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Six predation events by the Red-banded Snake, *Lycodon rufozonatus* Cantor, 1842, on Tsushima Island, Japan

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Tsushima Island has an area of 696 km^2 and is located between the Japanese main island of Kyushu and the Korean Peninsula. The sea around Tsushima is shallow due to the continental shelf and has been connected to the Eurasian continent and the Japanese main islands multiple times because of changes in sea level (Kitamura and Kimoto, 2006). Therefore, Tsushima functions as a stepping stone between Eurasia and the Japanese Archipelago, resulting in the distribution of endemic species on both Tsushima Island and the Japanese main islands as well as Eurasian continental species in many taxonomic groups, which has created unique ecosystems (Niwa et al., 2021).

A widely distributed nocturnal, nonvenomous snake, *Lycodon rufozonatus* Cantor, 1842, has been recorded from the southern part of Russia's Far East, the Korean Peninsula, eastern and southern China, Taiwan, Vietnam, northern Laos, Thailand, and Japan (Takeuchi, 2019; Uetz et al., 2024). In Japan, the subspecies *L. r. rufozonatus* occurs only on Uotsuri and Tsushima islands (Matsui and Mori, 2021). There are records of this snake eating frogs, lizards, snakes, and small fish (Clifford, 1935; Huang, 2021), and in some field guides it is reported that this snake also eats birds and mammals in many locations, but not on Tsushima (e.g., Wei, 2017). On Tsushima, where the biota is very different from other areas where this snake occurs, we expect its diet to be different and include other animals than on the mainland or larger islands. So far, only two species of frogs, *Dryophytes japonicus* (Günther, 1859) and *Rana tsushimensis* Stejneger, 1907, have been reported as prey of the Tsushima population of *L. rufozonatus* (Hamanaka et al., 2014). Therefore, we conducted a field survey on Tsushima to investigate the feeding habits of this snake. As a result, we identified five species of prey including frogs, lizards, snakes, and snake eggs (Table 1).

Observation 1. We collected a female *L. rufozonatus* on a road in northern Tsushima feeding on a male pitviper, *Gloydius tsushimaensis* (Isogawa et al., 1994), with snout–vent length (SVL) 268 mm, tail length (TL) 166 mm, and body weight (BW) 156 g (Figs. 1, 2A). When we found it, approximately two-thirds of the pitviper's total length had already been swallowed headfirst, while it was still alive. It took about 10 min for the red-banded snake to finish swallowing the entire pitviper. Although the prey was a venomous snake, we observed no ill effects in the physical condition of *L. rufozonatus* after the predation event. *Gloydius tsushimaensis* is a common, nocturnal, snake endemic to Tsushima (Matsui and Mori, 2021) and thus can be an abundant prey resource for *L. rufozonatus*.

Figure 1. *Lycodon rufozonatus* feeding on *Gloydius tsushimaensis* on a road in northern Tsushima Island, Japan. Photo by Ango Morikawa.

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Table 1. Prey data for *Lycodon rufozonatus* on Tsushima Island, Japan, from a survey in September 2024. Measurements include snout–vent length (SVL) and tail length (TL) in mm and body weight (BW) in g. Prey species are endemic to Tsushima (E), on the Eurasian continent (C), or invasive (I).

Observation	Date	Time	Location	SVL (mm)	TL (mm)	BW (g)	Prey Species: endemic (E), continental (C), or invasive (I)
1	21-Sep	02:00 h	34.5711°S, 129.4395°E	795	45	129	*Gloydius tsushimaensis* (E)
2	21-Sep	21:00 h	34.4753°S, 129.3276°E	989	186	288	*Elaphe climacophora* eggs (E)
3	22-Sep	21:30 h	34.4764°S, 129.3291°E	787	163	137	*Fejervarya kawamurai* (I)
4	22-Sep	00:00 h	34.4778°S, 129.3334°E	815	198	134	*Scincella vandenburghi* tail parts (C)
5	22-Sep	01:30 h	34.4738°S, 129.3102°E	821	192	119	*Gekko japonicus* (C)
6	24-Sep	22:00 h	34.4755°S, 129.3336°E	795	166	74	*Fejervarya kawamurai* (I)

Observation 2. We collected a male *L. rufozonatus* (Table 1) on a road in northern Tsushima and found two snake eggshells (60 mm length, 38 mm width; 64 mm length, 41 mm width) among its stomach contents (Fig. 2B). The egg surfaces were cracked, and the eggs had no content, suggesting that the snake may have used its teeth to puncture the eggs when swallowing them. Predation on reptile eggs in the genus *Lycodon* has been documented in several species (e.g., Nakachi, 1991; Melvinselvan et al., 2018; Asato, 2021; Barends and Maritz, 2022). Additionally, puncturing eggs during predation has also been reported for *L. nympha* (Daudin, 1803) and *L. r. walli* (Stejneger, 1907) (Melvinselvan et al., 2018; Morikawa, in press).

There are two oviparous snake species on Tsushima, *L. rufozonatus* and *Elaphe climacophora* Boie, 1826, with the former laying eggs of length 33–38 mm (Clifford, 1935) and the latter of length 41–68 mm (Matsui and Mori, 2021). Thus, based on the size of the eggs in Observation 2, they were most likely from *E. climacophora*.

Observation 3. We collected a female *L. rufozonatus* next to a rice field in northern Tsushima with a frog, *Fejervarya kawamurai* Tjong et al., 2011 in its stomach (Fig. 2C). This species is a medium-sized frog of 37 mm SVL, 16 mm tibia length, and 3.7 g BW that had been ingested headfirst; the head was already digested. This frog species is not naturally occurring on Tsushima (Matsui and Mori, 2021) and its presence was first confirmed in 2001, mainly around paddies in central Tsushima; unfortunately, its range has gradually expanded (Togashi et al., 2004; Mitani et al., 2009). This frog's natural range is in western Japan, on the Ryukyu Islands (except the Sakishima Islands), western Taiwan, and central and eastern China. *Fejervarya kawamurai* did not exist at our study site in 2008 (Mitani et al., 2009), but we observed many individuals in 2024.

Observation 4. We collected a female *L. rufozonatus* on a road in northern Tsushima whose stomach contained two parts (lengths 11 and 7 mm) of a skink's tail (Fig. 2D). Based on the tail's yellow dorsum, lack of keels on the scales, and broad subcaudals, we were able to determine that the tail belonged to *Scincella vandenburghi* Schmidt, 1927. The prey is a diurnal lizard inhabiting the forest floor in lowlands to higher mountain elevations in the southern part of the Korean Peninsula, Jeju Island, and Tsushima Island (Matsui and Mori, 2021). Because lizards of the genus *Scincella* autotomise their tail as an anti-predator strategy (Benjamin, 1983) and the body of the skink was not found in the snake's stomach, the tail might have been autotomised when the snake attacked the lizard.

Observation 5. We collected a male *L. rufozonatus* on a road in northern Tsushima and it contained a *Gekko japonicus* (Duméril and Bibron, 1836) of 60 mm SVL, 42 mm TL, and 2.8 g BW (Fig. 2E) in its stomach. The gecko had been ingested headfirst with its head completely digested. This nocturnal gecko has a large range, from the southern Korean Peninsula to southeastern China, and throughout the Japanese Archipelago, except for Hokkaido (Matsui and Mori, 2021).

Observation 6. We collected a male *L. rufozonatus* on a road in northern Tsushima that had a medium-sized *F. kawamurai* of 38 mm SVL, 17 mm tibia length, and 3.7 g BW in its stomach (Fig. 2F). The frog had been ingested hind leg-first with the hind legs already digested.

From our survey and collection of stomach contents we found that all five prey items have not been reported for *L. rufozonatus* on Tsushima Island. Clifford (1935) reported *F. kawamurai* as prey in Ningguo, China. Our

Figure 2. Six prey items recovered from stomach contents of *Lycodon rufozonatus* on Tsushima Island, Japan. (A) A pitviper, *Gloydius tsushimaensis*. (B) Eggs of *Elaphe climacophora*. (C) *Fejervarya kawamurai*. (D) Tail parts of a skink, *Scincella vandenburghi*. (E) *Gekko japonicus*. (F) *Fejervarya kawamurai.* Photos by Ango Morikawa.

study shows that *L. rufozonatus* eats a wide variety of vertebrates on Tsushima, as seen in other areas (Clifford, 1935; Huang, 2021). These findings suggest that the population of *L. rufozonatus* on Tsushima is a generalist.

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