Article

Fl. Medit. 35: 119-125
https://doi.org/10.7320/FlMedit35.119
Version of Record published online on 3 October 2025

Dar Ben-Natan & Bar Shemesh

Isoetes durieui (*Isoetaceae*) – a new species to the Flora Palaestina Region

Abstract

Ben-Natan, D. & Shemesh, B.: *Isoetes durieui* (*Isoetaceae*) – a new species to the Flora Palaestina Region. — Fl. Medit. 35: 119-125. 2025. — ISSN: 1120-4052 printed, 2240-4538 online.

Isoetes durieui, a Mediterranean lycophyte, is reported for the first time from the southern Levant, significantly extending its known range. Newly discovered populations inhabit rare, non-calcareous sandy clay soils – often near vernal ponds. These sites, largely unprotected, are threatened by habitat loss. The findings highlight both the underexplored status of Isoetes in the region and the importance of conserving its unique habitats.

Key words: Chorology, relict population, siliceous soil ecology, Lycophyte.

Article history: Received 6 August 2025; received in revised form 22 September 2025; accepted 23 September 2025; published 3 October 2025.

Introduction

Isoetes L. is a large genus in the class *Lycopodiopsida* Bartl., comprising roughly 200 species, distributed across all continents except Antarctica. *Isoetes* species richness centres are South America, SW USA and Australia, with a secondary centre in the northern Mediterranean (Troìa & al. 2016). In the Middle East, there are only few *Isoetes* species. In the entire Eastern Mediterranean, *Isoetes* is a relatively unstudied genus, with only seven currently known species, two of which described fairly recently (Prada & Rolleri 2005; Bolin & al. 2011).

In the Eastern Mediterranean, the abundance of *Isoetes* populations and species diminishes southwards from seven species in Turkey (Bolin & al 2008; Troìa & Greuter 2015a; Zare & al. 2016), to three in northern Lebanon (Mouterde 1966; Musselman & Al-Zein 2010; Bolin & al. 2011), and none recorded yet from Flora Palaestina region (Zohary 1966, 1972; Feinbrun-Dothan 1978, 1986; Feinbrun-Dothan & Danin 1998; Fragman-Sapir & al. 1999).

Most *Isoetes* species are aquatic and few, including *Isoetes durieui* Bory, are terrestrial. *I. durieui* has a wide Mediterranean distribution, including north Tunisia and Algeria (from which it was originally described), the southern Iberian Peninsula to Italy, some of the

Aegean Islands, and the northern Levant from western Turkey to northern Lebanon (Davis 1965; Bolin & al. 2008; Musselman & Al-Zein 2010; Troìa & Greuter 2015a, 2015b). Despite the general difficulty in distinguishing *Isoetes* sp. pl. due to lack of vegetative parts, *I. durieui* is easily characterized by the terrestrial habit, short phyllopodia of up to 3 mm, and most importantly - the clearly reticulate-alveolate megasphore coat (Davis 1965; Bolin et al. 2008; Musselman & Al-Zein 2010).

Materials and methods

In 2023, two populations of *Isoetes durieui* were discovered and identified by the authors during field survey for Deshe OLI (Open Landscape Institute) (Shemesh & al. 2023); one in the area of Hadera (Sharon Plain), and the other in Mt Kata, at the lower flanks of Mt Hermon. Both populations are very localized, although consisting of many individuals (Figs. 1-2). The habitat of both populations is sandy clay loam, with relatively similar water regime conditions and soil type. Since then, three further localities were discovered in similar habitats in the Sharon Plain, by Dar Ben-Natan, Bar Shemesh and Dvora Low-Ramati. New herbarium specimens were deposited at herbarium of The Hebrew University of Jerusalem (HUJ).

Prior to these discoveries, *I. durieui* was never collected or recorded in the Eastern Mediterranean south of Akkar in Northern Lebanon (Musselman & Al-Zein 2010), although its generally Mediterranean distribution makes its occurrence in the Coastal Plain of Israel unsurprising. It might be more common in Syria and Lebanon than is currently known, and should be looked for in sandstone areas, and along the coast.

Chorology and ecology

Geography and habitat: All Israeli populations occur on several variations of clay-rich red sandy clay loam, locally named Hamra (=Reddish, in Arabic). When shaded by shrubs and tall herbaceous vegetation, the more clay-rich variations of Hamra soil retains moisture during winter and spring, and dries in summer (Eig 1939). Similar conditions exist in the more mature soil variation locally named Nazaz – a soil comprised of sandy loam in A horizon, and a sandy clay or clay loam B horizon, often waterlogged (Dan 1984; Singer 2007); in which the porous, sandy A horizon locks the moisture in the underlying clay B horizon. In Sharon Plain, *I. durieui* is currently known only from the now-rare habitats of these two soil variations. On Mt Kata it is known from a single patch, growing on a steep slope, on yellowish-brown sandy clay loam, which is kept moist during winter and spring due to various small local aquifers.

These habitats are widely known locally as a sanctuary for several “calciphobic” plants. These do not occur at all in more calcareous soils in the region, but are sometimes abundant on sandy and basalt derived soils in the Coastal Plains, N Golan Heights and Mt Kata. Many have become locally endangered following the large-scale urbanization and agricultural cultivation of the Coastal Plains, which has drastically diminished their natural habitats. (Pollak 1984a, 1984b; Shmida & Pollak 2007; Shmida & al. 2011).

Fig. 1. *Isoetes durieui*: a) A whole plant, Hadera area, 4.4.2023, Dar Ben-Natan; b) Plants growing in Bryophyte soil crusts on sandy clay loam, Hadera area, 4.4.2023 Dar Ben-Natan; c) Plants growing in Bryophyte soil crusts in damp soil, Mt Kata, 28.3.2025 Dar Ben-Natan; d) Megasphores, Mt Kata, 28.3.2025, Shlomi Aharon (Scale bar 1 mm); e) habitat in Mt Kata – a batha of *Sarcopoterium spinosum* in Yellowish-brown sandy clay loam, 28.3.2025, Dar Ben-Natan.

Similarly, *Isoetes durieui* is described from the Iberian Peninsula as preferring a siliceous and acidic substrates, often near vernal ponds (Molina 2005; López-Tirado & al. 2015; López-Tirado 2022). In Italy, Sardinia and Sicily it occurs on siliceous soils, often waterlogged (Troìa & Greuter 2015b). From the Aegean Archipelago it is mentioned as occurring in ophiolitic schists (Troìa & Greuter 2015a); from Turkey, Syria and Lebanon as occurring on sandy soils and on basalt derived soils respectively, often near vernal ponds (Davis 1965; Bolin & al. 2011) – all of which are consistent with its non-calcareous, sand derived, and often vernal pond-adjacent habitats in Israel. Several species which were mentioned by Molina (2005) as associated with *I. durieui*, in Israel are also specialized to this particular habitat. They are locally rare and co-occur with *I. durieui* on sandy soils in the Coastal Plain and in Mt Kata. Among these are *Juncus capitatus* Weigel, *Tolpis umbellata* Bertol., *Ornithopus pinnatus* (Mill.) Druce, *Tuberaria guttata* (L.) Fourr., and *Centaurium maritimum* (L.) Fritsch.

Climate: Specific information on annual mean temperatures and precipitation is not recorded for most of the species' global range. However, by comparing meteorological maps (Aemet 2025) to distribution maps in relevant sources (Lopez-Tirado & al. 2015, 2022; Molina 2005), we can assess that mean temperatures in areas where *Isoetes durieui* is recorded in S Spain is 5-10 °C in January, and 22-25 °C in July, and annual precipitation is between 600 and 1000 mm in Huelva Province, 400-700 mm in Cordova Province, and

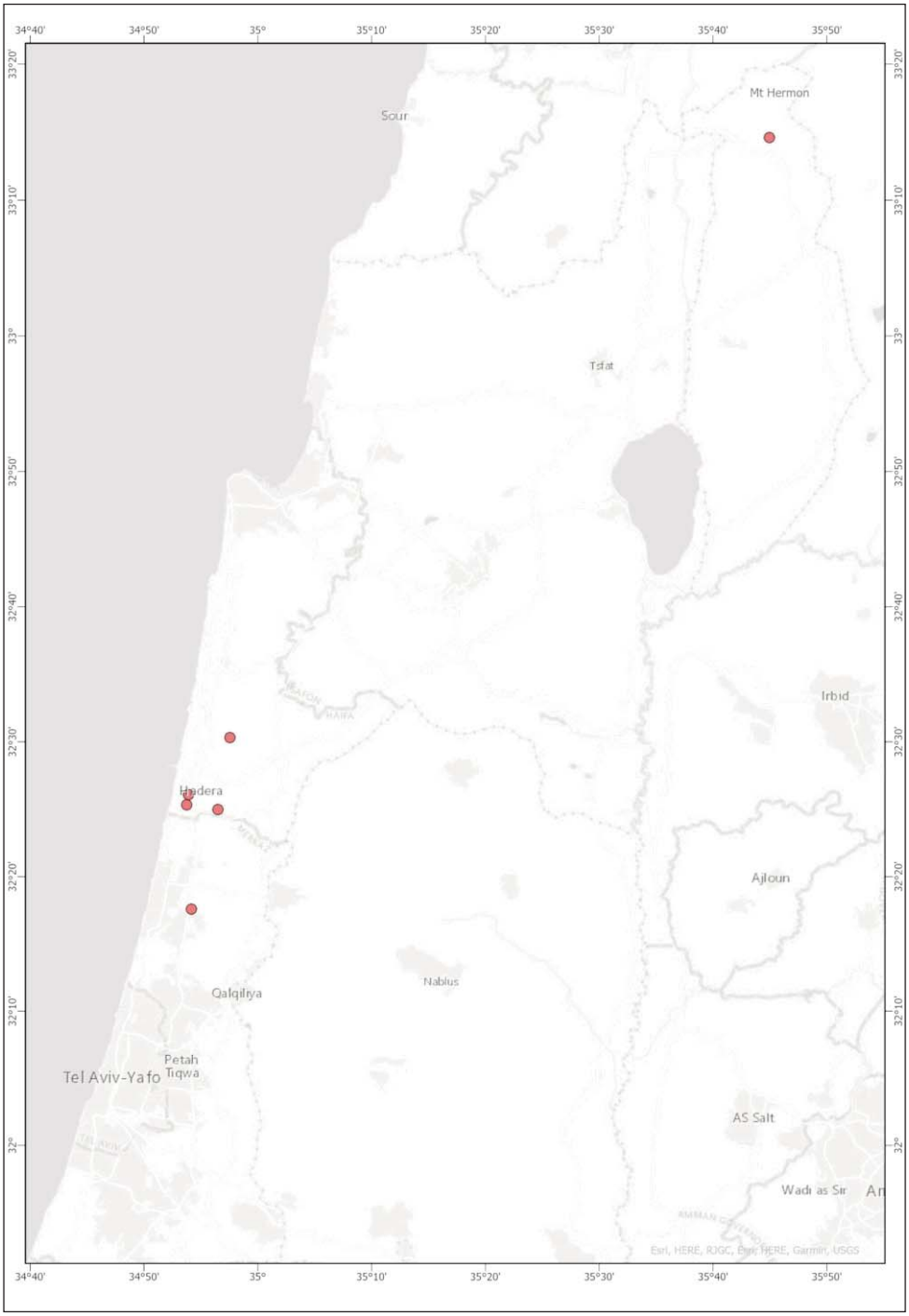

Fig. 2. A map showing *Isoetes durieui*'s distribution in Israel.

600-800 mm in Girona Province. In the area of Alger (Algeria), where the type for *I. durieui* was collected, annual mean temperature is 18.23 °C and average annual precipitation is 625 mm (World Bank Groupe 2025). Considering this, the Sharon Plain Populations experience warm and dry conditions, relative to most other known populations of this species – occurring at 20-40 m elevation in mean temperatures of 8–17 °C in January and 21–30 °C in July, and average annual precipitation of 550 mm. Meanwhile, Mt Kata population occurs at 1050 m elevation under cooler and wetter conditions: in mean temperatures of 3–9 °C in January and 17–25 °C in July, and annual precipitation of 950 mm (Israel Meteorological Service 2025).

Threats and conservation

Isoetes durieui is very rare in Israel, currently recorded from only six sites, all of which restricted in area, and mostly unprotected. Only the smallest of the known populations, consisting of few individuals, is included in a nature reserve. It should be considered as locally threatened according to the Israeli model of assessment, with a Red Number of 8 (Rarity: 3, Habitat vulnerability: 5, Endemism: 0, Attractivity: 0) (Shmida & Pollak 2007; Shmida & al. 2011, Lebel-Vine & al [in prep.]). The largest population both in terms of area and number of individuals, is in Hadera Forest. The plants grow there on moist Nazaz at the margins of a large vernal pond, exceptionally rich in locally rare and endangered species of Nazaz soils, and of wet habitats (Low-Ramati & al. 2022), in a forest of *Eucalyptus camaldulensis* Dehnh., planted and regulated by KKL-JNF, and are threatened by forest maintenance, urban development, and changes to the local drainage system.

Closing remarks

This discovery sets a new southern and southeastern border to *Isoetes durieui*'s area of distribution; from the previous southernmost known population in Akkar, in the northernmost part of Lebanon, to the Sharon Plain in central Israel. It is a partial result of considerable renewed interest and study of the local flora in the region recently, adjoined by more than 50 other species of vascular plants newly discovered to the local flora in the last two decades (Ben-Natan & al. 2024). It is worthwhile noting that in terms of soil and water regime characteristics, *I. durieui* occurs in similar habitats across much of its global distribution, and even in marginal populations such as those recently found in Israel. This should be taken into consideration worldwide in attempts to conserve this species *in-situ*.

Specimens examined

ISRAEL, Sharon Plain, Hadera, Giv'at Zeita, 6.4.2023, *Dar Ben-Natan and Bar Shemesh* (HUJ135046!); ISRAEL, Mt Katta, west of Nimrod, 18.5.2023, *Dar Ben-Natan* (HUJ1000046!); ISRAEL, Sharon Plain, Binyamina Meadow, 24.3.2024, *Bar Shemesh* (HUJ1003768!); ISRAEL, Sharon Plain, Illanot Forest – eastern side, sandy clay loam soil, moist with patches of Bryophytes, in the shade of *Cistus* and *Calicotome* shrubs, 20-30 individuals, 24.4.2024, *Dar Ben-Natan* (HUJ1003761!); ISRAEL, Hadera Forest, 26.2.2025, *Dvora Low-Ramati & Bar Shemesh*

(HUJ1008821!); ISRAEL, Lower Mt Hermon, Mt Kata, light brown sandy loam, moist from seeping from small, local aquifers, in an open batha of *Sarcopoterium spinosum* (L.) Spach, 28.3.2025, *Dar Ben-Natan* (HUJ1009193!).

References

Aemet, agencia Estatal de meteorologia 2025: Standard climate data. – https://www.aemet.es/en/serviciosclimaticos/datosclimatologicos/valoresclimatologicos [accessed 1/9/2025]

Ben-Natan, D., Fragman-Sapir, O. & Shemesh, B. 2024: Contributions to the Flora Palaestina Region. – Fl. Medit. **34:** 73-94. https://doi.org/10.7320/FlMedit34.073

Bolin, J. F., Bray, R. D. & Musselman, L. J. 2011: A New Species of Diploid Quillwort (*Isoetes*, *Isoetaceae*, *Lycophyta*) from Lebanon. – NOVON **21:** 295-298. https://doi.org/10.3417/2010028

—, —, Keskin, M., & Musselman, L. J. 2008: The genus *Isoetes* L. (*Isoetaceae*, *Lycophyta*) in southwestern Asia. – Turkish J. Bot. **32:** 447-457.

Dan, J. 1984: The Soils of the Coastal Plain. – Rotem **13** [in Hebrew].

Davis, P. H. & al. 1965: *Isoetes* Pp. 36-38 in Flora of Turkey and the East Aegean Islands, **1.** – Edinburg.

Eig, A. 1939: The vegetation of the light soils belt of the coastal plain of Palestine. – Palestine J. Bot., Jerusalem. Ser. 1 : 255-308.

Feinbrun-Dothan, N. 1986: Flora Palaestina, **4.** – Jerusalem.

— 1978: Flora Palaestina, **3.** – Jerusalem.

— & Danin, A. 1998: Analytical Flora of Eretz-Israel. – Jerusalem [in Hebrew].

Fragman-Sapir, O., Plitmann, A., Heller, D. & Shmida, A. 1999: Checklist and Ecological Database of the flora of Israel and its Surroundings. – Jerusalem.

Israel Meteorological Service 2025: Climatological data and statistics. – https://ims.gov.il [accessed 1/9/2025]

Lebel-Vine, M., Ben-Natan, D., Fragman-Sapir, O, Leschner, H., Ron, M., Sapir, Y., Shemesh, B., Singer, A., Ur, Y. Walczak, M. [in Prep]. Updates to the Israeli Model of Threat assessment for vascular plants. – INPA.

Low-Ramati, D., Ben-Natan, D., Perelberg, A., Rotem, D., Shalev, O., Talmon, I., Gleitman, S., Tsafrir, A. and Porat, Y. 2022: Tool and protocol development for mapping, surveying and tagging of protected natural assets in KKL forests designated for thinning or renewing, summary of a three-year pilot. – Tel-Aviv [in Hebrew].

López-Tirado, J. 2022: Updating the distribution of the genus *Isoetes* (*Isoetaceae*) in southern Spain (Córdoba, Andalusia). – Caldasia **44(1):** 1-7. https://doi.org/10.15446/caldasia.v44n1.91416

—, Sanchez Almendro, A. J., Carrasco Antelo, J. M. and Hidalgo Fernandez, P. J. 2015: New chorologic contributions to the endangered *Isoetes durieui* Bory (*Isotaceae*, *Pteridophyta*) in the province of Huelva (Andalusia, Spain). – Acta Bot. Malacitana **40:** 274-276. https://doi.org/10.24310/abm.v40i0.2511

Molina, J. A. 2005: The vegetation of temporary ponds with *Isoetes* in the Iberian Peninsula. – Phytocoenologia **35(2-3):** 219-230.

Musselman, L. J. & Al-Zein, M. S. 2010: Shorter notes: *Isoetes duriei* new to Lebanon. –Amer. Fern J. **99:** 333-334.

Mouterde, P. 1966: Nouvelle Flora du Liban et de la Syria. – Beirut.

Pollak, G. 1984a: The ecological challenges of rare plant species occurring on Hamra and Kurkar and conservation possibilities. – Rotem **13** [in Hebrew].

— 1984b: The state of the native Hamra and Kurkar vegetation today compared to the 1930'. – Rotem **13** [in Hebrew].
Prada, C. & Rolleri, C. H. 2005: A new species of *Isoetes* (*Isoetaceae*) from Turkey, with a study of microphyll intercellular pectic protuberances and their potential taxonomic value. – Bot. J. Linn. Soc. **147:** 213-228. https://doi.org/10.1111/j.1095-8339.2005.00362.x
Troìa, A. & Greuter, W. 2015a: A conspectus of and key to Greek *Isoetes* (*Isoetaceae*), based on a reassessment of Haussknecht's gatherings of 1885. – Willdenowia **45(3):** 391-403.
— & — 2015b: Flora Critica d'Italia: Isoetaceae. – Firenze.
—, Pereira, J. B., Changkyun, K. and Taylor, W. C. 2016: The genus *Isoetes* (*Isoetaceae*): a provisional checklist of the accepted and unresolved taxa. – Phytotaxa **277(2):** 101-145. https://doi.org/10.11646/phytotaxa.277.2.1
Shemesh, B., Ron, M. & Ben-Natan, D. 2024: Endangered plant survey, 2023. – Tel-Aviv [in Hebrew].
Shmida, A. & Pollak, G. 2007: The Red Data Book – Endangered plant species in Israel, **1.** – Jerusalem. [in Hebrew].
—, — & Fragman-Sapir, O. 2011: The Red Data Book – Endangered plant species in Israel, **2.** – Jerusalem. [in Hebrew].
Singer, A. 2007: The Soils of Israel. – Springer.
World Bank Groupe 2025: Climate Change Knowledge Portal, Algeria. – https://climateknowledgeportal.worldbank.org/country/algeria/climate-data-historical [accessed 1/9/2025]
Zare, G., Keskin, M. & Doğru-Koca, A. 2016: *Isoëtes vanensis* (*Isoëtaceae*) sp. nov. from Turkey. Phytotaxa 269(4):294-300. https://doi.org/10.11646/phytotaxa.269.4.5
Zohary, M. 1966: Flora Palaestina, **1.** – Jerusalem.
— 1972: Flora Palaestina, **2.** – Jerusalem.

Addresses of the authors:
Dar Ben-Natan & Bar Shemesh,
Open Landscape Institute (Deshe), The Steinhardt Museum of Natural History, Tel-Aviv University, Klausner St. 12, Tel Aviv-Yafo. E-mails: darbn@tauex.tau.ac.il, shemeshbar@tauex.tau.ac.il.