

A REVIEW OF *POTENTILLO TERNATAE – NARDION STRICTAE* ALLIANCE

Nikolay I. VELEV¹ & Iva I. APOSTOLOVA¹

Abstract

A classification of the *Nardus stricta* dominated communities in the Balkan Range is presented. Two associations are identified: *Nardetum strictae* and *Campanulo alpinae – Nardetum strictae* nom. nov. The alliance *Potentillo ternatae – Nardion strictae* is typified and some comments on its distribution range and syntaxonomical affiliation to the higher units are presented. A synopsis is included of all available associations referred to *Potentillo ternatae – Nardion strictae*.

Key words: grasslands, *nomen novum*, nomenclature, numerical methods, syntaxonomy.

Izvešček

V članku je predstavljena klasifikacija združb z dominantno vrsto *Nardus stricta* na Balkanu. Prikazali smo dve asociaciji: *Nardetum strictae* and *Campanulo alpinae – Nardetum strictae* nom. nov. Zvezo *Potentillo ternatae – Nardion strictae* smo tipizirali in predstavili njeno razširjenost in sintaksonomsko uvrstitev v višje enote. Prikazan je sinopsis vseh opisanih asociacij, ki jih uvrščamo v zvezo *Potentillo ternatae – Nardion strictae*.

Ključne besede: travniki, *nomen novum*, nomenklatura, numerične metode, sintaksonomija.

INTRODUCTION

The *Nardus*-rich communities are wide spread in the Bulgarian mountains. They are almost entirely of secondary origin and cover approximately 50000 ha (Velchev et al. 1989). A significant part of them is presented in the Balkan Range as a result of hundreds of years of extensive stock breeding. The syntaxonomical diversity of the mat-grass communities in the Bulgarian part of the Balkan Range has been studied so far following the dominant approach (see Bondev 1966; Ganchev & Kochev 1969; Meshinev et al. 2000). The same vegetation type, following the Braun-Blanquet approach, was described for Mt. Pirin (Simon 1958), Mt. Rila (Roussakova 2000) and reported for the Balkan Range, the Rhodopes and Mt. Sredna Gora (Meshinev et al. 2005). The successional changes of *Nardus stricta* communities in the Central Balkan Range

were commented by Velev & Apostolova (2008). The authors refer communities distributed below the timberline to *Nardion strictae* Br.-Bl. 1926, and those occupying higher elevations (above the timberline) to *Potentillo ternatae – Nardion strictae* Simon 1958. Similarly, for the Serbian territory, Kojić et al. (1998, 2004) refer the colline mat-grass pastures to *Nardion strictae* while the mat-grass pastures in the high mountains are considered as part of *Potentillo ternatae – Nardion strictae*, *Jasion orbiculatae* Lakušić 1966 and *Poion violaceae* Horvat 1937.

According to Krahulec (1985) *Potentillo ternatae – Nardion strictae* should be considered as a Carpathian-Balkan alliance, characteristic for the vegetation belt above the timberline. On the other hand, the associations recognized so far as being affiliated to this alliance represent an extremely broad variety of ecological and floristic peculiarities.

¹ Department of Phytocoenology and Ecology, Institute of Botany, Bulgarian Academy of Sciences, Acad. G. Bonchev St., bl. 23, 1113 Sofia, Bulgaria, e-mail: nvelev@bio.bas.bg; iva@bio.bas.bg.

The review of the literature revealed significant differences in authors' concepts regarding relation of the alliance to the higher units (orders and classes). The wealth of information gave us impetus to gather all available in the literature associations and to present the current overview on the *Potentillo ternatae* – *Nardion strictae* alliance. The aims of the present study are (i) to identify the syntaxonomy of *Nardus stricta* communities in the Balkan Range, and (ii) to review the *Potentillo ternatae* – *Nardion strictae* alliance.

2. MATERIAL AND METHODS

A data set of 336 relevés containing mat-grass were analysed. They are recorded for the Balkan Range (Figure 1) following the dominant approach (Bondev 1966, Ganchev & Kochev 1969, Meshinev et al. 2000) within an altitudinal range between 1400 and 2200 m.



Figure 1: Map of the sampled localities.
Slika 1: Zemljevid proučevanega območja.

Each relevé contains a full list of species excluding the mosses in some descriptions. The sample plots are 100 m². The original quantitative estimations are transformed to the old Braun-Blanquet scale following Meshinev & Apostolova (2002). The relevés are stored in the TURBOVEG data base (Hennekens & Schaminée 2001). They are exported into JUICE software (Tichy 2002) for further analysis. Subsequently unsupervised classification (TWINSPAN – Hill 1979) and supervised classification using the Cocktail method (Bruehlheide 1995, 2000) are applied. Two sociological groups (cf. Bruehlheide 2000; Chytrý 2007) were identified within the Cocktail method: (1) setting as an initial species *Nardus stricta* and rep-

resenting class *Calluno* – *Ulicetea*, and (2) setting as an initial species *Juncus trifidus* and representing class *Juncetea trifidi*. Each group includes five species. The classification of the relevés is based on the presence of at least three of these species. We used the logical operator AND (Bruehlheide 1997) to compose formal definitions for the two associations for the Balkan Range.

All available literature is referred to in order to elaborate a full list of associations of *Potentillo ternatae* – *Nardion strictae* alliance.

The syntaxonomical interpretation follows the floristic and ecological principles (Braun-Blanquet 1965; Westhoff & der Maarel 1973; Mueller-Dombois & Ellenberg 1974).

The syntaxonomical nomenclature of the revisions is in accordance with the *International Code of Phytosociological Nomenclature* (Weber et al. 2000) (in the text ICPN).

The nomenclature of the species follows Delipavlov et al. (2003), Kozuharov (1992), Natcheva & Ganeva (2005) and Wirth (1995), while the floristic elements are used after Oberdorfer (1994) and Assyov & Petrova (2006).

3. RESULTS AND DISCUSSION

The unsupervised classification of the relevés reveals that the mat-grass communities in the Balkan Range are divided into two distinct groups in relation to altitude and referring to different alliances. A part of the studied relevés is located within the subalpine belt and another part within the alpine belt. Although there are common species presented, the groups are well separated by a number of diagnostic species. The same groups are established as a result of the implementation of supervised classification and the Cocktail method (Bruehlheide 1995, 2000) as well. Two associations are clearly identified: *Nardetum strictae* and *Campanulo alpinae* – *Nardetum strictae* (Table 1).

The remaining relevés are spread among other cluster groups and are not considered in the subsequent analysis.

Association *Nardetum strictae* Grebenšćikov 1950

Sociological group *Nardus stricta*: *Nardus stricta*, *Festuca rubra*, *Agrostis capillaris*, *Hieracium hoppeanum*, *Verbascum longifolium*.

Formal definition for the Balkan Range: **Group**

Nardus stricta AND *Nardus stricta* cover > 25 %.

The identified *Nardetum strictae* association of the Balkan Range is developed at an altitudinal range of 1400–2080 m. It occupies formerly intensive pasturelands, which are currently extensively used. The communities are distributed over all the range of the studied area (Fig. 1). They are localized on ridges or slightly inclined slopes, creating conditions for preservation of the relatively well developed soil layer. The rocks are silicate.

The association was described by Grebenščikov for Mt. Stara Planina (Serbia) (Kojić et al. 1995). It is confirmed for the same locality also by Mišić et al. (1978) and Kojić et al. (1998). Janković (1982) and Kojić et al. (1995, 1998) stated that *Nardus stricta* dominated pastures (recognized as *Nardetum strictae* sensu lato) are a complex of many associations with different ecological characteristics. According to Kojić et al. (1998) the complex *Nardetum strictae* sensu lato is divided into 18 associations, one of which is ass. *Nardetum strictae* Grebenščikov 1950. This association is treated as a separate syntaxon also by Kojić et al. (2004) and Lakušić et al. (2005). Nevertheless, this association is accepted as having a broad ecological amplitude (Mišić et al. 1978, Kojić et al. 1995) but never interpreted as a synonym of the complex *Nardetum strictae* sensu lato. Kojić et al. (1995) mentioned that many authors misjudge the described association for the Stara Planina association. According to ICPN rules such associations are pseudonyms and in this case should be considered as *Nardetum strictae* auct. non Grebenščikov 1950.

Association *Nardetum strictae* Greb. 1950 ecologically is very close to that described for Romania by Simon (1966) as association *Viola declinatae* – *Nardetum strictae*. The difference between these associations is that *Viola declinata* Waldst. & Kit. is missing in *Nardetum strictae*. This species does not occur in Serbia and Bulgaria (see Diklić 1972; Delipavlov 1979; Assyov & Petrova 2006) where the taxonomically related species *Viola dacica* Borb. (= *V. declinata* Waldst. & Kit. ssp. *bulgarica* Form.) was recorded.

According to Grigoriu & Alda (2004) the *Viola declinatae* – *Nardetum strictae* association unifies the mat-grass communities in Eastern Europe. Such a statement could be proved by the fact that numerous relevés related to the *Viola declinatae* – *Nardetum strictae* association (Simon 1966; Mihăilescu 2001; Grigoriu & Alda 2004), includ-

ing its synonyms (e.g. *Nardetum alpigenum austro – carpaticum* Borza 1959 and *Nardo – Vaccinietum* Resm. 1970) do not contain *V. declinata* even in their original records.

Association *Campanulo alpinae* – *Nardetum strictae* (Simon 1958) nom. nov. hoc loco

Nomenclatural type: Simon (1958: Table 8, rel. 3), lectotypus hoc loco designatus

Homotypical synonym: *Nardetum alpinum moesiacum* Simon 1958 nomen illegitimum (Art. 34a).

Sociological group ***Juncus trifidus***: *Juncus trifidus*, *Campanula alpina*, *Festuca airoides*, *Agrostis rupestris*, *Sesleria comosa*.

Formal definition for the Balkan Range: **Group *Juncus trifidus* AND *Nardus stricta* cover > 5 %.**

The association was described by Simon for Mt. Pirin (Simon 1958: 179–180, Table 8). The originally recorded relevés of the association are included in Table 1 (relevés 52–57, and is typified by relevé 54). The confirmation of this syntaxon 50 years after its establishment reveals its particular character and does not provide reasons for it to be a *nomen dubium* (Art. 37); following the ICPN rules a *nomen novum* should be given. According to ICPN the new name is typified by the typus of the rejected one. We selected the typus following the recommendations of ICPN where both *Campanula alpina* and *Nardus stricta* are presented. *Nardus stricta* dominates (projection coverage > 25 %) and remains in the name (Art. 3k, 10b, 29b). The species *Campanula alpina* is well presented in the relevés under this association simultaneously from Mt. Pirin and Mt. Balkan (see Table 1). This species indicates the alpine character of the association and is mentioned as diagnostic for alliance *Seslerion comosae* by Horvat, Pawlowski & Wałas (1938), Simon (1958) and Horvat et al. (1974). According to Cheshmedzhiev (2003) in Bulgaria only *Campanula alpina* Jacq. ssp. *orbelica* (Pančić) Urum. is presented within an altitudinal range from 1700 to 2900 m a.s.l.

In the studied area the association is distributed occasionally within the alpine belt between 1950 and 2200 m altitude. The communities are localized mainly on ridges or highly inclined slopes where the soils are slightly eroded. The rocks are silicate. Considering the floristic composition of the association (see Table 1) we definitely support Simon's (1958) opinion that this type of vegetation is derived from *Agrostidi – Seslerietum comosae* Horvat, Pawlowski & Wałas

1938, or from *Seslerietalia comosae* meadows in the way of pasture digression.

Simon (1958) includes the association in *Potentillo ternatae* – *Nardion strictae* (*Nardetalia*, *Nardo-Callunetea*). At the same time, Simon (1958 in Table 8) points out diagnostic species for *Seslerion comosae*, *Poion violaceae* and *Seslerietalia comosae*. The main difference between *Seslerion comosae* and *Potentillo ternatae* – *Nardion strictae* after the cited reference is high abundance of *Nardus stricta*. The species *Potentilla ternata* is pointed out in this source as diagnostic also for *Seslerietalia comosae*. We do not support the decision taken by the author regarding association affiliation to higher syntaxa, because of lacking in diagnostic species both for the order and the class (see Table 1, rel. 52–57). Following the rules of floristic resemblance (Westhoff & van der Maarel 1973), and taking into account the presence of several diagnostic species (Table 1), we refer the *Campanulo alpinae* – *Nardetum strictae* association to *Seslerion comosae* alliance (*Seslerietalia comosae*, *Juncetea trifidi*). The dominant position of *Nardus stricta* in the communities is not sufficient reason for relating an association to *Nardetalia strictae* and *Calluno Ulicetea*. In maintenance of such an opinion many authors (Boşcaiu 1971; Coldea 1990; Krahulec et al. 1996; Roussakova 2000; Devillers & Devillers-Terschuren 2001; Rodwell et al. 2002; Chytrý & Tichý 2003; Kočí 2007, etc.) refer the mat-grass communities which contain Arctic-Alpine species to the *Juncetea trifidi* class.

Alliance *Potentillo ternatae* – *Nardion strictae* Simon 1958

Nomenclatural type: *Violo declinatae* – *Nardetum strictae* Simon 1966, [Simon (1966): p. 260, Table 2], *neotypus* hoc loco designatus.

This alliance is described by Simon (1958) from Mt. Pirin (Bulgaria). It is established by a single association – *Nardetum alpinum moesiacum* Simon 1958, which shares the same diagnostic species. According to Def. VIII (ICPN) this association should be considered as *holotypus*, being the only one described for the alliance. In this particular case it is not applicable because the association belongs to *Seslerion comosae* as was already pointed out (see Table 1). As a *neotypus* we suggest *Violo declinatae* – *Nardetum strictae* association described from Mt. Bihar (Romania). Simon (1966) did not point out its affiliation to higher units when he published the association. Later on, many Romanian authors (Coldea 1987;

Ivan et al. 1993; Sanda et al. 1997; Mihăilescu 2001; Pop et al. 2002; Niculescu 2004; Grigoriu & Alda 2004; Sarbu et al. 2004, etc.) included the association within *Potentillo ternatae* – *Nardion strictae*.

Simon (1958) refers *Potentillo ternatae* – *Nardion strictae* to *Nardo* – *Callunetea*, and many other researchers follow this concept, as for example Horvat et al. (1974), Dihoru (1975), Mišić et al. (1978), Pop et al. (1988, 2002), Sanda et al. (1997), Kojić et al. (1997, 1998, 2004), Mihăilescu (2001), Grigoriu & Alda (2004), Niculescu (2004), Sarbu et al. (2004). Some authors, however, refer it to *Juncetea trifidi* (cf. Boşcaiu 1971; Coldea 1990; Roussakova 2000; Devillers & Devillers-Terschuren 2001; Rodwell et al. 2002; Chifu et al. 2006). The problem with the syntaxonomic position of the alliance comes after its distribution close to the alpine belt and thus containing numerous alpine species, such as *Agrosris rupestris* All., *Alopecurus gerardii* Vill., *Dianthus microlepis* Boiss., *Euphrasia minima* Jacq. ex DC., *Festuca riloensis* (Hack. ex Hajek) Markgr.-Dannb., *Juncus trifidus* L., *Scleranthus neglectus* Rochel ex Baumg., *Sesleria comosa* Velen. etc (see Table 1). Particularly in Bulgaria the alpine belt is situated between 2400–2925m and very rarely, depending on the local climatic peculiarities, could start from 2000 m altitude and even lower (Velchev 1984, 2002; Bondev 1991). Simon (1958) describes the alliance at the range of 2100–2400 m a.s.l. and the relevés contain species from different altitudinal belts. The species composition causes ambiguous interpretation of the alliance by different authors. Sarbu et al. (2004) report *Potentillo ternatae* – *Nardion strictae* at 1450–1900 m altitude for Romania. They describe it as „acidic oligotrophic subalpine pastures”. In Ukraine it occupies altitudes of 1200–2061 m (Malinovsky & Kricsfalusy 2000; Prots et al. 2008). Rodwell et al. (2002) determine *Potentillo ternatae* – *Nardion strictae* as „Mat-grass swards of the alpine belt in the mountains of the eastern Balkans”.

The information included in Table 2 reveals relatively broad altitudinal range (500–2400 m) of the described associations within the *Potentillo ternatae* – *Nardion strictae* alliance. In fact, associations from different vegetation belts are related to the same alliance and thus combine ecologically different habitats. This contradicts to the Braun-Blanquet statement that the alliance unifies „the most closely related associations” (Braun-Blanquet 1965: 363).

The following 22 associations are referred to *Potentillo ternatae* – *Nardion strictae*:

In Romania: *Nardetum strictae subalpinum* Domin 1931, Krajina 1933; *Campanulo serratae* – *Festucetum ovinae* (Morariu 1942) Coldea 1987; *Festucetum ovinae* Morariu 1943; *Nardo* – *Callunetum vulgaris* Šmarda 1953, Hrynn. 1959, Csűrös 1964; *Poëtum mediae* Csűrös et al. 1956; *Scorzonero roseae* – *Festucetum nigricantis* (Puşc. et al. 1956) Coldea 1987; *Nardetum alpigenum austro – carpaticum* Borza 1959; *Festuco* – *Nardetum strictae montanum* Csűrös & Resm. 1960; *Potentillo* – *Festucetum ovinae* Resm. (1965) 1969, 1970; *Agrosteto* – *Callunetum vulgaris* Resm. & Csűrös 1966; *Violo declinatae* – *Nardetum strictae* Simon 1966; *Campanulo abietunae* – *Nardo* – *Festucetum commutatae* Boşcaiu 1971; *Antennario* – *Festucetum sudeticae* Dihoru 1975; *Carici* – *Nardetum strictae* (Resm. 1984) Resm. & Pop 1986; *Hieracio pilosellae* – *Nardetum strictae* Pop et al. 1988 (Resmeriţă & Csűrös 1966; Boşcaiu 1971; Dihoru 1975; Coldea 1987, 1990; Coldea & Pop 1988; Pop et al. 1988; Ivan et al. 1993; Sanda et al. 1997; Mihăilescu 2001; Pop et al. 2002; Niculescu 2004; Grigoriu & Alda 2004; Chifu et al. 2006).

In former Yugoslavia: *Nardetum strictae* Greb. 1950; *Trifolio pallescens* – *Nardetum strictae* Blečić & Tatić 1964; *Hygronardetum strictae* Puşc.-Soroc. 1965; *Succiso* – *Nardetum strictae* Stanković-Tomić 1969; *Festuco halleri* – *Nardetum strictae* Rajev. 1974; *Festuco fallaci* – *Nardetum strictae* Rajev. 1974; *Helianthemo* – *Nardetum strictae* Rajev. 1974; *Festuco nigrescenti* – *Nardetum strictae* Rexh. & Rand. 1980; *Festuco* – *Nardetum strictae subalpinum* Rexh. & Rand. 1980; *Carici oederi* – *Nardetum strictae* Petk. 1981; *Ophioslosso* – *Nardetum strictae* Gajić 1989 (Horvat et al. 1974; Mišić et al. 1978; Kojić et al. 1998, 2004).

In Bulgaria: *Nardetum strictae* Greb. 1950; *Carici* – *Festucetum microphyllae* Roussakova 2000 (Roussakova 2000; VeleV & Apostolova 2008).

In Ukraine: *Soldanello* – *Nardetum* Malinovsky & Kricsfalusy 2000 (Malinovsky & Kricsfalusy 2000).

According to some authors, several of the associations listed above are referred to other alliances, as for example:

Nardetum strictae Greb. 1950, *Hygronardetum strictae* Puşc.-Soroc. 1965 to the *Nardion strictae* alliance (Kojić et al. 1998; Puzović et al. 2006; Obratov-Petkovic et al. 2007);

Nardetum strictae Greb. 1950 to the *Poion violaceae* alliance (Kojić et al. 2004);

Antennario – *Festucetum sudeticae* Dihoru 1975 to the *Caricion curvulae* Br.-Bl. 1925 alliance (Sanda 1997);

Nardo – *Callunetum vulgaris* Šmarda 1953, Hrynn. 1959, Csűrös 1964 to the *Genistion* Böch. 1943 alliance (Sanda 1997);

Violo declinatae – *Nardetum strictae* Simon 1966 to the *Nardion strictae* alliance (Chifu et al. 2006).

In the literature as diagnostic for *Potentillo ternatae* – *Nardion strictae* are listed the following species: *Agrostis rupestris* All., *Alchemilla flabellata* Buser, *A. glaucescens* Wallr., *A. monticola* Opiz, *A. xanthochlora* Rothm., *Antennaria dioica* (L.) Gaertner, *Anthoxanthum alpinum* Á.Löve & D.Löve, *Bellardiocloa violacea* (Bell.) Chiov., *Botrychium lunaria* (L.) Sw., *Bruckenthalia spiculifolia* Rchb., *Campanula excisa* Presl., *C. kladniana* (Schur) Witasek, *C. patula* L. ssp. *abietina* (Griseb.) Somonkai, *C. rotundifolia* L., *C. serrata* (Kit.) Hendrych, *Carex bulgarica* (Domin) Lazare, *Carlina acaulis* L., *Centaurea nervosa* Willd., *Cerastium fontanum* Baumg., *Crocus neapolitanus* Mordant & Loisel., *Diphysium alpinum* (L.) Rothm., *Euphrasia minima* Lam. & DC., *Festuca airoides* Lam., *F. nigrescens* Lam., *F. ovina* L., *Gentiana acaulis* L., *Gentianella lutescens* (Velen.) J. Holub, *Geum montanum* L., *Helictotrichon versicolor* (Vill.) Pilger., *Hieracium alpinum* L., *H. aurantiacum* L., *H. hoppeanum* Schultes, *H. lactucella* Wallr., *Homogyne alpina* (L.) Cass., *Hypericum maculatum* Crantz, *Hypochaeris uniflora* Vill., *Leontodon rilaensis* Hayek, *Ligusticum mutellina* (L.) Crantz, *Luzula sudetica* (Willd.) DC., *Nardus stricta* L., *Phleum alpinum* L., *Plantago atrata* Hoppe, *P. gentianoides* Sibth. & Sm., *Poa alpina* L., *P. media* Schur, *Potentilla aurea* L., *P. erecta* (L.) Rausch., *P. ternata* C. Koch., *Primula elatior* (L.) Hill., *Pseudorchis albida* (L.) A. & D. Löve, *Scorzonera purpurea* L. ssp. *rosea* (Waldst. & Kit.) Nym., *Solidago virgaurea* L. ssp. *alpestris* (W. & K.) Gaud., *Thesium alpinum* L., *Thlaspi dacicum* Heuffel, *Thymus alpestris* Tausch, *T. pulegioides* L., *T. vandasii* Velen., *Veronica alpina* L., *V. officinalis* L., *Viola canina* L., *V. dacica* Borbas and *V. declinata* Waldst. & Kit. (Simon 1958; Boşcaiu 1971; Dihoru 1975; Coldea 1987, 1990; Coldea & Pop 1988; Sanda et al. 1988, 1997; Ivan et al. 1993; Roussakova 2000; Malinovsky & Kricsfalusy 2000; Mihăilescu 2001; Niculescu 2004; Grigoriu & Alda 2004; Sarbu et al. 2004; Petrik et al. 2005; Chifu et al. 2006).

Some species, as for example *Homogyne alpina*, *Festuca airoides*, *Nardus stricta*, *Poa media*, *Po-*

tentilla ternata, are pointed out also as diagnostic for *Seslerietalia comosae* or *Juncetea trifidi* (Simon 1958; Mucina et al. 1990; Roussakova 2000; Chytrý & Tichý 2003; Koči 2007). Horvat et al. (1937) point out *Potentilla ternata* as diagnostic for the alpine vegetation included in *Caricetalia curvulae* Br.-Bl. 1926. At the same time, species as *Veronica officinalis*, *Cerastium fontanum*, *Thymus pulegioides*, *Hieracium hoppeanum* and *Potentilla erecta* have broad distribution and practically are not considered characteristic for the sub-alpine and alpine vegetation.

The proximity of alpine vegetation much influences *Potentillo ternatae – Nardion strictae*. Floristic-geographical analysis of the diagnostic species shows that 49 % have Alpine and Arctic-Alpine distribution. Another 18 % of the species represent the sub-Atlantic floristic element. Carpathian-Balkan flora is presented by 14 % of diagnostic species and could be an argument for distinction of the alliance. The list of diagnostic species reveals significant resemblance between *Potentillo ternatae – Nardion strictae* and *Nardion strictae*.

Mention should also be made of *Nardo strictae – Agrostion tenuis* Sillinger 1933 which is presented in the Krkonoše and the West Carpathian Mts (Krahulec 1990; Krahulec et al. 1996). The species composition of the relevés from the Krkonoše Mts is similar to our data. It could be suggested that one large alliance (*Nardion* ?) actually includes geographically differentiated suballiances like *Potentillo ternatae – Nardion strictae* and *Nardo strictae – Agrostion tenuis*. But large data set analysis is needed to prove this hypothesis.

4. CONCLUSIONS

The mat-grass communities in Bulgaria, as in many European countries, are most often a sequence of long-time intensive grazing and trampling. The pastures are distributed in the mountains, mostly above the timberline and occur in different altitudinal vegetation belts. In the alpine vegetation, the communities characterized by significant *Nardus stricta* abundance are related to *Juncetea trifidi* class, which is supported by the presence of many preserved diagnostic species (e.g. *Juncus trifidus*, *Veronica bellidioides*, *Festuca airoides*, *Campanula alpina*, *Agrostis rupes-tris*). At lower altitudes, in the subalpine belt, the grazing has been more intensive. These ter-

ritories are covered by huge mountain pastures, quite uniform due to the strong dominance of the mat-grass. In the Balkan Range these communities are referred to *Potentillo ternatae – Nardion strictae*. We typified the *Potentillo ternatae – Nardion strictae* alliance by *Viola declinatae – Nardetum strictae* association. The *Potentillo ternatae – Nardion strictae* vegetation includes many character species (e.g. *Potentilla erecta*, *Agrostis capillaris*, *Hypericum maculatum*, *Festuca rubra*) for *Calluno – Ulicetea* and should be subordinated to this class. The high abundance of *Nardus stricta* in a vegetation type does not necessarily refer this vegetation to *Calluno – Ulicetea*. The mat-grass pastures developed on places of former *Juncetea trifidi* syntaxa remain syntaxonomically in the same class. It might be predicted that a decrease in the grazing and trampling intensity, which is ongoing currently at many places in the high mountains, will reduce the mat-grass abundance and will result in demutation to the primary vegetation communities.

5. SYNTAXONOMICAL SYNOPSIS:

- Class *Juncetea trifidi* Hadač in Klika & Hadač 1944 [Syn.: *Caricetea curvulae* Br.-Bl. 1948]
 Order *Seslerietalia comosae* (Simon 1958) Lakušić 1966
 Alliance *Seslerion comosae* Horvat 1935 em. Lakušić 1966
 Ass. *Campanulo alpinae – Nardetum strictae* (Simon 1958) nom. nov.
- Class *Calluno-Ulicetea* Br.-Bl. & Tüxen ex Klika & Hadač 1944 [Syn.: *Nardo – Callunetea* Preising 1949]
 Order *Nardetalia strictae* Preising 1949
 Alliance *Potentillo ternatae – Nardion strictae* Simon 1958
 Ass. *Nardetum strictae subalpinum* Domin 1931, Krajina 1933 nom. illeg. (Art. 34a) [Syn.: *Nardetum strictae montanum* Sillinger 1933]
 Ass. *Nardetum strictae* Greb. 1950
 Ass. *Poëtum mediae* Csűrös et al. 1956
 Ass. *Nardo – Callunetum vulgaris* Šmarda 1953, Hrynn. 1959, Csűrös 1964 [Syn.: *Vaccinio – Callunetum vulgaris* Bük. 1942; *Agrosteto – Callunetum vulgaris* Resm. & Csűrös 1966; *Arnica montana – Calluna vulgaris* Ghişa et al. 1970; *Festuceto rubrae – Callunetum vulgaris* Resm. 1970]

- Ass. *Trifolio pallescens* – *Nardetum strictae* Blečić & Tatić 1964
- Ass. *Hygronardetum strictae* Puşc.-Soroc. 1965 nom. illeg. (Art. 34a)
- Ass. *Violo declinatae* – *Nardetum strictae* Simon 1966 [Syn.: *Nardetum strictae alpinum* Borza 1934 (Art. 34a) p. p.; *Nardetum strictae alpinum* Ghişa 1940 (Art. 34a) p. p.; *Nardetum strictae alpinum* Csűrös 1955 (Art. 34a) p. p.; *Nardetum strictae alpinum* Puşcaru et al. 1956 (Art. 34a); *Nardetum alpigenum austro – carpaticum* Borza 1959 (Art. 34a); *Nardetum strictae subalpinum* Buia et al. 1962 (Art. 34a); *Nardetum strictae alpinum* Buia et al. 1962 (Art. 34a); *Nardetum strictae alpinum* Buia 1963 (Art. 34a) p. p.; *Nardetum strictae montanum* Resmeriţă & Csűrös 1963 nom. illeg. (Art. 34a); *Agrosteto-Festucetum rubrae montanum nardosum* Resm. & Csűrös 1966 nom. illeg. (Art. 34a); *Nardetum strictae alpinum* Beldie 1967 (Art. 34a) p. p.; *Nardo – Vaccinium* Resm. 1970; *Nardo-Festucetum tenuifoliae* Buiculescu 1971; *Festuco rubrae – Agrostetum capillaris* Horvat 1951 var. *Nardus stricta* Danciu 1974; *Nardo-Festucetum tenuifoliae* Buiculescu 1971; *Festuco rubrae – Agrostetum capillaris* Horvat 1951 subass. *nardetosum strictae* Pop 1976]
- Ass. *Succiso* – *Nardetum strictae* Stanković-Tomić 1969
- Ass. *Festuco fallaci* – *Nardetum strictae* Rajev. 1974
- Ass. *Festuco halleri* – *Nardetum strictae* Rajev. 1974
- Ass. *Helianthemo* – *Nardetum strictae* Rajev. 1974
- Ass. *Antennario* – *Festucetum sudeticae* Dihoru 1975 [Syn.: *Festucetum supinae* Domin 1933; *Festucetum supinae subalpinum* Sillinger 1933 p. p.; *Festuca supina* – *Nardus stricta* Şerbănescu 1939; *Festuca supina* Puşcaru et al. 1959; *Festuca supina* – *Deschampsia flexuosa* – *Vaccinium myrtillus* Puşcaru et al. 1959; *Festuca supina* – *Festuca rubra fallax* Puşcaru et al. 1959; *Festucetum supinae* Vicol et al. 1971; *Potentillo chrysocraspedae* – *Festucetum airoidis* Boşcaiu 1971; *Potentillo ternatae* – *Festucetum supinae* Boşcaiu 1971]
- Ass. *Festuco nigrescenti* – *Nardetum strictae* Rexh. & Rand. 1980
- Ass. *Festuco* – *Nardetum strictae subalpinum* Rexh. & Rand. 1980 nom. illeg. (Art. 34a)
- Ass. *Carici oederi* – *Nardetum strictae* Petk. 1981
- Ass. *Carici* – *Nardetum strictae* (Resm. 1984) Resm. & Pop 1986 [Syn.: *Hygronardetum strictae* Borza 1934, *Hygronardetum strictae* Puşc. et al. 1956; *Hygronardetum subalpinum* Resm. & Csűrös (1960) 1963; *Hygronardetum strictae alpinum* Buia et al. 1962, *Hygronardetum strictae alpinum* Resm. & Csűrös 1963; *Hygronardetum montanum* Resm. & Csűrös 1963, *Hygronardetum strictae montanum* Buia 1963]
- Ass. *Campanulo serratae* – *Festucetum ovinae* (Morariu 1943) Coldea 1987 [Syn.: *Festucetum ovinae* Morariu 1943; *Festucetum ovinae* – *Potentilletum aureae* Resm. 1965; *Potentillo* – *Festucetum ovinae* Resm. 1965, 1986; *Potentillo aureae* – *Festucetum ovinae* Resm. 1969, 1970, Resm. & Pop 1984; *Violo declinatae* – *Nardetum strictae* Simon 1966 subass. *festucetosum ovinae* (Morariu 1943) Chifu et al. 2006]
- Ass. *Scorzonero roseae* – *Festucetum nigricantis* (Puşc. et al. 1956) Coldea 1987 [Syn.: *Festucetum rubrae fallax* Puşc. et al. 1956; *Nardo* – *Festucetum rubrae fallax* Puşc. et al. 1959; *Festuca supina* – *Festuca rubra* Puşc. et al. 1959; *Festucetum rubrae montanum* Csűrös & Resm. 1960; *Festucetum rubrae subalpinum siliciculum* Csűrös & Resm. 1960; *Festuco* – *Nardetum strictae montanum* Csűrös & Resm. 1960; *Festuco rubrae* – *Nardetum* Csűrös & Resm. 1960; *Festuco* – *Alchemilletum vulgare* Csűrös & Resm. 1960; *Campanulo abietinae* – *Nardo* – *Festucetum commutatae* Boşcaiu 1971 nom. nud. (Art. 2a)]
- Ass. *Hieracio polosellae* – *Nardetum strictae* Pop et al. 1988 pro syn., nom. nud. (Art. 2b, 3a, Recomm. 46f) [Syn.: *Xeronardetum* Soó 1931; *Xeronardetum montanum* Resm. & Csűrös 1963]
- Ass. *Ophioslosso* – *Nardetum strictae* Gajić 1989
- Ass. *Carici* – *Festucetum microphyllae* Roussakova 2000
- Ass. *Soldanello* – *Nardetum* Malinovsky & Kricfalusy 2000

ACKNOWLEDGEMENTS

We thank the two anonymous reviewers for the helpful comments and critical remarks on a previous version of the manuscript.

6. REFERENCES

- Assyov, B. & Petrova, A. (eds): 2006. *Conspectus of the Bulgarian Vascular Flora. Distribution Maps and Floristic Elements. Ed. 3.* BBF, Sofia, 453 pp.
- Beldie, A. 1967: *Flora and vegetation of Bucegi Mountain.* Acad. Press, Bucharest, 578 pp. (in Romanian).
- Bondev, I. 1966: *Die Hochgebirgs-Pflanzendecke des Berkovischen und Ciprovischen Gebirges.* *Izv. Bot. Inst. (Sofia)*, 16: 79–169 (in Bulgarian).
- Bondev, I. 1991: *The Vegetation of Bulgaria. Map 1: 600000 with explanatory text.* St. Kliment Ohridski Univ. Press, Sofia, 184 pp. (in Bulgarian).
- Borza, A. 1959: *Flora and vegetation of Sebeşului valley.* Acad. Press, Bucharest, 326 pp. (in Romanian).
- Boşcaiu, N. 1971: *Flora and Vegetation of Tarcu, Godeanu and Cerna Mountains.* Acad. Press, Bucharest, 494 pp. (in Romanian).
- Boşcaiu, N. & Täuber, F. 1985: *Die zöologischen Verhältnisse der dazischen und dazisch-balkanischen Arten aus dem rumänischen Karpatenraum.* *Vegetatio* 59: 185–192.
- Braun-Blanquet, J. 1965: *Plant Sociology. The Study of Plant Communities.* Hafner Publishing Company, New York, London, 439 pp.
- Bruehlheide, H. 1995: *Die Grünlandgesellschaften des Harzes und ihre Standortbedingungen. Mit einem Beitrag zum Gliederungssystem auf der Basis von statistisch ermittelten Artengruppen.* *Dissertationes Botanicae* 244, 338 pp.
- Bruehlheide, H. 1997: *Using formal logic to classify vegetation.* *Folia Geobot. Phytotax.* 32: 41–46.
- Bruehlheide, H. 2000: *A new measure of fidelity and its application to defining species groups.* *Journal of Vegetation Science* 11: 167–178.
- Buia, A. 1963: *Les Associations á *Nardus stricta* L.* *De La R. P. R. Rev. de Biol.* 8(2): 119–138.
- Cheshmedzhiev, I. 2003: *Family Campanulaceae.* In: Delipavlov, D., Cheshmedzhiev, I., Popova, M., Terziyski, D. & Kovachev, I.: *Handbook to the vascular plants in Bulgaria.* Acad. Press of Agricult. Univ., Plovdiv, 370–376 pp. (in Bulgarian).
- Chifu, T., Mânzu, C. & Zamfirescu, O. 2006: *Flora and vegetation of Moldova: Romania. Vol. 2: Vegetation.* Univ. Press “Al. I. Cuza”, 700 pp. (in Romanian).
- Chytrý, M. 2007: *Project Vegetation of the Czech Republic: Preface and summary of methods.* In: Chytrý, M. (ed.): *Grassland and Heathland Vegetation. Vegetation of the Czech Republic. Vol. 1,* Academia, Prague, 35–52 pp.
- Chytrý, M. & Tichý, L. 2003: *Diagnostic, constant and dominant species of vegetation classes and alliances of the Czech Republic: a statistical revision.* *Folia Fac. Sci. Nat. Univ. Masaryk. Brun., Biol.* 108: 1–231.
- Coldea, G. 1987: *Contributions to the syntaxonomic and ecologic study of some acidophilous – mezophil meadows in the subalpine belt of the Romanian Carpathians.* *Contrib. Bot.* 27: 121–131 (in Romanian).
- Coldea, G. 1990: *The Rodna Mountains. A geobotanical study.* Edit. Acad. Press, Bucharest, 183 pp. (in Romanian).
- Coldea, G. & Pop, A. 1988: *Phytocoenological researches in the Cozia Mountains.* *Contrib. Bot.* 28: 51–65 (in Romanian).
- Csűrös, Ş. & Resmeriţă, I. 1960: *Study of *Festuca rubra* L. pastures in Transylvania.* *Contrib. Bot.* 2: 149–174 (in Romanian).
- Delipavlov, D. 1979: *Violaceae* Batsch. In: Jordanov, D. (ed.), *Fl. Reipubl. Popularis Bulgaricae. Vol. 7,* In Aedibus Acad. Sci. Bulgaricae, Serdicae, 338–395 pp. (in Bulgarian).
- Delipavlov, D., Cheshmedzhiev, I., Popova, M., Terziyski, D. & Kovachev, I. 2003: *Handbook to the vascular plants in Bulgaria.* Acad. Press of Agricult. Univ., Plovdiv, 591 pp. (in Bulgarian).
- Devillers, P. & Devillers-Terschuren, J. 2001: *Application and development of the Palaeartic habitat classification in the course of the setting up of the Emerald Project – Croatia.* Strasbourg, 147 pp.
- Dihoru, G. 1975: *The vegetal cover of the Siriu Mountain.* Edit. Acad. Press, Bucharest, 216 pp. (in Romanian).
- Diklić, N. 1972: *Violaceae* De Cand. In: Josifović, M. (ed.): *Flora of Serbia. Vol. 3,* Acad. Press, Belgrade, 128–164 pp. (in Serbian).
- Doniţă, N., Popescu, A., Paucă-Comănescu, M., Mihăilescu, S. & Biriş, I. A. 2005: *Habitats of Romania.* Tehnică Silvică Press, Bucharest, 496 pp. (in Romanian).
- Ganchev, S. & Kochev, H. 1969: *Investigations into the changes of the wire-bent coenoses (*Nardeta strictae*) depending on the various methods of influence in the Etropole Balkan.* *Izv. Bot. Inst. (Sofia)* 19: 63–75 (in Bulgarian).

- Gergely, I. 1969: The mesophile pastures in the northern part of Trăscău Mountain. *Contrib. Bot.* 9: 191–209 (in Romanian).
- Ghișă, E., Resmeriță, I. & Spârches, Z. 1970: Contribution to the study of *Calluna* vegetation in Apuseni Mountain. *Contrib. Bot.* 10: 183–190 (in Romanian).
- Grigoriu, A. & Alda, N. 2004: *Nardus stricta* L. meadow phytocoenology, synecology and chorology in the Timis river basin. *Contrib. Bot.* 39: 95–104.
- Hennekens, S. & Schaminée, J.H.J. 2001: TURBOVEG, a comprehensive data base management system for vegetation data. *J. Veg. Sci.* 12: 589–591.
- Hill, M.O. 1979: TWINSPAN. A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of individuals and attributes. *Ecology & Systematics*, Cornell University, Ithaca, NY, 45 pp.
- Horvat, I., Pawlowski, B. & Walas, J. 1937: Phytosociologische studien über die hochgebirgsvegetation der Rila Planina in Bulgarien. *Bull. Acad. Polon. Sci. Lettres Clas. Mat. Nat. B* 1: 159–197.
- Horvat, I., Glavač, V. & Ellenberg, H. 1974: *Vegetation Südosteuropas*. G. Fischer Verlag, Stuttgart, 766 pp.
- Ivan, D., Donita, N., Coldea, G., Sanda, V., Popescu, A., Chifu, T., Boscaiu, N., Mititelu, D. & Pauca-Comanescu, M. 1993: *Vegetation potentielle de la Roumanie*. *Braun-Blanquetia* 9: 1–79.
- Janković, M. 1982: Contribution to the study of the vegetation of the Šarplanina mountain with particular reference to some conspicuous relict plant species. – *Glasn. Inst. za botan. i botan. bašte Univ. u Bgd.* 15 (1–3): 75–129 (in Serbian).
- Koči, M. 2007: Alpine grasslands on base-poor soils. – In: Chytrý, M. (ed.), *Grassland and Heathland Vegetation. Vegetation of the Czech Republic*. Vol. 1, Academia, Prague, 76–83 pp.
- Kojić, M., Mrfat-Vukelić, S., Dajić, Z., Ajder, S. & Ostojić, S. 1995: Spreading, main characteristics and types of further research of the plant communities *Nardetum strictae* sensu lato in Serbia. *Glasn. Inst. za botan. i botan. bašte Univ. u Bgd.* 28: 115–136 (in Serbian).
- Kojić, M., Popović, R. & Karadžić, B. 1997: Vascular plants of Serbia as indicators of plant communities. *Institut za biološka istraživanja "Siniša Stanković"*, Belgrade, 160 pp. (in Serbian).
- Kojić, M., Popović, R. & Karadžić, B. 1998: A syntaxonomic Review of Vegetation in Serbia. Belgrade, 218 pp. (in Serbian).
- Kojić, M., Mrfat-Vukelić, S., Dajić, Z. & Djordjević-Milosević, S. 2004: Meadows and pastures of Serbia. Agricultural research institute Serbia, Belgrade, 89 pp. (in Serbian).
- Kozhuharov, S., (ed.). 1992: *Field Guide to the Vascular Plants in Bulgaria*. Nauka & Izkoustvo, Sofia, 788 pp. (in Bulgarian).
- Krahulec, F. 1985: The chorologic pattern of European *Nardus* – rich communities. *Vegetatio* 59: 119–123.
- Krahulec, F. 1990: *Nardo - Agrostion tenuis* communities in the Krkonoše and West Carpathians Mts. *Folia Geobotanica et Phytotaxonomica* 25: 337–347.
- Krahulec, F., Blažková, D., Balátova-Tuláčková, E., Štursa, J., Pecháčková, S. & Fabšičová, M. 1996: Grasslands of the Krkonoše Mountains: Plant communities and their dynamics. *Opera Conortica* 33: 3–250 (in Czech).
- Lakušić, D., Blaženčić, J., Randjelović, V., Butorac, B., Vukojičić, S., Zlatković, B., Jovanović, S., Šinžar-Sekulić, J., Žukovec, D., Čalić, I. & Pavićević, D. 2005: *Habitats of Serbia. Manual with descriptions and basic data*. *Glasn. Inst. za botan. i botan. bašte Univ. u Beogradu*, 684 pp. (in Serbian).
- Malinovsky, K. & Kricsfalusy, V. 2000: High-Mountain Vegetation. In: Solomakha, V. (ed.): *Vegetation of Ukraine*. Vol. 1, Kiev, 230 pp. (in Ukrainian).
- Meshinev, T., Apostolova, I., Kachaunova, E., Velchev, V. & Bondev, I. 2000: Flora and plant communities. In: Popov, A. & Meshinev, T. (eds): *High-Mountain Treeless Zone of the Central Balkan National Park. Biological Diversity and Problems of its Conservation*. BSBCP, Sofia, 337 pp.
- Meshinev, T. & Apostolova, I. 2002: Transformation of quantitative estimates from the phytocoenological relevés based on the dominance approach according to the combined scale of Braun-Blanquet. *Phytol. Balcan.* 8(3): 347–352.
- Meshinev, T., Apostolova, I., Georgiev, V., Dimitrov, V., Petrova, A. & Veen, P. 2005: Grasslands of Bulgaria. Final report on the National Grasslands Inventory Project – Bulgaria, 2001–2004. Dragon 2003 Ltd. Publishers, Sofia, 104 pp.
- Mihăilescu, S. 2001: The flora and vegetation of

- Piatra Craiului massif. Vergiliu, Bucharest, 400 pp. (in Romanian).
- Mišić, V. 1960: Results from ecological study of subalpine shrub vegetation of Kopaonik Mountain. Biol. Inst. N. R. Srbije, Posebna izdanja. Belgrade 6: 5–47 (in Serbian).
- Mišić, V., Jovanović-Dunjić, R., Popović, M., Borisavljević, L., Antić, M., Dinić, A., Danon, J. & Blaženčić, Ž. 1978: Plant communities and habitats of the Stara Planina Mountains. Belgrade, 389 pp. (in Serbian).
- Mucina, L., Valachovič, M., Jarolimek, I., Šeffler, J., Kubinská, A. & Pišut, I. 1990: The vegetation of rock fissures, screes and snow-beds in the Pirin Planina Mt. (Bulgaria). – *Studia Geobot.* 10: 15–58.
- Mueller-Dombois, D. & Ellenberg, H. 1974: Aims and Methods of Vegetation Ecology. John Wiley & Sons, Inc., New York, 547 pp.
- Natcheva, R. & Ganeva, A. 2005. Check-list of the bryophytes of Bulgaria. II. Musci. *Cryptogami, Bryol.* 26(2): 209–232.
- Niculescu, M. 2004: Contributions regarding the study of the *Nardo-Callunetea* Prsg. 1949 class in the upper basin of Lunca river (Valcea County). *Contrib. Bot.* 39: 89–93.
- Oberdorfer, E. 1994: Pflanzensoziozoologische Exkursionsflora. Verlag Eugen Ulmer, Stuttgart, 1050 pp.
- Obratov-Petković, D., Popović, I., & Dajić-Stevanović, Z. 2007: Diversity of the vascular flora of Mt. Zlatar (Southwest Serbia). – *EurAsia J. Bio. Sci.* 1(5): 35–47.
- Pavlović, Z. 1951: The vegetation of Zlatibor Mountain. – *Zborn. Rad. Inst. za ekol. i biogeog.* SAN Belgrade 2: 115–178 (in Serbian).
- Petrík, A., Šibík, J. & Valachovič, M. 2005: The Class *Carici rupestris – Kobresietea bellardii* Ohba 1974 also in the Western Carpathians. *Hacquetia* 4(1): 33–51.
- Petrov, I. & Mesaroš, G. 1988: Contribution to Myrmecofauna of the mountain Stara planina. *Biosistematika* 14(1): 43–50.
- Pop, I., Cristea, V., Hodişan, I. & Gergely, I. 1988: Le Conspectus des associations végétales sur l'étendue du département de Cluj. *Contrib. Bot.* 28: 10–23.
- Pop, I., Cristea, V. & Hodişan, I. 2002: The Vegetation of Cluj District (a phytocoenological, ecological, bioeconomic and ecoprotective study). *Contrib. Bot.* 35(2): 5–254 (in Romanian).
- Pop, V. 1997: Earthworm – vegetation – soil relationships in the Romanian Carpathians. – *Soil Biol. Biochem.* 29(3/4): 223–229.
- Prots, B., Kruglov, I., Bashta, A.-T. & Tassenkevich, L. 2008: Report on the results of data collection for Ukrainian Carpathian Mts. and encountered problems. BBI-MATRA project. – http://www.carpates.org/docs/2008/cbis08/Report_Ukraine.pdf (accessed 22.04.2008).
- Puşcaru, D., Puşcaru – Soroceanu, E., Paucă, A., Şerbănescu, I., Beldie, Al., Ştefureac, T., Cernescu, N., Saghin, F., Creţu, V., Lupan, L. & Taşenco, V. 1956: Alpine pastures of Bucegi Mountain. Acad. Press, Bucharest, 511 pp. (in Romanian).
- Puzović, S., Stojnić, N., Lazarević, P., Butorac B., Sekulić, G., Mijović, D., Vukelić M., Radosavljević & Čalakić, D. 2006: Information Sheet on Ramsar Wetlands. http://www.wetlands.org/reports/ris/3RS006_RIS2006.pdf (accessed 20.05.2008).
- Resmeriţă, I. 1970: Flora, vegetation and productivity potential of the Vlădeasa massif. Acad. Press, Bucharest, 318 pp. (in Romanian).
- Resmeriţă, I. 1986: Associations *Potentillo (ternatae – aureae) – Festucetum supinae* Boşcaiu 1971 and *Potentillo (ternatae – aureae) – Festucetum ovinae* Resmeriţă 1970 in Romanian Carpathians. *Contrib. Bot.* 26: 184–188 (in Romanian).
- Resmeriţă, I. & Csűrös, Ş. 1966: Geobotanical and agrotechnical mapping of Cionca pasture (region Huedin). *Contrib. Bot.* 2: 91–102 (in Romanian).
- Rodwell, J., Schaminecé, J., Mucina, L., Pignatti, S., Dring, J., & Moss, D. 2002: The diversity of European vegetation – An overview of phytosociological alliances and their relationships to EUNIS habitats. Wageningen, 168 pp.
- Roussakova, V. 2000: Végétation alpine et sous alpine supérieure de la montagne de Rila (Bulgarie). *Braun-Blanquetia* 25: 1–132.
- Sanda, V., Popescu, A. & Peicea, I. M. 1988: Les associations de buissons subalpins des Carpates de Roumanie. *Contrib. Bot.* 28: 85–95.
- Sanda, V., Popescu, A. & Barabaş, N. 1997: Syntaxonomy and characteristics of Romanian vegetation. Bacau, 366 pp. (in Romanian).
- Sanda, V., Alexiu, V. & Şincu, E. D. 2006: Alpine pastures and mountain ruderal vegetation in Bucegi Mountain. *Ecos* 18: 27–32 (in Romanian).
- Sarbu, A., Coldea, G., Negrean, G., Cristea, V., Hanganu, J. & Veen, P. 2004: Grasslands of Romania. Final report on National Grasslands

- Inventory 2000–2003. Univ. of Bucharest, 7 pp.
- Simon, T. 1958: Über die alpinen pflanzengesellschaften des Pirin-Gebirges. Acta Bot. Acad. Sci. Hung. 4(1–2): 159–190.
- Simon, T. 1966: Beiträge zur Kenntnis der vegetation des Bihar (Bihor) Gebirges. – Ann. Univ. Sci. Budapestensis. Sect. Biologica 8: 253–273.
- Tichý, L. 2002: JUICE, software for vegetation classification. J. Veg. Sci. 13: 451–453.
- Velchev, V. 1984: Vegetational belts in the mountains of Bulgaria. In: Velchev, V. (ed.): Contemporary theoretical and practical aspects of vegetation ecology, Vol. 1, 67–76 pp. (in Bulgarian).
- Velchev, V. 2002: Characteristic features and regularities in the distribution of the present-day vegetation. In: Koprlev, I. (ed.): Geography of Bulgaria, FarCom, Sofia, 321–324 pp. (in Bulgarian).
- Velchev, V., Bondev, I., Kochev, H., Roussakova, V., Vasilev, P., Meshinev, T., Nikolov, V., Georgiev, N. & Valchev, V. 1989: Vegetation. In: Mišev, K. (ed.): Natural and Economic Potential of the Mountains in Bulgaria. Nature and Resources. Vol. 1, Publ. House of the Bulg. Acad.Sci., Sofia, 273–337 pp. (in Bulgarian).
- Velev, N. & Apostolova, I. 2008: Successional changes of *Nardus stricta* communities in the Central Balkan Range (Bulgaria). Phytol. Balcan. 14(1): 65–74.
- Weber, H., Moravec, J. & Theurillat, J.-P. 2000: International Code of Phytosociological Nomenclature. 3rd ed. J. Veg. Sci. 11: 739–768.
- Westhoff, V. & van der Maarel, E. 1973: The Braun-Blanquet Approach. In: Whittaker, R. (ed.), Ordination and Classification of Communities. Handbook of Vegetation Science Vol. 5. Junk, The Hague, 617–726 pp.
- Wirth, V. 1995: Die Flechten Baden-Württembergs. Teil 1 & 2. Eugen Ulmer GmbH & Co., Stuttgart, 1006 pp.
- Witkowski, Z., Król, W. & Solarz, W. (eds.): 2003. Carpathian List of Endangered Species. WWF and Institute of Nature Conservation, Polish Academy of Sciences, Vienna-Krakow, 64 pp.

Received 18. 10. 2008

Revision received 9. 2. 2009

Accepted 25. 2. 2009

Table 1: Associations *Nardetum strictae* Greb. 1950 and *Campanulo alpinae* - *Nardetum strictae* (Simon 1958) nom. nov.

Locality	<i>Nardetum strictae</i>																													
	Balkan Mountain																													
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Altitude (m)	1600	1650	1650	1750	1900	1550	1550	1440	1400	1420	1540	1600	1480	1860	1930	1700	1580	1600	1500	1700	1500	1680	1850	1600	1650	1700	1600	1650	2000	
Exposition		E	SE	S	N	NE	W	S	E	E		S	S	S	NW	E	N	E	SW	SW		E	E	SW	E	NW	S			
<i>Potentillo ternatae</i> - <i>Nardion strictae</i>																														
<i>Nardus stricta</i> *	4	5	4	5	4	4	5	3	4	4	3	3	4	4	4	4	3	4	3	4	4	4	3	3	3	4	4	5	5	
<i>Bruckenthalia spiculifolia</i>	.	.	+	+	+	2	+	+	.	+	+	.	+	+	+	.	+	+	+	+	+	+	.	+	+	+	1	.	.	
<i>Hieracium hoppeanum</i>	.	.	.	+	.	+	+	2	1	+	2	.	2	1	1	.	1	+	.	.	+	.	.	1	+	+	.	+	+	
<i>Hypericum maculatum</i>	+	+	+	+	.	.	+	+	.	+	+	.	.	+	.	2	+	+	.	
<i>Potentilla erecta</i>	1	+	1	1	1	+	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	+
<i>Potentilla ternata</i> *	+	+	+	+	+	+	+	+	+	+	2	+	+	+	+	2	2	.	1	+	.	.	.	.
<i>Geum montanum</i>	+	.	+
<i>Antennaria dioica</i>	+	+	+	+	+	.	+	2	.	+	.	.	.	
<i>Bellardiocloa violacea</i>	+	+	+	.	+	1	+	.	.	3	2	.	.	.	.
<i>Thymus vandasii</i>	+	+	+	+	.
<i>Alchemilla flabellata</i>	+	1	+	.	1	.	+	.	.	.	+	+
<i>Viola dacica</i>	+	+	.	.	+	+	.	.	+	.	+	+	+	+	+	+	.	+	.	+
<i>Luzula sudetica</i>	.	.	+	+	+	+	+
<i>Festuca nigrescens</i>	+	+	+	.
<i>Homogyne alpina</i> *	+	.	.	.
<i>Campanula patula</i> ssp. <i>abietina</i>	+	.	+	+	+	+	+	+	+
<i>Ligusticum mutellina</i>	+
<i>Campanula rotundifolia</i>	+
<i>Scorzonera purpurea</i> ssp. <i>rosea</i>	+	.	.	+	.
<i>Carex ovalis</i>	+	+	+	+	+
<i>Veronica officinalis</i>	+	+	+	.	.
<i>Plantago atrata</i>
<i>Plantago gentianoides</i>
<i>Nardetalia strictae</i> and <i>Nardo</i> - <i>Callunetea</i>																														
<i>Agrostis capillaris</i>	2	1	+	+	2	1	1	2	1	+	1	+	2	2	2	2	3	3	2	2	3	2	3	2	+	3	2	2	2	
<i>Festuca rubra</i>	2	1	1	+	2	1	1	+	.	1	1	2	2	2	1	3	2	2	3	2	2	2	.	3	3	.	.	+	+	
<i>Vaccinium myrtillus</i>	.	.	.	+	+	1	+	+	.	+	+	.	+	1	+	.	+	+	1	1	+	+	.	2	+	+	2	+	+	
<i>Lerchenfeldia flexuosa</i>	.	.	.	+	.	+	1	+	.	+	+	.	.	.	+	.	+	2	2	+	.	+	.	2	2	+	1	+	+	
<i>Anthoxanthum odoratum</i>	1	+	+	+	+	+	.	.	.	.	.	.	+	+	.	.	.	.	+	+	+	+	+	.
<i>Vaccinium vitis-idaea</i>	.	.	.	+	+	+	+	+	.	.	+	.	+	+	+	.	1	+	+	+	+	+	.	+	.	.	1	.	+	
<i>Chamaespartium sagittale</i>	+	+	+	.	+	+	+	.	1	+	.	+	+	.	.	.	.	.	.
<i>Luzula multiflora</i>	1	.	.	.	+	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	.	.	2	+	.	.	.	.
<i>Rumex acetosella</i>	+	+	+	.	+	.	+	+	.	.	+	+	.	.	.	+	.	+	.	.
<i>Hieracium pilosella</i>	+	.	.
<i>Sieginglingia decumbens</i>	.	+	+	1	+	+	+	+
<i>Hypericum perforatum</i>	+	+	+	.	.	+
<i>Ranunculus acris</i>	+	+	.	.	+
<i>Luzula campestris</i>

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29		
Seslerion comosae																															
<i>Campanula alpina</i>	
<i>Juncus trifidus</i>	
<i>Agrostis rupestris</i>	+	
<i>Dianthus microlepis</i>	
<i>Cetraria islandica</i>	.	.	.	+	.	+	.	+	+	+	
<i>Festuca airoides</i>	
<i>Veronica bellidioides</i>	+	+	
<i>Omalotheca supina</i>	
<i>Euphrasia minima</i>	+	+	1	.	.	.	.
<i>Hieracium alpicola</i> gr.	
<i>Sesleria comosa</i>	+	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Seslerietalia comosae and Juncetea trifidi																															
<i>Poa media</i>	+	.	.	+	+	.	.	
<i>Scleranthus neglectus</i>	+	+	
<i>Ranunculus montanus</i>	+	1	+	+	+	+	+	.	+	+	.	1	1	+	.	+	.	+	.	.	.	.	+	+	+	+
<i>Alopecurus gerardii</i>	2	.	.	.	.	.
<i>Carex kitaibeliana</i>	
<i>Crocus veluchensis</i>	1	+	+	+	+	+	.	.	.	+	.	1	.	+	+	.	.	+	.	.	.	.	+	+	+
<i>Luzula italica</i>	+	+	+	
<i>Festuca riloensis</i>	
Other species																															
<i>Juniperus sibirica</i>	.	+	+	+	.	+	r	.	.	.	+	+	+	+	+	+	+	+	.	.	.	+	+	1	.	.	
<i>Vaccinium uliginosum</i>	.	.	+	+	+	+	+	+	+	1	.	+	.	.	.	
<i>Carex caryophylla</i>	+	+	+	+	+	+	.	+	.	+	.	.	.	+	1	+	1	.	.	+	.	.	.	.	.
<i>Genista depressa</i> s.l.	+	+	.	.	+	+	+	+	+	+	+	.	+	2	.	+	+	+
<i>Campanula patula</i> ssp. epigaea	+	+	+	.	+	.	+	+	.	+	.	2	.	+	1	.	.	+	.	.	.	.	+	+	.	+
<i>Verbascum longifolium</i>	+	+	.	.	+	+	+	.	+	+	.	+	+	1	+	+	.	2	+	.	+	+	.	+	+	
<i>Luzula luzuloides</i>	+	.	.	r	.	.	.	.	1	+	.	+	+	+	+	+	2	2	.	.	.	+	.	.	.	
<i>Acinos alpinus</i>	+	+	.	.
<i>Potentilla crantzii</i>	+	+	+	.
<i>Trifolium repens</i> s.l.	+	+	.	.	+	.	1	+	+	+	.	3	2	.	.	.	.	+	.	.	.	.	1	.	.	.	.	+	.	.
<i>Gentianella bulgarica</i>	.	.	+	+	1	1	+	+	+	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Agrostis canina</i>	+
<i>Arenaria biflora</i>
<i>Bistorta major</i>	+
<i>Thymus zygoides</i>	+	+	+	+	+	+	+	1	2	.	2	2	3	2	1	2	2	2	.	.	.	.	.	.	.	.
<i>Trifolium pratense</i>	1	.	.	.	+	.	+	.	.	.	.	+	2	+	.	1	+	+	.	.	.	+	+	+	+	+	.	.	.	.
<i>Veronica chamaedrys</i>	+	+	+	.	1
<i>Thymus jankae</i>
<i>Peucedanum oligophyllum</i>
<i>Campanula velebitica</i>	+	+	
<i>Cruciata glabra</i>
<i>Hieracium sparsum</i>	+
<i>Koeleria eriostachya</i>	+	+	.	.
<i>Geum coccineum</i>	1	.	+
<i>Luzula pindica</i>
<i>Omalotheca sylvatica</i>	+	+	+
<i>Plantago subulata</i>	1
<i>Polytrichum juniperinum</i>	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	+	+	+	.	.	.	.	.	.
<i>Potentilla haynaldiana</i>
<i>Veratrum lobelianum</i>	+	+
<i>Sagina saginoides</i>	+

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
<i>Stellaria graminea</i>	+	.	.	.	+	.	+	+	.
<i>Achillea millefolium</i>	+	+	+	+	+	.	.	+	.	+	.	.	.
<i>Alchemilla vulgaris</i> agg.	+	.	+	.	.	.	+	+	+	.	+
<i>Calamagrostis arundinacea</i>	+	.	.	.
<i>Campanula sparsa</i>
<i>Carduus carduelis</i>	+	.	+	+	+
<i>Centaurea napulifera</i>	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
<i>Cerastium arvense</i>	+	+
<i>Cerastium banaticum</i>	+	+	+	+	+	+
<i>Chamaecytisus pygmaeus</i>	+	+	+
<i>Cruciata laevipes</i>	+	.	+
<i>Deschampsia caespitosa</i>	+	+	+	+	.	.	.
<i>Euphrasia liburnica</i>	+	+	+	.	1	+	.	+	.	.	+	.	.	.	.	.	.	.
<i>Festuca valida</i>
<i>Helianthemum nummularium</i>	+	+	+
<i>Juncus conglomeratus</i>	1	2	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Leontodon autumnalis</i> s.l.	+	1	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Leontodon hispidus</i>	+	+
<i>Lotus corniculatus</i>	+	.	+	+
<i>Omalotheca norvegica</i>	+	+
<i>Plantago lanceolata</i>	+	.	+	+	.	+
<i>Poa annua</i>	+	+	.	+
<i>Potentilla argentea</i>	+	+	+
<i>Rubus idaeus</i>	+	+	+
<i>Satureja montana</i>	+	.	+	+	+
<i>Scleranthus perennis</i>	+	+	.	.	+
<i>Senecio abrotanifolius</i>	+	.	.	+	.	.	+
<i>Thlaspi kovatsii</i>	1	+	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
<i>Viola tricolor</i>	+	+	.	+
<i>Picea abies</i>	.	.	+
<i>Pinus mugo</i>
<i>Polytrichum piliferum</i>
<i>Rhizocarpon alpicola</i>
<i>Caloplaca sinapisperma</i>
<i>Cladonia pyxidata</i>
<i>Lepraria neglecta</i>
<i>Bryum</i> sp.
<i>Taraxacum</i> sp.

* Species mentioned in the literature as diagnostic also for order *Seslerietalia comosae* and class *Juncetea trifidi*.

Table 2: Altitudinal range of some *Potentillo ternatae* - *Nardion strictae* syntaxa.**Table 2:** Razpon nadmorskih višin nekaterih sintaksonov zveze *Potentillo ternatae* - *Nardion strictae*.

Syntaxon	Altitudinal range	Country	Reference
<i>Nardetum alpinum moesiacum</i>	2100–2400 m	Bulgaria	Simon 1958
<i>Carici – Festucetum microphyllae</i>	2170–2200 m	Bulgaria	Roussakova 2000
Poa media dominated communities	2160–2700 m	Bulgaria	Roussakova 2000
<i>Nardetum strictae</i>	1000–2080 m	FFRY *	Pavlović 1951; Mišić 1960; Mišić et al. 1978; Petrov & Mesaroš 1988
		Bulgaria	Velev & Apostolova 2008
<i>Hygronardetum strictae</i>	1370–1700 m	FFRY	Mišić et al. 1978
<i>Helianthemo – Nardetum strictae</i>	1700–1900 m	FFRY	Janković 1982
<i>Festuco fallaci – Nardetum strictae</i>	500–1800 m	FFRY	Janković 1982
<i>Festuco halleri – Nardetum strictae</i>	2000–2300 m	FFRY	Janković 1982
			Puşcaru et al. 1956; Borza 1959; Simon 1966; Beldie 1967; 2006
<i>Violo declinatae – Nardetum strictae</i>	570–2200 m	Romania	Coldea 1987; Resmeriță 1970; Pop et al. 2002; Grigoriu & Alda 2004
			Niculescu 2004; Sarbu 2004; Sanda et al. 2006; Chifu et al. 2006
			Puşcaru et al. 1956; Csűrös & Resmeriță 1960; Gergely 1969
			Coldea 1987, 1990; Coldea & Pop 1988; Mihăilescu 2001
<i>Scorzonero roseae – Festucetum nigricantis</i>	850–1950 m	Romania	Pop et al. 2002; Niculescu 2004; Sarbu 2004; Sanda et al. 2006
			Chifu et al. 2006
<i>Campanulo serratae – Festucetum ovinae</i>	1100–2120 m	Romania	Resmeriță 1986; Coldea 1987; Pop et al. 2002
<i>Hieracio polosellae – Nardetum strictae</i>	700–1250 m	Romania	Resmeriță 1970; Pop et al. 2002
<i>Carici – Nardetum strictae</i>	1100–1850 m	Romania	Puşcaru et al. 1956; Buia 1963; Beldie 1967; Resmeriță 1970
			Pop et al. 2002
<i>Nardo – Callunetum vulgaris</i>	800–1600 m	Romania	Ghișa et al. 1970; Resmeriță 1970; Pop et al. 2002
<i>Poetum mediae</i>	1700–2020 m	Romania	Coldea 1990; Niculescu 2004; Sarbu 2004; Doniță 2005
<i>Antennario – Festucetum sudeticae</i>	1550–2150 m	Romania	Boşcaiu 1971
<i>Soldanello – Nardetum</i>	1200–1750 m	Ukraine	Malinovsky & Kricsfalusy 2000

* FFRY - Former Federal Republic of Yugoslavia