Polish Botanical Journal 48(1): 21–41, 2003

A FLORISTIC CATALOGUE OF SERPENTINE AREAS IN THE EASTERN RHODOPE MOUNTAINS (BULGARIA)

DOLJA PAVLOVA, EKATERINA KOŽUHAROVA & DIMITAR DIMITROV

Abstract: The serpentine flora of the Bulgarian part of the eastern Rhodope Mts was studied in 1995–2001; 439 taxa of higher plants from 59 families and 210 genera were established, with 24 Bulgarian and Balkan endemics. Information on the distribution of the plants along six itineraries and brief ecological notes on some taxa are included. The taxonomic structure of the serpentine flora of the eastern Rhodope Mts is compared to the serpentine flora of Mt. Vourinos (northern Greece). Plant speciation in Bulgaria is relatively young, and no specific floristic complex has yet developed.

Key words: Chorology, serpentine flora, Eastern Rhodopes, Bulgaria

Doja Pavlova & Dimitar Dimitrov, Faculty of Biology, Department of Botany, St. Kliment Ohridski University of Sofia, 8 Dragan Tzankov, Sofia-1164, Bulgaria; e-mail: pavlova@biofac.uni-sofia.bg
Ekaterina Kožuharova, Faculty of Pharmacy, University of Medicine, 2 Dunav Str., Sofia-1000, Bulgaria

INTRODUCTION

Interest in the role of serpentine areas in the speciation process on a global scale, determined by the specific chemical composition of the basic rocks (Brooks 1987), has drawn attention to the flora of such areas in the Bulgarian part of the eastern Rhodope Mts. On Bulgarian territory the serpentine rocks differ in their diversity and stage of ultrabasicity, from the rocks distributed in Albania, Greece and former Yugoslavia (Kožuharova 1985). Geologically the Bulgarian serpentine bodies are rather ancient. Metamorphic processes in them have resulted in greater diversity of the chemical nature of the rocks, soils and plant cover (Brooks 1987).

Investigations of the serpentine flora in Bulgaria have been sporadic, limited to new taxa reported by Kožuharov (1985) and Pavlova *et al.* (1998, 2000).

The study area is characterized by its ring shape and the absence of direct contact with the center of active volcanic activity (Kožuharova 1985). Climatically it belongs to the South Bulgarian climatic subregion, with a well-expressed Mediterranean influence (Tischkov 1982). The climate in the northern foothills of the mountain features comparatively mild winters, with a southern wind and relatively cool summers. Mean July temperature is 22.5°C. The serpentine areas fall within the boundaries of the Eastern Rhodopes floristic subregion between 300 and 650 m a.s.l. in the oak xerothermic vegetation belt (Velchev *et al.* 1982). In general the areas lack woody vegetation; shrubby forms of several tree species are found in some places. The bare south-facing slopes are covered by highly dispersed xeromorphic herb flora composed of open plant populations. The vegetation of this terrain is montane and can be classified into two groups: (1) areas with sparse plant cover and low colonizing ability, and (2) *shibljaks* and pastures with compact plant cover (Pavlova 2001).

MATERIAL AND METHODS

The field work was conducted in 1995–2001. The flora along six itineraries was inventoried, encompassing terrain with outcrops of basic rock, situated as follows (Fig. 1):

1. Goljamo Kamenjane village eastwards to Gugutka village (41°22′N, 25°48′E, 450–470 m a.s.l. The serpentine rocks are barren on south-, southeast- and northfacing slopes. The length of the itinerary is *ca* 2 km.

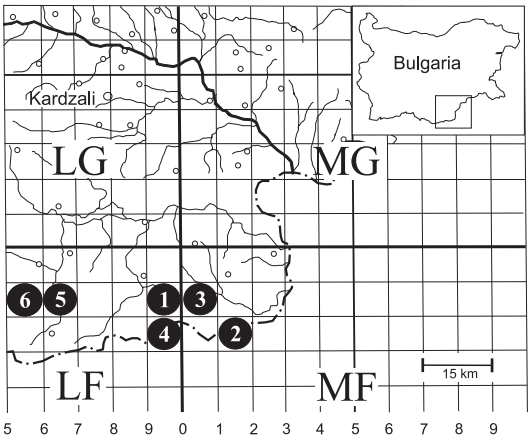

Fig. 1. UTM Grid Map of the Eastern Rhodope Mts. 1–6 – localities investigated.

Large rocky serpentine blocks are seen in the deep ravine. The vegetation is highly influenced by human activity. Chrome mines existed in the near past, the remains of flotation facilities are visible, and erosion is extensive.

2. Zalti Chal village (41°19′N, 25°58′E, altitude 300–400 m). The ultrabasic rocks are on north- and southwest-facing slopes. The length of the itinerary is *ca* 2 km.

3. Kazak village, Hambar dere (41°22′N, 25°54′E, altitude 260–420 m). The serpentine areas are found on southeast-facing steep slopes, with large rocky blocks on reddish-brown soil, altitude 260–420 m. The length of the itinerary is *ca* 1 km. The natural vegetation is completely destroyed. These areas are subject to the continuously increasing human impacts, basically linked with sheep and goat grazing.

4. Avren village southwards to the state border (41°18′N, 25°45′E, altitude 600–650 m). The slopes are north-facing, covered by closed diverse vegetation. The south-facing slope with ultrabasic rocks lacks tree and shrub layer. The length of the itinerary is *ca* 1 km.

5. Fotinovo village, southwest-facing slope northwards to the village (41°17′N, 25°20′E, altitude 300 m). This serpentine body is one of the largest in the Rhodopes Mts. It is located on both slopes of the Varbitza River, 5–6 km long and 1 km wide. The length of the itinerary is *ca* 3 km.

6. Dobromirtzi village, south-facing slope, westwards to the town of Zlatograd (41°20′N, 25°12′E, altitude 280 m). This is the most impressive serpentine massif in the Eastern Rhodopes, 5–6 km long and 3 km wide. The slopes are south- and southeast-facing, very steep close to the Varbitza River, almost vertical. The length of the itinerary is *ca* 3 km. Some places are poor in vegetation, and others are covered by artificial plantations of *Pinis nigra* Arn. Sheep, goat and cow grazing is also quite common and has caused degradation of the scarce plant cover.

The areas studied are situated respectively, in the 15 × 15 km squares LF–98, MF–17, MF–08, LF–97, LF–68 and LF–58 of the UTM grid map of Bulgaria. The plant material collected was determined using *Flora Reipublicae Popularis Bulgaricae* (Jordanov 1963–1995), and *Flora Europaea* (Tutin *et al*. 1964–1980).

The floristic catalogue contains in concise form the area number, abbreviated collectors' names (D. Pavlova = DP; D. Dimitrov = DD; E. Kožuharova = EK), the herbarium specimen number in the Herbarium of Sofia University (SO), and the date of collection. The symbol (*) indicates taxa that, when collected, were new for this floristic subregion or the whole country. The catalogue is arranged in alphabetical order of families and genera. Brief chorological notes are presented for a number of taxa.

The plant nomenclature mostly follows Kožuharov (1992) and *Flora Reipublicae Popularis Bulgaricae* (1963–1995).

FLORISTIC CATALOGUE

ASPLENIACEAE

Asplenium trichomanes L.

2, 3

Asplenium ruta-muraria L.

3

****Asplenium cuneifolium*** Viv.

6; DP & DD (SO 101360), 09 June 2000 (Pavlova & Dimitrov 2001). This species is in 'Red Data Book of Bulgaria' with category rare.

Ceterach officinarum DC.

1, 3, 6

HYPOLEPIDACEAE

Pteridium aquilinum (L.) Kuhn

1

SINOPTERIDACEAE

Cheilanthes marantae (L.) Domin

1, 3, 4, 5, 6; DP &DD (SO 98543), 09 June 2000.

CUPRESSACEAE

Juniperus oxycedrus L.

1, 2, 3, 4, 5

ACERACEAE

Acer campestre L.

4

Acer monspessulanum L.

4

Acer pseudoplatanus L.

4

Acer tataricum L.

4

ANACARDIACEAE

Cotinus coggygria Scop.

1

Pistacia terebinthus L.

1

APIACEAE

****Anthriscus nitida*** (Wahlenb.) Garcke

4; DP (SO 98665), with flowers, 21 June 1996 (Pavlova *et al*. 1997)

Bupleurum comutatum Boiss. & Balansa

1

****Bupleurum gerardii*** All.

1; DP (SO 98602) with flowers, 19 June 1996 (Pavlova *et al*. 1997). This species is in 'Red Data Book of Bulgaria' with category rare.

Daucus guttatus **Sm. subsp.** ***zahariadii*** Heyw.

3

Eryngium campestre L.

2, 3, 5, 6

Ferulago sylvatica (Bess.) Rchb.

4

Heracleum sibiricum L.

4

Oenanthe millefolia Janka

4; DP (SO 98675), with flowers, 19 June 1996. This species is in 'Red Data Book of Bulgaria' with category rare. Bulgarian endemic (Velchev 1984).

Oenanthe pimpinelloides L.

2, 3, 4; DP (SO 98666), with flowers, 09 June 1998. This species is in 'Red Data Book of Bulgaria' with category rare.

Orlaya grandiflora (L.) Hoffm.

1, 3

Orlaya daucoides (L.) Greuter

1

Physosplenium cornubiense (L.) DC.

4

Torilis heterophylla Guss.

1, 3

Trinia glauca (L.) Dum.

5, 6; DP (SO 101428), with fruits, 09 June 2000.

ARISTOLOCHIACEAE

Aristolochia pallida Willd.

1; DP & DD (SO 101381), with flowers, 09 June 2000.

ASCLEPIADACEAE

Cionura erecta (L.) Grisb.

3

Vincetoxicum fuscatum (Hornem.) Rchb. f.

1, 3, 4, 5, 6

ASTERACEAE

Achillea coarctata Poir.

1, 3

Achillea crithmifolia Waldst. & Kit.

2

Anthemis austriaca Jacq.

1

Anthemis cotula L.

6

Anthemis tinctoria L.

1

Anthemis ruthenica Bieb.

1

Bellis sylvestris Cyr.

1; DP & DD (SO 99894), with flowers, 19 June 1999.

Carduus candicans Waldst. & Kit. subsp. ***globifer*** (Velen.) Kazmi

1

Carduus nutans L.

3

Carduus pycnocephalus L.

1, 3; DP & DD (SO 101435), with flowers, 19 June 1999.

Centaurea cyanus L.

2, 3

Centaurea rutifolia Sm. subsp. ***jurineifolia*** (Boiss.) Nym.

1, 2; DP (SO 98529), with flowers, 20 June 1996.

****Centaurea rutifolia*** Sm. subsp. ***rutifolia***

6; DP (SO 101436), with flowers, 20 June 2000 (Pavlova *et al*. 1997).

Crepis foetida L. subsp. ***commutata*** (Spreng.) Babc.

1, 2, 5

Crepis sancta (L.) Babc.

2, 3, 5, 6

Crepis setosa Hall. f.

1, 3

Crupina vulgaris Cass.

1, 2, 3, 5, 6

Filago eriocephala Guss.

4

Hieracium hoppeanum Shult.

1

Hieracium piloselloides Viv. subsp. ***piloselloides***

1, 5, 6

Hieracium praealtum Vill. *ex* Goch.

1, 4

Hieracium pseudopilosella Ten. subsp. ***banaticola*** E. I. Nyár.

3

Hypochoeris glabra L.

1

Inula aschersoniana Janka

6

Inula ensifolia L.

3, 6

Jurinea mollis (L.) Rchb. subsp. ***anatolica*** (Boiss.) Stoj. & Stef.

3; DP & DD (SO 101434), with flowers, 20 June 2000.

***Lactuca perennis** L.

1, 3, 5; DP (SO 98544), with fruits, 20 June 1996 (Pavlova *et al*. 1997).

Leontodon cichoraceus (Ten.) Sanguin.

1

Leontodon crispus Vill. subsp. ***crispus***

1

Leontodon hispidus L.

1

Picnomon acarna (L.) Cass.

3; DP (SO 98540), with flowers, 19 June 1996 (Pavlova *et al*. 1997).

Picris pauciflora Willd.

1

Sonchus asper (L.) Hill var. ***glaucescens*** (Jord.) Stoj. & Stef.

1, 5, 6

Tanacetum corymbosum (L.) Schultz-Bip.

3, 4

Tragopogon balcanicum Velen.

1, 3; DP (SO 99896, SO 101410), with flowers, 09 June 2000. This species is included in 'Red Data Book of Bulgaria' with category rare. Bulgarian endemic (Velchev 1984).

Tragopogon dubius Scop.

1

Xeranthemum annuum L.

3

BETULACEAE

Carpinus orientalis Mill.

1, 4

BORAGINACEAE

Anchusa officinalis L. var. ***macedonica*** (Velen.) Gušul.

1, 2

Anchusa barrelieri (All.) Vitm.

3

Buglossoides arvensis (L.) Johnst.

1

Buglossoides purpurocoerulea (L.) Johnst.

1

Echium plantagineum L.

2, 3; the species is included in 'Red Data Book of Bulgaria' with category rare.

Echium vulgare L.

2, 3

Myosotis arvensis (L.) Hill

1

Myosotis ramosissima Roch.

3

Neatostema apulum (L.) Johnst.

1, 2, 3

Onosma aucherana DC.

1, 3, 6; DP & DD (SO 101430), with flowers, 09 June 2000.

Onosma echioides L.

3; DP &DD (SO 101431), with flowers, 09 June 2000.

Onosma thracica Velen.

1, 3, 4; DP& DD (SO 101432), with flowers, 19 June 1998. Bulgarian endemic (Petrova 1989).

BRASSICACEAE

Aethionema saxatile (L.) R. Br.

6; DP & DD (SO 101365), with flowers and fruits, 09 June 2000.

Alyssum alyssoides L.

1

Alyssum desertorum Stapf

1

Alyssum umbelatum Desv.

4

Alyssum murale Waldst. & Kit. subsp. ***murale***

4, 6

****Capsella rubella*** Reut.

2; DP & DD (SO 99889), with fruit, 30 May 1998 (Pavlova & Dimitrov 2001)

Clypeola jonthlaspi L.

1

Erophila verna (L.) Chevall.

1

Erysimum diffusum Ehrh.

1

Rorippa pyrenaica (L.) Rchb.

1, 3

Rorippa thracica (Grisb.) Fritsch

3; EK (SO 98114), with fruits, 11 June 1995.

Thlaspi kovatsii Heuff.

3, 6; DP (SO 101366), with flowers, 09 June 2000.

****Thlaspi goesingense*** Halácsy

3, DP & DD (SO 101358), with flowers and fruits, 10 June 2000 (Pavlova & Dimitrov 2001).

CAMPANULACEAE

Asyneuma limonifolium (L.) Janch.

5, 6; DP & DD (SO 101433), with flowers, 10 June 2000.

Campanula lingulata Waldst. & Kit.

1, 2, 5, 6

Campanula persicifolia L.

2

Campanula rapunculus L.

2, 3, 5

Jasione montana L.

5

Legousia speculum-veneris (L.) Chaix

2

CAPRIFOLIACEAE

Lonicera etrusca G. Santi

1

CARYOPHYLLACEAE

Arenaria leptoclados (Rchb.) Guss.

3

Arenaria serpyllifolia L.

1, 3, 6

Cerastium banaticum (Roch.) Heuff. subsp. ***speciosum*** (Boiss.) Jalas

1

Dianthus armeria L.

2, 4, 6

Dianthus cruentus Grisb.

1, 3; Balkan endemic (Stojanov 1966).

Dianthus corymbosus Sm.

1; Balkan endemic (Stojanov 1966).

Dianthus gracilis Sm.

2; DP & DD (SO 98679), with flowers, 19 June 1996. Balkan endemic (Stojanov 1966).

Dianthus moesiacus Vis. & Panč. subsp. ***moesiacus***

2; DP & DD (SO 98668), with flowers, 19 June 1996. This species is in 'Red Data Book of Bulgaria' with category rare. Balkan endemic (Stojanov 1966).

Herniaria glabra L.

4, 5

Herniaria incana Lam.

1

****Minuartia hybrida*** (Vill.) Schischk.

1; DP & DD (SO 99677), with flowers, 28 May 1998 (Dimitrov & Pavlova 2002).

Minuartia verna (L.) Hiern

5; DP & DD (SO 101423), with flowers, 28 May 1998.

****Minuartia viscosa*** (Schreb.) Schinz & Thell.

1, 2, 3, 5; DP & DD (SO 101356), with flowers and fruits, 10 June 2000 (Pavlova & Dimitrov 2001).

Moenchia graeca Boiss. & Heldr.

4; DP & DD (SO 101547), with flowers and fruits, 19 June 1998. Balkan endemic (Asenov 1966).

Moenchia mantica (L.) Bartl.

4

Moerhingia trinervia (L.) Clairv.

4

Paronychia kapela (Hacq.) A. Kern.

5, 6; DP & DD (SO 101424), with flowers, 09 June 2000.

Petrorhagia prolifera (L.) P. W. Ball & Heyw.

1, 5

Petrorhagia saxifraga (L.) Link

2

Saponaria stranjensis Jordanov

2, 5; DP & DD (SO 101544), with flowers, 19 June 2001. This species is in 'Red Data Book of Bulgaria' with category rare. Bulgarian endemic (Velchev 1984).

Scleranthus perennis L.

1, 2, 6

Scleranthus polycarpos L.

1

Silene bupleuroides L. subsp. ***bupleuroides***

1, 2, 3, 5, 6; DP & DD (SO 101425), with flowers, 09 June 2000.

Silene compacta Fisch.

2, 3

Silene gigantea L.

1; DP & DD (SO 98599), with flowers, 09 June 2000. Balkan endemic (Jordanov & Panov 1966).

Silene italica (L.) Pers.

1

Silene noctiflora L.

1

Silene subconica Friv.

1

Silene supina Bieb.

5

Silene vulgaris (Moench) Garcke

6

Velezia rigida L.

1

Viscaria vulgaris Röhl. subsp. ***atropurpurea*** (Griseb.) Stoj.

4

CELASTRACEAE

Euonymus verrucosus Scop.

4

CHENOPODIACEAE

Chenopodium botrys L.

1

CISTACEAE

Cistus incanus L.

1, 3, 5, 6

Fumana procumbens (Dunal) Gren. & Godr.

1, 2., 3, 4, 5, 6

Helianthemum nummularium (L.) Mill.

3, 5, 6

Helianthemum salicifolium (L.) Mill.

1

Tuberaria guttata (L.) Spach

1, 2, 3

CONVOLVULACEAE

Convolvulus boissieri Steud. subsp. ***parnassicus*** (Boiss. & Orph.) Kuzm.

1, 2, 3, 4, 5, 6; DP & DD (SO 101429), with flowers, 10 June 1999. This species is in 'Red Data Book of Bulgaria' with category rare.

Convolvulus cantabrica L.

2, 3, 5, 6

CORNACEAE

Cornus mas L.

1

Cornus sanguinea L.

1

CRASSULACEAE

Sedum caespitosum (Cav.) DC.

2

Sedum cepaea L.

4

Sedum hispanicum L.

1, 2, 4

Sedum ochroleucum Chaix

1, 5; DP (SO 99890), with flowers, 19 June 1999.

****Sedum rubens*** L.

1, 2, 3, 5, 6; DP (SO 98539), with fruits, 19 June 1996 (Pavlova *et al*. 1997).

CUSCUTACEAE

****Cuscuta approximata*** Bab.

4; DP (SO 98670), on *Genista anatolica* Boiss., with flowers, 22 June 1996 (Pavlova *et al*. 1997).

****Cuscuta epithymum*** (L.) L. subsp. ***epithymum***

1; DP (SO 98672), on *Sanguisorba minor* Scop., with flowers 20 June 1996 (Pavlova *et al*. 1997).

Cuscuta europaea L.

3, 5, 6

****Cuscuta planiflora*** Ten.

1; DP (SO 98671), on *Satureja* sp., with flowers 20 June 1996 (Pavlova *et al*. 1997).

CYPERACEAE

Carex caryophyllea Latourr.

1, 2, 3, 4

Carex cuprina (Sand.) Nendtv.

2

Carex digitata L.

1

Carex distans L.

2

Carex divulsa Stokes *ex* With.
1, 3

Carex flacca Schreb. subsp. ***flacca***
1, 2, 4

Carex liparocarpos Gaud.
2, 3

Carex otrubae Podp.
1

Carex remota L.
4

Carex rostrata Stokes
1, 3

Carex vesicaria L.
4

Eleocharis palustris (L.) R. Br.
1, 3

Holoschoenus vulgaris Link subsp. ***vulgaris***
1, 2

Pycreus longus (L.) Hayek
4

DIPSACACEAE

Knautia arvensis (L.) Coult.
4

Knautia orientalis L.
2

Scabiosa triniifolia Friv.
2

EUPHORBIACEAE

Euphorbia cyparissias L.
4

Euphorbia myrsinites L.
1, 5, 6

****Euphorbia seguieriana*** Neck.
1, 2; DP (SO 98532), with flowers and fruits, 20 June 1996 (Pavlova *et al*. 1997).

Euphorbia taurinensis All.
1, 2

FABACEAE

Astragalus glycyphyllos L.
1, 4

Chamaecytisus austriacus (L.) Link
2

Chamaecytisus hirsutus (L.) Link
1, 4, 3

Coronilla scorpioides (L.) Koch
1, 3

Dorycnium herbaceum Vill.
1, 4, 3, 5, 6

Genista anatolica Boiss.
1, 2, 5, 6; DP & DD (SO 101454), with flowers, 19 June 1999.

Genista carinalis Griseb.
1, 2, 6

Genista ovata Waldst. var. ***ovata***
2

Genista rumelica Velen.
5

Genista tinctoria L.
1, 2, 4

Lathyrus laxiflorus (Desf.) O. Kuntze
1, 2

Lathyrus niger (L.) Bernh.
2

Lotus angustissimus L.
3

Lotus corniculatus Waldst. & Kit.
1, 4

Lotus tenuis Waldst. & Kit.
1

Medicago falcata L.
1

Medicago lupulina L.
1

Medicago minima (L.) Bartal. var. ***minima***
1, 4, 5

Medicago rigidula (L.) All. var. ***glandulosa*** (Podp.) Kožuharov
1, 4

Melilotus albus Med.
1

Melilotus neapolitanus Ten.
1; DP (SO 101148), with fruits, 09 June 2000.

Onobrychis caput-galli (L.) Lam.
1

Onobrychis gracilis Bess.
1, 2; DP (SO 101447), with flowers and fruits, 09 June 2000.

Ononis spinosa L.
1, 2

Ornithopus compressus L.
2

Trifolium angustifolium L. subsp. ***angustifolium***
1, 2, 3, 6

Trifolium arvense L.
2, 4

Trifolium bocconei Savi
2, 3

Trifolium campestre Schreb. var. ***campestre***
2, 3

Trifolium cherleri L.
2, 3

Trifolium glomeratum L.
2

Trifolium grandiflorum Schreb.
2, 3

Trifolium hirtum All.
2, 3

Trifolium hybridum L. subsp. ***hybridum***
1

Trifolium incarnatum L. subsp. ***molinerii*** (Bartl. *ex* Hornem.) Syme
1, 2, 3

****Trifolium lappaceum*** L. subsp. ***adrianopolitanum*** Velen.
4; DP (SO 98538), with flowers, 22 June 1996 (Pavlova *et al*. 1997).

Trifolium latinum Sebast.
2

Trifolium leucanthum M. Bieb.
2, 3; DP (SO 101455), with flowers, 19 June 1999.

Trifolium medium L.
1

Trifolium michelianum Savi
2, 3

Trifolium micranthum Viv.
1

Trifolium purpureum Loisel.

2

Trifolium retusum L.

2

Trifolium scabrum L. subsp. ***scabrum***

1, 2, 6; DP (SO 101445), with flowers, 19 June 1999.

Trifolium striatum L. subsp. ***striatum***

1, 3

Trifolium strictum L.

2, 3

****Trifolium subterraneum*** L. var. ***brachycladum*** Gib. & Belli

3, DP & DD, SO 99675, with flowers, 28.05.1998 (Dimitrov & Pavlova 2002).

Trifolium tenuifolium Ten.

1, 2

Trigonella monspeliaca L.

1

Vicia cracca L.

1

Vicia angustifolia L.

1

Vicia hirsuta (L.) S. F. Gray var. ***hirsuta***

3

****Vicia incisa*** M. Bieb.

1, 3; DP & DD (SO 99673), with flowers and fruits, 29 May 1998 (Dimitrov & Pavlova 2002). This species is in 'Red Data Book of Bulgaria' with category rare.

****Vicia laeta*** Cesati

3 (as *V. barbazitae* Ten. & Guss.); DP & DD (SO 99674), 29 May 1998 (Dimitrov & Pavlova 2002). This species is in 'Red Data Book of Bulgaria' with category rare.

Vicia lathyroides L. var. ***lathyroides***

3

Vicia lutea L.

1

Vicia tetrasperma L.

2

FAGACEAE

Fagus sylvatica L. subsp. ***moesiaca*** (K. Malý) Hjelmq.

4

Quercus cerris L.

1, 2

Quercus frainetto L.

4

Quercus pubescens Willd.

1, 3

GENTIANACEAE

Centaurium erythraea Rafn subsp. ***erythraea***

1, 3, 4, 5, 6

****Centaurium turcicum*** (Velen.) Ronn. *ex* Fritsch

3; DP & DD (SO 99892), with fruits, 30 May 1998 (Pavlova & Dimitrov 2001). This species is in 'Red Data Book of Bulgaria' with category rare.

GERANIACEAE

Erodium cicutarium (L.) L'Hér.

1, 2

Geranium columbinum L.

1

Geranium sanguineum L.

1, 4

HYPERICACEAE

Hypericum aucheri Jaub. & Spach × ***H. simplex*** Jordanov & Kožuharov

1

Hypericum cerastioides (Spach) N. Robson

3

Hypericum elegans Steph. *ex* Willd.

1

Hypericum olympicum L.

1

Hypericum rumeliacum Boiss.

3; DD (SO 101545) with fruits, 19 June 1999. Balkan endemic (Jordanov & Kožuharov 1970).

IRIDACEAE

Crocus flavus West.

3

Gladiolus illyricus Koch

4

JUNCACEAE

Juncus articulatus L.

2

Juncus compressus Jacq.

2, 3

Juncus conglomeratus L.

1

Luzula alpino-pilosa (Chaix) Breistr.

2

Luzula campestris (L.) DC.

2, 3

Luzula forsteri (Sm.) DC.

3

Luzula multiflora (Retz.) Lej.

4

LAMIACEAE

Acinos arvensis (Lam.) Dandy

1

Acinos rotundifolius Pers.

4

Clinopodium vulgare L.

1, 3

Marrubium vulgare L.

4

Melittis melissophyllum L.

1

Micromeria cristata (Hampe) Griseb.

1, 4

Micromeria juliana (L.) Benth. *ex* Rchb.

1; DP & DD (SO 101442), with flowers, 09.06.1999.

Micromeria dalmatica Benth. subsp. ***bulgarica*** (Velen.) Guinea

6; DD (SO 101442), with flowers, 09 June 2000. Balkan endemic (Anchev 1989).

Origanum vulgare L. subsp. ***hirtum*** (Link) Ietswaart

1; DP & DD (SO 101451), with flowers, 09 June 2000.

Prunella laciniata (L.) L.

2

Prunella vulgaris L.

2

Salvia pratensis L.

2

Salvia virgata Jacq.

3

Scutellaria albida L.

1

Scutellaria altissima L.

4

Sideritis montana L.

1

Stachys angustifolia M. Bieb.

1; DP & DD (SO 101450), with flowers, 09 June 2000.

Stachys cretica L. subsp. ***bulgarica*** Rech. f.

1; DP & DD (SO 101452), with flowers, 09 June 2000. Bulgarian endemic.

Stachys obliqua Waldst. & Kit.

1, 2, 3, 4

Teucrium chamaedrys L.

1, 3, 5, 6

Teucrium montanum L. subsp. ***skorpilii*** (Velen.) Peev

1, 3, 5, 6

Teucrium polium L.

1

Thymus jankae Čelak.

1

****Thymus bracteosus*** Vis. *ex* Benth.

1, 4; EK (SO 98986, 101453), with flowers, 09 June 1995, 19 June 2000 (Pavlova *et al*. 1997)

Ziziphora capitata L.

1

LILIACEAE

****Allium ampeloprasum*** L.

3; DP & DD (SO 99885), with flowers and fruits, 29 May 1998 (Pavlova & Dimitrov 2001).

Allium flavum L.

3

Allium guttatum Stev.

3

Allium vineale L.

2, 3

Fritillaria pontica Wahlenb.

4; DP (SO 98530), with fruits, 22.06.1996. This species is in 'Red Data Book of Bulgaria' with category rare. Balkan subendemic (Velchev 1984).

Muscari comosum (L.) Mill.

4; EK (SO 98111), with fruits, 9 June 1995.

Ornithogalum comosum L.

1

Ornithogalum kochii Parl.

5

Ornithogalum narbonense L.

4, 5

Ornithogalum oligophyllum Clarke

3

Ornithogalum pyrenaicum L.

3, 4

Ruscus aculeatus L.

2

LINACEAE

Linum bienne Mill.

1, 6

Linum tauricum Willd. subsp. ***bulgaricum*** (Podp.) Petrova

1, 3; EK (SO 98545), with flowers, 09 June 1999. This species is in 'Red Data Book of Bulgaria' with category rare. Balkan endemic (Velchev 1984)

Linum tauricum Willd. subsp. ***tauricum***

6; Dp & DD (SO 101427), with flowers, 09 June 2000.

LORANTHACEAE

Arceuthobium oxycedri (DC.) M. Bieb.

1, 3, 6

OLEACEAE

Fraxinus ornus L.

1, 3, 4, 5, 6

Jasminum fruticans L.

1

Ligustrum vulgare L.

6

ONAGRACEAE

Circaea lutetiana L.

1, 4

Epilobium montanum L.

4

ORCHIDACEAE

Cephalanthera damasonium (Mill.) Druce

4

Neottia nidus-avis (L.) L. C. Rich.

4

Limodorum abortivum (L.) Swartz

3, 4; DP (SO 98536), with fruits, 19 June 1999. This species is in 'Red Data Book of Bulgaria' with category rare. Tertiery relic species (Velchev 1984).

Orchis mascula L.

2

Serapias vomeracea (Burm. f.) Briq. subsp. ***orientalis*** Greuter

2; DP & DD (SO 99887), with flowers, 19 June 1999. This species is in 'Red Data Book of Bulgaria' with category rare. Tertiery relic species (Velchev 1984).

OROBANCHACEAE

Orobanche ramosa L.

1

Orobanche purpurea Jacq.

1

PLANTAGINACEAE

Plantago media L.

1, 2

Plantago lanceolata L.

2

Plantago subulata L.

1, 2, 5, 6

PLUMBAGINACEAE

Armeria rumelica Boiss.

1; EK (SO 98542), with flowers, 19 June 1995. Balcan endemic (Anchev 1982).

POACEAE

Aegilops neglecta Req. *ex* Bertol.

1

Agropyron cristatum (L.) Gaertn.

1, 5

Aira elegantissima Schur

1, 2, 3, 5, 6

Anthoxanthum odoratum L.

1, 3

**** Apera interrupta*** (L.) P. Beauv.

1, 5; EK (SO 98107), with flowers, 9 June 1995 (Pavlova *et al*. 2002).

Apera spica-venti (L.) P. Beauv.

1

Avenula compressa (Heuff.) Sauer & Chmelit.

3; DP & DD (SO 98882), with fruits, 19 June 1999.

Brachypodium sylvaticum (Huds.) P. Beauv.

3, 4

Briza media L.

1

Bromus arvensis L.

1

****Bromus intermedius*** Guss.

3; DP (SO 98183), with fruits, 21 June 1996 (Pavlova *et al*. 2002).

Bromus japonicus Thunb.

1

Bromus mollis L.

3

Bromus scoparius L.

3

Bromus squarrosus L.

3

Bromus tectorum L.

1, 5

Chrysopogon gryllus (L.) Trin.

1, 3, 4, 5

Cynosurus cristatus L.

1

Cynosurus echinatus L.

1, 5, 6

Dactylis glomerata L. subsp. ***glomerata***

1

Danthonia alpina Vest

1, 3, 5, 6

Desmazeria rigida (L.) Tutin

1

Dischantium ischaemum (L.) Roberty

1, 5

Festuca pseudodalmatica Krajina *ex* Domin

1

****Festuca oviniformis*** Vett.

1

****Gastridium ventricosum*** (Gouan) Schinz. & Thell.

1, 3, 4; EK (SO 98109), with fruits, 9 June 1995 (Pavlova *et al*. 2002).

Hordeum bulbosum L.

1

Hordeum murinum L.

2

Koeleria penzesii Ujhelyi

1, 2; DP & DD (SO 101545), with flowers, 19 June 1999. Balkan endemic.

Koeleria simonkaii Adam.

3, 4; DP & DD (SO 99883), with flowers, 09 June 2000.

Melica ciliata L.

1, 3, 5

Melica uniflora Retz.

2

Phleum graecum Boiss. & Heldr.

1

Phleum phleoides (L.) Karst.

1

Phleum subulatum (Savi) Asch. & Graebn.

1

Poa bulbosa L.

1, 2, 5

Poa compressa L.

1, 2

Poa media Schur

1

Poa nemoralis L.

1

Psilurus incurvus (Gouan) Schinz & Thell.

1, 5, 6

****Sieglingia decumbens*** (L.) Bernh.

1; EK (SO 98108), with fruits, 10 June 1995 (Pavlova *et al*. 2002).

Stipa pulcherrima C. Koch

3

Taeniatherum crinitum (Schreb.) Nevsky

1, 3, 4, 5

Trachynia distachya (L.) Link

2

Ventenata dubia (Leers) Coss.

2

Vulpia ciliata Dumort.

3, 4, 5

Vulpia myuros (L.) C. C. Gmel.

1

POLYGALACEAE

Polygala anatolica Boiss. & Heldr.

3

Polygala major Jacq.

6

Polygala mediterranea Dalla Torre & Sarnth.

1, 2

Polygala vulgaris L.

1

POLYGONACEAE

Rumex acetosella L.

1, 2, 3, 6

Rumex tenuifolius (Wallr.) Á. Löve

5; DD (SO 101456), with flowers and fruits, 09 June 1999.

PRIMULACEAE

Anagallis arvensis L. subsp. ***foemina*** (Mill.) Schinz & Thell.

2

Lysimachia punctata L.

1

Primula acaulis (L.) L. subsp. ***acaulis***

4

Primula elatior (L.) Hill

4

RANUNCULACEAE

Clematis viticella L.

3

Ranunculus illyricus L.

1

Thalictrum aquilegiifolium L. subsp. ***aquilegiifolium***

4

Thalictrum minus L. subsp. ***minus***

4

RHAMNACEAE

Paliurus spina-christi Mill.

1, 3

Rhamnus saxatilis Jacq.

6

ROSACEAE

Filipendula vulgaris Moench

6

****Potentilla crantzii*** (Crantz) Beck *ex* Fritsch

1, 3; DP (SO 98604), with flowers, 19 June 1996 (Pavlova *et al*. 1997).

Potentilla laciniosa Waldst. & Kit.

1

Potentilla neglecta Baumg.

4

Potentilla reptans L.

1

Potentilla sulphurea Lam.

3, 4, 6; DP & DD (SO 101461), with flowers, 09 June 2000.

Pyrus elaeagrifolia Pall. subsp. ***elaeagrifolia***

1

Rosa agrestis Savi

1

****Rosa arvensis*** Huds.

1, 4; DP & DD (SO 98669), with flowers, 19 June 1996 (Pavlova & Dimitrov 2001).

Rosa canina L.

5

Rosa gallica L.

4

****Rosa mollis*** Sm.

4; DP (SO 98669), with flowers, 22 June 1996 (Pavlova *et al*. 1997).

Rosa pulverulenta Sm.

6

****Rosa turcica*** Rouy

1, DP (SO 98678), with flowers, 19 June 1996 (Pavlova *et al*. 1997).

Rubus discolor Weihe & Nees

1

Rubus thyrsanthus Focke

5

Sanguisorba minor Scop. subsp. ***minor***

1, 3, 5, 6

RUBIACEAE

Asperula aristata L. f.

1

Asperula cynanchica L.

3, 4, 5

Asperula purpurea (L.) Ehrend.

5, 6; DP & DD, SO 101460, with flowers, 09.06.2000.

Asperula tenella Heuff. *ex* Deg.

4

Crucianella latifolia L.

1; DP & DD (SO 101462), with flowers, 09 June 2000. This species is included in 'Red Data Book of Bulgaria' with category rare.

Cruciata laevipes Opiz

4

Galium album Mill.

1, 2

Galium divaricatum Pourr. *ex* Lam.

5, 6

****Galium heldreichii*** Halácsy subsp. ***protopycnotrichum*** (Ehrend. & Krendl) Ančev

1; EK (SO 98677), with flowers, 10 June 1995 (Pavlova *et al*. 1997).

Galium lucidum All.

1, 3, 4

Galium mirum Rech. f.

2; DP & DD (SO 98531), with flowers, 19 June 1998. Balkan endemic (Anchev 1989).

Galium parisiense L.

1, 2

Galium pseudoaristatum Schur

4

Galium tenuissimum M. Bieb. subsp. ***adrianopolitanum*** (Podp.) Ančev

1, 3; DP & DD (SO 101458), with flowers, 19 June 1999.

Galium velenovskyi Ančev

5; DP & DD (SO 101459), with flowers, 19 June 1999. Bulgarian endemic (Anchev 1989).

Galium verum L.

1, 3

Sherardia arvensis L.

1

RUTACEAE

Dictamnus albus L.

3

SALICACEAE

Salix alba L.

1

SANTALACEAE

Thesium arvense Horvatovszky

1, 3, 4

SCROPHULARIACEAE

Bellardia trixago (L.) All.

4; EK (SO 98113), with flowers and fruits, 20 June 1996.

Digitalis lanata Ehrh.

1, 2, 3

Digitalis viridiflora Lindl.

1; DP & DD (SO 101548), with flowers, 09 June 2000. Balkan endemic (Markova 1995).

Euphrasia officinalis L.

1, 6

Euphrasia pectinata Ten.

4

****Kickxia commutata*** (Bernh. & Rchb.) Fritsch

2; DP (SO 98110), with flowers and fruits, 20 June 1996 (Pavlova *et al*. 2002).

Linaria genistifolia (L.) Mill.

1, 4

Linaria pelisseriana (L.) DC.

1, 5, 6

Linaria simplex (Willd.) DC.

1, 2, 5, 6; DP & DD (SO 101444), with flowers, 19 June 1999.

Parentucellia latifolia (L.) Caruel

1, 4, 6

Scrophularia canina L.

1

Verbascum adrianopolitanum Podp.

2, 3; DP & DD (SO 98597, 98598), with flowers and fruits, 19 June 1998. This species is included in 'Red Data Book of Bulgaria' with category rare and also in 'European List of rare and endangered species'. Balkan endemic (Stefanova 1995).

Verbascum banaticum Schrad.

3

Verbascum humile Janka

1, 5; DP & DD (SO 97795, 101463, 101443), with flowers and fruits, 19 June 1998, 09 June 2000. This species is included in 'Red Data Book of Bulgaria' with category rare. Balkan endemic (Stefanova 1995).

Verbascum nobile Velen.

6; DP & DD (SO 97796), with flowers and fruits. This species is included in 'Red Data Book of Bulgaria' with category endangered. Bulgarian endemic (Stefanova 1995).

Verbascum phlomoides L.

2

Verbascum xanthophoeniceum Griseb.

3

Veronica austriaca L. subsp. ***jaquinii*** (Baumg.) Maly

1, 4, 6

Veronica officinalis L.

4

SOLANACEAE

Physalis alkekengi L.

4

ULMACEAE

Ulmus minor Mill.

3

VALERIANACEAE

Valerianella coronata (L.) DC.

1

Valerianella dentata (L.) Poll.

1, 3, 6

Valerianella muricata (Stev. *ex* M. Bieb.) Loudon

1

VIOLACEAE

****Viola aetholica*** Boiss. & Heldr.

1, 3; EK (SO 98676), with flowers and fruits, 11 June 1995 (Pavlova *et al*. 1997). Balkan endemic (Delipavlov 1979).

Viola kitaibeliana Schult.

1, 5

Viola riviniana Rchb.

1

CONCLUSION

As a result of the investigation, 439 taxa from 210 genera and 59 families are recorded. The list comprises 434 taxa of *Magnoliophyta*, 4 of *Polypodiophyta* and 1 of *Pinophyta*.

The following families are represented by large numbers of species: *Fabaceae* (57), *Poaceae* (47), *Asteraceae* (37), *Caryophyllaceae* (32), *Lamiaceae* (23), *Scrophulariaceae* (19), *Cyperaceae* (14), *Rosaceae* (12), *Apiaceae* (11), *Boraginaceae* (10). The greatest number of genera belong to *Poaceae* (26), followed by *Asteraceae* (19), *Fabaceae* (15), *Caryophyllaceae* (13), *Lamiaceae* (12), *Scrophulariaceae* (9), *Apiaceae* (9), *Brassicaceae* (7), *Boraginaceae* (6), *Liliaceae* (5). Among the genera, the most species-rich are *Trifolium* (23), *Carex* (11) *Vicia* (8), *Galium* (8) *Bromus* (7), *Silene* (8), *Potentilla* (5), *Sedum* (5), *Dianthus* (5).

The Submediterranean, Mediterranean, Oriental-Turanian and Central European floristic elements are best represented in the serpentine flora.

Xeromorphic species predominate, finding suitable phytoclimatic conditions for their growth on the serpentine rocks and the soils.

The 'Red Data Book of Bulgaria' (Velchev 1984) lists 18 taxa from the Eastern Rhodope Mts as rare. The presence in Bulgaria of two species, *Apera interrupta* and *Bromus intermedius*, so far doubtful in Bulgaria, was confirmed. *Thymus bracteosus* was a new record for the flora of the country. Altogether 34 taxa were reported as new for this part of the Rhodope Mts (the records for most of these were first published in Pavlova *et al*. 1997, 1998, 2000).

Comparison with the results from investigations in northern Greece (Babalonas 1984, 1988, 1989) reveals a complex of plant species common to the serpentine areas. This complex includes 76 taxa, most of them cosmopolitan and Mediterranean. The taxonomic structure of the serpentine flora of the Eastern Rhodopes is comparable to the serpentine flora of the Vourinus Mts (Babalonas 1989). The results from the Vourinus Mts show 303 plant taxa belonging to 173 genera and 52 families. Most of the species are from the *Asteraceae*, *Caryophyllaceae*, *Fabaceae*, *Poaceae*, *Liliaceae*, *Lamiaceae* and *Scrophulariaceae* families. The same families are characteristic for the Eastern Rhodope Mts but arranged in different order. The flora and vegetation on the serpentine areas within this part of the Rhodopes show great similarities with such areas in other Balkan countries but they are richer in species of Anatolian origin.

The endemics established for the serpentines in the Eastern Rhodope Mts are 24. This number is rather low compared to other serpentine areas on the Balkan Peninsula (Rechinger 1961; Krause *et al*. 1963; Babalonas 1984, 1989; Ritter-Studnicka 1970). This is explained by the low altitude, the relatively uniform climatic conditions, the short biological history of the serpentine areas in Bulgaria, and not least by the composition of the serpentine rocks (Kožuharova 1985; Brooks 1987). Such peculiarities favor the refugial character of the serpentine flora instead of their origination through intensive plant speciation processes. In contrast to the serpentine floras of Albania, Bosnia and Serbia, the plant speciation processes in Bulgaria are relatively young and specific floristic complexes have not yet been formed. The plant populations are mosaic; only relatively few species such as *Convolvulus boissieri* subsp. *parnassicus*, *Thymus bracteosus*, *Festuca oviniformi*, *Cheilanthes maranthae* and *Asplenium cuneifolium* are found exclusively on serpentine basic rock. Plant forms characteristic of other habitats show a certain morphological specificity that clearly demonstrates the speciation role of the serpentines in the Eastern Rhodope Mts. However, long-term floristic investigations are needed to evaluate plant speciation processes in the serpentine areas.

ACKNOWLEDGEMENTS. The authors are grateful to Professor Werner Greuter (Berlin, Germany) and the anonymous reviewer for helpful comments on the manuscript. This work was supported by the National Science Fund, Ministry of Education and Science in Sofia (Project B–908/99).

REFERENCES

ANCHEV M. 1982. *Armeria* Willd. In: S. KOŽUHAROV (ed.), *Flora Reipublicae Popularis Bulgaricae* **8**: 345–349. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

ANCHEV M. 1989. *Micromeria* Benth. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **9**: 356–369. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

ANCHEV M. 1989. *Galium* L. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **9**: 42–96. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

ASENOV I. 1966. *Moenchia* Ehrh. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **3**: 359–365. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

BABALONAS D. 1984. Zur Kenntnis der Flora und Vegetation auf Serpentin-Standorte Nordgrichenlands I. – Serpentinvegetation im Voras-Gebirge. *Feddes Repert*. **95**: 687–697.

BABALONAS D. 1988. Zur Kenntnis der Flora und Vegetation auf Serpentin stadorten Nordgrichelands II Serpentinvegetation auf submontanen Stufen. *Bot. Jahrb. Syst*. **110**(2): 145–156.

BABALONAS D. 1989. Beitrag zur Flora des serpentinischen Vourinos-Gebirges (Notdgriecheland). *Willdenowia* **18**: 387–399.

BROOKS R. 1987. Serpentine and its Vegetation (A multidisciplinary approach), Dioscorides Press, Portland, Oregon.

DELIPAVLOV D. 1979. *Viola* L. In: B. KUZMANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **7**: 339–395. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

DIMITROV, D. & PAVLOVA D. 2002. New chorological data for the Rhodopes Mts. and Slavjanka Mts. (Southern Bulgaria). *Annual of Sofia University* **92**(2): 136–140.

JORDANOV D. (ed.) 1963–1995. Flora Reipublicae Popularis Bulgaricae, 1–10. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

JORDANOV D. & PANOV P. 1966. *Silene* L. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **3**: 435–512. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

JORDANOV D. & KOŽUHAROV S. 1970. *Hypericum* L. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **4**: 224–263. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

KOŽUHAROVA E. 1985. Origin and structural position of the serpentinized ultrabasic rocks from the Precambrian ophiolite association in Rhodope Massif. III. Developement stages and age of the ophiolite association. *Geologica Balcanica* **15**(5): 53–69 (in Russian with English summary).

KOŽUHAROV S. 1985. Family *Poaceae* in Bulgaria – genofound, distribution and evolutionary strategies. Ph.D. Thesis. Institute of Botany, Bulgarian Academy of Sciences, Sofia (in Bulgarian with English summary).

KOŽUHAROV S. (ed.) 1992. Opredelitel na vischite rastenia v Bulgaria. Nauka i Izkustvo, Sofia.

KRAUSE W., LUDWIG W. & SIEDEL F. 1963. Zur Kenntnis der Flora und Vegetation auf Serpentinstandorten des Balkans. *Bot. Jahrb. Syst*. **82**(4): 337–403.

MARKOVA M. 1995. *Digitalis* L. In: S. KOŽUHAROV (ed.), *Flora Reipublicae Popularis Bulgaricae*. **10**: 134–142. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

PAVLOVA D. 2001. Mountain vegetation on serpentine areas in the Bulgarian Eastern and Central Rhodopes Mts. – ecology and conservation. In: K. RADOGLOU (ed.), *Proceedings of International Conference: Forest Research: a challenge for an integrated European approach*. **1**: 227–232. NAGREF – Forest Research Institute, Thessaloniki.

PAVLOVA D. & DIMITROV D. 2001. A contribution to the flora of the serpentine areas in the Rhodopes Mts. (Southern Bulgaria). *OT Sistematik Botanik Dergisi* **8**(2): 13–18.

PAVLOVA D., KOŽUHAROV S., STOJANOV D. & KOŽUHAROVA E. 1997. New chorological data and critical notes on the flora of the Eastern Rhodopes Mts. (Southern Bulgaria). *OT Sistematik Botanik Dergisi* **4**(1): 3–9.

PAVLOVA D., KOŽUHAROVA E. & DIMITROV D. 1998. The Serpentine Flora of the Eastern Rhodopes Mountains (Bulgaria), In: I. TSEKOS & M. MOUSTAKAS (eds), *Progress in Botanical Research* (*Proceeding of First Botanical Congress*), pp. 133–136. Kluwer Academic Publishers, Dordrecht.

PAVLOVA D., KOŽUHAROVA E. & DIMITROV D. 2000. New chorological data for the Flora of the East Rhodopes Mts. *Annual of Sofia University* **90**(2): 77–83.

PAVLOVA D., KOŽUHAROVA E. & DIMITROV D. 2002. New chorological data for the Flora of the East Rhodopes Mts. *Annual of Sofia University* **90**(2): 77–83.

PETROVA A. 1989. *Onosma* L. In: V. VELCHEV & B. KUZMANOV (eds), *Flora Reipublicae Popularis Bulgaricae* **9**: 126–134. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

RECHINGER K. H. 1961. Die Flora von Euboea. *Bot. Jahrb. Syst.* **80**: 294–465.

RITTER-STUDNICKA H. 1970. Die Vegetation der Serpentinvorkommen in Bosnien. *Vegetatio* **21**: 75–156.

STEFANOVA B. 1995. *Verbascum* L. In: S. KOŽUHAROV (ed.), *Flora Reipublicae Popularis Bulgaricae* **10**: 26–100. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

STOJANOV N. 1966. *Dianthus* L. In: D. JORDANOV (ed.), *Flora Reipublicae Popularis Bulgaricae* **3**: 409–434. Bulgarian Academy of Sciences, Sofia (in Bulgarian).

TISCHKOV H. 1982. Klimat. In: Z. GALABOV (ed.), *Geographia na Bulgaria. Fizicheska geographia. Prirodni uslovia i resursi*, pp. 228–247. Bulgarian Academy of Sciences, Sofia.

TUTIN T. E., HEYWOOD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M. & WEEB D. A. (eds) 1964–1980. Flora Europaea, **1**–**5**. Cambridge University Press, Cambridge.

VELCHEV V. (ed.) 1984. Chervena kniga na NR Bulgaria. Bulgarian Academy of Sciences, Sofia.

VELCHEV V., GANCHEV S. & BONDEV I. 1982. Rastitelni pojasi. In: Z. GALABOV (ed.), *Geographia na Bulgaria. Fizicheska geographia. Prirodni uslovija i resursi*, pp. 439–440. Bulgarian Academy of Sciences, Sofia.

Received 27 May 2002