

Bunium allioides (Apiaceae), a new species from Turkey

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Bunium allioides B. Bani, Pimenov & Adıgüzel *sp. nova* (Apiaceae), is described and illustrated from southern (Mediterranean) Turkey. The taxonomic affinities of the new species were determined by analysing morphological data and a molecular phylogenetic study of nrDNA ITS sequences. *Bunium allioides* belongs to the section *Elegantia*, and is related to *B. paucifolium* and *B. elegans*.

Introduction

The genus *Bunium* (Apiaceae) comprises about 50 species of geophytes with tuberiform storage roots, distributed in the arid and subarid SW and central Asia, Europe, and North Africa (Degtjareva *et al.* 2009). The center of diversity of *Bunium* is in the Mediterranean region. In Turkey, there are 15 known species, including the endemics *B. fallax*, *B. nudum* and *B. pinatifolium*.

Some of the characters of *Bunium* that are useful at the infrageneric level are unusual for Apiaceae. These include diploidy, with the basic chromosome numbers ranging from 6 to 11 (Vasilieva *et al.* 1985), and pseudomonocotly (vs. the usual dicotyly) in the embryos and seedlings. The variability in these characters is correlated with the geographical origin of the species.

The most recent classification of *Bunium* was elaborated by Kljuykov (1988), who based his

treatment on the chromosome number, embryo features and other characters. Six sections and 15 subsections were recognized, and they were subsequently partly supported by the molecular phylogenetic analysis of Degtjareva *et al.* (2009).

Material and methods

In June 2008 and July 2009, the first author collected an unknown Apiaceae species with root tubers in the Adana province of South Anatolia. The specimens were preliminarily identified as intermediate between *Bunium* and *Huetia* (i.e. *Geocaryum*, according to Engstrand 1977) based on the Umbelliferae account in Hedge *et al.* (1972) and Duman (2000). They were clearly different from those genera in the attenuate stylopodium and six large oil ducts in their mericarps. Using those sources and other relevant literature (Shishkin 1950, Tutin *et al.*

1968, Rechinger 1987, Zohary 1987) to identify the specimens and to provide more information about the genera *Bunium* and *Huetia*, the first author concluded that the specimens might belong to an undescribed taxon. Subsequently, using carpological and molecular phylogenetic analyses, the authors jointly identified the plant as a new species in *Bunium* sect. *Elegantia*. A description of the new species is presented below.

Fruit and other morphological characters were studied and described based on a set of taxonomically important characters in Apiaceae (Kljuykov *et al.* 2004). For the molecular phylogenetic analysis, nuclear ribosomal ITS sequences of the new species were generated and added to the already existing alignment by Degtjareva *et al.* (2009). The GenBank accession number is JX312805. The matrix includes representatives of major clades with special attention to representative sampling of the Pyramidopterae clade, which comprises *Bunium* and its allies. *Conopodium* and *Geocaryum* were also selected for the analysis on the basis of some morphological similarities of *B. allioides* with these taxa. Details of the PCR amplifications of the entire ITS region and sequencing strategies (including primer locations and characteristics) are provided in Valiejo-Roman *et al.* (2002). The aligned data matrix was analyzed using maximum parsimony (MP) and maximum likelihood (ML) methods. Parsimony analysis involved a heuristic search conducted with PAUP* ver. 4.0b8 (Swofford 2000) using TBR branch swapping with character states specified as equally weighted. One hundred replicates with random addition of sequences were performed and all shortest trees were saved. Bootstrap values (Felsenstein 1985) were calculated from 500 replicate analyses with TBR branch swapping and random addition sequence of taxa. One thousand most parsimonious trees from each replicate were saved. In the parsimony analyses, all gaps were treated as missing data.

The maximum likelihood analysis was conducted using the RAxML program ver. 7.2.6 (Stamatakis 2006) with the GTRGAMMA model. The model was selected by the Akaike Information Criterion in the program Modeltest (Posada & Crandall 1998). Bootstrapping was

done using the rapid bootstrapping algorithm implemented in RAxML with 500 replicates. Bootstrap support values were then drawn onto the best known likelihood tree.

Description and taxonomic affinities

Bunium allioides B. Bani, Pimenov & Adıgüzel, *sp. nova* (sect. *Elegantia*) (Fig. 1)

Species nova sine dubio ad sectio Elegantia Kljuykov pertinet; Bunio paucifolio et B. elegantii maxime similis, a speciebus his foliis caulinis inferioribus lobis ternis anguste linearibus vel filiformibus, ab 4 cm longis, 0.3 mm latis, umbellis compactis, radiis leviter incrassatis, 3.5–7 mm longis, bracteis umbellis aequilongis, lanceolatis vel linearibus, margine involutis, pedicellis brevibus, 1–1.3 mm longis, leviter incrassatis, bracteolis ovalibus vel obovatis, margine late albomarginatis, fructibus brevibus (ad 2 mm longis, sine stylopodiis styloidiisque), stylopodiis conicis attenuatisque (non planis), styloidiis fructuum superantibus, vittis vallecularibus paucis (non solitariis) bene differt.

HOLOTYPE: Turkey. B6 Adana: Tufanbeyli, Güzelim village, around Kumlupınar district, sandy soil under Black Pine forest, 1450 m, 26 June 2008 *B. Bani* 6580 (GAZI). — PARATYPE: Turkey. B6 Adana: Tufanbeyli, Güzelim village, around Kumlupınar district, sandy soil under and clearings black pine forest, 1450 m, 10 July 2009 *B. Bani* 6722 (GAZI).

Perennial polycarpic herbs, 40–100 cm tall, glabrous throughout, from tuber-like thickened root; tubers globose, dark or dark brown, to 1 cm in diam. Stems solitary, 1–3 mm in diam. at base, hollow, rounded in lower part, ribbed under umbels, with prominent angles, geniculate at nodes, branched from base; lateral branches equal to central umbel or overtopping it; lower internodes shortened. Radical leaves with thin petioles, to 4 cm long; leaf blades bipinnatisect, to 3 cm long, 2 cm broad, triangular in outline; basal segments petiolulate; terminal lobes narrowly linear, 10–18 mm long, 0.5 mm broad, acute. Lower cauline leaves with lanceolate–linear sheaths to 1 cm long, narrowly white–membranaceous at margin; petioles short;

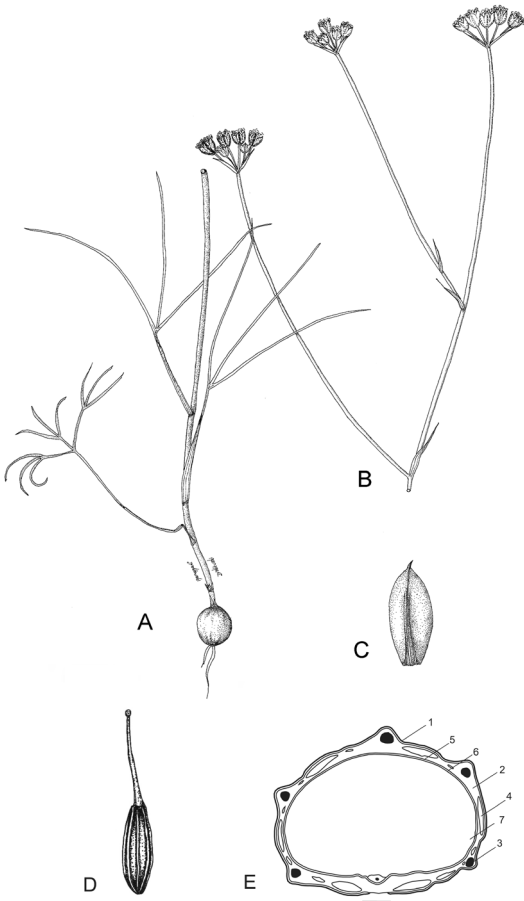


Fig. 1. *Bunium allioides* (from the holotype): — **A**: Lower part of plant. — **B**: Upper part of plant. — **C**: Bracteole. — **D**: General view of fruit. — **E**: Cross-section of mericarp (1 = exocarp, 2 = mesocarp, 3 = rib vallecular bundle, 4 = vallecular vittae, 5 = endocarp, 6 = spermoderm, 7 = endosperm).

sheaths of middle cauline leaves to 1.5 cm long. Blades of lower cauline leaves ternate; their lobes narrowly linear to almost filiform, with involute margins, to 4 cm long, 0.3 mm broad. Upper cauline leaves reduced to lanceolate-linear sheaths, 1–1.5 cm long. Terminal and lateral umbels equal, condensed, 1.5–2 cm in diam.; rays 9–11(8–12), slightly thickened, rounded in cross-section, slightly unequal, 3.5–7(9.5) mm long. Involucre of 5–7(8) bracts, equal to umbel rays, entire, lanceolate to linear, 4–8 mm long, 1 mm broad, broadly white-membranous and involute at margin. Umbellules condensed, 12–15(17)-flowered; pedicels short, 1–1.7 mm

long, thickened. Bracteoles 6–8, elliptic to obovate, to 4 mm long, 2 mm broad, entire, broadly white-membranous at margin, 3-ribbed, cuspidate. Calyx teeth obsolete. Petals white, 1–1.2 mm long, ovate, without claw, stout, deeply bifid, with narrow tip bent inward. Stamens 2–2.5 mm long, exceeding petals. Stylopodium narrow conical and long-attenuate, styles straight, to 2.5 mm long. Fruit elliptic, slightly compressed laterally, carpophore entire. Mericarps 2 mm long (excluding stylopods and styles), 0.8–1.3 mm broad, elliptic to lanceolate; ribs filiform, commissure narrow. In cross-section, mericarp semi-circular; exocarp of small cells interrupting near carpophore; mesocarp parenchymatous, vascular bundles thin, vittae in furrows one large and 1–2 small; at the commissural side, two large and two small; endocarp of small narrow cells. Endosperm flat on commissural side. Embryo with one developed cotyledon.

HABITAT: This species grows at an elevation of 1450 m and prefers sandy soils at clearings and in black pine forest with *Aethionema schistosum*, *Alyssum minutum*, *Bromus hordeaceus* subsp. *hordeaceus*, *Campanula argaea*, *Centaurea derderiifolia*, *Cerastium gracile*, *Cleome ornithopodioides*, *Consolida orientalis*, *Filipendula vulgaris*, *Grammosciadium confertum*, *Hordeum geniculatum*, *Luzula multiflora*, *Muscari mabeathianum*, *Ranunculus illyricus* subsp. *illyricus*, *Salvia recognita*, and *Trifolium ochroleucum*.

Bunium allioides has some morphological characters that are unusual for sect. *Elegantia*. One such character, in fact unusual for the whole genus, is the narrowly conic and attenuate stylopodium, similar to that found in *Conopodium*, another geophilic Mediterranean Apiaceae genus. It, like *Bunium*, possesses tuberiform roots. However, other morphological characters clearly indicate that *Conopodium*, as well as *Geocaryum*, are not closely related to *Bunium*, and these genera were never placed in tribe Scandiceae. Considerable divergence among *Bunium* and the two above-mentioned genera of geophilic ephemeroids is observed in the molecular tree (Fig. 2). Neither *Conopodium* nor *Geocaryum* belong to the *Bunium* clade and they are not closely related to the new species. *Bunium allioides* is a part of a clade with strong bootstrap support (MP-BS = 99%, ML-BS = 99%),

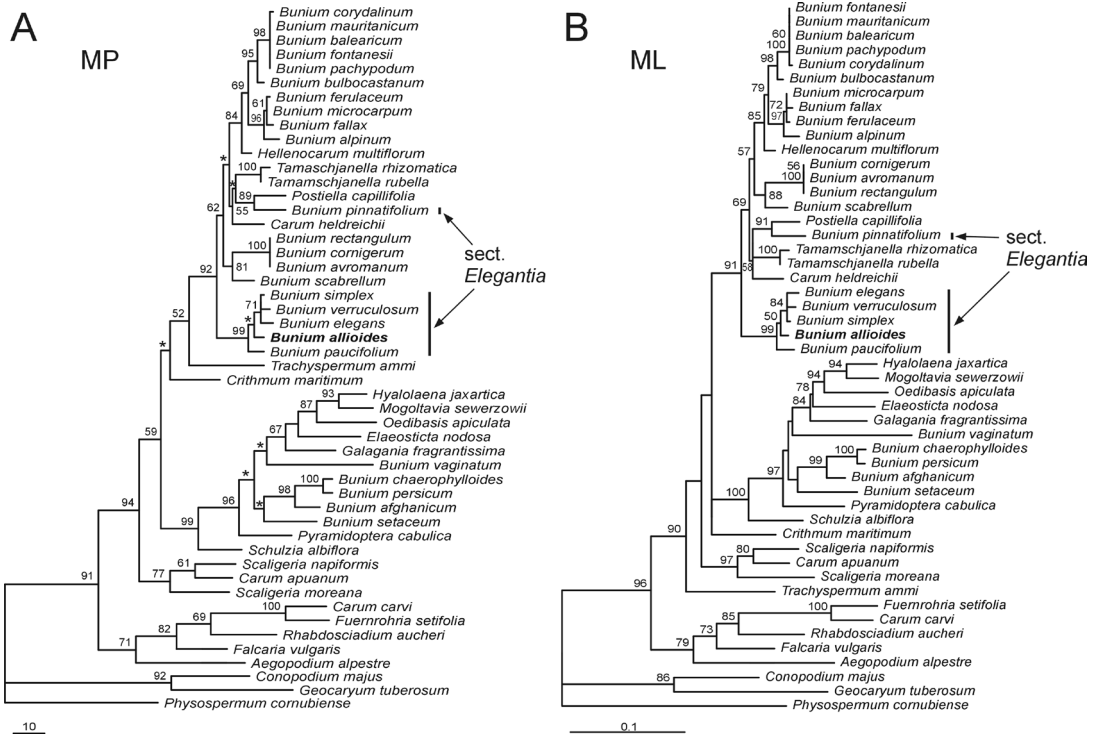


Fig. 2. Phylogenetic trees inferred from analyses of ITS data. — **A:** One of 360 maximum parsimony (MP) trees [949 steps; consistency index (CI), 0.496; retention index (RI), 0.667]. Branches marked with asterisks are absent in the MP strict consensus tree. — **B:** The maximum likelihood tree (ML). Branch lengths are proportional to the number of the expected nucleotide substitutions. Numbers above branches represent bootstrap values above 50% from MP (**A**) and ML (**B**) bootstrapping, respectively.

comprising *Bunium* species of section *Elegantia* except *B. pinnatifolium*. Within this clade, *Bunium allioides* is a sister (ML-BS = 50%) to a lineage that contains *B. elegans*, *B. simplex* and *B. verruculosum*, although the relationship was weakly supported (ML bootstrap value 50%) and was present in 59.7% of the maximum parsimony trees. In 40.3% of the maximum parsimony trees, *B. allioides* was sister to all other *Bunium* species within this strongly supported clade. Therefore, the new species is best treated as belonging in *Bunium* sect. *Elegantia*.

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References

- Degtjareva, G. V., Kljuykov, E. V., Samigullin, T. H., Valiejo-Roman, C. M. & Pimenov, M. G. 2009: Molecular appraisal of *Bunium* and some related arid and subarid geophilic Apiaceae–Apioidae taxa of the Ancient Mediterranean. — *Botanical Journal of the Linnean Society* 160: 149–170.
- Duman, H. 2000: *Bunium* L. — In: Güner, A., Özhatay, N., Ekim, T. & Baser, K. H. C. (eds.), *Flora of Turkey and The East Aegean Islands*, vol. 11: 140–141. Edinburgh University Press, Edinburgh.
- Engstrand, L. 1977: *Biosystematics and taxonomy in Geocaryum Coss. (Umbelliferae)*. — Ph.D. thesis, University of Lund.
- Felsenstein, J. 1985: Confidence limits on phylogenetics: an approach using the bootstrap. — *Evolution* 39: 783–791.
- Hedge, I. C., Lamond, J. M., Davis, P. H., Pesmen, H., Stevens, P. F., Matthews, V. A., Chamberlain, D. F., Herrstadt, J., Heyn, C. C., Snogerup, S., Leute, G. H., Alava, R. & Cullen, J. 1972: Umbelliferae. — In: Davis, P. H. (ed.), *Flora of Turkey and The East Aegean Islands*, vol. 4: 265–538. Edinburgh University Press, Edinburgh.
- Kljuykov, E. V. [Клюйков, Е. В.] 1988: [A survey of the genus *Bunium* L. Revision of the generic system]. — *Byulleten' Moskovskogo Obshchestva Ispytatelei Pri-*

- rody. *Otdel Biologicheskii* 93(1): 76–88. [In Russian].
- Kljuykov, E. V., Liu, M., Ostroumova, T. A., Pimenov M. G., Tilney, P. M. & Van Wyk, B.-E. 2004: Towards a standardised terminology for taxonomically important morphological characters in the Umbelliferae. — *South African Journal of Botany* 70: 488–495.
- Posada, D. & Crandall, K. A. 1998: Modeltest: testing the model of DNA substitution. — *Bioinformatics* 14: 817–818.
- Rechinger, K. H. (ed.) 1987: *Flora Iranica*, vol. 162: 1–528. Akademische Druck- und Verlagsanstalt, Graz-Austria.
- Shishkin, B. K. [Шишкин, Б. К.] (ed.) 1950: [*Flora of the USSR*, vol. 16]. — Akad. Nauk. SSSR, Moscow–Leningrad. [In Russian].
- Stamatakis, A. 2006: RAxML-VI-HPC: Maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. — *Bioinformatics* 22: 2688–2690.
- Swofford, D. L. 2000: *PAUP**. *Phylogenetic analysis using parsimony (*and other methods)*, version 4. — Sinauer Assoc., Sunderland, Massachusetts.
- Tutin, T. G., Heywood, V. H., Burges, N. A., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. 1968: *Flora Europaea*, vol. 2: 313–375. — Cambridge University Press, Cambridge.
- Valiejo-Roman, C. M., Terentieva, E. I., Samigullin, T. H. & Pimenov, M. G. 2002: nrDNA ITS sequences and affinities of Sino-Himalayan Apioideae (Umbelliferae). — *Taxon* 51: 685–701.
- Vasilieva, M. G., Kljuykov, E. V. & Pimenov, M. G. 1985: Karyotaxonomic analysis of the genus *Bunium* (Umbelliferae). — *Plant Systematics and Evolution* 149: 71–88.
- Zohary, M. 1987: *Flora Palaestina*, vol. 2 (text): 379–453. — The Israel Academy of Sciences and Humanities, Jerusalem.