SALAMANDRA **62**(3): 157–166
15 August 2026 | ISSN 0036–3375

SALAMANDRA
German Journal of Herpetology

Distribution of common and barred grass snakes (*Natrix natrix vulgaris*, *Natrix helvetica helvetica*, *Natrix helvetica sicula*) in southeastern Germany and western Austria inferred from Citizen Science data

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Manuscript received: 5 March 2026
Accepted: 19 May 2026 by Oliver Hawlitschek

Abstract. We inferred the distribution ranges of two subspecies of the barred grass snake (*Natrix helvetica helvetica*, *N. h. sicula*) and the common grass snake (*Natrix natrix vulgaris*) in western Austria and adjacent Bavaria (Germany) using coloration and pattern traits of 943 georeferenced photographic records from the citizen science platforms iNaturalist and Observation.org. Accordingly, the nominotypical subspecies of the barred grass snake is distributed in the Walgau, Montafon, and Klostertal regions of Austria (Vorarlberg), while *N. n. vulgaris* prevails in the Rhine Delta and the eastern Lake Constance area. However, a few grass snakes in the latter regions, including in Bavaria the district of Lindau (Bodensee) at Lake Constance, are putative hybrids or pure *N. h. helvetica*. The range of *N. h. helvetica* in the Klostertal is separated by the Arlberg region and a most likely less than 40-km-wide gap from the distribution of *N. h. sicula* in the Inn drainage in Tyrol (Austria). All records from the catchment systems of the Isel and Salzach rivers (eastern Tyrol and Salzburg, Austria, respectively) were identified as *N. n. vulgaris*, except for a single observation of *N. h. sicula* at the border between Salzburg and Bavaria and a few questionable hybrids in the Salzach drainage. *Natrix helvetica sicula* reached southern Bavaria from northern Tyrol along the rivers Loisach, Isar, Großache, and Inn. Its range abuts with that of *N. n. vulgaris* in southern Bavaria and in the border region of the Austrian states Tyrol and Salzburg and near Reutte (Tyrol), where representatives of both species and hybrids were recorded. The northernmost native records of *N. h. sicula* or hybrids in Bavaria are near Rosenheim and Lake Chiemsee. Other Bavarian records represent *N. n. vulgaris*.

Key words. Squamata, Serpentes, Natricidae, distribution, Alps, Bavaria, Salzburg, Tyrol, Vorarlberg.

Introduction

Grass snakes are medium-sized non-venomous and semi-aquatic snakes. They are widely distributed across the Palearctic and often represent one of the most abundant local reptile species (Kabisch 1999, Geniez 2023). The past decade has seen a rapid increase in the knowledge of their phylogeography and taxonomy. Grass snakes were traditionally thought to represent the single species *Natrix natrix* (Linnaeus, 1758) sensu lato (Mertens 1947, Mertens & Wermuth 1960, Thorpe 1979, Kabisch 1999). A series of investigations starting with Kindler et al. (2013) contributed to a deeper understanding of the genetic structuring of this snake complex and resulted in the recognition of three distinct polytypic species (Pokrant et al. 2016, Kindler et al. 2017, Speybroeck et al. 2020), namely, the Ibero-Maghrebian red-eyed grass snake *Natrix astreptophora* (López-Seoane, 1884), the Western European barred grass snake *Natrix helvetica* (Lacepède, 1789), and the most widely distributed species, the common grass snake *Natrix natrix* sensu stricto, ranging from Central Europe to Lake Baikal in Central Asia. Several further studies scrutinized finer scale differentiation within these three species and provided revised subspecies taxonomies for each (*N. astreptophora*: Kindler et al. 2018, Martínez del Mármol et al. 2025; *N. helvetica*: Kindler & Fritz 2018, Schultze et al. 2020; *N. natrix*: Asztalos et al. 2021a), leading among others to the assignment of southern Central European populations of the common grass snake to the subspecies *Natrix natrix vulgaris* Laurenti, 1768. Other publications examined the narrow hybrid zones between species and the much wider admixture regions among subspecies (Pokrant et al. 2016, Kindler et al. 2017, Schultze et al. 2019, 2020,

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Asztalos et al. 2020, 2021b, Fritz et al. 2023, Neumann et al. 2024, Criado-Flórez et al. 2026). An unexpected discovery in the course of this research was that a southern subspecies of the barred grass snake, *Natrix helvetica sicula* (Cuvier, 1829), having its core distribution in the Italian peninsula and Sicily, crossed the Alps and reached Tyrol (Austria) and southern Bavaria (Germany) in the Holocene (Glaw et al. 2019, Asztalos et al. 2021b). Later, it turned out that *N. h. sicula* has traversed the main chain of the Alps a second time and is widely distributed in southwestern Switzerland, where it meets the nominotypical subspecies (Schild et al. 2024). However, the precise distribution of *N. h. sicula* in Tyrol and adjacent areas of Bavaria remains unknown. The same applies to the potential distribution of the nominotypical subspecies of the barred grass snake in westernmost Austria (Vorarlberg) and neighboring southwestern Bavaria. Using the georeferenced photo material on the Citizen Science platforms iNaturalist and Observation.org, we examined the occurrence of *N. n. vulgaris*, *N. h. helvetica*, and *N. h. sicula* in southeastern Germany and western Austria and provide a detailed picture of their local distribution patterns based on phenotypic data.

Materials and methods

All georeferenced photographic records on iNaturalist and Observation.org as of 31 January 2026 were inspected for the Austrian federal states (Bundesländer) of Salzburg, Tyrol, and Vorarlberg and the following districts (Landkreise) and urban cities (Kreisfreie Städte) of Bavaria, Germany: Altötting, Bad Tölz-Wolfratshausen, Berchtesgadener Land, Ebersberg, Erding, Garmisch-Partenkirchen, Kaufbeuren, Kempten, Landkreis München, Landsberg am Lech, Lindau (Bodensee), Miesbach, Mühldorf am Inn, München, Oberallgäu, Ostallgäu, Rosenheim, Rottal-Inn, Starnberg, Traunstein, and Weilheim-Schongau. A few records from neighboring regions were added.

Out of this dataset, we selected all photographs that were informative enough for phenotypic identification of grass snake taxa using the traits outlined in Fritz & Ihlow (2022) and Fritz et al. (2023, 2026; see below). For observations with obscured coordinates, the submitters were consulted to obtain precise locality data.

Data on coloration and pattern, with a focus on the diagnostic traits, were collected for each photographed snake (compare Figs 1–3). These include the bipartite vs. tripartite occipital head pattern (*N. h. helvetica*/*N. h. sicula* vs. *N. n. vulgaris*), the presence or absence of side bars (*N. h. helvetica*/*N. h. sicula* vs. *N. n. vulgaris*), and the presence or absence of a coarsely spotted (i.e., tessellated) body pattern (*N. h. sicula* vs. *N. h. helvetica*/*N. n. vulgaris*). Furthermore, adult snakes of both subspecies of *N. helvetica* typically lose the light occipital crescent, in contrast to *N. n. vulgaris*. However, the nominotypical subspecies tends to retain the light crescents longer than *N. h. sicula*, and the side bars in *N. h. helvetica* are often more elongated and more pronounced than in the local populations of *N. h. sicula*. Also, there are shape and size differences in the light crescents. In *N. helvetica*, in particular in the nominotypical subspecies, these lunar marks tend to be more extended dorsomedially than in *N. n. vulgaris*, so that they appear in younger individuals as a nearly or, rarely, completely closed light neck ring. The color of the crescent is typically paler (i.e., whitish) in *N. h. helvetica* and *N. h. sicula* than in *N. n. vulgaris* (here: yellow), and in the latter taxon, the crescents can even show an orange color. Finally, *N. h. sicula* often has a unique silvery light grey body, whereas many *N. h. helvetica* are darker. *Natrix natrix vulgaris* are also darker and often display a grey body coloration with an olive tinge.

Based on these traits, every photographed snake was assigned to one of the taxa mentioned above. Individuals combining diagnostic traits of two taxa were identified as putative hybrids. A few individuals could only tentatively identified and their taxonomic assignment was denoted as questionable (Supplementary document 1). Taxonomic identification was impossible for fully melanistic snakes and individuals representing the so-called *picturata* phenotype, i.e., black snakes with small light speckles (Kabisch 1999, Bruni et al. 2022). The same was true for some partially melanistic snakes and individuals representing another coloration variant (uniform grey). Such snakes were recorded as the respective phenotype (melanistic or partially melanistic, *picturata*, uniform grey; Fig. 3) without taxonomic assignment. However, some nearly uniformly grey or partially melanistic individuals still exhibit species-diagnostic coloration and pattern traits, so that these could be taxonomically identified.

Geospatial analysis and visualization of records were performed using the statistical computing environment R (version 4.5.2). Two maps were generated to depict species identity and phenotypic variation separately. To provide topographic context, a high-resolution greyscale hillshade was generated using the ESRI World Shaded Relief and the maptiles package. Political borders and hydrological features, including rivers and lakes, were integrated from OpenStreetMap. The graphical routine to generate the maps was implemented using ggplot2, incorporating sf, terra, tidyterra, ggspatial, ggrepel, and patchwork. To resolve spatial overlap in high-density areas, an algorithm arranging clustered records in a spiraling pattern was implemented. All geospatial layers were projected in the WGS 84 (EPSG:4326) coordinate system.

Results

Our dataset comprised photographs of 941 grass snakes with sufficient information for phenotypic identification and precise geographic coordinates (see Supplementary document 1). The records of two further grass snakes (*Natrix natrix vulgaris*) were mapped with the obscured coordinates as provided by iNaturalist, i.e., the true sites lie within a box measuring 0.2 × 0.2 degrees (approximately 20 × 20 km) shared with the shown localities.

In the Alpine region, records of grass snakes were found to be concentrated along river valleys (Fig. 4a; a labelled map with relevant river, lake, and valley names is provided as Supplementary document 2). The mapped localities of phenotypically identified individuals indicate that the two subspecies of barred grass snakes are fully allopatric in the study region. *Natrix helvetica helvetica* is widely distributed in the Walgau, Montafon, and Klostertal regions of Vorarlberg, while the more northern records in this Austrian federal state represent mainly *N. n. vulgaris*. A few images from the Lake Constance region in Vorarlberg and Bavaria were identified as *N. h. helvetica* or *N. h. helvetica* × *N. n. vulgaris*, but the majority as *N. n. vulgaris* (Fig. 4a; Supplementary document 1). This includes also the records in the Rhine Delta. However, to the south, the Alpine Rhine valley is occupied by the nominotypical subspecies of the barred grass snake. From the Rhine valley eastward, *N. h. helvetica* reaches the Walgau and ranges to the regions of St. Gallenkirch (Montafon) and Dalaas (Klostertal). It does not cross the Arlberg Pass (ca. 1790 m a.s.l.), which constitutes the watershed between the Rhine and the Inn-Danube drainage systems. All records from the catchment system of the Inn river in Tyrol were assigned to *N. h. sicula*, separated by a gap of approximately 40 km from the easternmost records of *N. h. helvetica* in Vorarlberg (regions of Landeck and Dalaas, respectively). Some records of *N. h. sicula* from western Tyrol (region of Reutte) and adjacent Bavaria represent sites beyond the catchment system of the Inn, i.e., the Loisach and Isar rivers, as well as the Plansee and Eibsee lakes. There, *N. h. sicula* occurs in close proximity to or in sympatry with *N. n. vulgaris*, and some putative hybrids were identified in this region according to their intermediate traits.

All records in the drainage system of the Lech river at the Tyrolean-Bavarian border region refer to *N. n. vulgaris*. No grass snakes have been observed further south along the Lech. However, *N. h. sicula* and a putative hybrid with *N. n. vulgaris* were identified in the Plansee region, which is connected with the Lech river through the Archbach. *Natrix helvetica sicula* reaches Bavaria via the Inn river and its northern tributaries, as well as along the rivers Loisach, Isar, and Großache (Tiroler Achen). Scattered photographic records identified as *N. h. sicula* or as hybrids with *N. n. vulgaris* suggest dispersal through several Alpine valleys in this region, where *N. h. sicula* meets and hybridizes with *N. n. vulgaris*. A few iNaturalist photos from the border of



Figure 1. (a) Adult *Natrix natrix vulgaris* with unusually pale light crescents (iNaturalist record 54817169, photo: reddad), Hintersee, Ramsau bei Berchtesgaden, Bavaria; (b) juvenile *N. n. vulgaris* with orange crescents (iNaturalist record 212685280, photo: Wolfgang Thomas), Oberau, Garmisch-Partenkirchen, Bavaria. Note the species-diagnostic tripartite occipital head pattern (dark anterior blotch, light crescent, narrow posterior dark spot) and the widely separated light crescents in both individuals; (c) Juvenile *Natrix helvetica helvetica* (roadkill) with nearly closed light neck ring (iNaturalist record 282466255, photo: Cosimo Costanzia di Costigliole), Frastanz, Vorarlberg. Note the species-diagnostic bipartite occipital head pattern (no anterior dark occipital blotch) of younger individuals, the elongated dark posterior occipital spot, and the pronounced side bars; (d) three adult *N. h. helvetica* with typical adult coloration and faded light crescents (iNaturalist record 42331151, photo: Adrian Marte), Bürserberg, Bludenz, Vorarlberg.

the federal state of Salzburg (Austria) to Bavaria (Hirschbichl, Klausbach/Ramsauer Ache) were identified as a *N. h. sicula*. Several unambiguous *N. n. vulgaris* were recorded in close proximity to this site. Surprisingly, a small number of morphologically intermediate snakes resembling hybrids between *N. h. sicula* and *N. n. vulgaris* were also observed in Salzburg (and one even in adjacent Styria). All other observations in the catchment system of the Salzach river (Salzburg) refer to *N. n. vulgaris*. This is also true for eastern Tyrol, where the grass snake sites lie in the catchment basin of the Isel river, a tributary of the Drau river. The eastern Tyrolean records are not connected to those in the Salzach or Inn basins. It is unknown whether *N. n. vulgaris* meets *N. h. sicula* in the Puster valley, which links the Isel-Drau drainage and the Etsch (Adige) drainage in neighboring South Tyrol (Italy).

Photographic records of *N. h. sicula* from Bavaria concentrate in the southernmost part of the state near the Austrian border, mainly along the courses of the rivers Loisach, Isar, Inn, and Tiroler Achen (Großache). The northernmost observations of *N. h. sicula* or putative hybrids are in the regions of Rosenheim and the Chiemsee, while all more northern and more eastern records represent *N. n. vulgaris*. An isolated and most likely non-native record of a *N. h. sicula* is from the botanical garden of Munich, among many records of *N. n. vulgaris*.



Figure 2. Coloration and pattern variation in *Natrix helvetica sicula*; note the species-diagnostic bipartite occipital head pattern and the generally small and indistinct side bars. Such snakes have been mistaken in the past (Mayer 2001) as common grass snakes or hybrids. (a) Juvenile with well-developed light crescents and pale body (iNaturalist record 44711357, photo: Werner Unkrig), Wallgau, Garmisch-Partenkirchen, Bavaria; (b) adult with faded out light crescents and tessellated body (iNaturalist record 162967654, photo: Claudia Stix), Innsbruck-Igls, Tyrol; (c) juvenile with small side bars and body spots (iNaturalist record 273210636, photo: Robert Pisch), Pettnau, Tyrol; (d) young adult with spots instead of true side bars and almost uniformly grey body (iNaturalist record 268786371, photo: Robert Pisch), Pettnau, Tyrol; (e) juvenile with pronounced side bars and body spots (iNaturalist record 217168373, photo: Thomas Guggemoos), Garmisch-Partenkirchen, Bavaria; (f) adult with pale tessellated body pattern and faded out light crescents (iNaturalist record 308658048, photo: Pia Stermann), Krün, Bavaria.

The coloration variants were unevenly distributed and, except for a single uniform grey snake, absent from the westernmost study region (Fig. 4b). In total, we counted 69 melanistic and 27 partially melanistic grass snakes, 19 uniform grey individuals, and eight representatives of the *picturata* phenotype. Uniform grey snakes occurred across the distribution ranges of all three taxa. Melanistic and partially melanistic individuals were found only in the distribution ranges of *N. h. sicula* and *N. n. vulgaris*, and the *picturata* phenotype only in the range of *N. h. sicula*. Notably, no striped grass snakes were recorded.

Discussion

Our investigation provides another example of the value that occurrence records from Citizen Science platforms, such as iNaturalist and Observation.org, have for inferring species distributions (O'Neill et al. 2023, Mason et al. 2025). However, our approach included an important additional step: expert-driven quality control of the underlying taxonomy for each record. In many cases, this quality control disagreed with the original identification on iNaturalist and even more often on Observation.org. The



Figure 3. Coloration variants in adult grass snakes. (a) Partially melanistic individual with light crescents still present (iNaturalist record 202172604, photo: Marc Bulte), Ettaler Forst near Garmisch-Partenkirchen, Bavaria; (b) completely black melanistic snake, with the head of a second individual visible on the left (iNaturalist record 202172604, photo: Herbert Stadelmann), Marktoberdorf, Ostallgäu, Bavaria; (c) *picturata* phenotype (iNaturalist record 74165452, photo: Anton Heufelder), Innsbruck-Land, Tyrol; (d) almost uniformly grey *Natrix helvetica helvetica* (iNaturalist record 52790097, photo: Tobias Schönberg), Bludenz, Vorarlberg.

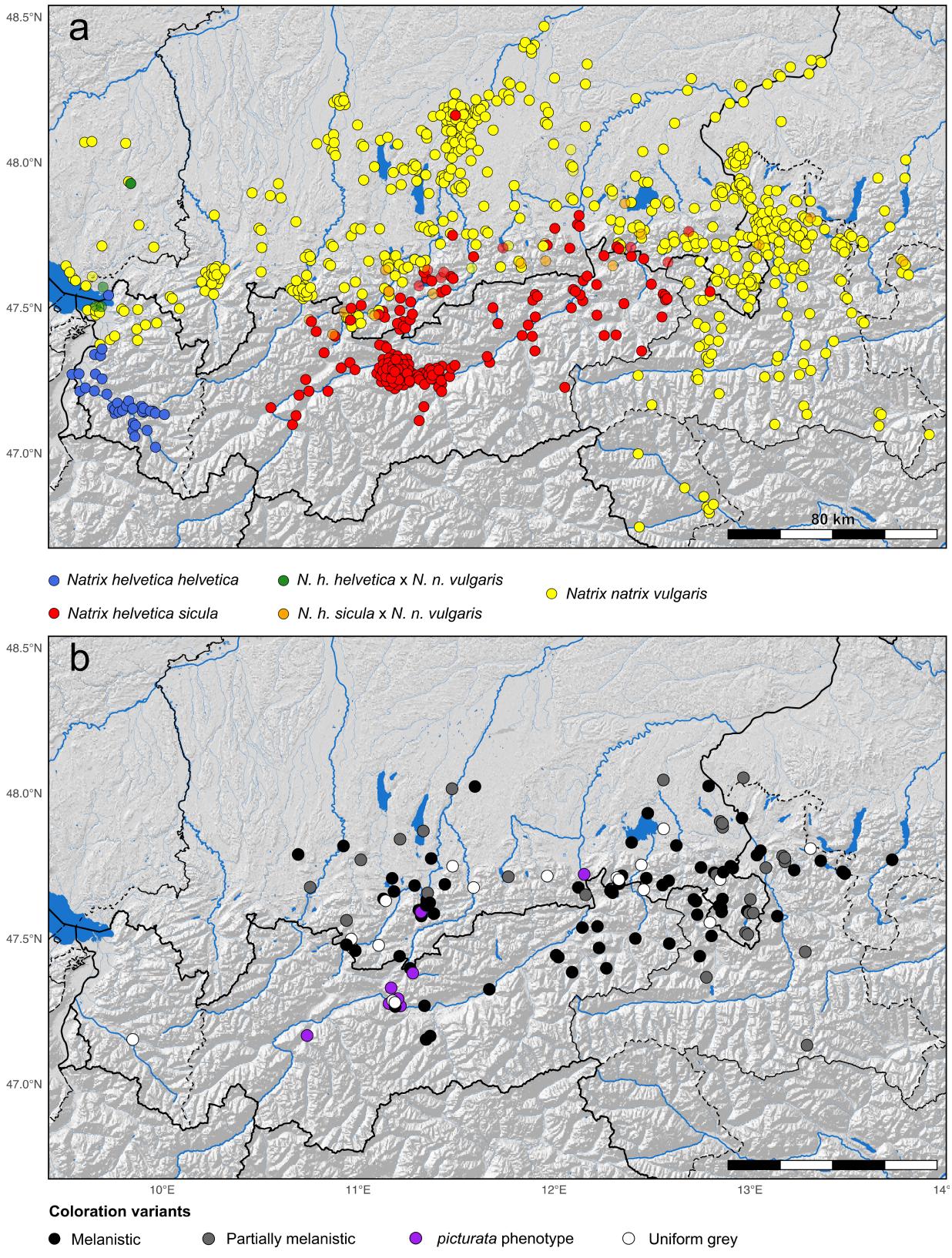


Figure 4. Distribution of (a) grass snake taxa and (b) coloration variants including species-undetermined snakes in Bavaria and western Austria, both based on photo material on iNaturalist and Observation.org (see Supplementary document 1). A few records from adjacent regions were added. Colors for tentative taxonomic assignments are translucent.

key advantage of iNaturalist records is the use of swarm intelligence by the iNaturalist community for taxonomic identifications. This resulted in better, though not complete, agreement with our conclusions. Our reidentifications of iNaturalist records during this study further improved their quality, supported by iterative feedback from the iNaturalist community.

Although we are confident that our identifications meet the highest standards, errors are possible. Most importantly, there is no genetic verification of the taxonomic identity of the photographed snakes. Previous genetic investigations (Asztalos et al. 2021b, Neumann et al. 2024) revealed low levels of admixture of *N. h. sicula* and *N. n. vulgaris* in Tyrol and Bavaria, which cannot be necessarily detected from photographs alone. Similarly, local hybridization of *N. h. helvetica* and *N. n. vulgaris* is known from the Lake Constance region (Kindler et al. 2017, Schultze et al. 2019). Thus, some of our putatively pure representatives of either taxon may actually possess some overlooked genetic impact from the other species. On the other hand, some of the snakes morphologically identified as hybrids could also be pure representatives of one species. However, the collection sites of the genetically verified records for the Lake Constance region (Kindler et al. 2017, Schultze et al. 2019) and Tyrol and Bavaria (Asztalos et al. 2021b) largely match our conclusions. This leads us to believe that this bias is negligible.

According to our mapping (Fig. 4a), the Inn drainage in Tyrol is inhabited exclusively by *N. h. sicula*, which extends from this region into several other river valleys (Loisach, Isar, Großache) spanning from Austria into Bavaria. Also, the single genetically verified record of the mitochondrial lineage of *N. h. sicula* in the Austrian federal state of Salzburg lies in the drainage system of the Großache (near Mittersill, at the Tyrolean border; Kaufmann et al. 2024). On the other hand, an iNaturalist observation from Hirschbichl at the border between Salzburg and Bavaria is already in the catchment system of the Klausbach/Ramsauer Ache, a tributary of the Salzach river, a drainage otherwise occupied by *N. n. vulgaris*.

The nominotypical subspecies of the barred grass snake occurs in the Walgau, Montafon, and Klostertal regions of Vorarlberg, i.e., in the catchment system of the Rhine (mainly Ill river and tributaries), and is separated from *N. h. sicula* in the Inn drainage of Tyrol by an approximately 40-km-wide distribution gap according to our Citizen Science data. However, a record in the Stanzertal on the map of Grillitsch & Cabela (2001a: p. 556) suggests that the distance between the two taxa is even smaller. The isolated occurrence of grass snakes in the Kleinwalsertal (Vorarlberg), shown on the map in Aschauer & Grabher (2021: fig. 100), most likely represents *N. n. vulgaris*, as the Breitach river (Kleinwalsertal) is connected through the Iller river to the records of this taxon in the Allgäu region, Bavaria. A single iNaturalist observation from Bavaria, Lindau (Bodensee), refers to a morphologically identified pure *N. h. helvetica*; a few iNaturalist photos from the same region were assigned to putative hybrids with *N. n. vulgaris*.

The distribution gap between the two subspecies of the barred grass snake in Austria lies in the Arlberg region, with its lowest elevation at the Arlberg Pass (ca. 1790 m a.s.l.). Elsewhere in the Alps, *N. helvetica* has been found at even higher elevations (Kindler & Fritz 2018, Schild et al. 2024). In the Western Alps (Switzerland), the distribution of *N. h. sicula* can best be explained by Holocene migration across the Simplon Pass (ca. 2000 m a.s.l.). There are recent, but no historical, records of the species at similar elevations in Switzerland (Schild et al. 2024), suggesting that its altitudinal distribution is shifting upward in response to current climate warming. Consequently, the distribution ranges of the two subspecies in Austria may merge in the future, as they already have in southwestern Switzerland (see Schild et al. 2024).

In Austria and Bavaria, the distribution of each *N. helvetica* subspecies abuts with that of the common grass snake *N. n. vulgaris*. For *N. h. helvetica*, this is the case close to Lake Constance in Vorarlberg and adjacent Bavaria, and for *N. h. sicula*, it is the case mainly in southern Bavaria eastward from the Loisach and Isar rivers. In Bavaria, *N. h. sicula* or hybrids with *N. n. vulgaris* were found as far north as Rosenheim and Chiemsee. Additional isolated records of single individuals of mismatched morphology could either refer to misidentifications or translocated snakes. Examples are an individual of *N. h. sicula* in the botanical garden of Munich, a putative *N. h. helvetica* × *N. n. vulgaris* hybrid far north of Lake Constance, and putative *N. h. sicula* × *N. n. vulgaris* hybrids from Salzburg and even adjacent Styria (Fig. 4a; Supplementary document 1). In any case, our investigation provides firm evidence for the occurrence of both subspecies of the barred grass snake in Austria and Bavaria, although *N. h. helvetica* reaches Bavaria only peripherally in the eastern Lake Constance region (Lindau). Additional questionable records of *N. h. helvetica* exist in the Lower Main region of Bavaria (Glaw et al. 2019, Hansbauer & Völkl 2019), which lies beyond the scope of the present investigation.

While the occurrence of barred grass snakes in Vorarlberg, broadly connected to the range in neighboring Switzerland, has long been known (Grillitsch & Cabela 2001a), the status of the northern Tyrolean populations was less clear before Glaw et al. (2019) and Asztalos et (2021b) discovered that these represent the southern subspecies *N. h. sicula*. Based on Thorpe (1979), Mayer (2001) misunderstood northern Tyrolean grass snakes as a mixture between barred and common grass snakes (then *Natrix natrix helvetica* and *N. n. natrix*; Thorpe 1979, Mayer 2001). However, the putative genetic impact of barred grass snakes was difficult to explain, and Mayer (2001) already considered a northward Holocene range expansion across the central Alpine passes to be the most likely possibility. Later research has indeed supported Holocene dispersal pathways across the Brenner and Reschen Passes for *N. h. sicula* (Glaw et al. 2019, Asztalos et al. 2021b).

The absence of grass snake observations in the Lech drainage in Vorarlberg and Tyrol, except near the Bavarian border, requires further investigation. The maps in

Grillitsch & Cabela (2001a: p. 556) show no grass snake records in this area, but numerous sites for smooth snakes (*Coronella austriaca*; Grillitsch & Cabela 2001b: p. 534) and adders (*Vipera berus*; Grillitsch & Cabela 2001c: p. 592), suggesting that grass snakes are at least very rare there. In Bavaria, *N. n. vulgaris* is widely distributed along the Lech (Fig. 4a).

With respect to coloration variants, Grillitsch & Cabela (2001a) pointed out that black grass snakes are generally rarer in lower altitudes of Austria. In our dataset, the geographic distribution of the coloration variants is also uneven (Fig. 4b). Uniform grey snakes were recorded from the distribution ranges of all three studied taxa, whereas melanistic and partially melanistic phenotypes were only found in those of *N. h. sicula* and *N. n. vulgaris* (for melanism in the latter taxon, see also Fritz & Ihlow 2022), but not in the range of *N. h. helvetica*. Furthermore, all records of the *picturata* phenotype refer only to the distribution of *N. h. sicula* in Tyrol and Bavaria. This suggests that neither the *picturata* phenotype occurs in *N. h. helvetica* and *N. n. vulgaris* nor that melanistic *N. h. helvetica* exist. However, the matter is more complicated. Melanistic *N. h. helvetica* are well known from other regions (Chèvre 2015, Fritz & Schmidtler 2020, Fritz et al. 2026), and Meyer (2020) and Fritz et al. (2026) illustrated such snakes from Switzerland and France. Meyer (2020) also showed a photo of a barred grass snake of the *picturata* phenotype from the Swiss canton of Bern. Furthermore, Fernández Guiberteau et al. (2015) figured a *N. h. helvetica* of the *picturata* morph from the Val d'Aran (Catalonia). This provides evidence that the *picturata* phenotype does occur in *N. h. helvetica* as well. The only focal taxon of the present study for which the *picturata* coloration has not yet been recorded is *N. n. vulgaris*.

Nevertheless, the occurrence of the *picturata* phenotype warrants further discussion. Bruni et al. (2022) and Fritz et al. (2026), studying *N. h. sicula* in Italy, found that the *picturata* coloration is relatively abundant in the northern and central part of the country, but absent in southern mainland Italy and Sicily. This phenotype was also reported and figured from Greece, western Anatolia, and Cyprus (Kreiner 2007, Fritz & Ihlow 2022, Yenmiş et al. 2022, Jablonski et al. 2023), i.e., from the distribution range of *Natrix natrix moreotica* (Bedriaga, 1882). Moreover, the *picturata* phenotype is known from Trabzon (eastern Anatolia), Azerbaijan (Fritz & Schmidtler 2020), and Mazandaran (Iran, Moradi 2025), i.e., from the distribution range of *Natrix natrix scutata* (Pallas, 1771), and also from the putative contact zone between these subspecies in Romania (Fănaru et al. 2022). Based on these data, the *picturata* phenotype occurs in two subspecies of *N. natrix*, but remains unknown in *N. n. vulgaris* and the nominotypical subspecies (see the large dataset used by Fritz & Ihlow 2022). The *picturata* phenotype is also unknown in the third grass snake species, *N. astreptophora*, although melanistic individuals are abundant in northern Spain and Portugal (Martínez del Mármol et al. 2025). Thus, any grass snake with the *picturata* phenotype from the Central European contact zones between *N. helvetica* and *N. natrix* can be confidently identified as a barred grass snake (*N. h. helvetica* or *N. h. sicula*), rather than a common grass snake (*N. n. natrix* or *N. n. vulgaris*). Likewise, any grass snake with the *picturata* phenotype from the contact zone between *N. astreptophora* and *N. h. helvetica* in southwestern Europe qualifies as a barred grass snake.

Acknowledgements

Thanks go to the iNaturalist and Observation.org communities and platforms for providing the data and photographic material for this investigation. The following individuals disclosed their obscured records and permitted the use of otherwise masked data: Wouter Beukema, Kevin Chen, Possum Fischer, Melina Heinrich, Insektix, Sotirios Liakas, Adrian Nielsen, Nikrom, Claudia Stix, and Jonas Wehrl. The usage of copyright-restricted iNaturalist photos was allowed by Marc Bulte and Adrian Marte. Michael Franzen and Oliver Hawlitschek provided helpful comments on an earlier version of this article.

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Supplementary data

The following data are available online:

Supplementary document 1. Individual records on iNaturalist and Observation.org.

Supplementary document 2. Federal states of Austria and Germany, rivers, lakes, and valleys mentioned in the text. German – English names, if different and relevant: Bayern – Bavaria, Bodensee – Lake Constance, Kärnten – Carinthia, Pustertal – Puster valley, Schweiz – Switzerland, Steiermark – Styria, Südtirol – South Tyrol, Tirol – Tyrol.