

**Tab. S1** - List of the *P. mugo* populations analysed in the study. (SUD, S): Sudetes; (A): Alps; (WA): Western Alps; (EA): Eastern Alps; (CAR): Carpathians; (WC): Western Carpathians; (EC): Eastern Carpathians; (SC): Southern Carpathians; (APN, Ap): Apennines; (BAL): Balkans; (DA): Dinaric Alps; (SB): southern Bulgaria; (NDA): no data available.

Acronym	Region	Location	Year of collection	Longitude (E)	Latitude (N)	Altitude [m a.s.l.]	No. of individuals cpSSR/morphology
SUD1	S	Czarny Kocioł Jagniątkowski, Sudetes (Poland)	2005	15°35'30"	50°47'05"	1350	30/33
SUD2	S	Śląskie Kamienie, Sudetes (Poland)	2005	15°36'10"	50°46'40"	1420	30/32
SUD3	S	Plateau under Śnieżka Mt., Sudetes (Poland)	2005	15°47'41"	50°44'44"	1410	29/30
SUD4	S	Side of Śnieżka Mt. above Kocioł Łomniczki, Sudetes (Poland)	2005	15°47'50"	50°44'40"	1400	30/31
A1	WA	Col de Tende, Alpes-Maritimes (Italy)	2001	7°22'30"	44°08'00"	2000	25/33
A2	EA	NW side of Kreuzspitze Mt., Ammergau Alps (Germany)	2001	10°55'12"	47°31'30"	1870	30/31
A3	EA	SW side of Hochkönig Mt., Berchtesgaden Alps (Austria)	2001	13°05'00"	47°26'00"	1500	25/34
A4	EA	S side of Negleck Mt. above Sölkpass, Austrian Central Alps (Austria)	2005	14°04'50"	47°16'21"	1900	25/NDA
A5	EA	Monte Altissimo di Nago, Monte Baldo, Italian Alps (Italy)	2002	10°56'08"	45°48'32"	2025	25/NDA
A6	EA	Passo di Pramollo, Carnic Alps (Italy)	2001	13°15'35"	46°32'45"	1530	25/30
A7	EA	Kamniška Bistrica, Kamnik-Savinja Alps (Slovenia)	2004	14°32'00"	46°21'26"	1600	26/NDA
CAR1	WC	N side of Grześ-Wołowiec Ridge, Tatra Mts. (Poland)	1999	19°45'50"	49°13'07"	1620	25/57
CAR2	EC	S side of Pasul Prislop Mt., Borsa, Rodna Mountains, Eastern Carpathians (Romania)	2002	24°48'00"	47°34'03"	1720	25/31
CAR3	SC	NE side of Negoiu above Bâlea Cascadă, below Lacul Bâlea, Făgăraş Mts., Southern Carpathians (Romania)	2002	24°32'19"	45°36'30"	2025	25/35
CAR4	SC	Buşteni, Bucegi Mts., Southern Carpathians (Romania)	2002	25°27'06"	45°25'55"	2070	25/37
APN	Ap	La Maiella, Abruzzi, Apennines (Italy)	2001	13°58'30"	41°46'20"	2200	25/33
BAL1	DA	NE side below the top of Bjelašnica Mt., Dinaric Alps (Bosnia and Herzegovina)	2002	18°13'08"	43°45'00"	2120	25/40
BAL2	DA	E side of Meded near Strug, Žabljak, Durmitor, Dinaric Alps (Montenegro)	2002	19°05'27"	43°09'33"	2100	29/34
BAL3	SB	Chrna Mt. above Aleko, Vitosha Mts. (Bulgaria)	2002	23°16'08"	42°34'01"	1900	24/31
BAL4	SB	Ribni Ezera above Rilski Manastir, Rila Mts. (Bulgaria)	2002	23°26'24"	42°05'20"	2100	25/30
BAL5	SB	Vikhren Mt. above Bansco, Pirin Mts. (Bulgaria)	2002	23°25'22"	41°46'07"	2000	25/33

**Tab. S2** - Composition of the 2 multiplex PCRs used in this study. (T<sub>A</sub>): annealing temperature.

Locus	Multiplex	Primers (fluorescent dye; Life Technologies, USA)	T <sub>A</sub> [°C]	Expected size ( <i>Pinus mugo</i> )	Reference
Pt15169	1	F: (6-FAM)-CTTGGATGGAATAGCAGCC R: GGAAGGGCATTAAAGGTCATTA	58	121-126	Vendramin et al. 1996
Pt26081	1	F: (PET)-CCCGTATCCAGATATACTTCCA R: TGGTTTGATTCATTTCGTTTCAT	58	109-113	Vendramin et al. 1996
Pt30204	1	F: (VIC)-TCATAGCGGAAGATCCTCTTT R: CGGATTGATCCTAACCATAACC	58	142-149	Vendramin et al. 1996
Pt36480	1	F: (NED)-TTTTGGCTTACAAAATAAAAAGAGG R: AAATTCCTAAAGAAGGAAGAGCA	58	-	Vendramin et al. 1996
Pt45002	1	F: (6-FAM)-AAGTTGGATTTTACCCAGGTG R: GAACAAGAGGATTTTTTCTCATACA	58	-	Vendramin et al. 1996
Pt71936	1	F: (PET)-TTCATTGGAAATACACTAGCCC R: AAAACCGTACATGAGATTCCC	58	145-151	Vendramin et al. 1996
PCP1289	2	F: (PET)-TCCTGGTTCCAGAAATGGAG R: TAATTTGGTTCCAGAATTGCG	60	106-108	Provan et al. 1998
PCP26106	2	F: (VIC)-AATCCGACAAAAAAGATTCCG R: GCTCCATTTACGTTGGTTG	60	145-149	Provan et al. 1998
PCP30277	2	F: (6-FAM)-TGTTGATGTCGTAGCGGAAG R: ATGAAATGAATCACTTCCCCC	60	114-120	Provan et al. 1998
PCP36567	2	F: (6-FAM)-AAAAGAGGAGGAAAAACACCTT R: AAGAGCAGACAAGTAAGGGGC	60	110-112	Provan et al. 1998
PCP41131	2	F: (PET)-AAAGCATTTCAGTTGGGG R: GGTCAGGATTCATGTTCTTCC	60	140-159	Provan et al. 1998
PCP45071	2	F: (NED)-ACTGGTCTGATCGACCCAAT R: TTCTACACTTGCGGAAACCC	60	145-153	Provan et al. 1998
PCP87314	2	F: (NED)-TCCAGGATAGCCCAGCTG R: TATATCCCCCGTACTTGGACC	60	112-117	Provan et al. 1998
PCP102652	2	F: (VIC)-TTCCCAGATCCATTGAAATACA R: TATGTGCGCGATAATTTCCA	60	114	Provan et al. 1998

**Tab. S3** - Characteristics of the 11 *cpSSR* loci studied. ( $A_N$ ): number of alleles; (MFA): most frequent allele; ( $F_{MFA}$ ): frequency of the most frequent allele; ( $A_E$ ): effective number of alleles (mean for all populations); ( $A_h$ ): diversity (mean for all populations); ( $A_{uh}$ ): unbiased diversity (mean for all populations).

<b>Locus</b>	<b><math>A_N</math></b>	<b>Size range [bp]</b>	<b>MFA</b>	<b><math>F_{MFA}</math></b>	<b><math>A_E</math></b>	<b><math>A_h</math></b>	<b><math>A_{uh}</math></b>
Pt15169	6	121-126	123	0.63	2.15	0.51	0.53
Pt26081	5	109-113	111	0.57	2.18	0.52	0.54
Pt30204	8	142-149	145	0.40	3.37	0.68	0.71
Pt71936	7	145-151	148	0.37	2.34	0.53	0.55
PCP1289	3	106-108	107	0.91	1.19	0.15	0.15
PCP26106	5	145-149	147	0.56	2.22	0.53	0.55
PCP30277	7	114-120	117	0.48	3.01	0.64	0.67
PCP36567	3	110-112	111	0.54	1.90	0.46	0.48
PCP41131	14	140-159	154	0.39	2.96	0.64	0.67
PCP45071	9	145-153	150	0.52	2.69	0.57	0.59
PCP87314	6	112-117	115	0.34	3.33	0.69	0.71
<b>Mean</b>	<b>6.63</b>			<b>0.52</b>	<b>2.49</b>	<b>0.54</b>	<b>0.56</b>
SE	0.93			0.05	0.20	0.05	0.05

**Tab. S4** - Geographic distance (km, lower diagonal) and number of shared haplotypes (upper diagonal) between the *P. mugo* populations.

	SUD1	SUD2	SUD3	SUD4	A1	A2	A3	A4	A5	A6	A7	CAR1	CAR2	CAR3	CAR4	APN	BAL1	BAL2	BAL3	BAL4	BAL5
SUD1		10	6	7	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
SUD2	1.1		7	6	1	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	1
SUD3	14.9	14.0		6	2	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1
SUD4	15.1	14.2	0.2		0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1
A1	962.4	962.4	969.1	969.1		0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0
A2	496.6	496.6	503.8	503.8	466.4		0	1	0	2	4	1	0	0	2	0	3	3	0	0	0
A3	414.9	414.6	417.8	417.8	574.7	162.9		0	0	2	0	1	0	0	1	0	0	0	0	0	0
A4	405.8	405.2	405.9	405.8	626.5	239.5	77.2		1	1	2	0	0	0	0	0	1	1	0	0	0
A5	651.4	651.2	655.9	655.9	336.4	190.8	244.0	290.4		0	1	0	0	1	0	0	0	0	0	0	0
A6	501.4	501.0	502.7	502.6	532.3	208.1	99.6	102.1	196.8		1	1	0	0	0	0	0	1	0	1	0
A7	498.4	497.8	496.7	496.6	612.4	303.6	162.8	107.5	284.2	100.0		0	1	0	1	0	1	2	0	0	0
CAR1	345.3	344.2	330.6	330.4	1099.4	679.4	532.1	473.1	763.1	568.6	503.6		0	0	0	0	0	1	1	1	0
CAR2	758.2	757.2	743.4	743.2	1399.2	1040.4	879.5	806.5	1073.9	880.7	789.9	414.6		0	3	0	0	0	0	0	0
CAR3	877.0	875.9	863.1	862.8	1359.8	1061.2	898.8	821.8	1055.2	875.5	776.8	538.5	218.8		0	1	1	1	1	1	2
CAR4	942.1	941.1	928.0	927.8	1430.9	1135.0	972.5	895.5	1128.2	949.1	850.3	600.6	242.6	73.8		0	1	0	0	0	0
APN	1009.8	1009.1	1007.5	1007.4	597.6	683.7	633.4	611.7	510.8	533.9	511.8	942.3	1069.8	949.4	1008.5		1	1	0	0	0
BAL1	806.8	805.9	799.0	798.8	868.6	705.3	572.0	507.2	618.5	497.7	409.5	619.4	664.3	540.5	602.2	410.3		3	4	1	2
BAL2	888.3	887.3	879.6	879.5	948.1	801.5	668.0	602.4	710.5	593.9	505.6	675.8	662.4	511.3	565.6	447.0	96.3		1	2	1
BAL3	1084.1	1083.0	1072.3	1072.1	1294.8	1114.0	965.3	891.9	1046.0	907.1	810.5	787.6	568.9	353.1	363.2	770.6	430.1	346.8		3	1
BAL4	1137.3	1136.2	1125.6	1125.4	1321.5	1155.9	1009.4	936.9	1081.7	948.4	852.8	842.4	618.5	401.1	405.3	783.4	463.4	375.2	55.0		1
BAL5	1167.8	1166.8	1156.3	1156.1	1330.0	1176.0	1031.4	959.6	1096.9	968.1	873.5	875.8	653.9	436.3	438.8	783.1	478.5	387.5	89.7	35.6	

**Tab. S5** - List and descriptive statistics of the needle traits analysed in this study based on 6150 measurements. (Min): minimum value; (Max): maximum value; (Mean): mean value; (CV): coefficient of variation.

Trait	Acronym	Min	Max	Mean	CV
Needle length [mm]	NL	26.60	74.80	44.77	17.21
Number of stomatal rows on convex (abaxial) side of needle	NSRC	4.70	13.20	9.02	14.63
Number of stomatal rows on flat (adaxial) side of needle	NSRF	4.20	10.70	6.67	15.03
Number of stomata on 2 mm-long section of needle, convex side	NSC	14.93	23.86	19.10	7.93
Number of stomata on 2 mm-long section of needle, flat side	NSF	14.80	24.00	19.03	7.85
Number of resin canals	NRC	1.00	6.60	3.98	22.79
Needle width [ $\mu\text{m}$ ]	NW	1054.00	1897.63	1426.28	10.25
Needle thickness [ $\mu\text{m}$ ]	NT	607.75	1119.78	838.81	9.15
Distance between vascular bundles [ $\mu\text{m}$ ]	DVB	20.31	215.71	98.41	34.33
Thickness of epidermal cells [ $\mu\text{m}$ ]	TE	27.47	56.61	40.04	11.14
Width of epidermal cells [ $\mu\text{m}$ ]	WE	11.15	23.39	14.52	9.29
Marcet's coefficient (DVB $\times$ NW/NT)	MC	32.11	395.00	168.76	36.39
Stomatal rows ratio (NSRC/NSRF)	SRR	0.97	1.76	1.38	9.37
Needle thickness/width (NT/NW)	NT/NW	0.50	0.73	0.59	4.55
Width/thickness ratio of epidermal cells (WE/TE)	WE/TE	0.26	0.57	0.37	10.00
Types of sclerenchyma cells between vascular bundles [%]:					
- fibre-like cells	FCVB	0.00	70.63	2.61	333.32
- intermediate, semi-fibrous cells	SCVB	0.00	90.00	9.38	174.89
- intermediate cells	ICVB	0.00	90.00	26.94	84.39
- cells with thin walls and large lumens	TCVB	0.00	90.00	55.38	53.26
Types of sclerenchyma cells around the resin canals [%]:					
- fibre-like cells	FCRC	0.00	75.82	11.47	126.32
- intermediate cells	ICRC	0.00	90.00	39.31	48.64
- cells with thin walls and large lumens	TCRC	0.00	90.00	44.46	52.10

**Tab. S6** - Climate conditions for the analysed *P. mugo* populations retrieved from the WorldClim database. (AMT): annual mean temp; (Max TWM): max. temp. of warmest month; (Min TCM): min. temp. of coldest month; (TAR): temp. annual range; (MT WetQ): mean temp. of wettest quarter; (MT DryQ): mean temp. of driest quarter; (MT WarQ): mean temp. of warmest quarter; (MT ColdQ): mean temp. of coldest quarter; (AP): annual precipitation; (P WetM): precipitation of wettest month; (P DryM): precipitation of driest month; (P WetQ): precipitation of wettest quarter; (P DryQ): precipitation of driest quarter; (P WarQ): precipitation of warmest quarter; (P ColdQ): precipitation of coldest quarter.

	AMT	Max TWM	Min TCM	TAR	MT WetQ	MT DryQ	MT WarQ	MT ColdQ	AP	P WetM	P DryM	P WetQ	P DryQ	P WarQ	P ColdQ
<b>SUD1</b>	3.1	15.2	-8.7	23.9	11.1	-4.5	11	-5.2	928	111	58	326	174	326	182
<b>SUD2</b>	3.1	15.2	-8.7	23.9	11.1	-4.5	11	-5.2	928	111	58	326	174	326	182
<b>SUD3</b>	3.6	16.3	-8.6	24.9	11.8	-4.1	11.8	-5	882	108	52	320	157	320	165
<b>SUD4</b>	3.6	16.3	-8.6	24.9	11.8	-4.1	11.8	-5	882	108	52	320	157	320	165
<b>A1</b>	4.2	16.3	-5.6	21.9	1.7	11.4	11.5	-2.3	1172	118	65	339	247	248	289
<b>A2</b>	3.1	15.8	-8.4	24.2	10.7	-4.5	10.7	-4.5	1134	149	64	417	205	417	205
<b>A3</b>	-1	11.5	-12.4	23.9	6.4	-7.9	6.4	-8.4	1521	169	92	494	315	494	326
<b>A4</b>	1.1	14.7	-10.9	25.6	9	-6	9	-6.8	1489	176	83	510	281	510	300
<b>A5</b>	8.4	23.6	-4.9	28.5	17.1	-0.6	17.1	-0.6	797	93	36	257	115	257	115
<b>A6</b>	3.5	17.6	-9.4	27	11.5	-3.9	11.5	-4.7	1208	138	57	407	194	407	202
<b>A7</b>	2.8	16.8	-8.9	25.7	10.9	-4.4	10.9	-5.1	1327	145	69	419	234	419	244
<b>CAR1</b>	1.9	14.9	-10.6	25.5	10.1	-5.9	10.1	-6.5	1347	189	74	504	233	504	249
<b>CAR2</b>	1.5	15	-11.6	26.6	8.3	-6.6	9.9	-7.1	984	145	51	400	162	393	169
<b>CAR3</b>	3.4	16.9	-10.1	27	10	-4.5	11.5	-5.2	907	135	49	367	149	357	154
<b>CAR4</b>	-0.2	11.7	-12.4	24.1	5.8	1.2	7.3	-8.2	1020	142	53	398	176	389	192
<b>APN</b>	8.2	22	-2.2	24.2	5.3	16.3	16.3	0.8	804	103	43	272	150	150	207
<b>BAL1</b>	3.8	17.5	-6.7	24.2	0.8	-3.3	11.7	-3.9	1143	116	82	319	248	291	275
<b>BAL2</b>	5.2	19.1	-6.7	25.8	2.1	13	13.2	-2.8	1179	125	81	341	258	266	300
<b>BAL3</b>	1.7	15.4	-10.3	25.7	4.1	6.9	9.5	-6.1	771	86	38	240	137	205	200
<b>BAL4</b>	1.5	15.3	-10.3	25.6	3.7	6.8	9.2	-6.1	776	80	33	232	126	187	221
<b>BAL5</b>	2.8	17.2	-9.2	26.4	-3.3	8.2	10.8	-5	738	76	32	219	120	169	213