Morphological variation of *Rumex longifolius* DC. in the Alps and the mountains bordering Bohemia

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Research Article

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Abstract

Neophytic populations of *Rumex longifolius* (Northern Dock) in the Alps and the mountain ranges bordering Bohemia differ in the length-width ratio of the basal leave blades, the shape and size of the valves and the tendency to develop tubercles of the valves. Five discrete populations from the Czech Republic (Krkonoše moutains and Ještěd mountain), Germany (Bavarian Forest), Austria (Arlberg mountain) and Switzerland (Engadin) are described by quantitative evaluation of specimens collected in the years 2014 – 2018 and their offspring cultivated in the Botanical Garden of Frankfurt a. M. for two vegetation periods. They have probably originated by independent introduction events. The Engadin population shows features of an introgression by *Rumex crispus.* It is possibly native there, which, however, can be concluded by indirect evidence only. The morphology of specimens from the upper Tyrolian Inn valley in the herbarium of the Natural History Museum Vienna suggests their origin from the Engadin, which should be confirmed statistically by additional collections. The taxonomical significance of subsp. *sourekii* Kubát which has been described based on a single character (leaf shape) is questioned considering the polymorphism of the species, and the seasonal dependence of the leaf width observed in the cultivation experiments. The observed morphological variability and ecological preferences of *R. longifolius* could be an indication of its experimentally yet not proved hybrid origin from *R. aquaticus* and *R. crispus*.

1. Introduction

Despite its subruderal preferences, *R. longifolius* (Northern dock) has been only sporadically noticed as an alien outside its native range (Scandinavia, Pyrenees, Massif Central in France) until the 1950ies. Shortly afterwards, the species became invasive almost exclusively in higher upland ranges, unlike most Central European neophytes. Here it has reached, apparently by chance, some climatically and ecologically suitable spots, subsequently spreading in a radial manner (Rechinger 1990). Considering this mode of expansion, the colonization of individual areas should have proceeded, although simultaneously, independently from possibly different regions of origin.

The latter fact should be reflected by morphological differences between the neophytic populations, because there is a geographical gradient of characters in the native range of *R. longifolius*. For example, plants from Middle and Southeast Scandinavia and adjacent Russia have narrow (length-width ratio > 4) and strongly undulate basal leaf blades, in contrast to plants from the West (Pyrenees, France, Iceland, Denmark) and North (Scandinavia north of 67°) with broader and less undulate blades (Jalas & Lindholm 1975; Holm & Korpelainen 1999). Additionally, Kubát (1984) describes an even more broad-leafed form from the Krkonoše mountains as subsp. *sourekii* with middle Russia as putative area of origin.

Another variable feature is the tendency to bear tubercles on the valves. In contrast to information found in many floras, one (not more!) of the fruiting inner perianth segments (valves) of *R. longifolius* may develop small tubercles up to 1 x 0.6 mm (Kubát 1990, Castroviejo et al. 1990). Although there is no relevant information in the literature about a variation of this character in the native range of the species, at least neophytic populations in the mountains bordering Bohemia were found to differ in this respect (Sonnberger 2015).

A special question concerns the nativeness of *R. longifolius* in the Alps. Adler (1992) presents conclusive circumstantial evidence that the species is native to the Swiss Upper Engadin, where local botanists have confused it for several decades with *Rumex crispus* L., which is said to be absent from this area.

2. Material And Methods

In the years 2014 to 2018 neophytic populations of Rumex longifolius in the Alps and the mountains bordering Bohemia were sampled (appendix I). In February 2019, seeds of 11 representative specimens (P specimens) from 5 areas of origin were sowed in the Botanical Garden Frankfurt a. M., and the obtained total of 70 F_1 individuals cultivated for two vegetation periods. The plants which had not reached flowering on 01.08.2020 were transferred to the author's garden in Memmingen and further cultivated until 25.07.2022.

Morphological comparison of the collected and cultivated plants was performed by means of five characters considered to be of taxonomical importance:

- *Length-width ratio of the basal leaf blades (L/W-B)*
- *Absolute length and width of the valves*
- *Length-width ratio of the valves (L/W-V)*
- *Development of tubercles on the valves*
- *Absolute length and width of the tubercles*

The specimens listed in appendix I and the examined material of the F_1 plants (basal leaves and infructescence fragments) are kept in the author's herbarium.

2.1 *Length-width ratio of the basal leaf blades*

The measurements were made with an accuracy of 1 mm using a ruler. In the case of the P specimens, all basal leaves in a suitably good state of preservation were used. In the F_1 generation, 5 – 9 basal leaves of each plant were examined in the first (sampled 12.08.2019), in the second (sampled 22.05.2020) and in the case of the plants cultivated further in the author's garden also in the third (sampled 11.05.2021) and fourth year of growth (sampled 12.05.2022).

2.2 Absolute length and width of the valves

10 arbitrarily selected flowers with fully developed valves were taken from each specimen. One valve per flower was examined, either the tubercle-bearing one, or, in the case of lacking tubercles, the visually largest each.

The measurements were made with an accuracy of 0.1 mm by means of a scale loupe (Eschenbach Fadenzähler). As for the basal leaves, the width was defined as the largest, orthogonally to the midvein measured gap between the leaf margins. The length was defined as the gap between the tip of the valve and a tangent to the larger basal lobe, drawn orthogonally to the mid vein.

2.3 Development of tubercles on the valves

The extent of development of tubercles on the valves is described by a semiquantitative estimation scale called tubercle index:

0 < 2% of the flowers bearing a valve with a tubercle

1 2-15% of the flowers bearing a valve with a tubercle

2 15 - 50% of the flowers bearing a valve with a tubercle

3 50% - 75% of the flowers bearing a valve with a tubercle

4 > 75% of the flowers bearing a valve with a tubercle

In the (rather infrequent) cases of doubt whether a swelling of the midvein should be already regarded as tubercle, it was included in the tubercle index, even if a measuring was not possible because of indistinct boundaries of the thickened area.

2.4 Absolute length and width of the tubercles

The measurement was limited to the tubercles formed on the valves selected as described above (see 2.2), to an accuracy of 0.05 mm using again a scale loupe (Eschenbach Fadenzähler).

2.5 Mean values

First, mean values were determined population-related over all sampled specimens of the same origin (tab. 1). For the P / F_1 comparison, the mean values were established individually for each discrete P specimen, and for the cultivated plants in each case over all F_1 individuals stemming from that specimen (tab. 2 and 3).

For reasons of clarity, statistical information (standard deviation and number of single values) is not given in the text tables, but separately as appendix II.

3. Results And Discussion

3.1 Life cycle

Almost all F_1 plants from the mountains bordering Bohemia, the Arlberg mountain and the offspring of the specimen REN#5 from the Engadin developed inflorescences already in the second year. In contrast, the offspring of the other specimens from the Engadin, except for two individuals, formed only leaf rosettes (Fig. 1; tab. 3, second column). For unknown reasons the growth conditions were no more optimal in the author's garden, despite climatic parameters rather favourable to the species (foothills of the Bavarian Alps, 587 m sea level). The plants showed only poor growth, did not flower in the third and developed only a single inflorescence in the fourth year (tab. 3).

3.2 Vegetative features

*If only the specimens collected in the field are considered, the length-width ratio of the basal leaf blades allows to divide the studied populations into three groups (tab. 1). The plants from the Czech Republic (*Krkonoše mountains, Ještěd mountain, Bohemian Forest) *have broad blades (L/W-B ca. 2.5) and may therefore be assigned, in accordance with the opinion being held in the Czech literature (e. g.* Kubát *1990), to subsp. sourekii. The plants from the Bavarian Forest and the Engadin with L/W-B ca. 3.5 correspond to the nominate form (Castroviejo et al. 1990), and the Arlberg population with L/W-B > 4 to the (taxonomical yet not described) Southeast Scandinavian group in the sense of* Holm & Korpelainen (1999).

As tab. 2 shows, these features are superimposed by the developmental stage of the plants. In the F_1 generation, the parental differences appear only in the second year, while the vegetative rosettes of the first year, as well as the poorly growing plants of the fourth year, are characterized by broader leaves. This finding provides a possible explanation for the leave shape of P specimen RAT#1d, which deviates from that of the other Arlberg plants by its much smaller L/W-B (tab. 2). The specimen consists of a leaf rosette formed during the current vegetation period, which is connected to the dead fruiting stalk (fig. 2). Obviously, such a secondary innovation shoot tends to get broader leaves in the same way as a first year's vegetative individual.

Tab. 1 Morphological features of basal leave laminas, valves, and tubercles; populational averages comprising the specimens collected in the field

Population	L/W-B	Valve length [mm]	Valve width [mm]	L/W-V	Tubercle index	Tubercle length [mm]	Tubercle width [mm]
Krkonoše mountains (RKr#*xx*)	2.3	4.5	5.2	0.88	4	0.7	0.4
Bohemian Forest (RSp#*xx*)	2.3	5.8	6.2	0.94	2	0.6	0.4
Bavarian Forest (RAr#*xx*)	3.5	5.1	5.8	0.87	1	0.6	0.3
Ještěd mountain (RJ#*xx*)	2.7	5.0	4.8	1.05	0	-	-
Upper Engadin (REN#*xx*)	3.6	6.4	6.6	0.97	0 (REN#6)	-	-
					4 (other)	1.0	0.6
St. Anton am Arlberg (RAT#*xx*)	4.2	4.7	5.2	0.91	3 (RAT#4)	0.8	0.3
					0 (other)	-	-

Tab. 2 Basal leave laminas of the cultivated F_1 plants and the corresponding P specimens

Population P specimen (number of F_1 plants)	L/W-B (P)	L/W-B (F_1) 12. 8. 2019	L/W-B (F_1) 22. 5. 2020	L/W-B (F_1) 11. 5. 2021	L/W-B (F_1) 12. 5. 2022
Krkonoše mountains RKr#1 (4)	2.8	1.8	2.2	-	-
Bavarian Forest RAr#1 (7)	3.5	2.6	3.9	-	-
Bavarian Forest RAr#2a (5)	1.7	2.4	3.2	-	-
Ještěd mountain RJ#1 (7)	1.9	2.4	3.8	-	-
Upper Engadin REN#2b (7)	3.3	2.5	3.5	3.5	2.8
Upper Engadin REN#4b (6)	3.2	2.5	3.2	3.4	2.7
Upper Engadin REN#5 (6)	3.8	3.8	4.8	-	-
Upper Engadin REN#8 (7)	4.0	2.5	3.1	3.4	3.0
St. Anton am Arlberg RAT#1a (7)	4.1	3.3	4.9	-	-
St. Anton am Arlberg RAT#1d (7)	2.7	2.9	4.4	-	-
St. Anton am Arlberg RAT#5 (7)	4.5	2.6	3.8	-	-

3.3 Generative features

In the Alps, the specimens from the Engadin are distinguished by their large valves which – except in the single specimen REN#6 – always bear tubercles. In contrast, the valves of the Arlberg plants are significantly smaller and, again except for a single specimen (RAT#4), always lack tubercles (tab 1 and 3, fig. 3). These differences persist - more or less - in the F_1 generation (tab. 3), hence obviously are genetically fixed. Taking into account the above-mentioned leaf traits it therefore can be concluded that the population of the Arlberg

mountain, which exists at least since the early 1990ies (Willner 1994), originated by a separate introduction instead, as supposed earlier (Sonnberger 2018), by migration from the Engadin down the upper Inn valley. This can be seen also from the aspect of the stands above St. Anton. The plants concentrate at 1850 m asl around the cable way building complex "upper terminus Gampenbahn / lower terminus Kapallbahn", from which they descend ca. 100 m downhill along the Gampenbahn cableway line. Here we are obviously dealing with the scheme described by Rechinger (1990), i.e., an isolated introduction followed by subsequent expansion.

The Valves of the plants from Ještěd mountain differ from those of all other examined populations by invariably lacking tubercles and a larger length-width ratio. As can be seen from tab. 3, the first trait is inherited unalteredly (tubercle index = 0 *in P as well as F_1), while the latter is varying between the generations (L/W-V (P) = 0.95; L/W-V (F_1) = 1.02; fig. 4). On the other hand, the plants from* Krkonoše mountains *and the Bavarian Forest differ in L/W-B and tubercle index, again as well in the P as in the F_1 generation (tab. 2 und 3). It can therefore be assumed that altogether three genetically discrete populations occur in the mountains bordering Bohemia, fig.5.*

Tab. 3 Generative features of the cultivated F_1 plants and the corresponding P specimens

Population P specimen	Fructifying plants 1. 8. 2020	Valve length [mm]		Valve width [mm]		L/W-V		Tubercle index		Tubercle length [mm]		Tubercle width [mm]	
		P	F_1	P	F_1	P	F_1	P	F_1	P	F_1	P	F_1
Krkonoše mountains RKr#1	4 of 4	4.7	4.5	5.4	4.9	0.88	0.91	4	4	0.7	0.9	0.3	0.3
Bavarian Forest RAr#1	7 of 7	5.6	4.7	6.2	5.2	0.90	0.90	2	2	0.6	0.5	0.2	0.2
Bavarian Forest RAr#2a	5 of 5	4.5	4.9	5.4	5.2	0.84	0.94	0	1	-	0.7	-	0.2
Ještěd mountain RJ#1	7 of 7	4.3	5.1	4.6	5.0	0.95	1.02	0	0	-	-	-	-
Upper Engadin REN#2b	1 of 7	6.3	6.0	6.9	6.1	0.92	0.98	4	3	0.8	0.7	0.5	0.4
	25.7.2022		5.2		5.3		0.99		4		1.1		0.7
	(1 plant)												
Upper Engadin REN#4b	1 of 6	6.6	6.2	6.8	6.6	0.97	0.93	4	4	1.1	1.1	0.6	0.7
Upper Engadin REN#5	6 of 6	5.7	5.8	6.1	6.1	0.93	0.97	4	4	1.7	1.5	0.9	0.8
Upper Engadin REN#8	0 of 7	6.7	-	7.2	-	0.93	-	4	-	1.2	-	0.7	-
St. Anton am Arlberg RAT#1a	7 of 7	4.6	4.9	5.1	5.5	0.91	0.89	0	1	-	0.7	-	0.3
St. Anton am Arlberg RAT#1d	7 of 7	4.2	4.8	4.6	5.3	0.91	0.90	0	0	-	-	-	-
St. Anton	6 of 7	4.6	4.7	5.1	5.3	0.90	0.89	0	1	-	0.5	-	0.3

am Arlberg RAT#5

3.4 Synopsis of the morphological findings

Combining the data obtained from the original collections and the F_1 cultures, the studied populations may be distinguished from each other by the following mean parameter ranges:

Population	*Length-width ratio of the basal leaf blades on current years flowering shoots*	*Length of the valves [mm]*	*Length-width ratio of the valves*	*Proportion of flowers with one mature valve bearing a tubercle*
Krkonoše mountains	*2 - 3*	*4 - 5*	*0.85 – 0.95*	*>50%*
Bavarian Forest	*3 - 4*	*4.5 – 5.5*	*0.85 – 0.95*	*<50%*
Ještěd mountain	*3 - 4*	*4.5 – 5.5*	*0.95 – 1.05*	*0% (without exception)*
Upper Engadin	*3 - 4*	*6 - 7*	*0.90 – 1.00*	*100% (except for single individuals)*
St. Anton am Arlberg	*>4*	*4 - 5*	*0.85 – 0.95*	*0% (*except for single individuals*)*

The values are sufficiently distinct to demonstrate that geographical separation is associated with morphological difference, which allows the conclusion that the individual populations originated by different introduction events. Unfortunately, as no ripe seeds were available, it was not possible to include the Bohemian Forest population (see tab. 1) into the cultivation experiments. In the Czech literature the plants occurring there, as well as those naturalized in the Krkonoše mountains, are assigned to a separate subsp. *sourekii* Kubát, which differs from the nominal taxon by broader leaves *(*Kubát *1990*). Although this trait could be confirmed here for the collections from the Krkonoše mountains, its taxonomical relevance should be assessed against the variability of the species, and the dependence of just this character from development stage and growth conditions (see 3.2). Considering the general polymorphism of *R. longifolius*, a categorisation based on a single character does not seem appropriate anyway. The rank of a subspecies clearly overemphasizes the taxonomical status of subsp. *sourekii* as defined hitherto.

4. Occurrence Of In The Engadin

4. Occurrence of *Rumex crispus* in the Engadin

The specimen REN#5 has been suspected already in the field to be *R.* x *propinquus* Aresch. (*R. crispus* x *R. longifolius*) because of its tubercles measuring on average 1.7 x 0.9 mm and its smaller valves and narrower leaves as compared with the other Engadin specimens. These traits are essentially inherited to the F_1

generation (Table 2 und 3), so it may be concluded that we are indeed dealing here with a fertile introgression form with *R. crispus*. Its narrow leaves and invariably entire valves allow to exclude other tubercle-bearing species like *R. obtusifolius* (which occurs in the region, see specimen REN#7, appendix I) and *R. patientia*. Also, the other specimens from the Engadin are characterized by unusually as for *R. longifolius* large tubercles. REN#4b and REN#8 exceed the maximum value given in the literature (1 x 0.6 mm, see 1.), and although the P specimen REN#2b itself has “normally sized” tubercles, the single F_1 plant reaching flowering in the fourth year again exceeds the above-mentioned limit. The latter moreover developed distinctly smaller valves (Table 3), which, however, may be due to the unfavourable growth conditions in this year (see 3.1).

Hence, in contrary to the hypothesis by Adler (1992), *R. crispus* apparently is occurring in the Engadin or at least has been occurring in the past. It could be possible, for example, that the alpine climatic conditions prevailing here constitute a severe growth limit for this species normally restricted to lower elevations. When *R. longifolius* became invasive in the middle of the 20th century, it may have quickly replaced and genetically assimilated its ecologically poorly adapted relative.

5. Nativeness Of In The Engadin

5. Nativeness of *Rumex longifolius* in the Engadin
The (former) occurrence of *R. crispus* in the Engadin does not disprove the hypothesis of *R. longifolius* being native in this area. The first, recently no more recorded species may have been sufficiently rare already in the 19th and early 20th century to explain its erroneous recording by contemporary botanists. Many records of *R. crispus* at that time refer probably to introgression forms with *R. longifolius* or to the latter species itself.

The F_1 plants from the Engadin (except the offspring of the considered as *R. x propinquus* specimen REN#5) did not reach flowering in the second year and developed only occasional inflorescences, respectively – in contrast to the plants of all other, certainly neophytic populations (Fig. 1; Table 3). This obvious developmental distinctiveness may be taken as another indication of the nativeness of *R. longifolius* in the Engadin. Further evidence results from its preference for wet habitats which has been observed only here. The specimens REN#1 und REN#6 grew in natural biotopes (riverbank and marsh, see appendix I), where they might have spread from the adjacent ruderal habitats. On the other hand, the ruderal stands prevailing today in the Engadin may have originated just in the middle of the 20th century after transition of the species to invasive behaviour, with natural habitats in the flood plains of the river Inn as area of origin and source of diaspores.

6. Other Records From Austria

Fischer et al. (2008) mention records of R. longifolius from the upper Tyrolean Inn valley and the Steiermark, which date back to the second half of the 20th century. They are documented by

Tab. 4 Herbarium specimens of *R. longifolius* from the upper Tyrolean Inn valley [Oberinntal] and the Steiermark

Herbarium code, specimen no.	Label text	Description of specimen
W, specimen 1, sheet 1	Oberinntal, unmittelbares linkes Innufer zwischen Stuben / Pfunds und Maria-Stein, ca. 955 m, 12. 09. 1983, leg. A. Polatschek, det. W. Forstner (als *R. patientia*), rev. K. H. Rechinger [Upper Inn valley, immediate bank of the river Inn between Stuben / Pfunds and Maria-Stein, ca. 955 m, 12. 09. 1983, leg. Al Polatschek, det. W. Forstner (as *R. patientia*), rev. K. H. Rechinger]	1 (presumably) basal leaf 24.7 x 7.8 cm ➔ length/width = 3.2; 1 immature infructescence with green-brown valves.
W, specimen 1, sheet 2		1 (presumably) basal leaf 32.3 x 12.4 cm => length/width = 2.6; 1 mature infructescence with brown valves bearing occasional tubercles; average of 8 valves: length = 6.6 mm, width = 7.1 mm ➔ length/width = 0.93; tubercles up to 1.5 x 0.8 mm.
W, specimen 2	Oberinntal: linkes Innufer zw. Schönwies und Imsterberg, Aubereich, 31. 08. 1972, leg. A. Polatschek, det. K. H. Rechinger [Upper Inn valley: left bank of the river Inn between Schönwies and Imsterberg, flood plain zone, 31 .08. 1972, leg. A. Polatschek, det. K. H. Rechinger]	1 (presumably) basal leaf 19.3 x 6.6 cm ➔ length/width = 2,9; 1 (presumably) stem leaf; 1 mature infructescence with brown valves bearing occasional tubercles; average of 12 valves: length = 5.8 mm, width = 6.1 mm ➔ length/width = 0.96; tubercles up to 0.9 x 0.5 mm.
W, specimen 3	Oberinntal, rechte Inn-Au zwischen Gh. "Neuer Zoll" und der Pontlatz-Brücke bei Prutz, ca. 860 m, 04.09.1983, leg. A. Polatschek (als *R. patientia*), det. K. H. Rechinger. [Upper Inn valley, right flood plain of the river Inn between inn "Neuer Zoll" and Pontlatz bridge near Prutz, ca. 860 m, 04.09.1983, leg. A. Polatschek (as *R. patientia*), det. K. H. Rechinger.	1 (presumably) basal leaf 27.4 x 13.1 cm ➔ length/width = 2.1; 1 mature infructescence with brown valves bearing numerous tubercles; average of 10 valves: length = 5.4 mm, width = 5.9 mm ➔ length/width = 0.91; tubercles up to 1.0 x 0.6 mm.
LI	Steiermark, oberes Murtal, nordöstl. von Kraubat auf einer Anschwemmung der Mur gegen St. Stefan zu, 24. 08. 1988, H. Melzer [Steiermark, upper Mur valley, northeast of Kraubat on alluviation of the river Mur towards St. Stefan, 24. 08. 1988, H. Melzer]	1 (presumably) basal leaf 23.5 x 8.3 cm ➔ length/width = 2.8; 1 mature infructescence with brown valves without or with only rudimentary tubercles; average of 10 valves: length = 5.0 mm, width = 5.3 mm ➔ length/width = 0.94.

four sheets in the herbarium of the Natural History Museum Vienna and one sheet in the herbarium of the Biology Centre Linz (with duplicate in the herbarium of the University Graz), tab. 4. The Tyrolean specimens have comparatively large valves regularly bearing tubercles, similarly to the Engadin plants investigated in this paper. Although an origin from this region seems likely because of short physical distance, this assumption should be verified statistically by more material. Two other specimens from Austria in the herbarium of the Tyrolean State Museum in Hall i. T. (Matrei in Eastern Tyrol, 26. 9. 2009; Ötztaler Ache North of Sölden 28. 8. 1999) have not been examined in the framework of this paper.

7. Putative Hybrid Origin Of

„This species has many common features with *R. aquaticus* and *crispus*. The stem is straight, high, furrowed; the leaves are very long, in the lower parts of the plant long-stalked; they are elongated, acute, attenuated at both ends, undulate-crispate at the margins; the flowers are in whorls, which are arranged to long spikes, these mostly simple, sometimes branched, usually paired in the leaf axils; the valves of the perianth are highly entire, obtuse and bear instead of tubercles just a slight swelling. This species has been sent to me by Mr. Coder, who found it in the surroundings of Prades (in Roussilon)".

The original description of *R. longifolius* (DeCandolle 1815; fig. 6; translation by the author) already points to a possible relationship to *R. aquaticus* und *R. crispus*. Kubát (1990) mentions a hybrid origin with these two species as parents but does not cite any references. Because a literature search did not yield any pertinent information, it can be assumed that we are dealing here with an unverified hypothesis which nevertheless is very plausible from morphological as well as ecological points of view. For example, the morphological variability of *R. longifolius* described in this paper is reflected by various combinations of traits of *R. aquaticus* (large valves without tubercles, broad, marginally not undulated leaves) and *R. crispus* (medium-sized valves with tubercles, narrow, strongly undulate leaves). Moreover, the limitation to higher mountain ranges which is unusual for an invasive species may be explained by humidity rather than temperature factors. An increased demand for moisture inherited by *R. aquaticus* should be met here much better than in corresponding (ruderal) lowland habitats.

Declarations

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Figures

Figure 1

Cultures of *R. longifolius* in the Botanical Garden Frankfurt a. M.,

22. 5. 2020.

From left to right:

F_1 – plants stemming from

RAT#1a (St. Anton am Arlberg),

REN#8 (Upper Engadin),

RAr#2a (Bavarian Forest),

REN#4b (Upper Engadin).

Figure 2

P – specimen RAT#1d

collected 1. 9. 2018.

Top right and bottom middle:

second year basal leaves of F_1 plants sampled 22. 5. 2020.

Figure 3

Valves of *R. longifolius* from the alps.

Top row: Upper Engadin,

specimen REN#2b.

Bottom row: St. Anton am Arlberg, specimen RAT#5.

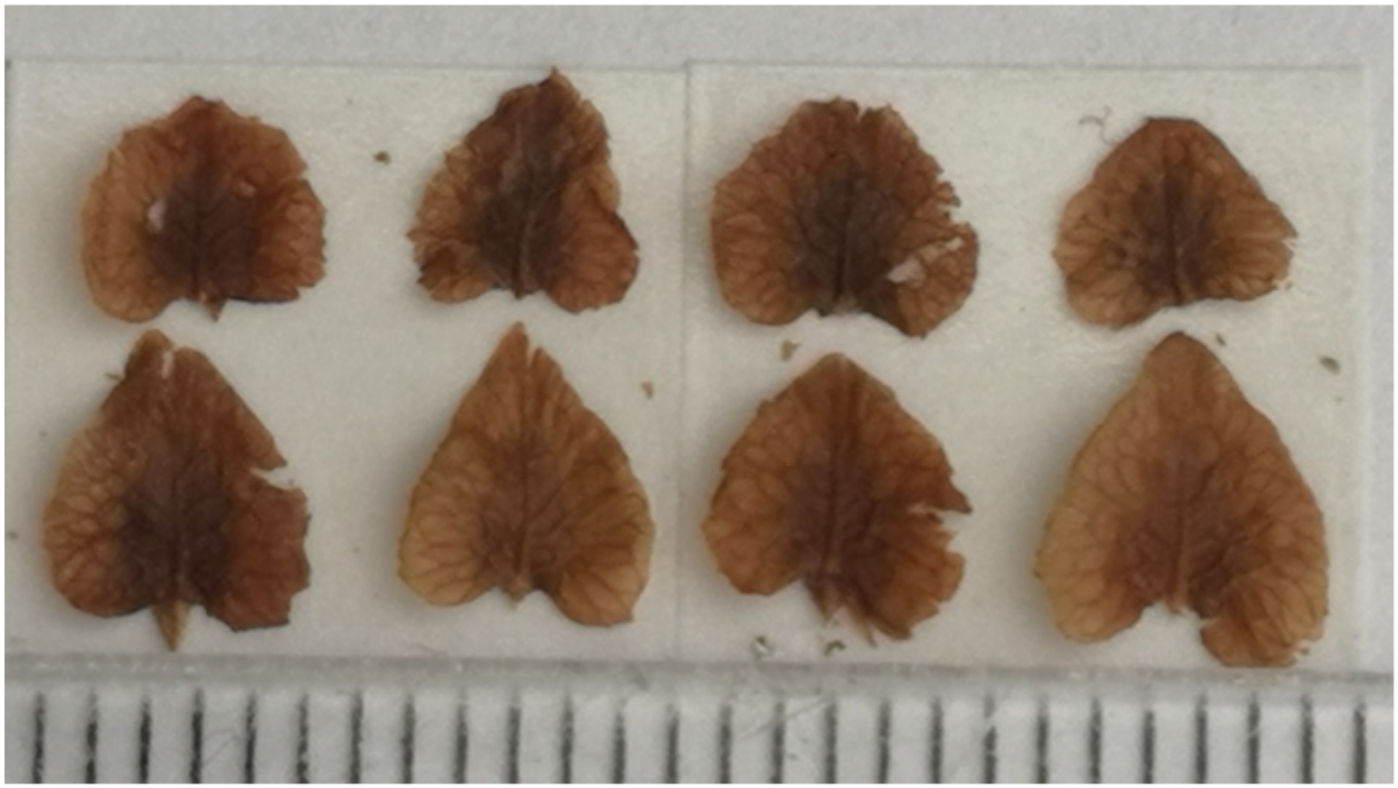


Figure 4

Valves of *R. longifolius* from Ještěd mountain, specimen RJ#1.

Top row: P, 14. 8. 2018.

Bottom row: F_1, 1. 8. 2020.

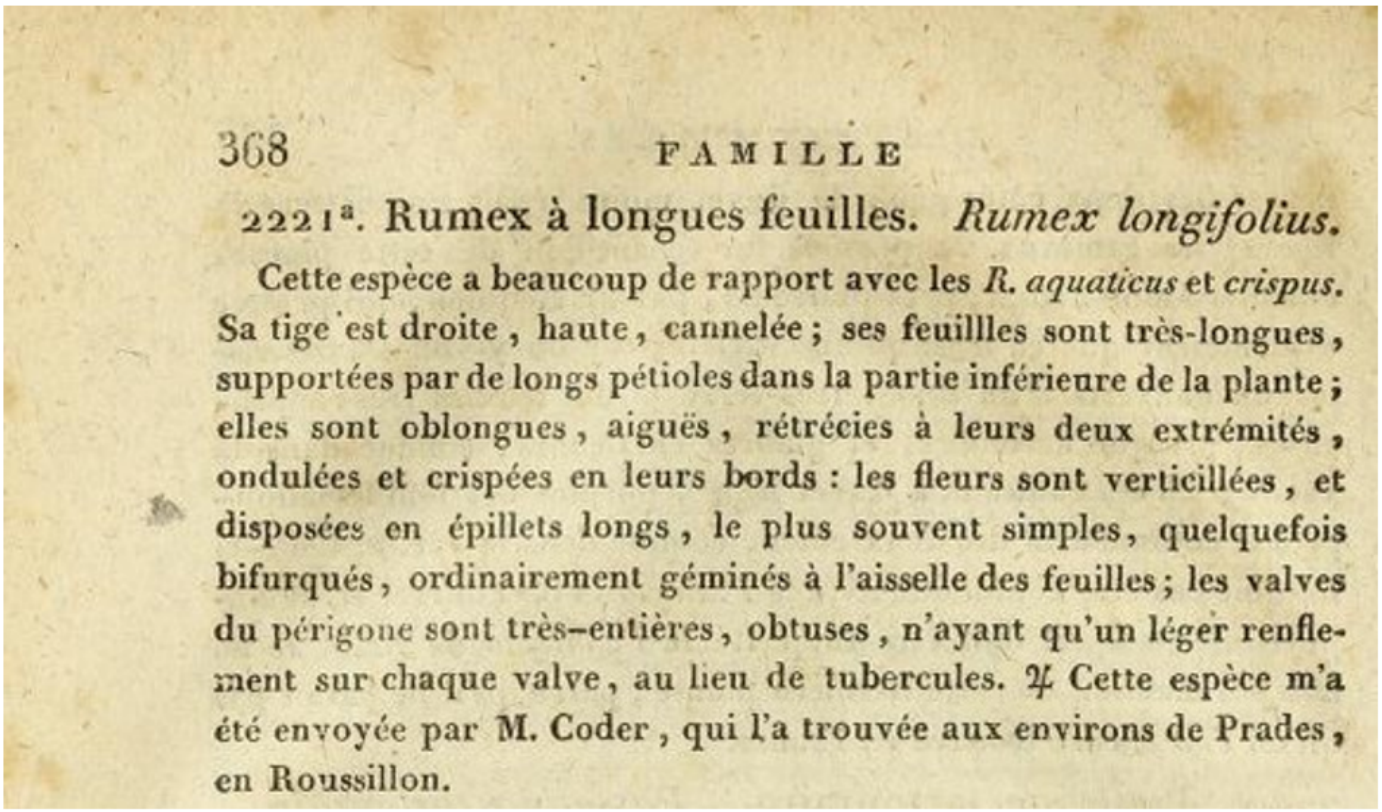
Figure 5

Valves of *R. longifolius* from the mountains bordering Bohemia.

Top row: Krkonoše mountains, specimen RKr#1;

middle row: Ještěd mountain, specimen RJ#2;

bottom row: Bavarian Forest, specimen RAr#1.



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2221ª. Rumex à longues feuilles. *Rumex longifolius.*

Cette espèce a beaucoup de rapport avec les *R. aquaticus* et *crispus*. Sa tige est droite, haute, cannelée; ses feuillles sont très-longues, supportées par de longs pétioles dans la partie inférieure de la plante; elles sont oblongues, aiguës, rétrécies à leurs deux extrémités, ondulées et crispées en leurs bords : les fleurs sont verticillées, et disposées en épillets longs, le plus souvent simples, quelquefois bifurqués, ordinairement géminés à l'aisselle des feuilles; les valves du périgone sont très-entières, obtuses, n'ayant qu'un léger renflement sur chaque valve, au lieu de tubercules. ♃ Cette espèce m'a été envoyée par M. Coder, qui l'a trouvée aux environs de Prades, en Roussillon.

Figure 6

Original description of *R. longifolius* from the year 1815.

Supplementary Files

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