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Newly recorded for the vascular flora of Lebanon: *Ferula biverticellata* J.Thiébaut (Apiaceae)

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Abstract. During surveys in 2020 on the Lebanese western slopes of Mount Hermon, we detected *Ferula biverticellata* J.Thiébaut, which is new to the flora of Lebanon. The species has a distribution extending from Mount Hermon, the Golan, and the Hauran in South Syria to the Negev and Transjordan. We discuss the range of this southern Levantine element, its presence in Lebanon, and its conservation status.

Keywords. Endemism, south-west Asia, eastern Mediterranean, Levant, Mount Hermon

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Introduction

Located at the meeting point of three floristic regions, the Saharo-Sindian region, the Mediterranean region, and the Irano-Turanian region (Takhtajan 1986; Zahran 2010), Lebanon is a hotspot of plant diversity in the Mediterranean Basin (Médail and Quézel 1997). During floristic surveys in Mount Hermon in summer 2020, we detected a plant species, *Ferula biverticellata* J.Thiébaut, that is new to the flora of Lebanon.

Ferula Tourn. ex L. is the third largest genus of the family Apiaceae (Umbelliferae) with 180–185 species (Yaqoob and Nawchoo 2016). The genus is distributed in central Asia, the Himalayan range, China, south-west Asia, the Mediterranean Basin, and Europe (Pimenov 2017, 2020). Analyses of sequence data from the chloroplast DNA and nuclear ribosomal DNA internal transcribed spacer regions have revealed that the subtribe Ferulinae originated in the Armeno-Iranian Province of Iran and diversified in central Asia (Panahi 2013, 2019). It has spread to the central and eastern part of the Irano-Turanian floristic region, the Mediterranean region of Europe, and China during the Pliocene (2.2–4.0 Ma).

Three species of the genus *Ferula* occur in Lebanon, namely *F.elaeochytris* Korovin, *F. hermonis* Boiss., and *F.tingitana* L. (Mouterde 1970). The species reported here for the first time in Lebanon, *F. biverticellata*, was previously known from Syria, Palestine, Jordan, and Israel. This species was described in 1935 by Joseph Thiébaut from a sample collected in 1930 in Cheikh Meskin (Thiébaut 1935), a locality of the plain of Hauran in southern Syria. Later, it was observed in the Golan Heights, the southern slopes of Mount Hermon, the Negev (Zohary 1972), the Nablus Mountains, Jerusalem, and the Hebron mountains (Zohary 1972; Ali-Shtayeh et al. 2022). Recent observations have confirmed its presence at these sites (GBIF.org 2023). In the Negev, it has been mostly observed in the Crater of Ramon, also known as Wadi er-Romman or Jorn Ramon. This area constitutes eroded canyons culminating at around 860 m above sea level (a.s.l.) (Ben-Dor et al. 1996). In the southern slopes of Mount Hermon above Majdal Shams, *F. biverticellata* was observed between 1100 and 1500 m

(Danin and Fragman-Sapir 2016). The species has been reported from northern Jordan, on the site of the Jordan University of Science and Technology in Irbid Governorate (Lahham and Al-Gharaibeh 2005). We discuss the distribution of this species in Lebanon.

Methods

Mount Hermon, known in Arabic as Jabal al-Shaykh, is the second highest mountain in the Levant. It spans the south-east border of Lebanon and its neighbouring countries (Fig. 1) and reaches a height of 2,814 m a.s.l.; its three spectacular summits are covered with snow for half of the year and are visible from a distance of more than 100 km. Mount Hermon massif is about 45 km long and up to 25 km wide (Encyclopedia 2023). The entire range covers an area of about 1000 km², with around 500 km² in Lebanon. Geographically, it is often considered as the southern continuation of Anti-Lebanon mountain range. Administratively, it is divided into four parts: the Lebanese western slopes, the Syrian eastern slopes, the United Nations buffer zone, and the Israeli-controlled southern slopes (Dar 1988).

The Lebanese western slopes of Mount Hermon have been recognized for their floristic richness (Arnold et al. 2015; Baydoun et al. 2015). This area was also identified as an important plant area (IPA) for conservation (Bou Dagher-Kharrat et al. 2018) and as a Key Biodiversity Area (KBA) in the Mediterranean region for plants (El Zein et al. 2018). It has been declared as a nature reserve in December 2020 by the Ministry of Environment of Lebanon.

Local floras (Post and Dinsmore 1932; Mouterde 1970; Zohary 1972) were used to identify *Ferula biverticellata*. The used taxonomy is in accordance with the International Plant Names Index (IPNI 2023), the Plants of the World Online (POWO 2023), and the Euro+Med plantbase (Euro+Med 2023). The maps were prepared with QGIS software (QGIS Development Team 2023) using layers available on the DIVA-GIS website (DIVA-GIS 2023). The distribution of the species was mapped based on the occurrences sourced from bibliographic references (Mouterde 1970; Zohary 1972), recent observations provided by Global Biodiversity Information Facility (GBIF.org 2023), and our new record. The occurrence data from GBIF were verified, cleaned, and manually compiled. The collected specimen has been deposited at the Post Herbarium of the American University of Beirut (BEI). The new record of the collected specimen was published in GBIF (El Zein 2023). The conservation assessment of *F. biverticellata* was made following the guidelines of the International Union for Conservation of Nature (IUCN) Red List categories and criteria (IUCN Standards and Petitions Committee 2022).

Results

***Ferula biverticellata* J.Thiébaut**, Bull. Soc. Bot. France 82: 190. 1935 (Thiébaut 1935).

Figures 2–5

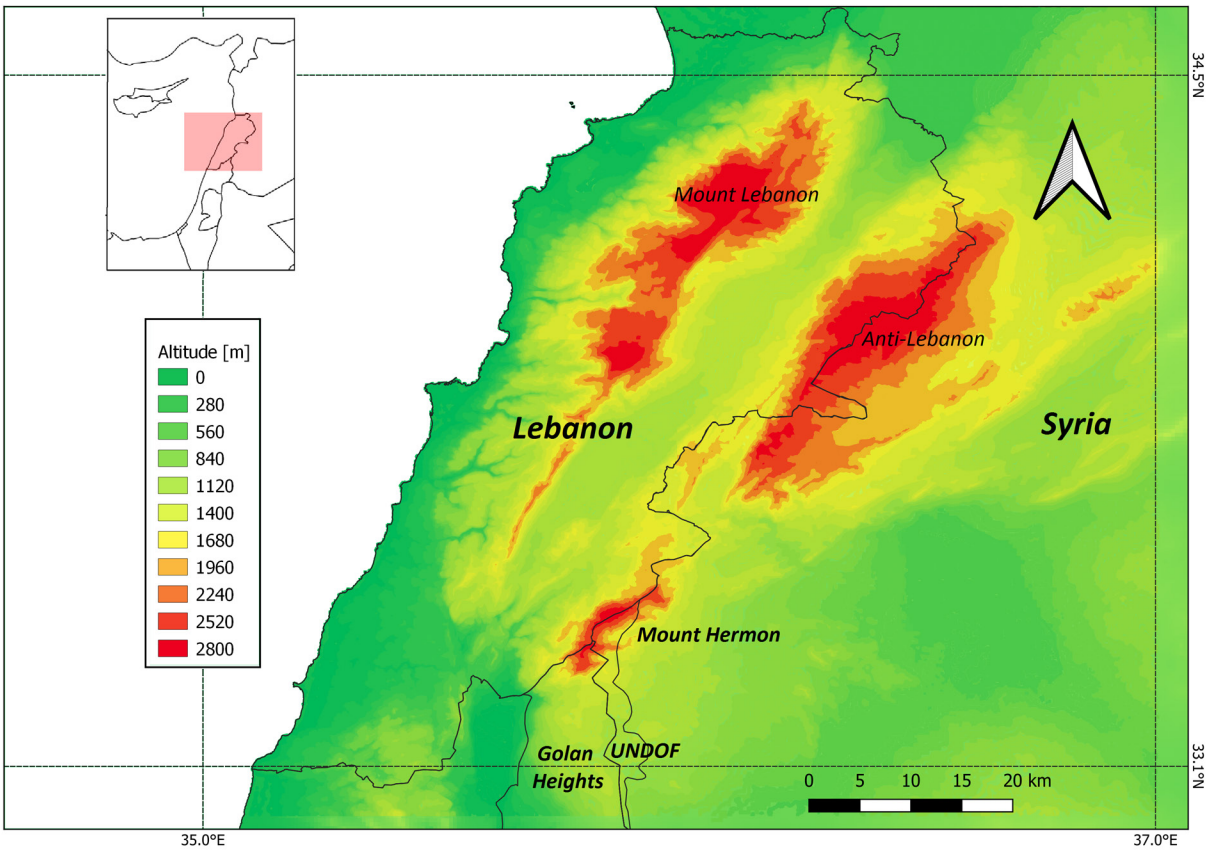

Figure 1. Location of Mount Hermon in Lebanon and adjacent areas.

New record. LEBANON – **Beqaa Governorate** • Rashaya district, Rashaya, Wadi el-Aarqoub; 33°27.075′N, 035°52.361′E; 1620 m alt.; 22.VIII.2020; H. El Zein leg.; BEI-HELB 1235.

Identification. Perennial herbaceous, 40–60 cm tall. Deep root up to 60 cm long ×15 cm wide. Leaves basal, 20–30 cm long, pubescent, triangular, quadripinnate. Leaflets 1–2 mm long, with bifide or trifide apex; lobules oblong and obtuse. Petiole 5 cm long, pubescent. Leaves develop in early spring and dry during flowering. Stem 40–60 cm tall, glabrous, yellow to red, develops during flowering, leafless. Few sheaths, light yellow-purplish, lanceolate, 5 cm long, 1–2 cm wide, alternate, clasping base of stem. Inflorescence in panicle of umbels, twice-verticillate. Primary branches verticillate by 3–8 around main axis. Umbels verticillate by 3–8 on primary branches. Umbellules 6–18-flowered, with pedicels of equal length, 8–11 mm, yellow to red. Bracts and bracteoles absent. Petals 5, yellow-reddish, triangular, 1 × 1 mm. Stamens 5, yellow with reflexed filaments up to 2 mm long. Stylopodium rounded, 2 mm in diameter, yellow. Styles depressed, 1.5 mm long, white. Flowering at the end of summer and during autumn. Mericarps oblong, glabrous, 6–7 mm × 2 mm; 3 filiform dorsal ridges, 2 lateral ridges at margin, 2 vittae per vallecula; brown when ripe.

Species of the genus *Ferula* are tall perennials or biennials characterized by prominent taproots, strong stems with large sheaths, finely divided leaves, and dorsally compressed fruits with plane commissural faces (Kurzyna-Młynik et al. 2008). Due to the large size of these plants, only lateral branches of the inflorescence are usually collected and preserved in herbaria. Thus,we add here a drawing of the complete architecture of the inflorescence. *Ferula biverticellata* can be distinguished from other species by having its basal sheaths longer than wide and its inflorescence in panicle of twice-verticillate umbels with 3–8 stalks each (Mouterde 1970).

Habitat. One population with around 120 individuals was found in a rocky grassland made up of scattered patches of bare rock, bare soil, and perennial grasses and forbs. The substrate is derived from limestone. The altitude was 1600–1650 m.

Conservation status. *Ferula biverticellata* is assessed as Critically Endangered, B1ab(iii)+2ab(iii) in Lebanon.

Discussion

Ferula biverticellata has a typical southern Levantine distribution. The Southern Levant extends northward from the Litani River, the Golan, and the Hauran to the Sinai Peninsula southward and to Transjordan eastward (Suriano 2013). The new occurrence of *F. biverticellata* on Mount Hermon is at the northernmost edge of this species' range, and only one occurrence is known from further north. That specimen was supposedly collected

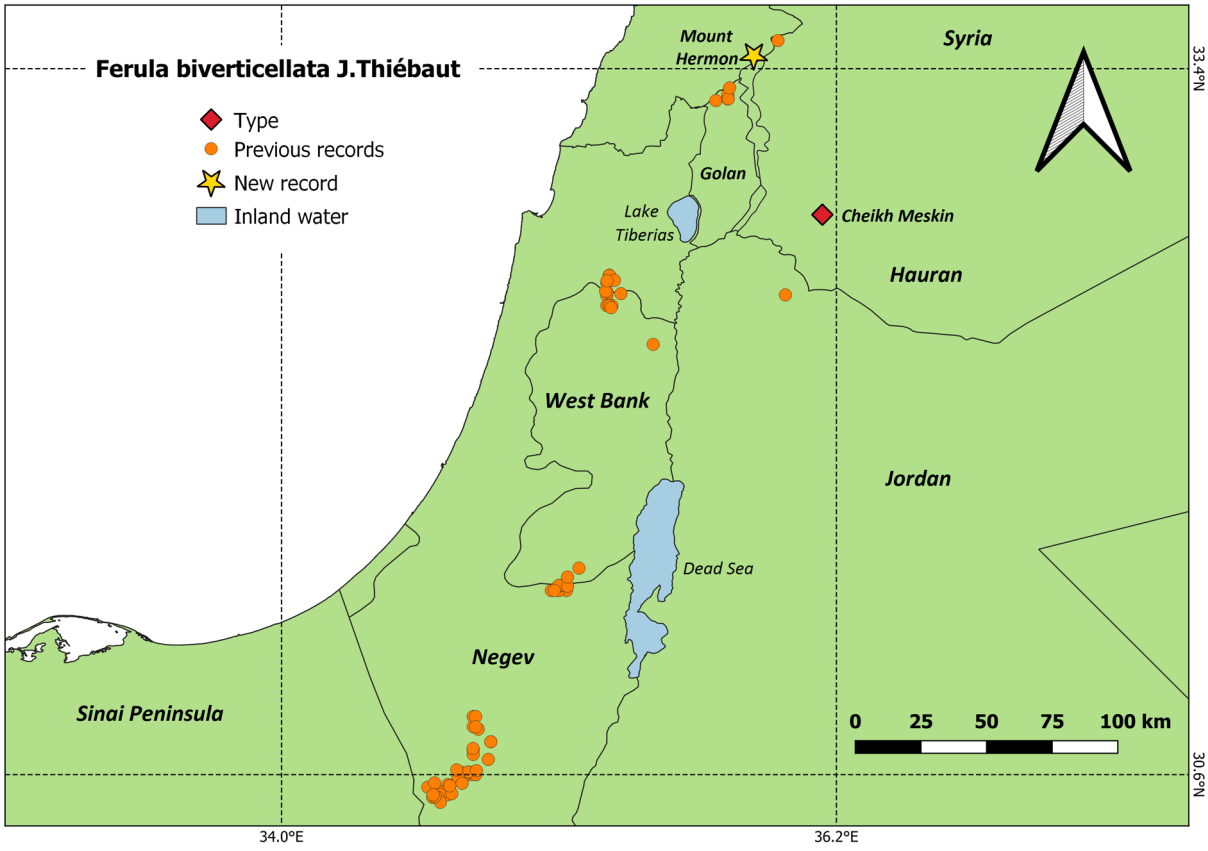

Figure 2. Distribution of *Ferula biverticellata* **J.**Thiébaut summarising records known prior to this work (Thiébaut 1935; Mouterde 1970; Zohary 1972; Lahham and Al-Gharaibeh 2005; Ali-Shtayeh et al. 2022; GBIF.org 2023) and the new record from the western slopes of Mount Hermon in Lebanon.

Figure 3. *Ferula biverticellata* in Mount Hermon, Rashaya District, Lebanon, August 2020. **A.** Details of the primary verticillate of the inflorescence. **B.** Details of the verticillates of the umbels. **C, D.** Details of the umbellules and flowers. **E.** Fruits. **F.** Base of stem and sheaths. Photographs: H. El Zein.

by George Edward Post in Rakhle in Syria, close to the Lebanese border. Its existence was reported by Zohary (1972). Although it was not found at the Post Herbarium of AUB (Mouterde 1970), we included this record in the distribution map (Fig. 2).

The Southern Levant is characterized by the dominancy of the hot-summer Mediterranean, semiarid, and arid climates, respectively, from north to south (Ziv et al. 2006; Peel et al. 2007; Rambeau 2010). *Ferula biverticellata* has ecological requirements adapted to semiarid and dry Mediterranean climates. The elevations where the specimens were collected on Mount Hermon ranged from 1500 m, on the southern slopes above Majdal Shams, to 1650 m for our new record in Lebanon. These altitudes are the highest known for the species; all other occurrences are from areas below 850 m in elevation. The mean annual rainfall during the period of 1981 to 2010 varied greatly between 800 mm on Mount Hermon, 600 m in the Nablous mountains and the Jerusalem and Hebron mountains, to less than 100 mm in the Crater of Ramon (Fuks et al. 2017). Another contrast is the presence of *F. biverticellata* in differing types of vegetation. For instance, there is a significant ecological difference between the vegetation

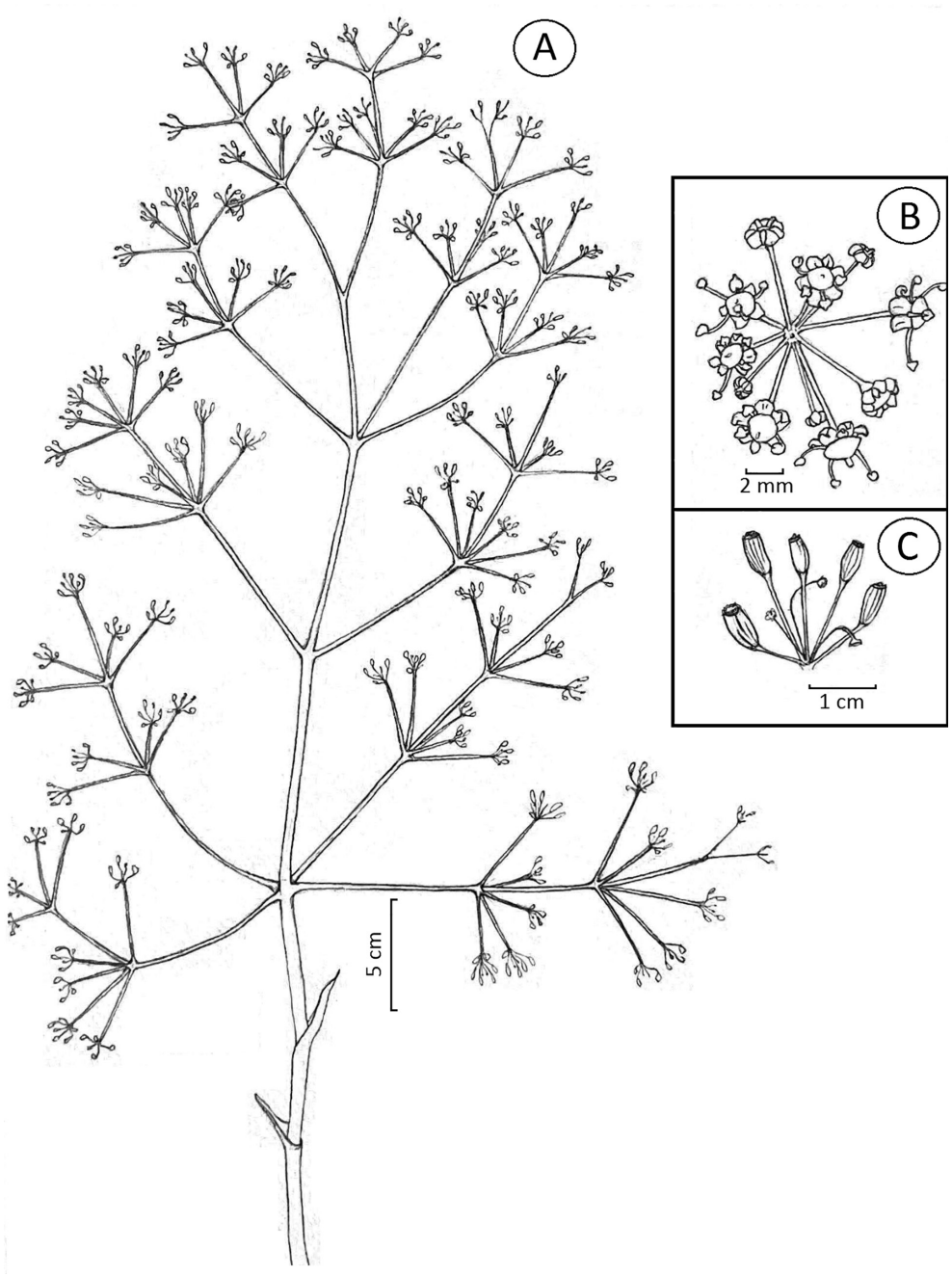

Figure 4. *Ferula biverticellata*. **A.** Inflorescence. **B.** Umbellule and flowers. **C.** Mature fruits. Drawings: K. Plouhinec.

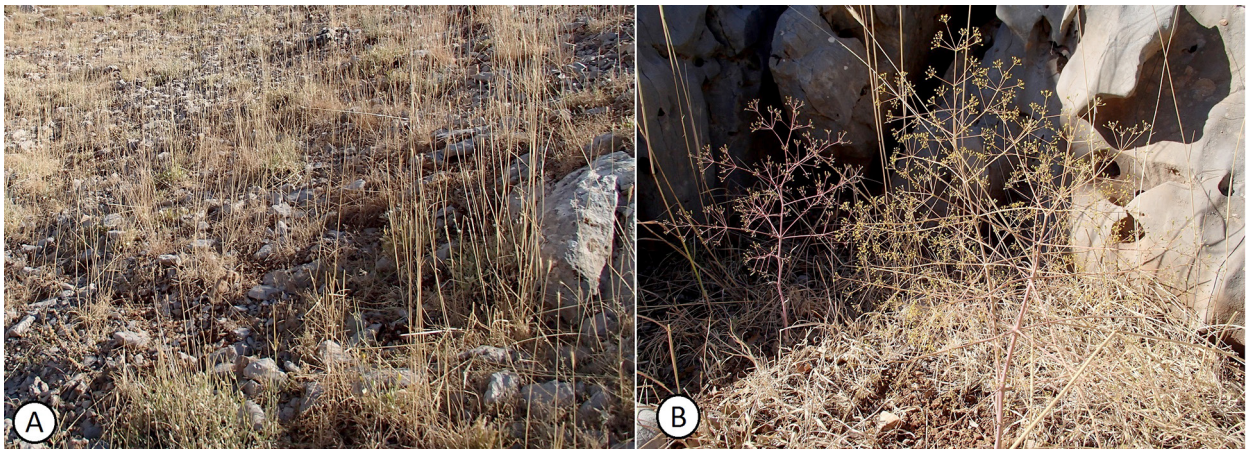

Figure 5. Habitats during flowering time.**A.** Rocky grasslands. **B.** *Ferula biverticellata* in habitat. Photographs: **H.**El Zein.

belt of oak woodlands where *F. biverticellata* occurs on Mount Hermon (Abi-Saleh 1982) and other sites, notably in the Negev desert where *F. biverticellata* occurs in steppes with scattered trees of *Pistacia atlantica* Desf. and in the Jerusalem and Hebron mountains where it occurs in semi-steppe batha dominated by *Sarcopoterium spinosum* (L.) Spach (Danin 1992; Schiebel and Litt 2018).

We assessed *F. biverticellata* as Critically Endangered, B1ab(iii)+2ab(iii), in Lebanon as it occurs at only one location on the western slopes of Mount Hermon with a limited extent of occurrence (4 km²) and area of occupancy (4 km²). Urbanisation is not considered a threat, as the site has been recently incorporated into a protected area. However, the degradation of the quality of habitat continues due to overgrazing by livestock and other human intrusions. The species was assessed as Critically Endangered in Palestine, as it is very rare in the Nablus mountains and the Jerusalem and Hebron mountains (Ali-Shtayeh et al. 2022). While it is also very rare in Israel, the species was assessed as Near Threatened due to its presence in protected areas (Danin and Fragman-Sapir 2016). We attempted to assess the species at the global level using the available data. Despite the limited area of occupancy (228 km²), it was assessed as Least Concern, as extent of occurrence is large (14,401 km²), the number of locations is greater than 10, and the species is not severely fragmented. However, a more thorough assessment is needed with more detailed information from experts working in all the regions where the plant occurs. One of the threats affecting this species is climate change, which is manifesting in the Northern and Southern Levants through the intensification of drought events. Over the past 40 years, the Mediterranean terrestrial biodiversity and ecosystems have been affected faster than many other areas of the world (MedECC 2020; Hassoun et al. 2021). In the near future, the spread of semiarid and arid climates is predicted at the expense of the Mediterranean climate (Beck et al. 2018).

The presence of southern Levantine elements gives more information about the complex floral affinities of Mount Hermon. This finding also improves the knowledge about the distribution of the genus *Ferula* and could also shed light on its diversification in the Levant. It is possible that the distribution of the species is actually larger. More studies are necessary to determine if *F. biverticellata* occurs south to the Sinai Peninsula at the border of the Negev or in the Governorate of Irbid in northern Jordan where the species was reported only once.

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Authors Contributions

Conceptualization: KP, SB, LC, HEZ. Data curation: HEZ. Formal analysis: HEZ. Funding acquisition: LC, SB. Investigation: HEZ. Methodology: HEZ. Project administration: LC, SB. Software: HEZ. Supervision: LC, SB, HEZ. Validation: LC, SB. Visualization: HEZ, KP. Writing – original draft: HEZ. Writing – review and editing: SB, KP, LC.

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Supplemental Data

The new data for *Ferula biverticellata* J.Thiébaut in Lebanon (Mount Hermon, 2020) is available on GBIF.org. https://doi.org/10.15468/zawghu