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A new record of *Natrix tessellata* (Laurenti, 1768) from the Alay Valley, Kyrgyzstan, suggests that high-elevation river valleys act as colonization corridors in Central Asia

Daniel Jablonski[1,2,*], Artem Lisachev[3], Konrad Mebert[4], and Evgeniy Simonov[5]

The Central Asian region is a landlocked area consisting of part of Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. It is considered a biodiversity hotspot due to its high level of endemism and habitat diversity, in large part due to massive mountain systems, Tian Shan and the Pamir (Mittermeier et al., 2011). However, limited availability of distribution and genetic data for the fauna of this region does not allow us to comprehensively evaluate this important part of Eurasia (Roll et al., 2017). Most of the work on the Central Asian herpetofauna comes from the Soviet Era when monographs and smaller publications related to their ecology and distribution were published (e.g., Yakovleva, 1964; Bannikov et al., 1971; Said-Aliev, 1979). These publications provided the first summaries of species distributions for today's countries in this area and are important baseline data, but overall, we still have only limited knowledge. Some historical data on species distributions are not well summarized or are limited or absent; data are scattered in the literature that is often difficult to obtain, and no comprehensive review for the region exists to date. This pattern is especially seen in many widely distributed Western Palearctic snake taxa, for example for members of the genera *Hemorrhois*, *Natrix*, or *Spalerosophis* (Sindaco et al., 2013).

One such species in the family Natricidae is the Dice Snake, *Natrix tessellata*, which is widely distributed in the Old World from central and southern Europe to Egypt in the south and Pakistan and China in the east (Mebert, 2024). However, the high genetic diversity of dice snakes and the existence of several deeply divergent evolutionary lineages suggest that they are a largely unresolved complex that needs comprehensive taxonomic evaluation (Guicking et al., 2009; Guicking and Joger, 2011; Jablonski et al., 2024). Moreover, region-specific selective pressures, such as contrasting temperatures, different aquatic habitats and varying levels of UV radiation, may have contributed to the broad ecological tolerance, which likely explains why these snakes can occupy a wide range of habitats and elevations, from sea level to high mountains and from temperate regions to semi-deserts (Mebert, 2011, 2024; Mebert and Masroor, 2013; Mebert et al., 2013; Pauwels et al., 2020).

Herein we report on records of *N. tessellata* from the Alay Valley of southern Kyrgyzstan. This valley is in the Pamir-Alay mountain system, forming part of the High Asia geographic region which remains poorly studied (Andrushko, 1951) but is considered one of the possible sources of cryptic regional reptile diversity (e.g., Wagner et al., 2016). The Kyzyl-Suu River, connecting lower elevations of northern Tajikistan and southern Kyrgyzstan, forms the main corridor in the Alay Valley and creates a possible route of species colonization. In the Kyrgyz part, the valley is broad (width 3–40 km) and extends approximately 170 km in an east–west direction. It is a high-elevation valley, with elevations ranging from 2440 m in the west at Karamyk Village to 3536 m in the east at Taunmurun Pass and an average of around 3000 m. Such elevations are close to the highest known elevational records for *N. tessellata* (Mebert et al., 2013).

[1] Department of Zoology, Comenius University Bratislava, Ilkovičova 6, Mlynská dolina, 842 15 Bratislava, Slovakia.
[2] Herpetological Collection, 1st Zoological Department, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria.
[3] Animal Genomics and Bioresource Research Unit, Faculty of Science, Kasetsart University, Bangkok, Thailand; and Institute of Cytology and Genetics, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia.
[4] Global Biology and IUCN SSC Viper Specialist Group, Waldmattstraße 15, 5242 Birr, Switzerland.
[5] A.N. Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences, 119071 Moscow, Russia.
[*] Corresponding author. E-mail: daniel.jablonski@uniba.sk

The valley is bounded to the north by the Alay Mountains, including Taldyk Pass, and to the south by the Pamir Mountains, represented here by the Trans-Alay Range. It is unlikely that *N. tessellata* populations crossed the Alay Mountain passes and entered the Alay Valley from the north. Therefore, we discuss records from the western part of the valley, which suggest that the species colonized the area from the southwest along the Kyzyl-Suu River.

The first discovery of *N. tessellata* in the western part of the Alay Valley was reported in 2007 in an unpublished report (PATCA Report & Survey; V.K. Eremchenko). This report was later referenced in Davletbakov et al. (2015) and one snake was reported to have been observed on 9 July 2007 in the Ak-Suu Gorge (39.517°N, 71.700°E; ~2500 m elevation), but there are no specimens or photographs. During ichthyological fieldwork on 4 July 2016 near the Chak Settlement, Alay Valley (39.549°N, 72.086°E; elevation 2455 m; Fig. 1), the last author (ES) found a shed snake skin on a bank of the Kok-Su River (Fig. 2A–C), a right (northern) tributary of the Kyzyl-Suu River, Kyrgyzstan. The skin (Fig. 2C) was collected and subsequently identified as *N. tessellata*. The species was identified based on the combination of head shape, cephalic shield configuration, and strongly keeled dorsal scales (Yakovleva, 1964; Bannikov et al., 1977). These characters clearly distinguish the material from other snake species known (*Elaphe dione*, *Gloydius rickmersi*) or potentially occurring (*Hemorrhois ravergieri*, *Platyceps* sp.) in this mountainous part of southern Kyrgyzstan (Yakovleva, 1964; Bannikov et al., 1977; Wagner et al., 2016; Jablonski and Bragin, 2019; Simonov et al., 2026; Velenská et al., 2026). The shed skin was found in a narrow, 20–30 m wide strip of rocky habitat with large stones between the Kok-Su River and a road, which is consistent with the known habitat requirements of *N. tessellata*. This location is approximately 33 km east of Eremchenko's initial observation in 2007, which confirms the species' existence within the Kyzyl-Suu Basin of the Alay Valley.

We used the phenol/chloroform protocol (Sambrook et al., 1989) to obtain DNA and amplify short mitochondrial fragments to determine the phylogenetic position of the

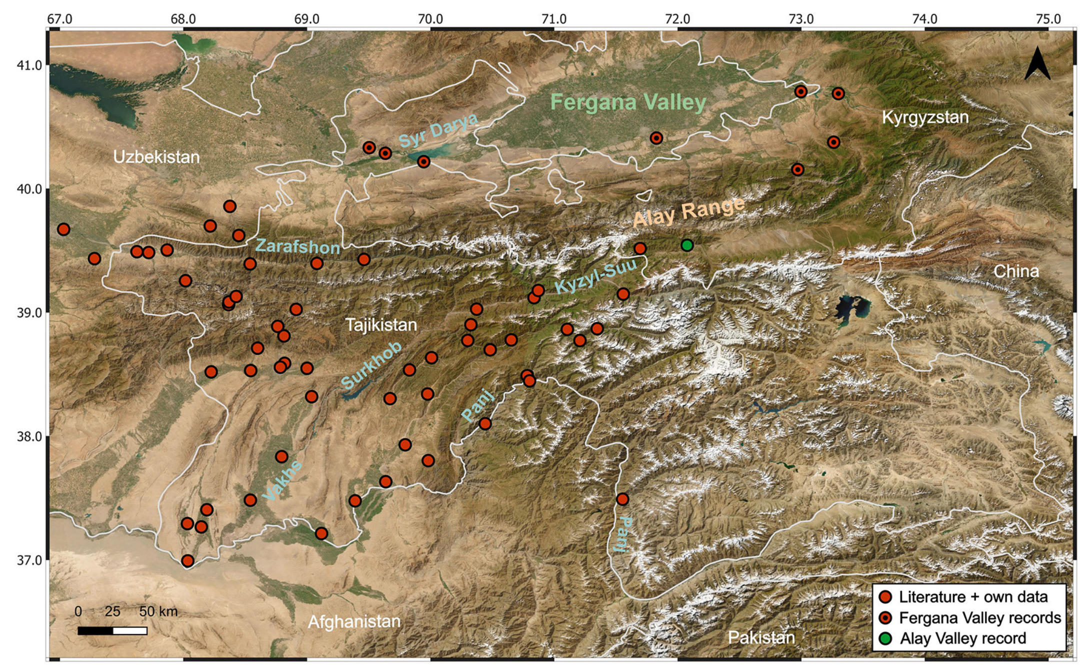

Figure 1. Localities of *Natrix tessellata* in southern Kyrgyzstan, Tajikistan, and Uzbekistan based on the data in Appendix 1 (red circles) and our new record (green circle). Fergana Valley records are indicated by a black centre in the red circle. The topography around the Alay Valley (with the Kyzyl-Suu River) shows that the new locality is in an area connecting Tajikistan locations with those further to the northeast in Kyrgyzstan. The Alay Range is a formidable barrier between the Alay Valley and the Fergana Valley populations of *N. tessellata*.

Figure 2. (A) View of the Alay Valley in southern Kyrgyzstan across the Kyzyl-Suu River. (B) The Kok-Su River and surrounding habitat, where the skin of *Natrix tessellata* (C) was found near the Chak Settlement among large stones and rocks along the riverbank. Photos by Daniel Jablonski (A) and Evgeniy Simonov (B, C).

snake. We have successfully applied this strategy to shed snake skins in other studies (e.g. Simonov et al., 2025), but we were unable to obtain any DNA data from this sample. One possible reason is that it was exposed to relatively high levels of UV radiation (which degrades DNA) at the elevation where it was found.

To place the Alay Valley records of *N. tessellata* into the context of the species' distribution in the Pamir-Alay mountain system and adjacent areas of Tajikistan and Kyrgyzstan, we reviewed and, when possible, georeferenced records based on Cernov (1959), Yakovleva (1964), and Said-Aliev (1979), as well as from online sources (iNaturalist) and our own unpublished field observations (Fig. 1, Appendix 1). Old faunistic data were georeferenced using Google Earth, according to the village or place mentioned in the source, and the geographical coordinates provided here should be viewed as approximate.

The revised distribution of *N. tessellata* in the Pamir-Alay mountain system shows that the new record from the Alay Valley is inside the species' range and connects records from northern Tajikistan with those from southern Kyrgyzstan. The closest records of *N. tessellata* from Tajikistan are from the villages of Muk (39.15°N, 71.56°E) and Khait (39.18°N, 70.88°E) in the Kyzyl Suu River Basin, about 60 and 112 km in straight-line distances from the Chak Settlement, respectively. The closest record from Kyrgyzstan outside the Alay Valley is from Kaplan-Kul Lake (40.37°N, 73.26°E; Nikolsky 1899) on the northern slopes of the Alay Mountains (near the Fergana Valley). Based on our data, we expect that the most likely origin of *N. tessellata* found in the Alay Valley is from the northern Tajikistan populations (currently not investigated) that inhabit the Kyzyl-Suu River environment but have not yet been investigated. A direct connection to populations from other parts of Kyrgyzstan is very unlikely because the Alay Mountain Range forms a natural barrier against dispersal by Fergana Valley populations.

Dispersal of *N. tessellata* via the Kyzyl-Suu River valley supports previous hypotheses for the species' colonization of broader Central Asia. Possible colonization corridors for *N. tessellata* in the Himalayan-Karakoram-Hindu Kush region, where the species reaches some of the highest elevations in its known range (e.g. Mastuj, Pakistan at 2300 m), were reviewed in detail elsewhere (Mebert et al., 2013; Mebert and Masroor, 2013). These studies suggested that this snake most likely expanded its range beyond high-elevation mountain passes, such as Shandur Pass, Hindu Kush (3700 m), during the Holocene Climatic Optimum (HCO: 8–5 thousand years ago). During that time the climate was warmer, allowing access to suitable habitats at higher elevations (> 3000 m) and subsequent colonization of areas in the Karakoram and Himalaya Ranges in the Gilgit-Baltistan region of northern Pakistan. However, recent colonization through mountain passes cannot be excluded because this snake has been recorded in Central Asia at high elevations (e.g., Afghanistan: 2440 m; Tajikistan: 2800 m; the upper Kögart River, Kyrgyzstan: 3000 m; reported by Anderson and Leviton, 1969; Said-Aliev, 1979; Yakovleva, 1964, respectively).

Distributional records of dice snakes from three Central Asian countries show that *N. tessellata* occurs mostly around rivers in western Tajikistan. Eastern Tajikistan is dominated by the Pamir Range which does not provide suitable habitat, as it is too arid. The only record from the southeast, at Khorog (37.49°N, 71.55°E; Said-Aliev, 1979), is around the high river mountain valley of the upper Panj River. Therefore, the possible distribution in this part of the country, as well as in the Wakhan Corridor (Mebert et al., 2013), needs further study. On the other hand, in Kyrgyzstan this species has a wider distribution and is found in several valleys with large rivers (Chuy, Fergana, Naryn, and Talas) and is also common around Issyk-Kul Lake (Yakovleva, 1964).

According to Guicking et al. (2009) and Jablonski et al. (2024), at least three phylogenetic lineages of this snake overlap in Central Asia. Although the phylogeography of *N. tessellata* in Central Asia has recently been investigated (Jablonski et al., 2024), further study is needed to determine the genetic connectivity among populations found in high-elevation river valleys of the region.

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Appendix 1. Records of *Natrix tessellata* (n = 68) from Kyrgyzstan, Tajikistan, and Uzbekistan used to create the map in Fig. 1. Localities are identified by latitude (Lat, °N), longitude (Long, °E), and elevation (Elev, m). For localities based on iNaturalist records, we provided the observation number.

No.	Locality	Lat	Long	Elev	Reference
Kyrgyzstan					
1	Ak-Suu Gorge	39.517	71.700	2464	Davletbakov et al., 2015
2	Kara-Tebe near River Gulcha (Lake Kaplan-Kul)	40.370	73.263	1668	Nikolsky (1899), Yakovleva (1964)
3	Kara-Suu	40.153	72.976	1891	198072561
4	Kok-Su, tributary of Kyzyl-Suu	39.549	72.086	2455	This study
5	Uzgen	40.770	73.299	1028	Yakovleva (1964)
Tajikistan					
6	Dizhik (Dzhizhik)	39.131	68.431	2004	Said-Aliev (1979)
7	Garm	39.026	70.374	1359	Said-Aliev (1979)
8	Isiz (Esizi-Bolo)	39.431	69.466	2045	Said-Aliev (1979)
9	Kalai-Khumb	38.454	70.789	1259	Said-Aliev (1979)
10	Kalailabiob	39.124	70.839	1539	Said-Aliev (1979)
11	Khait (Hoit)	39.183	70.875	1613	Said-Aliev (1979)
12	Khonakoh	38.714	68.605	1296	Said-Aliev (1979)
13	Khorog	37.493	71.553	2094	Said-Aliev (1979)
14	Lodzhirk	38.861	71.108	2127	Said-Aliev (1979)
15	Muk (Mok)	39.151	71.563	2206	Said-Aliev (1979)
16	Mullokoni	38.634	70.006	1620	Said-Aliev (1979)
17	Nizhniy Arzyng	38.851	71.326	2400	Said-Aliev (1979)
18	Obburdon	39.401	69.083	1794	Said-Aliev (1979)
19	Sangvor	38.778	71.214	2267	Said-Aliev (1979)
20	Sari-Khosor	38.536	69.832	1452	Said-Aliev (1979)
21	Sayot	38.777	70.653	1727	Said-Aliev (1979)
22	Sudjina	39.486	67.715	1057	Said-Aliev (1979)
23	Tavildara	38.696	70.482	1614	Said-Aliev (1979)
24	Yavan	38.315	69.037	653	Said-Aliev (1979)
25	Yori	39.505	67.869	1193	Said-Aliev (1979)
26	Zev	38.503	70.800	1455	the authors, unpubl. data
27	Zigar	38.103	70.445	1054	Said-Aliev (1979)
28	Ayni	39.392	68.539	1433	Said-Aliev (1979)
29	Ayvadzh	36.993	68.040	330	Cernov (1959)
30	Baldzhuan	38.307	69.675	995	Cernov (1959)
31	Baumanabad (Pyandzh)	37.217	69.114	371	Cernov (1959)
32	Devdor (Divdar-Bole)	37.803	69.981	1906	Cernov (1959)
33	Dushanbe	38.561	68.782	800	Cernov (1959)
34	Dushanbe	38.580	68.814	958	the authors, unpubl. data
35	Dushanbe	38.580	68.814	955	the authors, unpubl. data
36	Dzhilikul	37.484	68.541	360	Cernov (1959)
37	Gissar	38.532	68.552	810	Cernov (1959)
38	Khorog (Horog)	37.500	71.552	2145	Cernov (1959)
39	Hudzhand (Hodzhent/Leninabad)	40.287	69.637	350	Cernov (1959)
40	Childara	38.783	70.304	1469	Said-Aliev (1979)
41	Chil-Chor-Chashma	37.294	68.038	390	Cernov (1959)
42	Chubek	37.629	69.637	495	Cernov (1959)
43	Iskanderkul	39.085	68.371	2204	the authors, unpubl. data
44	Iskanderkul Lake	39.072	68.368	2191	Said-Aliev (1979)
45	Kalaikhum	38.500	70.800	1400	307939459

Appendix 1. continued.

No.	Locality	Lat	Long	Elev	Reference
46	Kalon	39.030	68.910	2300	147951564
47	Khodzha-Obigarm	38.889	68.765	2100	the authors, unpubl. data
48	Khovaling	38.347	69.975	1411	Cernov (1959)
49	Khushtarata Lake	39.260	68.015	2001	Said-Aliev (1979)
50	Kobadian	37.405	68.189	400	Cernov (1959)
51	Kulob	37.929	69.796	620	Cernov (1959)
52	Kurgan-Tube	37.840	68.802	441	Cernov (1959)
53	Mogoltau	40.332	69.501	1065	Cernov (1959)
54	Ordzhonikidzeabad	38.545	69.009	862	Cernov (1959)
55	Parharas	37.476	69.390	442	Cernov (1959)
56	Pendzhikent	39.492	67.618	1006	Cernov (1959)
57	Shaartuz	37.271	68.139	365	Cernov (1959)
58	Tursunzade (Regar)	38.518	68.221	731	Cernov (1959)
59	Varzob	38.810	68.820	1207	26435243
60	Bahri Tojik Reservoir (Kairakkumskoe)	40.222	69.947	350	Said-Aliev (1979)
Uzbekistan					
61	Baxmal	39.700	68.221	1875	319700128
62	Farg'ona	40.414	71.832	570	217825276
63	Jomboy	39.668	67.033	701	279615574
64	Qo'rg'ontepa	40.786	73.001	774	152870336
65	Urgut	39.436	67.284	884	295322281
66	Zomin	39.861	68.377	839	229218164
67	Zomin	39.625	68.447	2300	295318953