

Freshwater quillworts of Greece: Evidence of decline and emerging threats

Konstantinos Stefanidis, Eva Papastergiadou
Department of Biology, University of Patras, Patras, Greece

INTRODUCTION & AIM

Quillworts (*Isoetes* spp.) are among the least studied groups, with particularly scarce distributional data. In Greece, *Isoetes* is one of the most undercollected plant groups.

The first records of *Isoetes* in Greece date back to the late 19th century, beginning with the discovery of *I. gymnocarpa*, followed by two additional species, including the endemic *I. heldreichii*. Subsequent records from the early and mid-20th century included several misapplied names.

A major revision in 2015 clarified these uncertainties, increasing the number of recognized Greek species to seven:

I. duriei, *I. haussknechtii*, *I. heldreichii*, *I. histrix*, *I. phrygia*, *I. gymnocarpa*, *I. todaroana*

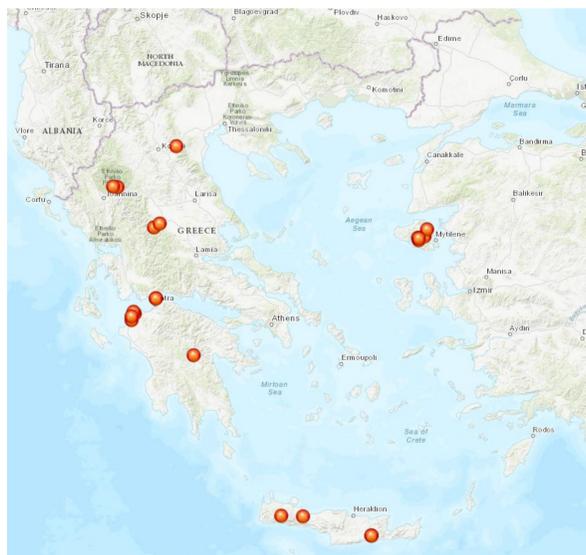
The specific objectives of research are:

1. **Discover new records** of quillworts and update their distribution patterns.
2. **Assess populations and habitats** of *Isoetes* species across Greece.
3. **Identify threats and stressors** impacting quillwort survival.
4. **Collect and barcode specimens** to enrich molecular databases and detect potential phylogenetic deviations.

METHOD

- Measurement of habitat characteristics (types of vegetation, water depth, flow regime, types of substrates) and water parameters (pH, dissolved oxygen concentration and saturation, turbidity and salinity)
- Pressures are recorded with emphasis placed on water abstraction, nutrient pollution originating from nearby agricultures, organic pollution, livestock presence and habitat destruction due to anthropogenic activities (e.g. dredging).
- Populations at each location are estimated using quadrats
- Plant material will be collected for DNA extraction and barcoding.

Figure 1. The map shows the sampling locations based on known records of *Isoetes* species. Each location has been sampled twice, with two additional campaigns planned for Spring and Summer 2026. New potential locations in Crete, Lesvos, Epirus, and Macedonia have also been visited for possible *Isoetes* occurrences. The upcoming sampling campaigns will target additional locations in the Peloponnese and Western Greece.



FUNDING

FUNDING: The project is implemented in the framework of H.F.R.I.'s 2nd Call "Actions to protect, conserve and promote biodiversity. Field studies of endemic, endangered and nationally important species of Greece" (Project Number: 83835) funded by the National Environment & Climate Change Agency (N.E.C.C.A.). This research was funded by the funding programme "MEDICUS", of the University of Patras

RESULTS & DISCUSSION

- **Thessaly:** Multiple locations have been visited including original locations of *I. heldreichii* and *I. haussknechtii* in Thessaly. Habitats have been significantly altered due to human induced changes in the hydrological regime and landscape (e.g. creation of the large reservoir Lake Plastira)
- **Lesvos:** The year 2025 was extremely dry, significantly impacting freshwater ecosystems. As a result, potential habitats for *Isoetes* were absent. New sampling campaigns are planned for early spring 2026.
- **Crete:** A well-established population of approximately 20 individuals of *I. phrygia* was recorded in the small lake at Omalos, despite ongoing drought conditions and harsh hydrological stress. The Omalos plain in eastern Crete, where populations had previously been documented, has completely dried out, likely due to the combined effects of climate change and water abstraction for livestock and agricultural use. Grazing pressure has further impacted the vegetation in these now-dry plains.
- **Peloponnese:** Sporadic occurrences of *I. gymnocarpa* have been recorded in temporary ponds in western Peloponnese. Additional field surveys are planned for early spring..

Figure 2. Photo of Omalos Lake (left) in Crete, where a population of *Isoetes phrygia* was found. An individual of *I. phrygia* is shown in the right photo.



Climate change, water withdrawal and livestock grazing major threats for aquatic plants in temporary ponds

- ✓ Changes in the hydrological regime have a dramatic effect in small ponds. Particularly temporary ponds maintain less and less water for shorter periods
- ✓ Increased demand for water exerts pressure to these systems as water withdrawal increases and speeds up the drying of small ponds
- ✓ Livestock breeding can be an issue (e.g., in Crete), as animals use ponds for drinking and graze on the small plants that emerge when the water recedes.



Figure 3. Trends in small livestock populations show a steady increase, indicating rising grazing pressure in mountainous areas of the Northern Aegean islands and Crete (Top) Climatic variables (surface temperature, runoff, and precipitation) on Lesvos have shifted since the 1950s, reflecting reduced water availability (Bottom)

FUTURE WORK

- Continue field sampling, focusing on temporary ponds during winter
- Conduct DNA barcoding of collected specimens
- Apply SEM microscopy to study megaspore ornamentation
- Assess threats and population sizes to support conservation planning
- Produce species distribution models to estimate future changes under different scenarios