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A new taxonomic treatment and comprehensive evaluation of the genus *Aegokeras* (Apiaceae) endemic to Turkey

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Abstract

The systematic position of the species *Pimpinella ibradiensis*, a narrow endemic to Turkey, was evaluated on the basis of morphological data and nrDNA ITS sequences. The species *Pimpinella ibradiensis* has been classified within the genus *Pimpinella*, particularly due to the similarity of leaf characteristics. However, the presence of trifoliolate leaves has been observed in both the isotype specimens and newly collected specimens from the field. Field observations, detailed morphological comparison, mericarp anatomy, and nrITS sequences data have supported the inclusion of this species within the genus *Aegokeras*. Furthermore, the description of the species *P. ibradiensis* has been emended, and the diagnostic morphological characters of all *Aegokeras* species are discussed. Additionally, the geographical distribution of the genus *Aegokeras* species is mapped, and an identification key with a description of all species is provided.

Key words: *Aegokeras*, carpology, nrITS, *Pimpinella*, phylogeny, taxonomy, Umbelliferae

Introduction

Pimpinella Linnaeus (1753: 263) is one of the largest genera of the Apiaceae. It is represented by c. 180 species in the world, which are mainly distributed through subtropical and temperate regions of the northern hemisphere. The Mediterranean region is however one of the most important centres of diversity for this group (Abebe 1992, Pimenov & Leonov 1993, 2004, Magee *et al.* 2010). *Pimpinella* species are annual, biennial or perennial and usually grow on dry rocky habitats such as rocky crevices, waste places, cultivated fields, meadows, mountain pastures, and grasslands. To date, 34 taxa of *Pimpinella* are known to grow in Turkey, including 29 species, 10 of them are endemic (Matthews 1972, Ertekin & Kaya 2005, Menemen 2012a, Çinbilgel *et al.* 2015, Akalın *et al.* 2016, Yeşil *et al.* 2016, Yıldırımlı & Kılıç 2019, Behçet & Cengiz 2023).

During the preparation phase of the paper about the new species *Aegokeras gazipashensis* A.Duran & Lyskov in Duran *et al.* (2023: 237), the first author examined the Apiaceae specimens from his private collection. Among the examined plants, there were also isotypes of the *Pimpinella ibradiensis* (Çinbilgel *et al.* 2015: 165), which were sent by Dr. İlker Çinbilgel (the first author of the *P. ibradiensis*). The latter species was described as a part of *Pimpinella* subsect. *Flabellifoliae* Wolff (1927: 222) with closely related species *P. flabellifolia* (Boissier 1844: 135) Drude (1898: 196), *P. sintenisii* Wolff (1927: 223), *P. neprophylla* Rech.f. & Riedl in Rechinger (1961: 226), and *P. paucidentata* Matthews (1972: 354). In the protologue of *P. ibradiensis*, the plant was described as having simple leaves. This feature becomes the main ground to refer this species to *Pimpinella* subsect. *Flabellifoliae*. However, during examination it was observed that some leaves of the isotype specimens are trifoliolate (Fig. 1). In this way we started to think that the species *P. ibradiensis* might belong to the genus *Aegokeras* Rafinesque (1840: 51).

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FIGURE 1. Representative specimens of *Pimpinella ibradiensis* (isotype).

The genus *Aegokeras* contains two species. The first species was previously described as *Seseli caespitosum* Smith in Sibthorp & Smith (1806: 200). After this the only species *Aegokeras caespitosa* (Smith) Rafinesque (1840: 51) was

mistakenly transferred to the genus *Olymposciadium* Wolff (1922: 132) and it take place in the Flora of Turkey as *Olymposciadium caespitosum* (Smith) Wolff (1922: 132) (Hedge & Lamond 1972). Later it was rearranged as *Aegokeras* genus in the plants list of Turkey (Menemen 2012b). Following the publication of the species *A. gazipashensis* (Duran *et al.* 2023), *Aegokeras* becomes a bitypic genus.

Morphology of leaf blades, number of vallecular vittae, and some other morphological features leading us to a decision to conduct fieldwork and population observations at the type locality of *P. ibradiensis* during the 2023 vegetation season. In order to determine the taxonomic position of the species, we undertook both morphological and molecular studies to understand the relationships of this taxon.

Materials and methods

On 19 July 2023 an excursion was made to the type locality of *Pimpinella ibradiensis* (Turkey, Antalya province, İbradı district, Toka Yayla), and fieldwork was conducted. Collected specimens and available herbarium collections were meticulously compared against the provided identification keys and descriptions (Hedge & Lamond 1972), and the Apiaceae accounts given in various relevant publications (Kaya & Başer 2002, Çinbilgel *et al.* 2015, Duran *et al.* 2023). Herbarium specimens from ANK, GAZI, HUB, K, KNYA, and MW herbaria were also examined and compared. Herbarium acronyms follow Thiers (2018).

DNA extraction, nuclear ITS amplification, and sequencing

Total genomic DNA was isolated from fruit material using a Diamond DNA Plant kit (ABT, Barnaul, Russia) following the manufacturer's instructions. Polymerase chain reaction (PCR) amplification was performed on a Biometra T3000 Thermocycler using an Encyclo PCR kit (Evrogen JSC, Moscow, Russia). Details of the PCR nrITS region amplifications (including primer locations and characteristics) and sequencing strategies for nrITS were described by Valiejo-Roman *et al.* (2002). Cycle sequencing was performed by automated sequencing using Big Dye Terminator version 3.1 for both forward and reverse strands was conducted on ABI Prism 3100-Avant (Applied Biosystems). Newly obtained sequences were deposited in the GenBank (Appendix 1).

Alignment and phylogenetic analysis

The sequences were aligned using the program MUSCLE (Edgar 2004) and then manually adjusted using the program BioEdit (Hall 1999). To infer phylogenetic relationships, maximum parsimony and Bayesian analyses were performed using a set of concatenated ITS1 and ITS2 sequences of 55 samples including 10 sequences of *Pimpinella* and three sequences of *Aegokeras* with addition of other species from the Careae and Pyramidoptereae clades. *Meum athamanticum* Jacquin (1776: 2) was used as the outgroup based on the results of an earlier phylogenetic study of the subfamily Apioideae (Banasiak *et al.* 2013).

Maximum parsimony analysis was performed using PAUP* version 4.0a (Swofford 2003) with TBR branch swapping and equal weighing of characters; gaps were treated as missing data. 1000 heuristic searches with random sequence additions were performed and 1000 of the shortest trees were saved in each run. Bootstrap values were calculated using 2000 replicates with TBR branch swapping and random addition of taxa (Felsenstein 1985) and 1000 most parsimonious trees from each replicate were saved.

Bayesian analysis of molecular data was performed using the program MrBayes version 3.2.6 (Ronquist *et al.* 2012). The SYM+G model of substitutions with gamma rate categories was selected by AICc in PAUP* version 4.0a (Swofford 2003). The Bayesian analysis used four independent runs of 20 million generations and four chains in each run sampling every 1000th generation and discarding the first 1000 trees as burn-in, the number of discarded trees was determined by Höhna-Sahlin's ESS-based estimator in VMCMC version 1.0.1 (Ali *et al.* 2017). The remaining trees were used to construct the 50% majority-rule consensus tree. We considered posterior probability (PP) > 0.90 as well supported, because PP in Bayesian analyses are not equivalent to BS and are generally much higher (Ericson *et al.* 2003). In all analyses gaps (indels) were treated as missing data. Visualization of trees was made using TreeView (Page 1996).

Study of morphology

Images of the living material were taken with a digital camera. Geographical coordinates were recorded using a GPS device. According to the grid system used in the *Flora of Turkey* (Davis 1965), the locality where *Pimpinella ibradiensis* was found (Fig. 2) is within the C3 square. Methodology, specimen description, anatomical features and terminology were used as described by Kljuykov *et al.* (2004) and Metcalfe & Chalk (1979).

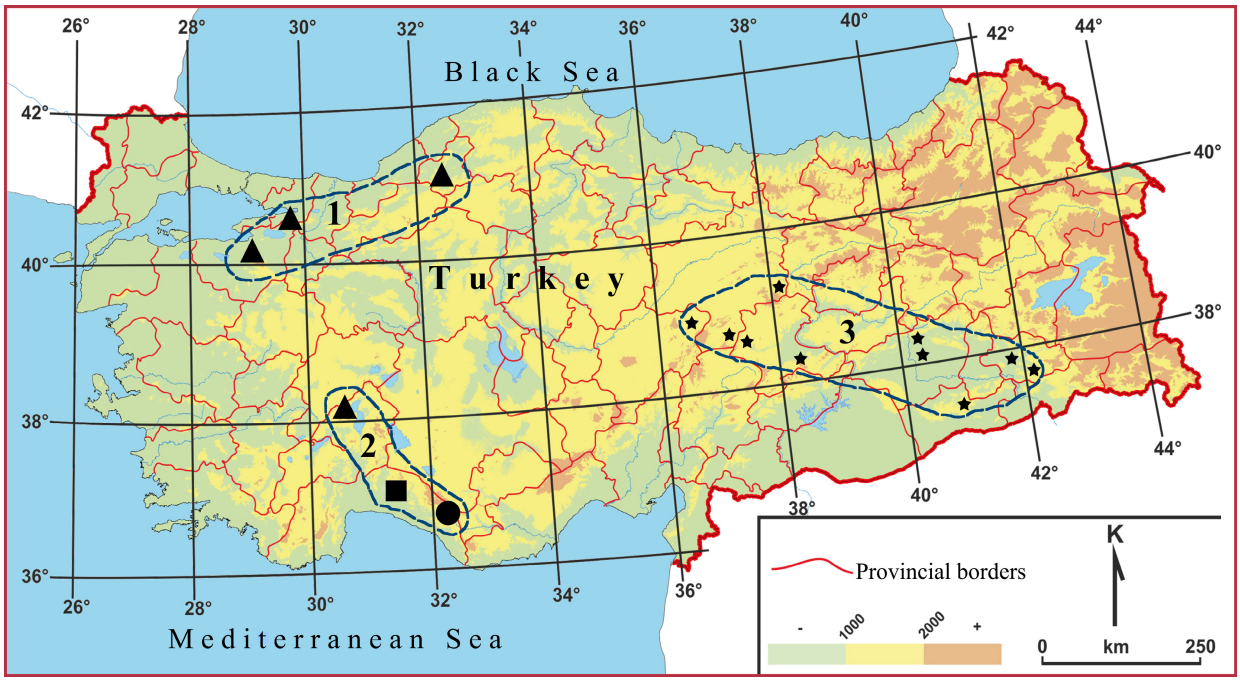

FIGURE 2. Distribution map of the genus *Aegokeras* (areas numbered 1 and 2) and *Pimpinella* sect. *Reutera*, subsect. *Flabellifoliae* (area number 3). *Aegokeras gazipashensis* (●), *A. caespitosa* (▲), *Pimpinella ibradiensis* (■), and subsect. *Flabellifoliae* species (★).

Results

The aligned matrix nrITS data contained 55 sequences. The final data matrix included 586 characters and contained 197 maximum parsimony informative sites. Trees generated by different methods (MP and BI) possessed congruent topology, so only the Bayesian tree is provided with indication of posterior probabilities and bootstrap support from maximum parsimony analysis (Fig. 3).

Species of Careae tribe form a clade with strong support (PP = 1, BS = 90). Species of the genus *Aegokeras* are a part of Careae clade with such genera as *Carum* Linnaeus (1753: 263), *Grammosciadium* Candolle (1829: 62), *Rhabdosciadium* Boissier (1844: 68), *Aegopodium* Linnaeus (1753: 265) etc. Sister clade to the *Aegokeras* includes two related monotypic genera—*Falcaria* Fabricius (1759: 34) and *Gongylosciadium* Rechinger (1987: 308). The genus *Aegokeras* also forms a clade with strong support (PP = 1, BS = 100). At the same time species of the genus *Pimpinella*, including species of subsect. *Flabellifoliae* (*P. flabellifolia*, *P. paucidentata*, and *P. sintenisii*), are attributed to Pimpinelleae clade and form a clade with strong support (PP = 1, BS = 100). Meanwhile, the specimen of *Pimpinella ibradiensis* is nested together with *Aegokeras caespitosa* and *A. gazipashensis* with strong support (PP = 1, BS = 100). Other genera of the Careae tribe pose more differences in the sequences of nrITS.

The main morphological characters of *P. ibradiensis* are as follows: nearly glabrous dwarf plant, bracts 1–2 or rarely absent, bracteoles present, petals white, fruits oblong-cylindrical, 4–5.5 × 1–2 mm (Figs. 4–7). Field observations show that both individuals with simple leaves and those with trifoliolate leaves were observed together in the population of the *P. ibradiensis*. The ratio of individuals with trifoliolate leaves was approximately 25%. Species of subsect. *Flabellifoliae* bears following features: glabrous or puberulent dwarf plants, bracts and bracteoles absent, petals yellow, fruits oblong to ovoid, 2–2.5 × 0.6–1. All species of subsect. *Flabellifoliae* have simple leaves. Species of the genus *Aegokeras* can be characterized by the following features: glabrous dwarf plant, leaves unipinnate or pinnatisect, bracts and bracteoles present, petals white, fruits narrowly oblong, 4–5.5 × 1.5–2 mm (Figs. 5–8). The diagnostic characters of studied species are compared in Table 1.

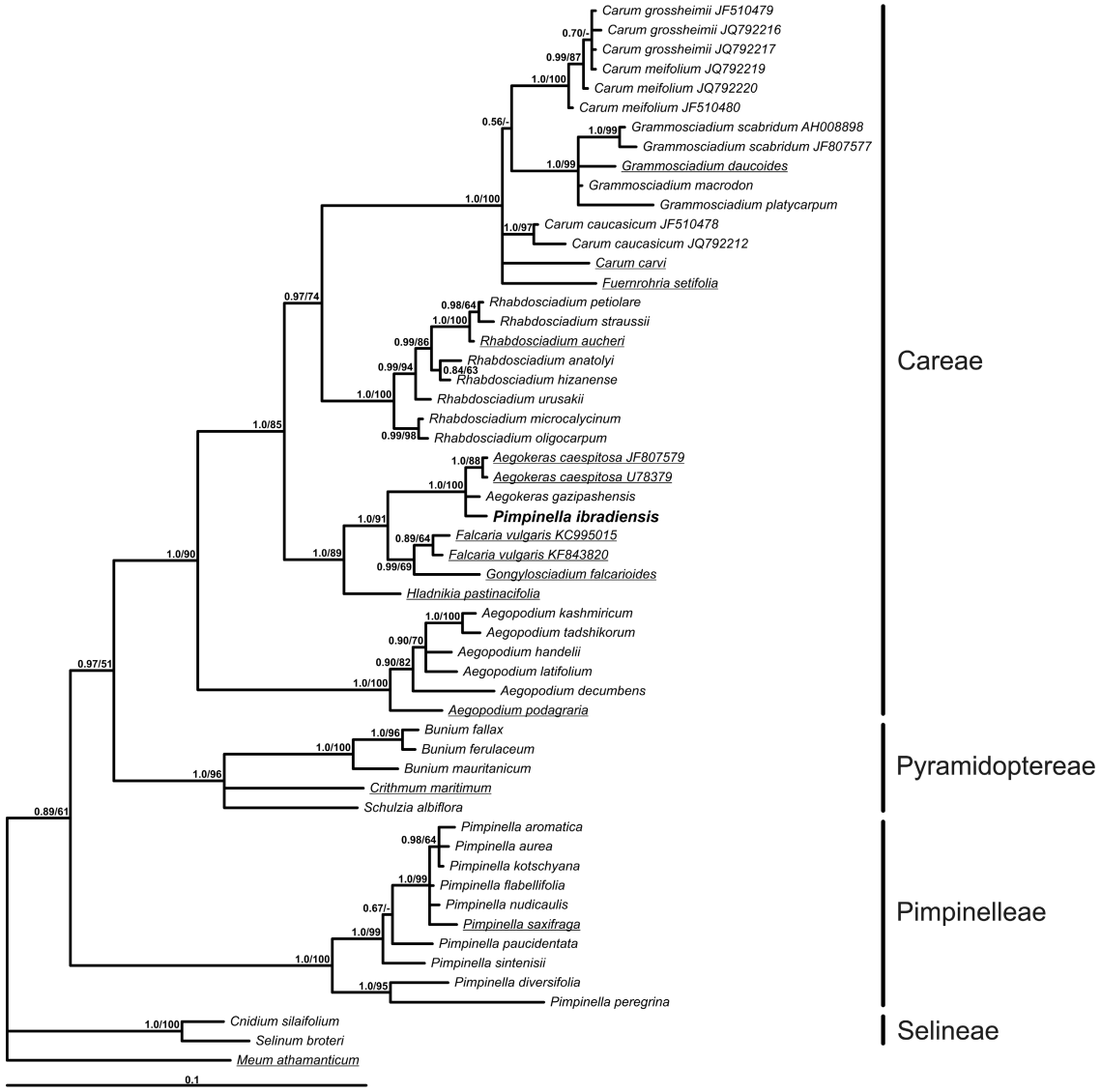

FIGURE 3. Fifty percent majority rule tree inferred by Bayesian analysis of nrITS nucleotide sequences. Posterior probability and bootstrap support values of maximum parsimony analysis are shown. Specimens attributed to type species are underlined.

TABLE 1. Comparison of diagnostic characters of *Aegokeras* species and *Pimpinella ibradiensis*.

Characters	***Aegokeras caespitosa***	***A. gazipashensis***	***P. ibradiensis***
Growing habitat	crevices of limestone cliffs	semi-arid mountain steppes	semi-arid mountain steppes
Plant habit	caespitose	non-caespitose	non-caespitose
Base of stem	with remains of old leaves bases	without remains of old leaves bases	without remains of old leaves bases
Roots	shapeless in cracks, in different positions	thick cylindrical-oblong, vertical	thick cylindrical-oblong, vertical
Leaves	unipinnate or pinnatisect, with herbaceous and ±greenish, rarely ±glaucous	unipinnate or pinnatisect, with distinctly coriaceous and glaucous	simple, trifoliolate or 2–3-lobed, with coriaceous and glaucous
Leaf margins	dentate or serrate, teeth apiculate, without cartilaginous teeth	acute-laciniate to dentate, with cartilaginous teeth	serrulate, with cartilaginous teeth

.....continued on the next page

TABLE 1 (Continued)

Characters	*Aegokeras caespitosa*	*A. gazipashensis*	*P. ibradiensis*
Segments of leaves	2–5-paired	2–5-paired	absent or trifoliolate
Petiole	with a scarcely dilated sheath, with greenish margin	with a well-developed sheath, clearly flattened, with whitish membranaceous margin	with a well-developed sheath, clearly flattened
Cauline leaves	decreasing size to umbels and similar to basal leaves or sheath-like	only at base of lateral branches sheath-like form or rarely absent	rarely one and reduced, mostly only at base of lateral branches sheath-like form
Bracts	4–13, narrow-triangular to 1inear-subulate	1–10 or rarely absent, lanceolate to linear, margins membranous	1–2 or rarely absent, mostly sheath-like form and subulate, rarely narrowly lanceolate
Rim of stylopodium	clearly dentate	slightly undulate	slightly undulate
Commissural vittae	2–4	2–4	5–7

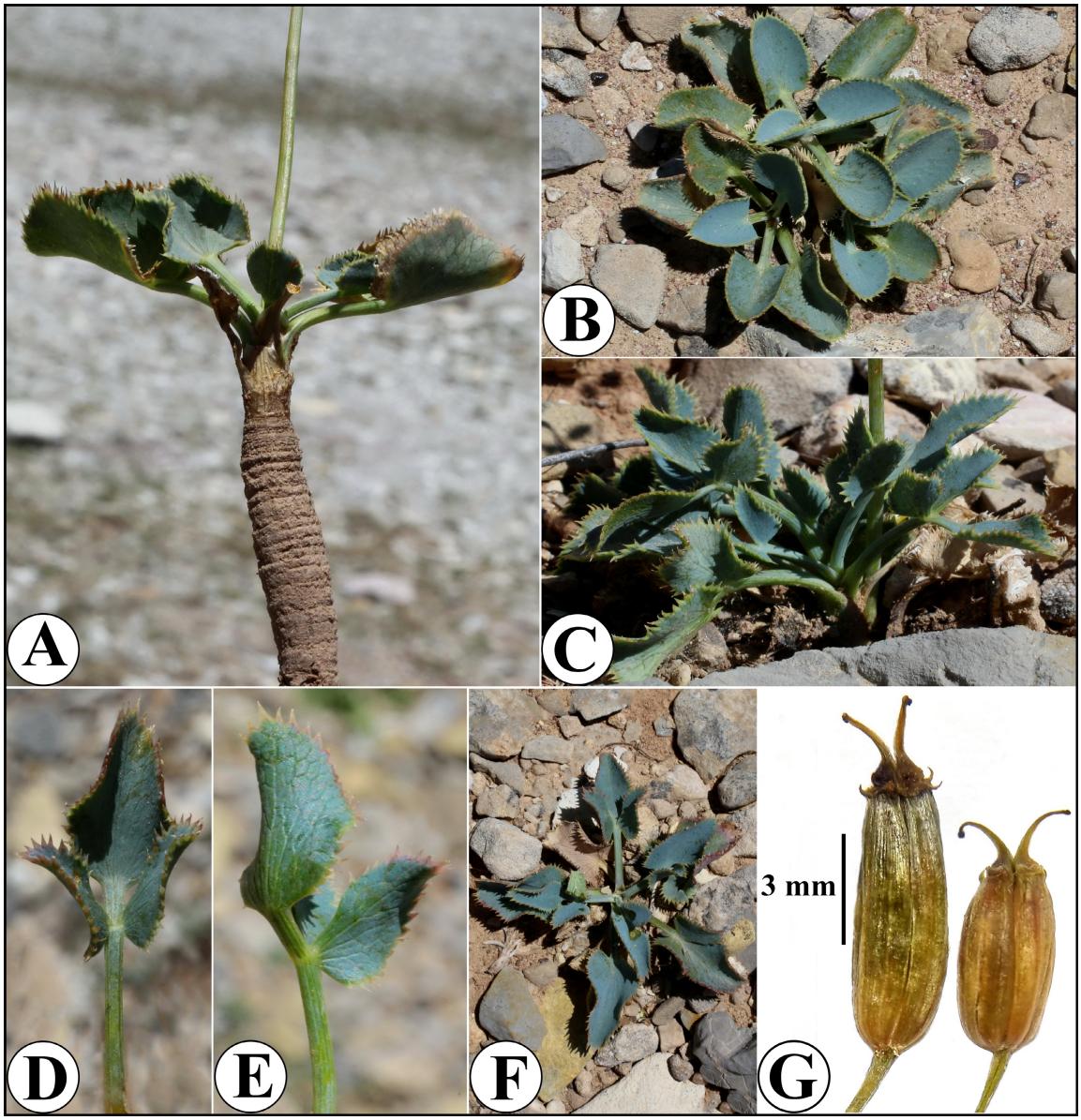

FIGURE 4. The roots and leaves of *Pimpinella ibradiensis*: **A**—root and basal leaves, **B**—simple basal leaves, **C**—trifoliolate basal leaves, **D** and **E**—trifoliolate leaves, **F**—trifoliolate and simple leaves, **G**—different sizes of fruits.

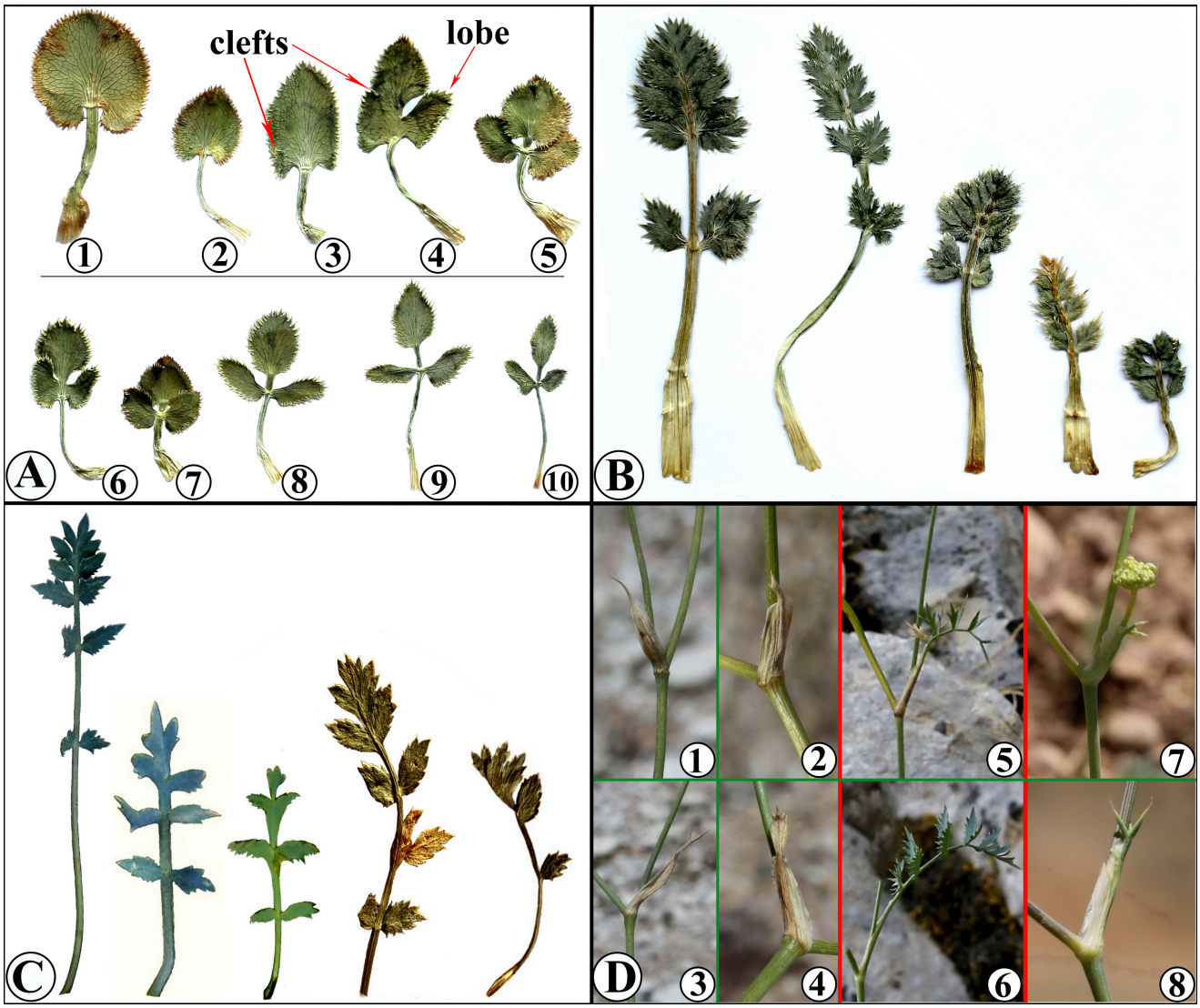

FIGURE 5. The leaf characteristics of the *Pimpinella ibradiensis* and *Aegokeras* species. *P. ibradiensis*: **A1** and **2**—simple leaves, **A3** and **4**—leaves with lobes and clefts, **A5**–**10**—different trifoliolate leaves, **D1**–**4**—various sheath-like cauline leaves. *A. gazipashensis*: **B**—different basal leaves, **D7**–**8**—sheath-like cauline leaves. *A. caespitosa*: **C**—different basal leaves, **D5**–**6**—cauline leaves.

The fruit morphology and anatomy have been considered as essential for identification of the taxonomy of Apiaceae. Especially, the number of vittae has reliable diagnostic importance in the family (Abebe, 1992). Fruits of *Pimpinella* species have 2–10 vallecular vittae in each furrow, usually larger than vascular bundles, sometimes equal to them or rarely smaller than vascular bundles (Khajepiri *et al.* 2010). Solitary vallecular vittae were observed in each furrow of the fruits of the genus *Aegokeras* (Duran *et al.* 2023, Hedge & Lamond 1972, Kaya & Başer 2002). Similarly, the fruits of the *Pimpinella ibradiensis* exhibit solitary vallecular vittae in each furrow (Çinbilgel *et al.* 2015). Additionally, fruit anatomy of *Pimpinella ibradiensis* species was studied within the scope of this research, and solitary vallecular vittae were observed in each furrow of its fruits (Fig. 7).

The species of subsect. *Flabellifoliae* are distributed in the southeastern Anatolia region of Turkey and its nearby surroundings (Fig. 2). However, species of the genus *Aegokeras* grow in the Western Black Sea and Western Mediterranean regions of Turkey. The simple-leaved species of *Pimpinella* (subsect. *Flabellifoliae*) and species of *Aegokeras* demonstrate allopatric distribution in Turkey (Fig. 2). At the same time *Pimpinella ibradiensis* also occurs in Antalya, Western Mediterranean regions of Turkey.

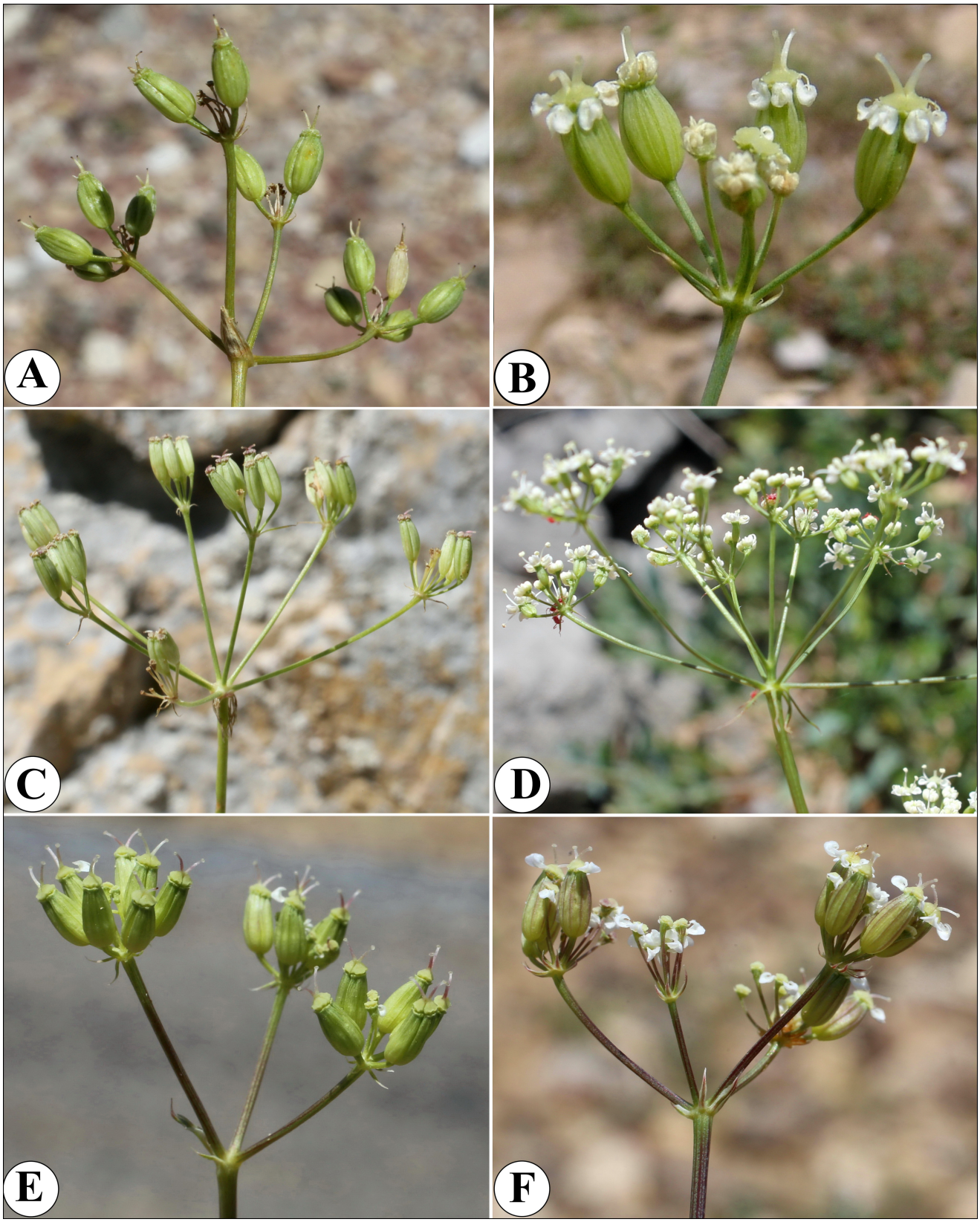

FIGURE 6. The characteristics of umbels, umbellules, bracts, bracteoles, petals, and fruits of the *Pimpinella ibradiensis* and within the genus *Aegokeras*. **A** and **B**—*P. ibradiensis*. **C** and **D**—*A. caespitosa.* **E** and **F**—*A. gazipashensis.*

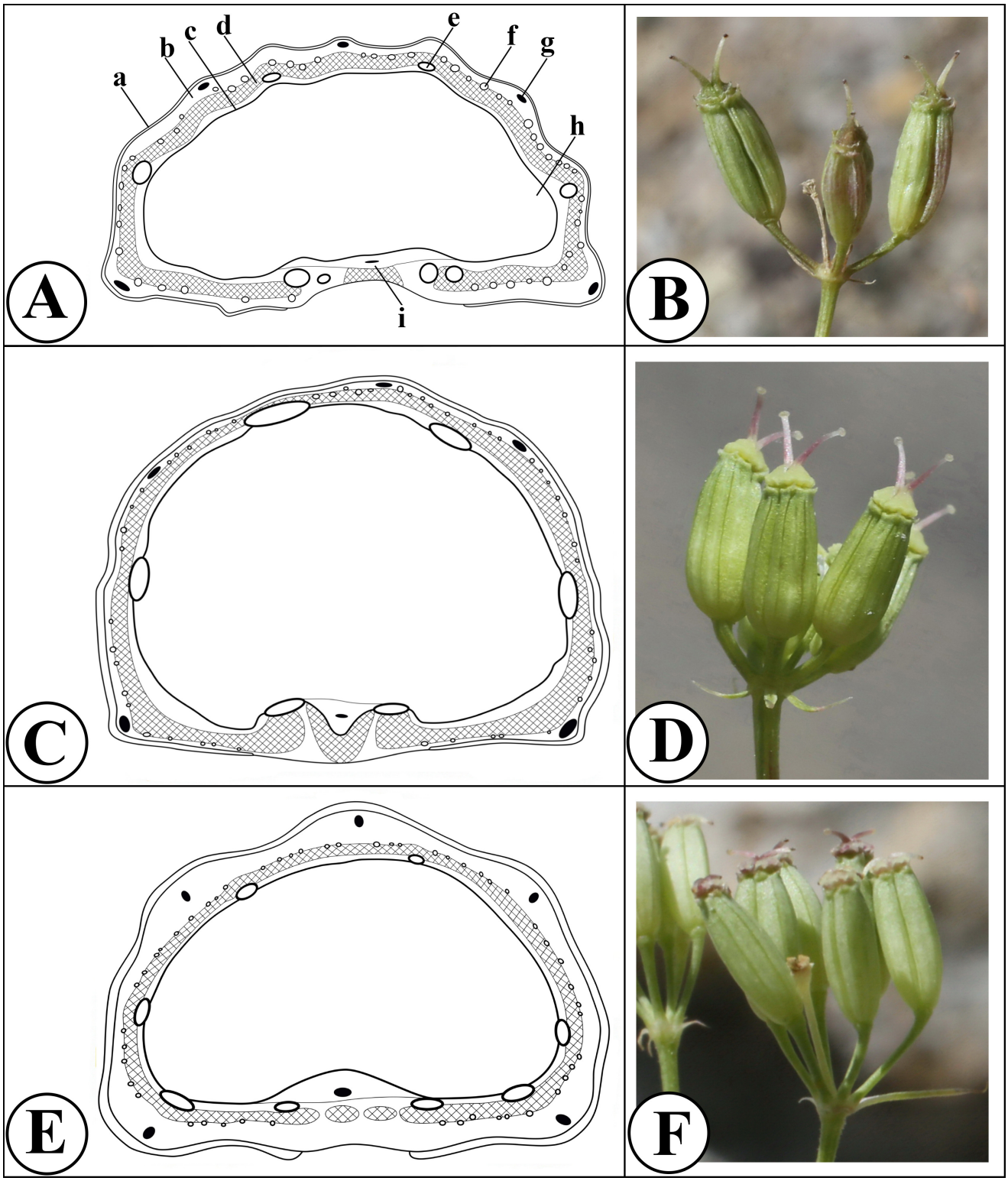

FIGURE 7. Cross-sections of the mericarps and the mature fruits in the genus *Aegokeras.* **A** and **B**—*Pimpinella ibradiensis.* **C** and **D**—*Aegokeras gazipashensis.* **E** and **F**—*A. caespitosa.* **A**: **a**—exocarp, **b**—mesocarp, c—endocarp, **d**—layer of sclerenchymatous cells in mesocarp, **e**—vitta, **f**—inconspicuous mesocarpic vitta, **g**—vascular bundle, **h**—endosperm, **i**—funiculus.

Discussion

As it was shown in earlier molecular studies (Lyskov *et al.* 2017, Zakharova *et al.* 2022), the genus *Aegokeras* with two species is a part of Careae. At the same time species of the genus *Pimpinella* are attributed to the Pimpinelleae clade

and this result is in accordance with previous studies too (Banasiak *et al.* 2013). This clade includes both generic type *P. saxifraga* Linnaeus (1753: 263) and species of subsect. *Flabellifoliae*. In conformity with this results consideration of *P. ibradiensis* as a part of the genus *Pimpinella* makes the latter a polyphyletic taxon. Therefore, these results confirm requirement of taxonomic revision of this species.

The genus *Pimpinella* was subdivided into three sections on the basis of petal color, fruit and petal properties, and life form by Wolff (1927). According to characters remarked in Wolff's revision, the species *Pimpinella flabellifolia*, *P. sintenisii*, *P. neprophylla*, *P. paucidentata*, and *P. enguezekensis* Yıldırım, Akalın & Yeşil (2016: 238) are attributed to *Pimpinella* sect. *Reutera*, subsect. *Flabellifoliae*. All above mentioned species have yellow flowers and entire leaves. However, the species *P. ibradiensis* differs from all species of subsect. *Flabellifoliae* by presence of trifoliolate leaves and white petals (Figs. 1, 4–5).

Pimpinella ibradiensis exhibits morphological similarity to certain *Pimpinella* species, with only some of its leaves being undivided. All other morphological and anatomical characteristics of this species (divided leaves, stems, branching, bracts, bracteoles, petal features, fruit morphology, and anatomy) correspond exactly to the features of the genus *Aegokeras* (Duran *et al.* 2023, Kaya & Başer 2002) (Figs. 4–7).

Pimpinella ibradiensis particularly shows close similarity to *Aegokeras gazipashensis* both in terms of habitus and habitat (Duran *et al.* 2023) (Figs. 4, 8–9, Tab. 1). However, *Pimpinella ibradiensis* differs by its leaves simple and/or trifoliolate (not unipinnate or pinnatisect, leaflets 2–5-paired in *Aegokeras gazipashensis*), leaf margins serrulate (not acute-laciniate to dentate), commissural vittae 5–7 (not 2–4) (Figs. 4–5, 7–8).

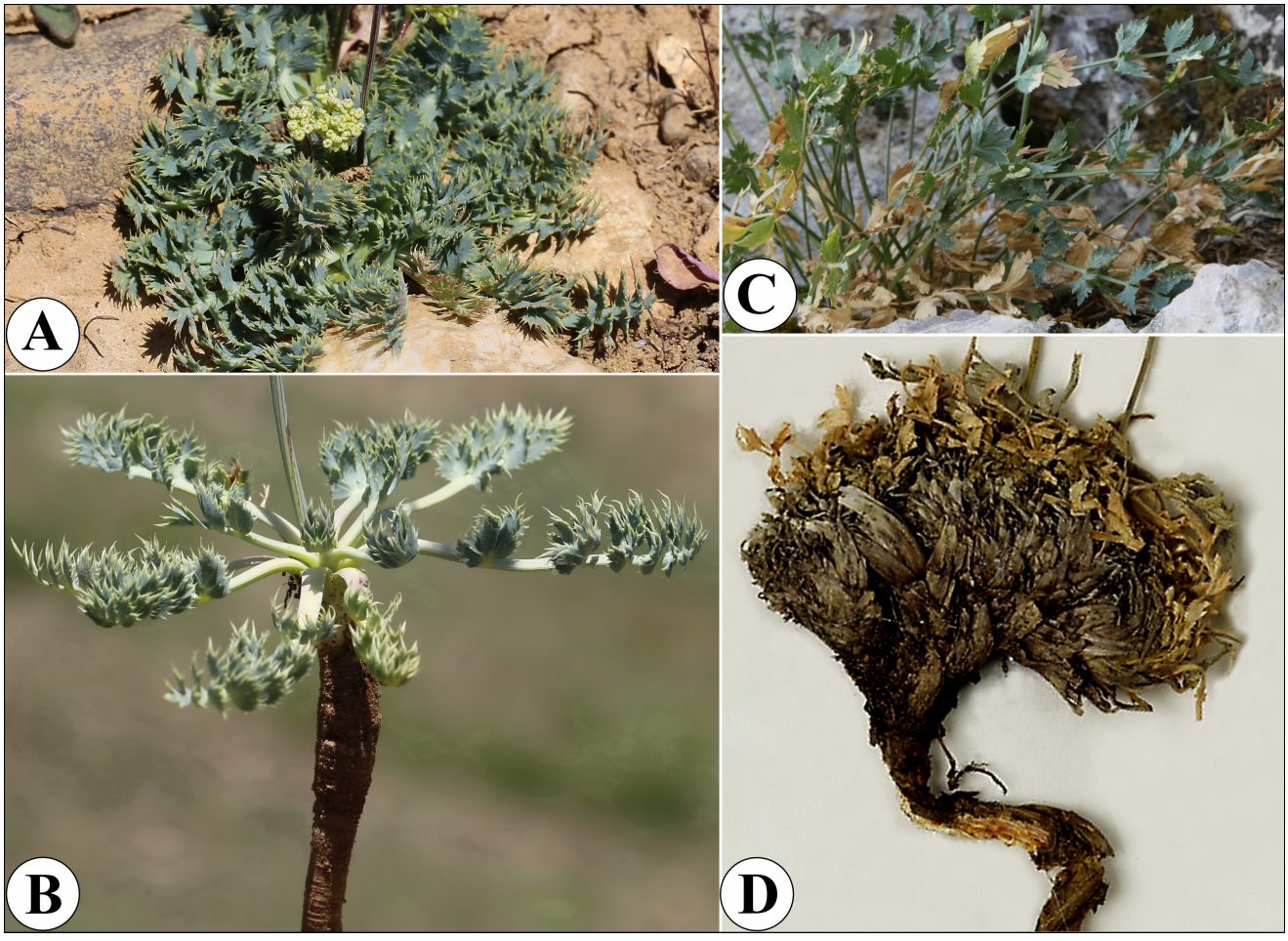

FIGURE 8. The roots and basal leaves of species *Aegokeras gazipashensis* and *A. caespitosa*. *A. gazipashensis*: **A**—rosette form leaves, **B**—root and basal leaves. *A. caespitosa*: **C**—basal leaves, **D**—remains of old leaves at the base of stems (herb. K).

Pimpinella ibradiensis is also closely related to *Aegokeras caespitosa*. It mainly differs from *A. caespitosa* because it has non-caespitose habit (vs. caespitose habit in *A. caespitosa*), habitat semi-arid mountain steppe (not crevices of limestone cliffs), base of stem without remains of old leaf bases (not with remains of old leaf bases), leaves simple and/or trifoliolate (not unipinnate or pinnatisect, leaflets 2–5-paired), leaflets margin serrulate, with cartilaginous teeth (not dentate or serrate, teeth apiculate, without cartilaginous teeth), commissural vittae 5–7 (not 2–4) (Figs. 4–5, 7–8).

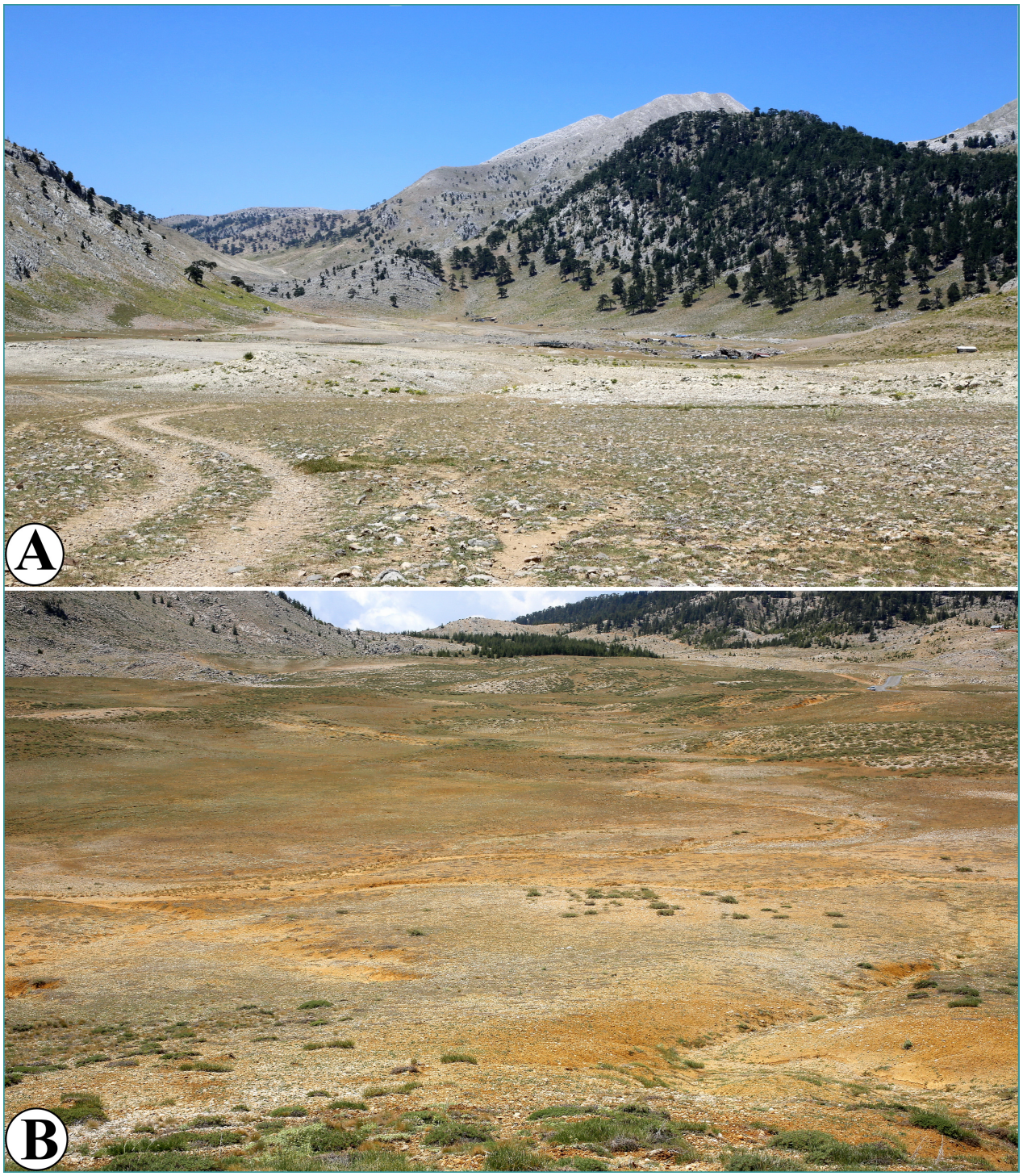

FIGURE 9. *Pimpinella ibradiensis* and *A. gazipashensis* grow in semi-arid mountain steppes. **A**—*P. ibradiensis.* **B**—*A. gazipashensis*.

The distinguishing characteristics of fruit anatomy have been specified for the Turkish species of *Pimpinella* by Akalın *et al.* (2016). The most important carpological characters are as follows: mericarp shape in transverse section, fruit indumentum, shape lateral and marginal ribs, number of vallecular and commissural vittae, and relative size of vittae and vascular bundles. The number and morphology of vittae on the dorsal and commissural surfaces are also considered as important diagnostic characters by Khajepiri *et al.* (2010). The mericarps of *Pimpinella* species usually have 5–10 vallecular vittae in each furrow (Khajepiri *et al.* 2010, Akalın *et al.* 2016). Meanwhile each mericarp of the genus *Aegokeras* has 4 solitary vittae on the dorsal surface (Hedge & Lamond 1972, Kaya & Başer 2002, Duran *et al.* 2023). In the species *Pimpinella ibradiensis* it has been reported that there are 4 vallecular vittae per mericarp on the dorsal surface (Çinbilgel *et al.* 2015), in other words vallecular vittae are solitary. Fruits of *Pimpinella* species are ovate, elliptic, ovate-oblong or subglobose. Mericarps are homomorphic, elliptic, half-round, pentagonal or almost

round in transverse section (Khajepiri *et al.* 2010, Akalın *et al.* 2016). Whereas, fruits of *Aegokeras* species are oblong, oblong-cylindrical or narrowly oblong to ovate (Çinbilgel *et al.* 2015, Duran *et al.* 2023, Hedge & Lamond 1972, Kaya & Başer 2002) (Figs. 4, 6–7).

The careful examinations showed significant similarity of *Pimpinella ibradiensis* and its close affinity, *Aegokeras caespitosa* and *A. gazipashensis*. At the same time, above mentioned species clearly distinguished between themselves in the set of obvious morphological features. In addition, these results were supported by molecular phylogenetic analysis using nrDNA ITS regions. Morphological, carpological, anatomical data and molecular study support that *Pimpinella ibradiensis* should be transferred to the genus *Aegokeras*. Thus, the number of species of the genus *Aegokeras* increased to three and all of them are endemic to Turkey.

Taxonomic novelties

Aegokeras ibradiensis (Çinbilgel, Eren, H.Duman & Gökceoğlu) A.Duran & Lyskov, **comb. nov.** ≡ *Pimpinella ibradiensis* Çinbilgel, Eren, H.Duman & Gökceoğlu (2015: 165)

Type:—Turkey. C3 Antalya: İbradı, Toka Yayla, in *Trifolio-Polygonetalia* community on flat or gently sloping stony places with plentiful fine soil and good water supply, limestone, 37°13′253″ N, 31°22′503″ E, 1527 m, 02 July 2011, *Çinbilgel 7975 & Eren* (holotype GAZI!, isotypes ANK!, AYDN, Herbarium of Akdeniz University, HUB! A.Duran's private collection!).

Emended description: Perennial, polycarpic, hemicryptophytic herbaceous plants, ± rosulate, 9–30 cm tall. **Rootstock** fairly stout, 0.5–1(–1.5) cm Ø, cylindrical, rarely branched, with rarely remains a few papery old-leaf petioles at base of stem or without petiolar remains. **Stems** fairly slender, 1–2 mm Ø at base, erect, longitudinally striate, mostly arising as a single stem or in a pair from the base, divided above into 2–3 unequal branches, glabrous, terete, smooth, greenish. **Leaves** multiple, *radical leaves* variable, simple or trifoliolate, 2–3-lobed or 1–2-cleft, petiolate, petiole (7–)10–15(–20) mm long, distinctly 6–10 veined, glaucous, glabrous to greyish very sparsely puberulent especially on veins, margin of petiole membranous; lamina of simple leaves suborbicular to orbicular, (10–)12–16(–20) × (9–)12–15(–20) mm, dark green, coriaceous, serrulate with strongly cartilaginous teeth, veins reticulate, prominent on both surface, glabrous to greyish puberulent, base cordate; trifoliolate leaves sizes of petiole and lamina same as simple leaves, leaflets margin serrulate with cartilaginous teeth, the terminal segment larger or same size with lateral segments, petiolulate or sessile, ovate-elliptic to orbicular, base cordate or rounded, 6–15 × 4–11, lateral segments sessile, elliptic to broadly ovate, 5–9 × 4–7 mm. *Cauline leaves* scanty, simplified, entire or reduced to sheaths, significantly smaller than radical, mostly at base of lateral branches; *uppermost leaves* reduced to sheaths, oblong to lanceolate, whitish-green ±membranaceous, 10–20 mm long (incl. teeth), 1–3(–5) linear-subulate teeth, teeth 1.5–2.5 mm long. **Synflorescence** composed of compound, 3–5 rayed umbels. **Rays** unequal, 0.3–3.5 cm long, glabrous; **bracts** 1–2 or rarely absent, sheath-like form and subulate or narrowly lanceolate, unequal, 1–6 mm long, persistent. **Umbellules** with (4–)7–10(–13) perfect pedicellate flowers, *pedicels* unequal, 2–6 mm long; **bracteoles** 3–5, linear-lanceolate to filiform, 1–4 mm long. **Flowers** 1–2 mm Ø, *petals* white, ovate to suborbicular, 1 × 0.8 mm, inflexed, glabrous. **Fruits** oblong-cylindrical, 4–6(–8) × 1.5–2 mm, glabrous, *mericarps* homomorphic, 5-ribbed, ± terete shape in transverse section; *stylopodia* ± conical, rim slightly undulate; *styles* 1.5–2 mm long, ± ascending; *stigma* capitate, *sepals* minute, inconspicuous, ± triangular. Thickness of cuticle with papilla 2.5–3 μm; epidermal surface not pubescent; ribs equal, prominent. Exocarp with 2–5 layers of hypodermal collenchyma; mesocarp consisting of 2–7 layers of lignified parenchymatous cells with thick wall. Vascular bundles small, numerous; vallecular vittae solitary, 4 in each mericarp, larger than vascular bundles; commissural vittae 5–7. Endocarp consisting of non-lignified parenchymatous cells.

Key to species of *Aegokeras*

1. Leaves simple, trifoliolate or 1–2-lobed..... ***A. ibradiensis***
- Leaves unipinnate or pinnatisect, leaflets 2–5-paired 2
2. Non-caespitose; base of stem without remains of old leaf bases; leaves with distinctly coriaceous leaflets, margin acute-laciniate to dentate, cartilaginous..... ***A. gazipashensis***
- Caespitose; base of stem with remains of old leaf bases; leaves with herbaceous leaflets, margin dentate or serrate, teeth apiculate, not cartilaginous ..... ***A. caespitosa***

Additional specimens examined:—***Aegokeras caespitosa***: Turkey. A4 Karabük: between Karaağaç village-Keltepe, 41°04′57″N, 32°28′55″E, 1666 m, limestone rock crevices, 06 August 2014, *A.Duran 9913* (KNYA); ibid., 41°03′85″N, 32°28′09″E, 1510 m, 15 July 2004, *A.Duran 6750* (ANK). B3 Isparta: Senirkent, Barla Dağı, 1647 m, 24 August 2013, limestone rock crevices, 38°05′12″N, 30°45′14″E, *A.Duran 9827* (KNYA).—***A. gazipashensis*:** Type:—Turkey. C4 Antalya: Gazipaşa, Çayıryaka Yaylası, 36°30′02″N, 32°32′18″E, 1730 m, mountain steppe, 12 June 2021, *A.Duran 10795* (holotype: HUB, isotypes: ANK, GAZI, MW barcodes MW0595828–MW0595831); ibid., 27 May 2021, *A.Duran 10745* (HUB). Antalya: Gazipaşa, Çayıryaka Yayla, 1700 m, 14 July 1983, *H.Sümbül 2336* (HUB).—***A. ibradiensis*:** Turkey. C3 Antalya: İbradı, Toka Yayla, semi-arid mountain steppe, 37°13′04″N, 31°22′32″E, 1518 m, 19 July 2023, *A.Duran 10909 & S.Uysal* (GAZI, HUB, MW barcodes MW1046197–MW1046199).

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APPENDIX 1 List of plant material used in molecular part of the study. Newly obtained sequences are in bold.
Aegokeras caespitosa (Sm.) Raf.: JF807579, JF807559, U78379, U78439; *A. gazipashensis* A.Duran & Lyskov: OQ994634; ***Aegokeras ibradiensis*: Turkey, Antalya, İbradı, 19 July 2023, *A.Duran & S.Uysal 10909* (MW1046197) PP475323**; *Aegopodium decumbens* (Thunb.) Pimenov & Zakharova: JQ792194; *A. handelii* H.Wolff: JQ792195; *A. kashmiricum* (R.R.Stewart ex Dunn) Pimenov: JQ792197; *A. latifolium* Turcz.: JQ792196; *A. podagraria* L.: JQ792200; *A. tadshikorum* Schischk.: JQ792201; *Bunium fallax* Freyn: DQ435217; *B. ferulaceum* Sm.: DQ435219; *B. mauritanicum* Batt.: DQ435226; *Carum carvi* L.: JQ792211; *C. caucasicum* Boiss.: JF510478, JQ792212; *C. grossheimii* Schischk.: JQ792216, JQ792217, JF510479; *C. meifolium* Boiss.: JQ792219, JQ792220, JF510480; *Cnidium silaifolium* Fiori & Paol.: AF008614; *Crithmum maritimum* L.: AH003474; *Falcaria vulgaris* Bernh.: KC995015, KF843820; *Fuernrohria setifolia* K.Koch: AF009112; *Gongylosciadium falcarioides* (Bornm. & H.Wolff) Rech.f.: EU169272; *Grammosciadium daucoides* DC.: AF073559; *G. macrodon* Boiss.: AF073553; *G. platycarpum* Boiss. & Hausskn. ex Boiss.: AH008896; *G. scabridum* Boiss.: AH008898, JF807577; *Hladnikia pastinacifolia* Rchb.: EU169287; *Meum athamanticum* Jacq.: AF077900; *Pimpinella aromatica* M.Bieb.: AY581784; *P. aurea* DC.: AY581785; *P. diversifolia* DC.: DQ516369; *P. flabellifolia* (Boiss.) Benth. & Hook.f. ex Drude: AY581791; *P. kotschyana* Boiss.: AY581793; *P. nudicaulis* Trautv.: AY581794; *P. paucidentata* V.A.Matthews: AY581796; *P. peregrina* L.: AY581797; *P. saxifraga* L.: AY581801; *P. sintenisii* H.Wollf: AY581802; *Rhabdosciadium anatolyi* Lyskov & Kljuykov: MF803734; *R. aucheri* Boiss.: MF803736; *R. hizanense* Fırat & Güzel: MH971221; *R. microcalycinum* Hand.-Mazz.: MF803738; *R. oligocarpum* (Post ex Boiss.) Hedge & Lamond: MF803739; *R. petiolare* Boiss. & Hausskn. ex Boiss.: MF803733; *R. straussii* Hasskn. ex Bornm.: MF803735; *R. urusakii* Akalın: MF803737; *Schulzia albiflora* (Kar. & Kir.) Popov: GQ379317; *Selinum broteri* Hoffmanns. & Link: AY179029.