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A new record of the Endangered Zolio's Shield-backed Ground Lizard, *Philochortus zolii* Scortecci, 1934, from Algeria, with genetic insights and a geographic distribution review

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The Afro-Arabian genus *Philochortus* currently comprises seven recognized species (Uetz et al., 2025), including the Saharo-Sahelien *Philochortus zolii*. Commonly known as Zolio's Shield-backed Ground Lizard, this species is one of the least studied and rarest lacertid lizards in North Africa. Its range is presumed to consist of widely scattered and isolated populations, as it is known from only a few records across the Sahara and Sahel regions, from Mauritania to Egypt (Naia et al., 2021). With an estimated total area of occupancy of < 500 km², and given the significant fragmentation of its range, the species has been classified as Endangered by the IUCN (Wagner et al., 2013).

Although studies on *P. zolii* are limited, some morphological characteristics and ecological aspects, including its habitat preferences, diet, and certain behavioural traits, have been documented, primarily from populations in Egypt and Mauritania (Baha El Din, 2006; in den Bosch, 2020; Naia et al., 2021), yet broader knowledge of the species across its range remains scarce. Genetically, the relationships among its disjunct populations remain virtually unexplored. To date, no comprehensive genetic assessment has been conducted to evaluate the degree of divergence between known populations, leaving the extent of genetic differentiation unresolved. The only available genetic data were obtained from the *COI* gene of two specimens, one from Egypt and one from Mauritania, and these were included in a DNA barcoding reference library (Velo-Antón et al., 2022).

In this study we document a new locality for *P. zolii* in Algeria and provide the first DNA sequence from an Algerian population. Our genetic data are comparatively analysed to assess potential genetic divergence across the species' range. Additionally, we compile and review all known occurrence records and provide an updated distribution map for the species.

Materials and Methods

Study area. Field data were collected during a scientific survey conducted by the third author at Oued Tamekrest, Tamanrasset Province, southern Algeria (22.7914°N, 5.8064°E, elevation 1428 m; Fig. 1A). This perennial stream lies within a rugged, rocky valley of the Atakor Mountain Massif, part of Ahaggar National Park, and falls within the West Saharan montane xeric woodland ecoregion (Naia and Brito, 2021). It is seasonally replenished by monsoonal rainfall during the summer months originating from the Sahel Region (Saighi, 2025). The riparian zone is characterized by scattered trees, primarily *Acacia*, and a sparse understorey of drought-adapted shrubs. Climatic data for the site, derived from the WorldClim database (~1 km² resolution; Fick and Hijmans, 2017), indicate a superior Saharan bioclimate with mild winters.

Genetic analyses. In the field a small piece of tail tissue was removed and stored in 96% ethanol for genetic analyses. DNA was extracted from this tissue using standard High Salt methods (Sambrook et al., 1989), and then a PCR was employed to amplify a section of the cytochrome c oxidase I (*COI*) gene, using the primers LCO1490 and HCO2198 from Folmer et al. (1994). Amplification conditions consisted of 35 cycles of 40 s at 95°C, 30 s at 50°C and 40 s at 72°C.

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Quality of the reaction was assessed by visual examination after electrophoresis in a 2% agarose gel, and the positive PCR product was then cleaned and sequenced at the facilities of BIOPOLIS.

Geographic distribution review. Data on the distribution of *P. zolii* were compiled from literature, museum, and institution collections, as well as the iNaturalist platform. An updated distribution map was generated using ArcGIS v10.8. The following museum and institutional abbreviations, adopted from Sabaj (2020), are used throughout the text: Collection Biogéographie et Écologie des Vertébrés, Laboratoire de Biogéographie et Écologie des Vertébrés, Montpellier, France (BEV); California Academy of Sciences, San Francisco, California, USA (CAS); Centro de Investigação em Biodiversidade e Recursos Genéticos, Porto, Portugal (CIBIO); Field Museum of Natural History, Chicago, Illinois, USA (FMNH); Museo Civico di Scienze Naturali "Enrico Caffi", Bergamo, Italy (MCSNB); Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA (MCZ); Muséum National d'Histoire Naturelle, Paris, France (MNHN); and The Natural History Museum, London, UK (NHMUK).

Results and Discussion

New record. On 28 November 2024 at 12:22 h, an adult *P. zolii* (Fig. 1B) was observed among thickets of *Acacia* bushes on sandy substrate along the stream edge of Oued Tamekrest. This is the third documented

Figure 1. (A) Landscape at Oued Tamekrest, Tamanrasset Province, southern Algeria, showing the waterway. (B) *Philochortus zolii* specimen observed at Oued Tamekrest. Photos by Larbi Tahar-Chaouch.

occurrence of *P. zolii* in Algeria and extends the known range by approximately 25 km east and 45 km southeast of previously documented localities (CAS 138637–38; Haddad et al., 2024; Fig. 2).

Our observation is consistent with previous reports indicating that *P. zolii* is active during the warmer periods of the day and tends to occupy mesic microhabitats, as observed in Mauritania (Naia et al., 2021) and Egypt (Baha El Din, 2006). The association of *P. zolii* with *Acacia* trees, documented in both Algeria and Mauritania (Naia et al., 2021; Haddad et al., 2024), further suggests a potential habitat preference for such trees.

It is likely that additional individuals and/or localities may be uncovered in the Hoggar Massif and further northeast in the Tassili n'Ajjer Massif. This possibility is reinforced by the existence of several wetlands in these regions (GDF, 2016), and the proximity of the Tassili n'Ajjer Massif to the type locality in Libya near the Algerian border (Scortecci, 1934).

Genetic characterization. A 624-bp partial *COI* sequence was generated (GenBank accession number PV810665) and compared to the two sequences of *P. zolii* of the same length from Velo-Antón et al. (2022), ON943711 from Mauritania and ON943712 from Egypt. The new sample differed by five base pairs (0.08%) from the Mauritania sample and by eight base pairs (1.3%) from the Egypt sample. The Mauritania and Egypt samples differed from each other by 0.08%.

With no other species of *Philochortus* available for comparisons using the same mitochondrial gene and only three specimens of *P. zolii* sequenced, phylogenetic conclusions cannot be drawn. However, it seems that despite the enormous geographic distances separating them, the examined populations are relatively closely related, with a maximum of 1.3% divergence between them with the *COI* marker. This would indicate that these isolated populations may not be ancient relicts but probably only became isolated during the Pleistocene, a period associated with notable expansion and contraction of the Sahara Desert. Additional sampling would be needed to further confirm this and determine phylogeographic relationships between extant populations.

Geographic distribution review. We provide an updated range map for *P. zolii* (Fig. 2). Below is a detailed account of its known distribution.

Algeria.—All known records, including our own, are from Tamanrasset Province. The earliest documented occurrence is based on two specimens collected in May 1974 by T.J. Papenfuss, R.C. Drewes, and E.J. Morris (CAS 138637–38) at approximately 3 km E Tamanrasset along the road to Adriane. More recently, Haddad et al. (2024) observed another specimen in July 2023 from a locality 500 m E Tagmart-Est Village (no specimen number, observed and photographed *in situ*). Additionally, six observations recorded in November 2023 by the 'Algerian Wildlife Watchers Association' are available on iNaturalist (Table 1), though it remains unclear whether they represent a single individual or multiple specimens.

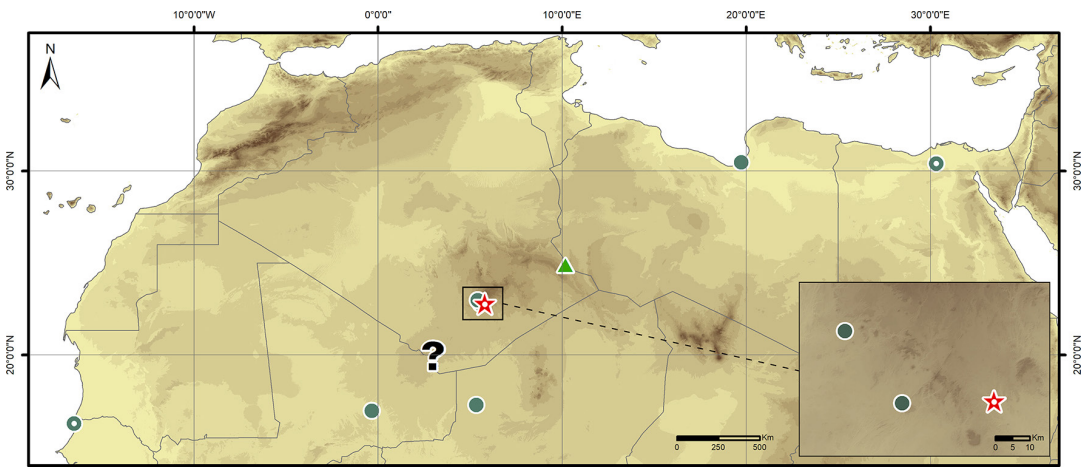

Figure 2. Known range of *Philochortus zolii*. Blue circles denote known localities, the green triangle marks the type locality, and the red star indicates the newly recorded locality. Symbols containing a white circle represent specimens included in genetic analyses, while the question mark denotes a locality with low spatial accuracy. The inset shows a close-up of the Algerian records in the rectangle of the main map.

Despite their relatively low spatial accuracy – attributable to iNaturalist's geoprivacy policy, which automatically obscures the coordinates of taxa with listed conservation status – these records are presumed to originate from areas near Tin Zaouatine, close to the Malian border.

Egypt.—The species is confirmed from a single population in Wadi El Natrun. The earliest documented specimens (NHMUK 1965.812–13), two adult males, were collected by A.M. Kamal (Kamal et al., 1966 *fide* Baha El Din, 2006). Marx (1968) later reported on eight additional specimens (FMNH 152606–07, 154606–11), originally misidentified as *P. intermedius* Boulenger, 1917, collected by H. Hoogstraal and I. Helmy in March 1964 and May 1965. More recently, five specimens were collected in April 2006 to be kept in a terrarium (in den Bosch, 2020), with no voucher specimens remaining after the death of the animals. A tissue sample (BEV.T365), later subsampled and preserved as CIBIO.15459 (Velo-Antón et al., 2022), likely originated from the same fieldwork reported by in den Bosch (2020).

Libya.—The species is known from two historical records. *Philochortus zolii* was originally described by Scortecci (1934) from a specimen collected in March 1934 at El Barkat Oasis [correctly spelled "Alberket", Khaled Etayeb, pers. comm.], a few kilometres south of Ghat in southwestern Libya. According to Bauer et al. (2017), the holotype, originally deposited at MCSNB, was likely destroyed during World War II. A second record consists of a specimen housed in the MCZ (R-46850), collected in December 1942 by J.H. Huntington, approximately 35 miles W Agedabia, Cyrenaica. Subsequent citations (e.g., Zavattari, 1937; Schleich et al., 1996; Trape et al., 2012; Bauer et al., 2017) are based on these original reports, and no recent confirmations exist.

Table 1. iNaturalist records of *Philochortus zolii*, providing the Observation ID, GPS coordinates, and the spatial accuracy (in km). All observations are from November 2023.

ID	Latitude (°N)	Longitude (°E)	Accuracy
191491889	19.6781	3.5441	394
190665178	20.2658	2.4723	30
191973863	19.9485	2.8145	279
191772259	19.9345	2.9114	279
191686382	19.8815	2.9794	279
191686381	9.8918	2.8644	279

Mali.—A single locality near Bourem represents the only confirmed record in the country, reported by Trape et al. (2012).

Mauritania.—A single population has been documented in the coastal peripheral zone of Diawling National Park. The first recorded evidence is a tissue sample (CIBIO.12840) from an individual observed in Ndiemar in February 2016 (Velo-Antón et al., 2022). Naia et al. (2019) provided the first formal report from this locality, and further fieldwork by Naia et al. (2021) in October–November 2020 documented eight additional individuals.

Niger.—The species is known from a single specimen, originally described as *P. lhotei* Angel, 1936, collected at In Abezou, approximately 100 km SW In Abangarit (Angel, 1936). This specimen (MNHN RA-1936.86) is the holotype of *P. lhotei*. Angel and Lhote (1938) confirmed this locality, and Trape et al. (2012) synonymized *P. lhotei* with *P. zolii* based on this specimen.

In conclusion, these findings enhance our understanding of the species' taxonomy, genetic structure, and biogeography, offering critical insights for its conservation as an endangered lacertid lizard.

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