Occurrence of *Hydra vulgaris* Pallas, 1766 in a Mediterranean insular freshwater system (Mallorca, Balearic Islands): expanding the known distribution of the species

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Deserti, M.I. and Matamales-Andreu, R. 2026. Occurrence of *Hydra vulgaris* Pallas, 1766 in a Mediterranean insular freshwater system (Mallorca, Balearic Islands): expanding the known distribution of the species. *Boll. Soc. Hist. Nat. Balears,* 69: 83-92. ISSN 0212-260X. e-ISSN 2444-8192. Palma.

The genus *Hydra* is widely distributed in continental aquatic environments worldwide; however, its presence in insular systems of the Mediterranean has been poorly documented. In this study, we report a new occurrence of these freshwater hydrozoans in Font de na Memòria, in the municipality of Manacor (Mallorca, Balearic Islands, western Mediterranean). This finding represents one of the few published records of the genus on the island and contributes to expanding current knowledge of its biodiversity. Polyps were analyzed through the evaluation of their general morphological characters and the study of their cnidome. The combined assessment of these features allowed us to determine that the examined specimens correspond to *Hydra vulgaris*. This record expands the known distribution of the species in the Mediterranean region and highlights the importance of documenting the fauna present in small freshwater systems. Furthermore, considering the sensitivity of these organisms to environmental conditions, their presence may provide relevant information about the conservation status of these ecosystems.
Keywords: Hydra*, freshwater hydrozoans, insular ecosystems.*

PRESÈNCIA D'*HYDRA VULGARIS* PALLAS, 1766 EN UN SISTEMA DULCIAQÜÍCOLA INSULAR MEDITERRANI (MALLORCA, ILLES BALEARS): AMPLIACIÓ DE LA DISTRIBUCIÓ CONEGUDA. El gènere *Hydra* està àmpliament distribuït en ambients aquàtics continentals d'arreu del món. Això no obstant, la seva presència en sistemes insulars de la Mediterrània ha estat poc documentada. En aquest estudi, es dóna a conèixer la presència d'aquests hidrozous d'aigua dolça a la Font de na Memòria, al municipi de Manacor (Mallorca, Illes Balears, Mediterrània occidental). Aquesta troballa representa un dels pocs registres publicats del gènere a l'illa, i contribueix a ampliar el coneixement actual de la seva biodiversitat. Els pòlips foren analitzats mitjançant l'avaluació dels seus caràcters morfològics generals i l'estudi del seu cnidoma. L'avaluació combinada d'aquestes característiques ha permès de determinar que els exemplars examinats corresponen a *Hydra vulgaris*. Aquest registre amplia la distribució coneguda de l'espècie a la regió mediterrània i destaca la importància de documentar la fauna present en petits sistemes d'aigua dolça. A més, considerant la sensibilitat d'aquests organismes a les condicions ambientals, la seva presència pot proporcionar informació rellevant sobre l'estat de conservació d'aquests ecosistemes.
Paraules clau: Hydra*, hidrozous d'aigua dolça, ecosistemes insulars.*

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Recepció del manuscrit: 5-03-2026; revisió acceptada: 30-04-2026; publicació online: 1-05-2026.

Introduction

The genus *Hydra* (Cnidaria: Hydrozoa) is globally distributed, except in the Antarctic region and oceanic islands (Jankowski *et al.*, 2008). It constitutes a monophyletic clade (Collins *et al.*, 2006) of sessile and solitary polyps, typically attached to submerged or floating macrophytes, and found in nearly all types of freshwater environments, being more abundant in lentic waters (Elliot *et al.*, 1997). It occurs mainly in mesotrophic to eutrophic habitats (Jankowski *et al.*, 2008).

The taxonomy of the genus is based primarily on Eurasian and North American species (Schulze, 1917; Hyman, 1929; Ewer, 1948; Forrest, 1963; Grayson, 1971; Campbell, 1989). Supported by molecular analysis, there are four morphological groups: *viridissima* (green hydras), *vulgaris* (common hydras), *braueri* (gracile hydras) and *oligactis* (stalked hydras) (Martínez *et al.*, 2010). The *viridissima* and *vulgaris* groups were probably present before the fragmentation of Pangaea, whereas the last two, *oligactis* and *braueri,* were restricted to the northern continents, presumably arising after the separation of Laurasia and Gondwana (Jankowski *et al.*, 2008). Species in the *viridissima* group are characterized by the presence of unicellular symbiotic algae, which give them their distinctive bright green colouration. In contrast, hydras of the *vulgaris*, *braueri*, and *oligactis* groups lack these symbionts and are therefore known as brown hydras (Campbell, 1983).

The *vulgaris* group represents a taxonomic challenge in its own right. The marked plasticity of morphological characters has generated considerable taxonomic confusion, not only within this group but across the genus as a whole. Indeed, Martínez *et al.* (2010) noted that the total number of species recognized in the genus *Hydra* depends largely on the extent of variation accepted within members of the *vulgaris* group. Standing out for its diversity and internal variability, this group has consequently been the subject of extensive research (Schwentner & Bosch, 2015) and includes one of the most cosmopolitan species of the genus, *Hydra vulgaris* Pallas, 1766.

In the Balearic Islands, records of *Hydra* date back to the early works of Ramon Margalef, who reported *Chlorohydra viridissima* from a roadside ditch along the Maó-Fornells road (km 16.5) in Menorca (Margalef, 1952) and from a water tank in Lluc, Mallorca (Margalef, 1953), as well as *Hydra vulgaris* from a water tank on the slopes of Puig Major, Mallorca (Margalef, 1953). These records were later expanded by Ferriol (1990), who found *Chlorohydra* in springs at Font des Noguer, S'Estret, and Orient, and *Hydra* in Font de sa Mata, Pla del Rei, Son Amer, and Son Creus, all within the Serra de Tramuntana. More recently, additional observations include a report by

X. Riera (pers. comm., 2026), who noted *Hydra vulgaris* about 50 years ago in an irrigation channel at Pla del Rei attached to *Myriophyllum* sp. Also, a photographic record from near Camí dels Reis (Mallorca) uploaded to iNaturalist (Navarro, 2026); together, these data indicate that all known occurrences are concentrated in the western part of Mallorca, within or near the Serra de Tramuntana.

For the Iberian Peninsula, reports of *Hydra* in the formal scientific literature appear to begin with the record by Margalef (1955), who documented *H. vulgaris* from the Tera and Negro subbasins (northern Duero basin, northwestern Spain). Subsequent contributions expanded the known distribution of the genus across different regions of the peninsula, incorporating additional species and localities over time. In more recent works in the same area, Morales *et al.* (2017, 2018) added the presence of *H. vulgaris* var. *aurantiaca*, *H. viridissima*, and *H. oligactis*. Near Madrid, Álvarez & Selga (1967) reported *Chlorohydra viridissima* and *Pelmatohydra oligactis*. In the north, Arlegui & Bergerandi (1981) recorded *H. viridis* in the Muniain de Guesalaz pond, while Domínguez *et al.* (1997) listed *Chlorohydra viridissima* from the Cabriel River basin in the east. Several studies focused on the Júcar River system: Rueda *et al.* (2003) reported *Chlorohydra viridissima* and *H. vulgaris*, and Rueda *et al.* (2008) illustrated *Hydra* sp. from the river and nearby springs in Carcaixent. In the Albufera de València, *Hydra* sp. was recorded from Tancat de la Pipa and Milia (Ortiz Ortiz, 2016). More recently, Maynou & Martín (2021) found a single *Hydra* sp. specimen attached to an odonate larva in a mountain river of the Montseny area (northeast), and De Araújo Costa *et al.* 2023) identified *H. viridissima* and *H. oligactis* in the Miño River near Vila Nova de Cerveira (northwest).

As early as Hickson (1930) observed, the widespread characterization of the genus *Hydra* as cosmopolitan in freshwater is largely accurate; however, the absence of records in certain regions should not be interpreted as true absence, considering the difficulty of observing and collecting these small polyps in the course of ordinary scientific exploration. In this context, the present study reports *Hydra vulgaris* Pallas, 1766, for the first time in Font de na Memòria, Manacor, Mallorca, representing the first record of this species for the area (Llevant de Mallorca).

Therefore, documenting its occurrence in previously unrecorded insular freshwater systems becomes essential for refining the biogeographic framework of the genus and for contributing to a broader understanding of regional biodiversity.

Material and methods

Geographical and ecological context

The specimens herein studied were found attached on the thallus of the submerged liverwort *Apopellia endiviifolia* (Dickson) Nebel *et* D. Quandt at Font de na Memòria, Manacor, Mallorca, Balearic Islands, western Mediterranean (39° 37′ 48.90″ N, 3° 09′ 54.24″ E) (Fig. 1). This spring, also known as Font de sa Vall, is the most abundant natural spring in the Vall de la Nou, located in the north-western part of the municipality of Manacor. The spring flows year-round, with an average discharge of approximately 450 L/min, although short-term increases may occur during periods of intense aquifer recharge (Mascaró *et al.*, 1999). This high and relatively stable discharge gives the spring a significant eco-

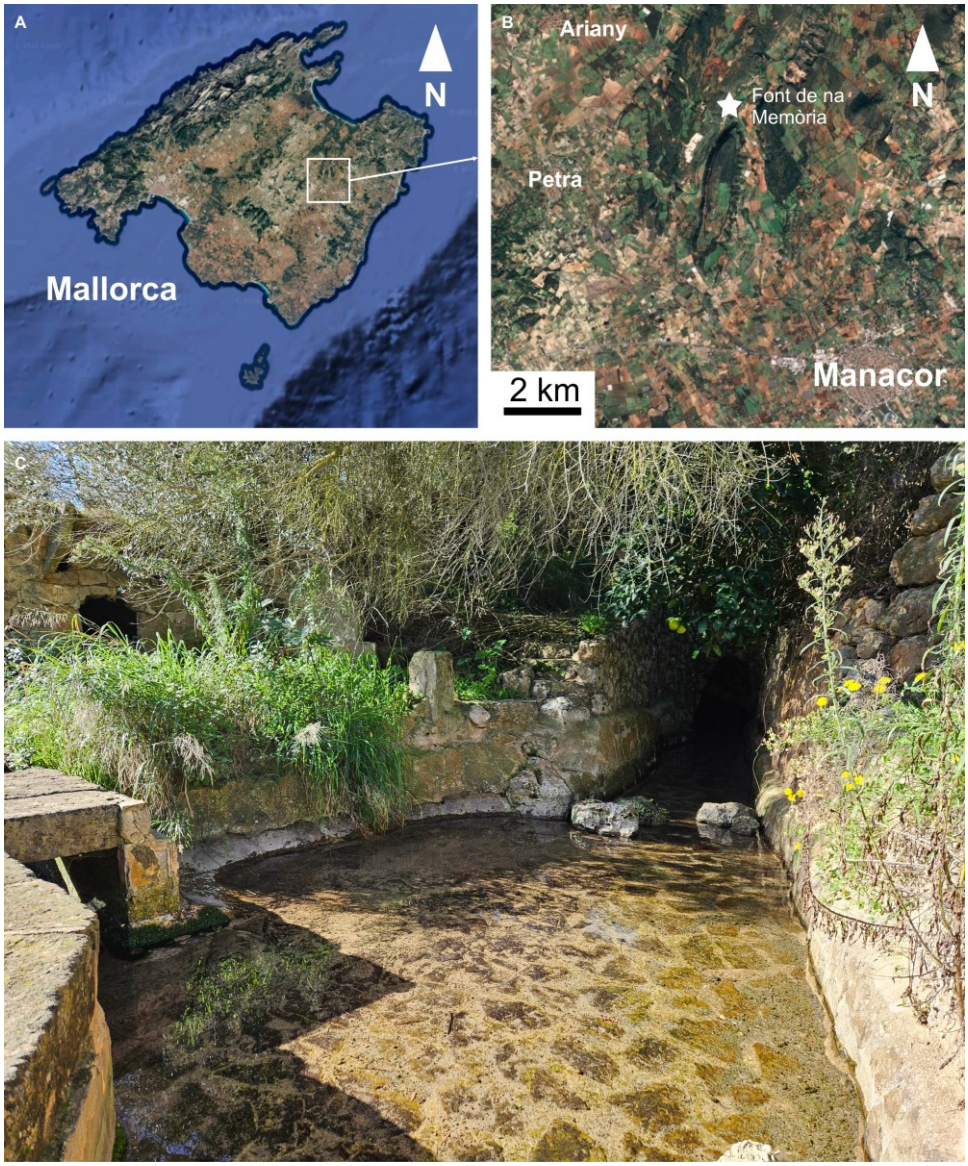

Fig. 1. A–B: Geographical context of Font de na Memòria on the island of Mallorca. **C:** Picture of the spring.
Fig. 1. A–B: *Context geogràfic de la font de na Memòria a l'illa de Mallorca.* ***C:*** *Fotografia de la surgència.*

logical role in an environament characterized by strong seasonal water scarcity. Apart from hydras, in the Font de na Memòria there are flatworms (*Dugesia* sp.), leeches (*Erpobdella* sp.), freshwater snails (*Ancylus* gr. *fluviatilis* O. F. Müller, 1774,

Physella acuta (Draparnaud, 1805), *Ampullaceana balthica* (Linnaeus, 1758), and *Pseudamnicola* aff. *artanensis* Altaba, 2007), water mites (*Torrenticola* sp.), crustaceans (Copepoda sp. indet., *Echinogammarus* aff. *eisentrauti* (Schellenberg, 1937), and *Proasellus banyulensis* (Racoviță, 1919), water crickets (*Velia (Plesiovelia) hoberlandti* Tamanini, 1949) and riff beetles (*Oulimnius echinatus* Berthélemy, 1979) (R.M.A., own data). As a whole, this community indicates clean, well-oxygenated waters.

Morphological analyses and taxonomic identification

Seven (7) specimens were collected. Once recognized in the field as belonging to the genus *Hydra*, they were photographed *in vivo* on site and subsequently preserved in 96% ethanol (Fig. 2).

The characteristics analyzed in the collected specimens were:

General: colour; column length; presence or absence of a peduncle near the foot. Total number of tentacles, relative length (estimated by visually comparing the full extension of tentacles in each polyp), and the tentacle growth pattern in young buds.

Cnidom: shape, width and length of 30 undischarged capsules (per polyp) from each cnidocyst types present in the genus (stenoteles, desmonemes, atrichous isorhizas, and holotrichous isorhizas). Cnidocyst nomenclature follows Wang *et al.* (2009) and was measured using whole-polyp squashes.

The characteristics were observed using a Leica EZ4W stereomicroscope. The cnidome analyses were conducted with a Zeiss Axiolab microscope at 1000× magnification with oil immersion. The measurements were performed using Leica Application Suite (LAS EZ - version 3.4.0).

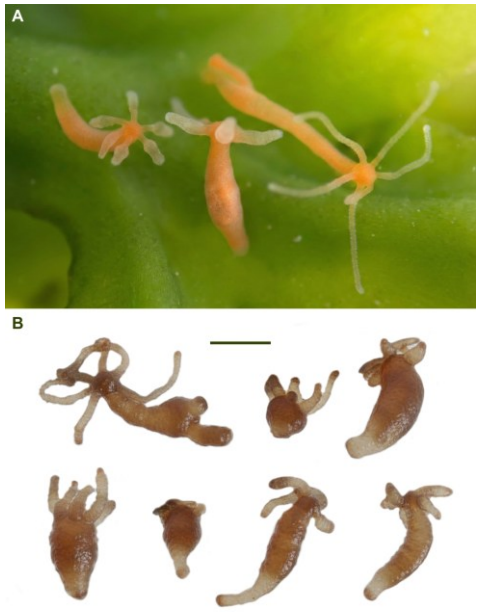

Fig. 2. A: Three *in vivo* specimens of *Hydra vulgaris* from the Font de na Memòria. **B:** Seven specimens after fixation in ethanol. Scale bar: 1 mm.
Fig 2. A: *Tres exemplars* in vivo *d'*Hydra vulgaris *de la font de na Memòria.* ***B:*** *Set exemplars després d'esser fixats en etanol. Barra d'escala: 1 mm.*

Results: taxonomy

Class **Hydrozoa** Owen, 1843
Order **Anthoathecata** Haeckel, 1879
Family **Hydridae** Dana, 1846
Genus ***Hydra*** Linnaeus, 1758
Species ***Hydra vulgaris*** Pallas, 1766
Hydra vulgaris
Figs. 2, 3

Description. The polyps exhibited an orange colouration *in vivo*, which markedly faded after fixation in ethanol. After preservation, the specimens show a column ranging from 0.86 to 2.54 mm in length and from 0.47 to 0.79 mm in width. It should be

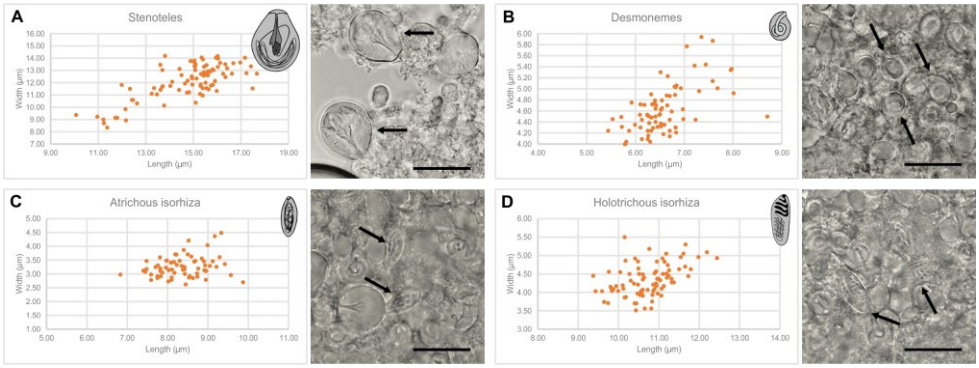

Fig. 3. Microphotographs and scatter plots corresponding to the four types of cnidocysts observed in *Hydra vulgaris*: (A) stenoteles, (B) desmonemes, (C) atrichous isorhiza, and (D) holotrichous isorhiza. In each panel, the graphs show the relationship between capsule length and width, while the microphotographs illustrate the cnidocysts present in the tissue. Arrows indicate the capsules identified in the microscopic preparations. Scale bars: 15 µm.

Fig. 3. *Microfotografies i diagrames de dispersió corresponents als quatre tipus de cnidocists observats en* Hydra vulgaris*: (A) estenotels, (B) desmonemes, (C) àtrics isorriza, i (D) holòtrics isorriza. A cada panell, els gràfics mostren la relació entre la longitud i l'amplada de les càpsules, mentre que les microfotografies il·lustren els cnidocists presents en el teixit. Les fletxes assenyalen les càpsules identificades en les preparacions microscòpiques. Barres d'escala: 15 µm.*

taken into account that, in living specimens, these measurements may reach up to three times the preserved size, as fixation induces considerable contraction of the polyps. The column does not exhibit a conspicuous peduncle near the basal disc. Three polyps possess five tentacles, whereas four have six; tentacle length is slightly greater than or approximately equal to column length. A single polyp displays one bud at a very early developmental stage, which does not allow observation of its tentacular growth pattern. No sexual structures have been observed.

Cnidome: The four cnidocyst types that characterize the genus *Hydra* are present: stenoteles, desmonemes, atrichous isorhizas, and holotrichous isorhizas, the latter two being slightly less abundant than the former.

Stenoteles (Fig. 3A) exhibit the typical pyriform shape, represent the largest cnidocyst type observed, and are distributed in both the column and tentacles; some capsules appear more spherical than others. Their measurements range from 10.1–17.7 µm (14.7 ± 1.6 µm) in length and from 8.3–14.2 µm (12.0 ± 1.4 µm) in width. Although the separation is not sharply defined, two partially overlapping size groups can be distinguished. The shaft presents three spines of equal size and occupies slightly more than half of the capsule length. In the lower half of the capsule, the thin tubule is coiled perpendicular to the main axis of the capsule.

Desmonemes (Fig. 3B), found abundantly and primarily in the tentacles, are nearly spherical, with the tubule making a single complete coil inside the capsule. Their measurements range from 5.4–8.7 µm (6.5 ± 0.6 µm) in length, and from 3.5–5.9 µm (4.5 ± 0.5 µm) in width. Their abundance is slightly greater than that of the stenoteles.

Atrichous isorhizas (Fig. 3C), seed-shaped, have also been found in the

tentacles. The tubule appears to be very thin and tightly coiled throughout the entire capsule. As observed, their size is slightly larger than that of the desmonemes. Their measurements range from 6.8–9.9 µm (8.3 ± 0.6 µm) in length, and from 2.6–4.5 µm (3.2 ± 0.4 µm) in width.

Finally, holotrichous isorhizas (Fig. 3D) are represented by a single morphotype, displaying an oblong shape, with some specimens showing a slightly constricted central region, giving them a parameciumlike appearance. They are located in the column, being more abundant in the vicinity of the pedal disc. Three to four thick coils have been observed in the distal region of the capsule, near the operculum, arranged in a more or less oblique disposition. The thin tubule is difficult to distinguish. Their measurements range from 9.4–12.4 µm (10.7 ± 0.6 µm) in length, and from 3.5–5.5 µm (4.3 ± 0.4 µm) in width.

The number of capsules measured for each cnidocyst type was as follows: 90 for stenoteles and desmonemes, 85 for holotrichous isorhizas, and 67 for atrichous isorhizas.

Remarks. The examined polyps are small, exhibit an orange-brown colouration, and lack a conspicuous peduncle near the basal disc. Specimens possess five or six tentacles of comparable or slightly greater length than the column, and no sexual structures have been observed. The cnidome comprises the four nematocyst types diagnostic of the genus. Stenoteles are the largest capsules and display the typical pyriform morphology with a well-developed shaft; desmonemes are abundant and nearly spherical; atrichous isorhizas are slightly larger than desmonemes and tightly coiled; and holotrichous isorhizas are represented by a single morphotype, typically oblong in shape, a form widely represented among species of the *vulgaris* group. The overall morphology, and the type and measurements of the cnidocysts are consistent with those described for *H. vulgaris* Pallas, 1766 (Ewer, 1948; Grayson, 1971; Campbell, 1989; Martínez *et al.*, 2010).

Among the available records from the Iberian region, only the study by Morales *et al.* (2018) provided a detailed morphological analysis of the examined specimens. Comparative analysis indicates that the Mallorcan population shows a high degree of concordance with the material identified by those authors as *H. vulgaris* var. *aurantiaca*. The cnidocyst measurements and morphology are nearly similar, with comparable size ranges for stenoteles, desmonemes, and holotrichous isorhizas; only atrichous isorhizas appear to be slightly larger in the Mallorcan material. Additionally, the orange-brown colouration and the number of tentacles is consistent with the condition described by Morales *et al.* (2018). Although our specimens are smaller in overall size, body dimensions in *Hydra* are known to be highly variable and strongly affected by fixation. Considering that measurements in living individuals may reach up to three times those observed after preservation, the estimated *in vivo* dimensions would be very close to the size reported for *H. vulgaris* var. *aurantiaca* by Morales *et al.* (2018).

It should be emphasized, however, that *H. vulgaris* var. *aurantiaca*, originally described by Ehrenberg (1838), is not a valid name and is currently regarded as a synonym of *H. vulgaris* (Schuchert *et al.*, 2026). In the original account, Ehrenberg referred to *Hydra vulgaris* var. *aurantiaca* based on Rösel's "orange polyp with long arms", clearly treating it as a chromatic form within *H. vulgaris* rather than as a distinct species. Thus, the name has no independent taxonomic standing under current nomenclatural criteria and is consequently no lon-

ger in use.

Conclusions

Although the genus *Hydra* has been cited on multiple occasions from Iberia, most of these records lack detailed morphological support. The present study provides a rigorously documented record of *H. vulgaris* in the Iberian region, based on diagnostic morphological characters and cnidome analysis.

Beyond its taxonomic relevance, this finding suggests that the group may be more widespread and locally abundant than previously recognized. The scarcity of documented occurrences likely reflects methodological limitations associated with the detection and collection of these small polyps. In addition, passive dispersal mechanisms, for example via waterbirds transporting resistant stages, as described for other freshwater invertebrates, may contribute to the colonization of isolated habitats such as springs.

Given that *Hydra* is highly sensitive to water quality, requiring reasonably unpolluted conditions for survival (Bossert & Galliot, 2012), and that, like other hydrozoans (Edwards, 2012; Folino-Rorem *et al.*, 2016), its presence in freshwater ecosystems constitutes a reliable indicator of good water quality and ecosystem conservation status (Deserti & Acuña, 2025), these attributes position *Hydra* not only as a model organism of biological interest but also as a powerful sentinel of freshwater ecosystem health. In this context, documenting and accurately identifying its distribution becomes particularly relevant in a scenario of accelerating environmental change.

In a broader perspective, these results highlight the importance of improving our knowledge of biodiversity associated with seemingly modest aquatic habitats such as natural springs, which nevertheless have a high ecological value. These systems function as true biological reservoirs, preserving autochthonous and endemic lineages that have persisted over long periods despite transformations in the surrounding landscape. Accurate documentation of their fauna not only reveals the biological singularity of each site, but also provides a fundamental tool for the early detection of environmental change, the assessment of ecosystem conservation status, and the development of informed management and protection strategies. Under increasing pressure on freshwater resources and accelerating global change, detailed knowledge of local biodiversity thus becomes a key element for the effective conservation of these fragile freshwater refugia.

Acknowledgements

To the *Direcció General de Medi Natural i Gestió Forestal, Conselleria d'Agricultura, Pesca i Medi Natural, Govern de les Illes Balears*, for granting us the specimen collection permits (file number CAP25/2025; extension file number CAP04/2026). To Sebastià Matamalas and Joan Díaz for aid in fieldwork. To Xisco Riera and Guillem X. Pons for the comments that improved the original manuscript.

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