

The *Ranunculus auricomus* L. complex (Ranunculaceae) in Croatia

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Zusammenfassung: In einer vorläufigen Übersicht des *Ranunculus auricomus*-Komplexes in Kroatien werden 24 Arten vorgestellt. Neu für Kroatien sind Nachweise von *R. cassubici* W.KOCH und *R. poldinioides* DUNKEL. Insgesamt werden 18 Arten als neu für die Wissenschaft beschrieben und abgebildet, darunter die als Diploide besonders bemerkenswerten *R. mutilicensis* und *R. slavonianus*, sowie weiter *R. albimonasterius*, *R. baranjanus*, *R. croaticola*, *R. divisor*, *R. dobranus*, *R. dravus*, *R. gradiscanus*, *R. istriacoides*, *R. marinianaënsis*, *R. plitvicensis*, *R. posavinanus*, *R. rondocroaticus*, *R. schlosseri*, *R. slavopontinus*, *R. turopoljensis*, und *R. velebiticus*.

Abstract: In this article, 24 species of the *Ranunculus auricomus* complex of Croatia are presented. New indications for Croatia include *R. cassubici* W.KOCH and *R. poldinioides* DUNKEL. In total 18 species are described as new to science among them the two diploids *R. mutilicensis* DUNKEL and *R. slavonianus* DUNKEL being of special interest and the polyploids *R. albimonasterius*, *R. baranjanus*, *R. croaticola*, *R. divisor*, *R. dobranus*, *R. dravus*, *R. gradiscanus*, *R. istriacoides*, *R. marinianaënsis*, *R. plitvicensis*, *R. posavinanus*, *R. rondocroaticus*, *R. schlosseri*, *R. slavopontinus*, *R. turopoljensis*, and *R. velebiticus*.

Key words: *Ranunculus auricomus*, *Ranunculus cassubicus*, Croatia, new species, taxonomy.

1 INTRODUCTION

The *Ranunculus auricomus* complex including *R. cassubicus* L. s.l. includes more than 850 species occurring at Central, Northern and Eastern Europe. At all edges of the distribution area, the populations get fewer and more scattered, and the diversity decreases (DUNKEL 2015, 2019, 2021, ERICSSON 2001, GRAU 1974, MELZHEIMER & HÖRANDL 2022). Only one taxon

grows in Iceland (ERICSSON 2001). Portugal on the western edge and Turkey on the eastern one are free of the *Ranunculus auricomus* complex.

The taxa of the *Ranunculus auricomus* complex belong to groups that are difficult to distinguish both morphologically and genetically and are known as taxonomically complex groups. The reasons are intricate evolutionary processes comprising pre-

dominantly hybridization, allopolyploidy and post-origin evolution (KARBSTEIN & al. 2022, HODAČ & al. 2023). Furthermore, epigenetic changes may explain some difficulties in unraveling genetic relationships (HÖRANDL 2022). In the *Ranunculus auricomus* complex, even prehension of morphology and determination is difficult due to the basal leaf cycle. All leaves of the cycle are almost never present at a single plant. Therefore, a careful examination is necessary which usually needs several plants. This should not be misinterpreted as morphological variability (HÖRANDL & GUTERMANN 1995).

In the last decades, genetic information has been accumulated for the European *R. auricomus* complex (KARBSTEIN & al. 2022, for overview see MELZHEIMER & HÖRANDL 2022). It has been confirmed that morphological shape is mainly associated with the subgenomic composition of the allopolyploids and overall genomic differentiation, and almost not with abiotic environmental conditions (HODAČ & al. 2023). However, the reticulate pattern of evolution hampers unraveling of phylogeny and relationships, not only in the *R. auricomus* complex (SOCHOR & al. 2015). Maybe in the future, some artificial intelligence can help to identify new species, and agreement of the species concept can be reached (KARBSTEIN & al. 2024).

Cytologically with the exception of *R. cassubicifolius* W.KOCH – belonging to the *R. cassubicus* collective group (HÖRANDL & GUTERMANN 1998, MAJESKÝ & al. 2017) –, almost all species of Central Europe are tetraploid and apomictic (DUNKEL & al. 2018, HÄFLIGER 1943, MELZHEIMER & HÖRANDL 2022). Only four diploid species have been recorded from outside the former Yugoslavia: *R. envalirensis* GRAU (France and Spain), *R. cebennensis* DUNKEL (France), *R. notabilis* HÖRANDL & GUTERMANN (Austria), and *R. flabellifolius* HEUFF. EX RCHB. (Romania and Serbia). However recently, further morphologically and ecologically well-differentiated diploid species have been found in Slovenia: *R. austroslovenicus* DUNKEL, *R. glechomus* DUNKEL, *R. mediocompositus* DUNKEL, *R. peracris* DUNKEL, *R. subcarniolicus* DUNKEL, and *R. vinicae* DUNKEL. The findings of diploid *R. calapius* DUNKEL in Croatia (DUNKEL & al. 2018), and *R. vinicae* in Slovenia near to the Slovenian-Croatian border seem to make the region of Croatia to an interesting field for further studies. In addition, literature about this complex in Croatia is scarce and seems to be restricted to historical records of *R. auricomus* and *R. cassubicus* by SCHLOSSER & VUKOTINOVIĆ (1869) and DEGEN (1937). The largest national collection of Croatian plants, located at the Herbarium of the University of Zagreb, Department of Biology (ZA), houses no more than about 30 specimens of the *Ranunculus auricomus* complex and relevant online resources such as the JACQ CONSORTIUM (2004 ff.) and GBIF.ORG (2024) had no records included. Thus a more detailed examination based on extensive field work and with special respect for diploid species seems logical. While a modern critical Flora of Croatia is still lacking, the Flora Croatica Database (NIKOLIĆ 2015) was a helpful tool for investigations and field research.

2 MATERIAL AND METHODS

Samples collected in Croatia during nine excursions (of several days' duration each) starting in 2015 were studied. Altogether, 69 populations of the *Ranunculus auricomus* complex were collected in the northern and western parts of Croatia.

Additionally, specimens from the following herbaria could be examined: Ljubljana (LJU), Munich (M), Wien (W), Zagreb (ZA and ZAHO), and the private herbarium of F.G. Dunkel (Du). Official herbarium acronyms here and elsewhere follow THIERS (2024).

In the text, the following abbreviations are used: Hb. = herbarium, vs. = versus, n = north, s = south, no = northeast etc.

To stay consistent with previous treatments of the group the most important characters for each species have been compiled in a data sheet (Figs. 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 30, 32, 34, 36 & 38). A standard sheet includes: the basal leaf sequence from the initial leaves (normally no. 1 and 2), the spring leaves evolving during flower period (no. 3–5), and the final leaves developing during period of fructification (no 6–7). The cycle is illustrated in vertical rows, from top to bottom. The small Arabic letters next to each basal leaf term the individuum of a population. Furthermore, the lowermost cauline or stem leaf with its specific number and form of segments is characteristic. Values of the largest segment are indicated in the description. In all diploid (and sexual) species, the flowers consist of five (rarely 6–7) well developed petals. Finally, the form and hairiness of the receptacle is illustrated at the bottom of the right column of the data sheet.

Since the characters have been explained several times (HÖRANDL & GUTERMANN 1998a, DUNKEL 2005, 2010, 2014), a description can be omitted. In the following text, it is necessary to be familiar with the special terminology and definitions used in the complex (cataphyll; length of basal leaf; main, first, second, third etc. lateral incision; degree of incision: lobed, cleft, divided, dissected, receptacle, carpellophore). Note that only the definition of the length of a basal leaf has changed recently. It is now defined as the complete length, not only from the basic point to the tip (see Fig. 1 in DUNKEL 2024: 22).

Pollen quality has been determined by carmine acetic staining according to HÖRANDL & al. (1997). About two hundred pollen grains per specimen were investigated.

All holotype specimens are deposited in ZA; isotypes and further specimens are found in public herbaria as well as in the private herbarium of F.G. Dunkel (Du; collection number and herbarium number are identical). All specimens illustrated are of Croatian origin (Figs. 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 29, 31, 33, 35, 37 & 39).

The geographical reference was given by coordinates and defined grid fields in the form of quadrants of topographic maps. A quadrant encompasses a latitude of 3' and a longitude of 5' and refers to the number of the official topographic maps of Germany with extrapolation to adjacent countries. This reference system is widely used in Central Europe for floristic purposes (e.g. JOGAN 2001).

Fresh leaves from available cultivated plants were used for flow cytometric ploidy estimation using the standard two-step

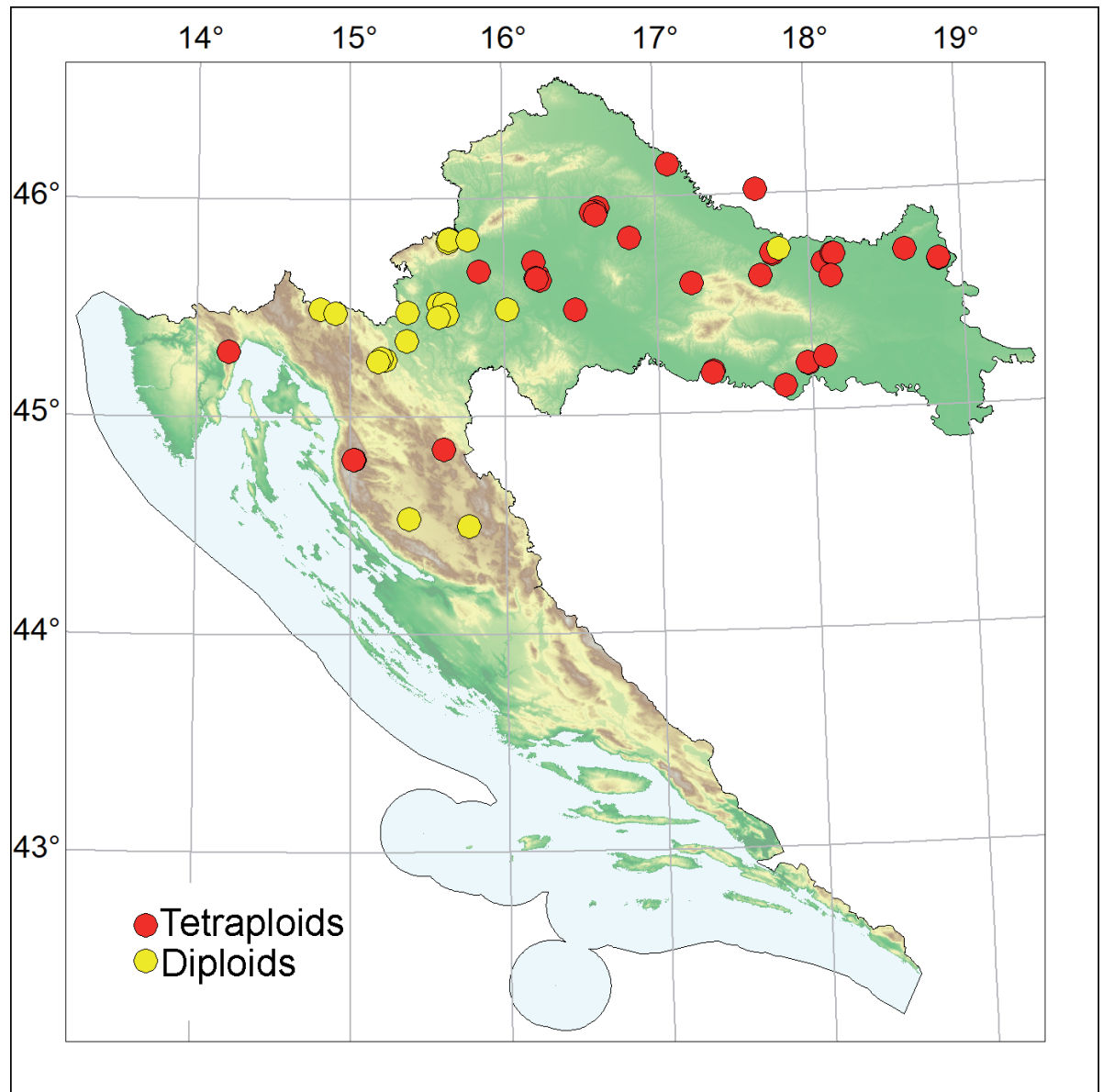


Fig. 1 – Distribution map of the collection sites of the *Ranunculus auricomus* complex. Tetraploid and diploid populations were indicated separately.)

Otto protocol (OTTO 1990; DOLEŽEL & al. 2007) and *Pisum sativum* L. cv. Ctirad (DOLEŽEL & al. 1998) as the internal standard (PAULE & al. 2018). Flow cytometric ploidy estimations (DNA-ploidy; SUDA & al. 2006) were calibrated using a chromosome count of an individual Du-30442.

3 RESULTS

In the northern and western parts of Croatia, the author could find rich populations and an unexpected number of species: altogether 24 ones, eighteen new to science. The species number is almost comparable to the recent findings for Slovenia and for the much larger Italy, with 25 and 28 taxa, respectively (DUNKEL 2010, 2011, 2019, CONTI & BARTOLUCCI 2017).

The southern edge of the distribution areas was reached at the Lika region, north to Obravac. From Zadar to Dubrovnik *Ranunculus auricomus* is lacking (Fig. 1). One species, *R. velebiticus* sp. nov., settles at the subalpine level around 1400 m. Both populations, collected in the 19th century and mentioned by DEGEN (1937) still exist. Another indication at subalpine level at the Snježnik (Krainer Schneeberg) by HORVATH (1930) proved to be wrong; he took *R. hybridus* BIRIA for *R. cassubicus* L. Some results concerning diploid sexual taxa have been previously published (DUNKEL & al. 2018).

In 26 of the collected 69 populations, the DNA content could be determined at the Senckenberg Research Institute, Frankfurt, by T. Gregor and J. Paule. Due to the results of the DNA content per cell, in twelve of these 26 a diploid chromosome set can be

assumed (see Tab. 1). Six of 24 species contain a DNA content arguing for diploidy, i.e. 25% of the species are diploid. Some populations assigned to a diploid species have not been analysed, but assuming homogeneity of ploidy level within a species 23 of the 69 populations represent diploids. This means a third or, in number, 33.3% of all populations are diploid. Keeping in mind, that almost all countries of Western and Central Europe harbour only one or two diploid taxa with few occurrences, this result signifies the highest portion of diploid populations in a single country.

4 DISCUSSION

The morphotypes here treated as species may represent dominant apomictic clones. In situ, they are stable and traceable for decades. For instance, the Austrian *R. sarntheinianus* DUNKEL had been collected in 1884 and is still present (DUNKEL 2020). Regarding the treated geographic area of the article, *R. velebiticus* sp. nov. was collected as *R. fallax* by L. Rossi already in 1896, is still growing at that locality in a subalpine meadow and is described and named here.

Of course, at the edge of distribution, e.g. here at the southeastern one, genetic exchange is less probable and stable populations exist. BRADICAN (2023, 2024) demonstrated that with a tiny exception all Spanish populations and almost all circumarctic populations of the *R. auricomus* complex are obligate apomicts. This is in accordance with our findings of morphologically stable and discriminable populations in Croatia.

In Central Europe, in the distribution centre of the complex, different ecological preferences may be characteristic of certain species: taxa of humid meadows are almost never found in forest alliances and vice versa. In Southern Europe during the Mediterranean summer, dryness puts high stress on populations. Characteristically, at colline or montane level they grow in shady forest alliances and only at higher altitude in sun exposed meadows. In Croatia, *R. mutilicensis* represents the only species in a humid meadow at rather low level (690 m). This strongly indicates that ecological niche as obviously less suitable for differentiation of the group in Southeastern Europe.

Hybridization and polyploidization is a common phenomenon in the evolution of plants and also in apomictic taxa. Regarding the evolutionary origin of apomictic taxa it is important to know if they arose from interspecific crosses (through allopolyploidization) and thus combine the genomes of two or more species, or if they originated via autopolyploidization. With the exception of a tetraploid population of *R. cassubicifolius* in Austria, all investigated populations are of allopolyploid origin (HÖRANDL & GREILHUBER 2002). This favours description of the morphotypes as species (MAJESKÝ & al. 2017).

The treatment of taxa as nothospecies in the *R. auricomus* complex as suggested by KARBSTEIN & al. in 2020 is debatable for the following reasons:

- hybridization has been evaluated as one mechanism of speciation, it is by no means the only one.
- hybridization events, i.e. combination of genomes of at least two species, could not be confirmed for all taxa of

the complex, e.g. *R. baldensis* (DUNKEL 2010, BRADICAN 2023).

- following hybridization important mechanisms of “post-origin evolution” and possible epigenetic changes exist (KARBSTEIN & al. 2022, HÖRANDL 2022).
- almost all species at the edge of the distribution range are obligate apomicts (BRADICAN 2023, 2024).
- in situ hybrid swarms of different morphotypes never exist, they “behave” as species. For Croatia, co-occurrence of two or more species at one site was found in less than 5% of the cases.

Other taxonomically complex groups with similar genetic background (allopolyploidy), e.g. genus *Rubus* and *Hieracium*, are much better examined (morphologically) for historical reasons and almost always gained the interests of field botanists. Regarding the brambles of the Higher Middle Mountains (Middle Rhine Highlands, Black Forest, Vosges, Bavarian Forest, Sudetes) and Alps, still in 1995 H.E. Weber stated that most of the populations produce populations consisting of innumerable and undeterminable heteromorphic individuals (WEBER 1995: 294). Meanwhile, intensive research demonstrated that by all means reproducible species occur at these regions (HASSLER 2023). Independently from the genetic background, they are all treated at a species level in modern floras (GOTTSCHLICH 2020, HASSLER 2023, TISON & FOUCAULT 2014). Consequently, in the *Ranunculus auricomus* complex, taxa here are treated as species, too, and definition of characters and depiction still follow HÖRANDL & GUTERMANN (1998a) and DUNKEL (2005). The high percentage of diploid populations in the *Ranunculus auricomus* complex of Croatia is worth mentioning (Fig. 1). HÖRANDL and coauthors (2000, 2004) postulated *Ranunculus notabilis* to be a progenitor species of the complex. Our data argue for a centre of evolutionary origin rather in the southeastern parts of Europe than in Styria with very scattered occurrences of *R. notabilis*. This needs to be investigated by further genetic studies.

5 PROSPECT OF THE SPECIES

Much information on the genus *Ranunculus* has been recently gained (PAUN & al. 2005, HÖRANDL & al., 2005, 2009, EMADZADE & al. 2010, HODAC & al. 2014, HOJSGAARD & HÖRANDL 2019, BRADICAN & al. 2023); however, little is known about phylogenetic relationships and the evolution of the microspecies of the *Ranunculus auricomus* complex.

Although a uniform procedure for all apomictic complexes is desirable, the *Ranunculus auricomus* complex is still classified by means of informal groups (BORCHERS-KOLB 1983, 1985; HÖRANDL & GUTERMANN 1998a, DUNKEL 2014). They are still speculative, based on morphology only and rather represent mnemonic help than monophyletic lineages. Some diploid species of Slovenia and Croatia, e.g. *R. austroslovenicus* and *R. perarcris* DUNKEL packed in one lineage by Karbstein & al. (2022) and Hörandl (2022), are morphologically different to such extent that they could not be readily placed in one common group. On the other hand, *R. dobranus* sp. nov. is similar to *R. austroslove-*

nicus and probably a descendant of it. Hence, it should be placed into the same group.

In the present work, species are ordered in the traditional way: groups with undivided basal leaves first, with more divided ones later and at the end. Within the groups the species are placed alphabetically.

5.1 *Ranunculus cassubicus* collective group

5.1.1 *Ranunculus cassubifolius*

5.2 *Ranunculus auricomus* collective group

5.2.a *Ranunculus bififormis* group

5.2.1 *Ranunculus baranjanus*

5.2.2 *Ranunculus marinianaënsis*

5.2.3 *Ranunculus rondocroaticus*

5.2.b *Ranunculus subatriticus* group

5.2.4 *Ranunculus istriacoides*

5.2.5 *Ranunculus istriacus*

5.2.c *Ranunculus marsicus* group

5.2.6 *Ranunculus mutilicensis*

5.2.d *Ranunculus notabilis* group

5.2.7 *Ranunculus austroslovenicus*

5.2.8 *Ranunculus calapius*

5.2.9 *Ranunculus dobranus*

5.2.10 *Ranunculus subcarniolicus*

5.2.e *Ranunculus croaticola* group

5.2.11 *Ranunculus croaticola*

5.2.12 *Ranunculus dravus*

5.2.13 *Ranunculus slavoianus*

5.2.14 *Ranunculus slavopontinus*

5.2.15 *Ranunculus posavinanus*

5.2.16 *Ranunculus turopoljensis*

5.2.f *Ranunculus puberulus* group

5.2.17 *Ranunculus gradiscanus*

5.2.18 *Ranunculus poldinioides*

5.2.g *Ranunculus stricticaulis* group

5.2.19 *Ranunculus plitvicensis*

5.2.h *Ranunculus argoviensis* group

5.2.20 *Ranunculus divisor*

5.2.i *Ranunculus schlosseri* group

5.2.21 *Ranunculus schlosseri*

5.2.22 *Ranunculus velebiticus*

5.2.j *Ranunculus indecorus* group

5.2.23 *Ranunculus albimonasterius*

5.1.1 *Ranunculus cassubicifolius* W.KOCH, Ber. Schweizer Bot. Gesellschaft 49: 553, 1939.

Lectotype (designated by DUNKEL in Webbia 65: 183): Switzerland, Kt. Solothurn, „Wald östlich Erlenmoos SE Rechterswil längs eines Baches am Waldrand, ca. 465 m, 03 May 1938, W. Koch 38/56, ZT. – Fig. 2, Tab. 1 in DUNKEL (2010).

Pollen quality — 99% well developed (Torlano, close to Robić, Du-15980; DUNKEL 2010).

DNA-Ploidy — 2x (Breganica Valley, Du-34897; PAULE & al. 2018, DUNKEL 2019).

Chromosome number — $2n = 16$ (HÄFLINGER 1943).

Distribution — Swiss Jura, northern prealps and foreland of Germany and Austria, Carnic Alps of Italy, and adjacent Slovenia, Kamnik-Savinja Alps, Slovenian Prealps, eastwards reaching Hungary and Croatia near to the Slovenian-Croatian border at Kumrovec and close to Samobor.

Ecology — along brooks and streams in alder and floodplain forests at colline to mountainous level, 190–300 m.

Etymology — large undivided basal leaves remind to *R. cassubicus* L.

Vulnerability — the populations of *R. cassubicifolius* are at the outmost southeastern edge of the distribution area. In the past few decades, there were only three known populations (PAVLETIĆ 1994). Solely the population at Breganica Valley could be confirmed. In 1993, Z. Pavletić visited the population at the foot of Somoborsko Gorje and stated that the locality along the stream Gradna “has been seemingly destroyed by construction activities in this presently suburban part of Samobor” (PAVLETIĆ 1994).

Several attempts failed to find *R. cassubicifolius* at the black alder forest “on the left side of the road a few kilometers before Kumrovec, when coming from the direction of Tuheljske Toplice” (PAVLETIĆ 1994). *R. cassubicifolius* has to be regarded as “highly vulnerable” in Croatia.

Taxonomy — the populations in the surroundings of Zagreb at the foot of Žumberačko and Samoborsko Gorje definitely belong to *R. cassubicifolius*. Whereas undivided basal leaves are representative for the whole *R. cassubicus* group, large flowers with up to seven petals (Fig. 1) and the irregular cauline leaf segments are evidence of *R. cassubicifolius*. Beyond that, by flow cytometry the diploid chromosome number was confirmed for the population of Breganica Valley. *R. cassubicifolius* occurs scatteredly in adjacent Slovenia (DUNKEL 2019). Its finding in Croatia is not a real surprise.

Specimens seen — Croatia, Zagreb County, **10159.4**: Samoborsko gorje, potok Breganica, WL 47, 225 m, 45°48'04"N 15°38'09"E, šuma uz potok, 24 Apr 2003, M. Vrbek & S. Bezjak, ZA; Bregana, Breganica Valley 1,08 km ssw s.u. Grdanjci, direkt am Bach, dicht bewachsenes Steilufer uner Laubbäumen, 202 m, 45°48'56"N 15°38'34,9"E, 09 Apr 2017, F.G. Dunkel, Du-34897; ibidem, Breganica Valley 1,72 km ssw Grdanjci, 45°48'35"N 15°38'39"E, 226 m, Uferbereich, Bachauenwald, Erlenbruch, 09 Apr 2017, F.G. Dunkel, Du-34899; **10260.1**: Samoborsko gorje, uz potok Gradna, leg. 24 Apr 1971, I. Šugar, det. I. Trinastić, ZA(2 specimens); **10062.3**: [Zagreb, Maksimir.] in silvis ad Jurja Ves prope Zagrabiā, leg. J.C. Schlosser, ZA-98 (2 specimens).

Literature — Croatia, Zagreb County, **09960.1**: Kumrovec, in Hrvatsko Zagorje, in a humid black alder forest on the left side of the road a few kilometers before Kumrovec, when coming from the direction of Tuheljske Toplice humid forest soil, leg. J. Trinastić, 1968, Hb. J. Trinastić; **10259.2**: Breganica valley at the foot of Žumberačko Gorje (PAVLETIĆ 1994).



Fig. 2 – Specimen of *Ranunculus cassubicifolius* (Du-34897-1).

5.2 *Ranunculus auricomus* collective group

5.2.a *Ranunculus bififormis* group (Fig. 40)

5.2.1 *Ranunculus baranjanus* DUNKEL sp. nov.

Holotype: Croatia, Slavonia, Osijek-Baranja County, 10379.1, Tikveš, 250 m so Schloss Tikveš, Eichen-Hainbuchen-Wald [oak hornbeam forest], 87 m, 45°40'12"N 18°50'50"E, 12 Apr 2019, F.G. Dunkel 36633 & S. Ozimec, ZA; isotypes GOET, Du-36633. – Figs. 3, 4 & 40, Tab. 1.

Description — *Flowering shoot* gracile to slim, 16–40 cm tall, scape 1.2–2.5 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to patent (15–65°), flowers 1–3(4), enrichment shoots 0–1; basal leaves 2–5 per rosette.

Basal leaf cycle: closed to narrow-angled at base (0–50(60)°), leaf edge irregularly and coarsely crenate to crenate-serrate, at the leaf cycle crenated teeth increasingly acute.

First basal leaf 15–30 mm long, undivided.

Second basal leaf 20–35 mm long, undivided, or lobed to cleft by the main incision (26–55%); middle lobe if present trapezoid to broadly deltoid with 3–5 teeth, lateral edge straight; lateral segment undivided.

Third basal leaf 30–40 mm long, lobed to cleft by main incision (30–65%); middle lobe (trapezoid,) broadly deltoid to spatulate, with 3–5 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Fourth basal leaf 40–55 mm long, divided by main incision (90–98%); middle lobe asymmetrically deltoid, with 3–7 teeth, lateral edge straight to slightly concave; lateral segment divided by first lateral incision (66–85%), cleft to divided by second lateral incision (60–70%), cleft by third lateral incision (35–55%), lobed to cleft by fourth lateral incision (27–40%), fifth lateral incision absent or up to 40%.

Fifth basal leaf 45–55 mm long, divided by main incision (75–90%); middle lobe irregularly and asymmetrically deltoid with 3–5 teeth, lateral edge slightly convex to slightly concave; lateral segment cleft to divided by first lateral incision (60–70%), second and third lateral incision absent or up to 60%, and 45%, respectively, fourth lateral incision normally absent, occasionally up to 30%.

Sixth basal leaf 35–55 mm long, divided by main incision (70–90%); middle lobe deltoid, with 3–7 teeth, lateral edge slightly convex to straight; lateral segment undivided or lobed to cleft by first lateral incision (26–50%).

Seventh basal leaf 40–50 mm long, undivided or cleft to divided by main incision (55–75%); middle lobe if present deltoid with 5–7 teeth, lateral edge straight; lateral segment undivided.

Lowermost stem leaf divided into 5–7 segments, largest segment 30–60 mm long, 3–7(9) mm wide, oblanceolate, undivided or with 1–2 teeth.

Petals 0–2(4), 8–11 mm long, 7–9 mm wide; *androclinium* 0.5–0.7 mm long; *receptacle* globose to ellipsoid, 2.0–2.8 mm long, 1.3–2.0 mm wide, glabrous, intervallum absent, carpellophores 0.2–0.4 mm long; *fruits* 1.5–2.2 mm long, beak 0.3–0.8 mm long, straight to uncinat.

Pollen quality — good; 70.50% well developed (Tikveš, holotype).

DNA-ploidy — 4x (Tikveš, Du-36632, Du-36633).

Distribution — known from the Croatia part of Baranja, the northeastern part of Slavonia, north of Osijek and around Donji Miholjac.

Ecology — humid hornbeam forests.

Etymology — refers to the occurrence in the Croatian part of Baranja.

Vulnerability — endangered due to small populations and possible change of forest management. Even at the type population, there are only few plants, scattered in the vast hornbeam forests around Tikveš.

Taxonomy — *R. baranjanus* presents with undivided or almost undivided initial and final leaves. All apertures at the base of the basal leaves are narrowly angled or even closed. The leaf edge is irregularly and coarsely crenate or crenate-dentate with a relatively sparse number of broad teeth. *R. baranjanus* may represent a group of similar species from Eastern Croatia including *R. marinianaënsis* and *R. rondocroaticus*. *R. baranjanus* itself is characterised by orbicular spring leaves with radial incisions and an almost globose receptacle.

Specimens seen — Croatia, Slavonia, Osijek-Baranja County, **10379.1:** Tikveš, am Zufahrtsweg zum Schloss Tikveš, 84 m, 45°40'18"N 18°50'45"E, Waldrand, Eichen-Hainbuchen-Wald, 12 Apr 2019, F.G. Dunkel & S. Ozimec, Du-36632; ibidem, cultivated, 20 Apr 2020, Du-37428; Tikveš, 250 m so Schloss Tikveš, 87 m, 45°40'12"N 18°50'50"E, Eichen-Hainbuchen-Wald, 12 Apr 2019, F.G. Dunkel & S. Ozimec, Du-36633 (isotypes); ibidem, cultivated, 26 Apr 2021, F.G. Dunkel, Du-38295; **10374.2:** Donji Miholjac, so Kapelna, nw Kučanci, an der Straße 4031, kurz nach 90°-Kurve und Eintritt in den Laubwald, 100 m, 45°40'29"N 18°05'31"E, feuchter Straßengraben im Hainbuchen-Wald, 28 Apr 2023, F.G. Dunkel, Du-41672 p.p. Probably representing this species:

10274.4: Donji Miholjac, 2,5 km wsw Rakitovica, O-Hälfte des Laubwaldgebietes, 100 m, 45°42'43"N 18°08'59"E, Hainbuchenwald, 28 Apr 2023, F.G. Dunkel, Du-41675.

5.2.2 *Ranunculus marinianaënsis* DUNKEL sp. nov.

Holotype: Croatia, Slawonien, 10274.4, Donji Miholjac, 2,3 km wsw Rakitovica, am O-Rand des Laubwaldgebietes, Hainbuchenwald [eastern edge of the deciduous forest region, hornbeam forest], 100 m, 45°42'39"N 18°09'40"E, 15 Apr 2022, F.G. Dunkel 40552, ZA; Isotypes GOET, M, Du-40552. – Figs. 5, 6 & 40, Tab. 1.

Description — *Flowering shoot* (slim to) robust, 28–48 cm tall, scape 2.4–4.0 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to patent (15–55°), flowers 3–10, enrichment shoots 0–2; basal leaves 1–5(6) per rosette.

Basal leaf cycle: leaf edge of the first two basal leaves crenate, of the following leaves irregularly crenate-serrate, at the leaf cycle crenated teeth increasingly acute.

First basal leaf 25–45 mm long, V-formed at base (80–

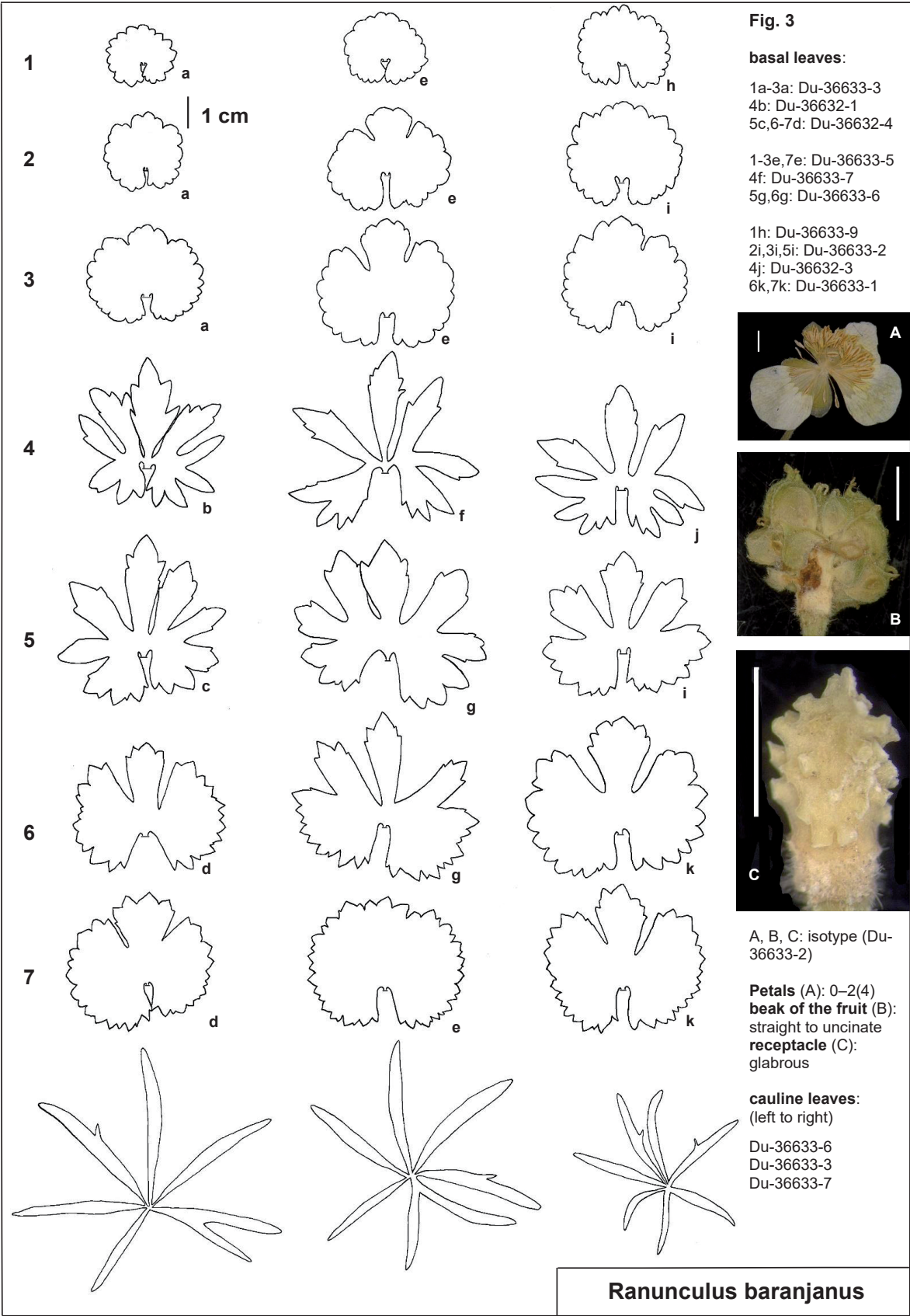




Fig. 4 – Holotype of *Ranunculus baranjanus* (ZA).

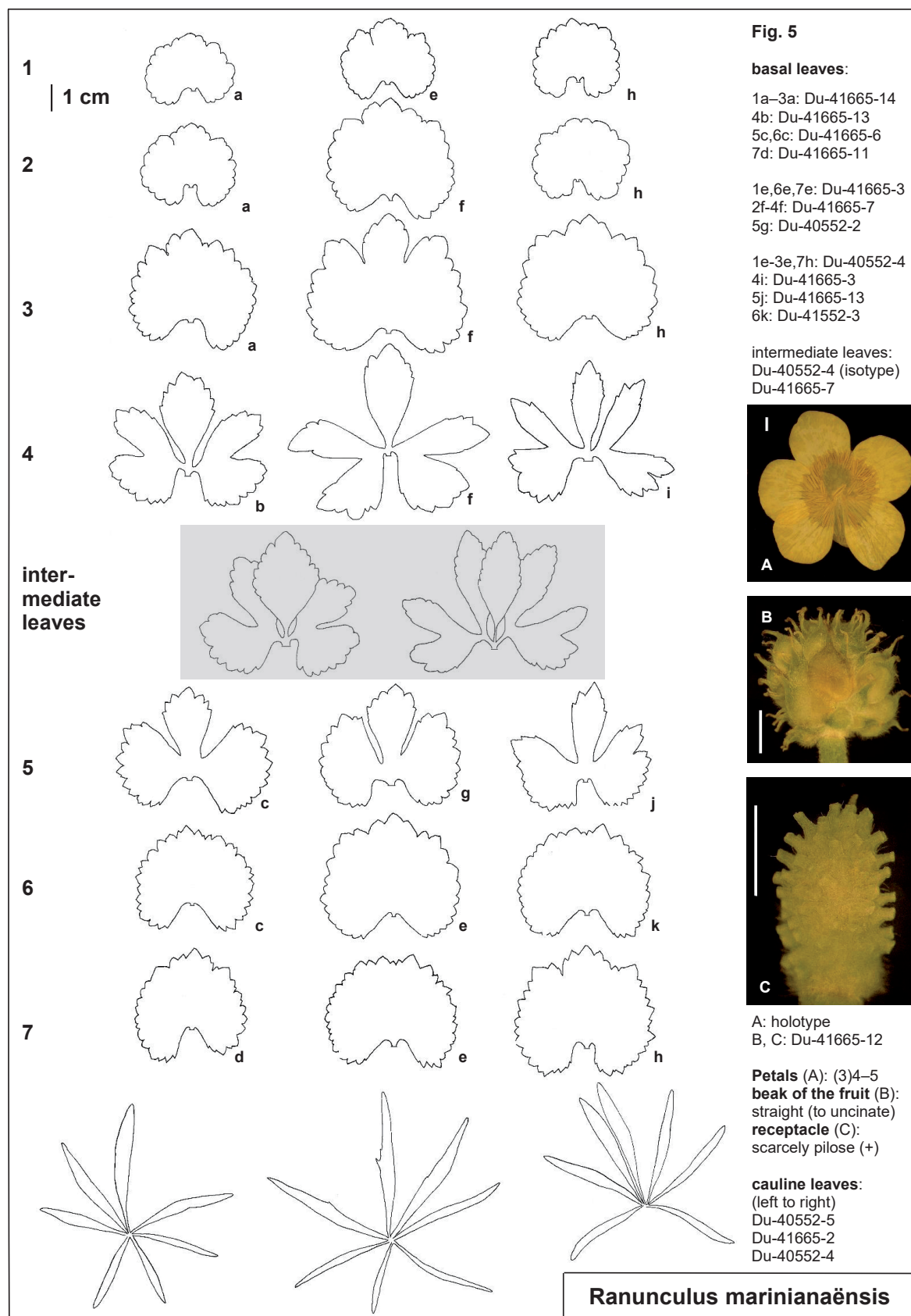


Fig. 5 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus marinianaënsis*. The white bars in the figures of detail equal 2 mm.



Fig. 6 – Holotype of *Ranunculus marinianaënsis* (ZA).

100°), undivided or cleft by the main incision (30–45%); middle lobe if present, broadly deltoid with 3–5 crenated teeth, lateral edge slightly convex to straight; lateral segment undivided.

Second basal leaf 30–55 mm long, narrow-angled to V-formed at base (30–100°), undivided or lobed by the main incision (up to 30%); middle lobe if present broadly deltoid with (3–)5 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Third basal leaf 45–60 mm long, narrow-angled to V-formed at the base (60–100°), lobed to cleft by main incision (26–50%); middle lobe trapezoid, broadly deltoid (to spatulate), with 3–7 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Fourth basal leaf 55–75 mm long, narrow-angled at the base (20–80°), divided by main incision (92–98%); middle lobe deltoid to spatulate, with 5–11 teeth, lateral edge slightly concave to slightly convex; lateral segment cleft to divided by first lateral incision (50–80%), second lateral incision absent or up to 30%.

Fifth basal leaf 45–60 mm long, narrowly formed to V-formed at the base (40–90°), divided by main incision (75–90%); middle lobe deltoid with 5–7 teeth, lateral edge slightly concave to slightly convex; lateral segment usually undivided, occasionally lobed to cleft by first lateral incision (26–40%).

Sixth basal leaf 40–55 mm long, narrowly angled to V-formed at the base (70–90°), undivided.

Seventh basal leaf 40–55 mm long, narrowly angled to V-formed at the base (40–90°), undivided or rarely lobed by main incision (26–32%); middle lobe usually absent, if present broadly deltoid with 5 teeth, lateral edge slightly concave; lateral segment undivided.

Intermediate leaves 55–65 mm long, narrowly to widely angled at the base (60–110°), dissected by main incision; middle lobe stalked up to 6 mm, deltoid to rhomboid with 11–15 rounded teeth, lateral edge slightly concave to slightly convex; lateral segment cleft to divided by first lateral incision (60–80%), second lateral incision absent or up to 35%.

Lowermost stem leaf divided into (6–)7(–9) segments, largest segment 40–85 mm long, 3–8 mm wide, narrowly lanceolate, usually undivided, rarely with 1–2 teeth.

Petals (3)4–5, 9–13 mm long, 8–12(13) mm wide; *androclinium* 0.3–0.5 mm; *receptacle* ellipsoid, 3.2–4.0 mm long, 1.8–2.4 mm wide, scarcely pilose, intervallum absent, carpellophores 0.2–0.4 mm long; *fruits* 1.8–2.7 mm long, beak 0.6–1.2 mm long, straight (to uncinat).

Pollen quality — bad; 18.2% well developed (Rakitovica, isotype Du-40552-1).

DNA-ploidy — 4x (Rakitovica, isotype Du-40552).

Distribution — known from the type locality and three further sites south of Donji Miholjac.

Ecology — rather humid hornbeam forests, ditches.

Etymology — refers to Donji Miholjac, which was called Mariniana during the time of Ancient Rome.

Vulnerability — potentially endangered due to rarity.

Taxonomy — despite usually complete flowers with (3)4–5 petals, an extremely bad pollen quality and the DNA content argue for a tetraploid, in general apomictic taxon. *R. mariniana* en-

sis is similar to *R. rondocroaticus* but differ by a basal leaf cycle with 2–5 completely undivided leaves. Another striking feature of *R. mariniana* ensis are mostly straight beaks of the achenes. Only well-developed lush plants with more than one enrichment shoot present intermediate leaves with stalked rhomboidal middle lobes. To present knowledge, the taxon is restricted to the most eastern parts of Slavonia around Donji Miholjac.

Specimens seen — Croatia, Slawonien, Osijek-Baranja County, **10274.4**: Donji Miholjac, 2,3 km wsw Rakitovica, am O-Rand des Laubwaldgebietes, Hainbuchenwald [eastern edge of the deciduous forest region, hornbeam forest], 100 m, 45°42'39"N 18°09'40"E, 15 Apr 2022, F.G. Dunkel, Du-40552 (isotypes); ibidem, Donji Miholjac, 2,5 km wsw Rakitovica, O-Hälfte des Laubwaldgebietes, 100 m, 45°42'43"N 18°08'59"E, Hainbuchenwald, 28 Apr 2023, F.G. Dunkel, Du-41665; ibidem: **10374.2**: Donji Miholjac, so Kapelna, nw Kučanci, an der Straße 4031, kurz nach 90°-Kurve und Eintritt in den Laubwald, 100 m, 45°40'29"N 18°05'31"E, feuchter Straßengraben im Hainbuchen-Wald, 28 Apr 2023, F.G. Dunkel, Du-41674; ibidem: **10374.4**: Donji Miholjac, w der D 53, s Malinovac, 100 m, 45°36'41"N 18°08'20"E, Auwald und Erlenbruch, 28 Apr 2023, F.G. Dunkel, Du-41676.

5.2.3 *Ranunculus rondocroaticus* DUNKEL sp. nov.

Holotype: Croatia, Brod-Posavinan county, **10872.4**, Bebrina, zwischen [between] Bebrina und Stupnički Kuti, w der Straße 4205, 88 m, 45°06'54"N 17°49'09"E, Graben, Waldrand, feuchter Hainbuchenwald [ditch, forest edge, humid hornbeam forest], 27 Apr 2022, F.G. Dunkel 40467, ZA; isotypes GOET, M, Du-40467. – Figs. 7, 8 & 40.

Description — *Flowering shoot* slim to robust, 25–55 cm, stalk 1.0–3.2 mm in diameter, reddish at the base, suberect to patent, angle between the main and secondary axis 15–60°, flowers 2–13, enrichment shoots 0–1; basal leaves 1–3(4) per rosette.

Basal leaf cycle: The leaf edge presents irregularly crenated in the first two to three, irregularly crenate-serrate in the (third) fourth to seventh basal leaves.

First basal leaf 25–35 mm long, blade at the base narrow-angled to V-formed (50–100°), undivided or occasionally lobed to cleft by the main incision (26–45%), middle segment if present trapezoid to deltoid with 3–5 teeth, lateral edge straight to slightly convex; lateral segment undivided.

Second basal leaf 33–55 mm long, base narrow-angled to V-formed (66–100°), cleft to divided by the main incision (50–80%), middle lobe deltoid to spatulate with 5(–7) teeth, lateral edge straight to slightly concave; lateral segment undivided.

Third basal leaf 35–50 mm long, base narrow-angled to V-formed (50–100°), divided by the main incision (75–85%), middle lobe deltoid with 5 teeth, lateral edge slightly concave to straight; lateral segment undivided or lobed to cleft by the first lateral incision (26–65%).

Fourth basal leaf 40–65 mm long, aperture at the base closed to narrow-angled (5–50°), divided by the main incision (90–98%), main incision conspicuously widely angled (50–75°), middle lobe narrowly deltoid to deltoid with 3–7 teeth, lateral edge straight; lateral segment cleft to divided by the first lateral

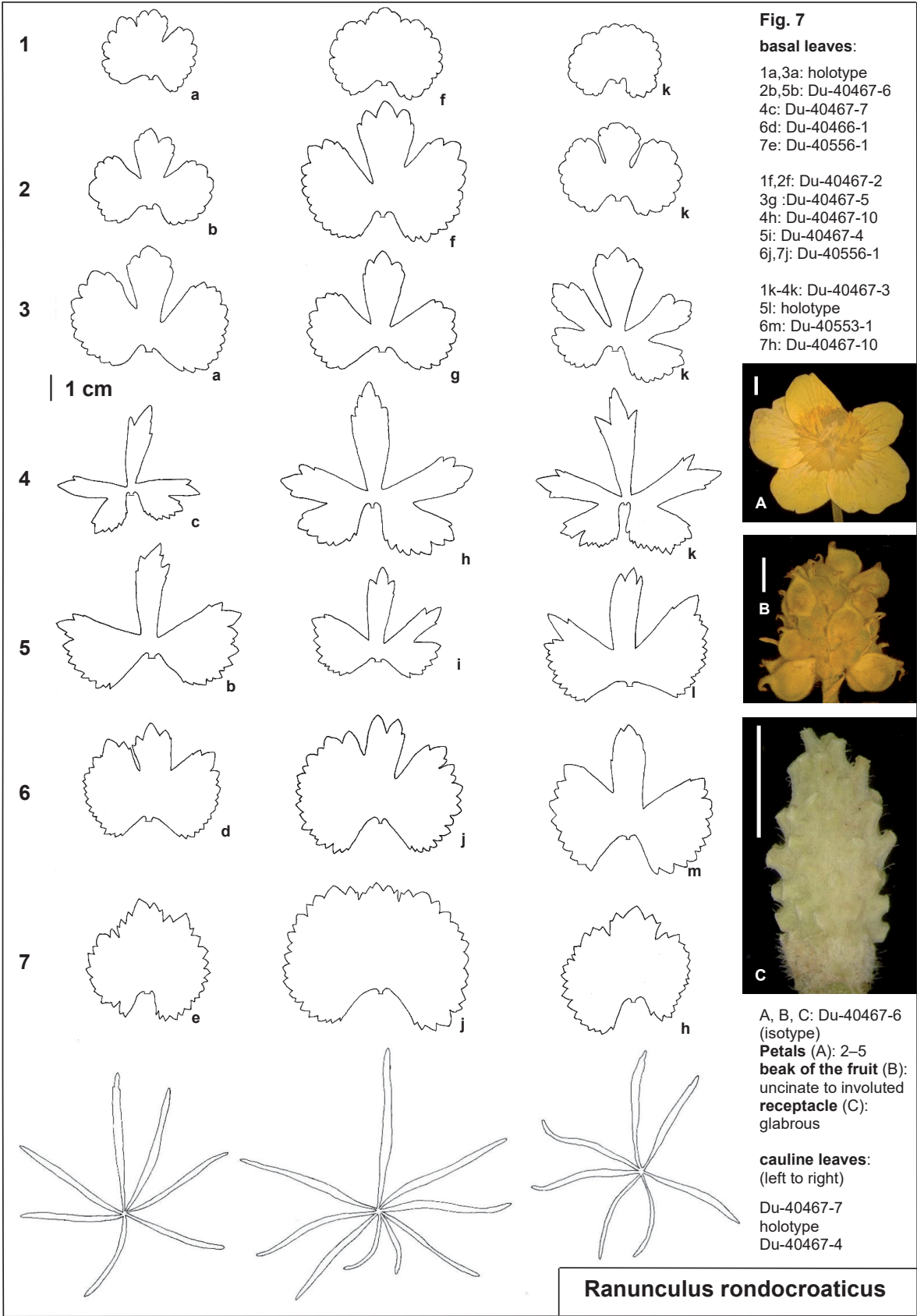


Fig. 7 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus rondocroaticus*. The white bars in the figures of detail equal 2 mm.



Fig. 8 – Holotype of *Ranunculus rondocroaticus* (ZA).

incision (40–75%), second lateral incision absent or up to 33%.

Fifth basal leaf 38–50 mm long, base V-formed to wide-angled (80–130°), divided by the main incision (80–90%), middle lobe narrowly deltoid to deltoid with 3–7 teeth, lateral edge straight; lateral segment undivided or occasionally lobed to cleft by the first lateral incision (26–55%).

Sixth basal leaf 35–55 mm long, base narrow-angled to V-formed (60–100°), cleft to divided by the main incision (50–80%), (narrowly deltoid to) deltoid with 3–5 teeth, lateral edge straight; lateral segment undivided.

Seventh basal leaf 30–65 mm long, undivided or lobed to cleft by the main incision (26–45%), middle lobe if present trapezoid or broadly deltoid with 5 teeth, lateral edge straight; lateral segment undivided.

Lowermost stem leaf divided into 7–9 segments, largest segment 40–80 mm long, linear, 2–5 mm wide, undivided or – in the largest plants – occasionally with two tiny steps.

Petals 2–5, 8–10 mm long, 7–9 mm wide; *androclinium* 0.6–0.8 mm long; *receptacle* ellipsoid, 3.0–4.0 mm long, 2.0–2.7 mm wide, sparsely pilose, intervallum absent, carpellophores 0.2–0.4 mm long; *fruits* 2.4–3.2 mm long, beak 0.5–0.8 mm long, uncinat to involuted.

Pollen quality — mediocre; 40.1% well developed (Bebri-na, holotype).

DNA-ploidy — not known.

Distribution — known from Slavonia around Slavonski Brod and further north near Donji Miholjac.

Ecology — humid hornbeam forests, forest edges, and ditches.

Etymology — refers to the rounded form of the basal leaves with partly semicircular lateral lobes and its occurrence in Croatia.

Vulnerability — endangered due to small populations and possibility of change in the forest management.

Taxonomy — *R. rondocroaticus* presents with undivided or almost undivided rounded basal leaves at the beginning and at the end of the basal leaf cycle. It belongs to the *R. baranjanus* group but differs from *R. baranjanus* by lack of circular incisions at the spring leaves and from *R. marinianaënsis* by one or two vs. 3–5 undivided leaves.

Specimens seen — Croatia, Osijek-Baranja County, **10274.4**: Donji Miholjac, 2.3 km wsw Rakitovica, am O-Rand des Laubwaldgebietes, 100 m, 45°42'39"N 18°09'40"E, Hainbuchenwald, 15 Apr 2022, F.G. Dunkel, Du-40553; **10374.4**: Donji Miholjac, w der D 53, s Malinovac, 100 m, 45°36'41"N 18°08'20"E, Auwald und Erlenbruch, 28 Apr 2023, F.G. Dunkel, Du-41732; Brod-Posavina county, **10773.4**: Glogovica, Dilj Gora, 2.5 km no NO-Ende Jezera Petnja, breite Wegschneise, 208 m, 45°12'47"N 17°58'17"E, nitrophiler Waldsaum, wenige Pflanzen, 29 Apr 2023, F.G. Dunkel, Du-41733; ibidem, Dilj Gora, 2.5 km no NO-Ende Jezera Petnja, breite Wegschneise, an der Abzweigung eines Weges zum Berg, 1 Pflanze, 215 m, 45°12'54"N 17°58'08"E, Gebüschrand, 1 Pflanze, 29 Apr 2023, F.G. Dunkel, Du-41734; **10872.4**: Bebrina, zwischen Bebrina und Stupnički Kutí, w der Straße 4205, Graben, Waldrand, feuchter Hainbuchenwald, 88 m, 45°06'54"N 17°49'09"E, 27 Apr 2022, F.G. Dunkel-40465 (isotypes); Stupnički Kutí, an

Forstraße 200 m w der Straße Stupnički Kutí → Bebrina (4205), n des Schotterweges, 90 m, 45°06'55"N 17°49'06"E, Hainbuchen-Wald, 27 Apr 2022, F.G. Dunkel, Du-40556.

5.2.b *Ranunculus subatricus* group

5.2.4 *R. istriacoides* DUNKEL sp. nov.

Holotype: Croatia, Velebit, Lika-Senj County, 1155.2, Krasno Polje, Jezera, Grund der Doline, 2.7 km sw Krasno, W-Hang des Pljišivica, subalpine Wiesen [bottom of doline, western slope of Pljišivica, subalpine meadows], 1390 m, 44°48'08"N 15°01'14"E, 07 Jun 2020, F.G. Dunkel 38764, ZA; isotypes Du-38764. – Figs. 9 & 10, Tab. 1.

Description — *Flowering shoot* gracile to slim, 15–30 cm, cataphylls 0–1, stalk 0.7–2.0 mm in diameter, reddish at the base, terete, suberect to moderately divergent, angle between the main and secondary axis 5–50°, flowers 1–3, enrichment shoots 0; basal leaves 1–4 per rosette.

Basal leaf cycle: widely angled at the base (100–160°), occasionally V-formed at the first basal leaf (90–100°), leaf edge irregularly crenated in the first to third basal leaf, crenate-serrate in the the fourth to sixth final leaf.

First basal leaf 10–15 mm long, undivided.

Second basal leaf 12–25 mm long, undivided or lobed to cleft by the main incision (26–45%); middle lobe (if present) trapezoid (to deltoid) with 3 teeth; lateral segment undivided.

Third basal leaf 12–26 mm long, divided by main incision (75–90%); middle lobe deltoid with 3–5 crenated teeth, lateral edge slightly concave to straight; lateral segment undivided or lobed to cleft by first lateral incision (26–65%).

Fourth basal leaf 18–30 mm long, divided to dissected by main incision (92–100%); middle lobe narrowly deltoid to deltoid, with 3–5 teeth, lateral edge slightly concave to slightly straight; lateral segment cleft to divided by the first lateral incision (50–90%), second lateral incision absent or up to 35%.

Fifth and sixth basal leaf similar, 23–32 mm, and 20–32 mm long, respectively; lobed by the main incision (26–32%, and 26–30%, respectively); middle lobe trapezoid with 3 teeth; lateral segment undivided.

Intermediate leaf: pedately divided, truncate at the base (170–190°), divided by the main incision; middle lobe narrowly deltoid with 3–5 teeth, lateral edge slightly convex; lateral segment divided by first lateral incision (75–85%), lobed to cleft by second lateral incision (30–40%).

Lowermost stem leaf divided into 5–7 segments, largest segment 22–35 mm long, 1.5–3 mm wide, lanceolate, rarely stalked, usually undivided, rarely with two short teeth.

Petals (1)2–5, 7–10 mm long, 6–8 mm wide; *androclinium* 0.5–0.8 mm; *receptacle* ellipsoid, 1.2–1.8 mm long, 0.5–0.7 mm wide, glabrous, intervallum long (>25%), carpellophores 0.10–0.3 mm long; *fruits* 1.8–2.6 mm long, beak 0.5–0.8 mm long, (uncinate to) involuted.

Pollen quality — bad, 37.5% well developed (Krasno Polje, holotype).

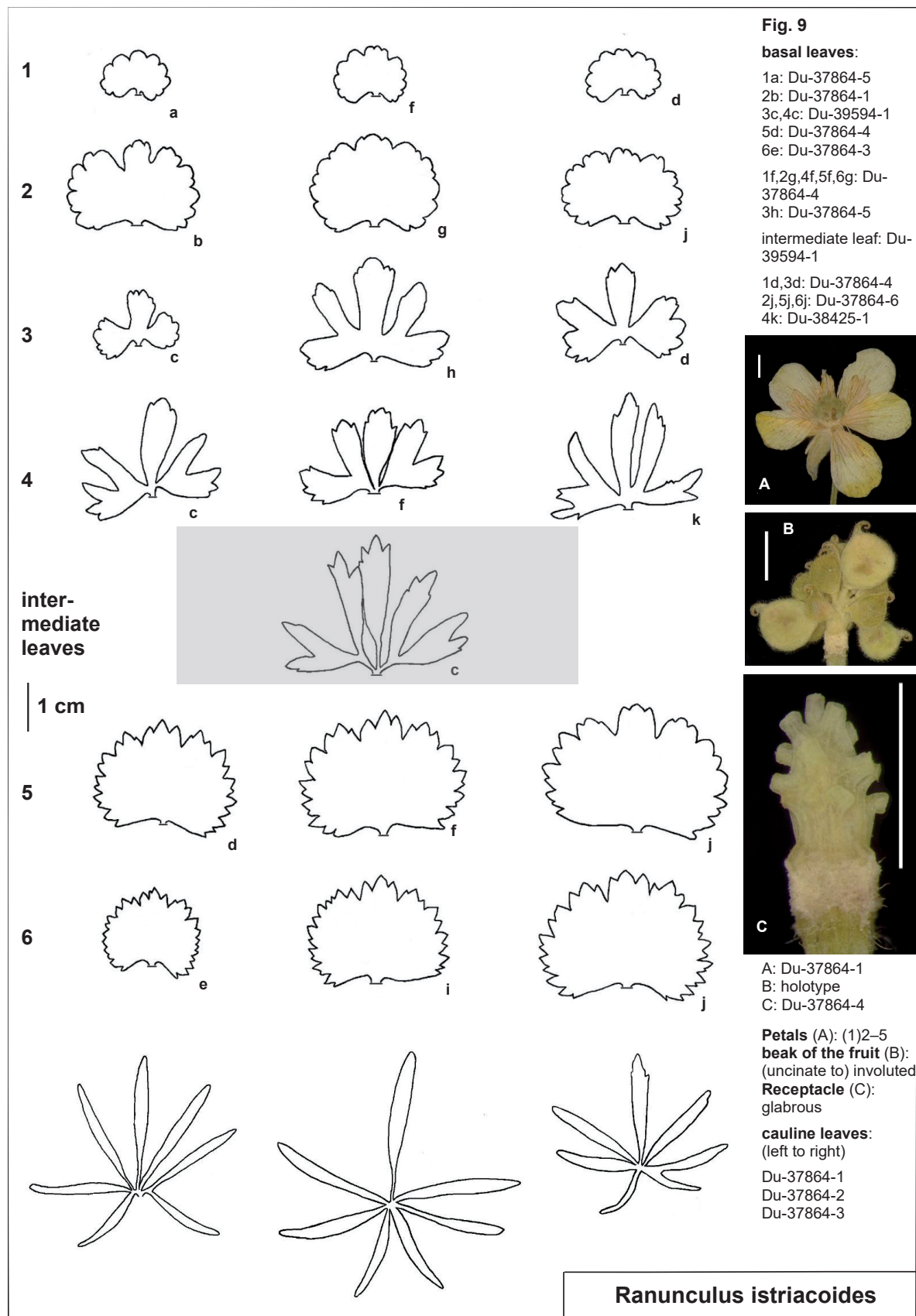


Fig. 9 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus istriacoides*. The white bars in the figures of detail equal 2 mm.



Fig. 10 – Holotype of *Ranunculus istriacoides* (ZA).

DNA-Ploidy — 4x (Krasno, isotype Du-38364).

Distribution — at the type locality Krasno Polje, in the Velebit.

Ecology — at dolines of subalpine meadows.

Etymology — refers to *R. istriacus* (see below) with similar undivided final leaves.

Vulnerability — risk of extinction due to rarity with a small number of plants and reforestation.

Taxonomy — *R. istriacoides* is a small plant of subalpine meadows, it reminds to the type collection of *R. istriacus*, all with only one basal leaf and 1–2 cataphyll. In contrast, the gracile plants of *R. istriacoides* present with up to four basal leaves. Cataphylls are usually absent. *R. istriacoides* differs from *R. istriacus* by shorter, not elongated teeth of the margin of the final leaves. The cauline leaf segments are narrowly lanceolate, obtuse, and usually undivided; in *R. braun-blanquetii* the largest segment of the lowermost cauline leaf has 2–8 teeth. *R. subistriacus* JASIEWICZ, a species of subalpine meadows of the Tatra region has almost the same leaf cycle with undivided initial and final leaves. Only plants in cultivation developed different spring leaves with a wide-angled base (JASIEWICZ 1956, DUNKEL in prep.).

Due to extremely bad pollen morphology and flow cytometry measurements, *R. istriacoides* is a tetraploid endemic. The small population outside the Velebit National Park (Nacionalni park Sjeverni Velebit) deserves high protection and is at risk of extinction.

Specimens seen — Croatia, Velebit, Lika-Senj County, 1155.2: Krasno Polje, Jezera, Grund der Doline, 2.7 km sw Krasno, W-Hand des Pljišivica, 1390 m, 44°48'08"N 15°01'14"E, subalpine Wiesen, 07 Jun 2020, F.G. Dunkel, Du-38764 (isotypes); ibidem, Krasno Polje, Jezera, cultivated, 10 May 2021, F.G. Dunkel, Du-38425; ibidem, Krasno Polje, Jezera, cultivated, 03 May 2022, Du-39594.

5.2.5 *Ranunculus istriacus* HÖRANDL & GUTERMANN, Bot. Jahrb. Syst. 120(4): 563, 1998.

Holotype: Croatia, Istrien, 0751.1, Čićarija (Tschitschenboden), Schutzhaus am Poklon – Učka-Gipfel, 960–1396 m, 30 May 1955, W. Gutermann, Gu-1392, Individuum a, WU 0033483; isotypes Hb. Gutermann. – Figure available under <https://wu.jacq.org/WU0033483>

Distribution — at present only known from the type collection at the summit area of Učka (Monte Maggiore) by W. Gutermann in 1955.

Ecology — unknown, subalpine meadows or beech forest. The type collection was obviously easy to collect without tools – W. Gutermann in litt. (2006) –, hence, an occurrence in a beech forest is more probable.

Etymology — refers to the occurrence in Istria, Croatia.

Vulnerability — possibly extinct.

Taxonomy — *R. istriacus* remains an enigma. There is only the type collection of Walter Gutermann realised during a botanical excursion in 1955. E. Hörandl and W. Gutermann as well as the author looked for the species in vain several times. As

indicated above, it is quite possible that *R. istriacus* grows or grew in the vast beech forests of the Učka. This is underlined by a specimen of *Ranunculus auricomus* in the herbarium WU: “Monte Maggiore, in fagetis, ca. 1200 m, substr. calc.”, collected by K.H. Rechinger in 1928. This plant has no basal leaves; therefore, a secure determination is not possible.

Morphologically and according to the collected plants, *R. istriacus* develops only one basal leaf and has one or two cataphylls, seen also at the specimen of WU. All basal leaves of the type material present the same basal leaf, not at all the second to fourth leaf as is indicated in the figure of its description (HÖRANDL & GUTERMANN 1998b). This is typical for the *R. monophyllous* group. Indeed, *R. istriacus* resembles *R. monophyllous* OVCZ. of Central Asia.

Specimens seen — Croatia, Istria, 0751.1: Čićarija (Tschitschenboden), Schutzhaus am Poklon – Učka-Gipfel, 960–1396 m, 30 May 1955, W. Gutermann, Gu-1392, WU; isotypes Hb. Gutermann; ibidem, Monte Maggiore, ca. 1200 m, in fagetis, substr. calc., 27 May 1928, K.H. Rechinger, WU.

5.2.c *Ranunculus marsicus* group

5.2.6 *Ranunculus mutilicensis* DUNKEL sp. nov.

Holotype: Croatia, Lika-Senj County, Krbavsko polje, 11560.2, Mutilić, 100 m w D1, 500 m sw Galovci, artenreiche Feuchtwiese [species-rich humid meadow], 690 m, 44°29'46"N 15°45'45"E, 28 Apr 2022, F.G. Dunkel 39590, ZA; isotypes GOET, M, Du-39590. – Figs. 11 & 12, Tab. 1.

Description — *Flowering shoot* slim, 8–20 cm tall, scape 1.0–1.8 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to moderately patent (15–50°), flowers 1–3, enrichment shoots 0–1(2); basal leaves 2–5(6) per rosette.

Basal leaf cycle: leaf edge irregularly crenated at the first, second and third basal leaf, at the fourth and fifth leaf irregularly crenated or crenate-serrate with obtuse teeth, at the sixth and seventh basal leaf irregularly crenate-serrate.

First basal leaf 10–20 mm long, V-formed at the base (80–100°), undivided or lobed to divided by the main incision (26–70%); middle lobe, if present, deltoid to spatulate with 1–5 crenated teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Second basal leaf 15–25 mm long, narrow-angled to V-formed at base (20–80°), divided by the main incision (70–85%); middle lobe deltoid to spatulate with 3–5 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or lobed to cleft by the first lateral incision (26–40%).

Third basal leaf 18–35 mm long, narrow-angled to V-formed at the base (40–100°), divided by main incision (80–95%); middle lobe deltoid (to spatulate), with 3–7 crenated teeth, lateral edge straight to slightly concave; lateral segment undivided or lobed to cleft by first lateral incision (26–60%).

Fourth basal leaf 22–45 mm long, narrowly to widely angled at the base (50–140°), divided to dissected by main incision (85–100%), occasionally stalked up to 1 mm; middle lobe rhom-

boid to deltoid, occasionally trileft with incisions of 45–60%, with 3–5 teeth, lateral edge slightly convex to straight; lateral segment divided by first lateral incision (66–80%), cleft to divided by second lateral incision (45–75%), lobed to cleft by third lateral incision (25–55%), fourth incision absent or up to 50%.

Fifth basal leaf 20–45 mm long, narrow-angled to V-formed at the base (40–100°), cleft to divided by main incision (60–80%); middle lobe narrowly deltoid to deltoid with 3 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or cleft by first lateral incision (26–60%), second, third and fourth lateral incision absent or up to 45%, to 35%, and 30%, respectively).

Sixth basal leaf 35–55 mm long, narrowly angled to V-Formed at the base (60–100°), cleft to divided by main incision (50–85%); middle lobe deltoid, with 3–5 teeth, lateral edge straight; lateral segment undivided.

Seventh basal leaf 30–55(65) mm long, narrowly angled to V-formed at the base (50–100°), undivided or lobed to cleft by main incision (26–45%); middle lobe, if present, trapezoid or broadly deltoid with 5 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Lowermost stem leaf divided into 7–13 segments, largest segment 18–30 mm long, 1.5–3 mm wide, lanceolate, undivided or with 1(–2) tooth (teeth).

Petals 5(–8), 7–11 mm long, 5–8 mm wide; *androclinium* 0.2–0.3 mm; *receptacle* globose to ellipsoid, 1.4–1.8 mm long, 1.1–1.6 mm wide, glabrous, intervallum short to long (10–45%), carpelophores 0.05–0.15 mm long; *fruits* 0.8–1.3 mm long, beak 0.2–0.4 mm long, (uncinate to) involuted.

Pollen quality — excellent; 96.9% well developed (Mutilić, holotype).

DNA-Ploidy — 2x (Mutilić, isotype Du-39590).

Distribution — known from the type locality near village Mutilić, 70 km northeast of Zadar, represents the southernmost population of Croatia.

Ecology — humid meadows with *Chouardia litardieri* (BREISTR.) SPETA (syn. *Scilla litardieri* BREISTR.) and *Lathyrus pannonicus* (JACQ.) GARCKE.

Etymology — refers to the nearby village of Mutilić at the Lika-Senj County.

Vulnerability — endangered due to rarity and its ecology.

Taxonomy — according to its morphology with always five or even more (up to eight) petals, its DNA content, and its pollen morphology *R. mutilicensis* is a diploid and probably sexual species. The type population is the southernmost one of the whole *Ranunculus auricomus* complex in Croatia. Further genetic studies should reveal whether it could be a starting point for further speciation processes (BRADICAN 2023). With the coarse leaf edge and rounded teeth *R. mutilicensis* resembles *R. marsicus* of the Italian Abruzzi. Due to morphological and ecological characters, it could be readily categorized in the *R. marsicus* group. The fourth and fifth basal leaves are more irregularly and deeper divided than in *R. marsicus*.

According to the literature, there should be more meadows with populations of *Ranunculus auricomus* s.l. in the surroundings, but the author looked for other well indicated occurrences in vain. Most of these places were drained and are no further

suited for *R. mutilicensis*. Hence, the taxon seems to be seriously endangered.

Literature — Flora Croatica Database (Nikolić 2015): Jošane, Kravsko polje, Lika: 44°35'42.3"N 15°43'59.8"E; 44°35'44"N 15°44'02"E; 44°35'44.2"N 15°44'06"E, leg./obs. various authors, 04 Jun 2006.

5.2.c *Ranunculus notabilis* group (Fig. 41)

5.2.7 *R. austroslovenicus* DUNKEL, Willdenowia 48(2): 230, 2018.

Holotype: Slovenia, Preddinarsko Območje, 0554.2, Kočevje, an der Kolpa 1 km vor Srobotnik, Gebüsch, Waldrand, [on the rivulet Kolpa 1 km before Srobotnik, shrubbery, forest edge], 250 m, 45°29'43"N 14°48'14"E, 23 Apr 2013, F.G. Dunkel, LJU 30441; isotypes B, M, Du-30441. — Fig. 41, Tab. 1; Figs. 1–3, Tab. 1 in DUNKEL & al. (2018).

Pollen quality — good; 87.7% well developed (Du-30441, DUNKEL & al. 2018: Tab. 1).

DNA-ploidy — 2x (Ogulin, Dobra riverside, Du-35326; Klek, Du-35720).

Chromosome number — 2n = 16 (Du-30442, DUNKEL & al. 2018: Tab. 1).

Distribution — from the Planinsko Polje SW of Ljubljana to the Kočevsko region in southeastern Slovenia and adjacent Croatia.

Ecology — meadows, brushes, riparian forests, beech and hornbeam forests.

Etymology — refers to the type of population and main distribution in southern Slovenia.

Vulnerability — critically endangered at poor-nutrient meadows by eutrophication or abandonment; less endangered in forest habitats.

Distribution — from the Planinsko Polje SW of Ljubljana to the Kočevsko region in southeastern Slovenia and adjacent Croatia.

Taxonomy — *R. austroslovenicus* possesses its main distribution at the southern parts of Slovenia, near to the Croatia border. From there, it does not only transgrede the border but reaches Central Croatia near Generalski Stol and Ogulin. Although *R. austroslovenicus* — typical for a sexual species — has a great morphological variation, it is readily distinguished from *R. calapius* by predominance of undivided basal leaves with a narrow-angled aperture at the base.

The plants of the ascent to Klek Mountain possess narrowly deltoid or even flabelliform-like segments of the lowermost cauline leaf. The whole aspect reminds of *R. magniflorus* DUNKEL another new species from the Southern Carpathians (manuscript submitted). Since the collection comprises only two plants and the distance to the sites of *R. magniflorus* is more than 600 km, we provisionally categorize the population of Klek to *R. austroslovenicus*.

Specimens seen — Croatia, Primorje-Gorski Kotar, 10554.2: Delnice, Kuželj, 11 May 1885, D. Hirc, det. sub *R. cassubicus* L., ZA; 10555.1: ibidem, Brod na Kupi, 1,3 km SW Friedhof und

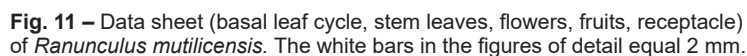


Fig. 12 – Holotype of *Ranunculus mutilicensis* (ZA).

Kirche Vinica, nahe N-Ufer der Kupa, Wiese und schlammiges, ausgetrocknetes Bachbett, 215 m, 45°28'30"N 14°54'03"E, F.G. Dunkel & S. Wittwer, 25 Apr 2015, Du-32738; Unterkrain (Dolenjska), **10558.1**: Donje Prilišće, o der Brückenzufahrt der Kulpa bei Donje Prilišće, 160 m, 45°28'44"N 15°22'05"E, Gebüsch Wiesenrand, 13 Apr 2019, F.G. Dunkel, Du-36634; Karlovac County, **10658.3**: Generalski Stol, am N-Ufer der Globoronica w Generalski Stol, 170 m, 45°20'50.6"N 15°21'58.2"E, Bachauenwald, 30 Apr 2023, F.G. Dunkel, Du-41726; **10757.1**: Ogulin, in dumetis circa Ogulin, 21 Apr 1880, L. Rossi, ZA s.n.; ibidem, Ogulin, ca. 630 m S des Ortskerns, unterhalb der Straße Šetalište Krlenac, am Ufer der Dobra, 316 m, 45°15'35"N 15°13'24"E, grasiges Flussufer unter Weiden, 22 Apr 2018, F.G. Dunkel Du-35325; ibidem, 1,8 km w Ogulin, nördliches Dobra-Ufer an der Brücke zwischen Puškarići und Sveti Petar, 320 m, 45°16'07"N 15°11'59"E, Flussufer, z.T. unter Bäumen, 22 Apr 2018, F.G. Dunkel, Du-35326; Velika-Kapela-Massiv, Ogulin, Auffahrt zum Klek, an der Straße, 536 m, 45°15'14"N 15°10'35"E, Buchenwaldrand, 22 Apr 2018, F.G. Dunkel, Du-35720.

5.2.8 *Ranunculus calapius* DUNKEL, Willdenowia 48(2): 234, 2018.

Holotype: Croatia, Turopolje, 10459.3, Karlovac, Orlovac, 1.1 km SE des Ortes [of the village], W Sisačka ulica, feuchter Hainbuchen-Auenwald [swampy hornbeam alluvial forest], 114 m, 45°31'08.2"N 15°34'15.0"E, 10 Apr 2017, F.G. Dunkel 34889, ZA; isotypes B, M, FR, WB, ZT, Du-34889. – Fig. 41, Tab. 1; Figs. 1, 4 & 5, Tab. 1 in DUNKEL & al. (2018).

Pollen quality — excellent (96.8% well developed; isotype Du-34889).

DNA-ploidy — 2x (Orlovac, isotype Du-34889; Orlovac, Du-35351; Popović Brdo, Du-35724; Domaslovec, Du-35778).

Eponymy — calapius, latin name for the river Kolpa, which is situated close to the type locality.

Ecology — softwood floodplain forest together with *Fritillaria spec.* and *Leucojum aestivum* L., damp deciduous forest.

Distribution — floodplain forests around Karlovac and at the park Maksimir in the centre of Zagreb.

Taxonomy — The sequence of the basal leaves is heterophyllous and characterized by split into three different types of basal leaves. The initial leaves, the first to third one, possess a broadly deltoid to spatulate middle lobe, and the leaf edge has obtuse crenated teeth or it is even only crenate. The spring leaves, no. 4 and 5, present often stalked middle lobes in narrowly deltoid to lanceolate form with deep and wide lateral incisions. In contrast, the lateral segments of the final leaves no. 6 and 7 are undivided. In the last leaf of the cycle the main incision is reduced to at most 65% or even lacking. In robust plants, sometimes intermediate leaves are developed (LOHWASSER 2001), obviously between the fourth and fifth basal leaf of the cycle. They present with a dissected blade by the main incision, and three mostly deep lateral incisions giving rise to a leaf resembling the basal leaf of *Ranunculus acris*. The number of known populations has increased from two in 2018 (DUNKEL & al 2018) to about ten in 2023. The occurrence at the Maksimir Park in the City of Zagreb

could reflect a relict of an ancient floodplain forest along the Danube.

Specimens seen — Croatia, Karlovac County, Turopolje, **10160.4**: Domaslovec, Domaslovečka ulica, 575 m nw Autobahnbrücke über die A3 bei Samobor, 129 m, 45°48'36.1"N 15°45'54.9"E, Eichen-Ulmen-Wald mit *Leucojum vernalis*, 21 Apr 2018, F.G. Dunkel, Du-35778, Du-35779; Zagreb City, **10162.3**: Zagreb, Maksimirski u šumi, Apr 1855, L. Vukotinović, det. L. Vukotinović sub *R. binatus* Kit., ZA; ibidem, Maksimir, Apr 1876, D. Hirc, ZA; ibidem, Maksimir, u šumi, Apr 1880, L. Vukotinović, ZA; ibidem, Maksimir, Apr 1886, S. Gjurašin, ZA; ibidem, Maksimir, 01 May 1908, D. Hirc, ZA; ibidem, Zagreb, Park Maksimir, SW-Teil, Ende der Ulca Maksimirski Perivoj, 70 m sw Vidikovac, 20 m vom NO-Ufer des Drugo Sees, 130 m, 45°49'26.1"N 16°01'14.8"E, offene Rasen unter Bäumen, feuchte Stellen, 22 Apr 2018, F.G. Dunkel, Du-35721; ibidem, Zagreb, Park Maksimir, SO-Teil, 150 m O vom O-Ufer des Drugo Sees, 134 m, 45°49'25.3"N 16°01'24.8"E, nitrophiler, feuchter Laubmischwald, 22 Apr 2018, F.G. Dunkel, Du-35722; **10459.3**: Karlovac, Orlovac, in silvula Lušćić, 20 Apr 1916, L. Rossi, ZA; ibidem, Orlovac, 04 May 1918, L. Rossi, ZA; Karlovac, 1.1 km se Orlovac, w Sisačka ulica, 114 m, 45°31'08.5"N 15°34'15.3"E, feuchter Hainbuchen-Auenwald [swampy hornbeam plainwood forest], 10 Apr 2017, holotype ZA; isotypes B, FR, M, WB, ZT, Du-34891; **10459.4**: Karlovac, 6 km ne Karlovac, s Rečička ulica, an der Verbindungsstraße nach Donje Mekušje, 118 m, 45°31'08.7"N 15°36'46.7"E, feuchter Hainbuchen-Auenwald, 23 Apr 2018, F.G. Dunkel, Du-35342; ibidem, 45°31'05"N 15°36'45"E, feuchter Hainbuchen-Auenwald, 23 Apr 2018, F.G. Dunkel, Du-35351; ibidem, **10559.2**: Turanj, 50–100 m s der Straße Karlovac → Popović Brdo, 114 m, 45°28'02.0"N 15°37'45.3"E, Flutrinne im feuchten Eichen-Hainbuchen-Wald, 23 Apr 2018, F.G. Dunkel, Du-35724; **10559.4**: Karlovac, silva Turanjski lug prope vicum Turanj, 115 m, 45°27'28"N 15°34'16"E, in silvis (Genisto elatae-Quercetum), 26 Apr 1964, T. Wraber, LJU-10102543.

Due to sparse material a secure determination is not possible but probable:

10162.3: Zagreb, Erzbischöflicher Park bei Agram = Park Maksimir, Apr 1855, L. Farkaš-Vukotinović, M-0251588, W-7459; Zagreb, Borongaj, 06 Apr 1903, D. Hirc, ZA; Zagreb, Jurjarves, auf frischen Wiesen, 1855, J.C. Schlosser sub *R. binatus* Kit., W-23565.

5.2.9 *Ranunculus dobranus* DUNKEL sp. nov.

Holotype: Croatia, Karlovac county, 10757.1, 1.8 km w Ogulin, nördliches Dobra-Ufer an der Brücke zwischen Puškarići und Sveti Petar, 320 m, 45°15'35"N 15°13'24"E, Flussufer, z.T. unter Bäumen [northern bank of river Dobra, near the bridge between Puškarići and Sveti Petar, riverside, partly under trees], 22 Apr 2018, F.G. Dunkel 35327, ZA; isotypes Du-35327. – Figs. 13, 14 & 41.

Description — Flowering shoot gracile to slim, 13–25 cm tall, scape 0.8–2.0 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to moderately patent (10–50°), flowers 1–4, enrichment shoots 0–1; basal leaves 2–4 per rosette.

Basal leaf cycle: aperture of the basal leaves wide-angled (110–140°), at the second leaf truncated (170–200°); division of all basal leaves pediform; leaf edge irregularly and coarsely crenate-serrate, form constant over the whole cycle.

First basal leaf 15–25 mm long, divided by the main incision (75–92%); middle lobe trapezoid with 3–5 teeth, lateral edge straight to slightly concave; lateral segment cleft to divided by the first lateral incision (55–75%), lobed to cleft by second lateral incision (30–65%), third lateral incision absent or up to 60%.

Second basal leaf 15–25 mm long, cleft by the main incision (50–65%); middle lobe trapezoid (to deltoid) with 3–5 teeth, lateral edge straight to slightly concave; lateral segment undivided or cleft by the first lateral incision (up to 55%).

Third basal leaf 25–35 mm long, cleft to divided by main incision (55–85%); middle lobe (broadly) deltoid with 3–5 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Fourth basal leaf 28–42 mm long, cleft to divided by main incision (40–75%); middle lobe trapezoid (rectangle) to broadly deltoid with 3–5 teeth, lateral edge straight to slightly concave; lateral segment undivided.

Fifth basal leaf 30–40 mm long, lobed to cleft by main incision (30–55%); middle lobe trapezoid (rectangle) to broadly deltoid with 3–5 teeth, lateral edge straight to slightly concave; lateral segment undivided.

Sixth basal leaf 30–42 mm long, lobed to cleft by main incision (26–40%) or main incision absent; middle lobe – if present – trapezoid to broadly deltoid with 3–5 teeth, lateral edge straight; lateral segment undivided.

Seventh basal leaf 25–35 mm long, lobed to cleft by main incision (26–45%) or main incision absent; middle lobe – if present – trapezoid to broadly deltoid with 3–5 teeth, lateral edge straight; lateral segment undivided.

Lowermost stem leaf divided into 5–9 segments, largest segment 20–40 mm long, 1.5–3.4 mm wide, narrowly lanceolate, undivided, occasionally with 1 short or up to 10 mm long patent tooth.

Petals 3–5(6), 9–12 mm long, 5–7 mm wide; *androclinium* 0.8–1.1 mm; *receptacle* ellipsoid to cylindrical, 2.0–3.0 mm long, 1.3–2.0 mm wide, glabrous, intervallum absent, carpellophores 0.05–0.2 mm long; *fruits* 1.5–2.5 mm long, beak 0.6–1.1 mm long, uncinata.

Pollen quality — mediocre; 53.1% well developed (Ogulin, holotype).

DNA-ploidy — unknown.

Distribution — known from the type locality close to Ogulin.

Ecology — riverbanks, escarpments.

Etymology — refers to the type locality at the banks of the river Dobra.

Vulnerability — endangered due to rarity.

Taxonomy — Among plants of *R. austroslovenicus* with narrowly angled and mostly undivided basal leaves, concomitant *R. dobranus* with wide-angled and divided leaves is conspicuous. The leaf margins of both species are different: crenate or crenate-serrate with teeth as long as wide in *R. austroslovenicus*

vs. acute teeth longer than wide in *R. dobranus*. Obviously, *R. dobranus* like similar *R. vinicae* DUNKEL, developed from *R. austroslovenicus*. However, mediocre pollen quality and a lower number of petals argue for apomixis: *R. dobranus* could not be a simple hybrid of *R. austroslovenicus* and some other species else.

5.2.10 *Ranunculus subcarniolicus* DUNKEL, Willdenowia 48(2): 249, 2018.

Holotype: Slovenia, Preddinarsko območje, 0053.2, Grosuplje, w des Ortes, ca. 150 m n der Ponova Vas, 250 m w des Flüsschens Bičje, magere Wirtschafswiese, [w of the village, 250 m w of the brook Bičje, nutrient-poor meadow], 45°56'46"N 14°38'54"E, 325 m, 08 Apr 2017, F.G. Dunkel 34772, LJU; isotypes B, M, Du-34772. – Fig. 41, Tab. 1; Fig. 1, 14 & 15, Tab. 1 in DUNKEL & al. 2018.

Pollen quality — excellent; 97.6% well developed (isotype Du-34772).

DNA-ploidy — 2x (Forest Jasikovac, Gospić, Du-34886).

Ecology — nutrient-poor meadows, moist hornbeam, and alder forests alongside brooks.

Etymology — refers to Lower Carniola, southeastern part of the historical Carniola region.

Distribution — Central Slovenia south of Ljubljana to southeastern Slovenia around Šentjernej, southern border at the Northern Velebit, region of Lika, close to Gospić in Croatia.

Taxonomy — see DUNKEL & al. 2018. Since the description in 2018, no further population has been found. Near Gospić *R. subcarniolicus* was already collected in 1895 and the (small) population is still extant.

Specimens seen — Croatia, Zagreb County, **10262.1**: Zagreb zu Savicu, livade [along the river Savica, meadows], 45°46'30"N 16°01'30"E ca., 21 May 1951, I. Horvat. ZAHO sub *R. cf. subcarniolicus*; Lika-Senj county, Lika, Gospić, **11458.3**: Jasikovac nad Gospić, 04 May 1895, S. Gjurašin, ZA; ibidem, Waldgebiet Jasikovac, 380 m vom O-Rand, 450 m von der S-Spitze, feuchter Quellbereich im Hainbuchen-Wald, 571 m, 44°31'45"N 15°22'30"E, 10 Apr 2017, F.G. Dunkel, Du-34886, Du-34887, Du-34930; ibidem, Waldgebiet Jasikovac 1,6 km s Brücke, 350 m vom O-Rand Eichen-Hainbuchen-Wald mit Kiefern, 572 m, 44°31'47.5"N 15°22'32.4"E, 10 Apr 2017, F.G. Dunkel, Du-34880.

5.2.e *Ranunculus croaticola* group (Fig. 42)

5.2.11. *R. croaticola* DUNKEL sp. nov.

Holotype: Croatia, Slavonia, Sveti Ivan Žabno, Waldgebiet 1,5 km s Sv. Ivan, am E-Rand, 123 m, 45°55'52"N 16°36'27"E, Eichen-Hainbuchenwald [forest 1,5 km s Sv. Ivan, eastern edge, oak hornbeam forest], 11 Apr 2017, F.G. Dunkel 34896, ZA; isotypes GOET, M, Du-34896. – Figs. 15, 16 & 42, Tab. 1.

Description — *Flowering shoot* slim to robust, 16–40 cm tall, scape 1.8–3.3 mm in diameter, at the base reddish, terete,

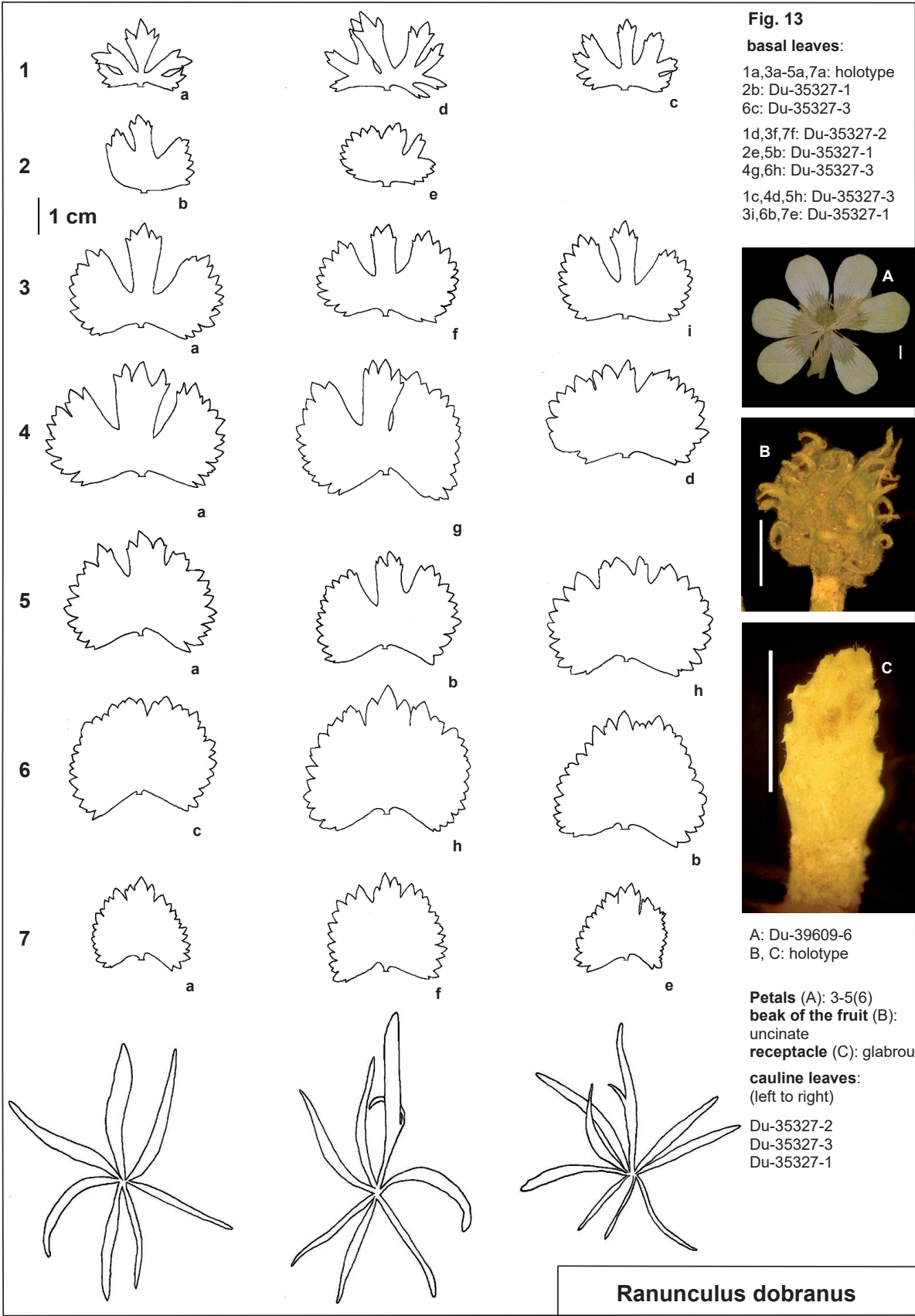


Fig. 13 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus dobranus*. The white bars in the figures of detail equal 2 mm.



Fig. 14 – Holotype of *Ranunculus dobranus* (ZA).

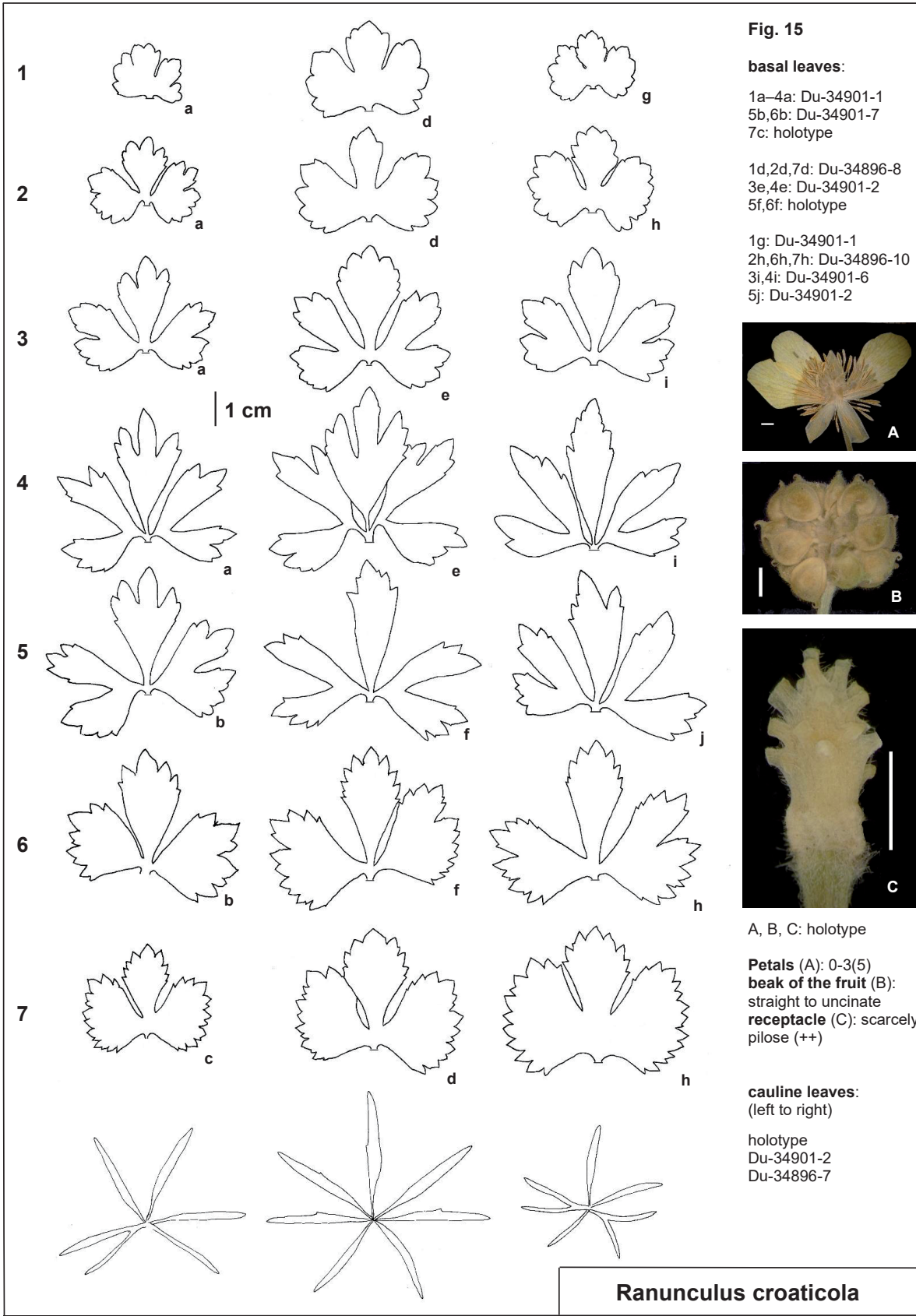




Fig. 16 – Holotype of *Ranunculus croaticola* (ZA).

angle between the main and secondary axis suberect to patent (15–70°), flowers 1–4(5), enrichment shoots 0–1; basal leaves 2–4 per rosette.

Basal leaf cycle: base of the basal leaves V-formed to widely angled (95–140°); with the exception of basal leaf no. 4 and 5 all ones have a tendency to a trifid shape with a rather deep main incision and almost undivided lateral lobes; leaf edge coarsely and irregularly crenated at the first to third basal leaf, increasingly acute crenate-serrate at the fourth to seventh basal leaf.

First basal leaf 16–32 mm long, cleft to divided by the main incision (55–75%); middle lobe trapezoid to broadly deltoid with 3–5 teeth, lateral edge slightly convex to straight; lateral segment undivided.

Second basal leaf 25–35 mm long, divided by the main incision (66–98%); middle lobe deltoid to spatulate with 3–7 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Third basal leaf 30–45 mm long, divided by main incision (92–97%); middle lobe deltoid to spatulate, with 3–7(9) teeth, occasionally irregularly trileft with incisions up to 35%, lateral edge slightly concave to straight; lateral segment lobed to cleft by first lateral incision (30–65%).

Fourth basal leaf 45–60 mm long, dissected by main incision, stalked up to 2 mm; middle lobe deltoid, with 5–9 teeth, usually irregularly trileft with incisions up to 50%, lateral edge slightly concave to straight (or slightly convex); lateral segment divided by first lateral incision (70–85%), lobed to cleft by second lateral incision (26–35%).

Fifth basal leaf 44–55 mm long, divided by main incision (94–99%); middle lobe irregularly (narrowly deltoid to) deltoid with 5–7 teeth, occasionally irregularly trileft with incisions up to 33%, lateral edge slightly concave to straight; lateral segment cleft to divided by first lateral incision (50–85%), second lateral incision absent or up to 30%.

Sixth basal leaf 40–55 mm long, divided by main incision (92–98%); middle lobe deltoid, with 5–9 teeth, lateral edge slightly concave to slightly convex; lateral segment lobed to cleft by first lateral incision (30–50%).

Seventh basal leaf 33–50 mm long, divided by main incision (66–90%); middle lobe deltoid to spatulate with 7–9 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Lowermost stem leaf divided into 5–7 segments, largest segment 30–55 mm long, 3–5(12) mm wide, lanceolate, rarely narrowly deltoid, usually undivided, or rarely with 1–2 teeth.

Petals 2–5, 8–11 mm long, 6–9 mm wide; **androclinium** 0.6–0.9 mm; **receptacle** (globose to) ellipsoid, 2.4–3.8 mm long, 1.6–2.0 mm wide, scarcely pilose (++), intervallum short (10–20%), carpellophores 0.25–0.5 mm long; **fruits** 1.7–2.3 mm long, beak 0.5–0.8 mm long, straight to uncinat.

Pollen quality — good; 68.5% well developed (Sveti Ivan Žabno, holotype).

DNA-ploidy — 4x (Daruvar, Du-34911; Slatina, Du-36631; Sveti Ivan Žabno, holotype).

Distribution — scattered in Northern Croatia, in the historical region Slavonia, north and northeast to east of Zagreb, eastward at least to Daruvar.

Ecology — hornbeam and oak-hornbeam forests, in parks.

Etymology — refers to the occurrence in Croatia. At the Herbarium of Zagreb (ZA), most specimens of the *R. auricomus* complex from Croatia belong to this species.

Vulnerability — not endangered due to populations in forests.

Taxonomy — Morphologically and ecologically, *R. croaticola* presents a widespread morphotype of Northern Croatia, from Zagreb to Osijek and Slavonski Brod. Even in the adjacent area of Hungary similar species are common, they always grow gregariously in more or less humid hornbeam forests. *R. croaticola* is morphologically similar to *R. trilobatooides* DUNKEL (2022) of Saxony, Germany, however, in Slovenia no such taxa are found. In southwestern Hungary and northern Croatia seems to be a hot spot of speciation of this morphotype. With the exception of at least some populations of *R. slavonianus* (see below), they are all tetraploid and obviously apomictic due to pollen morphology (Tab. 1).

The leaf cycle is rather homophyllous and characterized by a wide-angled aperture at the base and an irregularly, coarsely crenate-serrate leaf edge. The main incision of the basal leaves is always deep and present, thus forming trilobed or trileft patterns.

Specimens seen — Croatia, Slavonia, Krapina-Zagorje County, **9961.3:** Zabok, Veliko Trgovišće, 46°00'N 15°51'30"E, u šumi vlažno tlo [humid forest], 05 Apr 1968, H. Veledar, ZA – looked for in vain; Zagreb County, **10060.4:** Hrvatsko Zagorje, Pušća Bistra, Pojatno, u šumi johe [in alder forest], 45°54'15"N 15°48' 07"W ca., 17 Apr 1948, I. Horvat, ZAHO, 12 specimens; Koprivnica-Križevci County, **10065.2:** Sveti Ivan Žabno, Renčevica (= Renčevica), 130 m, 45°57'02"N 16°37'26"E, 02 May 1997, S. Car, ZA; **10065.3:** Sveti Ivan Žabno, Waldgebiet 2,5 km SW Sv. Ivan, w Škrinjari, 155 m, 45°55'49"N 16°34'52"E, Eichen-Hainbuchenwald, 11 Apr 2017, Du-34900; **10065.4:** Sveti Ivan Žabno, 1,5 km S Sv. Ivan, am E-Rand des Waldgebietes, 123 m, 45°55'52"N 16°36'27"E, Eichen-Hainbuchenwald, 11 Apr 2017, F.G. Dunkel, Du-34895; ibidem, Sveti Ivan Žabno, Waldgebiet 3 km s Sv. Ivan, o Žabnica ulica, 117 m, 45°55'00"N 16°36'29"E, Eichen-Hainbuchenwald, 11 Apr 2017, F.G. Dunkel, Du-34901; Bjelovar-Bilogora County, **10167.4:** Drljanovac, an der N 28 zwischen Drljanovac und Bulinac, 1,5 km NO Drljanovac, 120 m, 45°48'29"N 16°59'43"E, Wirtschaftswiese, 11 Apr 2017, F.G. Dunkel, Du-34082; ibidem, cultivated, 27 Apr 2018, F.G. Dunkel, Du-35136; **10469.1:** Daruvar, u gradskom perivoju prema željeznickoj pruzi čest [in town park at railway line], 180 m, 45°35'44"E 17°13'39"N, 16 Apr 1943, V. Loschnigg, ZA; Daruvar, nahe Stadtpark, so der Therme, o der Stadtbahn, 173 m, 45°35'45"N 17°13'42"E, Eichen-Hainbuchen-Wald, 11 Apr 2017, F.G. Dunkel, Du-34912, partly vergens ad *R. poldinioides*; Virovitica-Podravina County, **10272.4:** Slatina, 2,3 km so Medinci, 113 m, 45°43'08"N 17°45'50", Eichen-Hainbuchenwald, 12 Apr 2019, F.G. Dunkel, Du-36631; ibidem, cultivated, 13 Apr 2020, F.G. Dunkel, Du-37257; ibidem, cultivated, 26 Apr 2021, F.G. Dunkel, Du-38294; ibidem, Medinci, s D34, o Medinci, sso Vraneševci, 105 m, 45°44'35"N 17°48'23"E, Hainbuchen-Wald, 15 Apr 2022, F.G. Dunkel, Du-40439; Medinci, s D34, o Medinci, sso Vraneševci, 110 m, 45°43'34"N 17°45'25", Hainbuchen-Wald, 15 Apr 2022, F.G. Dunkel, Du-40440.

5.2.11 *Ranunculus dravus* DUNKEL sp. nov.

Holotype: Croatia, Podravina, 9868.4, Đurđevac, n Repaš, 109 m, 46°08'35"N 17°05'11"E, feuchter Hainbuchenwald [humid hornbeam forest], 29 Apr 2023, F.G. Dunkel 41731, ZA; isotypes GOET, M, Du-41731. – Figs. 17, 18 & 42.

Description — *Flowering shoot* slim to robust, 20–50 cm tall, scape 1.2–3.5 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to moderately patent (10–50°), flowers 1–6, enrichment shoots 0–1(2); basal leaves 2–5(6) per rosette.

Basal leaf cycle: leaf edge irregularly crenated at the first, deeply and irregularly crenated to crenated-serrate at the second basal leaf, at the third to seventh leaf margin irregularly and deeply crenate-serrate.

First basal leaf 20–40 mm long, narrow-angled to V-formed at base (30–90°), cleft to divided by the main incision (40–80%); middle lobe trapezoid to spatulate with 3–7 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Second basal leaf 30–45 mm long, narrow-angled at base (40–70°), cleft to divided by the main incision (60–95%); middle lobe deltoid to spatulate with 4–9 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Third basal leaf 40–65 mm long, narrow-angled to V-formed at the base (40–100°), divided to dissected by main incision (90–100%); middle lobe deltoid to spatulate, with 9–13 teeth, lateral edge straight to slightly concave; lateral segment cleft by first lateral incision (40–65%), lobed to cleft by second lateral incision (26–50%).

Fourth basal leaf 45–65 mm long, widely angled at the base (130–150°), dissected by main incision, occasionally stalked up to 2 mm; middle lobe rhomboid to oblanceolate, with 9–13 teeth, lateral edge slightly convex to straight; lateral segment divided by first lateral incision (80–98%), cleft by second lateral incision (35–65%), third lateral incision absent or up to 33%.

Fifth basal leaf 45–65 mm long, narrow-angled at the base (40–80°), divided to dissected by main incision (94–100%); middle lobe deltoid to spatulate with 9–11 teeth, occasionally stalked up to 2 mm, lateral edge slightly convex to slightly concave; lateral segment cleft to divided by first lateral incision (50–75%), second and third lateral incision absent or up to 45%, and 33%, respectively.

Sixth basal leaf 45–65 mm long, narrow-angled at the base (10–50°), divided by main incision (85–98%); middle lobe deltoid to spatulate with 9–15 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or first lateral incision up to 45%.

Seventh basal leaf 30–55 mm long, narrowly angled to V-formed at the base (40–90°), cleft to divided by main incision (40–92%); middle lobe trapezoid or deltoid with 7–13 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Lowermost stem leaf divided into 5–7 segments, largest segment 25–70 mm long, occasionally stalked, 1.5–15 mm wide, lanceolate or narrowly deltoid, (undivided or) with 1–6 teeth, obtuse.

Petals 2–4, 7–12 mm long, 6–9 mm wide; **androclinium** 0.5–0.8 mm; **receptacle** cylindrical, 3.0–6.5 mm long, 1.5–2.3

mm wide, glabrous, intervallum absent, carpellophores 0.10–0.25 mm long; **fruits** 1.6–2.2 mm long, beak 0.6–1.2 mm long, straight to uncinat.

Pollen quality — good; 75.4% well developed (Repaš, isotype Du-41731-1).

DNA-Ploidy — not known.

Distribution — known from the type locality near Đurđevac close to river Drava and scattered on the other side of the stream in Sellye District, Baranja County, Hungary.

Ecology — (humid) hornbeam forests.

Etymology — refers to the nearby river Drava.

Vulnerability — not endangered.

Taxonomy — *R. dravus* is a typical representative of the *R. croaticola* group. It is more heterophyllous and characterized by a change of the angle at the base of the blade. The fourth leaf is widely angled – angle more than 130° – and all other leaves bear an aperture of at most 75°, rarely 90°. Characteristic is an irregular coarse leaf edge and a spatulate middle lobe; only in the fourth leaf, it is rhomboid to oblanceolate. The glabrous receptacle possesses a cylindrical form with a length of up to 6.5 mm. A short visit at the adjacent Hungarian region, demonstrated that *R. dravus* is present there, too, and it seems to occur frequently at the northern side of the Drava in hornbeam forests.

Specimens seen — Hungary, Baranja County, **9972.3:** Nagydobsza, Waldgebiet s Nagydobsza, n der Bahn, nahe Weg zur Bahnüberquerung Kisdobsza, 120 m, 46°01'01"N 17°39'42"E, Hainbuchen-Wald, 14 Apr 2022, F.G. Dunkel, Du-40434 (paratypes); Croatia, Podravina, **9868.4**, Đurđevac, n Repaš, 109 m, 46°08'35"N 17°05'11"E, feuchter Hainbuchenwald [humid hornbeam forest], 29 Apr 2023, F.G. Dunkel, ZA, GOET, M, Du-41731 (isotypes).

5.2.13 *Ranunculus slavonianus* DUNKEL sp. nov.

Holotype: Croatia, Slavonia, Virovitica-Podravina County, 10272.4, Medinci, sso Vraneševci, 105 m, 45°44' 35" N 17°48'23"E, Hainbuchen-Wald [hornbeam forest], 15 Apr 2022, F.G. Dunkel 40439, ZA; isotypes GOET, M, Du-40439. – Figs. 19, 20 & 42, Tab. 1.

Description — *Flowering shoot* slim, 22–38 cm tall, scape 1.2–2.5 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to patent (15–50°), flowers 1–5, enrichment shoots 0–1; basal leaves 1–5 per rosette.

Basal leaf cycle: leaf edge irregularly and coarsely crenate-serrate.

First basal leaf 20–35 mm long, narrow-angled at the base (50–70°), undivided or occasionally lobed to cleft by the main incision (26–50%), if main incision present middle segment with 3–5 teeth, lateral edge straight to slightly convex, lateral segment undivided.

Second basal leaf 25–38 mm long, narrowly to widely angled at the base (50–120°), cleft by the main incision (35–65%); middle lobe broadly deltoid to trapezoid with 3–5 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Third basal leaf 30–45 mm long, narrow-angled to V-for-

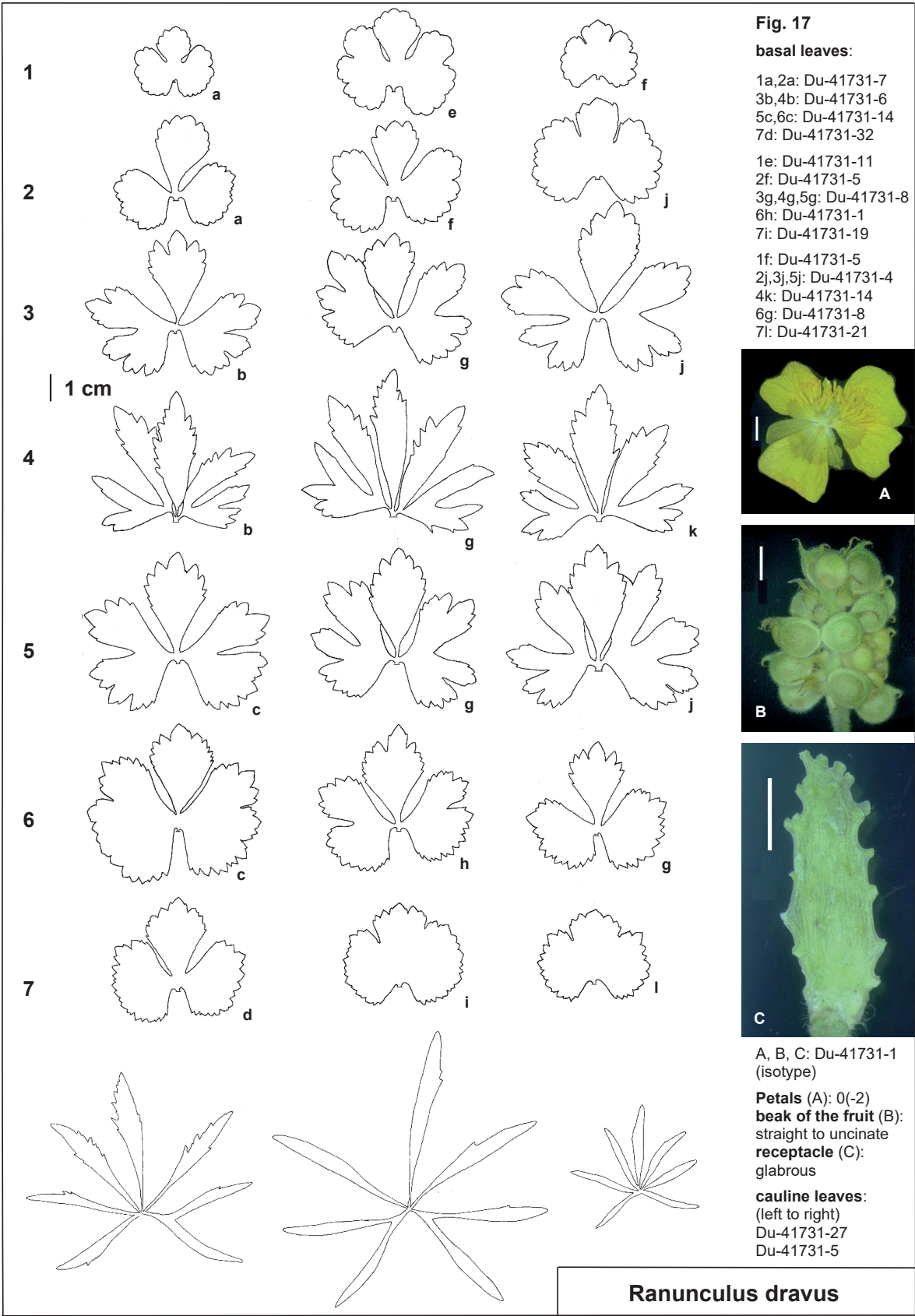


Fig. 17 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus dravus*. The white bars in the figures of detail equal 2 mm.

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Fig. 18 – Holotype of *Ranunculus dravus* (ZA).

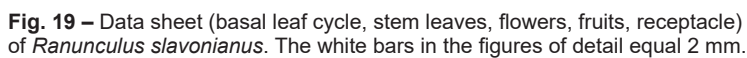




Fig. 20 – Holotype of *Ranunculus slavonianus* (ZA)

med at the base (50–100°), irregularly divided by main incision (75–85%); middle lobe deltoid (to spatulate), with 4–7 teeth, lateral edge slightly convex to slightly concave; lateral segment cleft by first lateral incision (35–65%), second lateral incision absent or up to 33%.

Fourth basal leaf 35–50 mm long, narrow-angled at the base (15–75°), divided by the main incision (92–99%); middle lobe irregularly deltoid with 3–7 teeth, lateral edge slightly concave to straight; lateral segment divided by first lateral incision (66–80%), cleft by second lateral incision (35–50%).

Fifth basal leaf 30–40 mm long, narrow-angled to V-formed at the base (60–100°), divided by main incision (70–95%); middle lobe irregularly narrowly deltoid to deltoid with 5–7 teeth, lateral edge straight to slightly concave; lateral segment undivided or occasionally lobed to cleft by the first lateral incision (26–55%).

Sixth basal leaf 30–45 mm long, narrowly angled at the base (10–30°), cleft to divided by the main incision (60–85%); middle lobe deltoid, with 5–7 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Seventh basal leaf 30–50 mm long, narrowly angled at the base (20–40°), undivided or cleft by main incision (50–60%); middle lobe if present, deltoid with 5–7 teeth, lateral edge straight; lateral segment undivided.

Lowermost stem leaf divided into 7 segments, largest segment 35–55 mm long, 2.5–5 mm wide, linear to narrowly lanceolate, undivided or with one up to 10 mm long tooth.

Petals 5, 9–11 mm long, 8–10 mm wide; *androclinium* 0.6–0.8 mm; *receptacle* ellipsoid, 2.8–3.5 mm long, 1.8–2.5 mm wide, glabrous, intervallum short (10–15%), carpellophores 0.10–0.25 mm long; *fruits* 1.8–2.3 mm long, beak 0.6–1.2 mm long, uncinately involuted.

Pollen quality — good; 90.4% well developed (Medinci, holotype).

DNA-ploidy — 2x (Medinci, holotype).

Distribution — known from the type locality near Medinci.

Ecology — hornbeam forests, brushes (*Salicion cinereae*).

Etymology — refers to the type locality in Slavonia, an eastern part of Croatia.

Vulnerability — endangered due to rarity and deforestation.

Taxonomy — the type locality is situated in hornbeam forests close to Medinci. Complete flowers, well developed pollen grains and flow cytometry measurements argue for a diploidy and amphimixis of the type population. *R. slavonsianus* is characterised by almost undivided first and seventh leaves with a narrow-angled base and coarsely crenate-serrate leaf edge. *R. croaticola* has final leaves with a wide-angled base. Morphologically, it is close to *R. mediocompositus* DUNKEL which is different by deeper incisions of the first four basal leaves. In the case of *R. mediocompositus*, a local on-site-hybridization of the diploids *R. austroslovenicus* and perhaps *R. peracris* is quite possible. Here, no other diploid species occurs together. Therefore, a hybrid origin is not derivable. Sometimes single concomitant plants with a V-formed base of the final leaves are not easy to classify (triploids?), but *R. slavonsianus* should be restricted to diploid plants with complete flowers. Since sexual and apomictic populations grow together in the same area, *R. slavonsianus* is an

interesting model for studying the phylogenetic development in this complex.

Specimens seen — Croatia, Sisak-Moslavina County, **10667.1**: Lipovljani, Fakultetska šuma Lipovljani u sastojini Querceto-Genistetum, 45°23'45"N 16°53'34"E ca., 11 May 1960, I. Horvat, ZAHO sub *R. cf. slavonsianus*.

5.2.14 *Ranunculus slavopontinus* DUNKEL sp. nov.

Holotype: Croatia, Slavonia, Brod County, **10775.4**, Slavonski Brod, oberhalb und w des Sees Ljeskove vode, Ende der Straße 4187, n Slavonski Brod, nahe des kleinen Weges 300 m w des Sees [above and w Lake Ljeskove vode, at the end of road 4187, north of Slavonski Brod, close to the path 300 m w of the lake, clear oak hornbeam forest], 245 m, 45°14'32.0"N 18°05'06.1"E, lichter Eichen-Hainbuchen-Wald, 20 Apr 2022, F.G. Dunkel 40558, ZA; isotypes GOET, M, Du-40558. – Figs. 21, 22 & 42, Tab. 1.

Description — *Flowering shoot* slim to robust, 28–48 cm tall, scape 1.2–3.3 mm in diameter, at the base reddish, terete, suberect to moderately patent, angle between the main and secondary axis (10–50°), flowers 2–7, enrichment shoots 0–2; basal leaves 1–5 per rosette.

Basal leaf cycle: leaf edge irregularly crenated at the first and second basal leaf, irregularly crenate-serrate at the third to seventh basal leaf, crenated teeth increasingly acute.

First basal leaf 20–38 mm long, narrow-angled at base (40–80°), divided by the main incision (66–95%); middle lobe deltoid to spatulate with 3–7 crenated teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or lobed to cleft by the first lateral incision (up to 50%).

Second basal leaf 25–40 mm long, narrow-angled to wide-angled at base (70–120°), divided by the main incision (70–90%); middle lobe deltoid to spatulate with 5–7(9) teeth, lateral edge straight to slightly concave; lateral segment undivided or cleft by the first lateral incision (35–55%).

Third basal leaf 30–40 mm long, widely angled at the base (110–150°), divided to dissected by main incision (98–100%); middle lobe deltoid (to spatulate), usually petiolated up to 4 mm, with 7–11 teeth, usually irregularly trileft with incisions up to 40%, lateral edge straight to slightly concave; lateral segment cleft to divided by first lateral incision (55–80%), cleft by second lateral incision (33–55%), lobed to cleft by third lateral incision (26–50%).

Fourth basal leaf 33–50 mm long, widely angled at the base (110–170°), divided to dissected by main incision (98–100%), occasionally stalked up to 2 mm; middle lobe rhomboid to deltoid, with 5–11 teeth, lateral edge slightly convex to straight; lateral segment cleft by first lateral incision (55–65%), second lateral incision absent or up to 40%, third lateral incision absent or up to 30%.

Fifth basal leaf 35–55 mm long, narrow-angled at the base (40–70°), divided by main incision (90–99%); middle lobe deltoid with 7–9 teeth, lateral edge slightly convex to slightly concave; lateral segment cleft to divided by first lateral incision (50–70%), cleft by second lateral incision (40–55%), third lateral incision absent or up to 30%.

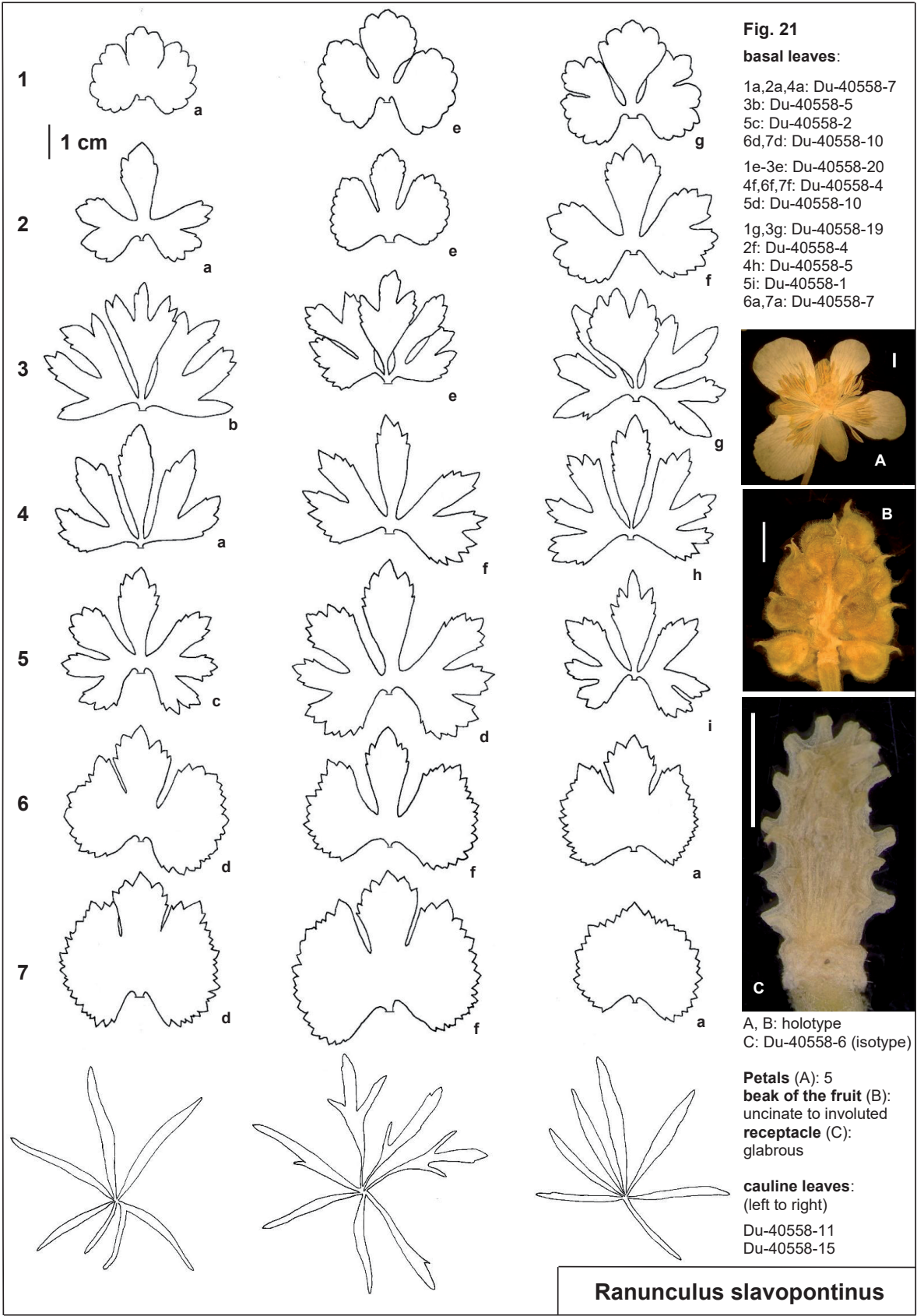


Fig. 21 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus slavopontinus*. The white bars in the figures of detail equal 2 mm.



Fig. 22 – Holotype of *Ranunculus slavopontinus* (ZA).

Sixth basal leaf 35–50 mm long, V-formed to widely angled at the base (80–120°), cleft to divided by main incision (50–85%); middle lobe (broadly) deltoid, with 7 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Seventh basal leaf 30–50 mm long, narrowly to widely angled at the base (60–110°), undivided or lobed to cleft by main incision (26–66%); middle lobe, if present, deltoid with 7 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Lowermost stem leaf divided into (5–)7 segments, largest segment 35–70 mm long, 2.5–7 mm wide, narrowly oblanceolate, undivided or occasionally with 1–2 patent up to 15 mm long teeth.

Petals 2–5, 8–13 mm long, 5–9 mm wide; *androclinium* 0.4–0.6 mm; *receptacle* (ellipsoid to) cylindrical, 4.0–5.2 mm long, 1.2–1.8(2.0) mm wide, glabrous, intervallum absent, carpellophores 0.25–0.4 mm long; *fruits* 2.8–3.5 mm long, beak 0.4–0.8 mm long, uncinat to involuted.

Pollen quality — mediocre; 55.9% well developed (Slavonski Brod, holotype).

DNA-ploidy — not known.

Distribution — known from the type locality north of Slavonski Brod.

Ecology — oak hornbeam forests.

Etymology — refers to Slavonski Brod.

Vulnerability — potentially endangered due to rarity.

Taxonomy — *R. slavopontinus* is morphologically close to *R. croaticola*, and I thought of putting it into the synonymy of *R. croaticola*. But there are some morphological differences: the first four leaves of the basal leaf cycle are similar to *R. croaticola*, in *R. slavopontinus* the fifth leaf is narrow-angled at the base, its circumference is orbicular with radial incisions vs. wide-angled leaf with a pediform division. The seventh leaf of *R. croaticola* differs by deeper main incision (66–90% vs. 10–66%) and a coarser leaf edge. The receptacle is at least scarce pilose and almost orbicular in *R. croaticola*, and glabrous and cylindrical in *R. slavopontinus*. In addition to that, *R. slavopontinus* grows isolated near Slavonski Brod, 50 km south of the closest populations near Slatina. To my opinion, this all together deserves a description of this taxon.

5.2.15 *Ranunculus posavinanus* DUNKEL sp. nov.

Holotype: Croatia, Brod-Posavinan county, 10872.4, Bebrina, zwischen [between] Bebrina und Stupnički Kut, w der Straße 4205, Graben, Waldrand, feuchter Hainbuchenwald [w of the road 4205, ditch, forest edge, humid oak hornbeam forest], 88 m, 45°06'54"N 17°49'09"E, 27 Apr 2022, F.G. Dunkel 40465, ZA (consisting of one individual currently mounted on two sheets clearly labelled as parts of the same preparation); isotypes Du-40465. – Figs. 23, 24 & 42, Tab. 1.

Description — *Flowering shoot* slim to robust, 22–50 cm tall, scape 1.2–4.0 mm in diameter, at the base reddish, terete, suberect to moderately patent, angle between the main and secondary axis (15–50°), flowers 3–10, enrichment shoots 0–1; basal leaves 1–4 per rosette.

Basal leaf cycle: leaf edge irregularly crenated and crenate-serrate at the first to third basal leaf, irregularly crenate-serrate to serrate at the fourth to seventh basal leaf, crenated teeth increasingly acute.

First basal leaf 22–40 mm long, aperture closed to V-formed at base (0–90°), lobed to divided by the main incision (30–90%); middle lobe trapezoid to deltoid with 5–9 crenated teeth, lateral edge slightly convex to straight; lateral segment undivided.

Second basal leaf 24–40 mm long, narrow-angled to V-formed at base (15–100°), divided by the main incision (75–92%); middle lobe deltoid to spatulate with 7–9 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or lobed to cleft by the first lateral incision (26–55%).

Third basal leaf 30–48 mm long, narrow-angled to V-formed at the base (50–100°), divided by main incision (92–99%); middle lobe deltoid to spatulate, with 7–9 teeth, lateral edge slightly convex to slightly concave; lateral segment cleft to divided by first lateral incision (50–80%), second and third lateral incision absent or up to 35%, and 33%, respectively.

Fourth basal leaf 50–60 mm long, narrow-angled at the base (5–30°), divided by main incision; middle lobe narrowly deltoid with 5–7 teeth, lateral edge slightly concave to straight; lateral segment divided by first lateral incision (66–90%), cleft to divided by second lateral incision (35–75%), lobed to cleft by third lateral incision (28–45%), fourth lateral incision absent or up to 30%.

Fifth basal leaf 56–70 mm long, narrow-angled at the base (45–60°), divided to dissected by main incision (95–100%); middle lobe irregularly narrowly deltoid with 3–5 elongated teeth, occasionally with incisions up to 40%, lateral edge more or less straight; lateral segment divided by first lateral incision (70–90%), cleft to divided by second lateral incision (55–70%), cleft by third lateral incision (33–45%), lobed by fourth lateral incision 26–32%.

Sixth basal leaf 35–50 mm long, narrow-angled to V-formed at the base (55–90°), divided by main incision (85–99%); middle lobe narrowly deltoid with 3–5 teeth, lateral edge straight; lateral segment cleft to divided by first lateral incision (55–80%), lobed to cleft by second lateral incision (26–50%), third and fourth lateral incision absent or up to 45%, and 35%, respectively.

Seventh basal leaf 35–50 mm long, narrowly angled to V-formed at the base (50–100°), divided by main incision (90–98%); middle lobe deltoid, with 5–9 teeth, lateral edge slightly concave to straight; lateral segment undivided or lobed to cleft by first lateral incision (26–65%).

Lowermost stem leaf divided into 7(–9) segments, largest segment 35–70 mm long, 2.5–5(7) mm wide, linear to narrowly lanceolate, usually undivided, rarely with one (long) tooth.

Petals 0–3(5), 8–11 mm long, 7–10 mm wide, orbicular; *androclinium* 0.25–0.4 mm; *receptacle* ellipsoid, 6.0–8.0 mm long, 3.0–4.0 mm wide, glabrous, intervallum absent, carpellophores 0.05–0.15 mm long; *fruits* 1.9–2.7 mm long, beak 0.6–1.2 mm long, straight to involuted.

Pollen quality — mediocre; 42.1% well developed (Stupnički Kut, isotype Du-40465-7).

DNA-ploidy — 4x (Stupnički Kut, isotype Du-40465).

Distribution — known from the type locality close to Bebrina, Brod-Posavina County.

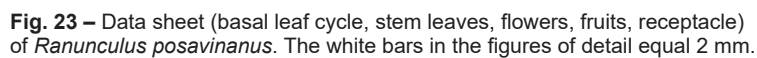




Fig. 24 – Holotype of *Ranunculus posavinanus* (ZA); image composed of the elements mounted on the two sheets of the holotype preparation.

Ecology — humid hornbeam forests, forest edges, and ditches.

Etymology — refers to the type locality in Brod-Posavina County (Croatian: Brodsko-posavska županija), the southern Slavonian County of Croatia.

Vulnerability — potentially endangered due to rarity and deforestation.

Taxonomy — due to the morphology with incomplete flowers and the results of flow cytometric measurements, *R. posavinanus* should be a tetraploid taxon. Morphologically, it is characterised by narrowly deltoid middle segments of the fourth to sixth basal leaf. This results in a wide-angled main incision of 45–60°. The fruiting plants bear a large ellipsoid receptacle of 6–8 mm length without hairs and short carpellophores (0.05–0.15 mm).

5.2.16 *Ranunculus turopoljensis* DUNKEL sp. nov.

Holotype: Croatia, Zagreb County, Turopolje, 10361.1, Kupinečki Kraljevec, Franje, Verlängerung der Franje ulica, nahe Waldrand [prolongation of Franje ulica, near forest edge], 160 m, 45°39'52"N 15°50'25"E, Senken und Bachrand im feuchten Hainbuchen-Wald (Carpinetum pseudostellarietum) [troughs and brookside in humid hornbeam forest], 10 Apr 2017, F.G. Dunkel 34904, ZA; isotypes GOET, M, Du-34904. — Figs. 25, 26, 42, tab. 1.

Description — *Flowering shoot* gracile to slim, 18–38 cm tall, scape 0.9–3.0 mm in diameter, at the base reddish, terete, suberect to moderately patent, angle between the main and secondary axis (10–50°), flowers 1–4, enrichment shoots 0–1; basal leaves 1–3 per rosette.

Basal leaf cycle: leaf edge crenated at the first basal leaf, at the following basal leaves very irregularly, crenate-serrate with crenated teeth increasingly acute.

First basal leaf 25–40 mm long, narrow-angled at base (40–60°), undivided or cleft by the main incision (40–55%); middle lobe if present trapezoid with 5–7 crenated teeth, lateral edge straight; lateral segment undivided.

Second basal leaf 30–50 mm long, V-formed at the base (80–100°), cleft by the main incision (35–55%); middle lobe trapezoid (to deltoid) with 5–7 teeth, lateral edge straight to slightly concave; lateral segment undivided.

Third basal leaf 30–50 mm long, narrow-angled to V-formed at the base (60–90°), divided by main incision (90–96%); middle lobe deltoid with 5–11 teeth, lateral edge straight to slightly concave; lateral segment cleft to divided by first lateral incision (60–75%), lobed to cleft by second lateral incision (26–40%).

Fourth basal leaf 40–50 mm long, narrow-angled at the base (40–60°), dissected by main incision, stalked up to 15 mm; middle lobe deltoid to spatulate, with 15–21 teeth, lateral edge straight to slightly concave; lateral segment occasionally stalked up to 12 mm, cleft to divided by first lateral incision (60–80%), lobed by second lateral incision (26–32%).

Fifth basal leaf 40–55 mm long, widely angled at the base (110–140°), divided to dissected by main incision, occasionally stalked up to 2 mm; middle lobe irregularly (narrowly) deltoid with 9–11 teeth, lateral edge straight to slightly concave; lateral

segment divided by first lateral incision (40–85%), cleft by second lateral incision (33–40%), lobed by third lateral incision (26–30%).

Sixth basal leaf 35–50 mm long, V-formed at the base (80–100°), divided by main incision (66–80%); middle lobe deltoid with 7–9 teeth, lateral edge straight; lateral segment undivided.

Seventh basal leaf 30–45 mm long, widely angled at the base (115–140°), undivided.

Intermediate leaves: in large plants, occasionally occur *intermediate leaves*: 35–50 mm long, wide-angled at the base (130–150°), divided to dissected by main incision (98–100%); middle lobe narrowly deltoid to deltoid with 5–9 teeth, leaf edge slightly concave to slightly convex; lateral lobe cleft to dissected by first lateral incision (50–100%), second lateral incision absent or up to 55%.

Lowermost stem leaf divided into 5–9 segments, largest segment 25–50 mm long, 4–8(12) mm wide, narrowly oblanceolate to oblanceolate or narrowly deltoid, occasionally stalked, rarely undivided, usually with 1–8 teeth of variable length.

Petals 0–3, 7–10 mm long, 6–8 mm wide; *androclinium* 0.4–0.6 mm; *receptacle* almost globose to ellipsoid, 3.0–4.0 mm long, 2.4–3.0 mm wide, glabrous, intervallum absent, carpellophores 0.25–0.35 mm long; *fruits* 2.2–2.8 mm long, beak 0.7–1.5 mm long, straight to uncinate.

Pollen quality — bad; 26.5% well developed (Kupinečki Kraljevec, holotype).

DNA-ploidy — 4x (Kupinečki Kraljevec, isotype Du-34904).

Distribution — known from the type locality south of Kupinečki Kraljevec and nearby Lekenik, a village of the Sisak-Moslavina County.

Ecology — humid deciduous forests, especially hornbeam forests, *Carpinetum pseudostellarietum*.

Etymology — refers to the type locality at Turopolje, a region in Croatia between the capital city Zagreb, Sisak, and Karlovac. The name is deduced from Croatian and Old Slavic word *Tur* ‘aurochs’ (*Bos primigenius*), a type of wild cattle present in the area during the Middle Ages.

Vulnerability — potentially endangered due to rarity.

Taxonomy — Bad pollen quality and incomplete flowers indicate tetraploidy for *R. turopoljensis*. It represents a typical member of the *R. croaticola* group. It has widely angled apertures of the final leaves, similar to *R. croaticola* and *R. slavopontinus*, and different from *R. dravus* and *R. slavonianus*. The leaf cycle is very heterophyllous, the leaves are variable. Only at *R. turopoljensis*, the middle lobes are occasionally stalked up to 10 mm. The leaf margin is rather finely crenato-serrate to serrate, herein it differs from *R. croaticola*. The spring leaves are foot-like divided (pedatilobed), correspondingly this taxon lacks the fifth basal leaf of *R. slavopontinus* with radial incisions, in the latter the receptacle is cylindrical, in *R. turopoljensis* ellipsoid. In the *Ranunculus auricomus* complex, the form of the beaks of the nutlets normally varies and is not a good character, but it is conspicuously straight in *R. turopoljensis*. At present, two populations are known at the western edge of the distribution area of the *R. croaticola* group.

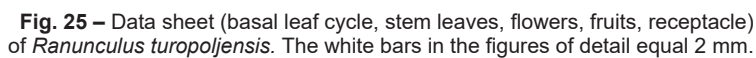




Fig. 26 – Holotype of *Ranunculus turopoljensis* (ZA).

Ranunculus puberulus group**5.2.17 *Ranunculus gradiscanus* DUNKEL sp. nov.**

Holotype: Croatia, Slavonia, Brod-Posavina County, 10870.1, Nova Gradiška, ca. 3 km ssw Ljupina, an Knick der Schotterstraße Ljupina-Savski Bok, an großem Graben n des Weges, Grabenböschung [at sharp bending of the dirty road, in a large ditch n of the road, escarpment], 45°11'21"N 17°21'23"E, 27 Apr 2022, F.G. Dunkel 40559, ZA; isotypes GOET, M, Du-40559. – Figs. 27 & 28.

Description — *Flowering shoot* slim to robust, 20–42 cm tall, scape 1.8–3.2 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to moderately patent (20–50°), flowers 3–10, enrichment shoots 0–2; basal leaves 2–4 per rosette.

Basal leaf cycle: leaf edge irregularly, finely to deeply crenate-serrate.

First basal leaf 25–40 mm long, narrow-angled at base (0–50°), divided to dissected by the main incision (90–100%); middle lobe spatulate to broadly spatulate, unstalked or regularly up to 5 mm stalked, with 5–19 crenated teeth, lateral edge slightly to strongly concave; lateral segment cleft to divided by the first lateral incision (40–90%), second and third lateral incision absent or both up to 45%, respectively.

Second basal leaf 35–45 mm long, narrow-angled to V-formed at base (40–100°), divided by the main incision (85–97%); middle lobe deltoid to spatulate with 5–7 teeth, lateral edge slightly convex to slightly concave; lateral segment cleft to divided by the first lateral incision (35–70%), second and third lateral incision absent or up to 45% and 40%, respectively.

Third basal leaf 35–45 mm long, closed to narrow-angled at base (0–60°), divided to dissected by main incision (95–100%); middle lobe deltoid to spatulate, occasionally stalked up to 2 mm, with 9–11 teeth, occasionally irregularly trileft with incisions up to 45%, lateral edge straight to slightly convex; lateral segment cleft to divided by first lateral incision (60–80%), lobed to cleft by second lateral incision (30–50%), third lateral incision absent or up to 33%.

Fourth basal leaf 45–55 mm long, closed to narrow-angled at the base (0–60°), dissected by main incision; middle lobe deltoid to spatulate, stalked up to 7 mm with 11–15 teeth, irregularly trileft with incisions up to 60%, lateral edge straight (to slightly concave); lateral segment divided by first lateral incision (75–90%), cleft to divided by second lateral incision (45–70%), cleft by third, fourth and fifth lateral incision (45–65%, 35–45%, and 33–40%, respectively).

Fifth basal leaf 45–60 mm long, V-formed to widely angled at the base (70–140°), pediformly divided, dissected by main incision; middle lobe stalked up to 5 mm, irregularly narrowly deltoid to deltoid with 9–13 irregular teeth, lateral edge slightly convex to slightly concave; lateral segment divided by first lateral incision (55–95%), cleft to divided by second lateral incision (50–70%), cleft by third lateral incision (40–55%), fourth lateral incision absent or up to 27%.

Sixth basal leaf 40–50 mm long, narrowly angled to V-formed at the base (40–100°), divided to dissected by main incision

(92–100%); middle lobe narrowly deltoid (rhomboid) to deltoid, with 7–13 teeth, lateral edge straight (to slightly concave); lateral segment cleft to divided by first lateral incision (45–80%), lobed by second lateral incision (26–32%).

Seventh basal leaf 40–50 mm long, narrowly angled to V-formed at the base (50–100°), cleft to divided by main incision (50–80%); middle lobe (broadly) deltoid with 5–7 teeth, lateral edge straight to slightly concave; lateral segment undivided.

Lowermost stem leaf divided into 7–11 segments, largest segment 30–80 mm long, 1.5–4 mm wide, linear to narrowly lanceolate, undivided (or rarely with 1–2 small teeth).

Petals 0(–2), 7–9 mm long, 5–7 mm wide; **androclinium** 0.7–0.9 mm; **receptacle** ellipsoid, 3.2–4.5 mm long, 1.7–2.3 mm wide, glabrous, carpellophores 0.2–0.4 mm long; **fruits** 1.5–2.6 mm long, beak 0.6–0.9 mm long, straight to uncinat.

Pollen quality — good; 70.1% well developed (Nova Gradiška, holotype).

DNA-ploidy — unknown.

Distribution — known from two sites near Nova Gradiška, Brod-Posavina County.

Ecology — forest edges and escarpments of ditches.

Etymology — refers to the type locality near the town Nova Gradiška.

Vulnerability — endangered due to rarity.

Taxonomy — *R. gradiscanus* presents with an irregular leaf blade and 11–15 irregular teeth of the middle lobe of the spring leaves. For the *Ranunculus auricomus* complex in Croatia, this is unique and only found in *R. poldinioides* DUNKEL, too (see below). The cauline leaf segments of the lowermost leaf are undivided or bear only 1–2 short teeth. This in contrast to the irregular blade with multiple teeth of *R. poldinii* DUNKEL and *R. poldinioides* with 2–9 teeth (DUNKEL 2011). The low number of petals - often lacking completely - argues for an apomictic mode of reproduction. At present, *R. gradiscanus* is only known from two localities, but it can be expected that there are more populations in the extensive forests around the type locality.

Specimens seen — Croatia, Slavonia, Brod-Posavina County, **10870.1:** Nova Gradiška, ca. 3 km ssw Ljupina, an Knick der Schotterstraße Ljupina-Savski Bok, an großem Graben n des Weges, 100 m, 45°11'21"N 17°21'23"E, Grabenböschung, 27 Apr 2022, F.G. Dunkel, Du-40559; *ibidem*, Nova Gradiška, ca. 3 km ssw Ljupina, an Knick der Schotterstraße Ljupina-Savski Bok, 2,5 km o St4156, 100 m, 45°11'01"N 17°21'12"E, Hainbuchen-Wald, Waldrand, 27 Apr 2022, F.G. Dunkel, Du-40570.

5.2.18 *Ranunculus poldinioides* DUNKEL, Stapfia 111: 50, 2019.

Holotype: Slovenia, Predalpsko Območje, Ljubljansko barje, 9953.3, Ljubljana, ad viam versus vicum Ig ducentem, haud procul confluentis fluviorum Ljubljanica et Iščica, in pratis paludosis, solo argilloso, 290 m, 10 Apr 1972, T. Wraber, LJU-10046583; isotypes LJU-10046583, Du-27930. – Fig. 29; Figs. 13 & 39 in DUNKEL (2019).

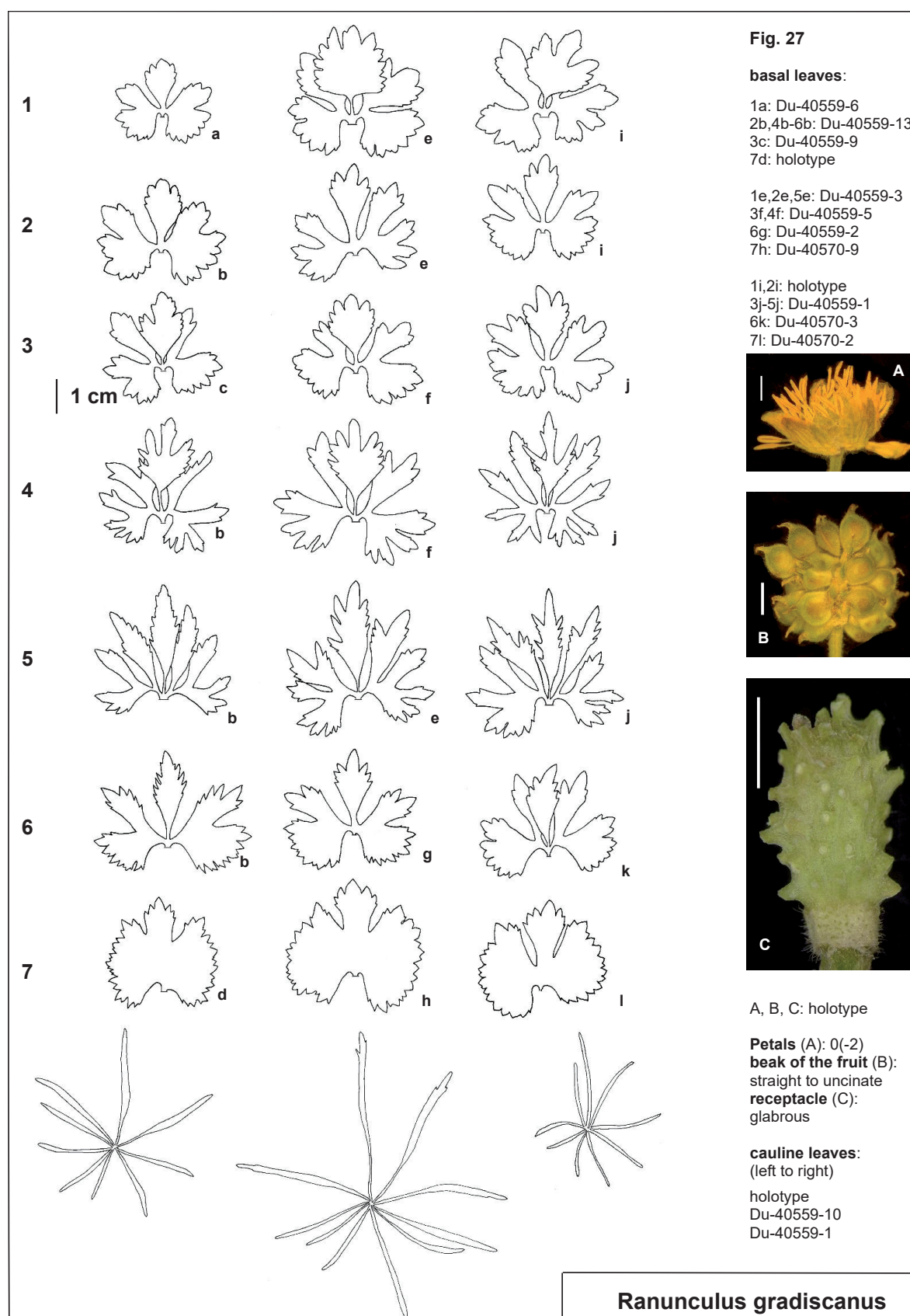


Fig. 27 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus gradiscanus*. The white bars in the figures of detail equal 2 mm.

Fig. 28 – Holotype of *Ranunculus gradiscanus* (ZA).



Fig. 29 – Specimen of *Ranunculus poldinioides* (Du-40441-14).

Pollen quality — mediocre; 58.0% well developed (isotype 27930-1).

DNA-ploidy — unknown.

Distribution — at present only known from the type locality near Postojn, Slovenia, and recently found near Slatina, Slavonia, Croatia.

Ecology — humid meadows, willow brushes.

Etymology — refers to the morphological similarity to *R. poldinii* (DUNKEL 2011).

Vulnerability — critically endangered due to rarity, and abandonment or eutrophication of humid meadows.

Taxonomy — *R. poldinioides* is characterized by irregularly formed middle and lateral lobes with an irregular crenate-serrate to dentated leaf edge. The basal leaves are usually wide-angled at the base, and the middle lobes rhomboid to deltoid. Populations with this type of irregular fine serrature are scarce. In Croatia, only *R. gradiscanus* presents a similar morphology but differs by elongated undivided teeth of the middle lobes of the spring leaves. This feature is name-giving in *R. longidens* (JULIN) ERICSSON, a species with a pilose receptacle, occurring only in the Swedish provinces of Södermanland and Upland (JULIN 1980). *R. longidens* bears more or less linear leaf segments with 0–2 small teeth vs. 2–9 irregular short to long patent teeth in *R. poldinioides*. Ecologically, both populations of the critically endangered species share the same type of vegetation: willow brushes at the edge of humid meadows (*Salicion cinereae*).

Specimens seen — Croatia, Slavonia, Virovitica-Podravina County, **10372.3**: Slatina, n Ulica Branka Radićevića, zwischen Bokane und Čeralije, 140 m, 45°37'17"N 17°40'50"E, Weidengebüsch, feuchte Wirtschaftswiese, 15 April 2022, F.G. Dunkel, Du-40441.

5.2.g *Ranunculus stricticaulis* group

5.2.19 *Ranunculus plitvicensis* DUNKEL sp. nov.

Holotype: Croatia, Lika-Senj County: 11159.2, Plitvice Lakes National Park, Plitvički Ljeskovac, 300 m s des S-Endes des [south of the southern end of] Prošćansko Jezero, lichter Erlenbruch [light alder swamp forest], 642 m, 44°50'59"N 15°35'57"E, 27 Apr 2023, F.G. Dunkel 41004, ZA; isotypes GOET, M, Du-41004. – Figs. 30 & 31.

Description — *Flowering shoot* gracile to slim, 15–28 cm, stalk 1.0–3.4 mm in diameter, reddish at the base, suberect to moderately patent, angle between the main and secondary axis 5–40°, flowers 2–5(7), enrichment shoots 0–2; basal leaves 2–6 per rosette.

Basal leaf cycle: similar to some Italian species, *R. plitvicensis* keeps occasionally basal leaves from the last summer, undivided leaves of 18 to 30 mm diameter, with closed to narrowly angled aperture at the base (–5°–50°) and irregularly crenated leaf edge. The leaf edge of the first to seventh basal leaf is irregularly and coarsely crenate-serrate.

First basal leaf 20–25 mm long, blade at the base narrow-angled to V-formed (50–100°), usually undivided, occasionally lobed to cleft by the main incision (26–45%), middle segment, if present, trapezoid to deltoid with 3–5 teeth, lateral edge straight

to slightly convex; lateral segment undivided.

Second basal leaf 20–35 mm long, base narrow-angled to V-formed (20–100°), cleft by the main incision (40–65%), middle lobe deltoid with 5–7 teeth, lateral edge slightly concave; lateral segment undivided or occasionally with a first lateral incision of up to 45%.

Third basal leaf 28–38 mm long, base narrow-angled (40–60°), cleft to divided by the main incision (60–90%), middle lobe deltoid to spatulate with (4)5–7 teeth, lateral edge slightly concave; lateral segment undivided or cleft by the first lateral incision (33–60%).

Fourth basal leaf 28–40 mm long, aperture at the base narrow-angled to V-formed (10–100°), divided to dissected by the main incision (96–100%), middle lobe occasionally stalked up to 1 mm long, rhomboid with 7–11 teeth, lateral edge slightly concave to straight; lateral segment divided by the first lateral incision (66–85%), second lateral incision absent or up to 33%.

Fifth basal leaf 24–40 mm long, base narrow-angled to wide-angled (50–150°), divided by the main incision (75–98%), middle lobe deltoid with 5–9 teeth, lateral edge slightly concave to straight; lateral segment cleft to divided by the first lateral incision (45–80%).

Sixth basal leaf 28–45 mm long, base narrow-angled to V-formed (50–100°), divided by the main incision (75–92%), narrowly deltoid to deltoid with 4–9 teeth, lateral edge slightly concave to straight; lateral segment undivided or cleft to divided by the first lateral incision (40–70%), second lateral incision absent or occasionally up to 50%.

Seventh basal leaf 22–33 mm long, at the base V-formed to widely angled (90–120°), usually undivided or occasionally divided by the main incision (70–80%), if present, middle lobe narrowly deltoid with 3 teeth, lateral edge slightly concave to straight; lateral segment undivided.

Lowermost stem leaf divided into 7–11 segments, largest segment 25–45 mm long, occasionally stalked, linear to oblanceolate, 2–4.5 mm wide, occasionally at small plants undivided, usually with (1)2–8 short or patent obtuse teeth.

Petals (2–)5, 7–9 mm long, 6–8 mm wide; *androclinium* 0.4–0.6 mm long; *receptacle* almost globose to ellipsoid, 2.5–3.5 mm long, 1.9–2.5 mm wide, glabrous, intervallum absent, carpellophores 0.2–0.4 mm long; *fruits* 2.0–2.8 mm long, beak 0.6–1.2 mm long, straight to uncinat.

Pollen quality — mediocre; 57.3% well developed (Plitvički Ljeskovac, holotype).

DNA-ploidy — not known, probably 4x.

Distribution — known from the type locality at the southern end of the Prošćansko lake, at two sites (Šegula 2000).

Ecology — alder-swamp woods (VUKELIĆ & al. 2019).

Etymology — refers to the type locality at the Prošćansko lake, part of the Plitvice lakes National Park.

Vulnerability — potentially endangered due to rarity.

Taxonomy — *R. plitvicensis* is similar to other members of the *R. croaticola* group but differs by rhomboid middle lobes with large and coarse margin teeth similar to *R. rhombilobus* BORCH.-KOLB (1985) and by a high number (7–11) of segments of the lowermost cauline leaf. The largest segment carries (1)2–8 obtuse teeth. The receptacle is almost globose and measures

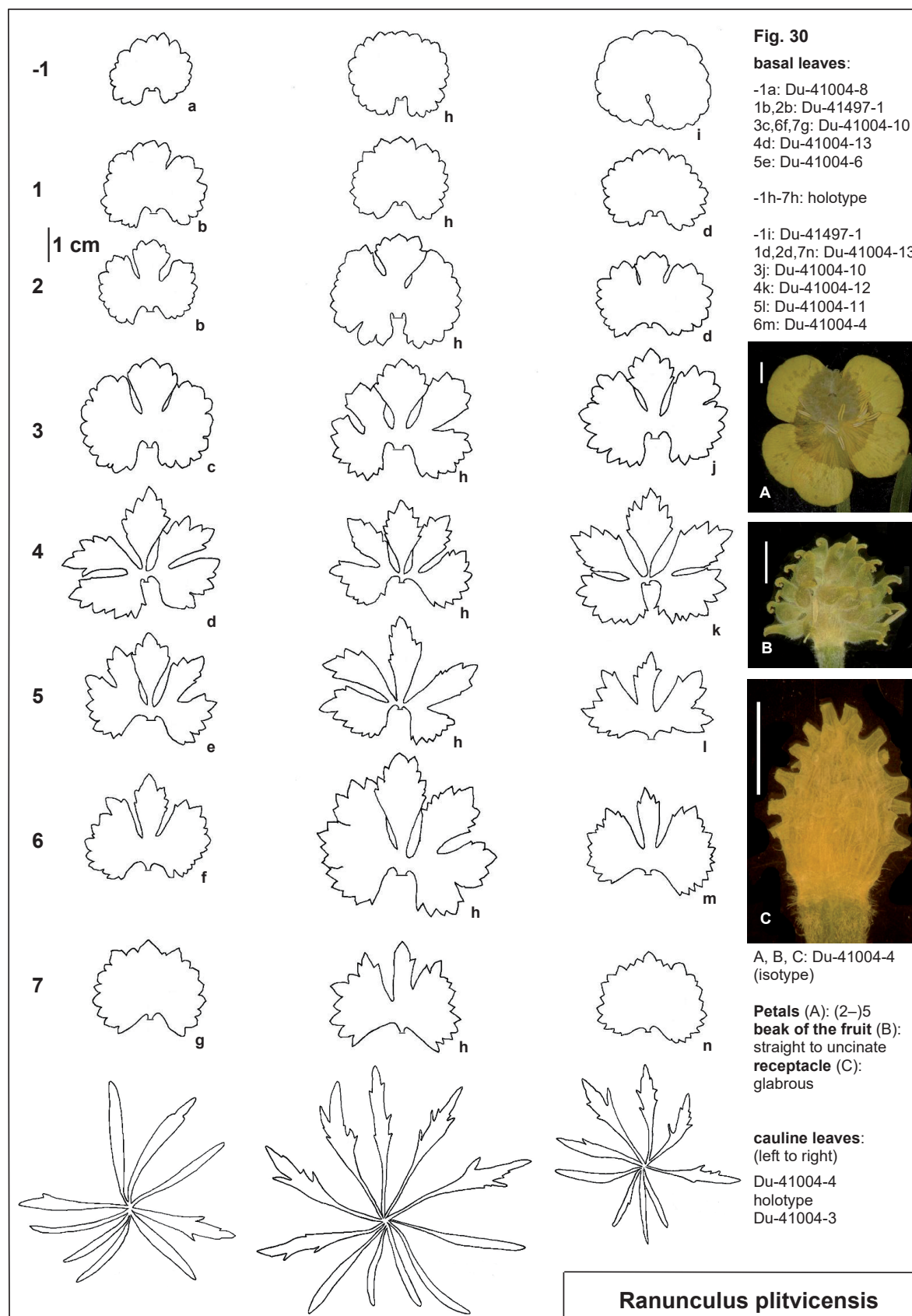


Fig. 30 – Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus plitvicensis*. The white bars in the figures of detail equal 2 mm.



Fig. 31 – Holotype of *Ranunculus plitvicensis* (ZA).

2.5–3.5 mm, hence, it is shorter than in other taxa of the group. Morphologically, *R. plitvicensis* is close to *R. gayeri* Soó (1964). Therefore, it is put into the *R. stricticaulis* group (HÖRANDL & GUTERMANN 1998a). The two populations of *R. plitvicensis* grow in the Plitvice lakes National Park, a highly protected area. Since the number of plants is not documented – a decrease or an increase in the last decennials – *R. plitvicensis* is of potential risk of extinction due to small populations.

Specimens seen — Croatia, Lika-Senj County, **11159.2**, Plitvice Lakes National Park, Plitvički Ljeskovac, 500 m s des S-Endes des Prošćansko Jezero, 44°50'58.1"N 15°36'04.4"E, 640 m, lichter Erlenbruch, vereinzelt, 27 Apr 2023, F.G. Dunkel, Du-41497.

5.2.h *Ranunculus argoviensis* group

5.2.20 *Ranunculus divisor* DUNKEL sp. nov.

Holotype: Croatia, Slavonia, Osijek-Baranja County, 10374.4, Donji Miholjac, w der D 53, s Malinovac, 100 m, 45°36'41"N 18°08'20"E, Auwald und Erlenbruch [floodplain forest and alder swamp forest], 28 Apr 2023, F.G. Dunkel 41677, ZA; isotypes Du-41677. – Figs. 32 & 33.

Description — *Flowering shoot* slim to robust, 28–55 cm, stalk 1.5–3.5 mm in diameter, reddish at the base, suberect to patent, angle between the main and secondary axis 30–80°, flowers 3–10, enrichment shoots 0–2; basal leaves 1–3(4) per rosette.

Basal leaf cycle: aperture at the base closed to narrowly angled ((–)0–50(60)°), leaf edge irregularly crenate-serrate.

First basal leaf 40–55 mm long, blade at the base narrow-angled (5–40°), divided by the main incision (90–95%), middle segment deltoid with 3–5 teeth, lateral edge straight; lateral segment cleft to divided by first lateral incision (50–75%), lobed to cleft by second lateral incision (26–55%).

Second basal leaf 45–60 mm long, blade at the base narrow-angled (40–60°), divided by the main incision (85–98%), middle segment deltoid with 5–7 teeth, lateral edge slightly concave to straight; lateral segment divided by first lateral incision (70–92%), cleft by second and third lateral incision (45–65%, and 33–40%, respectively).

Third basal leaf 45–60 mm long, blade at the base narrow-angled (5–20°), divided by the main incision (90–98%), middle segment deltoid with 4–7 teeth, lateral edge slightly concave to slightly convex; lateral segment cleft to divided by first lateral incision (60–75%), cleft by second and third lateral incision (45–55%, and 33–45%, respectively), lobed by fourth lateral incision (26–32%).

Fourth basal leaf 45–75 mm long, blade at the base narrow-angled (0–30°), divided to dissected by the main incision (95–100%), middle segment trileft, with incisions up to 55%, deltoid with 3–5 teeth, lateral edge slightly concave to slightly convex; lateral segment divided by first lateral incision (66–85%), cleft to divided by second lateral incision (45–70%), cleft by third and fourth lateral incision (35–50%, and 33–45%, respectively).

Fifth basal leaf 40–60 mm long, base closed to narrow-angled (–5–20°), divided by the main incision (92–98%), middle lobe deltoid to spatulate, partly trileft with incisions up to 30%,

lateral edge slightly convex to straight; lateral segment cleft by the first lateral incision (40–65%), second lateral incision absent or up to 35%.

Sixth basal leaf 35–50 mm long, base narrow-angled (5–15°), divided by the main incision (85–95%), middle lobe deltoid to spatulate with 7–9 teeth, lateral edge slightly concave to straight; lateral segment undivided or lobed to cleft by the first lateral incision (26–35%).

Seventh basal leaf 25–50 mm long, aperture at the base closed to narrow-angled (–5–50°), divided by main incision (70–95%), middle lobe deltoid to spatulate with 5–9 teeth, lateral edge straight to slightly concave; lateral segment undivided.

Lowermost stem leaf divided into 7–9 segments, largest segment 40–80 mm long, rarely stalked, linear to oblanceolate, 4–10 mm wide, undivided or with 1–2(3) teeth.

Petals 2–5, 9–12 mm long, 7–9 mm wide; *androclinium* 0.2–0.3 mm long; *receptacle* ellipsoid, 3.5–4.8 mm long, 2.8–3.2 mm wide, glabrous, invervallum absent, carpellophores 0.15–0.3 mm long; *fruits* 2.3–2.9 mm long, beak 0.4–1.0 mm long, uncinat to involuted.

Pollen quality — mediocre; 56.1% well developed (Donji Miholjac, isotype Du-41677-1).

DNA-Ploidy — not known.

Distribution — known from the type locality near Donji Miholjac.

Ecology — humid hornbeam forest and alder swamp forest.

Etymology — refers to the more divided spring leaves of the basal leaf cycle.

Vulnerability — potentially endangered due to rarity.

Taxonomy — visiting an alder forest and adjacent humid hornbeam forest, the plants of *R. divisor* were at once striking by the more divided spring leaves. The basal leaf cycle is rather homophyllous. Especially the first four leaves of the cycle are deeply divided with obtuse leaf lobules, the main incision amounts to 85–100%, at the seventh leaf occasionally only 70%. Although at present, there are only two known populations, the taxon is described as new to science. The plants could not be categorized into the *R. croatica* group.

Specimens seen — Croatia, Slavonia, **10374.2**: Donji Miholjac, so Kapelna, nw Kučanci, an der Straße 4031, kurz nach 90°-Kurve und Eintritt in den Laubwald, 100 m, 45°40'29"N 18°05'31"E, feuchter Straßengraben im Hainbuchen-Wald, 28 Apr 2023, F.G. Dunkel, Du-41672 pro parte.

5.2.i *Ranunculus schlosseri* group

5.2.21 *Ranunculus schlosseri* DUNKEL sp. nov.

Holotype: Croatia, Zagreb county, 10363.3, Orle, s Orle, Terasse an der Odra im Weiler Selce, 100 m, 45°38'25"N 16°13'39"E, Gebüschrand [terrace of the Odra in hamlet Selce; edge of brushes], 27 Apr 2022, F.G. Dunkel 40571, ZA (consisting of one individual currently mounted on two sheets clearly labelled as parts of the same preparation); isotypes GOET, LI, M, Du-40571. – Figs. 34 & 35, Tab. 1.

Description — *Flowering shoot* (slim to) robust, 28–55 cm tall, scape 2.4–4.0 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to patent (20–60°), flowers 2–8, enrichment shoots 0–1(2); basal leaves 1–5 per rosette.

Basal leaf cycle: at the base closed to narrow-angled at the initial leaves (0–10°), closed to narrowly angled at the third to seventh leaf (0–60°), at the third and fourth basal leaf occasionally up to 80°, leaf edge very irregularly crenate-serrate.

First basal leaf 25–40 mm long, divided by the main incision (70–95%); middle lobe spatulate with 5–13 crenated teeth, lateral edge slightly convex to slightly concave; lateral segment undivided or lobed to cleft by the first lateral incision (up to 55%).

Second basal leaf 40–60 mm long, divided to dissected by the main incision (90–100%); middle lobe deltoid to spatulate with 7–11 crenated teeth, lateral edge slightly convex to slightly concave; lateral segment divided by the first lateral incision (80–90%), second lateral incision absent or up to 45%.

Third basal leaf 50–65 mm long, divided to dissected by main incision (97–100%); middle lobe deltoid (to spatulate), usually stalked up to 3 mm, with 7–11 teeth, occasionally irregularly trileft with incisions up to 33%, lateral edge slightly convex to slightly concave; lateral segment divided by first lateral incision (80–94%), cleft to divided by second lateral incision (50–70%), cleft by third lateral incision (40–45%), lobed to cleft by fourth and fifth lateral incision (30–45%, and 30–40%, respectively).

Fourth basal leaf 60–95 mm long, divided to dissected by main incision (95–100%); middle lobe narrowly deltoid to elliptic with 7–11 teeth, occasionally irregularly trileft with incisions up to 33%, lateral edge normally more or less straight; lateral segment divided by first and second lateral incision (75–98%, and 70–90%, respectively), cleft to divided by third lateral incision (50–85%), cleft by fourth and fifth lateral incision (35–50%, and 33–46%, respectively), lobed to cleft by sixth lateral incision (28–35%).

Fifth basal leaf 40–70 mm long, divided to dissected by main incision (95–100%); middle lobe irregularly narrowly deltoid with 3–7 teeth, frequently irregularly trileft with incisions up to 50%, lateral edge straight; lateral segment divided to almost dissected by first and second lateral incision (85–98%, and 75–92%, respectively), cleft to divided by third lateral incision (60–80%), cleft by fourth and fifth lateral incision (35–50%, and 33–40%, respectively).

Sixth basal leaf 45–65 mm long, divided by main incision (70–92%); middle lobe deltoid, with 7–11 teeth, lateral edge straight; lateral segment undivided or occasionally lobed to cleft by first lateral incision (26–40%).

Seventh basal leaf 35–65 mm long, cleft to divided by main incision (50–92%); middle lobe deltoid, with 5–11 teeth, lateral edge straight; lateral segment undivided.

Intermediate leaves, similar to the fourth and fifth basal leaves with four to six lateral incisions.

Lowermost stem leaf divided into 7–11 segments, largest segment 35–80 mm long, 2.5–5(7) mm wide, linear to narrowly lanceolate, rarely narrowly deltoid, undivided or with 1–2 teeth.

Petals (3–)5, 10–16 mm long, (7)9–12 mm wide; *androcli-*

nium 0.7–0.9 mm; *receptacle* globose to ellipsoid, 3.4–4.5 mm long, 2.5–3.5 mm wide, glabrous, intervallum absent, carpellophores 0.15–0.3 mm long; *fruits* 1.8–2.8 mm long, beak 0.6–1.2 mm long, straight to uncinat.

Pollen quality — mediocre; 40.9% well developed (Orle, Selce, holotype).

DNA-ploidy — 4x (Orle, Selce, Du-40571).

Distribution — known from an area southeast of Velika Gorica in a good quantity.

Ecology — ditches, brushes, forest edges and adjacent humid meadows.

Etymology — refers to Josef Calasanz Schlosser, Ritter von Klekovski, (1808–1882), Moravian-born Austrian physician and botanist, together with Ludwig von Farkaš-Vukotinović author of the *Flora croatica* (1869).

Vulnerability — potentially endangered due to rarity.

Taxonomy — *Ranunculus schlosseri* is one of the largest and most beautiful taxa of the whole complex. It often develops two to three enrichments shoots with intermediate leaves. Indeed, the leaf cycle is very heterophyllous: the initial leaves have undivided or slightly divided lateral lobes with at most two incisions, the deeply divided spring leaves present with multiple, up to six lateral incisions and the leaf cycle terminates by final leaves with undivided lateral lobes. Although the flowers are almost complete, according to pollen morphology and DNA-content, *R. schlosseri* is tetraploid and probably apomictic. Its morphology justifies putting it in a group of its own. Due to several populations with multiple plants, *R. schlosseri* is only vulnerable in regard of its rarity.

Specimens seen — Croatia, Zagreb county, **10263.3**: Orle, s Čret Posavski, an kleiner Verbindungsstraße, 100 m, 45°42'17"N 16°11'46"E, Wirtschaftswiese und angrenzendes Gebüsch, 27 Apr 2022, F.G. Dunkel, Du-40591; **10363.3**: Orle, s Orle, Terasse an der Odra im Weiler Selce, 100 m, 45°38'25"N 16°13'39"E, Gebüschrand, 27 Apr 2022, F.G. Dunkel, Du-40571 (isotypes); Sisak-Moslavina County, **10363.3**: Lekenik, ca. 4,5 km n Lekenik, Schotterstraße parallel zur Odra, 100 m, 45°38'02"N 16°12'43"E, feuchter Graben, 28 Apr 2023, F.G. Dunkel, Du-41668; ibidem, Lekenik, ca. 5 km nno Lekenik, an Stichstraße (Schotterweg) zur Odra, 110 m, 45°37'20"N 16°14'07"E, Grabenrand, 28 Apr 2023, F.G. Dunkel, Du-41670; **10564.2**: Sisak, O-Rand von Novo Selo Palanječkoan an der D 36, 100 m, 45°29'02"N 16°27'45"E, umgebene Fläche, ehemalige Gebüsch- und Auwaldreste, 28 Apr 2023, F.G. Dunkel, Du-41671.

5.2.22 *Ranunculus velebiticus* DUNKEL sp. nov.

Holotype: Croatia, Velebit, Lika-Senj County, 11255.2, Krasno Polje, Jezera, 2,8 km sw Krasno, 1,6 km no Mali Rajinac, W-Hang des Pljišivica, subalpine Wiesen [subalpine meadows], 1480 m, 44°48'14"N 15°01'32"E, 07 Jun 2020, F.G. Dunkel 37863, ZA; isotypes GOET, M, Du-37863. — Figs. 36 & 37.

Description — *Flowering shoot* gracile to slim, 12–32 cm tall, scape 0.7–2.0 mm in diameter, at the base reddish, terete, cataphylls absent, angle between the main and secondary axis suberect to moderately patent (10–50°), flowers 1–5, enrichment

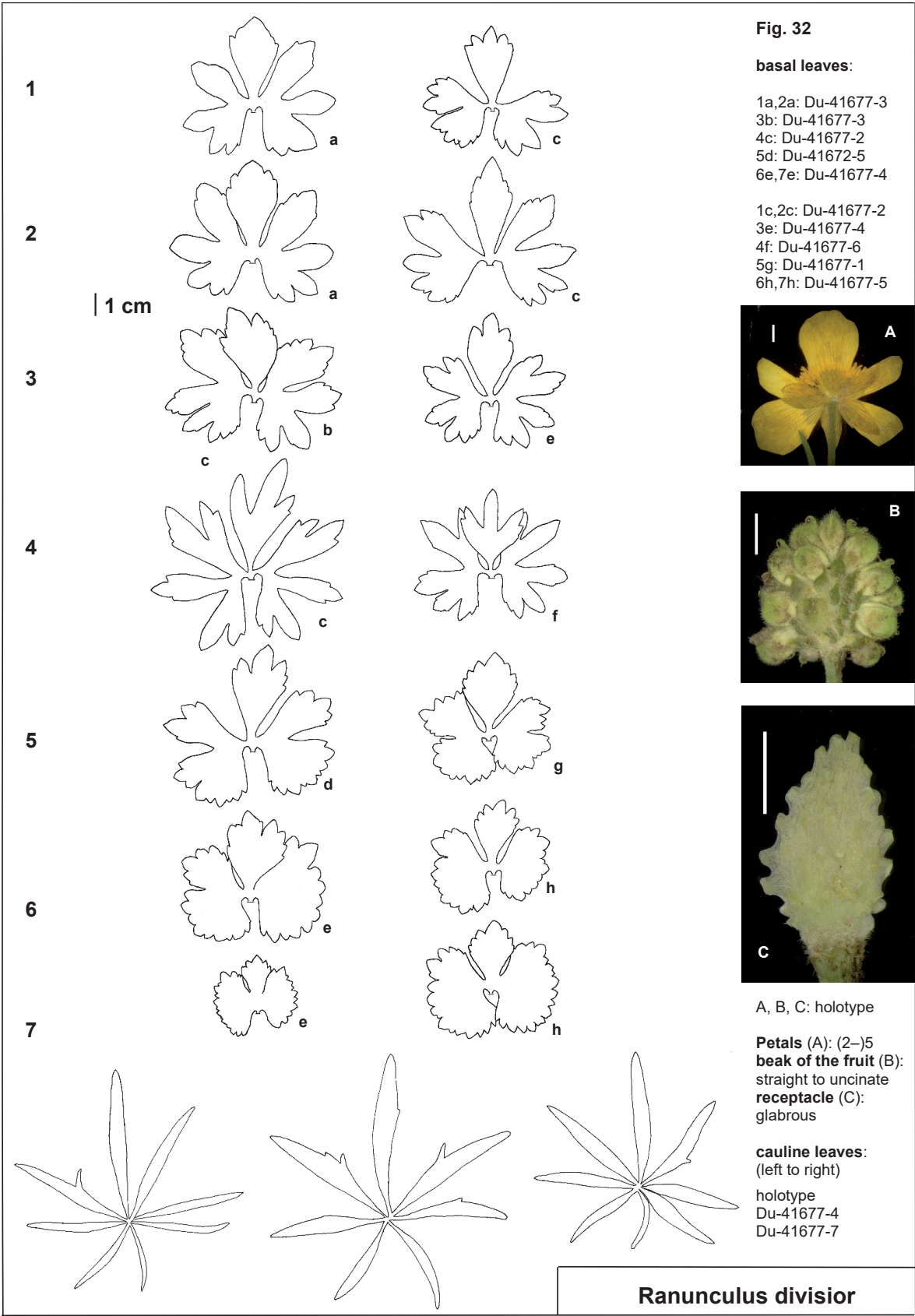


Fig. 33 – Holotype of *Ranunculus divisor* (ZA).

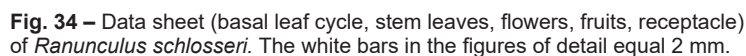




Fig. 35 – Holotype of *Ranunculus schlosseri* (ZA); image composed of the elements mounted on the two sheets of the holotype preparation.

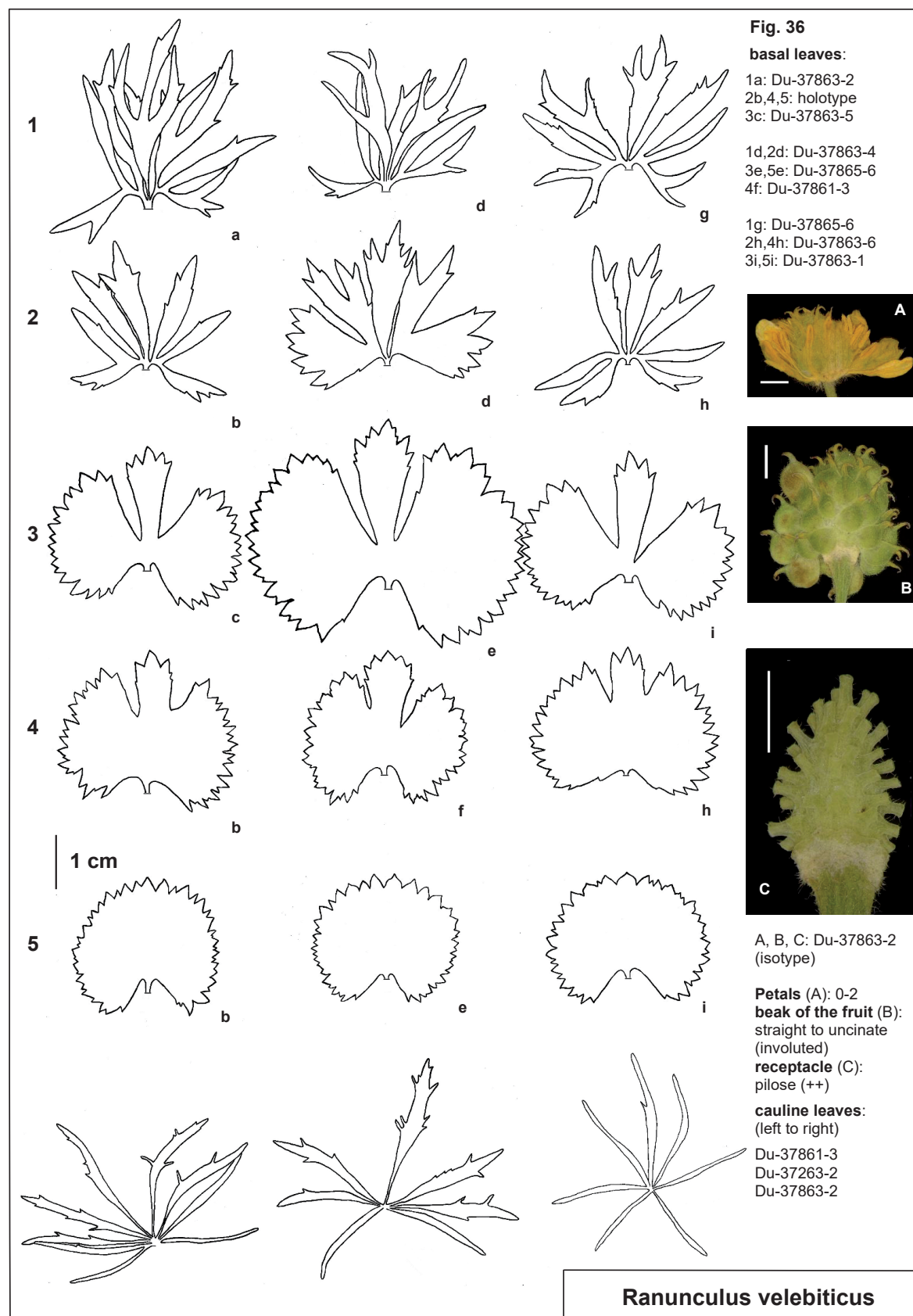


Fig. 36– Data sheet (basal leaf cycle, stem leaves, flowers, fruits, receptacle) of *Ranunculus velebiticus*. The white bars in the figures of detail equal 2 mm.



Fig. 37 – Holotype of *Ranunculus velebiticus* (ZA).

shoots 0–2; basal leaves 2–5 per rosette.

Basal leaf cycle: consisting obviously only of five leaves (*R. fallax* group), level of division of the leaf blade decreasing from the first to the fifth leaf, leaf edge irregularly and coarsely crenate-serrate, fifth leaf finely serrate with long teeth and some crenated teeth in between.

First basal leaf 40–65 mm long, aperture at the base V-formed to widely angled (80–140°), dissected by main incision; middle lobe irregularly deltoid with 5–9 teeth, trifid by incisions up to 60%, lateral edge straight to slightly concave; lateral segment divided by first and second lateral incision (85–99%, and 75–85%, respectively), cleft to divided by third lateral incision (45–80%), cleft by fourth lateral incision (40–60%), fifth lateral incision absent or up to 45%.

Second basal leaf 40–55 mm long, aperture at the base narrowly to widely angled (70–140°), dissected by main incision; middle lobe irregularly deltoid with 3–7 teeth, trilobed by incisions up to 33%, lateral edge slightly convex to slightly concave; lateral segment divided by first lateral incision (70–98%), cleft to divided by second lateral incision (35–90%), cleft by third lateral incision (30–40%), fourth lateral incision absent or up to 35%.

Third basal leaf 40–50 mm long, aperture at the base narrowly angled to V-formed (60–90°), divided by main incision (75–90%); middle lobe (irregularly) deltoid with 5–9(11) teeth, lateral edge straight; lateral segment undivided.

Fourth basal leaf 40–70 mm long, aperture at the base narrowly to widely angled (50–110°), cleft to divided by main incision (40–70%); middle lobe deltoid to rectangle with 3–7 teeth, lateral edge straight (to slightly concave); lateral segment undivided.

Fifth basal leaf 35–50 mm long, aperture at the base narrowly to widely angled (60–100°), undivided.

Lowermost stem leaf divided into 7–9 segments, largest segment 35–60 mm long, 3–7 mm wide, oblanceolate, with 2–8 teeth.

Petals 0–2, 5–9 mm long, 4–7 mm wide; **androclinium** 0.5–0.7 mm; **receptacle** ellipsoid, 3.0–4.5 mm long, 1.8–2.3 mm wide, pilose(++), intervallum absent, carpellophores 0.2–0.4 mm long; **fruits** 1.5–2.2 mm long, beak 0.6–1.0 mm long, straight to uncinate (involute).

Pollen quality — bad; 32.9% well developed (Krasno, isotype Du-37863-2).

DNA-ploidy — not known, probably 4x (measurements not successful).

Distribution — known from the type locality and surroundings in a circumference of 300 m, isolated occurrence.

Ecology — subalpine meadows at 1420–1480 m.

Etymology — refers to the type locality at the Velebit mountains.

Vulnerability — endangered due to rarity and risk of reforestation.

Taxonomy — it was more than 120 years ago, Ludovico Rosi collected “*Ranunculus auricomus*” at the Velebit mountains. A specimen is deposited at the central Zagreb Herbarium (ZA) and A. von Degen (1937) reported it in the Flora Velebitica: “Jezerka über Krasno. Two small populations of this taxon were found at

the indicated site by the author in 2020. It is morphologically different from the species of the floodplain and hornbeam forests, and indeed, it reminds to *Ranunculus fallax* in the sense of Scandinavian authors (grade 2 of S. Ericsson: ERICSSON 2001) with large partly divided basal leaves. Normally, the fourth spring leaf is the most divided. Here, it is the first one. Interestingly, this is the same mode of leaf cycle as in *R. wraberi* PIGNATTI from Mount Nanos in Slovenia (DUNKEL 2019). Clearly, the first leaves of *R. velebiticus* are more irregularly and deeper divided than in *R. wraberi*. The receptacle of *R. wraberi* is pilose, that of *R. velebiticus* only scarcely pilose. Both species occur at subalpine meadows. Hence, it would be interesting to investigate whether *R. velebitus* and *R. wraberi* (and *R. braun-blauquetii* PIGNATTI) possess a common origin.

Specimens seen — Croatia, Velebit, Lika-Senj County, 11155.2: Jezera ad Krasno, 25 Jun 1896, L. Rossi, ZA; ibidem, Krasno Polje, Jezera, 2,7 km sw Krasno, 1,5 km no Mali Rajinac, 1470 m, 44°48'17"N 15°01'31"E, subalpine Wiesen, 07 Jun 2020, F.G. Dunkel, Du-37861; ibidem, Jezera, ca. 2,8 km sw Krasno, zwischen Dolinengrund und Wanderweg nahe der verfallenen Kirche Sv. Ana, 1,3 km no Mali Rajinac, 1420 m, 44°48'20"N 15°01'15"E, subalpine Wiesen, 07 Jun 2020, F.G. Dunkel, Du-37865.

5.2.23 *Ranunculus albimonasterius* DUNKEL sp. nov.

Holotype: Croatia, Baranja, Osijek-Baranja County, 10277.4, Beli Manastir, s Beli Manastir, ca. 150 m w der Bahn, 250 m n Umspannwerk, Holzschlag, feuchter Vorwald [150 m w of railway line, 250 m n to electric power transformation substation, humid shrub community after forest cutting], 45°43'15"N 18°37'38"E, 26 Apr 2022, F.G. Dunkel 40496, ZA; isotypes GOET, LI, Du-40496. – Figs. 38 & 39, Tab. 1.

Description — **Flowering shoot** slim to robust, 18–46 cm tall, scape 1.2–2.7 mm in diameter, at the base reddish, terete, angle between the main and secondary axis suberect to patent (15–60°), flowers 2–6, enrichment shoots 0–3; basal leaves 1–4 per rosette.

Basal leaf cycle: leaf edge very irregularly crenate-serrate, at the leaf cycle crenated teeth increasingly acute.

First basal leaf 20–40 mm long, V-formed to widely angled at base (90–140°), cleft to divided by the main incision (55–90%); middle lobe trapezoid to deltoid with 3–11 crenated teeth, lateral edge straight to slightly concave, occasionally tricleft with incisions up to 45%; lateral segment undivided or lobed to cleft by the first lateral incision (up to 55%).

Second basal leaf 30–45 mm long, narrow-angled to V-formed at base (50–100°), divided by the main incision (75–90%); middle lobe deltoid with 5–9 teeth, lateral edge straight (to slightly concave); lateral segment cleft to divided by the first lateral incision (50–70%), second lateral incision absent or up to 33%.

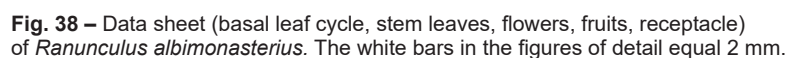




Fig. 39 – Holotype of *Ranunculus albimonasterius* (ZA).

Third basal leaf 30–50 mm long, V-formed at the base (80–100°), divided by main incision (90–98%); middle lobe deltoid with 5–11 teeth, lateral edge straight to slightly concave; lateral segment cleft to divided by first lateral incision (40–70%), second lateral incision absent or up to 33%.

Fourth basal leaf 35–50 mm long, V-formed to wide-angled at the base (90–120°), divided by main incision, pedatiform; middle lobe narrowly deltoid to deltoid, with 5–9 teeth, lateral edge straight; lateral segment divided by first lateral incision (70–80%), cleft by second lateral incision (33–45%).

Fifth basal leaf 35–50 mm long, V-formed to widely angled at the base (90–120°), divided by main incision (90–99%), pedatiform; middle lobe lanceolate to irregularly narrowly deltoid with 0–5 teeth, lateral edge slightly convex to straight; lateral segment divided by first lateral incision (66–85%), lobed to cleft by second lateral incision (30–40%), third lateral incision absent or up to 27%.

Sixth basal leaf 35–55 mm long, V-formed to widely angled at the base (80–140°), divided by main incision (80–90%), pedatiform; middle lobe narrowly deltoid to deltoid, with 3–7 teeth, lateral edge straight (to slightly concave); lateral segment cleft by first and second lateral incision (40–60%, and 33–40%, respectively).

Seventh basal leaf 25–40 mm long, widely angled at the base (120–150°), cleft to divided by main incision (40–75%); middle lobe deltoid with 5–11 teeth, lateral edge slightly convex to slightly concave; lateral segment undivided.

Lowermost stem leaf divided into 7–11 segments, largest segment 30–70 mm long, 2.5–4(5) mm wide, lanceolate, undivided, or occasionally with 1 tooth.

Petals 0–2(5), 6–9 mm long, 5–7 mm wide, sepals conspicuously patent pilose, reddish; *androclinium* 0.5–0.8 mm; *receptacle* ellipsoid, 2.7–3.5 mm long, 1.3–1.9 mm wide, sparsely pilose (+), intervallum absent, carpellophores 0.1–0.3 mm long; *fruits* 1.0–1.8 mm long, beak 0.4–1.0 mm long, uncinat.

Pollen quality — bad; 31.3% well developed (Beli Manastir, isotype Du-40496-9).

DNA-ploidy — unknown.

Distribution — known from the type locality near Bela Manastir, Osijek-Baranja County and a small population nearby.

Ecology — forest edges, hornbeam forests and clear cuttings.

Etymology — refers to the type locality near the small-town Beli Manastir in the Osijek-Baranja County.

Vulnerability — endangered due to rarity.

Taxonomy — In adjacent Slovenia, populations of the meadows quantitatively and qualitatively form a large part of the whole *Ranunculus auricomus* complex. However, in Croatia, such populations of humous meadows are almost completely absent. Those species possess small incomplete flowers and deeper divided blades of the basal leaves. *R. albimonasterius* is the only taxon which can be put into the *Ranunculus indecorus* group. At the moment, *R. albimonasterius* profits from sunlight readily available after a complete cutting of the oak hornbeam forest. However, it is a question of time before the present shrub community with *Juncus effusus* develops into a forest. Although there are plenty of plants in a local area, *R. albimonasterius* is

endangered and could only be found in a good condition at the type locality.

R. albimonasterius is similar to *R. labacensis* DUNKEL and *R. lanceolifer* DUNKEL (DUNKEL 2019), both belonging to the *R. indecorus* group. It differs from the first by a finely serrate leaf edge of the final leaf with > 25 vs. ≤ 20 teeth, and shorter carpellophores (0.1–0.3 vs. 0.4–0.75 mm). *R. lanceolifer* has densely pilose receptacles with a short intervallum, in *R. albimonasterius* the receptacle is at most sparsely pilose and the intervallum is absent.

Specimens seen — Croatia, Baranja, Osijek-Baranja County, **10277.4**: Beli Manastir, s Beli Manastir, ca. 200 m w der Bahn, 400 m n Umspannwerk, 95 m, 45°43'14"N 18°37'40"E, im Hainbuchen-Wald und Waldrand, 26 Apr 2022, F.G. Dunkel, Du-40600.

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8 References

- BORCHERS-KOLB E. (1983): *Ranunculus sect. Auricomus* in Bayern und den angrenzenden Gebieten. I. Allgemeiner Teil. — Mitt. Bot. Staatssamml. München **19**: 36–429.
- BORCHERS-KOLB E. (1985): *Ranunculus sect. Auricomus* in Bayern und den angrenzenden Gebieten. II. Spezieller Teil. — Mitt. Bot. Staatssamml. München **21**: 49–300.
- BRADICAN J.P., TOMASELLO S., BOSCUCCI F., KARBSTEIN K., HÖRANDL E. (2023): Phylogenomics of Southern European Taxa in the *Ranunculus auricomus* Species Complex: The Apple Doesn't Fall Far from the Tree. — Plants (Basel) **12**(21): 3664. <https://doi.org/10.3390/plants12213664>.
- BRADICAN, J.P., TOMASELLO, S., VOLLMER, J. HÖRANDL, E. (2024): Converging forms: an examination of sub-Arctic, circumarctic, and Central Asian *Ranunculus auricomus* agg. populations. — Front. Plant Sci. **15**: 1415059. doi: 10.3389/fpls.2024.1415059.
- CONTI F. & BARTOLUCCI F. (2017): *Ranunculus giordanoi* sp. nov. from the *R. auricomus* complex (Ranunculaceae), central Apennines (Italy). — Nordic J. Bot. **35**: 322–327. <https://doi.org/10.1111/njb.01433>.
- DOLEŽEL J., GREILHUBER J., LUCRETTI S., MEISTER A., LYSÁK M.A., NARDI L. & al. (1998): Plant genome size estimation by flow cytometry: Inter-laboratory comparison. — Ann. Bot. **82** (Suppl. A): 17–26.

- DOLEŽEL J., GREILHUBER J., SUDA J. (2007): Estimation of nuclear DNA content in plants using flow cytometry. — *Nat. Protoc.* **2**: 2233–2244.
- DUNKEL F.G. (2005): Der *Ranunculus auricomus*-Komplex in Südtirol – Artenspektrum, Verbreitung und Gefährdung. — *Gredleriana* **5**: 85–102.
- DUNKEL F.G. (2010): The *Ranunculus auricomus* complex in Northern Italy. — *Webbia* **65**: 179–227.
- DUNKEL F.G. (2011): The *Ranunculus auricomus* L. complex (Ranunculaceae) in Central and Southern Italy with additions for the north. — *Webbia* **66**: 165–193.
- DUNKEL F.G. (2014): Le complexe de *Ranunculus auricomus* (Ranunculaceae) en Alsace. — *J. Bot. Soc. Bot. France* **66**: 3–53.
- DUNKEL F.G. (2015): *Ranunculus pindicola* sp. nov., the only species of the *R. auricomus* complex (Ranunculaceae) in Greece. — *Willdenowia* **45**: 223–230.
- DUNKEL F.G. (2019): The *Ranunculus auricomus* L. complex (Ranunculaceae) in Slovenia. — *Stapfia* **111**: 33–91.
- DUNKEL F.G. (2020): *Ranunculus sarthenianus* Dunkel, spec. nova, eine neue Art aus dem *Ranunculus-auricomus*-Komplex – seit 135 Jahren im Oberen Inntal bei Innsbruck. — *Forum Geobot.* **9**: 60–65. doi: 10.3264/FG.2020.0115.
- DUNKEL F.G. (2021): Contribution to the knowledge of the *Ranunculus auricomus* complex (Ranunculaceae) in Spain. — *Stapfia* **112**: 5–59.
- DUNKEL F.G. (2022): Der *Ranunculus-auricomus*-Komplex (Ranunculaceae) in Sachsen. — *Kochia* **15**: 57–188.
- DUNKEL F.G. (2024): *Ranunculus integer* DUNKEL, spec. nov. – Neubeschreibung einer altbekannten Art. — *Kochia* **17**: 21–29. doi.org/10.2148/kochia.v17.191
- DUNKEL F.G., GREGOR T. & PAULE J. (2018): New diploid species in the *Ranunculus auricomus* complex (Ranunculaceae) from W and SE Europe. — *Willdenowia* **48**(2): 227–257. https://doi.org/10.3372/wi.48.48205.
- EMADZADE K., LEHNEBACH C., LOCKHART P. & HÖRANDL E. (2010): A molecular phylogeny, morphology and classification of genera of *Ranunculeae* (Ranunculaceae). — *Taxon* **59**(3): 809–828.
- ERICSSON S. (2001): Microspecies within the *Ranunculus auricomus* complex. In: JONSELL B. (ED.), *Flora Nordica*. **2**: 382–397. — Stockholm: The Swedish Museum of Natural History.
- GBIF.ORG (2024) GBIF Home Page. Available from https://www.gbif.org [accessed 23 February 2024].
- GOTTSCHLICH, G. (2020) Synopse der für Deutschland nachgewiesenen Arten und Unterarten der Gattung *Hieracium* s.l. (*Hieracium* s.str. und *Pilosella*), aufgeschlüsselt nach Vorkommen in den einzelnen Bundesländern. — *Forum Geobot.* **9**: 1–59. doi: 10.3264/FG.2020.0114.
- GRAU J. (1984): Preliminary review of the Iberian Representatives of *Ranunculus* sect. *Auricomus*. — *Mitt. Bot. Staats-samml. München* **20**: 1–28.
- HÄFLIGER E. (1943): Zytologisch-embryologische Untersuchungen pseudogamer Ranunkeln der *Auricomus*-Gruppe. — *Ber. Schweiz. Bot. Ges.* **53**: 317–382.
- HODAČ L., SCHEBEN A.P., HOJSGAARD D., PAUN O., HÖRANDL E. (2014): ITS Polymorphisms Shed Light on Hybrid Evolution in Apomictic Plants: A Case Study on the *Ranunculus auricomus* Complex. — *PLOS ONE* **9**(7): e103003.
- HODAČ, L. KARBSTEIN, K., TOMASELLO, S., WÄLDCHEN, J., BRADICAN, J.P., HÖRANDL, E. (2023): Geometric Morphometric Versus Genomic Patterns in a Large Polyploid Plant Species Complex. — *Biology* **2023**, **12**, 418. doi.org/10.3390/biology12030418.
- HOJSGAARD D. & HÖRANDL E. (2019) The Rise of Apomixis in Natural Plant Populations. — *Front Plant. Sci.* **10**: 358. doi: 10.3389/fpls.219.00358.
- HÖRANDL E. (2004): Comparative analysis of genetic divergence among sexual ancestors of apomictic complexes using isozyme data. — *Int. J. Pl. Sci.* **165**: 615–622.
- HÖRANDL E. (2022): Novel Approaches for Species Concepts and Delimitation in Polyploids and Hybrids. *Plants* **11**(2): 204. doi.org/10.3390/plants11020204.
- HÖRANDL E., DOBEŠ C., LAMBROU M. (1997): Chromosomen- und Pollenuntersuchungen an österreichischen Arten des apomiktischen *Ranunculus auricomus*-Komplexes. — *Bot. Helvet.* **107**: 195–209.
- HÖRANDL E. & EMADZADE K. (2012): Evolutionary classification: A case study on the diverse plant genus *Ranunculus* L. (Ranunculaceae). — *Perspectives in Plant Ecology, Evolution and Systematics* **14** (2): 310–324. doi:10.1016/j.ppees.2012.04.001.
- HÖRANDL E., GREILHUBER J., DOBEŠ C. (2000): Isozyme variation and ploidy levels within the apomictic *Ranunculus auricomus* complex: Evidence for a sexual progenitor species in southeastern Austria. — *Pl. Biol. (Stuttgart)* **2**: 53–62.
- Hörandl E. & Greilhuber J. (2002): Diploid and autotetraploid sexuals and their relationships to apomicts in the *Ranunculus cassubicus* group: insights from DNA content and isozyme variation. *Pl. Syst. Evol.* **234**: 85–100.
- HÖRANDL E., GREILHUBER J., KLIMOVA K., PAUN O. & TEMSCH E. (2009): Reticulate evolution and taxonomic concepts in the *Ranunculus auricomus* complex (Ranunculaceae): insights from analysis of morphological, karyological and molecular data. — *Taxon* **58**: 1194–1215.
- HÖRANDL E. & GUTERMANN W. (1995): Die Bearbeitung der *Ranunculus auricomus*-Gruppe für die „Flora von Österreich“ – ein Werkstattbericht. — *Fl. Austr. Novit.* **2**: 12–27.
- HÖRANDL E. & GUTERMANN W. (1998a): Der *Ranunculus auricomus*-Komplex in Österreich. 1. Methodik; Gruppierung der mitteleuropäischen Sippen. — *Bot. Jahrb. Syst.* **120**: 1–44.
- HÖRANDL E. & GUTERMANN W. (1998b): Der *Ranunculus auricomus*-Komplex in Österreich. 2. Die *R. cassubicus*-, *R. monophyllus*- und *R. fallax*-Sammelgruppe. — *Bot. Jahrb. Syst.* **120**: 545–598.
- HÖRANDL E., PAUN O., JOHANSSON J.T., LEHNEBACH C., ARMSTRONG T., CHEN L., LOCKHART P. (2005): Phylogenetic Relationships and Evolutionary Traits in *Ranunculus* s.l. (Ranunculaceae) Inferred from ITS Sequence Analysis. — *Molec. Phylogen. Evol.* **36**: 305–327.
- HORVATH, I. Vegetacijske studije o hrvatskim planinama. I. Zadruga na planinskim goletima. *Rad. Jugosl. akad. knj.*

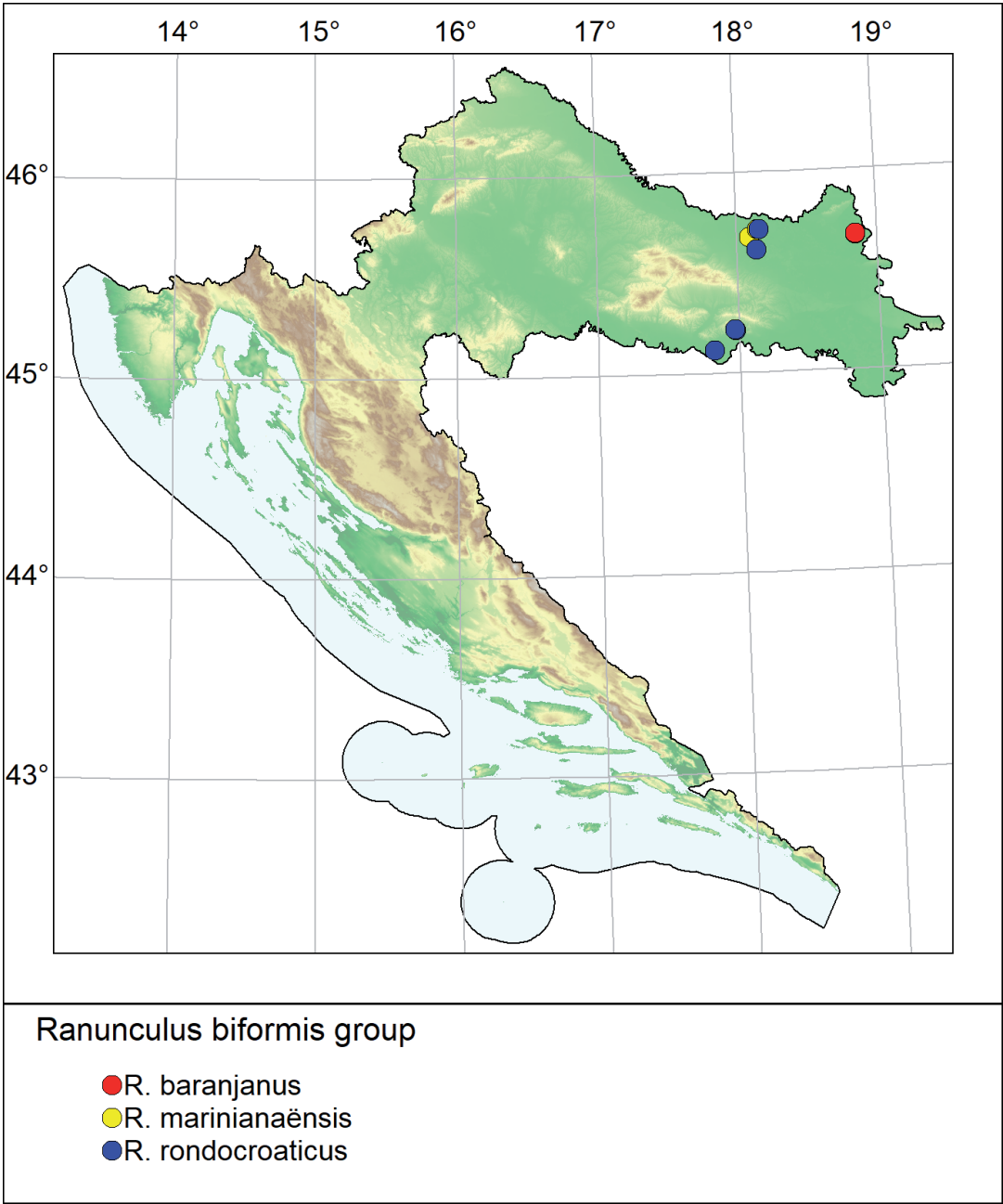


Fig. 40 – Distribution map of *Ranunculus biformis* group.

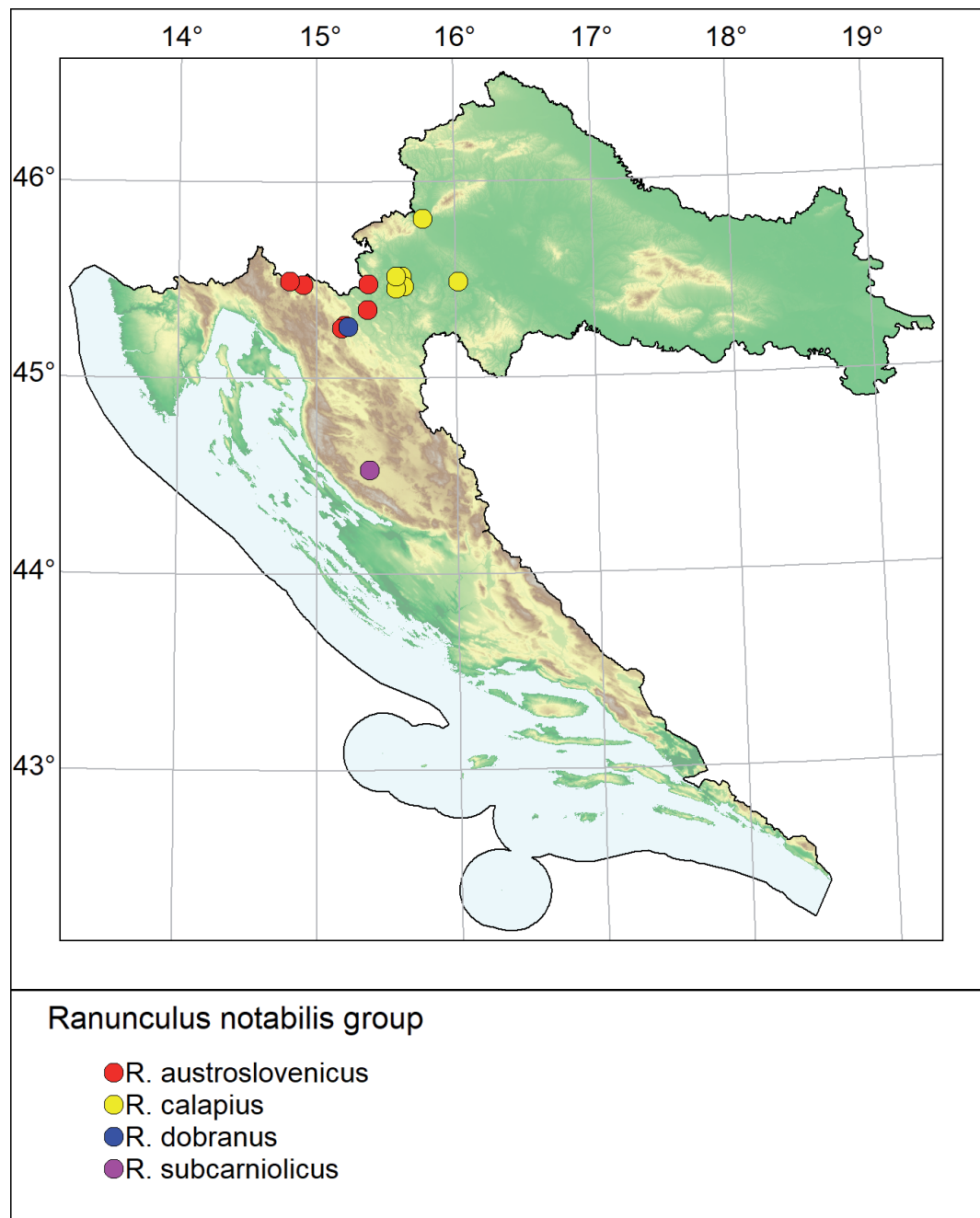


Fig. 41 – Distribution map of *Ranunculus notabilis* group.

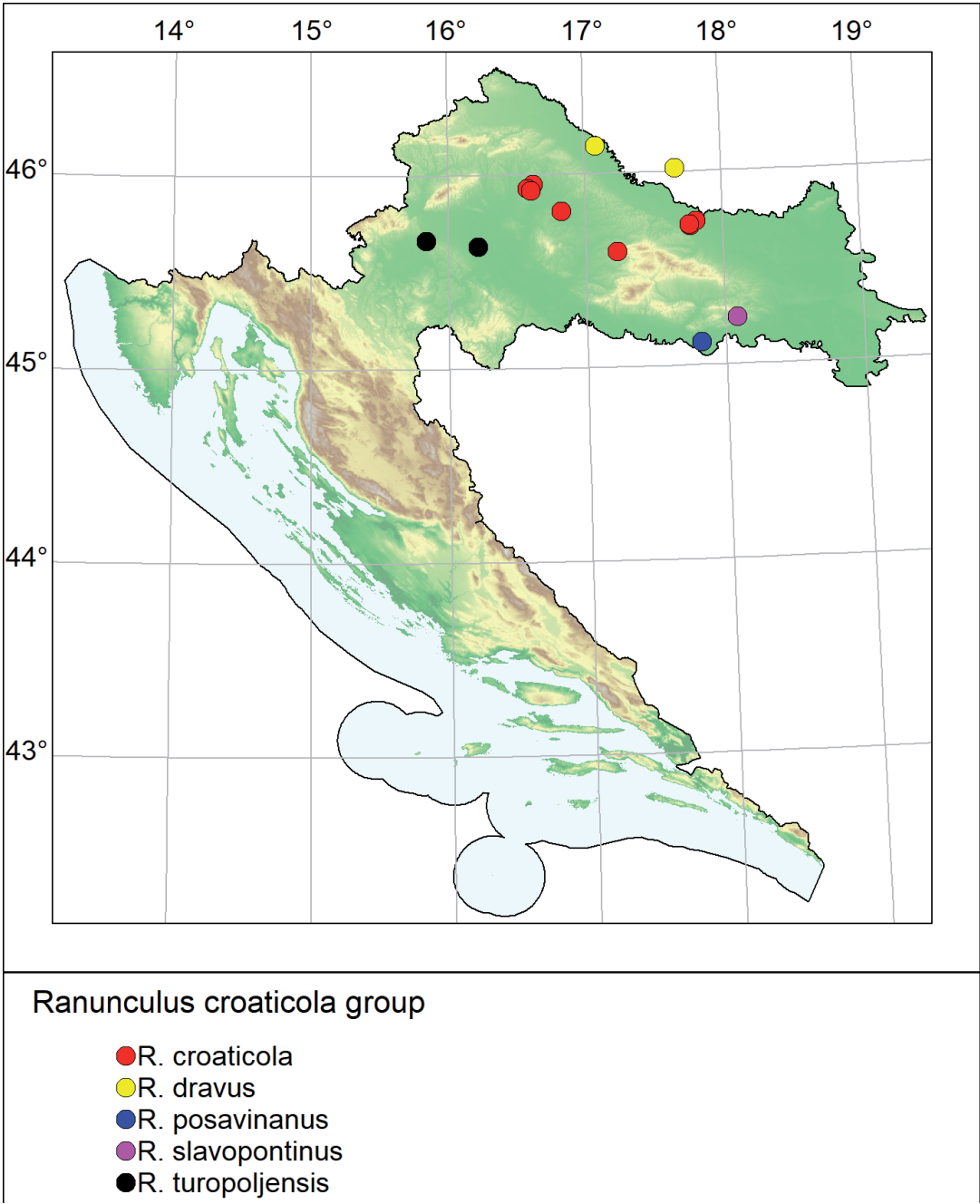


Fig. 42 – Distribution map of *Ranunculus croaticola* group.

6 Determination key (for the species of Croatia)	
1 cataphylls present, receptacle pilose, carpellophores short; robust plants, leaves of big size, 30–100 mm long, at the western edge of Croatia	5.1.1. <i>R. cassubicifolius</i>
1* cataphylls absent, receptacle glabrous or scarcely pilose, basal leaves mostly divided	2
2 flowers always complete, i.e. regularly 5 petals, fruits only with well developed achenes (diploid sexual species)	3
2* at least some flowers incomplete, i.e. less than 5 petals, fruits with badly developed, i.e. small, infertile achenes	7
3 one or two leaves – initial and/or final leaf – undivided (or main incision up to 40%)	4
3* all leaves divided, main incision of final leaves $\geq 50\%$	5.2.10 <i>R. subcarniolicus</i>

4 in humid meadows at the Lika region	5.2.6 <i>R. mutilicensis</i>
4* in forests or parks elsewhere	5
5 final leaves wide-angled, leaf edge with coarse triangled teeth, leaf cycle heterophyllous, fourth leaf with wide-angled base, floodplain forests and Park Maksimir at Zagreb (see also <i>R. dobranus</i> at Ogulin)	5.2.8 <i>R. calapius</i>
5* final leaves narrow-angled to V-formed	6
6 final leaves irregularly crenate-serrate to serrate, in hornbeam forests near Medinci	5.2.13 <i>R. slavonianus</i>
6* final leaves with crenated or crenate-serrate leaf edge, along brooks or rivulets	5.2.7 <i>R. austroslovenicus</i>
7 plants at subalpine meadows, or in beech forests > 1000 m a.s.l.	8
7* plants at colline or montane level ≤ 700 m	10
8 Učka (Monte Maggiore), leaves undivided with long acute teeth in beech forest (or subalpine meadows) (extinct?)	5.2.4 <i>R. istriacus</i>
8* Velebit Mountains, at subalpine meadows	9
9 receptacle glabrous, all leaves widely angled, base > 150°, largest segment of cauline leaves undivided (or with one tooth), gracile plants, base of final leaves wide-angled, receptacle glabrous	5.2.5 <i>R. istriacoides</i>
9* receptacle pilose, spring and final leaves narrowly angled to V-formed, largest segment of cauline leaves with 2–8 teeth, slim plants	5.2.22 <i>R. velebiticus</i>
10(7) first and last basal leaf undivided	11
10* first and/or last basal leaf divided	14
11 seventh leaf wide-angled (aperture at the base > 100°), only Turopolje	5.2.16 <i>R. turopoljensis</i>
11* first and final leaves narrowly angled (to V-formed) (<i>R. baranjanus</i> group), NO Croatia	12
12 spring leaves with 2–4 lateral (radial) incisions, aperture at the base mostly 0–20°	5.2.1 <i>R. baranjanus</i>
12* spring leaves with 0–1 lateral incision, aperture at the base mostly (40–100°)	13
13 main incision of spring leaves wide angled (50–75°)	5.2.2 <i>R. rondocroaticus</i>
13* main incision of spring leaves ≤ 50°, ≥ 3 leaves undivided	5.2.3 <i>R. marinianaënsis</i>
14(10) middle lobes of the spring leaves asymmetrical, with ≥ 9 teeth	15
14* middle lobes of the spring leaves symmetrical with < 9 teeth	17
15 final leaves with wide-angled base, largest cauline leaf segment with 2–8 teeth	5.2.17 <i>R. poldinioides</i>
15* final leaves with narrow-angled base, largest cauline leaf segment with 0–1 tooth	16
16 large flowers with (3–)5 petals, Zagreb county	5.2.20 <i>R. schlosseri</i>
16* small flowers with 0–1 petals, Nova Gradiška	5.2.18 <i>R. gradiscanus</i>
17(14) alder swamp forests in the Plitvice Lake National Park	5.2.19 <i>R. plitvicensis</i>
17* in hornbeam forests, occasionally in ditches	18
18 ≥ 3 leaves with narrowly deltoid middle lobe	19
18* 0–1 leaves with narrowly deltoid middle lobe	20
19 fourth to seventh leaf wide-angled, receptacle 2.7–3.5 mm, Bela Manastir	5.2.22 <i>R. albimonasterius</i>
19* fourth to seventh leaf narrow-angled, receptacle 6.0–8.0 mm, Bebrina	5.2.15 <i>R. posavinanus</i>
20(18) angles of basal leaves constant	21
20* angles of basal leaves variable	23
21 all basal leaves narrow-angled	5.2.20 <i>R. divisor</i>
21* all basal leaves wide-angled	22
22 final leaves undivided, initial leaf irregular, with 2–3 lateral incisions, heterophyllous, Ogulin	5.2.9 <i>R. dobranus</i>
22* final leaves cleft to divided by main incision, initial leaf with 0–1 lateral incision, homophyllous, Slavonia	5.2.11 <i>R. croaticola</i>
23(20) (3–)4 leaves dissected by main incision, Đurđevac	5.2.12 <i>R. dravus</i>
23* 2(–3) leaves dissected by main incision, Slavonski Brod	5.2.13 <i>R. slavopontinus</i>

- 238:** 1–96, 1930 (Vegetationsstudien in den kroatischen Alpen. I. Die alpinen Rasengesellschaften. Bull. Int. Acad. Yougosl. **24**: 51–87, 1930.
- JACQ CONSORTIUM (2004 ff.) Virtual Herbaria Website at <https://www.jacq.org/> accessed 23 February 2024
- JASIEWICZ A. (1956): Badania nad jaskrami z cyklu *Auricomi* Owcz. w okolicach Krakowa i w północnej części Karpat. De *Ranunculis* e circulo *Auricomi* Owcz. in regione Cracoviensi nec non in Carpatorum parte boreali crescentibus — Fragm. Florist. Geobot. **2**(1): 62–110.
- JOGAN N. (editor) (2001): Gradivozu Atlas flore Slovenije [Materials for the Atlas of Flora of Slovenia]. — Center za kartografijo favne in flore. Miklavž na Dravskem polju.
- JULIN E. (1980): *Ranunculus auricomus* L. in Södermanland, East-Central Sweden. — Opera botanica **57**: 1–145. Stockholm.
- KARBSTEIN K., TOMASELLO S., HODAČ L., DUNKEL F.G., DAUBERT M., HÖRANDL E. (2020): Phylogenomics supported by geometric morphometrics reveals delimitation of sexual species within the polyploid apomictic *Ranunculus auricomus* complex (Ranunculaceae). Taxon **69**: 1191–1220.
- KARBSTEIN, K., TOMASELLO, S., HODAČ, L., WAGNER, N., MARINČEK, P., BARKE, B.H., PAETZOLD, C., HÖRANDL, E. (2022): Untying Gordian Knots: Unraveling Reticulate Polyploid Plant Evolution by Genomic Data Using the Large *Ranunculus auricomus* Species Complex. New Phytol. **235**: 2081–2098. DOI: 10.1111/nph.18284.
- KARBSTEIN K., KÖSTERS, L., HODAČ, L., HOFMANN, M., HÖRANDL, E., TOMASELLO, S., WAGNER, N.D., EMERSON, B.C., ALBACH, D.C., SCHEU, S., BRADLER, S., DE VRIES, J., IRISARRI, I., SOLTIS, P., MÄHDER, P., WÄLDCHEN, J. (2023): Species delimitation 4.0: integrative taxonomy meets artificial intelligence. Trends Ecol. Evol. **2024** Jun 6: S0169-5347(23)00296-3. doi.org/10.16/j.tree.2023.11.002.
- MELZHEIMER V. & HÖRANDL E. (2022): Die Ranunculaceae der Flora von Zentraleuropa: *Ranunculus* sect. *Auricomus* <http://dx.doi.org/10.21248/gups.68734>.
- MAJESKÝ, L., KRAHULEC, F. & VAŠUT, R.J. (2017): How apomictic taxa are treated in current taxonomy: A review. Taxon **66**: 1017–1040. <https://doi.org/10.12705/665.3>.
- NIKOLIĆ T. ed. (2015 - onward): Flora Croatica Database (<http://hirc.botanic.hr/fcd>). Faculty of Science, University of Zagreb (accessed date: 23 February 2024).
- OTTO F. (1990): DAPI staining of fixed cells for high-resolution flow cytometry of nuclear DNA. In: Crissman H.A., Darzynkiewicz Z. (Eds) Methods in Cell Biology. Vol. **33**. — Academic Press, New York, pp. 105–110.
- PAULE J., DUNKEL F.G., SCHMIDT M. & GREGOR T. (2018): Climatic differentiation in polyploid apomictic *Ranunculus auricomus* complex in Europe. — BMC Ecol **18**:16, 1–12. <https://doi.org/10.1186/s12898-018-0172-1>.
- PAUN O., LEHNEBACH C., JOHANSSON J.T., LOCKHART P. & HÖRANDL E. (2005): Phylogenetic relationships and biogeography of *Ranunculus* and allied genera (Ranunculaceae) in the Mediterranean region and in the European Alpine System. — Taxon **54**(4): 911–930.
- PAVLETIĆ Z. (1994): The distribution of the species *Ranunculus cassubicus* L. in Croatia. — Acta Bot. Croat. **53**: 121–124.
- SCHLOSSER J.C. & FARKAŠ-VUKOTINOVIĆ L. de (1869): Flora Croatica. — Fr. Župan, Zagreb.
- Šegula N. (2000): Additions to the flora of Plitvice Lakes National Park (Croatia). — Acta Bot. Croat. **59**(1): 233–242.
- SOCHOR M., VAŠUT R.J., SHARBEL T.F., TRÁVNÍČEK B. (2015): How just a few makes a lot: Speciation via reticulation and apomixis on example of European brambles (*Rubus* subgen. *Rubus*, Rosaceae). Mol Phylogenet Evol. 2015 Aug;89:13–27. doi: 10.1016/j.ympev.2015.04.007. Epub 2015 Apr 13. PMID: 25882835.
- Soó R. (1964): Die *Ranunculus auricomus* L. emend. Korsh. Artengruppe in der Flora Ungarns und der Karpaten I. Acta Bot. — Acad. Sci. Hung. **10**: 221–237.
- Šugar I. (1972): *Ranunculus cassubicus* L. u flori Hrvatske I Jugoslavije. — Acta Bot. Croat. **31**: 215–216.
- TAMURA M. (1995): In: HIEPKO P. (ed.). ENGLER A. & PRANTL K.: Die natürlichen Pflanzenfamilien. Angiospermae: Ordnung Ranunculales Fam. Ranunculaceae. Band 17 a IV. Systematic Part: 223–519. — Dunker & Humblot, Berlin.
- THIERS B. (2024): [continuously updated]: Index herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's virtual herbarium. — Published at <http://sweetgum.nybg.org/science/ih/> (link is external) [accessed 23 February 2024].
- VUKELIĆ J., ŠAPIĆ I., MEI G., POLJAK I., VUSIĆ P. & OREŠKOVIĆ M. (2019): Šume crne johe (tip 91E0* Natura 2000, tip E.2.1.9 NKS) u nacionalnom parku Plitvička jezera (Black Alder forests (type 91E0* Natura 2000 type E.2.1.9) in the Plitvice Lakes National Park. UDK 630* 181.6 + 272 (001). — J. Forest. Soc. Croatia **143**: 7–8. <https://doi.org/10.31298/sl.143.7-8.1>.
- WEBER, H.E. (1995) *Rubus*. In: Hegi, Illustrierte Flora von Mitteleuropa, Bd. **IV/2A**. 3., völlig Neubearb. und erw. Aufl. 1995. Blackwell Wissenschafts-Verlag, Berlin.

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species	herbar number	coefficient	ploidy	location	ecology	date of collection	elevation	latitude	longitude
<i>R. albimosterius</i>	Du-40496	1,27	4	Baranja, Beli Monastir, Haljevo forest	forest edge, coppice	26.Apr.22	95 m	45,720833	18,627222
<i>R. austroslovenicus</i>	Du-35325	0,69	2	Ogulin, Šetalište Krienač, Dobra riverside	brook edge	22.Apr.18	317 m	45,259806	15,223472
<i>R. austroslovenicus</i> cf.	Du-35720	0,7	2	Ogulin, Klek	forest margin	22.Apr.18	536 m	45,254028	15,176444
<i>R. baranjanus</i>	Du-36632	1,33	4	n Osijek, Tikveš, hunting castle, alley	under trees	12.Apr.19	84 m	45,671660	18,845749
<i>R. baranjanus</i>	Du-36633	1,32	4	n Osijek, Tikveš, SO to the hunting castle	oak forest	12.Apr.19	87 m	45,669953	18,847201
<i>R. calapius</i>	Du-35778	0,69	2	Domaslovec, Domaslovečka ulica	oak-elm tree-forest	21.Apr.18	129 m	45,810028	15,765250
<i>R. calapius</i>	Du-35342	0,68	2	Karlovac county, Orlovac	humid oak-hornbeam forest	23.Apr.18	118 m	45,519083	15,612972
<i>R. calapius</i>	Du-35351	0,68	2	Orlovac (loc. 170 4.2018)	humid oak-hornbeam forest	23.Apr.18	117 m	45,519083	15,612972
<i>R. calapius</i>	Du-35724	0,7	2	Karlovac, Popović Brdo	humid oak-hornbeam forest	23.Apr.18	114 m	45,467222	15,629250
<i>R. calapius</i>	Du-35724	0,69	2	Karlovac, Popović Brdo	humid oak-hornbeam forest	23.Apr.18	114 m	45,467222	15,629250
<i>R. calapius</i> cf.	Du-32742	1,38	4	Karlovac, E Gornje Mekuše	humid hornbeam wood	25.Apr.15	115 m	45,481333	15,593366
<i>R. calapius</i>	Du-34889	0,68	2	Karlovac, Orlovac	floodplain forest, trough	10.Apr.17	114 m	45,518944	15,570917
<i>R. calapius</i>	Du-34889	0,68	2	Karlovac, Orlovac	floodplain forest, trough	10.Apr.17	114 m	45,518944	15,570917
<i>R. cassubicifolius</i>	Du-34897	0,62	2	Brganica valley	brookside	09.Apr.17	201 m	45,815528	15,643342
<i>R. croaticola</i>	Du-36631	1,38	4	5,2 km NE to Slatina	hornbeam forest	12.Apr.18	100 m	45,718888	17,763888
<i>R. croaticola</i>	Du-34911	1,35	4	Daruvar, Julijev Park along the railway	alley under trees, parkside	11.Apr.17	168 m	45,595840	17,227277
<i>R. croaticola</i>	Du-34896	1,42	4	Sveti Ivan Žabno 1,6 km N	hornbeam forest	11.Apr.17	126 m	45,931232	16,607457
<i>R. istriacoides</i>	Du-37864	1,26	4	Velebit, Krasno Polje, Jezera	subalpine meadows	07.Jun.20	1390 m	44,802222	15,020555
<i>R. istriacoides</i>	Du-37864	1,26	4	Velebit, Krasno Polje, Jezera	subalpine meadows	07.Jun.20	1390 m	44,802222	15,020555
<i>R. marinianaënsis</i>	Du-40552	1,23	4	Donji Mihaljac, w Rakitovica	willow shrub	15.Apr.22	100 m	45,710277	18,164722
<i>R. mutlicensis</i>	Du-39590	0,65	2	Krbavsko polje, Mutlić	humid meadow	28.Apr.22	690 m	44,496111	15,759722
<i>R. mutlicensis</i>	Du-39590	0,53	2	Krbavsko polje, Mutlić	humid meadow	28.Apr.22	690 m	44,496111	15,762500
<i>R. posaviranus</i>	Du-40467	1,26	4	Stupnički Kuti	grassy ditch	27.Apr.22	90 m	45,115000	17,819166
<i>R. schlosseri</i>	Du-40571	1,28	4	Turopolje, e Velika Gorica	meadow	27.Apr.22	100 m	45,704722	16,196111
<i>R. schlosseri</i>	Du-40571	1,3	4	Turopolje, e Velika Gorica	meadow	27.Apr.22	100 m	45,704722	16,196111
<i>R. slavonianus</i>	Du-40439	0,69	2	Veraneševci, e Medinci	hornbeam forest	15.Apr.22	130 m	45,743055	17,806388
<i>R. slavopontinus</i>	Du-40558	1,3	4	Slavonski Brod, w Ljeskove vode	oak hornbeam forest	26.Apr.22	245 m	45,241888	18,084722
<i>R. subcaemicus</i>	Du-34886	0,69	2	Gospic, Jasikovac (1,8 km S Gospic)	source area	10.Apr.17	570 m	44,529389	15,375083
<i>R. turopoljensis</i>	Du-34904	1,37	4	Zagreb, Franje, Kraylovac	deciduous forest, brookside	10.Apr.17	181 m	45,664639	15,840500

Tab. 1 – results of flow cytometric measurements of Croatian populations.