

An annotated list and key to the species of *Ranunculus* sect. *Batrachium* (*Ranunculaceae*) in Greece

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Abstract. An extensive literature and herbarium study of the Greek *Ranunculus* sect. *Batrachium* was carried out. The occurrence of *Ranunculus aquatilis* in Greece (Crete) was confirmed and another location was detected in the northernmost part of the country. The species has been reported from other parts of Greece, but these reports were based on confusion with similar taxa. An additional location of the recently described species *Ranunculus dahlgreniae* was communicated. As the species has been collected before without being recognized as a separate taxon, revision of the available material will be necessary. A complete list of the Greek taxa of *R.* sect. *Batrachium* has been supplied. Eight species were recognized, while three species mentioned in literature were excluded. Phytogeographic characteristics have been given for all species. A key to the species was outlined allowing verification of their distribution during future research. Due to the phenotypic and geographical variation of the species, the key must be applied with care.

Key words: aquatic flora, Hellenic flora, hydrophytes, identification key, new plant records, *Ranunculus aquatilis*, *Ranunculus dahlgreniae*

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Introduction

During preparation of the *Ranunculus* sect. *Batrachium* chapters of *Die Ranunculaceae der Flora von Zentraleuropa* (Wiegleb 2020) and the 22nd edition of *Rothmaler Exkursionsflora von Deutschland* (Wiegleb 2021), comprehensive herbarium studies were carried out (see list of herbaria in Wiegleb 2020). The main focus of the revisions was identification of *R.* sect. *Batrachium* taxa from Germany and adjacent countries.

Many Mediterranean specimens of taxonomic and phytogeographical interest were seen but not studied in detail. These were, first, specimens identified as *R. aquatilis* L., a temperate European species whose occurrence in Greece has never been fully confirmed. Dahlgren (2002) did not include *R. aquatilis* into her treatment in *Flora Hellenica*. Bergmeier & Abrahamczyk (2008) reported a specimen of *R. aquatilis* as 'second record for, if not new to, Crete and the Aegean', leaving some room for interpretation. The

assumed occurrence of *R. aquatilis* in Greece was shown on current distribution maps of data portals such as GBIF (2023), POWO (2023), and Hörandl & Raab-Straube (2023). Images of *R. aquatilis* have appeared in many online photo portals such as iNaturalist, Alamy or Agephotostock, without being properly identifiable. Second, identification problems were recognized in specimens from the Aegean Islands and Crete resembling *R. baudotii* Godr. but lacking some typical characters such as winged achenes. The first reference to these forms was found in Dahlgren (1991) who noted that typical *R. baudotii* had ‘northern distribution’ in Greece. These atypic forms have recently been described as *R. dahlgreniae* Zalewska-Gał., Wiegleb & Jopek (Jopek et al. 2023). The objectives of this report have been to give a more detailed account of *R. aquatilis* and *R. dahlgreniae* beyond what has been known so far, to offer an overview of *R. sect. Batrachium* species confirmed for Greece, including with phytogeographical remarks, and to provide an analytic key to the species.

Material and methods

Collections of *R. sect. Batrachium* in Botanischer Garten and Botanisches Museum Berlin (B) and Staatliches Museum für Naturkunde, Stuttgart (STU) were re-examined in March 2023. Specimens of the private collection of E. Bergmeier (Göttingen) were examined in September 2023. Furthermore, the results of the revision of G. Dahlgren’s collection at the Botanical Museum of Lund University (LD), visited in 2019, were re-evaluated based on high-resolution scans of selected specimens. Specimens seen on the herbarium sheets have been marked ‘!’. Online data bases were searched for herbarium specimens and field photographs of the Greek plants. Specimens seen online only have been marked ‘?’. Results of a recent paper on the genetic structure of *R. sect. Batrachium* (Jopek et al. 2023) were used for interpretation of the Greek herbarium specimens and their taxonomic position. Greek regions were named according to the Flora of Greece Web (2023).

Results

Species new or confirmed for Greece

Ranunculus aquatilis L.

Gr Nomos & Eparchia Dramas: 5 km northeast of Kato Nevrokopi, in fishpond, 600 m, 09.05.1990, 41°24′ N, 23°54′ E, M. Nebel MN GR 90 368 (STU!). Fig. 1.

That specimen was collected as ‘*R. aquatilis* s.str.’ in the fishpond area near the village of Levkogeia. It was not mentioned in the relevant literature. The location does not belong to the Mediterranean zone but is situated in a deciduous oak zone with ‘warm-summer humid continental climate’ (Dfb – Koeppen-Geiger classification; Hellenic National Meteorological Service 2017). That followed the general distribution pattern of *R. aquatilis* (Wiegleb et al. 2017).



Fig. 1. *Ranunculus aquatilis* from Greece, Anatoliki Makedonia ke Thraki, coll. M. Nebel MN GR90368 (with permission of Staatliches Museum für Naturkunde, Stuttgart, STU).

Gr Nomos Lasithiou, Eparchia Mirambelou: Fourni, between Neapoli and Aj. Nikolaos, Oropedio, in water filled ditch, ca. 280 m, 10.04.2005, 35°15' N, 25°38' E, *E. Bergmeier* 04-45 (Herb. Bergmeier!!).

The specimen was collected in a small water body on a table land near a village (Bergmeier & Abrahamczyk 2008). The location is characterized by a hot-summer Mediterranean climate (Csa – Koeppen-Geiger classification, Hellenic Meteorological Service 2017). That was unusual in two respects: first, the specimen was found far away from the continuous range of the species and, second, it grew in the Mediterranean climate zone, where it was seldom found (e.g., Sicily near Ficuzza; field observation, A. Troia & G. Wiegleb, 2018). Both Greek specimens did not develop true laminar leaves but deeply dissected intermediate leaves instead. This morphotype has been described as *R. radians* Revel, and regarded as a heterotypic synonym of *R. aquatilis* L. (Wiegleb et al. 2017)

No more Greek specimens of *R. aquatilis* were found. Most laminar-leaved Greek specimens of '*R. aquatilis*' in botanical collections belonged to *R. baudotii* Godr., *R. peltatus* Schrank or *R. saniculifolius* Viv. instead. Specimens of small-flowered plants lacking laminar leaves might belong to *R. trichophyllus* Chaix, e.g., a specimen from Flora Attica, Liossa (*Heldreich* s.n., in L!; revised by Cook 1966 as *R. aquatilis* L.), or specimens from Flora Ionica (2023; as *R. aquatilis* s.l. or *R. aquatilis* agg., in WU!). A specimen mentioned by Chilton & Turland (1997) was preserved in Chilton's private herbarium and might be lost (N. Turland, pers. communication). An image published in a report by Willing & Willing (2021) might belong to *R. aquatilis* without laminar leaves, but specimens could not be traced down.

***Ranunculus dahlgreniae* J. Zalewska-Gał., Wiegleb & Jopek**

Gr Kriti (Crete). Nomos Chanion, Eparchia Kydonias: Lefka Ori, at a seasonal lake on the Omalos Plateau, 1062 m a.s.l., 08.04.2018, 35°19' N, 23°53' E; *J. Zalewska-Gałosz* KRA629945! (holotype), isotypes. KRA629943, KRA629946-52.

That species was collected before in its type locality. Specimens were cited in Jopek et al. (2023). Furthermore, it was shown on a photograph by N. Turland (<https://www.flickr.com/photos/nturland/52022399382/in/album-72177720298063378/>) and in an entire set of photographs by K. van Herk (<https://kok-van-herk.smugmug.com/search?q=ranunculus+saniculifolius>). Another specimen from Crete represented that species (Nomos Lasithiou, westwards of Fourni, between Neapoli and Aj. Nikolaos, in a pond in a wet meadow, *E. Bergmeier* 05-27, Herb. Bergmeier!!). The species might have been also collected in Thessalia, Peloponnesus, and several Aegean Islands (Delos, Mykonos, Naxos, and Milos; see Jopek et al. 2023). All specimens need checking according to the present state of knowledge.

Overview of *R. sect. Batrachium* species in Greece

Assumptions of possible hybrids are based on morphologically intermediate characters. All observed taxa have been fertile.

R. aquatilis L. That temperate European species seems to be very rare in Greece. It is only confirmed for NE and KK. The species is not confirmed for the adjacent Balkan countries due to a lack of modern revisions. It is shown, however, on high-quality field photographs from Albania (K. Tan) and Bulgaria (GBIF 2023). In the European part of Turkey, it was collected in the early 19th century (Dreyer s.n., 1836, CLF!; see GBIF 2023) but has not been confirmed ever since. Thus, its occurrence in NE marks the southern edge of its continuous range, while its occurrence in KK is a geographical outlier (see above).

R. baudotii Godr. The typical morphotype of this European species, resembling the northern plants from the Baltic region, occurs in the northern continental parts of the country such as NC and NE, partly in freshwater bodies far away from the coast (e.g., Eparchia Kozanis, Servia, *E. & R. Willing* 295.546 in B!!). It also occurs on islands in EAe (Lesvos, Tokmakia), and IoI (Korfu). Plants reported from Pe (Zarkos et al. 2019) need confirmation. They are described as an unusual landform, with 4-petaled flowers and lack of capillary leaves, which may as well belong to *R. saniculifolius*.

R. dahlgreniae J. Zalewska-Gał., Wiegleb & Jopek.

That species is found further south, where the typical morphotype of *R. baudotii* is absent. The species has been observed in freshwater bodies, between ca. 280 and 1060 m. So far, the species has been only confirmed for two sites in KK, but may also occur in EC, Pe, KiK and EAe. Several specimens deposited in B, LD and other herbaria have been preliminarily assigned to *R. saniculifolius* Viv., due to a lack of an appropriate name (G. Wiegleb 2018-2019). Hybrids with *R. trichophyllus*, *R. rionii* or *R. saniculifolius*, respectively, are highly likely to occur (see Dahlgren 1991).

R. fucoides Freyn. That West Mediterranean species was erroneously included into *R. peltatus* as a subspecies, either as a separate taxon or synonymous with *R. saniculifolius*. The taxon was absent from Greece.

R. peltatus Schrank. Typical forms of the temperate European-West Asian species are only present in NC. Elsewhere (especially in NE, EC, Pe, KiK, EAe), less typical morphotypes occur, some of which may as well stand for hybrids. Those plants show uncorrelated variation in flower size, nectar pit shape and fruit characters (size, number, hairiness). Examples: Mainland. NE: Imeros, s. Komotini, *M. Nebel* s.n. (STU!!); NC: Thessalia, Karditsa: *R. & E. Willing* 170-431-170-467 (B!!). Islands. KiK, Mykonos: *G. Dahlgren* B6, 7, 10, 11, 15 (as *R. peltatus* s.l. or *R. tripartitus* DC, LD!!); Milos: *B. Biel* Mi22.084 (as *R. tripartitus* DC., Herb. Biel!); EAe, Rhodos: *M. Ristow* RH3-68 (B!!). Likewise, the specimens from Viotias (StE) mentioned by Polymenakos & Tan (2020) need confirmation.

R. penicillatus (Dumort.) Bab. (incl. *R. pseudofluitans* (Syme) Newbould). That aggregate taxon is absent from Greece. It has a temperate European Oceanic distribution. Neither *R. fluitans* Lam. nor any of its hybrid siblings occur in the East Mediterranean region. Records are based on confusion with long-leaved forms of *R. sphaerospermus* and *R. rionii* (indicated by the chromosome no. $2n = 16$, Dahlgren 1991), as well as on *R. trichophyllus* from streams.

R. rionii Lagerg. That Central-East European West-Central Asian species occurs across the country, incl. KK, also in temporary streams. It may hybridize with *R. trichophyllus* and *R. sphaerospermus*.

R. saniculifolius Viv. That polymorphic species

was originally described from North Africa but might have a circum-Mediterranean distribution. The occurrence in Greece has been poorly known due to a morphological overlap with *R. dahlgreniae* and *R. baudotii*. Many *R. sect. Batrachium* populations collected in Pe, StE, WAe, EAe, KiK, and KK (as well as on the adjacent Turkish islands and mainland; Meikle 1959; Cook 1965) fall within the morphological limits of that species. Island populations have often shown peculiar character combinations with respect to laminar leaf shape, nectar pit shape, number and size of achenes, and hairiness and elongation of the receptacle. This was caused either by independent hybridization with *R. baudotii*, *R. sphaerospermus* or *R. trichophyllus*, respectively, or by epigenetic adaptation to the variable and partly extreme habitat conditions.

R. sphaerospermus Boiss. & C.I. Blanche. That East-Mediterranean West-Central Asian species is scattered across the country. It may hybridize with *R. rionii* and *R. trichophyllus* (see below, also Dahlgren 1991).

R. trichophyllus Chaix. That polymorphic Holarctic species occurs across the country. It may hybridize with *R. baudotii*, *R. rionii*, *R. saniculifolius*, or *R. sphaerospermus*. The recognition of the hybrid *R. trichophyllus* × *R. sphaerospermus* has been based on a triploid specimen from Kos (KiK; Dahlgren B43, LD!!). Further hybrids may occur in KK. According to J. Zalewska-Gałocz (pers. communication), in the Lasithi region, plants with an unusual ribotype of *R. trichophyllus* (r5) appear, which may be unrecognized hybrids with *R. sphaerospermus* (see Jopek et al. 2023). Dahlgren (1991) had described specimens from Crete with an unusual chromosome number $2n = 48$, (*Dahlgren* B29, 33, from Chania; B31, 32, from Lasithi; LD!!), which she included into *R. trichophyllus*. The Lasithi plants have been robust, with broadly obovate petals of variable size, lunate to partly circular nectar pits, variable pedicel diameter (some thin and not setting flowers), and a variable number of mature seeds, besides the undeveloped carpels. Similar specimens have been collected nearby (e.g., *Bouharmont* 13319, 3.41980; BR!; *Kyriakopoulos & Turland*, *Turland* 1690; MO, UPA, fide N. Turland). The status of these plants

is unresolved. Note: Even though the name *R. peucedanifolius* All. has priority over *R. trichophyllus* Chaix (Wiegleb 2020), the recommendation of Bartolucci et al. (2022) has been followed for using the well-established name *R. trichophyllus*.

R. tripartitus DC. That EU-Oceanic species is absent from Greece. It is easily recognizable by its large free stipules. Records from KiK are based on confusion with small annual morphotypes of *R. peltatus* or *R. peltatus* hybrids.

Key to the species

The key excludes possible hybrids, local morphotypes and juvenile and terrestrial forms. In practical identification, one must consider that under the Mediterranean hydrological and climatic conditions the phenotypic variability of *R. sect. Batrachium* is much greater than in the temperate regions.

1 Laminae leaves present.....2

1* Laminae leaves absent.....6

Remark: In the Greek species, the presence of intermediate leaves indicates that the species is able to form laminae leaves as well. If fully developed laminae leaves are absent from some specimens of these species, see couplets 3/3* or 5/5* for differential characters of intermediate leaves.

2 Laminae leaves deeply dissected (to 2/3 or 3/4 of the lamina); stem and leaves fleshy, often whitish; achenes glabrous (*R. baudotii* agg.).....3

2* Laminae leaves mostly only incised up to 1/2 of the lamina; stems and leaves not fleshy; achenes hairy, at least in juvenile state.....4

3 Achenes 1.2–1.5(–1.8) mm long, dorsally and ventrally conspicuously winged, style caducous; intermediate leaves tripartite, symmetric, lobes narrow with parallel margin, rounded at apex; pedicels longer than 50 mm, elongating in fruit, mostly recurved; petals 5.5–13 mm long; receptacle considerably elongating in fruit; 2n = 32 (*R. peltatus* subsp. *baudotii* (Godr.) Meikle ex C.D.K. Cook; *R.*

confusus Godr.; *R. aquatilis* s.l.; *R. aquatilis* auct. non L.).....*R. baudotii* Godr.

3* Achenes 1.5–2.2(–2.4) mm long, unwinged except for the lower ventral part, style occasionally persistent; intermediate leaves with 2–3 cuneate lobes, occasionally with rigid filiform apical segments; pedicels shorter than 50 mm, slightly recurved; petals (4–)5–6.5 mm long, receptacle slightly elongating in fruit; 2n = 32 (*R. baudotii* auct. non Godr.; *R. peltatus* s.l., *R. peltatus* auct. non Schrank, *R. saniculifolius* auct. non Viv.).....*R. dahlgreniae* J. Zalewska-Gał., Wiegleb & Jopek

4 Receptacle puberulent, hairs c. 0.2 mm long; laminae leaves often truncate at base, basal sinus 120–180°, intermediate leaves with cuneate lobes; capillary leaves with up to 100 final segments; pedicels elongating in fruit, recurved; nectar pits lunate or triangular; 2n = 16; 32? (*R. peltatus* var. *microcarpus* Meikle, *R. peltatus* subsp. *saniculifolius* (Viv.) Meikle ex C.D.K. Cook; *R. peltatus* subsp. *fucooides* auct. non Freyn).....*R. saniculifolius* Viv.

4* Receptacle densely pubescent, hairs 0.5–1 mm long; laminae leaves seldom truncate at base; basal sinus 0–150°; intermediate leaves without cuneate lobes; capillary leaves with up to 250(–400) final segments; pedicels not elongating or elongating before fruit; nectar pits circular or pyriform.....5

5 Intermediate leaves with apical filiform segments; secondary lobes of laminae leaves rounded; capillary leaves with up to 200(–400) final segments; pedicels elongating before flowering, straight or slightly recurved; nectar pits pyriform; 2n = 32, 48 (*R. peltatus* subsp. *peltatus*; *R. peltatus* s.l.; *R. tripartitus* auct. non DC.)*R. peltatus* Schrank

5* Intermediate leaves with basal filiform segment, asymmetric; secondary lobes of laminae leaves acute; capillary leaves with up to 100 final segments; pedicels not elongating, mostly straight; nectar pits circular or cup-shaped; 2n = 48 (*R. peltatus* auct. non Schrank; *R. kastamonuensis* **Dönmez**)..... *R. aquatilis* L.

- 6 Petals 4–7 mm long, nectar pits lunate, capillary leaves flaccid to subrigid, elongated or spreading, achenes 0.8–1.8 mm long, elliptical, style caducous or persistent..... 7
Remark: Check for non-laminar leaf forms of *R. baudotii* agg., as well as for dwarf forms of *R. peltatus* and *R. saniculifolius*.
- 6* Petals 8–20 mm long, nectar pits pyriform, capillary leaves mostly rigid, hemispherical, achenes about 0.8–1.0(–1.2) mm long, rounded, style caducous; $2n = 16$ (*R. peltatus* subsp. *sphaerospermus* Meikle; *R. penicillatus* auct. p. max. p.; *R. aquatilis* var. *microcarpus* Meikle).....
*R. sphaerospermus* Boiss. & C.I. Blanche
Remark: Check for non-laminar leaf forms of *R. baudotii*, *R. aquatilis*, *R. saniculifolius*, and *R. peltatus*.
- 7 Pedicel less than 1 mm in diameter, achenes 0.8–1.3 mm long, glabrous, style persistent, petioles of capillary leaves of the same length along the stem; $2n = 16$ (*R. trichophyllus* auct.; *R. penicillatus* auct. p. min p.)*R. rionii* Lagger
- 7* Pedicels more than 1 mm in diameter, achenes 1.3–1.8 mm long, pubescent, at least some hairs persisting in maturity, style caducous, petioles of lower capillary leaves elongated; $2n = 32$ (*R. peucedanifolius* All.)..... *R. trichophyllus* Chaix

Discussion

Overall, eight species have been confirmed for Greece. These include four species with main distribution in the cold temperate region of Europe (*R. aquatilis*, *R. baudotii*, and *R. peltatus*), or the Holarctic region (*R. trichophyllus*). Three species mainly occur in the meridional regions of Europe and Asia (*R. saniculifolius*, *R. rionii*, *R. sphaerospermus*). One recently described species (*R. dahlgreniae*) is endemic to the Aegean region. Given the high number of unresolved morphotypes and potential hybrids, the number of species may increase after further genetic and karyological investigation. So far, it has been impos-

sible to decide whether these morphotypes are ‘old’ taxa, persisting since before the last Glacial Age, ‘new’ taxa developed by rapid adaptation to local habitat conditions, or hybrids. Dahlgren (1991) has shown that hybrids occur. All taxa with $2n = 24$, 40 and 48 are presumably allopolyploid hybrids.

For two species, some new substantial information has been gathered. Many earlier records of *R. aquatilis* were based on misidentification. In several cases, discrepancies were caused by informal notation and loose usage, such as ‘*R. aquatilis*’ (without author), ‘*R. aquatilis* s.str.’, ‘*R. aquatilis* s.l.’ or ‘*R. aquatilis* agg.’, instead of *R. aquatilis* L., as defined by Cook (1966) and more narrowly circumscribed by Wiegleb et al. (2017). Future studies would be necessary to establish the exact frequency and distribution of that species. The special nature of *R. dahlgreniae* was recognized by T. Peschel and G. Wiegleb during revisions in 2019 in B. Specimens were left unidentified and set aside. Along with that, J. Zalewska-Gałocz has collected specimens in Crete, which could not be identified with the available keys. Subsequent cooperation has led to the description of a new species (Jopek et al. 2023). The new species would need tracing down in the existing collections and in the course of future field surveys, in order to delimit it from *R. saniculifolius* and *R. baudotii*. Three species were excluded from the Greek flora, either on the basis of false synonymy (*R. fucoides*; as *R. peltatus* subsp. *fucoides*) or due to misidentification (*R. penicillatus*, *R. tripartitus*).

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