

The *Pinus mugo* complex – its structuring and general overview of the used nomenclature

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ABSTRACT: The *Pinus mugo* complex (*P. mugo* Turra sensu lato, and/or species aggregate or group – *P. mugo* agg., including its internal as well as external aggregate hybrids) is an important fragment of European dendroflora. For its high variability this complicated group has not been solved in taxonomical terms satisfactorily yet. Most problems are mainly caused by a large amount of taxa of uncertain value described in the past, which often more or less overlap or are based on insufficiently researched and unsuitably interpreted characters. Such facts coincidentally cause further problems in applied disciplines. Specialized European literature already contains a large amount of information referring to individual taxa of this complex. Much information is listed under various, often commonly not known or not used scientific names. In order to make the information available and useful, it was necessary to collect the most frequent names used in the past and to assort them in a tabular manner into a convenient synoptic schedule respecting the present concepts of the complex – and assign them with the present most commonly used names.

Keywords: *Pinus mugo* agg. (= *P. mugo* Turra [sensu lato] complex); *P. uncinata* Ram.; *P. rotundata* Link; *P. mugo* Turra (sensu stricto); *P. × pseudopumilio* (Willk.) G. Beck; *P. × digenea* G. Beck; *P. × celakovskiorum* A. et Gr.; *P. rhaetica* Brügger

The *Pinus mugo* complex – “mountain pine” *Pinus mugo* Turra sensu lato – and/or *Pinus mugo* agg. – the species aggregate or complex (hereinafter the complex or aggregate), is a significant but rather complicated European species group. Specialists in botany and dendrology have been trying to understand it and if possible to establish the most suitable classification since the 19th century with rather unsatisfactory results. That reflects also in contemporary disunion and perhaps even “overly thriving” scientific nomenclature used by various authors in this taxonomical group (see for example CHRISTENSEN 1987a,b,c). Such facts subsequently complicate mutual communication regarding merits of professional or scientific interests. The present study is aimed to prepare a guiding summary from selected knowledge of the whole complex, its structuring and used nomenclature. Mainly it is based on the widely prepared written literature analysis, processed for a doctoral thesis of the first listed author (HAMERNÍK 2004).

Natural range area

The studied complex (*Pinus mugo* agg.) is an exclusive European group of conifers. Its natural range has an island character spreading from the Pyrenees and Cordillera Ibérica mountains in the west through the French Massif Central, Vosges, Schwarzwald, Jura, Alps, Dinaric Alps to the Eastern and Southern Carpathians and Bulgarian-Greek Rhodops in the east, and from Spanish mountains (Sierra de Gudar – a part of the above-mentioned massif Cordillera Ibérica), Mid-Italian mountains (Abruzzi), and Rhodops in the south to the Western Carpathian Mountains and Sudetic mountains, including border areas between the Czech Republic – Slovakia – Poland and Czech Republic – Germany on its northern boundary of natural range. It can be simplified as it includes conifers of rather extreme expositions of Central and Southern Europe (growing partly on peat bogs as well as on mountain stony debris and rocky ridges, including limestone),

spread within medium elevations up to areas above the upper forest limit.

Comments on variability, structuring and nomenclature points

At first sight the complex may resemble quite a simple entity: in the Czech Republic (hereinafter CR) it includes mainly shrubby dwarf pine (*Pinus mugo* Turra [sensu stricto], Czech name “borovice kleč, kosodřevina”), mostly growing above the upper forest limit (and at places also within the forest zone, in both cases on mineral or peaty soil), and a smaller size arborescent form from peat bogs at a medium elevation which is usually called “bog pine” or “peatbog pine” (*Pinus rotundata* Link, Czech name “borovice blatka”). Among the forestry community it is less known that for instance in the mountain part of the forest zone, mainly on raised bogs of Western and Southern Bohemia, various pine growth forms could also be found next to monocormic arborescent bog pines (up to 10–17[–20] m tall): starting with completely low, sometimes even prostrate specimens, through larger shrubs with upright branches, to polycormic arborescent forms (reaching 2–5[–10] m height). Flora of the Czech Republic (HEJNÝ, SLAVÍK 1997; and/or SKALICKÁ, SKALICKÝ 1997) and Key to the Flora of the Czech Republic (KUBÁT et al. 2002; and/or BUSINSKÝ 2002) classify them under the taxon “peatbog pine” *Pinus* × *pseudopumilio* (Willk.) G. Beck (Czech name “borovice rašelinná”).

The above-mentioned bog pine is not the only arborescent taxon of the researched complex. Another arborescent taxon grows in the western part of the range (approximately from north-eastern Spain to north-western Austria) that is listed in Flora of the Czech Republic (HEJNÝ, SLAVÍK 1997) as *P. uncinata* Mill. ex Mirbel (common name “Pyrenean pine”, Czech name “borovice pyrenejská”, “borovice zobanitá”). The valid scientific name should be *P. uncinata* Ramond (mountain pine sensu stricto), as it was published by L. F. Ramond (authentic?) in 1805, which was one year earlier than it was done by Ph. Miller (ex Mirbel). This pine grows in mountains up to the upper forest limit and even up to the upper tree limit, mostly on rocky and debris (limestone or silicate) bedrock rather than on peat bogs. Thus it differs from bog pine not only in the geographic region (location and elevation) but also in ecological demands.

More or less fluent “swarms” of transition types also contribute to the difficulty of the complex, as it is indicated by preliminary results of the biometrics of cones, prepared in the framework of this doctoral

thesis (hereinafter DT). Next to respective variability within individual partial taxa, caused e.g. by the geographic situation of individual populations, their evolution and spreading in the postglacial period, it also caused by hybridization, let it be of earlier or more recent character, within the aggregate or with external species. The latter, external hybridization is mostly related to Scots pine (*Pinus sylvestris* L., Czech name “borovice lesní, sosna”). The best-known hybrid with Scots pine, most often found on borders of bog pine stands, is the arborescent species *P. × digenea* G. Beck (= *P. rotundata* × *P. sylvestris*, common name in Czech “borovice zkřížená”). A less known hybrid found on boulder debris at the Plešné jezero (lake) (in the Šumava Mts.) is *P. × celakovskiorum* A. et Gr. (= *P. mugo* [s. stricto] × *P. sylvestris*, Czech name “borovice Čelakovských”).

Note 1. The name *P. rhaetica* Brügger (or *P. × rhaetica* Brügger), sometimes used to describe *P. × celakovskiorum*, could possibly be based on the hybrid “*P. sylvestris* subsp. *engadinensis* × *mugo* cum introgressionem *P. uncinatae*” (SKALICKÁ, SKALICKÝ 1997), which has obviously evolved from different subspecies of Scots pine. That is why the use of such name would be inappropriate in this case.

Note 2. FUKAREK (1960, sec. VIDA KOVIĆ 1991) presents another kind of pine standing out of the aggregate *P. mugo* that should be naturally hybridizing with a taxon that belongs to this aggregate: in the area of Trebević Mt. (Trebovac mountains in Bosnia?) he found a pine tree that differed from “*P. mugo* var. *mughus*” in oval-conical cones, broadest in the middle and 8–10 cm long needles. He described it under the name *Pinus* × *mugodermis* Fuk. and assumed that it was a hybrid *P. mugo* var. *mughus* × *P. heldreichii* var. *leucodermis*.

An extraordinary difficulty of the mountain pine complex (mainly morphological), together with high disunion at evaluation and interpretation of individual taxonomical characters (mostly cone shape and apophysis of their seed scales as well as growth habit) led in the past to repetitive descriptions of a number of forms often taxonomically less important or which were of no importance or unclearly interpreted. Those were often based on characters whose taxonomical value and occurrence range in individual populations were not sufficiently researched. Such facts have lately affected even concepts made of different taxa of researched aggregate in the field, also regarding their origin and position in the framework of botanical system.

A logical consequence of complex difficulty was the creation of many “scientific names” (including synonyms) while their existence was often unneeded or directly misleading. Taxa themselves could not describe the nature of the whole complex with sufficient accuracy.

Described facts correspond with the presently not yet finalized general description of the aggregate, as

well as with conceptions regarding its Quaternary evolution. Ideas differ whether it is possible to consider this group as one species (*Pinus mugo* sensu lato) divided into two, three or even more subordinate (infraspecific) taxa, or as two species (*Pinus mugo* [sensu stricto] and *P. uncinata* [sensu lato]), with ± fluent lines of transitional populations or hybrids (including hybrids with *P. sylvestris*), or even as three microspecies (*P. mugo* s. stricto, *P. rotundata* and *P. uncinata* s. stricto), with hybrids within this complex – as well as with Scots pine. There is no uniform opinion whether the bog pine is or is not a proper (taxonomically small) species although it may be of hybridogenic origin (that means an old, steady hybrid) or even a descendant of some (Tertiary?) ancestor, common for the whole complex, or whether the bog pine represents a hybrid between *Pinus mugo* × *P. uncinata* (hybrid on the species level [nothospecies], HOLUBIČKOVÁ [1965], or on the subspecies

level [nothosubspecies] CHRISTENSEN [1987a,b,c]), or perhaps a hybrid of *P. mugo* × *P. sylvestris* (older Polish authors STASZKIEWICZ, TYSZKIEWICZ 1969, 1972), or whether it comes from recent hybrids. Lately other solutions have also been considered (younger Polish authors, and others).

MATERIAL AND METHODS

The material consisted of selected dendrologic literature published in the period 1912–2004, containing information on the researched complex and its individual taxa and hybrids, including related nomenclature. The literature consisted of more than 50 specialized publications (see HAMERNÍK 2004 – available from the author or at the Czech University of Life Sciences Prague).

Acquired information was subsequently divided and processed by common procedures.

Table 1. Nomenclature overview and structuring of the *Pinus mugo* complex (*Pinus mugo* agg., with relation to *Pinus sylvestris*, including possible hybrids) according to selected authors, within approx. the last 100 years
Arborescent forms (monocormic [exceptionally even polycormic?]; usually 4–25 m tall)

Author/taxon	Ad morph. form “ <i>uncinata</i> ” (1.1) Western part of range; high elevation, usually rocks or debris	Ad morph. form “ <i>rotundata</i> ” (1.2); Central part of range; peat bogs of medium elevation
1 TUBEUF 1912	<i>P. montana</i> Mill. (1) var. <i>arborea</i> (baumförmige Bergkiefer, Spirke): “Bergspirke” (?)	“Moorspirke” (?)
	<i>P. montana</i> Mill. (1), “race”:	
2 POLÍVKA et al. 1928	(<i>P. uncinata</i> var. <i>rostrata</i> Ant.?)	(<i>P. uncinata</i> var. <i>rotundata</i> Willk. f. <i>pyramidata</i> Hartig)
	<i>P. mugo</i> Turra (1) subsp. <i>uncinata</i> (Ramond) Domin	
3 NOVÁK 1953 (in KLIKA et al.)	var. <i>rostrata</i> (Ant.) Domin	var. <i>rotundata</i> (Link) Domin
	<i>P. mugo</i> Turra (1) f. <i>arborea</i> Tub.	
4 SVOBODA 1953	var. <i>uncinata</i> Ant. f. <i>rostrata</i> Ant. (1)?	var. <i>uncinata</i> f. <i>rotundata</i> Ant. (1)?
	<i>P. Mugo</i> Turra (1), var.:	
5 REHDER 1954	<i>rostrata</i> (Ant.) Hoopes	<i>rotundata</i> (Link) Hoopes f. <i>pyramidata</i> Hartig
6 DOSTÁL 1954	–	<i>P. m.</i> ssp. <i>uncinata</i> (Ant.) Dom. (1)
	(“Sammelart”) <i>P. mugo</i> Turra (1):	
7 OBERDORFER 1962 (1983)	<i>P. uncinata</i> Ramond	<i>P. rotundata</i> Link (var. <i>arborea</i> Tub.)
8 ROTHMALER 1963	<i>P. uncinata</i> Ramond	<i>P. mugo</i> Turra (1) ssp. <i>rotundata</i> (Link) Janch. et Neumayer
9 GAUSSEN et al. 1964	<i>P. uncinata</i> Miller (!) (incl. <i>P. rotundata</i> Link)	
9a PILÁT 1964	<i>P. Mugo</i> var. <i>uncinata</i> subvar. <i>rostrata</i> (Ant.)	<i>P. Mugo</i> var. <i>uncinata</i> subvar. <i>rotundata</i> (Link)
	<i>P. mugo</i> complex (1) ?	<i>P. mugo</i> complex (2)
10 HOLUBIČKOVÁ 1965	<i>P. uncinata</i> Ram.	<i>P. uncinata</i> Ram. subsp. <i>rotundata</i> (Link) Janch. et Neumayer (<i>P. rotundata</i> Link)
11 STASZKIEWICZ, TYSZKIEWICZ 1969	–	<i>P. sylvestris</i> × <i>P. mugo</i> (?)
12 SZWEYKOWSKI 1969	<i>P. uncinata</i> auct. germ.	<i>P. uliginosa</i> Neumann (part of <i>P. m.</i> s.l.)

Table 1 to be continued

	Author/taxon	Ad morph. form “ <i>uncinata</i> ” (1.1) Western part of range; high elevation, usually rocks or debris	Ad morph. form “ <i>rotundata</i> ” (1.2); Central part of range; peat bogs of medium elevation
13	HOLUBIČKOVÁ 1972	<i>P. uncinata</i> Ram.	<i>P. uncinata</i> subsp. <i>rotundata</i> (Link) Janch. et Neumayer
14	STASZKIEWICZ, TYSZKIEWICZ 1972	<i>P. uncinata</i> (<i>P. rotundata</i> ecomorph.?)	<i>P. × rotundata</i> Link (= <i>P. sylvestris</i> L. × <i>P. mugo</i> Turra) ecomorph. “ <i>rotundata</i> ” (= <i>P. uliginosa</i>)
15	Garcke 1972, sec. MAIER 1993	<i>P. m.</i> Turra ssp. <i>uncinata</i> (Ram.) Domin	<i>P. m.</i> ssp. <i>rotundata</i> (Link) Janch. & Neumay.
16	MUSIL 1975, 1977a,b	–	<i>P. uncinata</i> Ram. ssp. <i>rotundata</i> (Link) Janch. et Neumay.
17	HOLUBIČKOVÁ 1980a,b	<i>P. uncinata</i> Miller ssp. <i>uncinata</i> (!)	<i>P. uncinata</i> ssp. <i>uliginosa</i> (Neum.) Holubičková
18	VIEWEGH 1981	<i>P. uncinata</i> Ramond	<i>P. mugo</i> ssp. <i>uncinata</i> (Ram.) Domin (var. <i>rotundata</i> [Link] Domin?)
19	HOLUBIČKOVÁ, ŠTURSA 1984	<i>P. uncinata</i> subsp. <i>uncinata</i>	<i>P. uncinata</i> ssp. <i>uliginosa</i> (Neumann) ?
<i>P. mugo</i> Turra complex (1):			
20	CHRISTENSEN 1987b (a,c) and CHRISTENSEN, DAR 1997	<i>P. mugo</i> Turra ssp. <i>uncinata</i> (Ram.) Domin	<i>P. m.</i> nothosp. <i>rotundata</i> (Link) Janch. et Neumay. f. <i>mughoides</i> (Willk.) K.I.Christ. c.n. (= <i>P. m.</i> ssp. <i>mugo</i> × ssp. <i>uncinata</i>) !?
21	SKALICKÁ, SKALICKÝ ⁵ 1988, 1997	<i>P. uncinata</i> Mill. (!)	<i>P. rotundata</i> Link
22	Fitschen 1988, sec. MAIER 1993	<i>P. mugo</i> var. <i>rostrata</i> (Ant.) Gord.	<i>P. m.</i> var. <i>rotundata</i> (Link) Hoopes
23	Schmeil-Fitschen 1988, sec. MAIER 1993	<i>P. mugo</i> (s. l.) (1)	
		ssp. <i>uncinata</i> (Ramond) Domin	ssp. <i>rotundata</i> (Link) Janch. & Neumay
24	DOSTÁL 1989	(emend.: <i>P. uncinata</i> Ramond)	(<i>P. uncinata</i> Mill. ssp. <i>uncinata</i> !); emend.: <i>P. uliginosa</i> Neumann ex Wimmer
25	DEBAZAC 1991	<i>P. montana</i> Miller (1): <i>P. uncinata</i> Ram. in D.C.	<i>P. uncinata</i> var. <i>rotundata</i> Willk.
26	STASZKIEWICZ 1993	(<i>P. uncinata</i> Ram.)	<i>P. × rhaetica</i> Brügg. (1) (= <i>P. mugo</i> Turra × <i>P. sylvestris</i> L.) ?
27	LEWANDOWSKI et al. 2000	<i>P. uncinata</i>	<i>P. uliginosa</i> (= <i>P. mugo</i> × <i>sylvestris</i>)
27a	FRELÉCHOUX et al. 2000	–	<i>P. uncinata</i> var. <i>rotundata</i>
28	BUSINSKÝ 2002 ¹ , 1998 ² , 1999 ² , 2004 ⁶	<i>P. mugo</i> agg. (1):	
		<i>P. uncinata</i> Ramond	<i>P. rotundata</i> Link

Comments and notes for Table 1 to 4a,b

? There are doubts whether the schedule classification corresponds with the concept of the author of quoted publication or if it is completely relevant to it

! Notice of different character

¹A Key to the Flora of the Czech Republic (BUSINSKÝ in KUBÁT et al. 2002) does not contain *Pinus uncinata* and its hybrids for obvious reasons

²From the boundary of morphological forms “*rotundata*” and “*uncinata*” BUSINSKÝ (1998, 1999) presents another form assigned only by the hybrid term *P. rotundata* × *P. uncinata* (subform 1.3), located only outside the Czech Republic territory (e.g. in western Austrian Tyrols; their ranges indeed do not overlap, in places they just come near each other)

³BUSINSKÝ (1998, 1999) records another even triple (internal aggregate) hybrid, assigned also only by hybrid formulae – *P. mugo* s. str. × *P. rotundata* × *P. sylvestris* (= *P. × pseudopumilio* × *P. sylvestris*). He localizes it into well-known parts of the Šumava Mts. (Bohemian Forest) – Borová Lada, Strážný, Lenora, Mrtvý luh and even Klínovec in the Krušné hory mountains (Ore Mts.); perhaps it could be found on other sites

⁴The same name is used also by JENÍK and SOUKUPOVÁ (1999)

⁵The relevant part of the text regarding the *P. mugo* complex was written by V. Skalický

⁶Research of the aggregate continues. More precise classifications are being prepared, including nomenclature changes (see e.g. BUSINSKÝ 2004)

Table 2. Nomenclature overview and structuring of the *Pinus mugo* complex (*Pinus mugo* agg., with relation to *Pinus sylvestris*, including possible hybrids) according to selected authors, within approx. the last 100 years
Transitive forms within the aggregate (usually larger shrubs; incl. hybrids)

Author/taxon	Subforms on the boundary of <i>P. mugo</i> s. str. and <i>P. uncinata</i> (2.1)	Subforms on the boundary of <i>P. mugo</i> s. str. and <i>P. rotundata</i> ³ (2.2)
1 TUBEUF 1912	<i>P. montana</i> Mill. (2) var. <i>frutescens erecta</i> (aufrechte Buschföhre) "hochbuschige Bergföhre"?	"hochbuschige Moorföhre"?
2 POLÍVKA et al. 1928	<i>P. montana</i> Mill. (2), "race": –	(<i>P. uncinata</i> Willk. var. <i>pseudopumilio</i> Willk.; var. <i>rostrata</i> Antoine (?))
3 NOVÁK 1953 (in KLIKA et al.)	<i>P. mugo</i> Turra (2) subsp. <i>uncinata</i> (Ramond) Domin –	var. <i>pseudopumilio</i> (Willk.) Domin
4 SVOBODA 1953	<i>P. mugo</i> Turra (2) f. <i>frutescens</i> Tub.? f. <i>rostrata</i> Ant. (2)?	f. <i>rotundata</i> Ant. (2)?
5 REHDER 1954	<i>P. Mugo</i> Turra (2), var. ??	<i>P. Mugo</i> Turra (2), var. ??
6 DOSTÁL 1954	–	<i>P. m.</i> ssp. <i>uncinata</i> (Ant.) Dom. (2)
7 OBERDORFER 1962	("Sammelart") <i>P. mugo</i> Turra (2): –	<i>P. rotundata</i> Link var. <i>pseudopumilio</i> (Willk.) Neumay. ("Latsche")
8 ROTHMALER 1963	–	<i>P. mugo</i> Turra (2) ssp. <i>rotundata</i> (Link) Janch. et Neumayer (2) ?
9 GAUSSEN et al. 1964	–	(introgres. hybrid?) <i>P. uncinata</i> var. <i>rotundata</i> (Link) Ant. ?
10 HOLUBIČKOVÁ 1965	? (<i>P. rotundata</i> = <i>P. mugo</i> × <i>P. uncinata</i>)	<i>P. mugo</i> complex (3) <i>P. mugo</i> Turra s. s. subsp. <i>pseudopumilio</i> (Willkomm) comb. nova
11 STASZKIEWICZ, TYSZKIEWICZ 1969	–	<i>P. mugo</i> Turra (introgres. <i>P. sylvestris</i>) ?
12 SZWEYKOWSKI 1969	–	(hybrid origin)
13 HOLUBIČKOVÁ 1972	–	<i>P. mugo</i> Turra subsp. <i>pseudopumilio</i> (Willk.) Holubičková
14 STASZKIEWICZ, TYSZKIEWICZ 1972	<i>P. × rotundata</i> Link – ecomorph.?	<i>P. × rotundata</i> Link (= <i>P. sylvestris</i> L. × <i>P. mugo</i> Turra) ecomorph. "pseudopumilio"
15 Garcke 1972, sec. MAIER 1993	?	?
16 MUSIL 1975 (1977a,b)	–	<i>P. mugo</i> subsp. <i>uncinata</i> var. <i>pseudopumilio</i> (Willk.) Dom.
17 HOLUBIČKOVÁ 1980a,b	–	<i>P. mugo</i> ssp. <i>pseudopumilio</i> (Willk.) Holubičková
18 VIEWEGH 1981	–	–
19 HOLUBIČKOVÁ, ŠTURSA 1984	–	<i>P. mugo</i> subsp. <i>pseudopumilio</i> (Willk.) Holubičková
20 CHRISTENSEN 1987b (a,c) and CHRISTENSEN, DAR 1997	<i>P. mugo</i> Turra complex (2): ?	<i>P. m.</i> nothosp. <i>rotundata</i> (Link) Janch. et Neumayer f. <i>rotundata</i> (<i>P. mugo</i> ssp. <i>mugo</i> × ssp. <i>uncinata</i>)!?
21 SKALICKÁ, SKALICKÝ ⁵ 1988, 1997	–	<i>P. mugo</i> × <i>rotundata</i> = <i>P. × pseudopumilio</i> (Willk.) Beck ⁴
22 Fitschen 1988, sec. MAIER 1993	?	?
23 Schmeil-Fitschen 1988, sec. MAIER 1993	<i>P. mugo</i> (s. l.) (2) ?	?
24 DOSTÁL 1989	–	<i>P. m.</i> ssp. <i>pseudopumilio</i> (Willk.) Holubičková; also subsp. <i>rotundata</i> (Link) Neumayer ??

Table 2 to be continued

Author/taxon	Subforms on the boundary of <i>P. mugo</i> s. str. and <i>P. uncinata</i> (2.1)	Subforms on the boundary of <i>P. mugo</i> s. str. and <i>P. rotundata</i> ³ (2.2)
25 DEBAZAC 1991		<i>P. montana</i> Miller (2) ?
26 STASZKIEWICZ 1993	<i>P. × rotundata</i> Link (= <i>P. mugo</i> Turra × <i>P. uncinata</i> Ram.)?	<i>P. × rhaetica</i> (2)?
27 LEWANDOWSKI et al. 1999	–	–
28 BUSINSKÝ 2002 ¹ , 1998 ² , 1999 ² , 2004 ⁶	<i>P. mugo</i> s. str. × <i>P. uncinata</i> ²	<i>P. mugo</i> agg. (2): <i>P. × pseudopumilio</i> (Willk.) Beck (= <i>P. mugo</i> s. str. × <i>P. rotundata</i>) ^{2; 3}

RESULTS AND DISCUSSION

After their evaluation individual taxa of the *Pinus mugo* (sensu lato) complex, including internal and external aggregate hybrids, published in selected publications from the period 1912–2004, were divided into 4 working categories with 10 subcategories (Tables 1 to 4b):

1. Arborescent forms (monocormic [rarely even polycormic]; usually 4–25 m tall)

- 1.1 ad morphological form “*uncinata*”; usually on rocky or debris localities of high elevation in the western part of the range of the complex *P. m.* s. lato (only outside the CR territory; mountain pine [s. stricto]);
- 1.2 ad morphological form “*rotundata*”; peat bogs of medium elevation in the central and/or northern part of the range of the complex (including the CR territory; [peat]bog pine);
- 1.3 hybrid subforms on the boundary of morphological forms “*rotundata*” and “*uncinata*” (usually arborescent [?]); only rare occurrence at places with closely located ranges of both forms (only outside the CR territory).

2. Transitive forms – within the aggregate; usually larger shrubs (polycormic; including appropriate hybrids; usually 2–10 m tall)

- 2.1 subforms on the boundary between *P. mugo* s. stricto and *P. uncinata*; western area of the Alps (only outside the CR territory);
- 2.2 subforms on the boundary between *P. mugo* s. stricto and *P. rotundata*; northern area of the complex range (Central Europe, including the CR territory).

3. Shrub forms (usually only 2–3 m tall); central and eastern part of the complex range (including the CR territory; dwarf pine)

- 3.1 subform – var. *mugo* (syn. *mughus*; ??);
- 3.2 subform – var. *pumilio* (??).

4. Hybrid forms – hybrids with *P. sylvestris* (of various growth habit)

- 4.1 subforms on the boundary between *P. mugo* s. stricto and *P. sylvestris* (more likely of smaller height?); central (and eastern?) part of the complex range (including the CR territory);
- 4.2 subforms on the boundary between *P. rotundata* and *P. sylvestris* (usually arborescent); borders of peat bogs in Central Europe (including the CR territory);

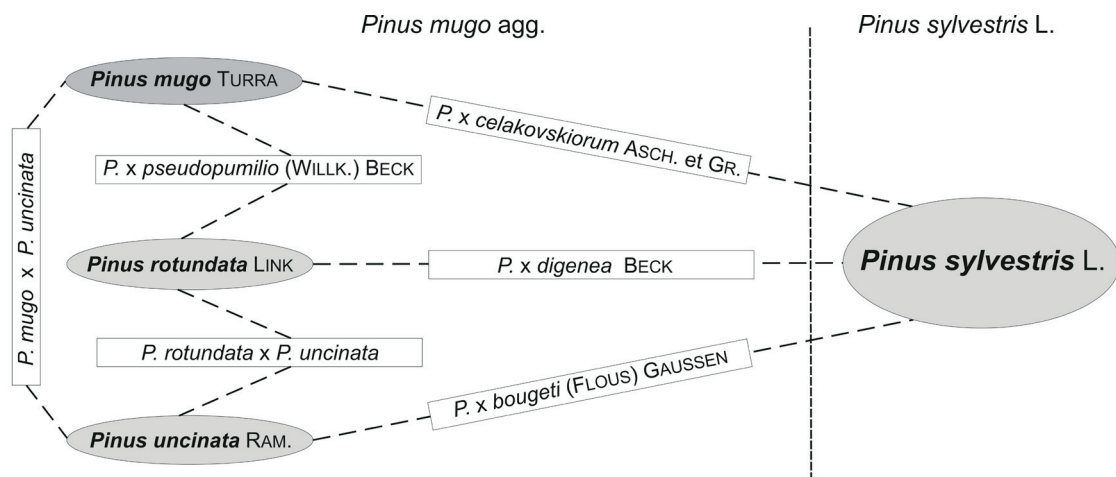


Fig. 1. One of the possible schedules of the *Pinus mugo* (s. lato) complex or aggregate (*P. mugo* agg.) including hybridization within the aggregate even towards *P. sylvestris*. The name *P. × bougeti* (Flous) Gaussen was quoted as invalid publication

Table 3. Nomenclature overview and structuring of the *Pinus mugo* complex (*Pinus mugo* agg., with relation to *Pinus sylvestris*, including possible hybrids) according to selected authors, within approx. the last 100 years
Shrub forms (*P. mugo* sensu stricto; usually only 2–3 m tall; subalpine or upper mountain belt)

Author/Taxon	Subform – var. <i>mugo</i> (?) (3.1)	Subform – var. <i>pumilio</i> (?) (3.2)
1 TUBEUF 1912	<i>P. montana</i> Mill. (3) var. <i>prostrata</i> (Legföhre, Latsche) (“Berglatsche – Moorlatsche”)	
2 POLÍVKA et al. 1928	(<i>P.</i>) <i>mughus</i> Willk.	<i>P. montana</i> Mill. (3), “race”: (<i>P.</i>) <i>pumilio</i> Willk.
3 NOVÁK 1953 (in KLIKA et al.)	var. <i>typica</i> (Beck) ?	<i>P. mugo</i> Turra (3) subsp. <i>mugus</i> (Scopoli) ? var. <i>pumilio</i> (Haenke) ?
4 SVOBODA 1953	<i>P. mugo</i> Turra (3) var. <i>applanata</i> Beck f. <i>prostrata</i> Tub. f. <i>mughus</i> Scop.	f. <i>eupumilio</i> (!) Dom.
5 REHDER 1954	<i>Mughus</i> (Scop.) Zenari, var.	<i>P. Mugo</i> Turra (3), var.: <i>pumilio</i> (Haenke) Zenari, var.
6 DOSTÁL 1954	<i>P. mugo</i> ssp. <i>mughus</i> (Scop.) Dom. (2)	
7 OBERDORFER 1962	(“Sammelart”) <i>P. mugo</i> Turra (3): <i>P. mugo</i> Turra s. str.	
8 ROTHMALER 1963	<i>P. mugo</i> Turra subsp. <i>mugo</i> (lime areas) ??	<i>P. mugo</i> Turra subsp. <i>pumilio</i> (Haenke) Franco (limeless areas) ??
9 GAUSSEN et al. 1964	<i>P. mugo</i> Turra (syn. <i>P. mughus</i> Scop.; incl. <i>P. pumilio</i> Haenke)	
10 HOLUBIČKOVÁ 1965	<i>P. mugo</i> complex (4) taxa “ <i>mugus</i> ” and “ <i>pumilio</i> ” are probably synonyms	
11 STASZKIEWICZ, TYSZKIEWICZ 1969	<i>P. mugo</i> Turra	
12 SZWEYKOWSKI 1969	<i>P. mugo</i> Turra (a part of <i>P. mugo</i> s. l.)	
13 HOLUBIČKOVÁ 1972	<i>P. mugo</i> s. s.	
14 STASZKIEWICZ, TYSZKIEWICZ 1972	<i>P. mugo</i> Turra	
15 Garcke 1972, sec. MAIER 1993	<i>P. m.</i> ssp. <i>mugo</i> var. <i>mughus</i> (Scop.) Zenari	<i>P. m.</i> ssp. <i>mugo</i> var. <i>pumilio</i> (Haenke) Zen.
16 MUSIL 1975 (1977a,b)	–	<i>P. mugo</i> s. l. complex: <i>P. m.</i> s. str.; <i>P. m.</i> ssp. <i>pumilio</i>
17 HOLUBIČKOVÁ 1980a,b	<i>P. mugo</i> ssp. <i>pumilio</i> (Haenke) Franco (and ssp. <i>mugo</i> ?)	
18 VIEWEGH 1981	–	<i>P. mugo</i> ssp. <i>mughus</i> var. <i>pumilio</i> (Haenke) Zenari; (<i>P. pumilio</i>)
19 HOLUBIČKOVÁ, ŠTURSA 1984	<i>P. mugo</i> subsp. <i>pumilio</i> (Haenke) Franco (and subsp. <i>mugo</i> ?)	
20 CHRISTENSEN 1987b (a,c) and CHRISTENSEN, DAR 1997	<i>P. mugo</i> Turra complex (3): <i>P. m.</i> Turra ssp. <i>mugo</i> f. <i>mugo</i> (?)	
21 SKALICKÁ, SKALICKÝ ⁵ 1988, 1997	<i>P. mugo</i> Turra var. <i>mugo</i>	<i>P. m.</i> Turra ssp. <i>mugo</i> f. <i>applanata</i> (Willk.) K.I. Christ. comb. et stat. nov. (?)
22 Fitschen 1988, sec. MAIER 1993	<i>P. mugo</i> Turra var. <i>mughus</i> (Scop.) Zenari	<i>P. m.</i> Turra var. <i>pumilio</i> (Haenke) Zenari
23 Schmeil-Fitschen 1988, sec. MAIER 1993	ssp. <i>mugo</i>	<i>P. mugo</i> (s. l.) (3) ssp. <i>pumilio</i> (Haenke) Franco
24 DOSTÁL 1989	?	<i>P. mugo</i> Turra subsp. <i>pumilio</i> (Haenke) Franco em. Holubičková (?)
25 DEBAZAC 1991	<i>P. mughus</i> Scopoli	<i>P. montana</i> Miller (3): <i>P. pumilio</i> Haenke
26 STASZKIEWICZ 1993	<i>P. mugo</i> Turra (s. str.?)	
27 LEWANDOWSKI et al. 1999	<i>P. mugo</i> (s. str.)	
28 BUSINSKÝ 2002 ¹ , 1998 ² , 1999 ² , 2004 ⁶	<i>P. mugo</i> agg. (3): <i>P. mugo</i> Turra s. str.	



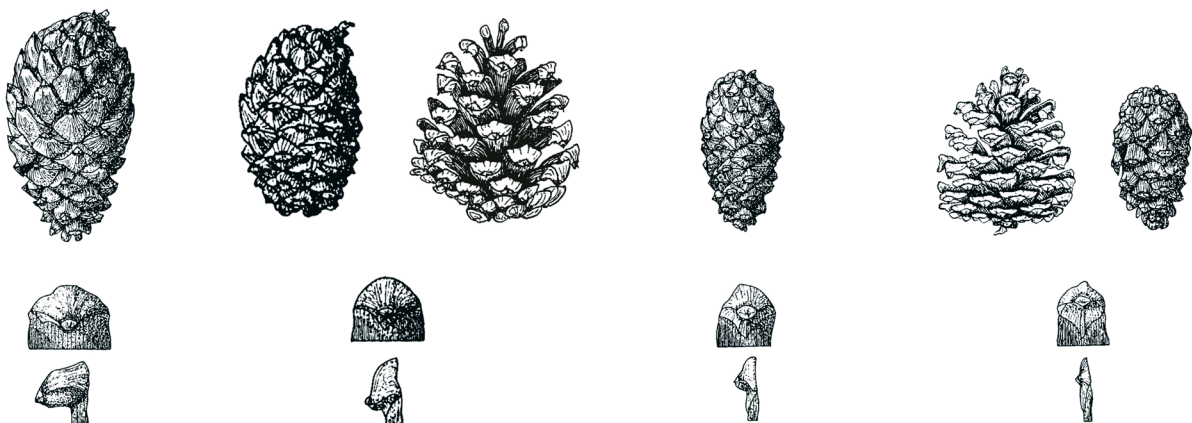
Pinus uncinata Ram. *Pinus rotundata* Link *Pinus* × *pseudopumillo* (Willk.) Beck *Pinus mugo* Turra s. s.

Fig. 2. Growth habits of different taxa from the *Pinus mugo* s. lato complex or aggregate (*P. mugo* agg.); compiled from drawings of KINDEL (1995)

4.3 subforms on the boundary between *P. uncinata* s. stricto and *P. sylvestris* (usually arborescent); western part of the complex range (thus outside the CR territory).

Question marks behind subforms 3.1 and 3.2 indicate doubts regarding the adequate distinction of both varieties (among other methods cone biometrics, processed in the framework of prepared DT, which subsequently does not verify the usability of the character that usually serves for their distinction). A similar view was held e.g. by BUSINSKÝ

(1998, 1999). Another problem arising next to categorization is the solution of a question to what hierarchic level within the plant system the above-mentioned individual forms and subforms should be assorted. Obviously, this is likely a task for specialized taxonomists. For that reason we based our text on the conception used in the Flora of the CR (HEJNÝ, SLAVÍK 1997) or in Key to the Flora of the CR (KUBÁT 2002). In general, in both volumes the researched complex was presented as an aggregate of three microspecies (*P. mugo*, *P. rotundata* and



Pinus uncinata Ram. *Pinus rotundata* Link *Pinus* × *pseudopumillo* (Willk.) Beck *Pinus mugo* Turra s. s.

Fig. 3. Cones and details of seed scales (with apophyses) of different taxa from the *Pinus mugo* s. lato complex or aggregate (*P. mugo* agg.); compiled according to various authors (CHRISTENSEN 1987; KINDEL 1995)

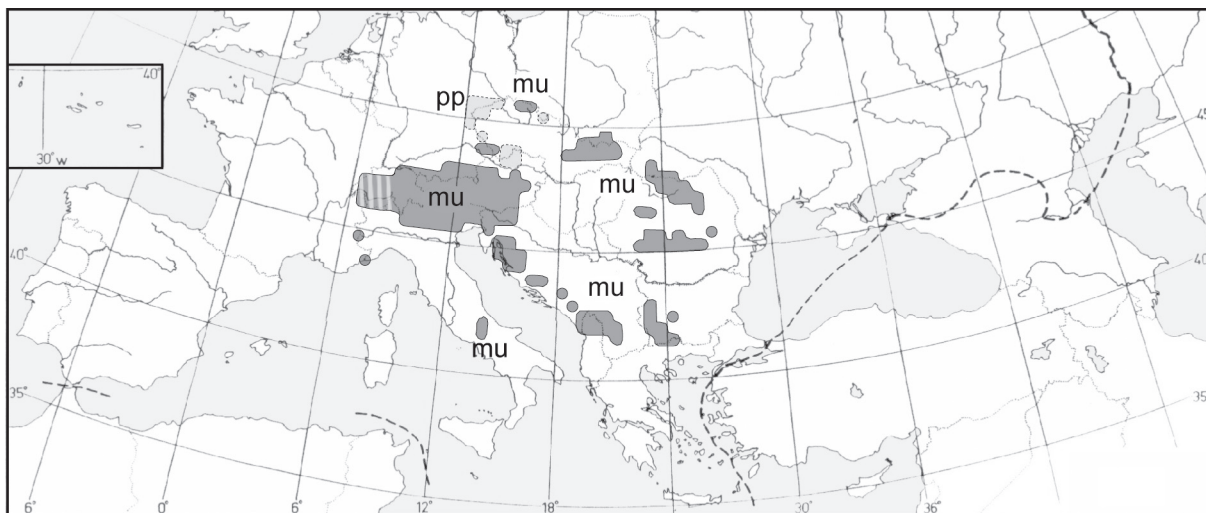


Fig. 4. Ranges of shrubby taxa from the *Pinus mugo* s. lato complex: **mu** (dark area) – *Pinus mugo* Turra (sensu stricto); **pp** (light area) – *Pinus* × *pseudopumilio*; the hatched part represents an uncertain part of the range (adjusted according to: JALAS, SUOMINEN 1972; SKALICKÝ et al. 1997)

P. uncinata) and several hybrids – even though it is not introduced exactly in this way (depending on whether to regard the generally intended chapter in Flora of the CR, under the title “Concept of basic taxonomic categories”).

Tables 1 to 4b contain quoted taxa under names used by individual authors, even with some inaccuracies (an exception is the uniform quotation of Linnaean epithet “*sylvestris*” – always with “y”, instead of “i” in the first syllable; for more detailed information see GREUTER et al. 2000: 60.1).

A synoptic schedule of the aggregate concept with three microspecies and their hybrids, including hybrids with *P. sylvestris* (which does not belong to the aggregate), is presented in Fig. 1.

The potential growth habit of selected taxa – representing basic forms and subforms – is informatively presented in Fig. 2, and their cones with apophyses

are presented in Fig. 3. Preliminary maps showing the areas of basic arborescent and shrub taxa of the complex are presented in Figs. 4 and 5.

In spite of the large amount of selected information, some “names” representing individual taxa did not come in a sufficient number, and therefore it was not subsequently possible to locate all taxa in chosen categories (forms and subforms) in a fully explicit manner. It predicates the fact that all information published until now is not completely sufficient and that it is not always based on those morphological characters that could describe an individual taxon in the best possible way or to distinguish it from other taxa. Similar insufficiency could be found in the variability of used characters within taxa. Proper location of individual taxa into different categories was also complicated by various concepts of taxonomical range applied to individual taxa by various authors.

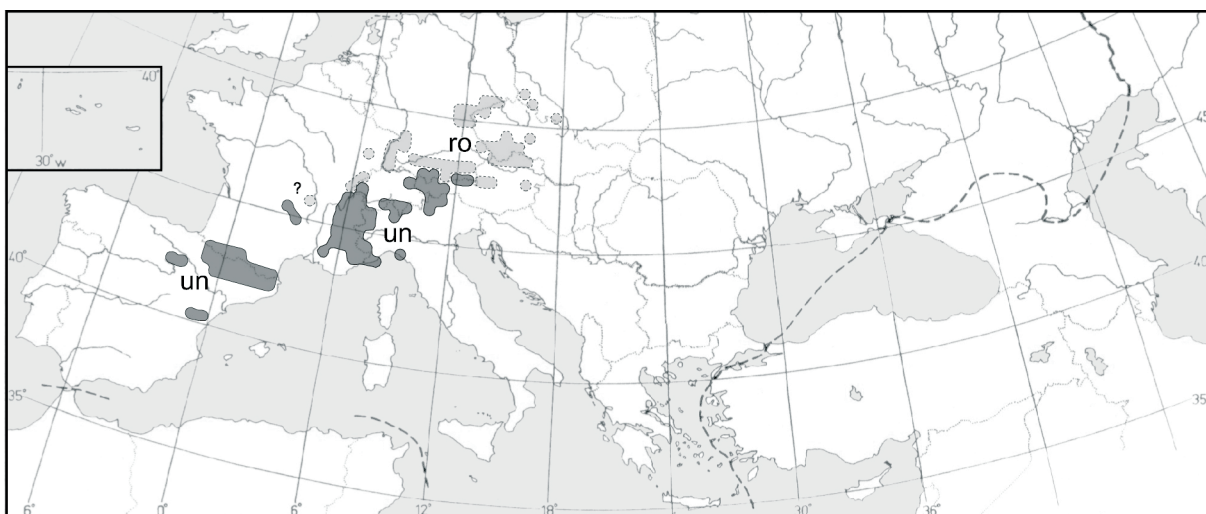


Fig. 5. Ranges of arborescent taxa from the *Pinus mugo* s. lato complex: **ro** (light area) – *Pinus rotundata*; **un** (dark area) – *Pinus uncinata* (adjusted according to: JALAS and SUOMINEN 1972; DEBAZAC 1991; SKALICKÝ et al. 1997; BUSINSKÝ 1999)

table 4a. Nomenclature overview and structuring of the *Pinus mugo* complex (*Pinus mugo* agg., with relation to *Pinus sylvestris*, including possible hybrids) according to selected authors, within approx. the last 100 years
Hybrid forms – hybrids with *P. sylvestris* I (various growth habit)

Author/Taxon	Subforms on the boundary of <i>P. mugo</i> s. str. and <i>P. sylvestris</i> (usually smaller height) (4.1)	Subforms on the boundary of <i>P. rotundata</i> and <i>P. sylvestris</i> (usually arborescent) (4.2)
1 TUBEUF 1912		(<i>P. montana</i> × <i>P. sylvestris</i>) (1)
2 POLÍVKA et al. 1928	<i>P. Čelakovskiorum</i> Aschers. et Graebn. (= <i>P. pumilio</i> × <i>sylvestris</i>)	<i>P. digenea</i> Beck (= <i>P. sylvestris</i> × <i>uncinata</i>)
2a DOSTÁL 1950 (sec. PILÁT 1964)		<i>P. Fockei</i> Dostál
		<i>P. rhaetica</i> Brügger apud Christ (1):
3 NOVÁK 1953 (in KLIKA et al.)	<i>P. Čelakovskýorum</i> (!) Asch. et Graebn. (= <i>P. pumilio</i> × <i>sylvestris</i>)	<i>P. digenea</i> Beck (= <i>P. sylvestris</i> × <i>uliginosa</i>)
4 SVOBODA 1953	<i>P. hybrida</i> Heer <i>Čelakovskiorum</i> Asch.-Graeb. = <i>P. sylvestris</i> × <i>mugo prostrata</i>	<i>P. hybrida</i> Heer <i>digeana</i> (!!) G. Beck = <i>P. sylv. hercynica</i> × <i>mugo herc. (uliginosa)</i>
		? <i>P. rhaetica</i> Bruegg. (1) (= <i>P. mugo</i> × <i>sylvestris</i> [?]):
5 REHDER 1954	<i>P. Celakovskiorum</i> Aschers. et Graebn.	<i>P. digenea</i> Beck
6 DOSTÁL 1954	–	–
7 OBERDORFER 1962	–	–
8 ROTHMALER 1963	<i>P. × celakovskiorum</i> A. et Gr. (= <i>P. mugo</i> ssp. <i>pumilio</i> × <i>P. sylvestris</i> ssp. <i>hercynica</i>)	<i>P. × digenea</i> Beck (= <i>P. mugo</i> ssp. <i>rotundata</i> × <i>P. sylvestris</i> ssp. <i>hercynica</i>)
9 GAUSSEN et al. 1964	–	–
9a PILÁT 1964	<i>P. Čelakovskiorum</i> Asch. et Gr. ? <i>P. rhaetica</i> Brügger (= <i>P. sylvestris</i> var. <i>engadinensis</i> × <i>P. Mugo</i> var. <i>uncinata</i>)	<i>P. digenea</i> Beck
10 HOLUBIČKOVÁ 1965	–	–
11 STASZKIEWICZ, TYSZKIEWICZ 1969	? (<i>P. mugo</i> × <i>sylvestris</i>) ?	? (<i>P. mugo</i> × <i>sylvestris</i>) ?
12 SZWEYKOWSKI 1969	hybrid origin (<i>P. mugo</i> × <i>P. sylvestris</i>)	–
13 HOLUBIČKOVÁ 1972	–	–
14 STASZKIEWICZ, TYSZKIEWICZ 1972	<i>P. × rotundata</i> Link (= <i>P. sylvestris</i> L. × <i>P. mugo</i> Turra) ecomorph. “ <i>pseudopumilio</i> ”?	<i>P. × rotundata</i> Link (= <i>P. sylvestris</i> L. × <i>P. mugo</i> Turra) ecomorph. “ <i>digenea</i> ”
15 Garcke 1972, sec. MAIER 1993	?	?
16 MUSIL 1975 (1977a,b)	<i>P. Čelakovskýorum</i> Asch. et Gr., later <i>P. celakovskiorum</i> , <i>P. × celakovskiorum</i>	<i>P. × digenea</i>
17 HOLUBIČKOVÁ 1980a,b	–	–
18 VIEWEGH 1981	<i>P. × celakovskiorum</i> Asch. et Graebner	<i>P. × digenea</i> Beck
19 HOLUBIČKOVÁ, ŠTURSA 1984	<i>P. × celakovskiorum</i>	<i>P. × digenea</i> Dom. (?)
20 CHRISTENSEN 1987b (a,c) and CHRISTENSEN, DAR 1997		<i>P. mugo</i> Turra × <i>sylvestris</i> L. (= <i>P. × rhaetica</i> Brügger) (1)
21 SKALICKÁ, SKALICKÝ ⁵ 1988, 1997	<i>P. mugo</i> × <i>sylvestris</i> = <i>P. × celakovskiorum</i> A. et Gr.	<i>P. rotundata</i> × <i>sylvestris</i> = <i>P. × digenea</i> Beck
22 Fitschen 1988 sec. MAIER 1993	?	?
23 Schmeil-Fitschen 1988, sec. MAIER 1993	?	?
24 DOSTÁL 1989	<i>P. × celakovskiorum</i> Aschers. et Graebn.	–
25 DEBAZAC 1991	–	–
26 STASZKIEWICZ 1993, partly 1994	<i>P. × rhaetica</i> Brügg. (3) (= <i>P. mugo</i> Turra × <i>sylvestris</i> L.)	<i>P. × rhaetica</i> Brügg. (4) (= <i>P. mugo</i> Turra × <i>sylvestris</i> L.) ?
27 LEWANDOWSKI et al. 1999	–	–
28 BUSINSKÝ 2002 ¹ , 1998 ² , 1999 ² , 2004 ⁶	<i>P. × celakovskiorum</i> A. et Gr. (= <i>P. mugo</i> s. str. × <i>P. sylvestris</i>) ³	<i>P. × digenea</i> Beck (= <i>P. rotundata</i> × <i>P. sylvestris</i>) ³

Table 4b. Nomenclature overview and structuring of the *Pinus mugo* complex (*Pinus mugo* agg., with relation to *Pinus sylvestris*, including possible hybrids) according to selected authors, within approx. the last 100 years
Hybrid forms – hybrids with *P. sylvestris* II (usually arborescent)³

	Author/Taxon	Subforms on the boundary of <i>P. uncinata</i> s. str. and <i>P. sylvestris</i> (4.3)
1	TUBEUF 1912	(<i>P. montana</i> × <i>P. sylvestris</i>) (2)
2	POLÍVKA et al. 1928	–
3	NOVÁK 1953 (in KLIKA et al.)	<i>P. rhaetica</i> Brügger (2): <i>P. Christii</i> Brügger (= <i>P. uncinata</i> × [? <i>sylvestris</i> ssp.] <i>engadinensis</i>)
4	SVOBODA 1953	<i>P. hybrida</i> Heer?
5	REHDER 1954	? [<i>P. rhaetica</i> Bruegg. (2) (= <i>P. mugo</i> × <i>sylvestris</i> (?/))]
6	DOSTÁL 1954	–
7	OBERDORFER 1962	–
8	ROTHMALER 1963	–
9	GAUSSEN et al. 1964	<i>P. mugo</i> Turra × <i>sylvestris</i> L. (<i>P.</i> × <i>rhaetica</i> Brügger) ?
9a	PILÁT 1964	? <i>P. rhaetica</i> Brügger (= <i>P. sylvestris</i> var. <i>engadinensis</i> × <i>P. Mugo</i> var. <i>uncinata</i>)
10	HOLUBIČKOVÁ 1965	–
11	STASZKIEWICZ, TYSZKIEWICZ 1969	? (<i>P. mugo</i> × <i>sylvestris</i>) ?
12	SZWEYKOWSKI 1969	–
13	HOLUBIČKOVÁ 1972	–
14	STASZKIEWICZ, TYSZKIEWICZ 1972	<i>P.</i> × <i>rotundata</i> Link (= <i>P. sylvestris</i> L. × <i>P. mugo</i> Turra) ecomorph. “ <i>rotundata</i> ”??
15	Garcke 1972, sec. MAIER 1993	?
16	MUSIL 1975 (1977a,b)	–
17	HOLUBIČKOVÁ 1980a,b	–
18	VIEWEGH 1981	–
19	HOLUBIČKOVÁ, ŠTURSA 1984	–
20	CHRISTENSEN 1987b (a,c) and CHRISTENSEN, DAR 1997	<i>P. mugo</i> Turra × <i>sylvestris</i> L. (= <i>P.</i> × <i>rhaetica</i> Brügger) (2)
21	SKALICKÁ, SKALICKÝ ⁵ , 1988 1997	–
22	Fitschen 1988, sec. MAIER 1993	?
23	Schmeil-Fitschen 1988, sec. MAIER 1993	?
24	DOSTÁL 1989	–
25	DEBAZAC 1991	<i>P. bougeti</i> Flous (invalid name?)
26	STASZKIEWICZ 1993, 1994	<i>P.</i> × <i>rhaetica</i> Brügg. (5) (= <i>P. mugo</i> Turra × <i>sylvestris</i> L.) ?
27	LEWANDOWSKI et al. 1999	–
28	BUSINSKÝ 2002 ¹ , 1998 ² , 1999 ² , 2004 ⁶	<i>P. uncinata</i> × <i>P. sylvestris</i> ³

The results indicate that the research of the complex *Pinus mugo* sensu lato and its hybrids is not over definitely yet. We suppose that classical research should continue as more detailed investigations in the variability of individual morphological characters not only in the framework of until now established taxa, but also in the framework of individual populations and hybrid swarms – and in some cases even on the level of individuals (e.g. cone characters variability in individual specimens, etc.).

Thus future changes should be expected regarding the structure of the complex, hierarchic position of

individual lower taxa and their nomenclature. Proper advancement will not be reached until modern biochemical and especially genetic methods are used.

CONCLUSION

An objection could be made that from the strictly productive aspect the researched pine complex is of rather low importance; in the CR territory there would be a low economic value perhaps only in southern Bohemia just from the bog pine (and its hybrids with Scots pine). A different situation is in

the mountain area between the eastern Pyrenees and the western Alps, all included, even the economic value of the researched taxon, especially *Pinus uncinata* taxon, is in places quite large and undisputed one. From environmental and natural conservation aspects as well as from landscaping and subsequently also from forestry aspects it is not possible to regard any nature section as unimportant. And that fact fully stands about this group of woody species.

For that reason the *Pinus mugo* Turra (sensu lato) complex (or *P. mugo* agg., including its internal and external aggregate hybrids) should be regarded as an important and significant component of European dendroflora. Such a fact cannot be changed by an argument pointing out that this group is very variable and thus complicated and taxonomically not properly solved out yet. Many problems are mostly caused by a large amount of previously described taxa of uncertain value, often more or less overlapping, which are usually based on unsatisfactorily researched characters interpreted in an improper or inaccurate manner. Subsequently there must arise problems in applied disciplines. Contemporary specialized European literature contains a large amount of significant and efficient information related to the individual taxa of the complex. Such information is often placed under various, often not commonly known, lost or unused scientific names. In order to be able to use all this information at first it was necessary to collect all those names used in the past and try to divide them into a synoptic schedule of individual categories (see Tables 1 to 4b and Figs. 1 to 5), so that subsequent work with studied literature written during the past hundred years would thus become simplified.

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Komplex *Pinus mugo* agg. – jeho členění a orientační přehled užívanou nomenklaturou

ABSTRAKT: Komplex *Pinus mugo* Turra sensu lato (resp. agregát či souborný druh *P. mugo* agg. včetně jeho kříženců vnitroagregátových i vněagregátových) je důležitou součástí evropské dendroflóry. Jedná se však o skupinu značně variabilní a tím i komplikovanou, taxonomicky dosud ne zcela uspokojivě dořešenou. Problémy působí především velké množství v minulosti popisovaných taxonů nejisté hodnoty, často více či méně se překrývajících nebo založených na nedostatečně prozkoumaných a nevhodně interpretovaných znacích. To způsobuje problémy i v aplikovaných

disciplínách. Evropská odborná literatura obsahuje dnes již značné množství informací, vztahujících se k jednotlivým taxonům tohoto komplexu. Tyto informace jsou však umístěné pod nejrůznějšími, často běžně neznámými nebo nepoužívanými vědeckými jmény. Aby bylo možné využít všech zmíněných informací, bylo nejprve zapotřebí shromáždit nejfrekventovanější jména používaná v minulosti, pokusit se přehledně je rozřadit do vhodných kategorií respektujících současné představy o komplexu a přiřadit k nim i jména v současnosti nejčastěji používaná.

Klíčová slova: *Pinus mugo* agg. (= komplex *P. mugo* sensu lato); *P. uncinata* Ram.; *P. rotundata* Link; *P. mugo* Turra (sensu stricto); *P. × pseudopumilio* (Willk.) G. Beck; *P. × digenea* G. Beck; *P. × celakovskiorum* A. et Gr.; *P. rhaetica* Brügger

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