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***Phleum commutatum* and *Ph. rhaeticum* (Poaceae) in the Eastern Alps: Characteristics and Distribution**

By

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With 6 Figures

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Key words: *Gramineae*, *Poaceae*, *Phleum alpinum* group, *Phleum commutatum* GAUDIN, *Phleum rhaeticum* (HUMPHRIES) RAUSCHERT. – Morphology, anther length, determination. – Eastern Alps, Bohemian Forest, Europe.

Summary

ZERNIG K. 2005. *Phleum commutatum* and *Ph. rhaeticum* (Poaceae) in the Eastern Alps: characteristics and distribution. – *Phyton* (Horn, Austria) 45 (1): 65–79, 6 figures. – English with German summary.

The two species of *Phleum alpinum* group – *Ph. commutatum* GAUDIN and *Ph. rhaeticum* (HUMPHRIES) RAUSCHERT – were investigated. They can be differentiated morphologically by the presence (*Ph. rhaeticum*) or absence (*Ph. commutatum*) of ciliae on the awns of the glumes. But this character turned out to be insufficient for populations which have one or few ciliae on the base of awns. Some other morphological characters were tested, if and to what extent they provide additional features to facilitate correct determination. The length of the anthers shows distinct differences between the two species: anthers of *Ph. commutatum* are (0.6) 0.7–1.2 (1.3) mm long, while those of *Ph. rhaeticum* measure (1.0) 1.3–2.0 (2.3) mm. Collection sites of more than 1200 revised herbarium specimens are localized and shown in dot maps. *Ph. rhaeticum* is very common and frequent in the central and southern regions of the Eastern Alps, towards the north it becomes rarer. It prefers pastures in the subalpine and alpine belt. *Ph. commutatum*, in contrast, grows especially in the alpine belt of the Central Alps, there forming part of the snow-bed vegetation. Towards the north it becomes more common, where it grows in moderate altitudes from 1500 m upwards. In the Bavarian and Bohemian Forest *Ph. commutatum* occurs exclusively.

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Zusammenfassung

ZERNIG K. 2005. *Phleum commutatum* and *Ph. rhaeticum* (Poaceae) in den Ostalpen: Merkmale und Verbreitung. – *Phyton* (Horn, Austria) 45 (1): 65–79, 6 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Die beiden Arten der *Phleum alpinum*-Gruppe – *Ph. commutatum* GAUDIN und *Ph. rhaeticum* (HUMPHRIES) RAUSCHERT – werden untersucht. Sie werden morphologisch durch das Vorhandensein (*Ph. rhaeticum*) bzw. das Fehlen (*Ph. rhaeticum*) von Wimpern auf der Hüllspelzengranne unterschieden. Dieses Merkmal stellt sich aber als unzureichend heraus bei Individuen mit einer einzigen oder ganz wenigen Wimpern an der Basis der Granne. Daher werden einige andere Merkmale daraufhin überprüft, ob und in welchem Ausmaß sie für eine sicherere Bestimmung tauglich sind. Die Länge der Antheren stellt sich bei beiden Arten als deutlich verschieden heraus: die Staubbeutel von *Ph. commutatum* sind (0,6) 0,7–1,2 (1,3) mm lang, jene von *Ph. rhaeticum* hingegen (1,0) 1,3–2,0 (2,3) mm. Die Fundpunkte von über 1200 revidierten Herbarbelegen wurden lokalisiert und werden in Punktkarten gezeigt. *Ph. rhaeticum* ist in den zentralen und südlichen Teilen der Ostalpen häufig, nach Norden hin wird diese Art seltener. Sie bevorzugt nährstoffreiche Weiden in der subalpinen Höhenstufe. Im Gegensatz dazu ist *Ph. commutatum* seltener, es wächst vor allem in der alpinen Stufe der Zentralalpen – nach Norden hin wird es häufiger, dort wächst es schon in tieferen Lagen ab ca. 1500 m. Im Bayerischen Wald und im Böhmerwald kommt nur *Ph. commutatum* vor.

1. Introduction

Phleum L. sect. *Phleum* contains four taxa, which have been frequently causing heartburn to botanists. Morphologically they can be split up into two distinct groups: The *Phleum pratense* group, consisting of *Phleum pratense* L. and *Phleum bertolonii* DC., and the *Phleum alpinum* group, comprising *Phleum commutatum* GAUDIN and *Phleum rhaeticum* (HUMPHRIES) RAUSCHERT. The assignment of *Phleum* populations, both to a group and to a species often involves considerable difficulties. The present paper tries to provide more suitable morphological criteria for an accurate determination of *Ph. commutatum* and *Ph. rhaeticum*.

While *Ph. pratense* and *Ph. bertolonii* differ from each other mainly in size, the crucial morphological feature to distinguish the taxa within the *Ph. alpinum* group is the absence or presence of ciliae on the glume awns (CONERT 1983, 1985; DOĞAN 1991). This character seems to be apparently clear, as it provides – at least theoretically – two sharply defined and mutually exclusive conditions. But it turns out to be insufficient for populations that have one or few ciliae on the base of awns. Till now such populations were seen both as *Ph. rhaeticum* (e. g. ROESSLER 1983) and as *Ph. commutatum* (e. g. JOACHIMIAK 38; KULA 1996), or it was stated that with today's insight a final decision could not be made (TEPPNER 1980).

Ph. rhaeticum can be found in most Central and South European mountain ranges, whereas the area of *Ph. commutatum* additionally comprises Scandinavia, the Caucasus, mountain ranges of Central Asia, the

Rocky Mountains in North America and the southern Andes in South America. In the Alps both species grow in subalpine and alpine regions, reaching altitudes up to 2900 m above sea level (CONERT 1985).

Until now distribution maps were published mostly for the total *Ph. alpinum* group (e. g. MEUSEL & al. 1965, HAEUPLER & SCHÖNFELDER 1988), probably due to the difficulties of distinguishing the species. For the same reason wrong identifications are frequent and it is necessary to be aware of erroneous reports in literature. Additional confusion was caused by nomenclatural reasons.

Concise History of the Taxonomy of *Ph. alpinum* Group

GAUDIN 1808 distinguished two morphological variants of the alpine timothy grass (in German: Alpen-Lieschgras), which was named *Phleum alpinum* by LINNÉ 1753. The first variant, with ciliated awns and more common in the Swiss Alps, he considered as the Linnean *Ph. alpinum*, whereas the second one, with glabrous awns, was described as a new species: *Ph. commutatum* GAUDIN. The existence of these two taxa was broadly accepted, although they have been variously treated as species, subspecies or varieties.

HUBBARD 1968 was the first to express doubts as to the identity of Linnean *Ph. alpinum* as interpreted by GAUDIN. He considered *Ph. commutatum* as an erroneous name for *Ph. alpinum*. BOR 1971 realized that the type specimens of *Ph. alpinum* and *Ph. commutatum* resemble each other; therefore he proposed to give a new name to *Ph. alpinum* sensu GAUDIN, or to use an older name if there exists one. KERGUÉLEN 1975 was conscious of taxonomical and nomenclatorial difficulties concerning *Ph. alpinum* as he was compiling a catalog of *Poaceae* from France. Thus, he gave a list of names (*Ph. capitatum* SCOP., *Ph. geniculatum* BELL. ex VITMAN, *Ph. subalpinum* BRÜGGER), which perhaps could be used for the taxon with ciliated awns, but he did not investigate this matter further.

Typification of *Ph. alpinum* was examined in detail by HUMPHRIES 1978. He designated a specimen out of Linnean Herbarium Laponicum (Fl. lapp. 25), which contains a single plant with glabrous awns, as the lectotype. Since HUMPHRIES accepted the two taxa only on subspecies level, *Ph. commutatum* GAUDIN became a synonym of *Ph. alpinum* subsp. *alpinum*. For the taxon with ciliated awns the new name *Ph. alpinum* subsp. *rhaeticum* HUMPHRIES was introduced. Finally RAUSCHERT 1979 put the taxa on species level, so that the one with ciliated awns nowadays is named *Ph. rhaeticum* (HUMPHRIES) RAUSCHERT. To consider these taxa as species, this taxonomic view is accepted now to a great extent. According to the rules of the International Code of Botanical Nomenclature the correct names are *Ph. alpinum* L. and *Ph. rhaeticum* (HUMPHRIES) RAUSCHERT. So we are faced with the situation, that the name *Ph. alpinum* was applied

to both taxa, a fact that – combined with the difficulties in distinguishing them morphologically – increases confusion.

For reasons of clarity, the unambiguous names *Ph. rhaeticum* und *Ph. commutatum* are used in this paper and *Ph. alpinum* is applied to name the species group only.

2. Material and Methods

The present study is based on more than 1200 herbarium specimens from the herbaria FI, GJO, GZU, IB, KL, LI, LJU, M, MSB, SZU, U, W, WHB, WU (herbarium acronyms following HOLMGREN & HOLMGREN 1990) and the private herbaria of W. GUTERMANN (Vienna), H. HEIMEL (Graz), R. KARL (Köflach) and H. TEPPNER (Graz). Geographically this study is limited to the Eastern Alps (including Bohemian Forest).

Various characters were tested, if and to what extent they are able to improve the morphological differentiation between *Ph. commutatum* and *Ph. rhaeticum*. Quantitative analyses of morphological leaf and inflorescence characters and of anther length were performed on herbarium material.

The specimens were examined carefully, their collections sites were identified (as far as possible) and geographical coordinates were assigned to them, so that dot maps of the studied taxa could be generated with the help of a Geographic Information System (GIS). A list of all seen specimens is deposited in the libraries of the herbaria GJO and GZU. Furthermore, the list is published in Internet (<http://www.museum-joanneum.at/botanik>; search for “Phleum”, “specimen list” and “Phyton”).

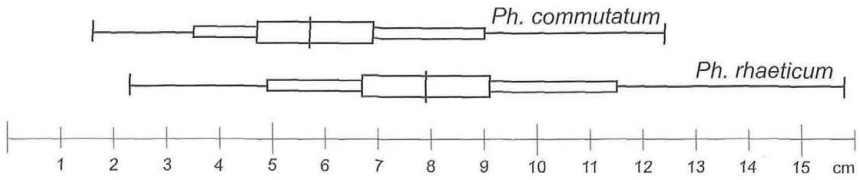
3. Results

3.1. Morphological Analysis

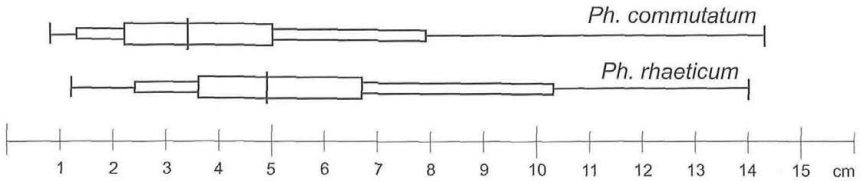
The length of blades and of sheaths of the uppermost leaves of both *Ph. commutatum* and *Ph. rhaeticum* were measured on fully-grown culms, i. e. when flowering or bearing fruits. The data are summarized in Fig. 1 (for detailed figures see ZERNIG 2004). Although the medians are clearly different – usually leaves of *Ph. rhaeticum* are somewhat longer than leaves of *Ph. commutatum* –, it seems reasonable, that actual dimensions of leaves, and of its parts, are more dependent upon prevailing habitat conditions. This view is supported by the fact that the distribution of the ratio values (length of blade to length of sheath) is almost identical in both species.

The inflorescence of the *Ph. alpinum* group is a spike-like panicle, where the panicle branches are almost totally adnate to the main axes. Length and width of inflorescences were measured on fully-grown culms, the results are given in Fig. 2. The width of inflorescences varies within the same range for both species, whereas there is a clear difference in the in-

Sheath length



Blade length



Ratio of blade length to sheath length

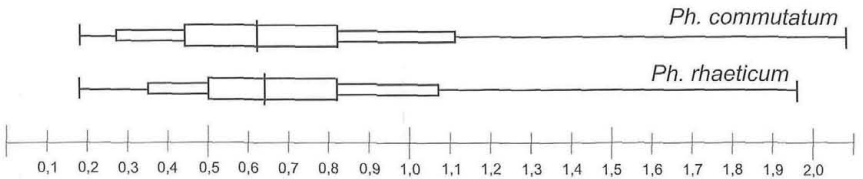


Fig. 1. Distribution of sheath lengths and blade lengths of the uppermost leaf in *Ph. commutatum* (n = 410) and *Ph. rhaeticum* (n = 671). The Box-and-whisker plots show the median, the 50 % and the 90 % quantile, and the range of values.

florescence length (and therefore also in the distribution of the ratio values of length to width). 75 % of the panicles in *Ph. rhaeticum* are longer than 21 mm whereas 75 % in *Ph. commutatum* are shorter than 21 mm. Expressed in terms of the ratio length to width, 75 % of the panicles in *Ph. rhaeticum* are at least, and 75 % in *Ph. commutatum* at the most three times as long as broad.

Although the panicle length is not a qualified character, with which it is able to distinguish between the two species, the difference is obvious. The figures coincide with the fact, that often the panicles of *Ph. rhaeticum* are described as \pm cylindrical and those of *Ph. commutatum* as spheroid or ovoid. But it has to be emphasized, that in the process of determination inflorescence length and form has to be applied with certain care, as 25 %

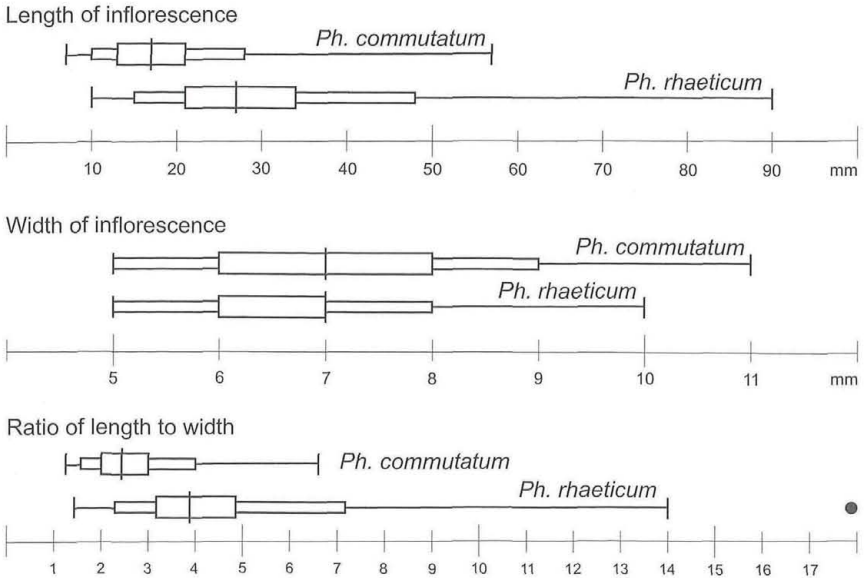


Fig. 2. Distribution of inflorescence lengths and widths in *Ph. commutatum* (n = 524) and *Ph. rhaeticum* (n = 470). The Box-and-whisker plots show the median, the 50 % and the 90 % quantile, and the range of values. The isolated dot represents an extreme value.

of the individuals of each species show inflorescence lengths common within the other species.

The length of fully developed anthers was measured with a precision of 0.1 mm. Both, anthers filled with pollen and already empty ones were treated similarly, whereas aberrant anthers (i. e. anthers which had developed mainly unfertile or no pollen) were not taken into account. The results are shown in Fig. 3.

Anthers of *Ph. commutatum* (0.6–1.3 mm) are considerable shorter than those of *Ph. rhaeticum* (1.0–2.3 mm). Fig. 3 shows on the one hand that 95 % of *Ph. commutatum* anthers are shorter than 1.2 mm and on the other that 95 % of *Ph. rhaeticum* anthers are longer than 1.3 mm. So just 5 % of all measured anthers show lengths in the overlapping range between 1.0 and 1.3 mm. On the base of these findings the anther length seems to be a good morphological character to distinguish between the species of the *Ph. alpinum* group.

To get a more detailed idea of anther lengths in *Ph. alpinum* group, the distribution within particular herbarium specimens were analyzed, presuming that all culms on an herbarium sheet of a specified collection come from one and the same clone. Such an analysis should be able to clarify, if

Anther length

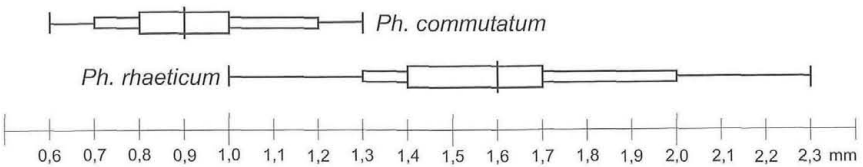


Fig. 3. Distribution of anther lengths in *Ph. commutatum* (n = 979) and *Ph. rhaeticum* (n = 996). The Box-and-whisker plots show the median, the 50 % and the 90 % quantile, and the range of values.

the anther lengths of one individual show the whole previous mentioned range, or if anther lengths of specified individuals are quite different and therefore the total of different individuals gives the whole range.

Fig. 4 shows anther lengths within individual clones of *Ph. commutatum* and *Ph. rhaeticum*. Based on the comparison of anther-length ranges the following conclusions can be drawn:

Especially on individuals of *Ph. commutatum* from the Alps there are mostly anthers shorter than 1.0 mm, even more than half of the anthers can be that short. But there are 1.0–1.3 mm long anthers as well, especially in masty individuals and on plants from Scandinavia and the northern parts of the Alps.

Within all individuals of *Ph. rhaeticum* at least some anthers are longer than 1.3 mm (as already shown, only 5 % of all the measured anthers are shorter). Anther lengths exclusively within the overlapping range from 1.0 to 1.3 mm were observed on only one very poorly nourished and therefore badly developed individual.

Considering the distribution within individuals, the ranges of anther lengths can be stated as following (extreme values given in brackets):

Ph. commutatum: (0.6) 0.7–1.2 (1.3) mm;

Ph. rhaeticum: (1.0) 1.3–2.0 (2.3) mm.

3.2. Distribution of *Ph. commutatum* and *Ph. rhaeticum*

Geographical coordinates were assigned to collection sites of revised herbarium specimens as far as possible, the resulting dot maps are given in Fig. 5 and Fig. 6. They do not show the distribution area of the taxa in concern, but the origins of studied material.

4. Discussion

4.1. Morphology

The revealed difference in anther lengths of *Ph. commutatum* and *Ph. rhaeticum* provide a good additional morphological character to dis-

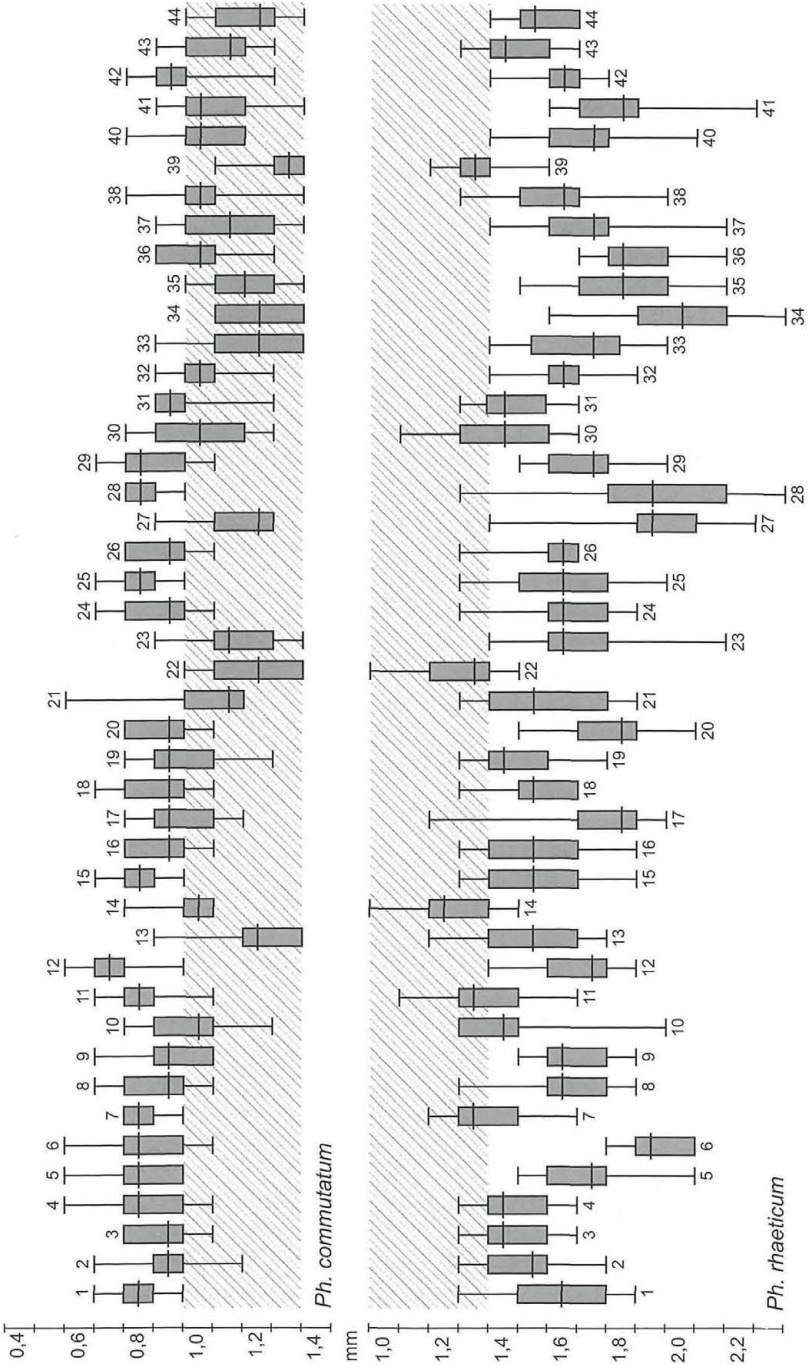


Fig. 4.

Fig. 4. Distribution of anther lengths within particular herbarium specimens of *Ph. commutatum* (above) and *Ph. rhaeticum* (below). The Box-and-whisker plots show the median, the 50 % quantile, and the range of values. The hatched area marks the value range, that the two species have in common.

Ph. commutatum: Styria (1) Etrachböden, leg. ZERNIG Nr. 3354, n = 32; (2) Süßleiteck, leg. ZERNIG Nr. 3329, n = 33; (3) Süßleiteck, leg. ZERNIG Nr. 3337, n = 31; (4) Schimpelsee, leg. ZERNIG Nr. 3341, n = 47; (5) Preber, leg. ZERNIG Nr. 3350, n = 29; (6) Hochwurzen, leg. ZERNIG Nr. 3074, n = 37; (7) Hochwurzen, leg. ZERNIG Nr. 3079, n = 37; (8) Planai, leg. WAGNER (SZU 24.496), n = 27; (9) Tattermann, leg. HESKE (GZU), n = 20; (10) Schreinl, leg. HAFELLNER (GZU), n = 21; (11) Kühlnbrein, leg. MELZER (GZU 212.162), n = 22; (12) Trisselberg, leg. SALZMANN (GZU 58.868), n = 13; (13) Turrach, leg. MELZER (LI 23.422), n = 17; (14) Rax, leg. FRITSCH (GZU), n = 22; (15) Schneecalpe, leg. BAYER (GJO 10374), n = 20. Carinthia (16) Dösner Alm, leg. ZERNIG Nr. 3114, n = 17; (17) Dösner See, leg. ZERNIG Nr. 3117, n = 11; (18) Glocknerstraße, leg. ZERNIG Nr. 3121, n = 37; (19) Glocknerstraße, leg. ZERNIG Nr. 3124, n = 26; (20) alpinus carinthiacis (GZU, Herb. HOPPE Nr. 2881), n = 13. Tyrol (21) Fimbatal, leg. WITTMANN & PILSL (SZU 14.844), n = 12; (22) Komperdell, Inst.-Ex. 1981 (SZU 16.333), n = 12; (23) Kalser Törl, [collector not given] (LI), n = 27. Vorarlberg (24) Tilisunahütte, leg. ERNET (GJO 27.005/5), n = 30. Salzburg (25) Gastein, leg. FRITSCH without collection date (GZU), n = 12; (26) Gastein, leg. FRITSCH Juli 1889 (GZU), n = 14; (27) Untersberg, leg. FRITSCH (GZU), n = 15. Upper Austria (28) Wurzeralm, leg. ZERNIG Nr. 2982, n = 15; (29) Kasberg Sepp-Huber-Hütte, leg. TEPPNER (GZU), n = 29; (30) Kasberg Spitzplaneck, leg. TEPPNER (GZU), n = 26. Lower Austria (31) Schneeberg, leg. ZERNIG Nr. 3239, n = 14; (32) Schneeberg, leg. ETTINGSHAUSEN (GZU), n = 22; (33) Wechsel, leg. VIERHAPPER (WHB 42.810), n = 20. Italy (34) Ortlergruppe, leg. WAGNER (SZU 25.082), n = 13. Germany (35) Karwendelgebirge, leg. MAYER (M 53.024), n = 18. Romania (36) Királyö, leg. DE DEGEN (GZU 97.974), n = 16. Sweden (37) zwischen Änn und Enafors, leg. WARDELL (GZU 15.628), n = 14; (38) Jukkasjärvi, [collector not given] (GZU), n = 17; (39) Åre, leg. FOLKESON (GZU), n = 18. Norway (40) Dovrefjell, leg. BUSCHARDT 38; POELT (GZU), n = 25. Finland (41) Ylikyrö, leg. TALLGREN (GZU), n = 24; (42) Itämäki, leg. ULVINEN (LJU 75.207), n = 20. Iceland (43) Dimmuborgir, leg. HESKE (GZU), n = 11. Greenland (44) Augpilagtoq, leg. GRAVESEN 38; HANSEN (GZU), n = 20.

Ph. rhaeticum: Styria (1) Koralpe, leg. ARBESSER (GZU 21.924), n = 29; (2) Koralpe, Reihalm, leg. BURRI (LI 407.104), n = 26; (3) Stubalpe, leg. SCHAEFTLEIN (GZU 150.838), n = 15; (4) Zirbitzkogel, leg. SALZMANN (GZU 58.868), n = 23; (5) Vorderhüttenalpe bei Stadl, leg. FEST (LI 103.765), n = 31; (6) Großer Bösenstein, leg. ZERNIG Nr. 2981, n = 13; (7) Triebenstein, leg. RÖSSLER (GZU 112.450), n = 16; (8) Etrachsee, leg. FEST (GJO 25.187), n = 17; (9) Preber, leg. DOBE (LI 365.106), n = 11; (10) Silberkarsee, leg. ZERNIG Nr. 3248, n = 22; (11) Feisterscharte, leg. ZERNIG Nr. 3246, n = 36; (12) Stoderzinken, leg. PALLA (GZU), n = 22; (13) Hochschwab, Häuslalm, leg. ZERNIG Nr. 3229, n = 32; (14) Hochschwab, Sackwiesensee, leg. ZERNIG Nr. 3230, n = 18. Carinthia (15) in alpinus carinthiacis (GZU, Herb. HOPPE Nr. 2881), n = 24; (16) Gössnitzal, leg. PALLA (GZU), n = 26; (17) Karawanken, Matschacher Alpe, leg. SABIDUSSI (KL 13.406), n = 17; (18) Poludnig, leg. LEUTE (KL 83.468), n = 29; (19) Kreuzeck, Rottensteiner Graben, leg. DOLENZ (GZU), n = 18; (20) Kreuzeck, Embargeralm, leg. EGGLEER (GZU 103.048), n = 25; (21) Heiligenblut (GZU, Herb. HOPPE Nr. 2880), n = 13; (22) Tauernkreuz, leg. ZERNIG Nr. 3092, n = 20, albinotic individual; (23) Laschgewand, leg. ZERNIG Nr. 3110, n = 45; (24) Dösner Alm, leg. ZERNIG Nr. 3113, n = 16; (25) Dösner Alm, leg. ZERNIG Nr. 3118, n = 39; (26) Glocknerstraße, leg. ZERNIG Nr. 3125, n = 47; (27) Glocknerstraße, leg. ZERNIG Nr. 3126, n = 42. Tyrol (28) Stamser Alpen, leg. EVERS (GZU), n = 50; (29) Obergurgl, leg. TANNICH (LI 403.213), n = 19; (30) Obergurgl, leg. POLATSCHKE (W 1988/7805), n = 27; (31) Floitengrund, leg. POLATSCHKE (W 1988/7809), n = 15; (32) Innerschmirn, leg. POLATSCHKE (W 1976/14512), n = 27. Vorarlberg (33) Gortipohl, leg. POLATSCHKE (W 1988/7814), n = 29. Salzburg (34) Krimml, leg. RONNIGER (W 1966/4354), n = 30; (35) Wengeraiblalm, leg. RONNIGER (W 1966/4337), n = 30; (36) Krimmler Achenal, leg. SCHRÖCK (LI 457.466), n = 19; (37) Rauris, leg. MITTENDORFER (LI 18.827), n = 31; (38) Radstädter Tauern, Grünwaldsee, leg. WITASEK (GZU), n = 30; (39) Pinzgauer Alpen, leg. FRITSCH (?) (GZU), n = 26; (40) Tennengebirge, leg. WITTMANN & al. (LI 167.081), n = 33. Upper Austria (41) Gjaidal, leg. ŽILA (LI 320.991), n = 37. Bosnia (42) Maglic, leg. BECKER (?) (LI 871.017), n = 17. Switzerland (43) Sustenpass, leg. ŽILA (LI 320.989), n = 17. France (44) Mont Blanc, Lac de Charamillon, leg. KŁAPKA (LI), n = 25.

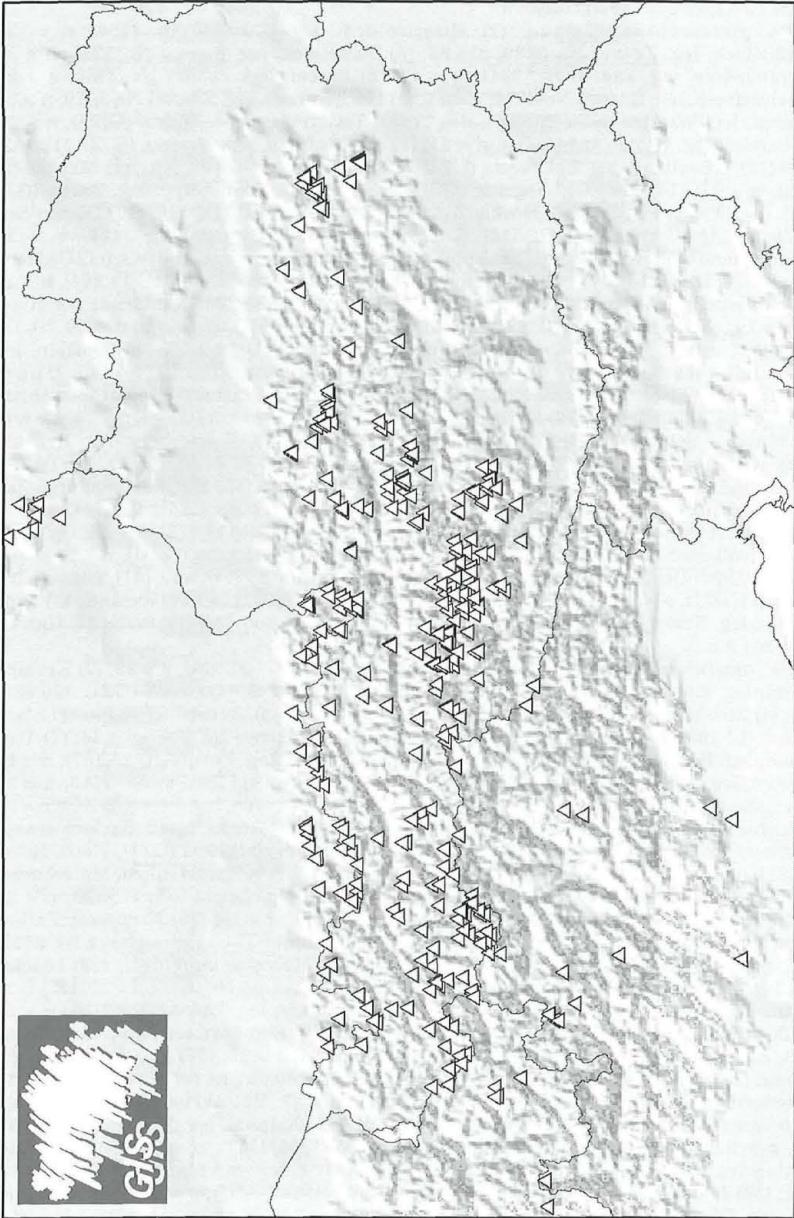


Fig. 5. Origins of revised herbarium specimens of *Ph. commutatum* in the Eastern Alps and the Bohemian Forest.

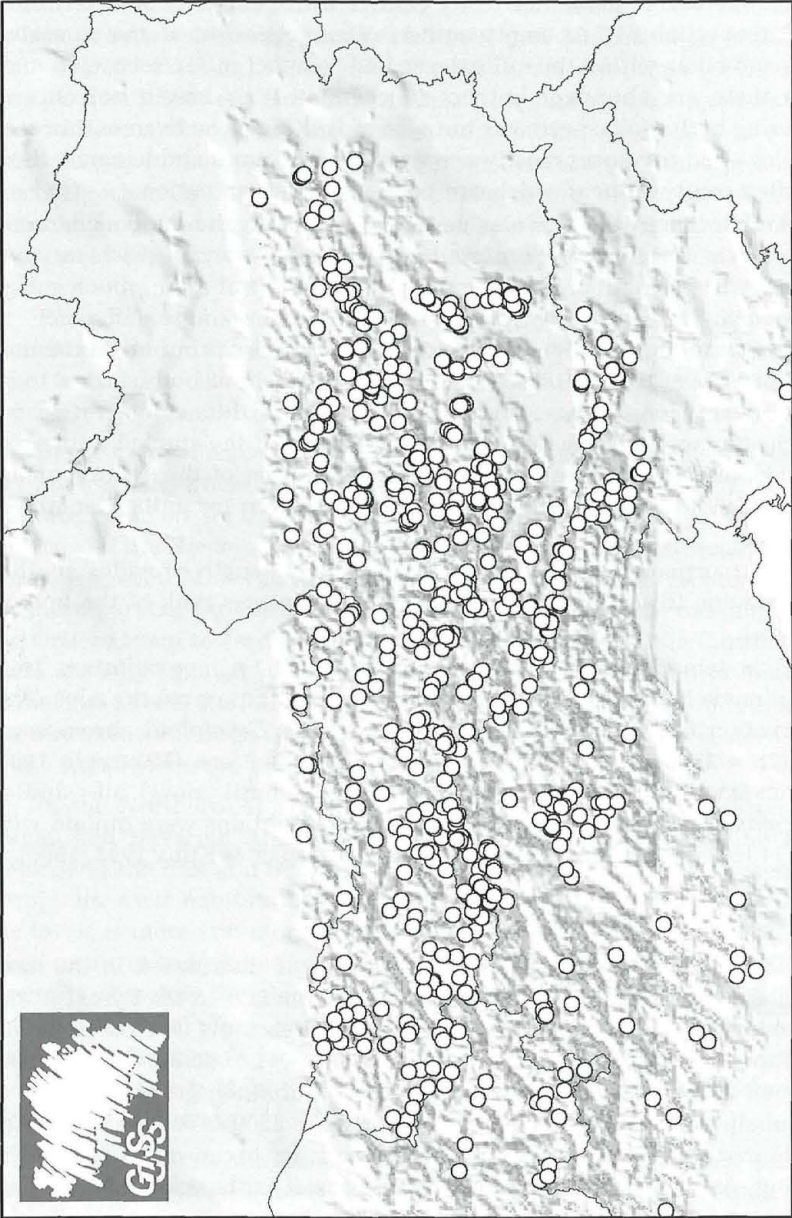


Fig. 6. Origins of revised herbarium specimens of *Ph. rhaeticum* in the Eastern Alps.

criminate the two taxa. Most of the specimens with one or few ciliae on the base of awns, which formerly remained of doubtful identity because they neither showed glabrous nor really ciliated awns, can now be determined with great reliability. As empty anthers often get caught on the numerous awns and ciliae within the quite dense and compact inflorescence, in most cases there are abundant anthers to examine their length not only in flowering herbarium specimens but also in fruiting ones. Even within seed samples – the caryopses mostly are wrapped in glumes and lemma – there are often empty anthers which can be used for determination.

Anther length till now was never given as a discriminative character between the species of *Ph. alpinum* group. HUMPHRIES 1978 mentioned anthers with a length of 1.0–1.8 mm in his diagnosis of *Ph. alpinum* subsp. *rhaeticum*, but obviously he did not recognize any difference to *Ph. commutatum* (i. e. *Ph. alpinum* subsp. *alpinum* within his taxonomic concept). CONERT 1983, 1985 considered the anthers of both species to be 1.5–2.2 mm long. These figures are a little bit exaggerated for *Ph. rhaeticum*, and they do not match with any of the studied anthers of *Ph. commutatum*. In the latest worldwide revision of the genus *Phleum* (DOĞAN 1991) a single range of 1.2–1.8 mm is given for anther lengths of both taxa.

The morphological difference in the anther length provides another confirmation to the already broadly accepted species rank of the taxa in concern.

It is remarkable that individual plants of *Ph. commutatum* from Scandinavia have a little bit longer anthers than those from the Alps. This observation coincides with karyological results: Tetraploid chromosome sets ($2n = 28$) were found in Scandinavian populations (MÜNTZING 1935, NORDENSKIÖLD 1945, and others), whereas until now, all studied *Ph. commutatum* in the Alps and the Tatra Mountains were diploid with $2n = 14$ (MICHALSKI 1955, TEPPNER 1980, JOACHIMIAK & KULA 1993, 1996).

4.2. Distribution

According to CONERT 1985 *Ph. rhaeticum* is distributed in the most mountain ranges of Central and Southern Europe, i.e. in the Pyrenees, the Appenin, the mountain ranges of the Balkan Peninsula, the Carpathians, the Sudeten, and the Alps. In the Eastern Alps *Ph. rhaeticum* is the more common and wider distributed species of *Ph. alpinum* group. It grows in the subalpine and alpine belt from 1000 m up to 2500 m on well-nourished and humid habitats, especially on alpine pastures because it is favored by grazing. As it is both frequent and numerous, it is the economically most important grass species in high mountain regions.

Ph. rhaeticum grows in quite all regions of the Eastern Alps even though in different frequencies. In the central parts of the Eastern Alps it

occurs abundantly, in the southern parts it is also quite common, and in the Northern Alps it becomes more and more scattered. The gaps in the west of the studied area (in Vorarlberg and Tyrol) seem to be artificial due to lack of seen specimens; MAIER & al. 2001 give additional records especially from Vorarlberg. The area of *Ph. rhaeticum* comprises whole of the Northern and most of the Southern Alps. Although suitable habitats exist in adequate altitudes, on the eastern edge of the Alps there is a conspicuous gap in the Steirisches Randgebirge between the Stubalpe and the Wechsel, where this species is absent. The record of *Ph. rhaeticum* on Schöckl mountain in EGGLEER 1952, and subsequently in MAURER & al. 1983, was based on a misidentified herbarium specimen of *Ph. pratense*.

Ph. commutatum, in contrast to the former species, is distributed worldwide, and in the Eastern Alps its area is smaller and in general it is rare. It grows in the alpine and subalpine belt in moist grasslands and especially in higher altitudes it forms part of the snow-bed vegetation.

In the Central Alps this species can be found mainly in the alpine belt of those regions, where the highest peaks reach at least 2300 m. This grass is quite common in the Silvretta Group, the Ötztaler Alps, the Hohe Tauern and the Niedere Tauern. The gaps in Tyrol may be artificial, but for Vorarlberg even MAIER & al. 2001 do not give additional records. In the southern parts of the Eastern Alps this species seems to be missing. From the Ortler Group towards the East, in the Dolomites and the Carnic Alps, there are only isolated reports resulting from mainly old and/or doubtful herbarium sheets. No *Ph. commutatum* is reported from the Julic Alps, the Karawanken and the Savisc Alps, and it is missing even at the eastern edge of the Alps (where the peaks are not high enough).

In the Northern Alps we face a quite different situation. From the Allgäu and Bavarian Alps across the Berchtesgaden Alps and the Totes Gebirge to the Rax and Schneeberg mountain, *Ph. commutatum* seems to occupy the same habitats as *Ph. rhaeticum* does in the Central Alps, while the latter is more and more replaced by the former. It prefers well-nourished pastures and grows predominantly in moderate altitudes from 1500 m upwards, therefore the plants get taller and in general appear more vigorous. In this region plants with one or few ciliae on the base of the awns are noteworthy frequent, a fact that resulted till now in a lot of misidentifications (WITTMANN & al. w. y., ROESSLER 1983), as these plants mostly were seen as *Ph. rhaeticum*.

In the mountain ranges at the Bavarian-Bohemian boundary (Bavarian Forest, Bohemian Forest) the *Ph. alpinum* group is represented with *Ph. commutatum* exclusively. For these populations the remarks on morphology and preferred habitats are the same as for the plants in the Northern Alps.

This work is the first attempt to provide separate distribution maps for the two species of *Ph. alpinum* group in the Eastern Alps. Such an effort for the Western Alps is still lacking. A similar study from the Carpathians (KOVÁTS 1981) should be reworked, as it is based on a profound misunderstanding of the taxonomic concept of the species in question.

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