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Colonization of Artificial Islands in the Kazakh Sector of the Caspian Sea by the Aquatic Snake *Natrix tessellata* (Squamata: Natricidae)

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Abstract

We report the colonization by the aquatic Dice snake *Natrix tessellata* of five artificial islands (A Island, D Island, DC 05, EPC 03 and EPC 04), built in the 2000s to house oil industry activities in the Kazakh sector of the Caspian Sea, western Kazakhstan. We discuss possible modes of colonization (e.g., accidental transport by boat originating from the Bautino harbor in Mangystau Region; active swimming from the coast). We present several observations of predation on fish (Cyprinidae: *Carassius auratus*; Gobiidae: *Neogobius caspius*, *N. fluviatilis* and *N. melanostomus*) and on the Laughing frog (Ranidae: *Pelophylax ridibundus*).

Keywords

Biodiversity, herpetofauna, aquatic fauna, gobies, Kazakhstan, Russia, Eurasia, Caspian Sea, oil and gas industry.

Introduction

The Dice snake *Natrix tessellata* (Laurenti, 1768) has an immense distribution extending from Germany to China (isolated westernmost records, namely in Belgium, probably result from deliberate releases, according to Meirte and Pauwels, 1999). It is aquatic, and frequents all kinds of stagnant or flowing freshwater habitats, including brackish waters and seashores (Brischoux and Kornilev, 2014; Van der Meijden and Chiari, 2006). Among the seashores it frequents are those of the northern Caspian Sea, shared between Russia and Kazakhstan.

Natrix tessellata is indeed well known from the Volga Delta, Astrakhan Oblast (i.e., Astrakhan Region), in Russia (see, among others, Guicking et al., 2009) and from the Ural Delta, Atyrau Oblast, in western Kazakhstan (Diarov et al., 2008; Sarayev and Pestov, 2010). The type-locality of *Coleger hydrus* Pallas, 1771, a junior subjective synonym of *Natrix tessellata*, is “Gurief Gorodok,” an ancient name for Atyrau (Borkin and Litvinchuk, 2015), the administrative centre of Atyrau Oblast. The type-locality of *Enhydryis caspia* Oken, 1816, another such synonym, is “from the river Rhyrnus into the Caspian Sea,” i.e., from the Ural River (Tuniyev et al., 2011), in its delta area. The type-locality of *Tropidonotus gracilis* von Eichwald, 1831 is the mouth of the Volga River, thus in Astrakhan Region in Russia, and that of *T. tantalus* von Eichwald, 1831 is Tjub-Karagan (= Tupkaragan), i.e., at direct proximity to Bautino in Mangystau (= Mangistau) Region, western Kazakhstan.

The Kazakh sector of the northern Caspian Sea houses some of the largest oil reserves in the world, including the Kashagan oil field. Local weather conditions are characterized by extreme temperature differences between summer (as high as 40°C) and winter (as low as -40°C). The sea is on average only three or

four meters deep, and the waters freeze in the winter. Because of the shallow waters combined with the movements of large ice blocks (Mayne et al., 2002), conventional rigs could not be used for oil extraction, and had to be replaced by innovative artificial islands, built with boulders from onshore quarries, aimed at protecting the extraction facilities. Ten artificial islands were created in order to exploit and export oil from the Kashagan field. Eight of them (A Island, DC 01, DC 04, DC 05, D Island, EPC 02, EPC 03 and EPC 04) are located S-SE of the Ural Delta, at more than 40 km from the mainland, and the two others (Aktote and Kairan) are located further east, closer to the mainland. During the winter, the islands are surrounded by thick ice for about four months, from early December to late March, and exposed to strong blizzards. Due to these harsh meteorological conditions and the rocky substrate, vegetation is nearly absent from these islands.

Since their construction between 2001 and 2007 (Gökalp and Düzceer, 2008), these artificial islands and other assets on the mainland are included in a large-scale environmental monitoring program (Ogar et al., 2014). Data on the presence and abundance of all zoological and botanical groups are seasonally collected. We present hereafter data we gathered on snakes on and near the artificial islands in the frame of these environmental surveys, as well as opportunistic observations made on the nearby mainland.

Material and Methods

Except for a short visit, 15–18 September 2014, by two of us (OSGP and SU), dedicated to a survey of Dice snakes on A Island (46°28'15.2"N, 52°20'03.3"E) and D Island (46°26'13.6"N, 52°15'59.4"E; Figures 1 and 2), observations were opportunistically gathered during general environmental surveys on and

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Figure 1. Biotope of *Natrix tessellata* on D Island, Kazakh sector of the northern Caspian Sea, in the summer. Photograph courtesy of NCOC Multimedia Team.

around the artificial islands between 2010 and 2015.

Snake ventral scale counts follow the method of Dowling (1951); the terminal, pointed tail tip is not included in the subcaudal count. We follow Guicking et al. (2009) in treating all populations of the *Natrix tessellata* complex as a single taxon until more phylogenetic data are available, and Kindler et al. (2013) in attributing the North Caspian populations of *Natrix natrix* to the subspecies *scutata* (Pallas, 1771). Fish taxonomy follows FishBase (www.fishbase.se).

Results

Artificial islands and offshore

In late September 2010 VK observed several Dice snakes on EPC 03 Island (46°24'20.9"N, 52°16'16.7"E). At this time there was active construction work on this island, with barges importing limestone boulders and soil from the mainland.

On 15, 16 and 18 September 2014, OSGP and SU made dedicated snake surveys on D Island. On the 15th, while surveying the Icebreaking Emergency Evacuation Vessel (IBEEV) hangar area between 17.30 and 18.00, they observed one active adult snake and examined one subadult shed skin. On 17 September 2014, they surveyed A Island from 8.30 to 10.00 A.M., and examined ten shed skins (Figure 3), among them all size classes from juveniles to adults, in all parts of the island. During



Figure 3. Shed skin of an adult *Natrix tessellata*. Photographed *in situ* by O. S. G. Pauwels on A Island, Kazakhstan, in September 2014.



Figure 2. Biotope of *Natrix tessellata* on D Island, Kazakh sector of the northern Caspian Sea, in the winter. Photograph courtesy of NCOC Multimedia Team. Within the perimeter of the island, the ice is regularly broken by incoming icebreakers.

these four days, the weather was windy, fresh and partly clouded; daytime temperatures varied between 11 and 17°C. This might explain the low number of snakes observed, while the employees working on these islands informed us that these snakes are seen in much larger numbers in mid-summer, when temperatures are sensibly higher. The employees typically observe them basking on large rocks along the sea, or actively searching for fish near the shore.

OSGP examined the habitus and scalation of two live subadult Dice snakes from D Island. These snakes, released on the spot after having been examined and photographed, were characterized as follows (paired characters given left/right):

1st specimen (Figure 4): 2 internasals; 2 prefrontals; 8/8 supralabials, on each side 4th supralabial in contact with the orbit; on each side 2nd supralabial in contact with the 1st supralabial, the nasal, the loreal and the 3rd supralabial; 1/2 suboculars; 1/1 loreal, squarish; 2/2 preoculars (upper larger than lower); 1/1 supraocular; 2/2 postoculars (lower larger than upper); 1+2+3 temporals on each side; 10/10 infralabials, on each side the five first in contact with the anterior sublingual; 2 pairs of sublinguals; 2 preventrals + 184 ventrals; a divided anal; and a complete original tail with 62 divided subcaudals.



Figure 4. Live subadult *Natrix tessellata* on D Island. Photograph by O. S. G. Pauwels in September 2014. This individual, left quiet for a few minutes after it was disturbed and feigned death, is checking if the situation is safe again.



Figure 5. Another live subadult *Natrix tessellata* on D Island. Photograph by O. S. G. Pauwels in September 2014. Note the defensive posture with the flattened head.

2nd specimen (Figure 5): 2 internasals; 2 prefrontals; 8/8 supralabials, on each side 4th and 5th supralabials in contact with the orbit; on each side 2nd supralabial in contact with the 1st supralabial, the nasal, the loreal and the 3rd supralabial; 0/1 subocular; 1/1 loreal, squarish; 2 (upper larger than lower)/1 preoculars; 1/1 supraocular; 3/2 postoculars; 1+2 temporals on each side; 10/10 infralabials, on each side the five first in contact with the anterior sublingual; 2 pairs of sublinguals; 1 pre-ventral + 192 ventrals (umbilical scar still visible on ventrals 165 to 169); a divided anal; and a complete original tail with 68 divided subcaudals.

Both specimens also showed a round pupil; 19 dorsal scale rows at one head length behind head, 19 at midbody, and 17 at one head length before vent; and keeled dorsal scales, except the lowest row.

All shed skins examined by OSGP on A and D islands also showed 8 supralabials on each side, of which the 4th was in contact with the orbit; one anterior temporal; 19-19-17 dorsal scale rows, all keeled except the first; a divided anal and divided subcaudals. None of the shed skins included a complete tail, as the tail tips of the shed skins were broken during or after the shedding. Based on scalation features, all shed skins were unambiguously attributable to *Natrix tessellata*.



Figure 7. Adult *Natrix tessellata* basking onboard the *Nomad* in the northern Caspian Sea in September 2014. Photograph by S. Yerbulekov.



Figure 6. Adult *Natrix tessellata* basking on boulders on the shore of EPC 04 Island. Photograph by V. Kovshar in September 2014.

On 22 September 2014 VK observed several individuals basking on rocks and foraging at EPC 04 Island (46°27'18.0"N, 52°20'26.3"E; Figure 6).

On 20 September 2014, an adult *Natrix tessellata* was observed on board our environmental survey ship *Nomad*. The ship had left Bautino on that same day. The snake was regularly seen basking every day (Figure 7), and for the rest of the time it was hiding under the ship's deck. Its presence was daily checked by SY. It left the *Nomad* on 30 September on its own initiative, when the ship bunkered at D Island.

In June 2014, an adult individual was photographed from on board the *Caspian Maria* environmental research vessel (Figure 8). It was off DC 05 Island (46°22'19.9"N, 52°12'46.4"E) where several individuals were seen basking and foraging in the sea. Several times during the study period, isolated individuals were observed in the open sea at several kilometers from the artificial islands.

Mainland

Natrix tessellata is abundant along the shore of the Bautino harbor (Figure 9) in Bautino Bay. For instance, on 30 April 2013, during a dedicated walk of 200 m along the beach inside Bautino Bay from Bautino Shagala Hotel (44°33'11.6"N 50°14'58.0"E) southwards, one of us (OSGP) counted 17 individuals, mostly adults. One of the individuals (Figure 10), in a



Figure 8. Adult *Natrix tessellata* swimming in proximity to DC 05 Island. Photograph taken from the *Caspian Maria* vessel by Vyacheslav Mishenko in June 2014.



Figure 9. Biotope of *Natrix tessellata* at Bautino Bay along the Kazakh sector of the northern Caspian Sea. Photograph by O. S. G. Pauwels in April 2013.

similar manner to the one shown in Figure 4, feigned death when handled, lying on its back, opening its mouth and protruding its tongue, a well-known defense mechanism in the Dice snake (Golubović et al., 2019). In April 2014 OSGP also observed two adult individuals on the beach of Akku Hotel (44°30'43.7"N, 50°14'33.5"E; see Figure 11), West of Fort Shevchenko.

A survey of three hours by OSGP during the sunny afternoon of 26 April 2013 on the beach of Aktau (Figure 12), rocky and nearly devoid of any vegetation, on the mainland of the north-eastern Caspian Sea revealed four individuals of *Natrix tessellata* (Figure 13).

Although we observed *Natrix tessellata* actively foraging in the water along the rocky shores of D Island and other islands in search of fish, no predation was documented, but several feeding observations were made in nearby coastal areas. On 6 August 2007 FAS observed an adult Dice snake preying on a *Neogobius melanostomus* (Pallas, 1814) on a beach (43°26'49.5"N, 51°18'52.2"E) located about 25 km south of Aktau (Figure 14). On the same beach on 26 August 2008 FAS photographed an adult individual swallowing a *Neogobius caspius* (von Eichwald, 1831) (Figure 15). On 25 May 2012 SU photographed an adult preying on an adult male Monkey goby *Neogobius fluviatilis* (Pallas, 1814) (Gobiidae) in breeding colors along the pier in Karazhanbas (extending from 45°11'49.63"N, 51°15'34.45"E to 45°11'59.8"N, 51°14'53.0"E) in Buzachi Peninsula (Figure 16).

That same day, walking along the same pier, SU counted a



Figure 11. Adult *Natrix tessellata* on the beach West of Fort Shevchenko, Mangystau Oblast, Kazakhstan. Photograph by O. S. G. Pauwels in April 2014.



Figure 10. Subadult *Natrix tessellata* feigning death in Bautino Bay, Mangystau Oblast, Kazakhstan. Note the open mouth and the protruding, immobile, tongue. Photograph by O. S. G. Pauwels in April 2013.

total of near 2000 Dice snakes basking and foraging for fish along both rocky sides of the one-kilometer-long section of the pier penetrating into the sea (Figure 17). SU counted slightly more than 1000 on one side, and between 950 and 1000 on the other, i.e., both sides of the pier combined, there was about one individual every meter. A snake survey by FAS along both sides of the same pier on 14 October 2011, thus in autumn, had given a total, both sides of the pier combined, of only 265 individuals.

OSGP observed an adult individual catching an adult Round goby *Neogobius melanostomus* in Bautino in April 2013. Both *Neogobius fluviatilis* and *N. melanostomus* have already been recorded in the diet of the Dice snake in several other countries (Weiperth, Potyó and Puky, 2014); *N. caspius*, endemic to the Caspian sea, seems to represent an addition to its known prey spectrum. An adult Dice snake was observed near Atyrau preying on a Goldfish (Cyprinidae: *Carassius auratus* (Linnaeus, 1758)) (Figure 18), an established exotic fish species already known to be part of the prey spectrum of *Natrix tessellata* (Weiperth, Potyó and Puky, 2014).

In an evaporation pond (47°06'13.2"N, 51°59'50.4"E) of a waste treatment plant in the eastern suburbs of Atyrau, VK photographed on 20 June 2016 a large adult Dice snake preying on an adult Laughing frog *Pelophylax ridibundus* (Pallas, 1771) (Figure 19). This frog species is already known to be part of the diet of the Dice snake, although only few records exist (Weiperth, Potyó and Puky, 2014). VK documented *Natrix natrix scutata* in syntopy with *N. tessellata* in this same evaporation pond.



Figure 12. Biotope of *Natrix tessellata* on the beach of Aktau. Photograph by O. S. G. Pauwels in April 2013.



Figure 13. Subadult *Natrix tessellata* on the beach of Aktau in April 2013. Photograph by O. S. G. Pauwels. This individual showed a complete original tail with 61 divided subcaudals.



Figure 14. Adult *Natrix tessellata* preying on a *Neogobius melano-stomus* near Aktau, Mangystau Oblast, Kazakhstan. Photograph by F. A. Sarayev in August 2007.



Figure 15. Adult *Natrix tessellata* eating a *Neogobius caspius* near Aktau. Photograph by F. A. Sarayev in August 2008.



Figure 16. Adult *Natrix tessellata* preying on a Monkey goby *Neogobius fluviatilis* in Karazhanbas, Mangystau Oblast, Kazakhstan. Note the yellow margins on the unpaired fins of the goby, typical for the breeding males. Photograph by S. Ukhov in May 2012.



Figure 17. Four individuals of *Natrix tessellata* on Karazhanbas Pier, Mangystau Oblast, Kazakhstan. Photograph by S. Ukhov in May 2012. Note the three different color patterns in strict syntopy: checkered, gray and black.



Figure 18. Adult *Natrix tessellata* consuming a Goldfish *Carassius auratus* along the Chernaya Rechka (47°07'08.6"N, 51°43'50.2"E) near Atyrau, Atyrau Oblast, Kazakhstan. Photograph by Mark Crowther in September 2014.



Figure 19. Adult *Natrix tessellata* catching an adult Laughing frog *Pelophylax ridibundus* near Atyrau, Atyrau Oblast, Kazakhstan. Photograph by V. Kovshar in June 2016.



Figure 20. Live adult *Natrix tessellata* on the bank of the Ural River (47°06'47.9"N, 51°55'15.7"E) in Atyrau. The snakes are found on the open banks and among rocks rather than among the reeds. Photograph by O. S. G. Pauwels in August 2013.



Figure 21. Biotope of *Natrix natrix scutata*, *Emys orbicularis* and *Pelophylax ridibundus* in Peshnoy (46°54'09.4"N, 51°40'25.3"E), Ural Delta, Atyrau Oblast, Kazakhstan. Photograph by O. S. G. Pauwels in September 2011.

Discussion

Our records are the first of this species for the recently built artificial islands in the Kazakh sector of the Caspian Sea. The minimal distance between the mainland and the Kazakh islands where we recorded the Dice snake is about 50 km. In the Azerbaijan sector of the Caspian Sea, *Natrix tessellata* has colonized abandoned oil drilling platforms at not more than 8–9 km from the mainland (Tuniyev et al., 2011).

Analyzing the construction design of the islands, it appears possible that snakes were included in the loads of limestone boulders used to build the islands, thus at the earliest phase of their construction. The rocks were first extracted from a quarry at Fort Shevchenko, then from a quarry in Atash, the latter quarry being taken in production since September 1998 (Granneman and Goris, 2001). Both quarries are located in the direct vicinity of the Bautino harbor (44°32'41.0"N, 50°14'47.0"E), where the rocks were stored before being sent by boats to the islands. Our observations of Dice snake individuals in the open sea suggests that the species could also have colonized the artificial islands through active swimming, without human intervention.

The most common dorsal color pattern for northern Caspian Dice snake populations is checkered (Figures 4–6, 8, 10, 13, 15–18, 20), but gray (Figures 7, 14, 17) and black (Figures 11



Figure 23. Laterodorsal view of an adult *Natrix natrix scutata* dead on a road (46°55'31.5"N, 51°42'20.2"E) between Damba village and Peshnoy Base, Atyrau Oblast, Kazakhstan. This individual showed 2 preventrals + 177 ventrals, a divided anal, and 1 divided + 4 single + 52 divided subcaudals. Photograph *in situ* by O. S. G. Pauwels in August 2013.



Figure 22. Live juvenile *Natrix natrix scutata* in Peshnoy (46°54'09.4"N, 51°40'25.3"E), Ural Delta, Atyrau Oblast, Kazakhstan. Photograph by O. S. G. Pauwels in September 2011.

and 17) individuals are found in smaller numbers. The three patterns are known to co-exist in the species (Atjić et al., 2013), including in strict syntopy as shown on Figure 17.

Natrix tessellata is the only reptile species observed so far on the Kazakh artificial islands, with one notable exception. A single individual of *Emys orbicularis* (Linnaeus, 1758), a terrapin species commonly found in the Ural Delta, was photographed by Y. Bokov on EPC 04 in late August 2016 while it was basking on rocks. The photograph was unfortunately not preserved, but before deletion it had been shown to FAS, who unambiguously identified it.

The bare and rocky biotope found on the artificial islands is similar to the biotopes where Dice snakes are found on the beaches and river banks on the mainland, for example in Aktau (Figures 12 and 13) and in Atyrau (Figure 20). The other aquatic snake species that occurs together with *Natrix tessellata* in the lower Ural and its delta, *Natrix natrix scutata*, was not observed on or near these islands.

Within the Ural Delta, *Natrix natrix scutata* is generally found in sites with dense vegetation (Figures 21–24). It is easy to envision that individuals of *Natrix natrix scutata* may have reached the islands, but in the near-total absence of vegetation, in the absence of any other food resources than saltwater fishes and in competition with *N. tessellata*, they probably had no chances to establish. When comparing *Natrix natrix* and *N.*



Figure 24. Ventral view of the same *Natrix natrix scutata* individual shown in Figure 23. Photograph by O. S. G. Pauwels.

tessellata sharing a site, the latter is indeed much more aquatic and specialized in predation on fish, and more able to live in bare, rocky environments and brackish water (see among others Filippi et al., 1996; Weiperth, Gaebele et al., 2014). *Natrix tessellata* is able to consume fish from birth and for life (Filippi et al., 1996; Ioannidis and Mebert, 2011). The artificial islands do not offer food resources and ecological conditions for the other snake species recorded from the northern Caspian coast (see Diarov et al., 2008, and Sarayev and Pestov, 2010).

The aquatic frog *Pelophylax ridibundus*, whose type-locality was restricted to “Gurjew, Nord Küste des Kaspischen Meeres” (thus Atyrau) by Mertens and Müller (1928), is abundant in the Ural Delta, but absent from the islands, as are all the amphibian species recorded from the northern coast of the Caspian Sea (see Diarov et al., 2008).

Potential predators of Dice snakes on the islands include the exotic invasive Raccoon dogs (*Nyctereutes procyonoides* (Gray, 1834)). Raccoon dogs are known to prey on *Natrix tessellata* (see among others Musilová and Zavadil, 2011). They hibernate during at least a part of the winter, but occasionally drift to islands on ice floes in the spring. For instance, on 6 May 2014 we photographed an adult individual on an ice barrier of DC 05; it was observed foraging among rocks; we trapped it and released it on the mainland. Steppe wolves *Canis lupus campestris* Dwigubski, 1804 reach the islands in the winter by walking on the frozen sea, in search of Caspian seal pups (Wilson et al., 2017), and occasionally isolated individuals do not return in

time to the mainland when ice melts, but the few individuals stuck on the islands were caught and released on the mainland before the snakes emerged from hibernation. Other potential local predators include among others the Black-headed gull *Chroicocephalus ridibundus* (Linnaeus, 1766) and the Caspian gull *Larus cachinnans* Pallas, 1811, reported in other parts of their range to prey upon *Natrix tessellata* (Jelić and Lauš, 2011), and possibly the Short-eared owl *Asio flammeus* (Pontoppidan, 1763) (Strigidae), recorded by us on the islands in direct proximity of the snakes, and known to occasionally prey on squamates (Cramp, 1985).

The finding of Dice snakes of all age classes, including juveniles, indicates that they are reproducing on the islands. Although not yet confirmed from all artificial islands of the northern Caspian Sea, given their colonization potential, there is no doubt that they will be eventually found on all.

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