. ex Vel.) Tutin.

CYAN	*B. lapidarius + B. mastrucatus*	*B terrestris*	*B. pratorum*	*B. pyrenaeus*	*B. hortorum*	*Halictidae*	*Megachillidae*
DISH/BOWL+FUNNEL/TUBE							
Jasione laevis Lam. [3]	0.10		0.20				
FUNNEL DEEP							
Gentiana verna L.			0.02				
BELL							
Campanula cochlearifolia Lam.							
Campanula velebitica Borbas.				0.01		0.03	0.01
Campanula alpina Jacq.				0.25			
GULLET							
Ajuga genevensis L.	0.01						

Table 4. Visit rate of bees (number of visits per minute) on plant species with yellow blossoms; [5]*Alyssum cuneifolium* Ten. subsp. *pirinicum* Stoj. et Acht. [6]*Cerinthe glabra* Mill subsp. *pirinica* (Stoj. et Acht.) N Andr. Et Peev.

YELLOW	*B. lapidarius + B. mastrucatus*	*B terrestris*	*B. pratorum*	*B. pyrenaeus*	*B. hortorum*	*Halictidae*	*Megachillidae*
DISH/BOWL							
Helianthemum nummularium.							
Rhodax canus (L.) Fuss.				0.01			
Alyssum cuneifolium Ten. [5]							
Sedum alpestre Vill.							
Verbascum longifolium Ten.							
Verbascum davidoffii Murb.							
DISH/BOWL+FUNNEL/TUBE							
Hieratium naegelianum Panc..							0.02
Hieratium hoppeanum Schult.							0.02
FUNNEL SHALLOW							
Linum capitatum Kit. ex Shult							
BELL							
Cerinthe glabra Mill. [6]			0.04				
FLAG							
Anthyllis vulneraria L. (s.l.)	0.17						
Oxytropis urumovii Jav.							
Oxytropis campestris (L.)DC.	0.18			0.03			
Genista depressa Bieb.							
Chamaecytisus absinthioides (Janka) Kuzm.	0.10		0.05		0.24		
GULLET							
Teucrium montanum L.	0.10			0.06			
Rhinanthus javorkae Soo.	0.02	0.01	0.01				
Digitalis viridiflora Lindl.					0.01		
Linaria genistifolia (L.) Mill.							

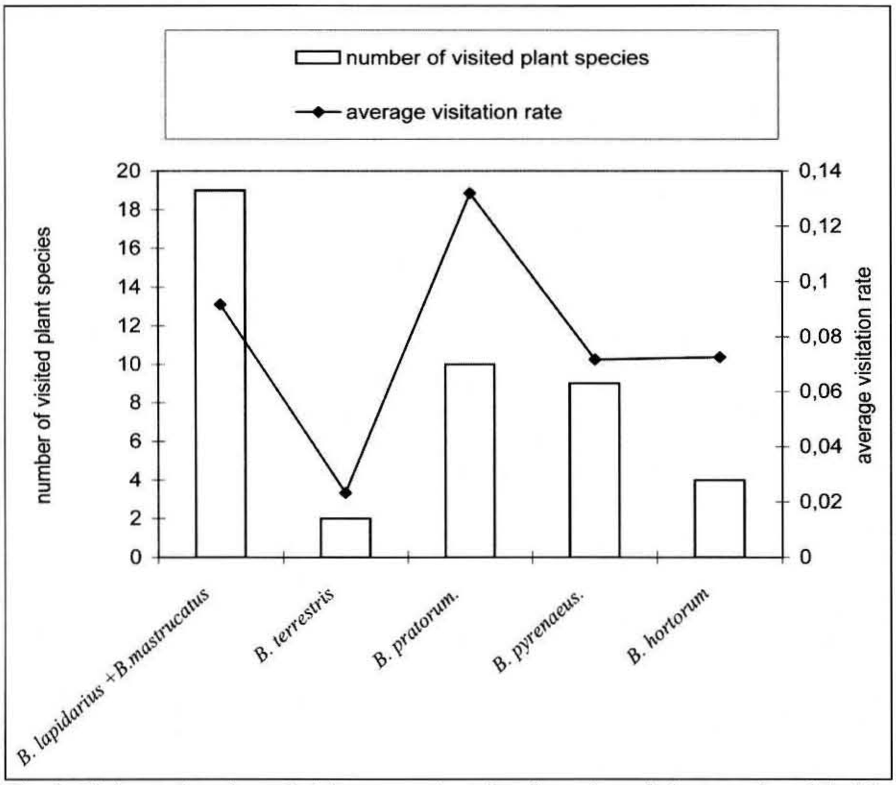

Fig. 3. Visit rate (number of visitors per minute) and number of plant species visited by bumblebees.

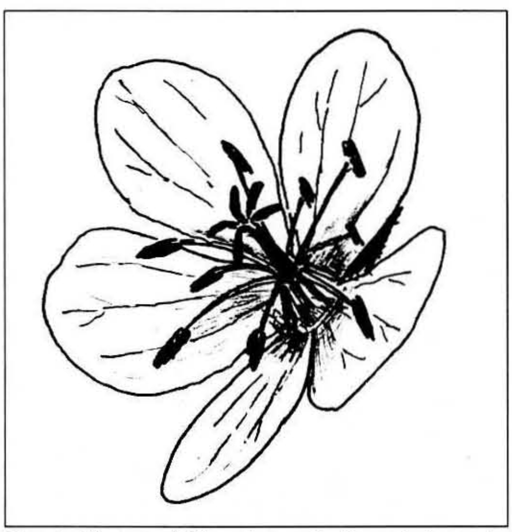

Fig. 4. Flower of *Geranium sylvaticum* belongs to the typical "dish/bowl" class.

Table 5. Visit rate of bees (number of visits per minute) on plant species with white blossoms.

WHITE	*B. lapidarius + B. mastrucatus*	*B terrestris*	*B. pratorum*	*B. pyrenaeus*	*B. hortorum*	*Halictidae*	*Megachillidae*
DISH BOWL /							
Galium gr. molugo							
Rubus sp.			0.50				
Sedum album L.							
DISH/BOWL+FUNNEL/TUBE							
Antennaria dioica (L.) Gaertn.							
Achillea ageratifolia (							
FUNNEL SHALLOW							
Cerastium alpinum L.							
Daphne oleoides Schreb.							
FUNNEL DEEP							
Dianthus petraeus W. et K.							

1994; Gumbert 2000; Fauria & al. 2000). They more willingly switch between flowers of distinct morphologies when the colours are similar, than between flowers of distinct colours when the morphologies are similar (Wilson & Stine 1996). Behavioral records in the course of our field study agree with this conclusions (Tables 1-5). For instance two species with yellow flowers – *Rhinanthus javorkae* (gullet) was a "minor" for *Bombus terrstris* while its "major" was *Cerinthe glabra* (bell). Bumblebees switch more frequently from rare than from common species but even more frequently between similar species (Chittka & al. 1997). Particular example was highest flower constancy of the pollinators of *Oxytropis campestris* and *Onobrychis pindicola*, connected to their dense patches and suitable food resources. They were "majors" for the bumblebees (Tables 1-5, see also Kozuharova 1999, 2000b).

In the flora of Southern Greek mountains the highest percentage corresponds to plants with white flowers. Next are plants with yellow flowers (Diamantopolos & Margaris 1981). Similar is the trend in the Greek aromatic plants (Voliotis 1984). To the north, in Bulgarian mountains, according to data that we have for particular plant communities, dominate yellow and purple colour. There are some specificities in plant communities in different mountains at different altitude and basic rock (Fig. 6).

1) In the subalpine meadows on the Northern slopes of Vitosha Mts., at altitude 1800-2200 m dominate plant species with yellow or purple "flag" and yellow "gullet" (zygomorphic) or white "dish/bowl" (actinomorphic) blossoms that are pollinated mainly by flies and bees (Kozuharova 1997a).
2) In the same Vitosha Mts. but on the southern limestone slopes at 1000 m altitude plant species with purple or yellow "flag" and "gullet" (zygomorphic) blossoms are the most numerous and their main pollinating agents are bees (Kozuharova 2000a).
3) On the marbles of Pirin Mts. at 1900 – 2650 m, the highest number of plant species have purple "gullet" (zygomorphic), purple "dish/bowl+funnel/tube" and yellow "dish/bowl" (actinomorphic) blossoms. The number of plant species with "flag" blossoms which are usually bright or pale yellow is also high. Bumblebees were the most frequent bee visitors. All of them showed preference to "flag" and "gullet" blossom morph, mainly purple and yellow.

Outlines for further research

Next step will be a comparative analysis from this blossom functional morphology point of view between the flora of Pirin Mts (Bulgaria) and Madonia Mts (Sicily). This way we shall try to answer the following questions: Migration process of the plant species, together or without their pollinators? To understand better the process of speciation of endemic species. To explanation some phytogeografical enigma of critical species on the base of future field tests and experiments for the behavioural response of the pollinators to the flower shape, size and colour. Comparative analysis of the floras (animal-pollinated plants) of distant regions, namely Carolina and temperate Japan, showed that phylogenetic and life history constraints are likely to influence the evolution of many community characters besides flowering time (Kochmer & Handel 1986).

The diversity of flower forms and pollinating agents is considered to be the result of a

Table 6. Distribution of bees and some flies on plant species according to their blossom morphology and colour

Blossom classes		Number of plant species visited by								
number of plant species per blossom class	TOTAL	*B. lapidarius + B.mastrucatus*	*B. terrestris*	*B. pratorum.*	*B. pyrenaeus.*	*B. hortorum*	*Halictidae*	*Megacachilidae*	*Muscidae* flies	*Empididae* flies
DISH/BOWL	**11**	**1**			**2**					**1**
purple	2	1			1					1
cyan										
yellow	6				1					
white	3			1						
DISH/BOWL+FUNNEL/TUBE	**11**	**4**		**2**				**2**		
purple	5	4		1						
cyan	1			1						
yellow	2							2		
white	2									
FUNNEL SHALLOW	**5**									
purple	2									
cyan										
yellow	1									
white	2									
FUNNEL DEEP	**3**			**1**						
purple	1									
cyan	1			1						
yellow										
white	1									
BELL	**4**			**1**	**2**		**1**	**1**	**1**	**2**
purple										
cyan	3				2		1	1	1	2
yellow	1			1						
white										
FLAG	**7**	**5**	**1**	**2**	**2**	**2**				
purple	2	2	1	1	1	1				
cyan										
yellow	5	3		1	1	1				
white										
GULLET	**12**	**8**	**1**	**3**	**3**	**3**				
purple	7	4		2	2	2				
cyan	1	2								
yellow	4	2	1	1	1	1				
white										

process of adaptive radiation in the method of pollination Grant & Grant 1965). From this point of view further investigations in the method of pollination in *Geranium* is worth to be done. Large flowered *Geranium sylvaticum* and *G. pratense* are mainly or entirely cross-pollinated, while *G. molle* and *G. dissectum* are automatically self-pollinated. Radially symmetric, actinomorphic flower of *Geranium sylvaticum* is well known as pollinated by *Empididae* (Diptera) and bees. Hoverflies (*Syrphidae*, Diptera) pollinate *Geranium robertianum* flowers (Proctor & al. 1996). *Geranuim palustre* flowers have a mechanism (short stamens and styles and flexible flower stalk) to restrict pollinators to small insects – mainly anthophylous flies – *Empididae, Syrphidae, Calliphoridae* (Dlussky & al. 2000). The flowers of *Geranuim pratense* have similar flower morphology and symmetry (Weberling 1989). They are pollinated by small bees (Proctor & al. 1996) or honeybees and bumblebees (Dlussky & al. 2000). We have primary observations on *Geranuim macrorrhizum* functioning as "flag" according to generative organs despite of radially symmetric, actinomorphic corolla "advertisement". *Geranium phaeum* can be "buzz" pollinated according to the more or less pendulin position of the flower and our sporadic observations on foraging behaviour of its bumblebee visitors support such hypothesis. Similar is probably the pollination mechanism of *Geranium reflexum*.

Acknowledgements

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Fig. 5. Flower of *Geranuim macrorrhizum* has "dish/bowl" corolla and "flag" function.

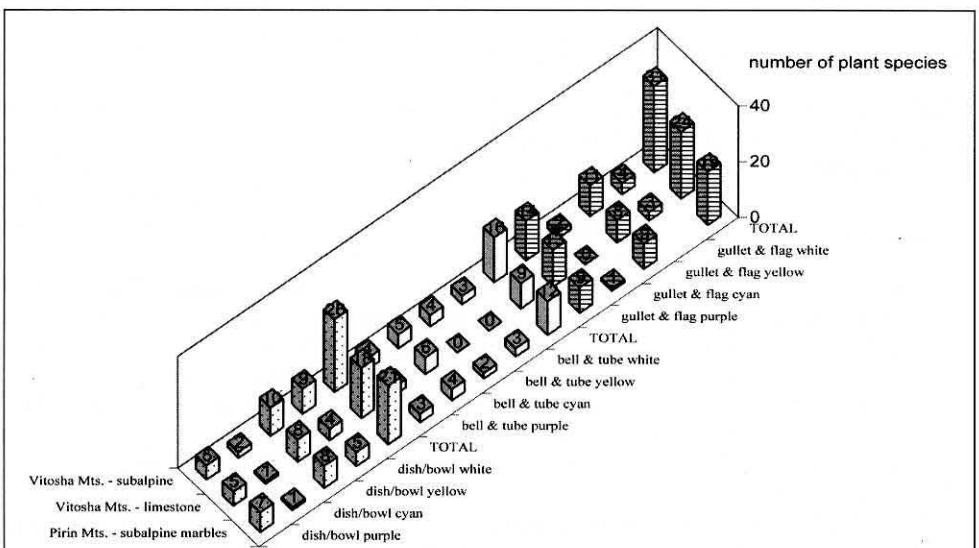

Fig. 6. Distribution of blossom structural classes according to both morphology and colour - comparison between plant communities in different mountains at different altitude and basic rock.

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