

The *Poa alpina* L. Complex in Bulgaria

Komplex *Poa alpina* L. v Bulharsku

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Variation of *Poa alpina* L. in Bulgaria was studied. Four taxa differing by their morphology have been found growing in habitats well defined ecologically. Two new subspecies are described, defined by paleas with keels merely denticulate: subsp. *balcanica* (including var. *balcanica* and var. *macedonica*) and subsp. *stefanovii*. Plants with lemma hairy on the lower parts and denticulate distally are referred to subsp. *alpina*. This subspecies includes, in addition to few Bulgarian specimens, all populations of the species from Central and Northern Europe.

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Introduction

In Bulgaria, *Poa alpina* has been known to occur since the last century. It was reported from several mountain ranges in the first comprehensive Bulgarian flora by VELENOVSKÝ (1881), summarizing findings of the author and several other researchers of that time (Pančić, Vandas). The author mentioned neither the variation of the species nor intraspecific differentiation. Data concerning the distribution of the species, at that time not yet fully known, have been completed in the subsequent floras.

STOJANOV and STEFANOV (1921) distinguished — in addition to the typical individuals — only var. *brevifolia* BOISS. In 1930 STEFANOV described a new species *Poa borisii* STEF. which he considered to be closely related to *Poa alpina*. It was also treated as a separate species by HAYEK (1933). Later ACHTAROV (1939) identified *Poa borisii* with *Poa alpina* L. var. *divaricata* SCHUR described by SCHUR (1866). Under that name it is listed in the recent floras as a variety or a form.

STOJANOV and STEFANOV (1948) recognize var. *divaricata* SCHUR (syn. *Poa borisii* STEF.), var. *brevifolia* GAUD., var. *minor* HOPPE (syn. *Poa alpina* L. var. *pumila* STOJ. et ACHT. non RCHB.), and var. *macedonica* ACHT.; the latter was described by ACHTAROV (1939) as an endemic of the Pirin.

In the next edition of the flora of Bulgaria (KITANOV, STOJANOV et STEFANOV 1966) only var. *alpina* f. *divaricata* SCHUR (syn. *Poa borisii* STEF.), var. *alpina* f. *minor* HOPPE, and var. *macedonica* ACHT. are recognized.

In the new flora of Bulgaria (KITANOV et PENEV 1963), *Poa alpina* is subdivided into var. *alpina* (including f. *contracta* ASCHERS. et GRAEBN., f. *minor* HOPPE, f. *divaricata* SCHUR (syn. *Poa borisii* STEF.), and var. *macedonica* ACHT.

Poa alpina is an amphiarctic-alpine species with a European centre of origin (MEUSEL 1943). The distribution area may be characterized by the formula [(m) (alp)- temp(alp) + b(mo) — arct.] [oz₁₋₃] Eur-WAs-Am. (see MEUSEL et al. 1965). The species seems to have reached the Balkan Peninsula from the Alps and Carpathians. Bulgarian localities, especially those in the southern part of the country, constitute the southern edge of the distribution area. This fact, combined with the specific conditions of the Balkan Peninsula, accounts for the variation of this species.

Material and methods

To collect and study *Poa alpina*, I visited Bulgaria in 1971 and 1972. I travelled all the mountain ranges where the species is known to occur — the Stara Planina, the Vitoša, the Rila, the

Pirin, the Rodopi — making it possible for me to collect plants from different populations and to investigate their ecology. Additional material was collected in the Sllflovak Carpathians and in the Romanian Bucegi Mountains. For comparison, herbarium material from other parts of the distribution area — the Alps, the Scandinavian mountains, and the Pyrenees — was also examined.

This study is mainly based on my own collections made in the field. Herbarium material was only used to supplement the research. The morphology of lemmata and paleae was studied in detail; the length of the lowermost hairs and teeth in the keels and nerves was measured using a microscope. Qualitative differences having been found out (palea merely denticulate, which has not been observed in my material from any other part of the distribution area), it was decided to analyze the other morphological characters, too. These included the width of leaves, the length of ligules, the size of spikelets, the number of flowers in a spikelet, and the number of spikelets in a panicle. Several taxa were compared using graphical methods.

Variation of *Poa alpina* L. in Bulgaria

In Bulgaria, the dependence of natural populations upon the conditions of the environment and geographical units is more evident than in other parts of Europe. The amount of variation also increases in Bulgaria. Certain populations differ from each other in a number of morphological characters and are therefore worthy of taxonomic recognition.

Collecting material in the Bulgarian mountains in 1971 and 1972, I found four morphologically different taxa. Two of them are classified as subspecies of *Poa alpina* L. (subsp. *alpina* and subsp. *stefanovii*) and two as varieties (var. *balcanica* and var. *macedonica* ACHT.) of subsp. *balcanica*.

In the last edition of the flora of Bulgaria (KITANOV et PENEV 1963), these taxa are referred to as follows: *Poa alpina* L. subsp. *alpina* and *Poa alpina* L. subsp. *balcanica* var. *balcanica* are included under the common name *Poa alpina* L. var. *alpina*. *Poa alpina* L. subsp. *stefanovii* appears referable to *Poa alpina* L. var. *alpina* f. *divaricata* SCHUR (syn. *Poa borisii* STEF.); *Poa alpina* L. subsp. *balcanica* var. *macedonica* ACHT. is named *Poa alpina* L. var. *macedonica* ACHT. Tiny plants from the highest peaks of the Pirin are referred to as *Poa alpina* L. var. *alpina* f. *minor* HOPPE. They evidently arose from var. *macedonica* in which the same type of palea is found. Thus the identification with Hoppe's form appears incorrect. (Morphologically similar plants arose from other types also in other areas.)

The present author does not consider *Poa alpina* L. var. *alpina* f. *contracta* ASCHERS. et GRAEBN. (also listed in the flora by KITANOV et PENEV) to be a separate taxon because the distinguishing character — panicle more contracted before and after bloom (ASCHERSON et GRAEBNER 1900) — appears fortuitous.

Poa alpina L. subsp. *alpina*

Typical individuals of *Poa alpina* (characterized by palea with hairs on the lower parts of keels which on the upper parts assume the form of teeth, and by the pyramidal form of the panicle with longer branches) have been found only in several localities in Bulgaria, while they are abundant in northern parts of the species area. All plants with these characters are referred to the subspecies *alpina*. This subspecies is not very homogeneous morphologically (variation is shown mainly in the hairiness of lemma and palea) which may be due to the wide geographical distribution. In particular larger or smaller areas populations with a certain type of hairiness predominate. Bulgarian plants of this subspecies are characterized by the hairiness of the lemma and particularly of the palea. Unlike most of Central and North European plants, the hairs are rather short and thin (fig. 7a, b). Therefore

they resemble plants described below under the name *Poa alpina* L. subsp. *balcanica*. Ligules of Bulgarian plants (fig. 5a, b) are 2–4 mm long, spikelets (fig. 6a) often 6 mm long, usually 4–5-flowered, but are often more-flowered



Fig. 1–2. — 1. *Poa alpina* L. subsp. *alpina*. — 2. *Poa alpina* L. subsp. *balcanica* var. *balcanica*.

in Central European populations. By its habit, *Poa alpina* subsp. *alpina* does not differ very much from *Poa alpina* subsp. *balcanica* which is more abundant here (for the habit of *Poa alpina* subsp. *alpina*, see Fig. 1).

In Bulgaria, *Poa alpina* subsp. *alpina* is found only above timberline, usually on silicate rocks (In the Carpathians it is more frequent on calcareous rocks.) Vivipary, which is frequent in this subspecies, occurs only rarely in Bulgaria. As far as the hairiness of the palea is concerned, the limits between *Poa alpina* subsp. *alpina* and *Poa alpina* subsp. *balcanica* (which is common in Bulgaria) are not always clean-cut. There are also intermediate types which cannot be classified with any certainty.

Descriptio

Poa alpina L. subsp. *alpina*

Gramina 25–50 cm alta, viridia, saepe leviter colore violaceo tineta. Culmi teretes, leves. Laminae foliorum planae, 2–5 mm latae. Ligulae foliorum inferiorum truncatae, 1–3 mm longae. Ligulae foliorum superiorum lanceolatae, 2–4 mm longae. Panicula pyramidata, laxa, ramuli elongati. Spiculae 2–10-florae, ± 6 mm longae. Flores aliquando vivipari. Glumae inferiores superioresque 3-nervia, ovato-lanceolatae, aliquando cum muricibus sparsis in carinis. Lemmata ovato-lanceolata cum pilis in carinis et nervis lateralibus 0,38–0,86 mm longis, in carinae parte superiore in murices sparsissimos transientibus, inter nervos \pm glabra aut pilis vestita. Paleae ovato-lanceolatae, in parte inferiore cum pilis in carinis 0,30–0,86 mm longis, in parte superiore in murices transientibus; paleae area media glabra vel pilosa.

i Habitat: locis saxosis et herbis supra silvae litem superiorem Europae septentrionalis t mediae satis frequenter, austro-orientalis raro.

List of localities of the specimens studied*

Stara planina: town Černi Vit, Boatín, Reserve, VII. 1971, NĚMCOVÁ, herb. NĚMCOVÁ. — Vitoša: Malk Rezen, granitic rocks, ca 2100 m, VII. 1972, FIŠEROVÁ, PRC; Goljam Rezen, granitic rocks, ca 2000 m, VII. 1972, FIŠEROVÁ, PRC; Goljam Rezen, granitic rocks, ca 2150 m, VII. 1972, FIŠEROVÁ, PRC; Černi vrach, VII. 1971, NĚMCOVÁ, herb. NĚMCOVÁ. — Rila: road from Borovec to Musala, N of Samokov, granite, ca 1500–1600 m, VIII. 1971, FIŠEROVÁ, PRC; below the Musala Peak, on road to Samokov, granite, ca 2000 m, VIII. 1971, FIŠEROVÁ, PRC. — Pirin: Vasiláški ezera, silicate rocks, ca 2000 m, VII. 1972, FIŠEROVÁ, PRC.

Poa alpina L. subsp. *balcanica* FIŠEROVÁ, subsp. nova

In 1971 uniform populations of robust plants were found in the Vitoša Mountains. Similar plants have also been observed in different parts of the Rila and the Pirin Mountains. A detailed study demonstrated that these plants are not identical with subsp. *alpina*. They differ by palea with keels merely denticulate, without hairs at the base. However, there are also intermediate types with several short, abortive hairs. The absence of hairs on the lowermost parts of keels is here considered to be the most important character separating Balkan populations from the Central and North European *Poa alpina* subsp. *alpina*. Another distinguishing character is the oval shape of the panicle, which is rather dense, with short branches and congested spikelets. Ligules of the lowermost leaves (Fig. 5c) of these individuals are very short; those of the uppermost culm leaves (Fig. 5d) are somewhat lanceolate, but also shorter than in *Poa alpina* subsp. *alpina*. Spikelets (Fig. 6b) are usually smaller and more numerous (often up to 70). No viviparous plants have been found.

* Abbreviations of herbaria: International abbreviations follow LANJOUW J. et F. A. STAFLEU (1964): Index Herbariorum, Utrecht. Private herbaria: Herb. NĚMCOVÁ, Prague; Herb. REJMÁNEK, Prague.

On the basis of these characters, Bulgarian plants are here considered to be a separate subspecies, *Poa alpina* L. subsp. *balcanica*. In my classification, the var. *macedonica*, described by ACHTAROV, and defined by palea only with teeth and an oval form of panicle, also belongs to the subsp. *balcanica*. Therefore the typical plants of the subspecies have to be referred to var. *balcanica* (for the habit, see Fig. 2). Var. *balcanica* occurs on silicate rocks above timberline and prefers grassy or even slightly stony places.



Fig. 3-4. — 3. *Poa alpina* L. subsp. *balcanica* var. *macedonica* ACHT. — 4. *Poa alpina* L. subsp. *stefanovii*.

The differences between the subspecies of *Poa alpina* may be summarized in the following table.

Tab. 1. — A comparison of taxonomic characters

Character \ Taxon	<i>Poa alpina</i>			
	subsp. <i>alpina</i> (populations from Bulgaria)	subsp. <i>balcanica</i>		subsp. <i>stefanovii</i>
		var. <i>balcanica</i>	var. <i>macedonica</i>	
Height of plants (cm)	25–50	25–50	10–25	25–60
Width of leaves (mm)	2–5	2–4	1–3	2–4
Length of ligules of uppermost leaves (mm)		(2–) 2.5 (–4)	(1–) 2 (–3)	(2–) 3–4 (–5)
Length of ligules of lowermost leaves (mm)	(1–) 2 (–3)	0.5–1.0	(1–) 2 (–3)	(2–) 3 (–4)
Number of spikelets per panicle	30–60	40–70	13–27	25–60
Average length of spikelets (mm)	6	5	7	9
The most frequent number of flowers per spikelet	4–5	4	4–6	7–8
Vivipary	rare	not observed	frequent	not observed
Geological substratum	silicate rocks	silicate rocks	limestone	limestone

Var. *macedonica* (Fig. 3) differs from var. *balcanica* by the lower growth, narrower leaves and longer, lanceolate ligules (Fig. 5e, f). My material from the Northern Pirin contains plants with larger spikelets (Fig. 6c) and a much lower average number of spikelets per inflorescence. The panicle branches are usually shorter than in var. *balcanica*, making the panicle more congested. The sheaths of var. *macedonica* are conspicuously long which is apparently due to the habitat, the plants growing most often in fine scree. Palea intermediate between the two types (that is, merely denticulate as opposed to hairy at the base and denticulate distally) was found only once in var. *macedonica*. It was more frequent in var. *balcanica*.

Var. *macedonica* occurs in extreme sites at higher altitudes in the Pirin Mountains. It grows on calcareous rocks from 2500 m up to the highest peaks (2900 m). Vivipary abounds. Tiny 2-flowered individuals found in the highest altitudes are referred to as f. *minor* HOPPE in the Bulgarian floras.

Phytocoenologically, var. *macedonica* is an important element of the association *Carici (ruepstris)-seslerietum klåsterskiji* SIMON 1957 (SIMON 1958) of the class *Elyno-seslerietea* Br.-Bl. 1948.

The differences between these two varieties are not always clean-cut; transitional situations may be found particularly in the size of the plants and the width of the leaves. Intermediate plants occur at lower altitudes where var. *macedonica* is replaced by var. *balcanica*. They always have longer ligules, thus approaching var. *macedonica*.

Var. *macedonica* seems to have arisen as a response to the extreme habitats in the Pirin Mountains. The predominance of individuals with longer ligules is probably due to selection.

Both the varieties were compared with each other using graphical methods. Of the morphological characters, the length of ligules and number of flowers in the spikelet were used. The

diagrams show the variation in the length of ligules (Fig. 8) and in the number flowers per spikelet (Fig. 9). Curve peaks in both diagrams approximate conspicuously which is an evidence of the relationship between these two types. They are therefore best treated as varieties of one subspecies.

Descriptio

Poa alpina L. subsp. *balcanica* FIŠEROVÁ, subsp. nova

Gramina 10–50 cm alta, viridia, saepe leviter colore violaceo tincta. Culmi teretes, leves. Ligulae foliorum inferiorum truncatae, 0,5–3 mm longae. Ligulae foliorum superiorum lanceolatae, 1–5 mm longae. Panicula ovalis, densa, ramuli breves. Spiculae plerumque 2–6-florae. Glumae inferiores superioresque 3-nervia, in carina aliquando cum muricibus lateralibus $\pm 0,50$ mm longis in carinae parte superiore in murices sparsos brevesque transientibus; lemmata inter nervos glabra, raro pilis paucissimis oblecta. Paleae ovato-lanceolatae, carinae solum in 2/3 partis superioris muricatae, muricibus inferioribus longioribus. Paleae area media saepissime cum pilis brevibus, aliquando etiam glabra, raro pilosa muricataque vel rarissime solum sparse muricata.

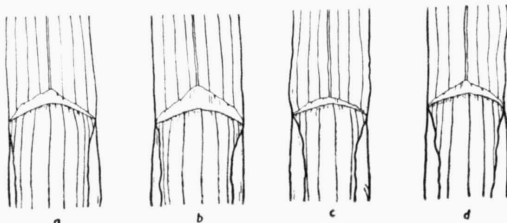


Fig. 5. — Ligules of the lowermost and uppermost culm leaves of *Poa alpina* L. — a, b: *Poa alpina* L. subsp. *alpina*; c, d: *Poa alpina* L. subsp. *balcanica* var. *macedonica* ACHT.; g, h: *Poa alpina* L. subsp. *stefanovii*.

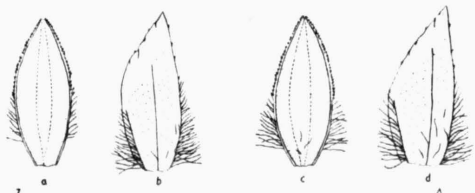
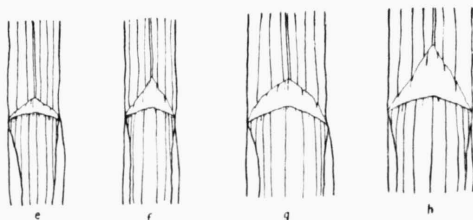


Fig. 6–7. — 6. Spikelets of *Poa alpina* L. a: *Poa alpina* L. subsp. *alpina*; b: *Poa alpina* L. subsp. *balcanica* var. *balcanica*; c: *Poa alpina* L. subsp. *balcanica* var. *macedonica* ACHT.; d: *Poa alpina* L. subsp. *stefanovii*; — 7. Paleae and lemmata of *Poa alpina* L. — a, b: *Poa alpina* L. subsp. *alpina* from Bulgaria; c, d: *Poa alpina* L. subsp. *alpina* from the Carpathians (the Malá Fatra Mountains); e, g: *Poa alpina* L. subsp. *balcanica*; f: a less frequent type of palea of *Poa alpina* L. subsp. *balcanica*; h, i: *Poa alpina* L. subsp. *stefanovii*.

Typus: Bulgaria occidentalis; montes Vitoša; in declivitate orientali montis Černi vrach, in substrato silicoso, alt. ca 2280 m s. m., VIII. 1971, leg. FIŠEROVÁ (PRC).

Stationes: locis herbidis saxosisque supra silvae limitem superiorem.

Area: Bulgaria occidentalis.

Var. *balcanica*

Gramina 25—50 cm alta, viridia, aliquando leviter colore violaceo tincta. Vaginae foliorum culmi basin innovationesque steriles breviter involventes. Laminae foliorum 2—4 mm latae.

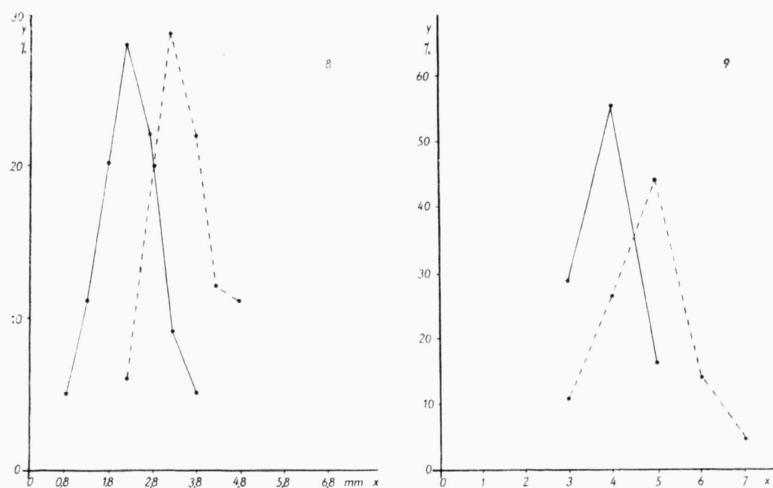


Fig. 8—9. — 8. Showing variation in the length of the ligules; 9. Showing variation in the number of flowers per spikelet. (A relative frequency in per cent is given on *y* coordinate.)

— *Poa alpina* L. subsp. *balcanica* var. *balcanica*
 - - - - - *Poa alpina* L. subsp. *balcanica* var. *macedonica*

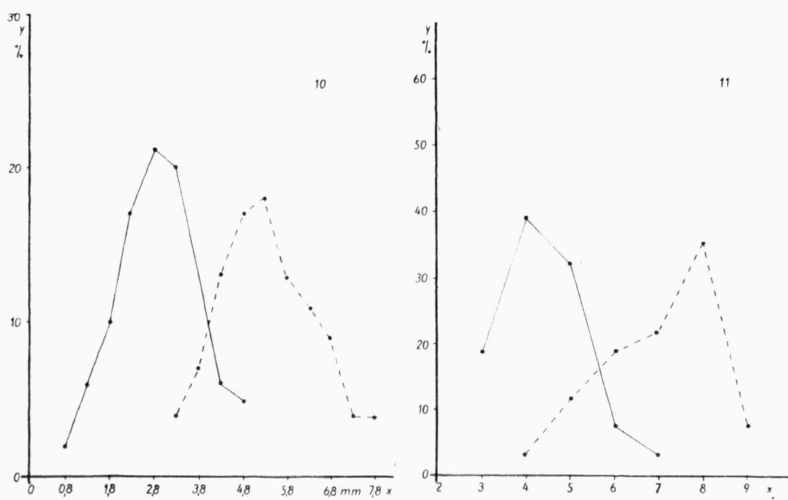


Fig. 10—11. — 10. Showing variation in the length of the ligules; 11. Showing variation in the number of flowers per spikelet. (A relative frequency in per cent is given on *y* coordinate.)

— *Poa alpina* L. subsp. *balcanica*
 - - - - - *Poa alpina* L. subsp. *stefanovii*

Ligulae foliorum inferiorum brevissimae, $\pm 0,50$ mm longae. Ligulae foliorum superiorum 1–3 mm longae, lanceolatae. Panicula ovalis, cum spiculis numerosis. Spiculae parvae, ± 5 mm longae, saepissime 4-florae, numerus spicularum in inflorescentia 50–60, aliquando usque 70. Flores non vivipari.

Var. *macedonica* АСНТ. Изв. Bulg. Bot. Друж. 8 : 146, 1939.

Descriptio notis novis completa:

Gramina humilia, 10–25 cm alta, laete prasina, leviter colore violaceo tineta. Vaginae foliorum culmi basin innovationesque steriles alte involventes. Laminae foliorum planae, angustae, 1–3 mm latae. Ligulae foliorum inferiorum ± 2 mm longae. Ligulae foliorum superiorum lanceo-

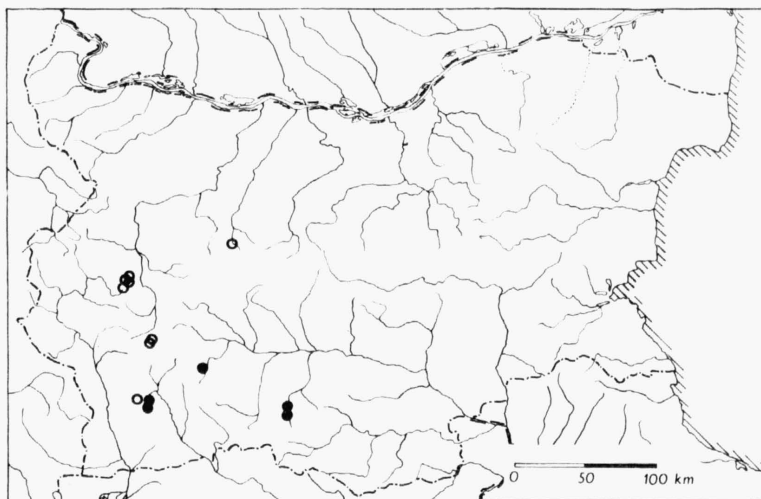


Fig. 12. — Distribution of *Poa alpina* L. subsp. *alpina* (circles) and *Poa alpina* L. subsp. *stefanovi* (dots) in Bulgaria.

latae, usque 5 mm longae. Panicula ovalis, densa, cum numero spicularum parvo, paniculae ramuli breviores quam apud var. *balcanicam*, spiculis 1–3 instructae. Spiculae ± 7 mm longae, saepissime 4–6-florae. Numerus spicularum in inflorescentia ± 20 –25. Flores saepe vivipari.

Habitat: Bulgaria austro-occidentalis: locis saxosis regionis alpinae montium Pirini.

Typus (non vidi): Eltepe mt. Pirini, 2600–2918 m. s. m., 24. VIII. 1936, B. АСНТАРОВ; Орчолова скала, mt. Pirini, supra urb. Nervokop, 2000–2050 m. s. m., 18. VII. 1936, B. АСНТАРОВ;

List of localities of the specimens studied

Poa alpina subsp. *balcanica* var. *balcanica*

Vitoša: Černi vrach, NE slope, silicate rocks, ca 2260 m, VIII. 1971, FIŠEROVÁ, PRC; Černi vrach, E slope, silicate rocks, ca 2280 m, VIII. 1971, FIŠEROVÁ, PRC, (typus); Černi vrach, top, silicate rocks, 2290 m, VIII. 1971, FIŠEROVÁ, PRC; Černi vrach, top, silicate rocks, 2290 m, VII. 1971, NĚMCOVÁ, herb. NĚMCOVÁ; Zlatni mostove, direction Černi vrach, VI. 1971, NĚMCOVÁ, herb. NĚMCOVÁ; in high-mountain grasslands, VII. 1887, VELENOVSKÝ, PR. — Rila: on road from Borovec to Musala, north of Samokov, granite, ca 1500 m, VIII. 1971, FIŠEROVÁ, PRC; below the Musala Peak, north of Samokov, granite, ca 2000 m, VIII. 1971, FIŠEROVÁ, PRC; Malovica, VI. 1971, NĚMCOVÁ, herb. NĚMCOVÁ; Vapsko ezero, VIII. 1971, REJMANĚK, herb. REJMANĚK. — Pirin: near the hut Viehren, silicate rocks, 1950 m, VIII. 1971, FIŠEROVÁ, PRC; Vasilaški ezera, silicate rocks, 2200 m, VI. 1972, FIŠEROVÁ, PRC.

Poa alpina subsp. *balcanica* var. *macedonica*

Pirin: below Kabata, stony places, limestone, ca 2400 m, VIII. 1971, FIŠEROVÁ, PRC; below the Vichren Peak, stony places, limestone, ca 2850 m, VIII. 1971, FIŠEROVÁ, PRC; Kabata, stony places, limestone, ca 2700 m, VIII. 1971, FIŠEROVÁ, PRC; Vichren Peak, stony places, limestone, 2914 m, VIII. 1971, FIŠEROVÁ, PRC.

Poa alpina L. subsp. *stefanovii* FIŠEROVÁ, subsp. nova

In 1972 robust specimens of *Poa alpina* were found by the present author in some isolated sites in the forest part of the Pirin and the Rodopi Mountains. Morphologically, they differed from all other Bulgarian material of

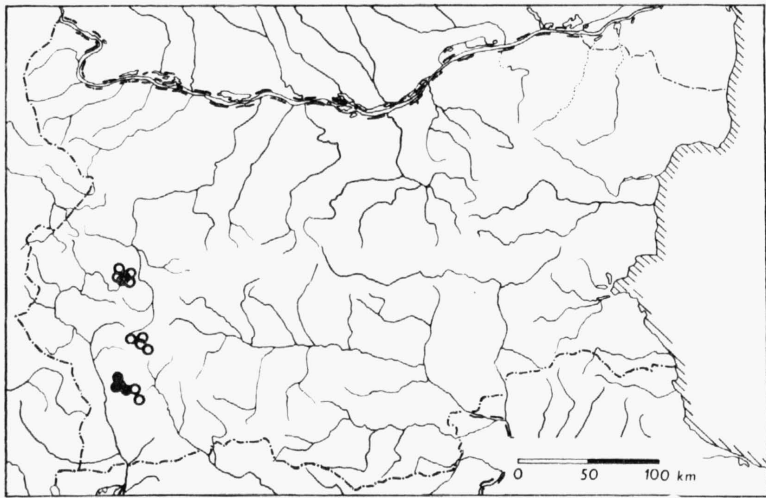


Fig. 13. — Distribution of *Poa alpina* L. subsp. *balcanica* var. *balcanica* (circles) and *Poa alpina* L. var. *macedonica* ACHT. (dots) in Bulgaria.

the species from above timberline. The typical character is the long ligules (Fig. 5g, h), especially those of the upper leaves of the culm, the length of which may amount to 8 mm. The panicle is pyramidal, the branches are often flexuous and, unlike, subsp. *balcanica*, they are long. Spikelets (Fig. 6d) are larger than those of var. *balcanica* and var. *macedonica* and the most frequent number of flowers in spikelet (7–8) is the largest number ever found by the present author in *Poa alpina*. Lemmata and paleae (Fig. 7h, i) are lanceolate, more extended and more pointed than in subsp. *balcanica* and typical Central European specimens of *Poa alpina* subsp. *alpina*. These differences are responsible for the appearance of the spikelets. The hairiness of lemmata is rather dense, often visible without a lens, and is confined to the keel and lateral nerves. The paleae have teeth on their keels which is an evidence of the relationship to *Poa alpina* subsp. *balcanica* rather than to *Poa alpina* subsp. *alpina* from Central and Northern Europe. The ecology of these plants is quite different. They are confined to calcareous rocks in mountain woods, in lower altitudes than *Poa alpina*. No vivipary was observed and it seems to be completely absent in this subspecies. Specimens with these characters are here referred to the subsp. *stefanovii* (habit, Fig. 4).

This subspecies is named in honour of Professor STEFANOV because it proved to be identical with what was described as *Poa borisii* STEFANOV in 1930. *Poa borisii* was later identified with *Poa alpina* L. var. *divaricata* SCHUR. In the Bulgarian flora (KITANOV et PENEV 1963), this taxon is referred to as *Poa alpina* L. f. *divaricata* SCHUR.

Using a graphical method, *Poa alpina* subsp. *stefanovii* was compared with the most typical Bulgarian subspecies *Poa alpina* subsp. *balcanica*. Both the subspecies have one character in common, namely the palea merely denticulate. This character is only known to occur in Bulgarian populations. For comparison, the length of the ligules (Fig. 10) and the number of flowers per spikelet (Fig. 11) were used. Unlike the two varieties of subsp. *balcanica* (Fig. 8 and 9), the peaks of the curves are more distant, indicating a considerable difference. The curves showing the variation in the length of the ligules are less steep (especially in subsp. *stefanovii*) which is an evidence of the wide range of values of the character examined (in subsp. *stefanovii* from 3 to 8 mm).

Descriptio

Poa alpina L. subsp. *stefanovii* FIŠEROVÁ, subsp. nova

Gramina 25–60 cm, aliquando usque 70 cm alta, griseo prasina. Culmi teretes, leves. Vaginae foliorum culmi basin innovationesque steriles breviter involventes. Laminae foliorum planae, plerumque 2–4 mm latae. Ligulae foliorum inferiorum 2–4 mm longae, ± laceratae. Ligulae foliorum superiorum prolongatae, lanceolatae, saepissime 6 mm, aliquando usque 8 mm longae. Panicula pyramidata, ramuli longi, saepe flexuosi. Spiculae magnae, usque 9 mm longae, ovaes, aliquando dilutissime colore violaceo tinctae, saepissime 7–8-florae. Flores non vivipari. Glumae inferiores et superiores 3-nervia, lanceolatae, acutae usque mucronatae, carina muricata. Lemmata lanceolata, acuta usque breviter mucronata, inter nervos ± glabra, nervis interioribus inconspicuis. Pili in carina et nervis lateralibus longiores, in carinae parte superiore in murices transientes. Paleae lanceolatae, lemmatibus aequilongae vel saepe breviores, 3/4 longitudinis lemmatis attingentes. Paleae carinae solum muricibus, raro in parte inferiore 1–3 pilis brevioribus praeditae. Paleae area media pilis paucissimis brevioribus instructa.

Typus: Bulgaria austro-occidentalis: montes Pirini: sub cacumine montis Gradišćeto in valle fluminis Demjanica, in substrato calcareo, alt. ca 1300 m. s. m., VI. 1972, leg. FIŠEROVÁ (PRC).

Stationes: in silvis regionis subalpinae, locis saxosis.

Area: Bulgaria austro-occidentalis.

List of localities of the specimens studied

Rila: Velingrad, VII. 1971, NĚMCOVÁ, herb. NĚMCOVÁ. — Pirin: below the Gradišćeto Peak, in valley Demjanica, calcareous rocks in forest, ca 1300 m, VI. 1972, FIŠEROVÁ, PRC, (typus); below the Gradišćeto Peak, in valley Demjanica, calcareous rocks in forest, ca 1250 m, VI. 1972, FIŠEROVÁ, PRC. — West Rodopi: on road from Progled to Pamporovo, calcareous rocks in forest, ca 1600 m, VI. 1972, FIŠEROVÁ, PRC; on road from Progled to Pamporovo, calcareous rocks in forest, ca 1500 m, VI. 1972, FIŠEROVÁ, PRC.

Key to subspecies and varieties

- 1a) Palea hairy on the lowermost parts of keels, denticulate distally: subsp. *alpina*.
- 1b) Palea with denticulate keels, rarely with some very short hairs on the lowermost parts of keels — 2.
- 2a) Panicle pyramidal, rather thin, with long branches; spikelets mostly 7–8-flowered; lemmata and paleae lanceolate, clearly acuminate; ligules of uppermost culm leaves up to 8 mm long: subsp. *stefanovii*.
- 2b) Panicle oval, rather dense, with short branches; spikelets mostly 3–6-flowered; lemmata and paleae oval-lanceolate; ligules up to 5 mm long: subsp. *balcanica* — 3.
- 3a) Plants 25–50 cm tall; leaves 2–4 mm wide; ligules up to 3 mm long; spikelets small, ± 5 mm long; spikelets up to 70 per inflorescence: subsp. *balcanica* var. *balcanica*.
- 3b) Plants 10–25 cm tall; leaves 1–3 mm wide; ligules longer; spikelets ± 7 mm long; spikelets up to 25 per inflorescence: subsp. *balcanica* var. *macedonica*.

V Bulharsku byly shledány morfologicky odlišné typy druhu *Poa alpina* vážící se na určitá stanoviště. Rostliny charakteristické pluškou s chlupy na kýlech výše přecházejícími v zoubky byly v práci hodnoceny jako poddruh *Poa alpina* L. subsp. *alpina*. Tento poddruh, rostoucí ve všech ostatních částech areálu druhu, je v Bulharsku jen řídké rozšířen. Exempláře s pluškou pouze se zoubky, zjištěné zde v hojném počtu, byly zařazeny ke dvěma novým poddruhům — *Poa alpina* L. subsp. *balcanica* zahrnující var. *balcanica* a var. *macedonica* ACHT. a *Poa alpina* L. subsp. *stefanovi*. Tyto rostliny s pluškou pouze se zoubky byly nalezeny jen v Bulharsku. Lze je očekávat ještě v přilehlých oblastech Balkánského poloostrova, v ostatních částech areálu druhu však zaznamenaný nebyly.

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S. Analytis:

Methodik der Analyse von Epidemien dargestellt am Apfelschorf (*Venturia inaequalis* (COOKE) ADERH.)

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Publikace je příkladem využití matematiky a moderních počítačů v ochraně rostlin. V metodické kapitole jsou definovány a matematicky vyjádřeny základní pojmy intenzity a četnosti napadení i jejich změn, dále jsou charakterizována tzv. fenometrická data, jako je stáří listů, jejich barva, plocha, tvar, počet nově vyrostlých listů, jejich postavení na letorostu, orientace k světovým stranám a další jednoduché údaje (délka a šířka listu, délka řapíku aj.). V dalších odstavcích jsou stanoveny vlastnosti eizopasně houby, jako uvolňování askospor, počet období nákaz a jejich trvání, průběh teplot ve vztahu k houbě, růst houby a jeho kontrola, klíčení výtrusů, růst klíční hyfy aj. V závěru metodik je popsáno použití standardních statistických metod na počítačích.

V následující kapitole jsou rozborů dat získaných podle popsáných metod, jež jsou zachycena číselně i graficky. Tato data jsou pak zhodnocena v závěrečné diskusi a stručném souhrnu, který je též přeložen do angličtiny. V seznamu literatury jsou uvedeny německy a anglicky psané práce z oboru matematiky, statistiky, biometrie a fytopatologie.

A. Příhoda