

## Ploidy level variability of some Central European fescues (*Festuca* subg. *Festuca*, Poaceae)

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**Abstract:** Using flow cytometry, ploidy levels for 205 living samples of various European species of *Festuca* L. subg. *Festuca* were determined. We used successfully flow cytometry also for ploidy level estimation of other 28 additional, 1/2–2-year-old herbarium specimens. About 23 taxa and two spontaneous hybrids originating from natural populations from Austria, the Czech Republic, France, Hungary, Germany, Italy, Poland, Romania and Slovakia were studied. The following ploidy levels were documented: *F. alpestris*  $2n = 2x$ ; *F. amethystina*  $2n = 4x$ ; *F. billyi*  $2n = 6x$ ; *F. brevipila*  $2n = 6x$ ; *F. carnuntina*  $2n = 6x$ ; *F. cinerea*  $2n = 4x$ ; *F. degenii*  $2n = 4x$ ; *F. duernsteinensis*  $2n = 4x$ ; *F. duvalii*  $2n = 4x$ ; *F. gracilior*  $2n = 2x$ ; *F. lemanii*  $2n = 6x$ ; *F. ovina* subsp. *questfalica*  $2n = 4x$ ; cf. *F. ovina*  $\times$  *F. pallens*  $2n = 2x$ ; *F. pallens*  $2n = 2x, 3x, 4x$ ; *F. psammophila*  $2n = 2x$ ; *F. pseudodalmatica*  $2n = 4x$ ; *F. pseudovina*  $2n = 2x$ ; *F. rupicola*  $2n = 6x$ ; *F. stricta*  $2n = 6x$ ; *F. vaginata* subsp. *dominii*  $2n = 2x$ ; *F. vaginata* subsp. *vaginata*  $2n = 2x$ ; *F. vaginata*  $\times$  *F. valesiaca*  $2n = 2x$ ; *F. valesiaca*  $2n = 2x$ ; *F. versicolor* subsp. *versicolor*  $2n = 2x$ ; *F. wagneri*  $2n = 4x$ .

**Key words:** dry material, flow cytometry, karyology, polyploidy.

### Introduction

Including about 360 species (WATSON & DALLWITZ, 1999), *Festuca* L. is one of the largest genera within the Poaceae family. CLAYTON & RENVOIZE (1986) divided the genus into the nine subgenera, with the most species-rich group being *Festuca* subg. *Festuca*. One center of diversity of this subgenus is located in the mountains and uplands of central and southern Europe. Within the subgenus, two sections, sect. *Festuca* and sect. *Variae* HACK., are recognized by TZVELEV (1971). Further division in smaller species groups and aggregates vary in the concepts of different authors.

In subgen. *Festuca*, there is a remarkable morphological similarity among the taxa included, caused to a great extent by the morphological variability of particular characters. Based on morphological characters alone, interpretation of many taxa is very problematic and sometimes nearly impossible. As already proved in the 1920s, ploidy level variability is very important for taxon delimitation (LITARDIÈRE, 1923; LEWITSKY & KUZMINA, 1927). Soon it was shown that the most problematic species groups of the genus represent more or less miscellaneous polyploid complexes, and ploidy

level became one of the basic classification and description criteria. Without knowledge of ploidy level, almost no systematic and taxonomic study can be done in this group at present.

This raises the question of what method to use for ploidy level determination. The widely used aceto-orcein method and similar techniques are very time-consuming and do not allow determination of a large amount of samples. Recently, flow cytometry has become the method of choice for rapid and accurate determination of ploidy level and DNA content in fresh plant tissues (DOLEŽEL, 1997). In *Festuca*, flow cytometry was first used by HUFF & PALAZZO (1998) and ARUMUGANATHAN et al. (1999) and was successfully applied in *Festuca* sect. *Variae* by WALLOSSEK (1999).

The base chromosome number of *Festuca* species is  $x = 7$ , diploids ( $2x$ ) possess 14 chromosomes, triploids ( $3x$ ) 21, tetraploids ( $4x$ ) 28 and hexaploids ( $6x$ ) 42 chromosomes; sometimes accessory chromosomes (B-chromosomes) have also been reported (MIZIANTY & PAWLUS, 1984; FUENTE et al., 2001; ŠMARDA & KOČÍ, 2003).

The aim of this work was to determine the ploidy levels of Central European species of *Festuca* subg. *Fes-*

*tuca* and some of their Mediterranean relatives; special attention was devoted to species from the *F. pallens* group and to the possibility of using of flow cytometry in herbarium specimens. The results of this study build upon previous records on chromosome numbers obtained by the aceto-orcein method (ŠMARDA & KOČÍ, 2003).

In this work, we follow the concept of Central European species and groups by TRACEY (1980), which corresponds to the subsection divisions of PAWLUS (1985). For taxa delimitation, we adopt the species concepts of MARKGRAF-DANNENBERG (1980) and PORTAL (1999). This work addresses the following European taxa and groups:

**-sect. *Festuca***

***F. ovina* group (ser. *Festuca*):**

*F.* × *duernsteinensis* J. VETTER\*

*F. ovina* subsp. *guestfalica* (BOENN. ex RCHB.) K. RICHT.

*F. lemanii* BASTARD

***F. pallens* group (ser. *Psammophilae* PAWLUS):**

*F. billyi* KERGUÉLEN et PLONKA

*F. cinerea* VILL.

*F. degenii* (ST.-YVES) MARKGR.-DANN.

*F. duvalii* (ST.-YVES) MARKGR.-DANN.

*F. gracilior* (HACK.) MARKGR.-DANN.

*F. pallens* HOST\*\*

– Oberösterreich-Niederösterreich type (TRACEY 1980, PILS 1981)

– Weizklamm type (TRACEY 1980)

– Pannonisches-Hügelland type (TRACEY 1980)

– scabrifolia type (ŠMARDA & KOČÍ 2003, *F. glaucina* STOHR)

– Steiermark-Kärnten type (sensu TRACEY 1980)

*F. psammophila* (HACK. ex ČELAK.) FRITSCH

*F. vaginata* WALDST. et KIT. ex WILLD. subsp. *vaginata*

subsp. *dominii* (KRAJINA) SOÓ

***F. valesiaca* group (ser. *Trachyphyllae* PAWLUS + ser. *Valesiaca* PAWLUS):**

*F. brevipila* R. TRACEY

*F. carnuntina* R. TRACEY

*F. pseudodalmatica* KRAJINA ex DOMIN

*F. pseudovina* HACK. ex WIESB.

*F. rupicola* HEUFF.

*F. stricta* HOST

*F. valesiaca* GAUDIN

*F. wagneri* (DEGEN, THAISZ et FLATT) DEGEN, THAISZ et FLATT

**miscellaneous taxa in sect. *Festuca***

*F. amethystina* L.

**-sect. *Variae* HACK.**

*F. alpestris* ROEM. et SCHULT.

*F. versicolor* TAUSCH subsp. *versicolor*

**Material and methods**

For determination of ploidy level, flow cytometry was used. Measurements proceeded in 2000 with a PAS (Partec GmbH, Münster, Germany) ploidy analyser. We used both living and dried plant specimens. Living material came from field-collections, and was cultivated after collection (1997 or later) in the Botanical Garden of Masaryk University in Brno, Czech Republic. One to three (seven at maximum) individuals from each population were investigated. Altogether 205 living plants representing 142 populations of 21 taxa and two spontaneous hybrids were studied. Additionally, 31 dried, 1/2–2-year-old plant specimens from authors' herbaria collections, representing 27 populations of 4 taxa, were investigated. These specimens were dried by classical methods, e.g. pressed among sheets of newspapers and filtering paper at room temperature. In addition to these, one 20-year-old and three 6–7-year-old specimens of *F. brevipila* stored in the Moravian Museum in Brno (BRNM) were used. Specimens of all determined living plants and authors' collections are stored at the Herbarium of the Department of Botany, Faculty of Science, Masaryk University in Brno (BRNU). The localities of plants of which ploidy levels were determined are given in the appendix.

Young, basal parts of leaves were used for analysis of both fresh and dried plant material. Fresh diploid *F. pallens* ( $2n = 14$ , sample F2, ŠMARDA & KOČÍ 2003) served as external standard. A two-step procedure (OTTO, 1990) was used for sample preparation. Leaf tissue of ca 0.5 cm<sup>2</sup> was chopped using a sharp razor blade in a glass Petri dish containing 0.5 mL Otto I buffer (0.1M citric acid, 0.5% Tween 20). The crude nuclei suspension was filtered through a 50 μm nylon mesh. 1 mL of Otto II buffer (0.4M Na<sub>2</sub>HPO<sub>4</sub>·12H<sub>2</sub>O) supplemented with 2 μg/mL 4,6-diamidino-2-phenylindole (DAPI) was then added to the nuclei suspension. For verification of the results, ploidy level was also tested by flow cytometry for several samples with known chromosome numbers (ŠMARDA & KOČÍ, 2003). They are marked by asterisks in the appendix.

Coordinates of the localities in Austria, Germany and Slovakia were calculated from 1:50 000 maps, those of Czech Republic were obtained through the program Geobáze (GEODÉZIE ČS, 1997–1998). For the remaining (France, Hungary, Italy, Poland, and Romania) the program Encarta World atlas 99 (MICROSOFT CORPORATION, 1995–1998) was used.

**Results and discussion**

*Festuca ovina* group

In the *F. ovina* group, special attention was paid to various transitional types to *F. pallens*. Tetraploid ploidy level was confirmed for the population of robust *F. ovina* like plants from Moravský Krumlov (SW Moravia), supposed to represent hybrids of *F. ovina* and *F. pallens*

\* tetraploid taxa of the supposed *F. ovina* × *F. pallens* hybrid origin, incl. population of the same hybrid combination from Vihorlat Mts (*F.* × *vihorlatica* MAJOVSKÝ nom. inval.), excl. sporadic diploid hybrids.

\*\* taxon with several karyologically and geographically differentiated types with unresolved taxonomic status.

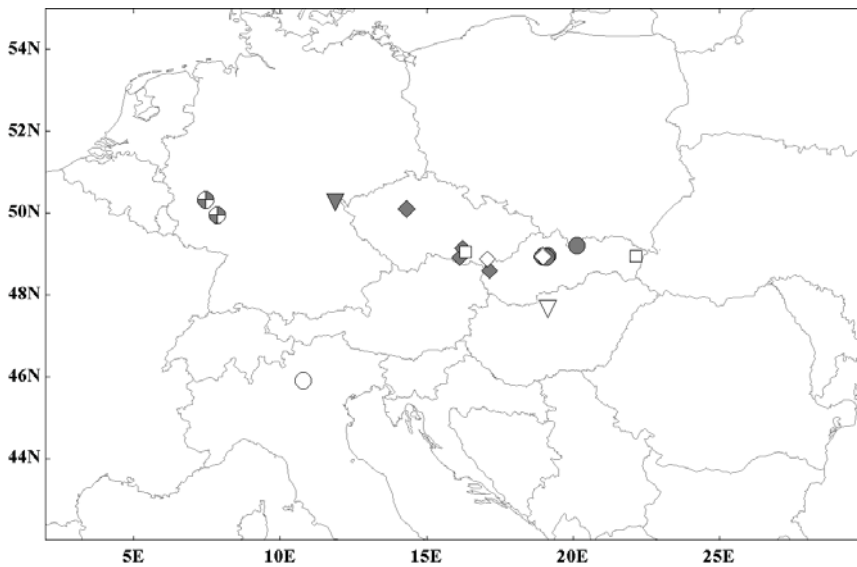


Fig. 1. Map of the localities of plants from the *Festuca ovina* group, *F. amethystina*, hybrids and *Festuca* sect. *Variae* for which ploidy level was investigated: white circle – *F. alpestris* ( $2n = 2x$ ); dark circles – *F. versicolor* ( $2n = 2x$ ); checked circles – *F. lemanii* ( $2n = 6x$ ); dark triangles – *F. ovina* × *F. pallens* ( $2n = 2x$ ); white triangle – *F. vaginata* × ? *F. valesiaca* – ( $2n = 2x$ ); white diamonds – *F. amethystina* ( $2n = 4x$ ); dark diamond – *F. ovina* subsp. *guestfalica* ( $2n = 4x$ ); white squares – *F. “x” duernsteinensis* ( $2n = 4x$ ). Altogether 30 ploidy level records are shown.

and sometimes being assigned to *F. × duernsteinensis* (VETTER, 1922; ŠMARDA & KOČÍ, 2003). A further transitional population of assumed *F. ovina* × *F. pallens* origin from the Vihorlat Mts (called *F. × vihorlatica*, MÁJOVSKÝ, 1962) was also proved to be tetraploid. Besides these populations, we found also sporadically occurring plants of the expected *F. ovina* × *F. pallens* hybrid origin in population of both species in Woja (NE Bayern, Germany) and determined them to be diploids. Because of the only sporadic occurrence, different ploidy level and consequently different origin they were treated separately from *F. × duernsteinensis* in this work. All samples of regular *F. ovina* were determined as tetraploids and associated with *F. ovina* subsp. *guestfalica* (Fig. 1), which agrees with the previous results of WATSON (1958), PILS (1980), TRACEY (1980), and ŠMARDA & KOČÍ (2003).

Stout plants from siliceous rocks in SW Germany (Mosel and Nahe valley) which had formerly been attributed to the tetraploid *F. heteropachys* (ST.-YVES) PATZKE ex AUQUIER (MARKGRAF-DANNENBERG, 1980; KORNECK et al., 1983; STOHR, 2002) were found to be hexaploid. These plants fall morphologically within the limits of the hexaploid *F. lemanii*, a polymorphic taxon with a broad distribution in France (KERGUÉLEN & PLONKA, 1989, sub *F. bastardii* KERGUÉLEN & PLONKA) and is also native in England (WILKINSON & STACE, 1991), Belgium (AUQUIER & RAMMELOO, 1973), and Luxembourg (AUQUIER & KERGUÉLEN, 1978: 51). Occurrence of *F. lemanii* in Germany was postulated by BANK-SIGNON & PATZKE (1986) for Düren (Nordrhein-Westfalen) and by DENGGLER (1999) for Schleswig-Holstein. However, these assumptions were based exclusively on morphology and were highly speculative because of considerable morphological overlap with similar taxa (e.g., *F. ovina* subsp. *guestfalica*).

#### *Festuca pallens* group

In *F. pallens*, the supposed geographical dependence of both ploidy levels and currently distinguished types (Fig. 2) (TRACEY, 1980; PILS, 1981; ŠMARDA & KOČÍ, 2003) was confirmed. The relatively wide distribution of tetraploid *F. pallens* of the scabrifolia type in central Germany is of particular interest. This type is unquestionably identical to *F. cinerea* var. *lapidosa* Stohr, which was recently raised to the species level as *F. glaucina* STOHR (STOHR, 2001). The expected occurrence of tetraploid plants of Pannonisches-Hügelland type in Hungary, Slovakia and Austria was also proven (Fig. 2). Tetraploid ploidy level was also observed in plants from the surroundings of Graz (Austria, Steiermark-Kärnten type). Diploid plants of *F. pallens* belong to the Weizklamm type and the standard Oberösterreich-Niederösterreich type (Fig. 2). Three triploid plants of *F. pallens* from Germany and the Czech and Slovak Republics were also documented. As in the previous works (BAKSAY, 1956; PÓLYA, 1949; SCHWARZOVÁ, 1967; TRACEY, 1980), *F. psammophila* and both subspecies of *F. vaginata* were confirmed to be exclusively diploid (Fig. 3). Diploidy was also found in a single hybrid plant of *F. vaginata* and *F. valesiaca*, originating from a *F. vaginata* subsp. *vaginata* population in Hungary (Fig. 1). Diploid chromosome number for the hybrid plant of *F. vaginata* × *F. valesiaca* was also published by TRACEY (1980).

*Festuca duvalii* from the type location near Kallstadt was reported to be tetraploid by KERGUÉLEN (1975). We determined the same ploidy level in the material from another population in SW Germany. *Festuca duvalii* is known from Germany (SW Germany and the central Main region), Belgium, and France (Alsace, KERGUÉLEN & PLONKA, 1989). Taxonomy and morphological delimitation of this species are still problematic and have been conceived differently by var-

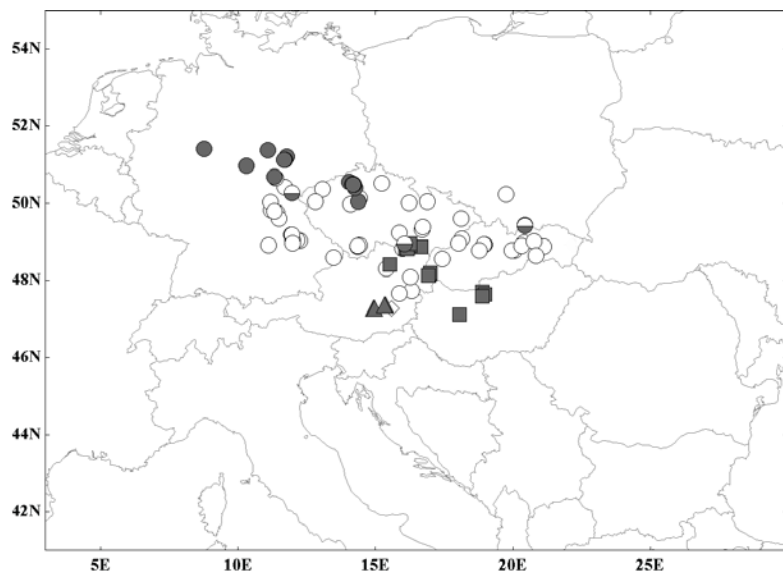


Fig. 2. Map of the localities of plants of the *Festuca pallens* types for which ploidy level was investigated, part 1: dark circles – *F. pallens* scabri-*folia* type ( $2n = 4x$ ); white circles – *F. pallens* Oberösterreich-Niederösterreich type ( $2n = 2x$ ); dark/white circles – *F. pallens* triploid plants ( $2n = 3x$ ); dark triangles – *F. pallens* Steiermark-Kärnten type ( $2n = 4x$ ); white diamond – *F. pallens* Weizklamm type ( $2n = 2x$ ); dark squares – *F. pallens* Pannonisches-Hügelland type ( $2n = 4x$ ). Altogether 122 ploidy level records are shown.

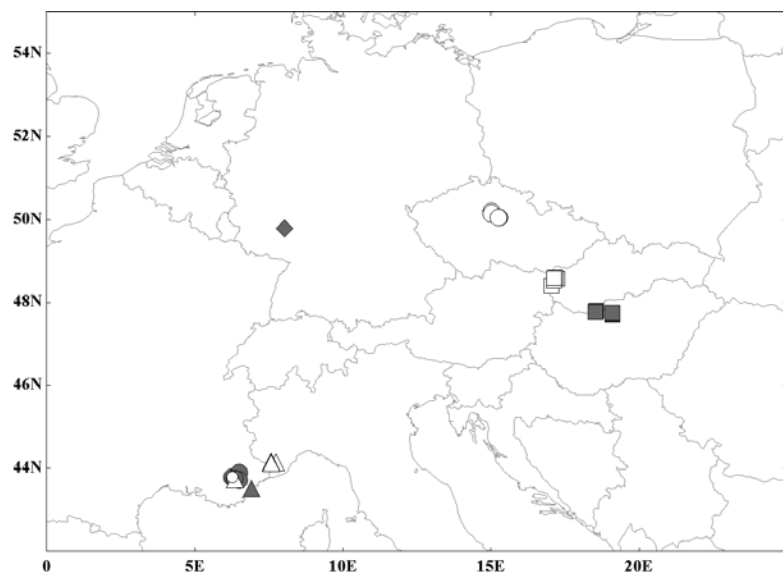


Fig. 3. Map of the localities of plants of the *Festuca pallens* group for which ploidy level was investigated, part 2: small white circle – *F. billyi* ( $2n = 6x$ ); large white circle – *F. psammophila* ( $2n = 2x$ ); dark circle – *F. gracilior* ( $2n = 2x$ ); dark squares – *F. vaginata* subsp. *vaginata* ( $2n = 2x$ ); white squares – *F. vaginata* subsp. *dominii* ( $2n = 2x$ ); white triangles – *F. cinerea* ( $2n = 4x$ ); dark triangles – *F. degenii* ( $2n = 4x$ ); dark diamond – *F. duvalii* ( $2n = 4x$ ). Altogether 42 ploidy level records are shown.

ious authors (e. g. MARKGRAF-DANNENBERG, 1958; STOHR, 1960, 2001; TZVELEV 1972; PAWLUS, 1985; KERGUÉLEN & PLONKA, 1989). Regular plants of *F. duvalii* have marginal and central sclerenchyma strands (like those of *F. valesiaca* group), but also individuals with uniform sclerenchyma rings can be found among typical representatives, e.g. on dunes of the upper Rhine plains and on andesite rocks in Rheinhessen (Flonheim). Plants with the uninterrupted sclerenchyma ring resemble morphologically *F. pallens*, a taxon which on the other hand also especially in tetraploid populations can often form leaves with partly interrupted sclerenchyma ring. Hence, we suppose *F. duvalii* to be probably closely related to *F. pallens*. *Festuca longifolia* THUILL. subsp. *longifolia* and subsp. *pseudocostei* AUQUIER & KERGUÉLEN (= *F. patzkei* MARKGR.-DANN., AUQUIER & KERGUÉLEN, 1978), a pair of close diploid relatives, one with a uniform sclerenchyma ring

and the other with rather marginal and central strands, could serve as an analogy for the further study of this topic.

Among the (sub)mediterranean species of the *F. pallens* group, *F. gracilior* was found to be diploid, *F. cinerea* and *F. degenii* tetraploid, and *F. billyi* hexaploid (Fig. 3). These results are in concordance with the karyological data presented by LITARDIÈRE (1949, *F. gracilior* sub *F. ovina* var. *occitana* f. *mucronulata* LITARD.), BIDAULT (1966: 182, *F. degenii*, sub *F. ovina* var. *glauca* HACK.), KERGUÉLEN (1975, *F. cinerea*; 1987, *F. gracilior*), KERGUÉLEN & PLONKA (1991, *F. billyi*), KERGUÉLEN et al. (1994, *F. billyi*), and FOGGI & ROSSI (1996, *F. billyi*). Plants from Spain previously assigned to *F. gracilior* and reported to be tetraploid (FUENTE & ORTÚÑEZ, 1998; FUENTE et al., 2001) were recently described as new species, *F. michaelis* CEBOLLA & RIVAS PONCE (CEBOLLA & RIVAS PONCE, 2001), and

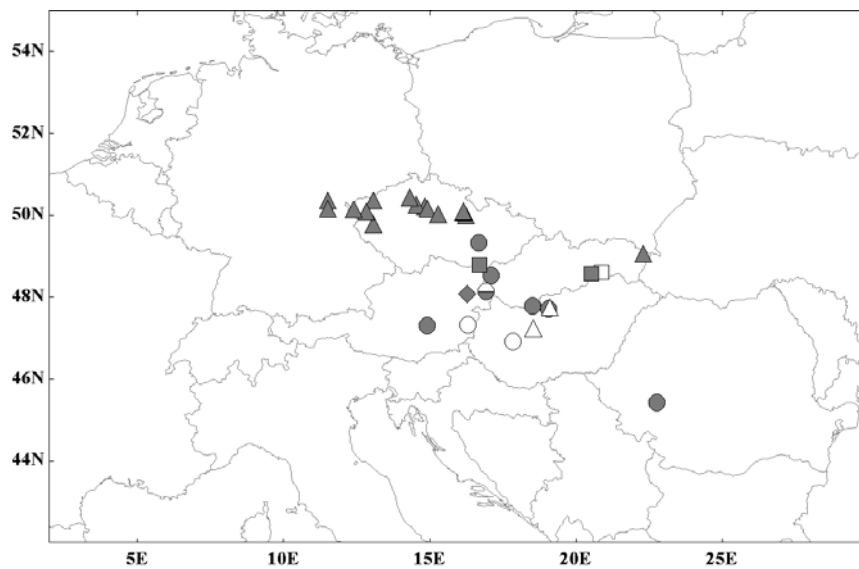


Fig. 4. Map of the localities of plants from the *Festuca valesiaca* group for which ploidy level was investigated: dark circles – *F. rupicola* ( $2n = 6x$ ); white circles – *F. pseudodalmatica* ( $2n = 4x$ ); dark/white circles – *F. carnuntina* ( $2n = 6x$ ); white triangles – *F. wagneri* ( $2n = 4x$ ); dark triangles – *F. brevipila* ( $2n = 6x$ ); dark diamond – *F. stricta* ( $2n = 6x$ ); dark squares – *F. pseudovina* ( $2n = 2x$ ); white squares – *F. valesiaca* ( $2n = 14$ ). Altogether 40 ploidy level records are shown.

do not correspond with the diploid ones reported in this work from France. Our record of *F. billyi*, hitherto known from the Massif Central (PORTAL, 1999) and the Apennine (FOGGI & ROSSI, 1996), is the first karyologically proven evidence from the Alps. PORTAL (1999) and JORDAN & FARILLE (2000) supposed this taxon to be found in the French Alps, but there were some doubts because of strong morphological similarity with the octoploid *F. laevigata* GAUDIN.

#### *Festuca valesiaca* group

In the *F. valesiaca* group, *F. valesiaca* and *F. pseudovina* were found to be diploid, *F. pseudodalmatica* and *F. wagneri* tetraploid, and *F. brevipila*, *F. carnuntina*, *F. rupicola* and *F. stricta* hexaploid (Fig. 4). All these results agree with the previous ones from the study area given by ALEXEEV et al. (1988, *F. brevipila* sub *F. trachyphylla*, *F. pseudodalmatica*, *F. pseudovina*, *F. valesiaca*), BAKSAY (1961, *F. wagneri* sub *F. conficta* BAKSAY), ČINČURA (1967, *F. pseudodalmatica*), JAROLÍMOVÁ (1992, *F. valesiaca*), MIZIANTY & PAWLUS (1984, *F. carnuntina*, *F. brevipila*, *F. rupicola*, *F. stricta*, *F. valesiaca*), PILS (1984, *F. rupicola* sub *F. stricta* subsp. *sulcata* (HACK.) PATZKE ex J. MÜLLER, *F. valesiaca*), TRACEY (1980, all mentioned species, *F. pseudovina* sub *F. valesiaca* subsp. *parviflora* (HACK.) R. TRACEY), TVERETINOVA (1977, *F. brevipila*, *F. pseudovina*, *F. pseudodalmatica*, *F. rupicola*, *F. valesiaca*), and VÁCHOVÁ (1987, *F. valesiaca*). Literature records of tetraploid *F. stricta* from Slovakia (UHRÍKOVÁ & MÁJOVSKÝ, 1983) probably refer to tetraploid *F. pallens*, which we document from the same locality in the present study. Reports of tetraploid *F. brevipila* (TVERETINOVA, 1977; ALEXEEV et al., 1988), hexaploid *F. valesiaca* (MIZIANTY & PAWLUS, 1984) and various sources reporting tetraploid or hexaploid *F. pseudovina* (FELFÖLDY, 1947, TRACEY, 1980; RYBNICKÁ, 1987) contrast with the most frequent chromo-

some numbers and the results of this work. Due to the high morphological variability of *F. valesiaca* group and potential hybridization, it is impossible to discuss these results without detailed knowledge of the respective herbaria specimens.

#### Other groups

In the section *Variae*, the diploid level was found in both *F. alpestris* and *F. versicolor* subsp. *versicolor* (Fig. 1). The same ploidy level was reported in *F. versicolor* subsp. *versicolor* from the Western Carpathians by UHRÍKOVÁ (1970), MIZIANTY & FREY (1973) and MURÍN & MÁJOVSKÝ (1978, 1987).

The first karyological records of *F. amethystina* from the Czech and Slovak Republics are documented in this work. All samples studied were determined as tetraploids (Fig. 1), which agree with the results of WITTMANN & STROBL (1984) from Austria.

#### Determination of ploidy level of the herbarium specimens

With the method used, we were able to determine ploidy level in 28 of the 35 investigated herbarium specimens. Signals of 1/2–2-year-old herbarium specimens were in quality comparable to those of living samples and do not differ in expected position to the standard. Three specimens of *F. picturata* PILS from Romania, which had been dried under wet conditions in the field for several days, showed very degraded signal and therefore they could not be determined. No signal was observed in one 20-year old and three 6–7-year old specimens of *F. brevipila* and in the leaves of herbarium specimens which had died naturally in the tufts before herbarisation (brown leaves).

The use of flow cytometry for dried material analysis, however, is an object of speculation and has not been published yet. It is especially interesting whether older specimens and plants of other genera are suitable

to be determined and to what extent this process is influenced by xeromorphic structure (e.g. parenchyma leaf cells protected by sclerenchyma ring in *F. pallens*) or other eco-physiological adaptations. All these questions are subject for further study. Success of flow cytometry estimation will possibly be influenced also by the length and conditions of drying process. This should be proceeded fast (as indicated by failing of analysis of naturally dried and died leaves and of *F. picturata* specimens pressed under humid conditions), under drought and probably at moderate temperatures.

### Acknowledgements

For help with plant collecting, we are much obliged to our colleagues whose names appear in the particular locality descriptions in Appendix. The text was translated into English by Sierra Stoneberg HOLT and was improved by anonymous reviewer. This project was partially supported by the grant GAČR 206/03/0228.

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Received March 15, 2003

Accepted Oct. 12, 2004

## Appendix

List of taxa and localities of ploidy level determined plants and specimens. The name just before the colon represents the nearest town/village. Collector name, date of collection and plant cultivation numbers are given in parentheses at the end of the locality description. The letter F indicates cultivated plants, H samples in which only herbarium specimen was available. Samples with previously known chromosome numbers are marked by asterisks; samples in which ploidy level was determined from dry material or herbarium specimens are marked by # before the sample number. Observed ploidy level and expected chromosome numbers are in parentheses by the taxon name.

**F. alpestris Roem. et Schult.** ( $2n = 2x = 14$ ): **Italy**: Prov. Trento, Riva del Garda: Bocca Sperone saddle, 2.5 km SW of the town, glade in brush on W exp. limestone rocky slope, common, 950 m a.s.l., 45°52'39"N, 10°49'21"E (P. ŠMARDA, 10.6.2000; F1122\*)

**F. amethystina L.** ( $2n = 4x = 28$ ): **Czech Republic**: district Hodonín, Mutěnice: 3.8 km SE of the railway station in the village, 100 m SE of the crossroad of Topolová alej forest track and the road (also railway), open stand thermophilous oak forest, edge of a moist depression on sand, small colony, 180 m a.s.l., 48°53'04"N, 17°05'02"E (V. GRULICH & K. KOČI, 20.5.1995; F111\*). **Slovakia**: Velká Fatra Mts., district Martin, Blatnica: Top part of Tlštá Mt. (1373 m), limestone rockeries, common, 1350 m a.s.l., 48°56'01"N, 18°58'28"E (K. KOČI & M. KOČI, 29.10.2000; F147\*, F148, F151\*)

**F. billyi Kerguelen et Plonka** ( $2n = 6x = 42$ ): **France**: Dép. Var, Grand Canyon du Verdon, Aiguines: 1.5 km E of the village, above the canyon near Col Iloire view point, steep, rocky limestone slopes, small colony, 1040 m a.s.l., 43°46'44"N, 06°15'17"E (P. ŠMARDA, 8.6.2000; F1123)

**F. brevipila R. Tracey** ( $2n = 6x = 42$ ): **Czech Republic**: district Cheb, Hájek: SOOS Nature Reserve, 200 m N of the village, fringe of nature trail near the wood, some plants, 440 m a.s.l., 50°08'53"N, 12°24'12"E (O. ROTREKLOVA & P. ŠMARDA, 12.7.2000; F1215) – district Karlovy Vary, Bečov nad Teplou: 800 m NE of the railway station, on an artificial rise on top of the ridge of the slope above the railway tunnel, in deeper soil on siliceous substrate, small colony, 560 m, 50°05'22"N, 12°50'13"E

(P. ŠMARDÁ, 9.10.1999; F1043, F1044) – district Karlovy Vary, Boč: 600 m SSW of the railway station, above the railway, edge of siliceous rockery, small colony, 350 m a.s.l., 50°21'19"N, 13°04'35"E (P. ŠMARDÁ, 10.10.1999; F1040) – district Kolín, Konárovice: 0.7 km SSE of the church in the village in the local waterworks site, on sand in open vegetation in pine-wood glade, small colony, 200 m a.s.l., 50°01'59"N, 15°17'21"E (P. ŠMARDÁ, 18.6.2000; F1143) – district Litoměřice, Bechlín: 1.7 km N of the church in the village, 600 m E of Klouček (209.7 m) elevation point, near the road to Předonín village, sunny pine-wood edge on sand, small colony, 168 m a.s.l., 50°26'18"N, 14°19'03"E (M. CHYTRÝ & P. ŠMARDÁ, 2.6.1999; F81) – district Mělník, Tišice: Píščiny u Tišic Nature Reserve, sandy SE exp. slopes of the reservation, common, 160 m a.s.l., 50°15'49"N, 14°32'46"E (P. ŠMARDÁ, 31.5.1999; F68) – district Nymburk, Kersko: NE part, 1.15 km SW of the church in the village of Hradištko, near the fence near the road, grassland along the forest track, in pine-wood on sand, together with *F. psammophila*, small colony, 185 m a.s.l., 50°09'45"N, 14°55'20"E (P. ŠMARDÁ, 3.6.1999; F80) – district Nymburk, Lysá nad Labem: 1.05 km ENE of "226.2 m" elevation point, sandy clearing in the pine-wood adjacent to Hrabanovská černava Nature Reserve, small dense colony, 185 m a.s.l., 50°13'12"N, 14°49'46"E (P. ŠMARDÁ, 29.5.1999; F67) – district Rychnov nad Kněžnou, Čermná nad Orlicí-Čížová: 0.5 km NW of the church in the village, wood edge on sand, abundant, 270 m a.s.l., 50°04'33"N, 16°08'42"E (P. FILIPPOV, 26.5.2000; F1115) – district Rychnov nad Kněžnou, Zdelov: near the agricultural cooperative at the locality of *As-tragalus arenarius*, on sand, abundant, 270 m a.s.l., 50°06'03"N, 16°08'42"E (P. FILIPPOV, 26.5.2000; F1116) – district Tachov, Malovice: 1.1 km SE of the village, 100 m W of the railway bridge over the Hracholusky dam, siliceous rocky slope, on a platform near the cottage in denser growth of grass, rare, 380 m a.s.l., 49°47'12"N, 13°04'19"E (P. ŠMARDÁ, 8.10.1999; F1042) – district Ústí nad Orlicí, Chocení: Peliny Nature Reserve, 1.3 km NE of the railway station in the town, wood edge above the river, argillite rock edge, in places, 350 m a.s.l., 50°00'11"N, 16°14'04"E (K. KOČÍ & M. KOČÍ, 12.10.2000; F139). **Germany:** Bayern, Kreis Kronach, Stoffelsmühle: near the branch road to Nordhalben, in railway yard below a siliceous rocky slope, small colony, 450 m a.s.l., 50°21'33"N, 11°31'19"E (O. ROTREKLOVÁ & P. ŠMARDÁ, 12.7.2000; F1212, F1213) – Bayern, Kreis Kulmbach, Stadtsteinach: end of the railway on E village periphery, crushed stone heaps (probably transported from a quarry), small colony, 330 m a.s.l., 50°09'49"N, 11°30'49"E (O. ROTREKLOVÁ & P. ŠMARDÁ, 12.7.2000; F1214). **Slovakia:** Východné Karpaty Mts., district Snina, Jalová: road breakthrough, 100 m E of "539.6 m" elevation point, 4 km ENE of the church in the village, road bank, common, 500 m a.s.l., 49°02'95"N, 22°17'74"E (P. ŠMARDÁ, 5.8.2000; F1220, F1221)

***F. carnuntina* R. Tracey** ( $2n = 6x = 42$ ): **Austria:** Niederösterreich, Hundheim-Neusiedlung: Nature Reserve on NE village periphery, rocky steppe on SW exp. dolomite slope, common, 400 m a.s.l., 48°08'00"N, 16°56'04"E (P. KARLÍK, 20.5.2000; F1190, F1191)

***F. cinerea* Vill.** ( $2n = 4x = 28$ ): **France:** Dép. Alpes Maritimes, Tende:  $\pm 7$  km NNW of the town, below Col de Tende, road border on S exp. stony calcareous slopes, common, 1300–1600 m a.s.l.,  $\pm 44^{\circ}08'44''N$ ,  $07^{\circ}44'10''E$  (P. ŠMARDÁ, 9.6.2000; F1128, F1129\*, F1131, F1132\*, F1133, F1134, F1135) – Dép. Var; Grand Canyon du Verdon, Aiguines: 9 km SE of the village, slopes below les Cavaliers hut, heap of fine limestone gravel, small colony, 800 m a.s.l.,  $43^{\circ}44'33''N$ ,  $06^{\circ}19'50''E$  (P. ŠMARDÁ, 8.6.2000; F1120, F1121) – Dép. Var; Grand Canyon du Verdon, Aiguines: 9 km SE of the village, slopes below les Cavaliers hut, sunny limestone rocky slopes, small colony, 800 m a.s.l.,  $43^{\circ}44'33''N$ ,  $06^{\circ}19'49''E$  (P. ŠMARDÁ, 8.6.2000; F1119)

***F. degenii* (St.-Yves) Markgr.-Dann.** ( $2n = 4x = 28$ ): **France:** Massif de l'Estérel, Dép. Alpes-Maritimes, Cannes-la Napoule: Tremblant, la Caldère, rock below Maure-Vieil monastery, acidic andesite rockery with species-poor vegetation,

small colony, 5.6.2000, P. ŠMARDÁ, 250 m a.s.l.,  $43^{\circ}30'64''N$ ,  $06^{\circ}54'53''E$  (F1127)

***F. × duernsteinensis* J. Vetter** ( $2n = 4x = 28$ ): **Czech Republic:** Moravský Krumlov: Pod Floriánkem Nature Reserve, platform near the edge of the NW exp. slope of the reservation (near "312" elevation point), on Křepelčín vrch hill, deeper sandy soil on basic conglomerate rock, together with *Festuca* sp. div. rare, 310 m a.s.l.,  $49^{\circ}02'48''N$ ,  $16^{\circ}19'17''E$  (P. ŠMARDÁ, 24.5.1998; F1094, F1095, F1096). **Slovakia:** Vihorlat Mts., district Snina, Zemplínske Hámre: rocky platform on the top of Sninský kameň hill, andesite rock, abundant, 1006 m a.s.l.,  $48^{\circ}55'78''N$ ,  $22^{\circ}11'22''E$  (P. ŠMARDÁ, 4.8.2000; F1222, F1223, F1224, F1225, F1226)

***F. duvalii* (St.-Yves) Stohr** ( $2n = 4x = 28$ ): **Germany:** Rheinland-Pfalz, Kreis Alzey-Worms, Flonheim: S of the village, ENE Auleimermühlen, dry grassland on andesite, 240 m a.s.l.,  $49^{\circ}46'58''N$ ,  $08^{\circ}01'55''E$  (J. MÜLLER et al. 6710, 17.4.1999; #H343)

***F. graciliior* (Hack.) Markgr.-Dann.** ( $2n = 2x = 14$ ): **France:** Grand Canyon du Verdon, Dép. Var, Aiguines: 1.5 km E of the village, above the canyon near Col Iloire view point, steep, rocky limestone slopes, small colony, 1040 m a.s.l.,  $43^{\circ}46'44''N$ ,  $06^{\circ}15'17''E$  (P. ŠMARDÁ, 8.6.2000; F1124) – Grand Canyon du Verdon, Dép. Var, Aiguines: 9 km SE of the village, slopes below les Cavaliers hut, sunny, rocky limestone slopes, common, 800 m a.s.l.,  $43^{\circ}44'33''N$ ,  $06^{\circ}19'49''E$  (P. ŠMARDÁ, 8.6.2000; F1117, F1118, F1139) – Dép. Var, Comps-sur-Atruby: along the road in the town, low, rocky limestone slope, small colony, 900 m a.s.l.,  $43^{\circ}42'70''N$ ,  $06^{\circ}30'45''E$  (P. ŠMARDÁ, 8.6.2000; F1125, F1126)

***F. lemanii* Bastard** ( $2n = 6x = 42$ ): **Germany:** Rheinland-Pfalz, Kreis Mainz-Bingen, Dorsheim: Eierfels, NE of the village, Permian conglomerate rock, 160 m a.s.l.,  $49^{\circ}55'45''N$ ,  $07^{\circ}52'22''E$  (J. MÜLLER 6986, 24.5.2000; #H341) – Rheinland-Pfalz, Kreis Mayen-Koblenz, Dieblich: E of the village, upper SW slope of the Blumsley, schistaceous cliff, 200 m a.s.l.,  $50^{\circ}18'39''N$ ,  $07^{\circ}28'30''E$  (J. Müller 6984, 24.5.2000; #H342)

***F. ovina* subsp. *guestfalica* (Rchb.) K. Richt.** ( $2n = 4x = 28$ ): **Czech Republic:** district Praha-město, Praha-Liboc: Divoká Šárka Nature Reserve, 300 m a.s.l. N of Džbán elevation point, NW exp. siliceous rocks with growth of *Avenella flexuosa*, in places, 350 m a.s.l.,  $50^{\circ}05'53''N$ ,  $14^{\circ}19'18''E$  (P. ŠMARDÁ, 21.11.1999; F1065) – district Třebíč, Senohrady: 1.55 km NNW of the church in the village near Senohradský mlýn mill, siliceous slope, common, 290 m a.s.l.,  $49^{\circ}08'15''N$ ,  $16^{\circ}14'18''E$  (T. VYMYSLICKÝ, 25.9.1999; F1035) – district Znojmo, Tvořihráz: "238.9 m" elevation point on the ESE village periphery, closed growth of grass on siliceous rocks, abundant, 230 m a.s.l.,  $48^{\circ}55'02''N$ ,  $16^{\circ}08'28''E$  (P. ŠMARDÁ, 29.8.1999; F1029). **Slovakia:** district Senica, Šišulákovci: 1 km NE of the village, sands of S exp. sunny pine-wood margin, small colony, 210 m a.s.l.,  $48^{\circ}34'65''N$ ,  $17^{\circ}08'94''E$  (P. ŠMARDÁ & T. VYMYSLICKÝ, 26.6.2000; F1181, F1184\*)

**cf. *F. ovina* × *F. pallens*** ( $2n = 2x = 14$ ): **Germany:** Bayern, Kreis Hof, Woja: 0.7 km SSW of the village, slopes of Nature Reserve above the railway, S exp. rocky serpentine slope, plants of this type only rare, 510 m a.s.l.,  $50^{\circ}15'17''N$ ,  $11^{\circ}58'28''E$  (O. ROTREKLOVÁ & P. ŠMARDÁ, 12.7.2000; F1206, F1207)

***F. pallens* Host–Oberösterreich–Niederösterreich type** ( $2n = 2x = 14$ ): **Austria:** Burgenland, Forchtenstein near Mattesburg: 300 m NW of Forchtenstein castle, dolomitised limestone rocks, common, 580 m a.s.l.,  $47^{\circ}42'43''N$ ,  $16^{\circ}19'43''E$  (K. KOČÍ, –5.2000; F1085) – Niederösterreich, Aggsbach-Dorf: 0.7 km S of main crossroad, W exp. limestone rocks above the Donau river, abundant, 280 m a.s.l.,  $48^{\circ}17'13''N$ ,  $15^{\circ}24'28''E$  (K. KOČÍ, –5.2000; F1088) – Niederösterreich, Mödling: 0.5 km E of Ruine Burg Mödling elevation point, edge of N exp. dolomite rocky slope in autochthonous *Pinus nigra* wood, small colony, 340 m a.s.l.,  $48^{\circ}04'50''N$ ,  $16^{\circ}16'32''E$  (K. KOČÍ, P. ENGLMAIER & P. ŠMARDÁ, 30.5.2000; F1112) – Niederösterreich, Schottwien (near Gloggnitz): NW village periphery, gorge near the road, rocky slopes, abundant, 600 m a.s.l.,  $47^{\circ}39'33''N$ ,  $15^{\circ}52'14''E$  (K. KOČÍ, P. ENGLMAIER & P. ŠMARDÁ, 30.5.2000; F1097). **Czech**



**Republic:** district Beroun, Beroun: 1.3 km ENE of Beroun railway station, above a purification plant, limestone rockery on SE exp. slope, abundant, 250 m a.s.l., 49°57'38"N, 14°05'35"E (P. ŠMARDA, 8.10.1999; F1039) – district Blansko, Josefov: Býčí skála elevation point, S exp. slope on top of a vertical limestone cliff, dense colony, 350 m a.s.l., 49°18'30"N, 16°41'45"E (P. ŠMARDA, 23.4.1998; F2\*) – district Blansko, Sloup: Pustý žleb valley, 4 km SSW of the church in the village, Koňský spád elevation point, top of W exp. limestone rock face, abundant, 480 m a.s.l., 49°22'44"N, 16°43'41"E (P. ŠMARDA, 28.4.2000; F1070) – district Brno-venkov, Nové Bránice: 300 m NW of Šibeniční vrch (296.6 m) elevation point, above the road opposite the quarry, siliceous rocky promontory, small colony, 215 m a.s.l., 49°04'10"N, 16°27'04"E (P. ŠMARDA, 24.5.1999; #F49\*) – district České Budějovice, Kamenný Újezd: 2.0 km WNW of the village, near Maškovec ruin, siliceous rocks, common, 450 m a.s.l., 48°54'06"N, 14°25'10"E (V. GRULICH, 5.11.1999; F1063) – district Český Krumlov, Tríso: 900 m NE of the village, Dívčí kámen ruin, in ruin wall, abundant, 500 m a.s.l., 48°53'21"N, 14°21'27"E (K. KOČÍ, 20.7.2000; F1235, F1236) – district Český Krumlov, Záluží: 1.1 km W of the village, "U Rohana" rocks on the right bank of the Vltava river, granulite rocks (*Alyso-Festucion pallentis*), common, 500 m a.s.l., 48°52'32"N, 14°21'54"E (V. GRULICH, 5.11.1999; F1062) – district Cheb, Mnichov: 450 m SE of Skalka (719.8 m) elevation point, 2.6 km ENE of the church in the village, E exp. siliceous rocks above the road, small colony, 490 m a.s.l., 50°02'32"N, 12°49'19"E (O. ROTREKLOVÁ & P. ŠMARDA, 13.7.2000; F1210, F1211) – district Jičín, Újezd pod Troskami: Trosky ruin, 2.3 km NW of the village, 480 m a.s.l., 50°30'58"N, 15°13'58"E (M. HORSÁK, 11.7.2000; F1217) – district Karlovy Vary, Boč: 1.6 km SSW of the church in the village, 400 m W of Čedičová žíla Boč Nature Reserve, above the road on left bank of the Ohře river, scree habitat on rocky basalt cliff, common, 350 m a.s.l., 50°21'01"N, 13°04'16"E (J. VOZANKA, 24.10.1999; F1057) – district Nový Jičín, Štramberk: Bílá hora hill (557.0 m), limestone rock, common, 540 m a.s.l., 49°35'42"N, 18°07'23"E (V. GRULICH, 8.7.1999; F1055) – district Nový Jičín, Štramberk: Kotouč Nature Reserve, limestone rocks, common, 450 m a.s.l., 49°35'16"N, 18°07'03"E (V. GRULICH, 8.7.1999; F1054) – district Praha-město, Praha-Trója: Jabloňka Nature Reserve, S exp. slopes of a siliceous rockery above the Vltava river, sparse, 240 m a.s.l., 50°07'01"N, 14°26'21"E (T. VYMYSLICKÝ, 19.11.1999; F1064) – district Šumperk, Raškov u Hanušovic: Modřínový vrch Nature Reserve, 1.2 km NW of the church in the village, S exp. serpentine rocks, abundant, 580 m a.s.l., 50°02'28"N, 16°53'15"E (P. ŠMARDA, 17.6.2000; F1150) – district Třebíč, Třebíč-Hrádek: 40 m NE of the foot-bridge, blue marked hiking trail from the centre of the town, siliceous sunny SSW exp. slopes above the Jihlava river, abundant, 405 m a.s.l., 49°13'01"N, 15°53'02"E (P. ŠMARDA, 26.6.1999; #H187, #H188, #H189) – district Ústí nad Orlicí, Choceň: Peliny Nature Reserve, 1.3 km NE of the railway station in the town, edge of argillite rock above the river, in places, 350 m a.s.l., 50°00'12"N, 16°14'03"E (K. KOČÍ & M. KOČÍ, 12.10.2000; F140, F141) – district Znojmo, Dyje: Dyjské svahy Nature Reserve, 1.1 km SSE of the church in the village, above the dirt track along the Dyje river, siliceous rocky outcrops, abundant, 210 m a.s.l., 48°50'17"N, 16°07'21"E (P. ŠMARDA, 25.5.1999; #F51\*) – district Znojmo, Havraníky u Znojma: Nad Papírnou elevation point, above the Dyje river, 200 m W from "400.6 m" elevation point, rocky siliceous slopes, common, 300 m a.s.l., 48°49'31"N, 15°58'53"E (P. ŠMARDA, 27.5.1999; #H2\*). **Germany:** Bayern, Kreis Bayreuth, Pottenstein: rock block above the crossroad by Teufelhöhle cave, 2.5 km SE of the village, limestone rock, common, 390 m a.s.l., 49°45'10"N, 11°25'40"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1216) – Bayern, Kreis Bayreuth, Pottenstein: SE of the village, between Schüttermühle and Teufelhöhle, 430 m a.s.l., 49°45'18"N, 11°25'33"E (J. MÜLLER 6870, 6.5.2000; #H320) – Bayern, Kreis Eichstätt, Schernfeld: S of the village, S exp. Jurassic limestone cliff, 470 m a.s.l., 48°53'55"N, 11°06'41"E (J. MÜLLER 7605, 3.6.2000; #H328) – Bayern, Kreis Forchheim, Gößweinstein: near

the railway station in the village, SW exp. dolomite rock, 400 m a.s.l., 49°46'25"N, 11°19'35"E (J. MÜLLER 6862, 6.6.2000; #H334) – Bayern, Kreis Forchheim, Streitberg: above houses along the road to Störn Hof, 0.5 km NNW of the church in the village, limestone rocks, small colony, 400 m a.s.l., 49°49'01"N, 11°13'07"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1204) – Bayern, Kreis Hof, Woja: 0.7 km SSW of the village, slopes of the Nature Reserve above the railway, S exp. serpentine rocky slope, 510 m a.s.l., 50°15'17"N, 11°58'28"E (O. ROTREKLOVÁ & P. ŠMARDA, 12.7.2000; F1208, F1209) – Bayern, Kreis Kelheim, Lohstadt: NNE of the village, SE exp. Jurassic limestone slope, 370 m a.s.l., 48°57'20"N, 11°59'10"E (J. MÜLLER 7625, 2.6.2000; #H331) – Bayern, Kreis Lichtenfels, Kleinziegenfeld: above the road in the village, limestone rocks, small colony (abundant in marble quarry near this locality), 430 m a.s.l., 50°01'23"N, 11°12'01"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1205) – Bayern, Kreis Nürnberger Land, Rupperechtstegen: NE of the village, E of Mühlberg, foot of S exp. Jurassic limestone cliff, 370 m a.s.l., 49°36'17"N, 11°29'23"E (J. MÜLLER 6973, 4.6.2000; #H332) – Bayern, Kreis Regensburg, Eich: SE foot of the Eichenberg, SW of the village, Jurassic limestone rock, 360 m a.s.l., 49°10'25"N, 11°58'12"E (J. MÜLLER 6923, 2.6.2000; #H329) – Bayern, Kreis Regensburg, Etterzhausen: 1.4 km NE of the railway station in the village, edge of limestone quarry above the Naab river, small colony, 410 m a.s.l., 49°02'14"N, 11°59'47"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1200, F1201) – Bayern, Kreis Regensburg, Kallmünz: 300 m NW of "434 m" elevation point in NW part of the village, 350 m NW of the church in the village, grassy edge of the slope beside the road, on calcareous bedrock, scattered, 350 m a.s.l., 49°09'54"N, 11°56'54"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1202, F1203) – Bayern, Kreis Regensburg, Sulzbach a. d. Donau: village periphery, S exp. siliceous rocks above the Danube river, abundant, 400 m a.s.l., 49°01'39"N, 12°14'44"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1196, F1197) – Bayern, Stadt Passau, Passau-Ilstadt: Klosterberg hill, siliceous S exp. rocky slopes near the Danube river, abundant, 320 m a.s.l., 48°34'37"N, 13°29'09"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1193, F1194) – Bayern, Stadt Regensburg, Schwabelweis: Fellingerberg Nature Reserve, N of the village, S exp. limestone slope, scattered, 360 m a.s.l., 49°01'50"N, 12°09'27"E (O. ROTREKLOVÁ & P. ŠMARDA, 11.7.2000; F1199) – Thüringen, Kreis Saalfeld-Rudolstadt, Oberritz: Bohlen, N of the village, W exp. schistaceous limestone slope, 280 m a.s.l., 50°37'52"N, 11°23'04"E (J. MÜLLER 6935, 21.5.2000; #H324) – Thüringen, Saale-Orla-Kreis, Blankenberg: W of the village, S exp. schistaceous rock along the Saale river, 430 m a.s.l., 50°24'21"N, 11°42'34"E (J. MÜLLER 7663, 18.6.2000; #H322). **Poland:** Krakow region, Jerzmanowice: Lysa skala hill on NW village centre periphery, top of limestone rock, some tufts, 480 m a.s.l., 50°12'48"N, 19°45'00"E (O. ROTREKLOVÁ, 15.6.2000; F1137, F1138) – Nowosadeckie region, Pieniny National Park, Krościenko nad Dunajcem: Sokolnica hill, 2.7 km SSW of the church in the village, limestone rocks, common, 700 m a.s.l., 49°25'07"N, 20°26'40"E (K. KOČÍ, 30.10.1999; F1060). **Slovakia:** Biele Karpaty Mts., district Ilava, Vršatské Podhradie: Vršatec hill on W village periphery, limestone rocks, common, 700 m a.s.l., 49°04'01"N, 18°09'04"E (J. NEMEC, 1.5.2000; F1071) – Biele Karpaty Mts., district Trenčín, Dolná Súča: below Krasín (516.2 m) elevation point, 750 m NW of the church in the village, rocky slope on limestone, common, 500 m a.s.l., 48°57'40"N, 18°01'12"E (J. NEMEC, 1.5.2000; F1072) – district Košice, Malá Lodina: Bokšov Nature Reserve, S of the village, 500 m N of Bokšovská skala (810.2 m) elevation point, limestone rocks below the ridge, abundant, 700 m a.s.l., 48°51'95"N, 21°08'05"E (V. GRULICH, 5.7.2000; F1192) – district Levoča, Spišské Podhradie: Spišský hradný vrch Nature Reserve, 1 km E of the village, S exp. calcareous rocks, common, 580 m a.s.l., 48°59'51"N, 20°45'43"E (P. ŠMARDA, 8.5.2000; F1218, F1219) – Kremnické vrchy hills, district Prievidza, Ráztočno: large limestone quarry, rocky terrace, scattered, 450 m a.s.l., 48°45'54"N, 18°46'36"E (P. ŠMARDA, 7.5.2000; F1076) – Malé Karpaty hills, district Trnava, Buková: 2 km ENE of the church in the vil-

lage (Horné Mlyny settlement), limestone rock, abundant, 280 m a.s.l., 48°32'75"N, 17°26'00"E (P. FILIPPOV, 8.5.2000; F1084) – Muráňský kras Mts., district Revúca, Muráň: 1.4 km SE of Velká Stožka (1296.9 m) elevation point, along yellow-marked hiking trail, rocky limestone outcrop (view point), common, 1180 m a.s.l., 48°46'00"N, 19°57'55"E (P. ŠMARDÁ, 9.5.2000; F1079) – Muráňský kras Mts., district Revúca, Muráň: 900 m SE of Velká Stožka (1296.9 m) Mt., edge of limestone rocky slopes, abundant, 1210 m a.s.l., 48°46'29"N, 19°57'50"E (P. ŠMARDÁ, 9.5.2000; F1080) – Muráňský kras Mts., district Revúca, Muráň: S edge of Muráň ruin, ruined walls, common, 930 m a.s.l., 48°45'44"N, 20°03'31"E (P. ŠMARDÁ, 8.5.2000; F1078) – Slovenský Kras hills, district Košice, Zádiel: 2 km N of the church in the village, upper edge of limestone canyon, common, 560 m a.s.l., 48°38'05"N, 20°50'07"E (P. ŠMARDÁ, 8.8.2000; F1230) – Slovenský Kras hills, district Košice, Zádiel: 200 m from Zadielsky kameň (600.6 m) elevation point, 900 m NE of the church in the village, upper edge of limestone canyon, common, 580 m a.s.l., 48°37'38"N, 20°50'19"E (P. ŠMARDÁ, 8.8.2000; F1229\*) – Slovenský raj National Park, district Rožňava, Stratená: next to the road through Stratená dolina valley, 1.3 km W of Remlaška (1167.6 m) elevation point, E exp. limestone rock, common, 830 m a.s.l., 48°53'18"N, 20°18'88"E (P. ŠMARDÁ, 11.5.2000; F1081) – Slovenský raj National Park, district Spišská Nová Ves, Hrabušice: in Vyšný Kysel' brook valley, 3.4 km N of Bykarka (1057.9 m) elevation point, S exp. limestone rocky slope, common, 900 m a.s.l., 48°56'65"N, 20°24'17"E (P. ŠMARDÁ, 11.5.2000; F1074) – Slovenský raj National Park, district Spišská Nová Ves, Hrabušice: Prielom Hornádu Nature Reserve, above the Hornád river near Mníchova díra elevation point, limestone rock, abundant, 550 m a.s.l., 48°57'49"N, 20°24'83"E (P. ŠMARDÁ, 1.5.2000; F1075) – Velká Fatra Mts., district Martin, Blatnica: Blatnická dolina valley, 1.1 km SW of Ostrá Mt. (1247 m), limestone rockeries above the footpath, common, 700 m a.s.l., 48°54'41"N, 18°57'24"E (K. KOČÍ & M. KOČÍ, 29.10.2000; F146) – Velká Fatra Mts., district Martin, Blatnica: top of Ostrá Mt. (1247 m), limestone rockeries, common, 1240 m a.s.l., 48°55'08"N, 18°58'04"E (K. KOČÍ & M. KOČÍ, 29.10.2000; F144, F145)

***F. pallens* Host** ( $2n = 3x = 21$ ): **Czech Republic:** district Znojmo, Plaveč: 1.7 km NW of the church in the village, left bank of the Jevišovka river, opposite the mouth of Plenkovický potok brook, overgrown siliceous rocky outcrop (deciduous trees and grass cover), small colony, 245 m a.s.l., 48°56'17"N, 16°03'46"E (P. ŠMARDÁ, 29.8.1999; F1025\*). **Germany:** Bayern, Kreis Hof, Woja: natural reserve 0.7 km SSW of the village, S exp. serpentine slopes, 520 m a.s.l., 50°15'20"N, 11°58'28"E (J. MÜLLER 6864, 6.5.2000; #H318). **Slovakia:** Pieniny National Park, district Stará Ľubovňa, Lesnica: 2.5 km WNW of the church in the village, Dunajec river canyon, near the footpath to the "Sedem mníchov" rocks, limestone, common, 500 m a.s.l., 49°24'24"N, 20°26'13"E (K. KOČÍ, 30.10.1999; F1059\*)

***F. pallens* Host – Pannonisches-Hügelland type** ( $2n = 4x = 28$ ): **Austria:** Niederösterreich, Dürnstein: 1.5 km NNE of the church in the village near the way to Vogelberg hill, W exp. limestone rocky slopes, very abundant, 400 m a.s.l., 48°24'31"N, 15°31'41"E (K. KOČÍ, – 5. 2000; F1089; F1090, F1091) – Niederösterreich, Hundheim-Neusiedlung: Nature Reserve on NE village periphery, rocky steppe on SW exp. dolomite slopes, common, 340 m a.s.l., 48°07'50"N, 16°55'48"E (P. KARLÍK, 20.5.2000; F1189/1, F1189/2) – Niederösterreich, Hundheim-Neusiedlung: Nature Reserve on NE village periphery, rocky steppe on upper SW exp. edge of dolomite slope, 400 m a.s.l., 48°07'41"N, 16°56'25"E (K. KOČÍ, – 5.2000; F1073). **Czech Republic:** district Břeclav, Pavlov: Děvín Nature Reserve, on the top of the hill near the transmitter, elevation with deeper sandy soil on bunker ruin, a single tuft isolated here, 530 m a.s.l., 48°52'10"N, 16°39'00"E (P. ŠMARDÁ, 22.5.1998; F23\*) – district Znojmo, Derflice: Kamenná hora Nature Reserve, 850 m NE of the chapel in the village, granodiorite steppe slope, scattered, 220 m a.s.l., 48°48'51"N, 16°09'04"E (T. VYMYSLICKÝ, 1.5.2000; F1068) – district Znojmo, Hodonice: Vraní vrch (232.4 m) elevation point, 2.5 km SE of the railway station in the vil-

lage, 600 m SE of the sandpit, grass-covered flattish siliceous hill, on shallow soil without rocky outcrops, rare scattered tufts, 230 m a.s.l., 48°49'28"N, 16°11'17"E (P. ŠMARDÁ, 25.5.1999; #F55\*) – district Znojmo, Hostěradice: NE village periphery, U Kapličky Nature Reserve, S exp. siliceous rocky steppe slopes, scattered, 240 m a.s.l., 48°57'12"N, 16°15'47"E (T. VYMYSLICKÝ, 1.5.2000; F1069) – district Znojmo, Moravský Krumlov: Pod Floriánkem Nature Reserve, Křepelčín vrch hill, near "312" elevation point, platform near the edge of the NW exp. basic conglomerate slope, scattered, 310 m a.s.l., 49°02'48"N, 16°19'08"E (O. ROTREKLOVÁ, 24.5.1999; #F62\*) – district Znojmo, Načeratice: 200 m S of Načeratický kopec (291 m) hill, S exp. acidic rocky granodiorite slope, scattered, 275 m a.s.l., 48°49'30"N, 16°05'52"E (T. VYMYSLICKÝ, 1.5.2000; F1067) – district Znojmo, Oleksovice: Oleksovické vřesoviště Nature Reserve 0.8 km SSE of the church in the village, on deep sand bank, small colony, 240 m a.s.l., 48°53'51"N, 16°15'05"E (T. VYMYSLICKÝ, 1.5.2000; F1066) – district Znojmo, Tasovice: W part of Nad Splavem Nature Reserve, 1.6 km W of the bridge in the village, S exp. steppe siliceous rocky slope above the Dyje river, common, 210 m a.s.l., 48°50'06"N, 16°07'55"E (P. ŠMARDÁ, 25.5.1999; #F53\*). **Hungary:** Veszprém County, Király-Szentistván: N village periphery, grazing steppe on calcareous bedrock, abundant, 300 m a.s.l., 47°06'30"N, 18°02'58"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 24.6.2000; F1172, F1173) – Budai-hegy hills, Pest County, Nagykovácsi: N village periphery, S exp. calcareous rocks with steppe vegetation (*Seselio leucospermi-Festucetum pallentis*), common, 500 m a.s.l., 47°35'27"N, 18°52'50"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 23.6.2000; F1167, F1168) – Pilis hills, Pest County, Csobánka: E village periphery, W exp. limestone steppe slopes, common, 400 m a.s.l., 47°37'56"N, 18°58'19"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 22.6.2000; F1157) – Pilis hills, Pest County, Dobogókő: 1.7 km SW of the village, rocky limestone promontory above the road, small colony, 600 m a.s.l., 47°42'28"N, 18°53'06"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 22.6.2000; F1156). **Slovakia:** district Bratislava, Devín: Devínská Kobyla Nature Reserve, 0.8 km N of the church in the village, W exp. rocky dolomite slopes, common, 340 m a.s.l., 48°10'94"N, 16°59'46"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 25.6.2000; F1176, F1177) – district Bratislava, Devín: Devínsky hrádok ruin area, dolomite fissures, common, 230 m a.s.l., 48°10'41"N, 16°58'88"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 25.6.2000; F1175)

***F. pallens* Host – scabrifolia type** ( $2n = 4x = 28$ ): **Czech Republic:** district Litoměřice, Hrdly: 0.6 km NE of the railway station in the village, S exp. sunny, sandy pine-wood margin, scattered, 160 m a.s.l., 50°29'21"N, 14°10'53"E (P. ŠMARDÁ, 19.6.2000; F1149) – district Litoměřice, Kleneč: Klenečská stráň Nature Reserve, dry sandy slope (*Plantagini-Festucetum ovinae*), on the edge of the S part of the reserve shaded by trees, rare, 220 m a.s.l., 50°23'20"N, 14°15'24"E (M. CHYTRÝ & P. ŠMARDÁ, 2.6.1999; F73\*) – district Litoměřice, Libotenice: 0.8 km W of the cemetery, grassland with *F. valesiaca* on sandy S exp. pine-wood margin, small colony, 185 m a.s.l., 50°28'45"N, 14°12'58"E (P. ŠMARDÁ, 19.6.2000; F1147) – district Litoměřice, Oleško: 0.5 km NW of the church in the village, SW exp. sunny, sandy pine-wood margin, small abundant colony, 160 m a.s.l., 50°29'03"N, 14°11'34"E (P. ŠMARDÁ, 19.6.2000; F1145, F1146) – district Litoměřice, Oleško: 300 m E of the church in the village, in *Robinia pseudacacia* grove, on sand along the dirt track, small colony, 165 m a.s.l., 50°28'50"N, 14°12'07"E (P. ŠMARDÁ, 19.6.2000; F1151) – district Litoměřice, Velké Žernoseky: 1.25 km NNW of the church in the village, slopes above the railway below the "ttt" wiew point, S exp. gneiss rocky terraces, abundant, 260 m a.s.l., 50°32'50"N, 14°02'53"E (P. ŠMARDÁ, 10.10.1999; F1048) – district Praha-město, Praha-Hlubčepy: Děvín Nature Reserve in the Dalejský potok valley, S of Jezírko reservoir, top of the limestone rocky faces, abundant, 260 m a.s.l., 50°02'30"N, 14°22'55"E (P. ŠMARDÁ & M. HORSÁK, 3.11.1998; F31\*). **Germany:** Nordrhein-Westfalen, Hochsauerlandkreis, Padberg: S of the village, upper SW slope of the Lichtenberg, siliceous rock, 430 m a.s.l., 51°23'30"N, 08°46'11"E (J. MÜLLER 6854, 14.5.2000; #H339) – Sachsen-Anhalt, Burgenlandkreis, Freyburg: SE of the

village, SSE of the Neuenburg, dry grassland on Triassic limestone, 200 m a.s.l., 51°12'30"N, 11°46'36"E (J. MÜLLER 6868, 7.6.2000; #H335) – Sachsen-Anhalt, Burgenlandkreis, Saaleck: 500 m SSW of the village, dry grassland on Triassic limestone, 140 m a.s.l., 51°06'33"N, 11°41'52"E (J. MÜLLER 6881, 1.6.2000; #H337) – Sachsen-Anhalt, Burgenlandkreis, Saaleck: SE of the village, W of the Rudelsburg, W exp. Triassic limestone cliff, 180 m a.s.l., 51°06'38"N, 11°42'20"E (J. MÜLLER 6883, 1.6.2000; #H336) – Thüringen, Kreis Saalfeld-Rudolstadt, Remschütz: Kellerberg, NW of the village, S exp. sandstone cliff, 230 m a.s.l., 50°40'30"N, 11°21'03"E (J. MÜLLER 6936, 21.5.2000; #H323) – Thüringen, Kyffhäuserkreis, Bad Frankenhausen: Wüstes Kalktal at the lower slope of the Schlachtberg, N of the village, dry grassland on gypsum, 200 m a.s.l., 51°21'53"N, 11°06'05"E (J. MÜLLER 6869, 7.5.2000; #H325) – Thüringen, Stadt Eisenach, Eisenach: SW of the town, below the Wartburg, S exp. conglomerate cliff, 370 m a.s.l., 50°57'59"N, 10°18'27"E (J. MÜLLER 7679, 12.6.2000; #H340)

***F. pallens* Host – Steiermark-Kärnten type ( $2n = 4x = 28$ ):** **Austria:** Steiermark, Zlaten: above the road opposite a power station near a bridge, calcareous rocky face, abundant, 490 m a.s.l., 47°22'10"N, 15°19'06"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1110) – Steiermark, Kraubath an der Mur: Wintergraben valley, 2.1 km SE of the Chromwerk village, bare loamy slopes with fine stony debris at the edge of *Erico-Pineta* forest, small colony, 800 m a.s.l., 47°17'15"N, 14°58'18"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1107) – Steiermark, Pernegg: 1.05 km NE of the church in the village, serpentine outcrop near the forest track, small colony, 790 m a.s.l., 47°21'54"N, 15°21'35"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1104, F1105, F1106) – Steiermark, Kraubath an der Mur: Gulsenberg hill, 2.8 km SSW of the church in the village, serpentine rocks, very abundant, 600–700 m a.s.l., ±47°17'00"N, 14°55'38"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1100, F1101, F1102, F1103)

***F. pallens* Host – Weizklamm type ( $2n = 2x = 14$ ):** **Austria:** Steiermark, Weiz: Weizklamm valley, W exp. limestone slopes, abundant, 600 m a.s.l., 47°16'23"N, 15°34'50"E (K. KOČÍ, –5.2000; F1086, F1087)

***F. psammophila* (Hack. ex Čelak.) Fritsch ( $2n = 2x = 14$ ):** **Czech Republic:** district Kolín, Konárovice: 0.7 km SSE of the church in the village in the local waterworks site, on sand in open vegetation in pine-wood glade, small colony, 200 m a.s.l., 50°01'59"N, 15°17'21"E (P. ŠMARDA, 18.6.2000; F1141, F1142) – district Kolín, Konárovice: 600 m E of the church in the village, sunny S exp. sandy slopes on pine-wood margin, small colony, 200 m a.s.l., 50°02'20"N, 15°17'38"E (P. ŠMARDA, 18.6.2000; F1144) – district Kolín, Tři Dvory: 0.5 km NE of the centre of the village opposite the agricultural cooperative by the road, S exp. sandy pine-wood margin, 4 tufts, 202 m a.s.l., 50°02'03"N, 15°15'36"E (P. ŠMARDA, 17.6.2000; F1148) – district Nymburk, Kostelní Lhota: 1.5 km WNW of the church in the village, W exp. grassy pine-wood margin, some obviously overgrown tufts, 186 m a.s.l., 50°07'54"N, 15°00'42"E (P. ŠMARDA, 19.6.2000; F1140) – district Nymburk, Písty u Nymburku: 700 m NE of the village, 250 m SE of Na Ptáku (185.6 m) elevation point, S exp. small bare sand slope on the pine-wood edge, small colony, 185 m a.s.l., 50°10'00"N, 15°00'41"E (P. ŠMARDA, 3.6.1999; F77)

***F. pseudodalmatica* Krajina ex Domin ( $2n = 4x = 28$ ):** **Austria:** Burgenland, Rumpersdorf: 0.95 km SSE of the church in the village, road bank, small colony, 380 m a.s.l., 47°18'29"N, 16°20'05"E (K. KOČÍ, –5.2000; F1113, F1114). **Hungary:** Fejér County, Pákozd: Reservation 1 km N of the village, steppe, species-poor vegetation on rocky acidic siliceous substrate, common, 300 m a.s.l., 47°14'23"N, 18°32'43"E (P. ŠMARDA & T. VYMYSLICKÝ, 23.6.2000; F1171) – Veszprém County, Tihány: 1.5 km WNW of the village, N part of the peninsula, road fringe on shallow andesite bedrock, scattered, 200 m a.s.l., 46°54'31"N, 17°52'24"E (P. ŠMARDA & T. VYMYSLICKÝ, 24.6.2000; F1174)

***F. pseudovina* Wiesb. ( $2n = 2x = 14$ ):** **Czech Republic:** district Břeclav, Sedlec u Mikulova: Slanisko u Nesytu Nature Reserve on SE village periphery, halophilous meadow, scattered,

190 m a.s.l., 48°46'96"N, 16°42'04"E (P. ŠMARDA, 25.5.2000; F1092). **Slovakia:** Slovenský Kras hills, district Rožňava, Silica: N village periphery by the cemetery, grassland on limestone karst pastures, common, 560 m a.s.l., 48°33'59"N, 20°31'84"E (P. ŠMARDA, 10.8.2000; F1231)

***F. rupicola* Heuff. ( $2n = 6x = 42$ ):** **Austria:** Steiermark, Kraubath an der Mur: Gulsenberg hill, 2.85 km SSW of the church in the village, glades in pine-wood on serpentine screes, rare, 620 m a.s.l., 47°16'59"N, 14°55'45"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1098, F1099). **Czech Republic:** district Blansko, Josefov: between Býčí skála and Krkavčí skála elevation points, wood footpath fringe on limestone slope, 350 m a.s.l., 49°18'34"N, 16°41'32"E (P. ŠMARDA, 23.4.1998; F4\*). **Hungary:** Szentendre river island, Pest County, Szigetmonostor: 1 km S of the village, drifting sand steppe grassland in young pine-wood, very abundant, 150 m a.s.l., 47°41'45"N, 19°05'31"E (P. ŠMARDA & T. VYMYSLICKÝ, 23.6.2000; F1160). **Romania:** Retezat Mts., Hunedoara region, Hațeg: main valley 10 km NW of Peleaga (2509 m) peak, 27 km SSW of the town, rocky siliceous slope above the road, common, 650 m a.s.l., 45°24'06"N, 22°46'40"E (P. ŠMARDA, –8.1999; F204). **Slovakia:** district Malacky, Malacky: 10 km NE of the village, sands on pine-wood margin near the road, small colony, 190 m a.s.l., 48°30'30"N, 17°06'94"E (P. ŠMARDA & T. VYMYSLICKÝ, 26.6.2000; F1180) – district Nové Zámky, Čenkov: Čenkovská lesostep Nature Reserve, 0.5 km NW of the village, sand steppe grassland, abundant, 108 m a.s.l., 47°46'15"N, 18°31'41"E (P. ŠMARDA & T. VYMYSLICKÝ, 21.6.2000; F1154)

***F. stricta* Host ( $2n = 6x = 42$ ):** **Austria:** Niederösterreich, Mödling: 0.5 km E of Ruine Burg Mödling elevation point, edge of N exp. dolomite rocky slope in autochthonous *Pinus nigra* wood, scattered, 340 m a.s.l., 48°04'50"N, 16°16'32"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1111) – Niederösterreich, Mödling: 1 km SE of Ruine Burg Mödling elevation point, low steppe grassland on dolomite in autochthonous *Pinus nigra* wood, scattered, 320 m a.s.l., 48°04'25"N, 16°16'42"E (K. KOČÍ, P. ENGLMAIER & P. ŠMARDA, 30.5.2000; F1108, F1109)

***F. vaginata* subsp. *dominii* (Krajina) Soó ( $2n = 2x = 14$ ):** **Slovakia:** district Malacky, Malacky: 10 km NE of the village, sands on pine-wood margin near the road, small colony, 190 m a.s.l., 48°30'30"N, 17°06'94"E (P. ŠMARDA & T. VYMYSLICKÝ, 26.6.2000; F1179) – district Malacky, Mikulášov: between Mikulášov and Plavecký Mikuláš villages, 2.2 km SE of the Mikulášov village, near the road on sand, in places, 220 m a.s.l., 48°33'15"N, 17°13'50"E (P. FILIPPOV, 8.5.2000; F1082, F1083) – district Malacky, Plavecký Štvrtok: 0.9 km NE of Plavecký Štvrtok railway station, sands in pine-wood next to the road, small colony, 160 m a.s.l., 48°22'82"N, 17°01'26"E (P. ŠMARDA & T. VYMYSLICKÝ, 26.6.2000; F1178) – district Senica, Horné Vály: 0.5 km NE of the village, sunny place in pine-wood on sand slope, small colony, 200 m a.s.l., 48°34'48"N, 17°07'42"E (P. ŠMARDA & T. VYMYSLICKÝ, 26.6.2000; F1185, F1186, F1187, F1188) – district Senica, Šišulákovci: 1 km NE of the village, sands of S exp. sunny pine-wood margin, small colony, 210 m a.s.l., 48°34'65"N, 17°08'96"E (P. ŠMARDA & T. VYMYSLICKÝ, 26.6.2000; F1182, F1183)

***F. vaginata* Waldst. et Kit. ex Willd. subsp. *vaginata* ( $2n = 2x = 14$ ):** **Hungary:** Szentendre river island, Pest County, Szigetmonostor: 1 km N of the village, steppe stand of grass on sand dune near the road, abundant, 150 m a.s.l., 47°42'51"N, 19°06'07"E (P. ŠMARDA & T. VYMYSLICKÝ, 23.6.2000; F1161, F1162, F1163) – Szentendre river island, Pest County, Szigetmonostor: 1 km S of the village, drifting sand steppe grassland in young pine-wood, very abundant, 150 m a.s.l., 47°41'45"N, 19°05'28"E (P. ŠMARDA & T. VYMYSLICKÝ, 23.6.2000; F1158) – Szentendre river island, Pest County, Táhitotfalu: 2 km S of the village, slightly ruderalized steppe grass stand on drifting sand near the road, abundant, 150 m a.s.l., 47°45'12"N, 19°06'06"E (P. ŠMARDA & T. VYMYSLICKÝ, 23.6.2000; F1165). **Slovakia:** district Nové Zámky, Čenkov: Čenkovská lesostep Nature Reserve, 0.5 km NW of the village, sand steppe grassland, abundant, 108 m a.s.l., 47°46'12"N, 18°31'42"E (P. ŠMARDA & T.

VYMYSLICKÝ, 21.6.2000; F1153) – district Nové Zámky, Čenkov: Čenkovská lesostep Nature Reserve, 1.5 km N of the village, in N-S forest track, sand steppe grassland, abundant, 108 m a.s.l., 47°46'96"N, 18°31'71"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 21.6.2000; F1152)

***F. vaginata* × *F. valesiaca* ( $2n = 2x = 14$ ): Hungary:** Szentendre river island, Pest County, Sziget-monostor: 1 km S of the village, drifting sand steppe grassland in young pine-wood, very abundant, 150 m a.s.l., 47°41'45"N, 19°05'32"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 23.6.2000; F1159)

***F. valesiaca* Gaudin ( $2n = 2x = 14$ ): Slovakia:** Slovenský Kras hills, district Košice, Turňa nad Bodvou: Turnianský hradný vrch Nature Reserve, steppe SW exp. rocky calcareous slopes, abundant, 260 m a.s.l., 48°36'57"N, 20°52'36"E (P. ŠMARDÁ, 8.8.2000; F1227, F1228)

***F. versicolor* Tausch subsp. *versicolor* ( $2n = 2x = 14$ ): Slovakia:** Velká Fatra Mts., district Ružomberok, Liptovské Revúce: Suchý vrch Mt. (1549 m), top of limestone rocks, common, 1540 m

a.s.l., 48°54'33"N, 19°05'40"E (K. KOČÍ & M. KOČÍ, 29.10.2000; F153\*, F154) – Velká Fatra Mts., district Martin, Blatnica: saddle between Ostrá (1247 m) and Tlstá (1373 m) hills, limestone rockeries, common, 1100 m a.s.l., 48°55'32"N, 18°58'45"E (K. KOČÍ & M. KOČÍ, 29.10.2000; F142, F143) – Velká Fatra Mts., district Ružomberok, Liptovské Revúce: Čierny-kameň Nature Reserve, rockeries below the Čierny-kameň Mt. (1479 m), limestone outcrops, common, 1450 m a.s.l., 48°56'14"N, 19°09'09"E (K. KOČÍ & M. KOČÍ, 29.10.2000; F152\*) – Vysoké Tatry National Park, district Poprad, Starý Smokovec: 1 km E of Slavkovský štít peak, alpine grassland on siliceous rocks, common, 2100 m a.s.l., 49°10'60"N, 20°09'02"E (P. ŠMARDÁ, 12.5.2000; F1077\*)

***F. wagneri* (Degen, Thaisz & Flatt) Degen, Thaisz & Flatt ( $2n = 4x = 28$ ): Hungary:** Szentendre river island, Pest County, Táhitotfalu: 2 km S of the village, slightly ruderalized steppe grass stand on drifting sand near the road, common, 150 m a.s.l., 47°45'12"N, 19°06'06"E (P. ŠMARDÁ & T. VYMYSLICKÝ, 23.6.2000; F1164, F1166)