Habrosia (Caryophyllaceae) a monotypic genus endemic to Western Asia: morphological and molecular remarks

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Abstract – Habrosia (Sagineae, Caryophyllaceae) is a genus that includes only H. spinuliflora, a species occurring in Iran, Iraq, Syria, Lebanon, and Turkey (Irano-Turanian floristic chorological element). Based on the available molecular data published in 2011, Habrosia appears to be nested in a Minuartia-clade, which includes taxa currently recognized under the genus Sabulina. Consequently, Habrosia should be treated as a genus to be included in Sabulina. However, the molecular tree published in 2011 considered only 9 Sabulina members whereas, according to the current concept, Sabulina is a genus comprising about 65 species. Unfortunately, the molecular phylogeny including a larger Sabulina sample published in 2014 did not include H. spinuliflora and the taxonomic position of Habrosia remains, therefore, uncertain. With the aim of verifying the correct position of Habrosia in the tribe Sagineae with respect to its relationship to Sabulina, a comprehensive molecular investigation based on ITS sequences, linked to detailed morphological data, is presented. The results obtained revealed that Habrosia is not part of Sabulina. A detailed description of H. spinuliflora, its ecological preference, and a distribution map are provided. Eventually, the name Arenaria spinulifolia (basionym of H. spinuliflora) is lectotypified on a specimen preserved at G (barcode G00212963).

Keywords: Arenaria spinulifolia, Iraq, ITS, Lebanon, Syria, Turkey, typification.

Introduction

The family Caryophyllaceae Juss. comprises ca. 100 genera and 3000 species, occurring mainly in the northern hemisphere (Hernández-Ledesma et al. 2015). Caryophyllaceae is monophyletic as circumscribed by Bittrich (1993), but the traditional recognition of three subfamilies (Alsinioideae Fenzl, Caryophylloideae Arnott, and Paronychioideae Meissner; see e.g., Bittrich 1993) based on features of stipules, petals, sepals, and fruits does not provide monophyletic groups and should be replaced with the tribe-based scheme as reported by Harbaugh et al. (2010) and confirmed by subsequent studies (e.g. Greenberg and Donoghue 2011). At genus rank, several studies have been carried out on Arenaria L., Minuartia L., Dianthus L., Gypsophila L., Polycarpion L., Silene L., etc. (see e.g., Kool et al. 2007, Iamonico 2013, 2014, 2015, 2016, 2018, Dillenberger and Kadereit 2014, Iamonico and Domina 2015, Iamonico et al. 2015, Sadeghian et al. 2015, Dillenberger and Rabeler 2018, Madhani et al. 2018), but various questions are still open.

As part of the ongoing studies on Caryophyllaceae (e.g., Iamonico 2013, 2014, 2015, 2018, 2020, Iamonico and Domina, 2015), I here present a note about the monotypic genus Habrosia Fenzl [including the species H. spinuliflora (Ser. ex DC.) Fenzl], since some issues about its position in the tribe Sagineae J.Presl still need clarification. The aims of the research are: 1) to verify the correct position of Habrosia in the tribe Sagineae with special regards to its relationship to Sabulina, 2) to consider the morphology of H. spinuliflora in comparison with its position in the molecular tree, 3) to clarify the identity of the name of Arenaria spinulifolia (basionym of H. spinuliflora).

Materials and methods

The present research is based on both the analysis of the relevant literature and the examination of the specimens preserved at BAG, G, MO, P, SAV, and W (codes according to Thiers 2021-onward).

The ITS sequences, used for the alignment and phylogenetic reconstruction, were publicly available in GenBank (see Smissen et al. 2003) and refer to 65 members of Sabulina Rchb., Colobanthus Bartl., Drypis L., Facchinia Rchb., Habrosia, Minuartia, Mcneillia Dillenb. & Kadereit,
Sagina L., and (outgroups) Bufonia tenuifolia L. and Cheleria garckeana (Asch. and Sint. ex Boiss.) A.J. Moore and Dillenb. RAxML v8.2.12 (Stamatakis 2014) was run under the GTR+GAMMA model (bootstrapping was stopped automatically) for phylogenetic reconstruction.

The distribution map was prepared using Google Earth Pro (2021). Data derive from both herbarium specimens and literature.

The articles cited throughout the text follow the International Code of Nomenclature for algae, fungi, and plants (Turland et al. 2018, hereafter as ICN).

Results

Literature data

Arenaria spinuliflora Ser. ex DC., after its original description in the 1st volume of Candolle’s Prodromus (Candolle 1824: 406), was treated under the genus Arenaria up until 1833, when Fenzl (1833: 57) proposed transferring this taxon to the genus Alsine L. (note that neither morphological information nor a general reason about this nomenclatural choice was given by Fenzl 1833). No subsequent papers or monographs, in which Fenzl’s Al. spinuliflora was accepted, have been traced. Ten year later, Fenzl (1843: 323–324) validly described the new genus Habrosia to accomodate Candolle’s species, correcting his previous choice under Alsine. A detailed generic description was provided, as well as a diagnosis and description of his H. spinuliflora (Ser. ex DC.) Fenzl. The genus Habrosia has been accepted until today (see e.g., Hernández-Ledesma et al. 2015, Rabeler 2020).

At suprageneric rank, Habrosia spinuliflora is currently to be included in the tribe Saginaeae, together with Sagina, Colobanthus, Sabulina, and Bufonia Sauvage. Fenzl (1843: 326) proposed to treat his new genus Habrosia as belonging to a new subtribe (named “Habrosieae”) of the tribe Scleranthus Link. In the same year, Endlicher (1843), proposed transferring Fenzl’s subtribe into tribe rank [Habrosieae (Fenzl) Endl.]. More recently, Novosel (1982) published “Habrosieae Novosel, tribus nov.” which would be morphologically similar to the tribe Pollichioeae DC. (including the genus Pollichia Aiton) from which it would differ by the inedelicious fruit, absence of sterile branches, occurrence of petals in flowers, and 1-4 ovules [see the diagnostic key (steps 1-3) provided by Novosel 1982: 222]. According to Art. 6.3 (Note 2) of ICN, Novosel’s name “Habrosieae” is an isonym (and therefore invalid) being based on the same type (H. spinuliflora) of Endlicher’s name.

The first authors to have included Habrosia in a molecular analysis were Smissen et al. (2003) in their study on the genus Scleranthus L. where Fenzl’s genus resulted to be sister of Drypis.

A more detailed study was carried out by Greenberg and Donoghue (2011) who investigated many samples of Caryophyllaceae members (630 accessions) and revealed that Drypis (a monotypic genus with Drypis spinosa L.) was basal to a well-supported clade (bootstrap value: 91) including species of Sagina, Colobanthus, Minuartia, Habrosia, and Bufonia, plus Arenaria fontinalis (Short and R.Peter) Shinners. This clade corresponds to the tribe Saginaeae.

Dillenberger and Kaderireit (2014), who investigated in detail the genus Minuartia, did not consider the genus Habrosia in their analysis. However, the species of Minuartia, included in the tribe Saginaeae by Greenberg and Donoghue (2011), were treated by Dillenberger and Kadereit (2014) as belonging to the resurrected genus Sabulina Rchb. In contrast to Habrosia, Dillenberger and Kadereit (2014) included Arenaria fontinalis in their analysis, which was also investigated by Greenberg and Donoghue (2011), and confirmed that it is to be treated as a member of Sabulina and, in fact, a new combination, S. fontinalis (Short and R. Peter) Dillenb. and Kadereit, was proposed.

Based on Greenberg and Donoghue (2011), Habrosia should be a genus to be included in Sabulina.

Molecular data

Greenberg and Donoghue (2011: 1642, Fig. 2) considered nine members of Sabulina (sub Minuartia spp.). However, according to the current concept, Sabulina is a genus comprising ca. 65 species (Hernández-Ledesma et al. 2015, Rabeler 2020). As a consequence, the position of Habrosia in the ITS tree (clade Saginaeae) published by Greenberg and Donoghue (2011) cannot be considered as conclusive. As discussed above (see paragraph “Literature data”), Dillenberger and Kadereit (2014) studied the majority of the Minuartia s.l. taxa, and included in their analyses the Sabulina clade by Greenberg and Donoghue (2011, sub Minuartia), reaching the conclusion that these taxa are to be transferred to a different genus, i.e. the resurrected Sabulina. However, Habrosia was not included in the study by Dillenberger and Kadereit (2014), and an indirect inclusion of Habrosia into Sabulina would represent a risk from the taxonomical point of view.

All things considered, I decided to merge the molecular data of Dillenberger and Kaderireit (2014) and Greenberg and Donoghue (2011) in a single matrix and run a new comprehensive tree to verify if Habrosia is actually nested in the Sabulina clade or not. The results obtained (Fig. 1) reveal that Habrosia is not nested in the clade comprising the members belonging to Sabulina, but is in an unresolved position outside of Sabulina.

Morphological data

Starting from important works by McNeill (1962, 1967), the genus Minuartia (at that time morphologically related to Arenaria), was later accepted by most authors until the molecular studies by Dillenberger and Kaderireit (2014). These latter authors demonstrated that Minuartia is highly polyphyletic, and 11 different genera were recognized and later accepted by many authors (e.g., Iamonico 2014, Legler and Dillenberger 2017, Moore and Dillenberger 2017, Dillenberger and Rabeler 2018).
Among the resurrected genera, there is *Sabulina* which comprises McNeill’s sects. *Acutiflorae* (Fenzl) Hayek, *Alsinanthe* (Fenzl) Graebn., *Greniera* (Gay) Mattf., *Sabulina* (Rchb.) Graebn., *Sclerophylla* Mattf., and *Tryphane* (Fenzl) Hayek, as well as *Stellaria fontinalis* Short & R.Peter (Dillenberger and Kadereit 2014, Hernández-Ledesma et al. 2015: 330). *Sabulina* can be morphologically distinguished in having the following characters (see Dillenberger and Kadereit 2014: 80-81): stems neither spiny nor quadrangular, leaves linear to subulate, flowers white without episepalous staminoids, nectary glands not cup-shaped, calyx not hardened at the base, sepals acute and 1–3-veined, petals usually not exceeding the sepals, styles 3 and free, fruit dehiscent (capsule) 3-toothed.

According to my examination of herbarium specimens, *Habrosia* differs from *Sabulina* by the following characters, which have a high taxonomic value in Caryophyllaceae (see e.g., Dillenberger and Kadereit 2014, Hernández-Ledesma et al. 2015): apex of the sepals [awned (awns about 2/3 as long as the membranous part of the sepals) in *Habrosia* vs. not awned in *Sabulina*], number of styles (2 vs. 3), and fruit [indehiscent (utricule) in *Habrosia* vs. dehiscent (capsule) in *Sabulina*].
Typification of Arenaria spinuliflora

Arenaria spinuliflora Ser. ex DC. [basionym of Habrosia spinuliflora (Ser. ex DC.) Fenzl] was validly published by Candolle (1824: 406) who provided a short diagnosis and the provenance (“in Oriente”) and cited a syntype (“v. s. [vidi sicco] comm. à cl. Rosseau”). Candolle (1824) reported “Ser. mss.” just after the binomial, so referring to an unpublished Seringe’s manuscript.

Tropicos (2021) does not list the name Arenaria spinuliflora, erroneously reporting “Habrosia spinuliflora Fenzl” and citing, as syntypes, a specimen at MO (barcode MO256214, available at http://legacy.tropicos.org/Image/59784) collected by T. Kotschy (no. 120) in Aleppo (Syria) in April 20, 1841. However, not only did Fenzl (1843: 323–324) not propose a new species (rather a new combination of Candolle’s name), but the cited specimen of Kotschy (MO256214) cannot be regarded as syntype (or included in the original material) since it was not cited by Candolle (1824: 406) but only by Fenzl (1843). Also The Plant List (2013) and IPNI (2021–onward) accepted the citation “Habrosia spinuliflora Fenzl” [note that The Plant List (2013) reported, as synonym of “Habrosia spinuliflora Fenzl”, the name Arenaria spinuliflora which is therefore (and wrongly) considered as heterotypic synonym]. Among the main online database of plant names, only POWO (2021–onward) correctly cited the name by Fenzl (1843) which is considered a new combination of Candolle’s name (basionym).

I traced one sheet at G (barcode G00212963) bearing two plants which are clearly part of the same gathering. In fact, both the plants were collected by M. Rousseau in “Orient” in 1818. G00212963 is part of the original material for Arenaria spinuliflora, matches Candolle’s diagnosis (1824: 406), and it is here designated as the lectotype (Arts. 9.3 and 9.4 of ICN). In addition, an original label by Seringe (“Ser. mss.” just after the binomial, so referring to an unpub-lished Seringe’s manuscript).

Taxonomic treatment

Habrosia Fenzl., Bot. Zeitung (Berlin) 1: 323. 1843.
Original type: Habrosia spinuliflora (Ser. ex DC.) Fenzl.

Habrosia spinuliflora (Ser. ex DC.) Fenzl, Bot. Zeitung (Berlin) 1: 323–324. 1843 (as “Habrosias-pinuliflora” which is a typographic error) = Arenaria spinuliflora Ser. ex DC., Prodr. [DC.], 1: 406 (1824) = Alsine spinuliflora (Ser. ex DC.) Fenzl, Vers. Darstell. Alsin.: 57 (1833), fig. 2.

Lectotype (designated here) – Unknown country, Orient, 1818, M. Rousseau s.n. (G00212963).

Description – Annual herb, erect, 4–15 cm tall. Stems filiform, dichotomously branched, slightly purple in colour, glabrous to sparsely pubescent [trichomes short, uniseriate, multicellular, eglandular, see Chandra et al. 2019]. Leaves opposite, setaceous, 0.5–2.0(–2.5) cm long, up to 0.5 mm width, connate at the base, glabrous to sparsely pubescent, sessile, margins entire, apex obtuse. Stipules adnate to the margins at the base of the leaf, with membranous borders.

Distribution map of Habrosia spinuliflora (Ser. ex DC.) Fenzl from Mardin, SE-Turkey. A – habit, B – detailed of the inflorescence (photo by Musa Geçit, @MusaGeçit).

Inflorescences 4–10-flowered, terminal, lax; bracts leaf-like, shorter than leaves (ca. 3 mm long). Flowers peryginous, on pedicels up to 6 mm long; sepals 5, glabrous, ovate-sublan-ceolate, 1.5–2.5(–3.0) mm long, 1(–3)-veined, membranous at the margins, apex awned, 2/3–1 as long as the membranous part of the sepals; petals 5, ovate-rounded, 1.0–1.5 mm long, shorter than sepals, white, entire; stamens 5, alternate to the sepals, with distinct glands attached to the adaxial surface extending in front of petal bases; styles 2, free, very short; ovary small, up to 1 mm long, sub sessile, each ovary including 2 ovules. Fruit indehiscent nutlet, ovoid, ca. 1 mm long; seed 1 per fruit, globose.

Pollen grain spheroidal, diameter about 27 μm, polypo-rate with 12–13 pores, each pore circular, in diameter about 4 μm, granulate; interpolar distance 5–8 μm. Exine ca. 3 μm thick, tectate. Sexine ca. 2.5 μm thick, punctulate. Tegillum < 0.5 μm thick with minute spines. Bacula broader at the apex than the base (Chanda 1962: 73–74, and Pl. 3, Figs. 10–12).

Etymology – From the Greek Habros (χάβρος) which means “delicate, graceful”, presumably referring to the thinness of the plant, especially of stem and leaves.
Vernacular names – Çöl kumota (Turkish; Ekim 2012), Western Asian sandwort (English common name, here proposed).

Habitat and phenology – Rocky limestone slopes, gullies, scrubs, calcareous steppe, arable field, open banks, 300–1500 m a.s.l. Flowering and fruiting times March to June.

Distribution and chorology – NE Iran (see also Rechinger et al. 1988), N Iraq (see also Blakelock 1957, Ghazanfar and Edmundson 2016), C- and NW Syria (see also Boissier 1867, Post 1932), NE Lebanon (see also Musselman 2011), SE Turkey (see also Davis 1988, Kaya and Ketenoğlu 2010, Bakis et al. 2011, Ekim 2012) plus Mt Taurus (Fig. 3). According to Takhtajan (1986), the distribution area of Habrosia spinuliflora is included in the Irano-Turanian floristic region, Western Asiatic subregion, Mesopotamian Province.

Additional specimens – Iran: Kurdistania Persica: montes supra pagum Režab dit. Kasr-i-Širin, in lapidosis, 05 May 1910, F. Nábělek 4114 (SAV0005141!), Iraq: in montis Kuh-Sefin reg. inf. Supra pagum Schaklava (ditionis Erbil), 15 May 1893, J. F. N. Bormüller 949 (P05380908!); ibidem (P05380911!); Mindan, 20 April 1947, Rawi 28533 (BAG); Dokan, 26 May 1948, O. Stapf 461 (P05380912!); Acra, Mosul liwa, 20 May 1910, Rawi 11305 (BAG); Jebel Sinjan, racky clay mountain, 16 April 1980, Al Kaisi 52008 (BAG); ibidem, 18 April 1980, Al Kaisi 52224 (BAG). Lebanon: ad Antilibani radices occidentales, in decliviitatis supra Baalbek, 1150-1300 m, 20 May 1910, J. Bornmüller 11506 (P05380909!); Baalbek, 11 May 1933, M. R. Gombault 2233 (P05110464!); ibidem (P05110465!); Syria: In colibbis lapidosis pr. Aleppum, 20 April 1841, T. Kotschy 120 (P05049467!, as "Habrosyne spinuiflora"); ibidem (P00712781!); ibidem (P00712782!); ibidem (P00712783!); ibidem (MO256214!); Aleppo, in graminis, 1330 ped. (= feet), 24 March 1865, C. Haussknecht s.n. (P05380913!), the nineteen plants on the botton-half of the sheet); Syria borealis, Aleppo, 1865, A. de Bunge s.n. (P00712788!); Dans Djebel Belas, 28 May 1895, coll. illec. 2964 (P05380913!, the seven plants of the top-half of the sheet); Alep., 1834, A. Montbret s.n. (P00712786!); ibidem (P00712787!); Alep., s.d., s.coll. 590 (P00712785!); Alep., s.d., A. Montbret s.n. (P05380910!). Turkey: Mont Taurus, 1837, M. Aucher-Eloy 590 (P00712784!); Birıcik: Djebel Taken, 30 April 1888, O. Stapf 461 (P05380912!); ibidem (P05380915!).

Discussion

The available molecular data for Habrosia placed this genus as sister of Drypis (Smissen et al. 2003) or Minuartia s.l. (tribe Saginaeae; Greenberg and Donoghue 2011). More recently, Dillenberger and Kaderiit (2014) resurrected the genus Sabulina in which to place the Minuartia species included in the tribe Saginaeae by Greenberg and Donoghue (2011). Although Dillenberger and Kaderiit (2014) did not consider the genus Habrosia in their analysis, Habrosia should be indirectly treated as a genus to be included in Sabulina based on published data. On the contrary, the phylogenetic tree obtained in the present study, which derives from a single matrix including the sequences by both Dillenberger and Kaderiit (2014) and Greenberg and Donoghue (2011), shows that Habrosia cannot be merged with Sabulina and it should be left separate. This result highlights the relevance, in molecular analysis, of considering all the taxa involved in the investigated genus and the related ones, especially in taxonomically critical groups as Minuartia s.l. (specifically Sabulina in this case).

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