

Discovery of new marginal populations of a regionally vulnerable snake, the Halys Pit Viper (*Gloydius halys*)

The Halys pit viper *Gloydius halys* (Pallas, 1776) is a species of venomous viperid snakes with a range in South Siberia (Russia), Northern Mongolia and Northern China. Previously, it was believed to have much wider distribution, but at the present, the populations from the Caucasus, Central Asia and the Far East are considered separate species (Wagner et al. 2016, Shi et al. 2016). However, new findings greatly expanding the known range of the species and genus in general are still occurring (Orlov et al. 2018), pointing out the need for further research. The north-western limit of the Halys pit viper range is located at the north of Kemerovo Region and the Novosibirsk Region (West Siberia, Russia) (Kuranova et al. 2010). Here, the populations are sporadic and isolated from the main range. They are associated with steep slopes of river valleys with rocky outcrops and patches of mountain steppe vegetation, surrounded by forests and meadows. The currently known populations occur in the valleys of the rivers Tom (Kemerovo Region) and Berd (Novosibirsk Region). These populations are considered as relicts of the Holocene climatic optimum, which was characterized by a warmer climate in comparison to the present. Apparently, during that time *G. halys* occupied a wider range, which shrank with the subsequent climate cooling and humidification that started about 5 000 years ago (Quante 2010), leaving small populations in limited habitats with preserved appropriate microclimatic conditions. This hypothesis is supported by population genetics data (Simonov & Wink 2012). Similar relict populations are known for a number of temperate snake species in Europe, Asia and North America (e.g. Joger et al. 2010, Somers et al. 2017).

In Novosibirsk Region, this species had not been discovered until 2002 (Pestov 2003) in spite of herpetological research conducted in the region, due to its very limited areas of occurrence. The ecology, origin and genetics of this population have been extensively studied in the following years (e.g. Simonov & Wink 2011, 2012; Simonov & Zinchenko 2010). Halys pit viper is redlisted in Novosibirsk Region as a vulnerable species due to its limited distribution and habitat availability. However, no special efforts have been conducted to investigate the presence of this species in other parts of the region.

While examining zoological collections of the Faculty of Natural Sciences of the Novosibirsk State University, we found two specimens of *G. halys* labelled as "Karakan river valley, 1986", collector unknown. These specimens were apparently collected during biology students' fieldwork. That year, the fieldwork was held near the village Rozhdestvenka (Dr. Prof. M.G. Sergeev, pers. comm.). This village is in 100 km west from the nearest known location inhabited by *G. halys* in the Berd river valley. Apparently, this is the earliest record of *G. halys* in the Novosibirsk Region. However, at the time the importance of the find was not recognized, and it has never been published. This finding motivated us to carry out field studies to validate the locality of specimens found in the collection and to explore previously unstudied parts of the region potentially suitable for *G. halys*.

Candidate localities were identified using satellite images provided by Google Earth (earth.google.com/web/). We visually examined images in a search for woodless and steep slopes of river valleys with potential rocky outcrops (Fig 1a) which could serve as hibernating sites for the Halys pit viper. We did not rely on GIS tools to remotely derive vegetation/landscape features of interest, because such identification of rocky outcrops is prone to various biases and might fail (Fitzsimons & Michael 2017). Field surveys of identified candidate localities were conducted not only during the season of pit vipers activity (May-September) but also in April and October, by searching for shed skins near potential hibernating sites. The snake sheddings are proven to be a reliable tool for species surveys and identification (e.g. Tsai et al. 2020), and a shed skin of *G. halys* is easily distinguishable from the skins of the co-occurring species (*Natrix natrix* and *Vipera berus*) by the presence of loreal pits and by scutation features. Because there is no dense vegetation or snow cover in April and October, it is easier to search for the shed skins.

During the fieldwork in 2016-2020, we visited a number of locations in the valleys of the rivers Berd, Karakan, Verkhniy Karakan, Ik, Inya and Izdrevaya. The specimens of *G. halys* and/or shed skins were found in three new locations (Fig 1d). In May 13, 2016 five individuals (2 adults, 1 subadult, 2 juveniles) of Halys pit viper were found in Karakan river valley, 3 km north-west of Rozhdestvenka village (54.3978° N, 82.3914° E, 150 m a.s.l.), 100 km to the west from the previously known population in Berd river valley. In April 23, 2019 we found a shed skin of *G. halys* near the rocky outcrops in Verkhniy Karakan river valley, 15 km to the south from the locality described above (54.2680° N, 82.4473° E, 190 m a.s.l.). In October 23, 2019 another shed skin was found near the rocky outcrops on steep slopes of Inya river valley (Fig 1c), and in May 13, 2020 an adult pit viper was found at the same location (55.3081° N 84.1205° E, 154 m a.s.l.). This population is located 70 km south-west from the nearest known population in Tom river valley (Kemerovo Region), and 77 km north from the population in Berd river valley.

Thus, the distribution of *G. halys* in the region is much wider than previously thought. It is quite probable that the species could be found in other locations with appropriate habitat conditions. Moreover, the places which we surveyed and found no pit vipers should be considered for further surveys as well, since our searches were not systematic and cannot prove species absence. Our findings are also of medical importance: according to Shikalova et al. (2019) in 2011-2017 snake bite envenomation were registered in 11±2 patients per year on average in Regional Toxicological Center of Novosibirsk (this most probably does not fully reflect the real number of cases). To the best of our knowledge, all these cases were treated as an envenomation by the most common snake species in the region – the common adder *V. berus*. We found the Halys pit viper in the administrative districts where it was not recorded previously, and importantly, the species occupies some sites attractive to local people as recreation sites, increasing the probability of snake bite accidents with pit vipers. The local clinical toxicologists must be aware of such possibility and avoid using the *V. berus* antivenom (which is available in Novosibirsk Region) in case if there is a probability of pit viper envenomation.

The rediscovered locality in Karakan river valley is the westernmost known population of the species, advancing the known north-western range limits of the Halys pit viper

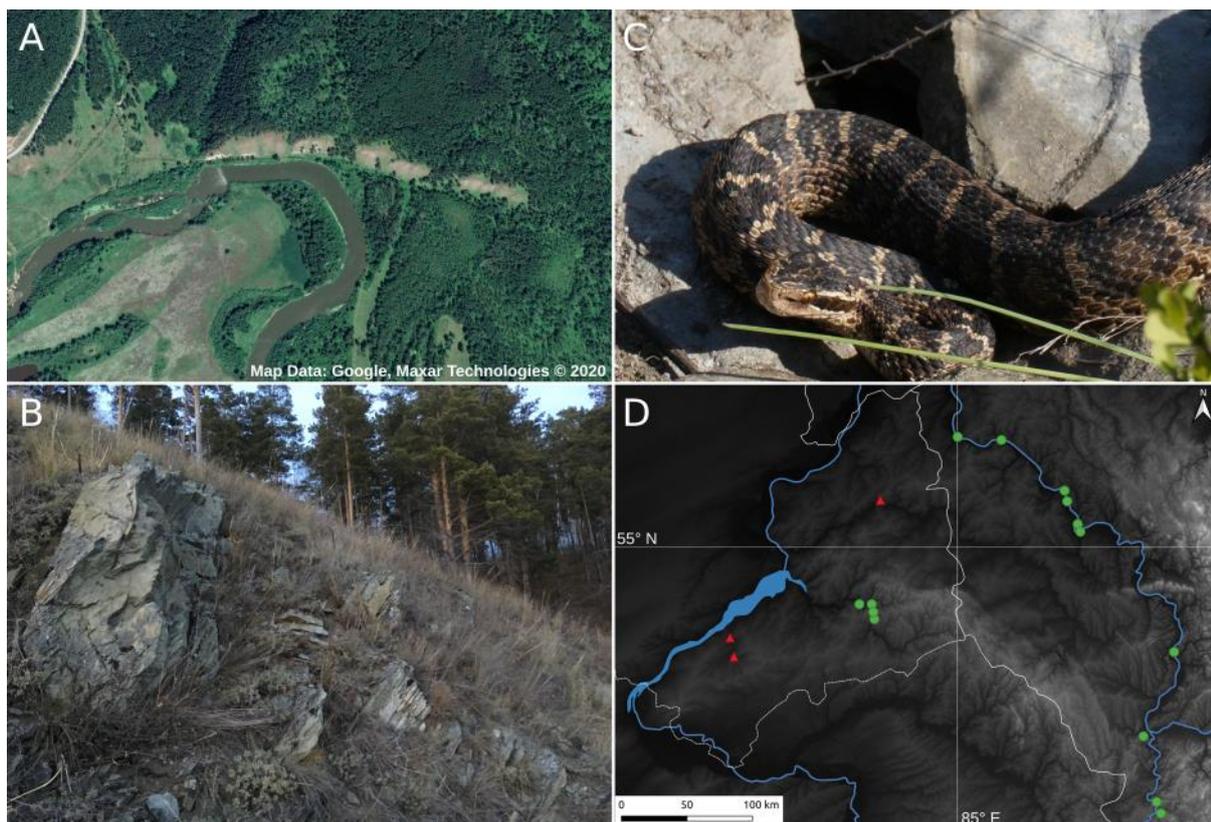


Figure 1. A – example of a satellite imagery of *G. halys* habitat (Inya river valley) (Google, Maxar Technologies), B – *G. halys* habitat in Inya river valley (photo by authors), C – adult female *G. halys* encountered in Karakan river valley (photo by authors), D – occurrence of *G. halys* in north-western part of its range, new records depicted as red triangles. Major rivers (in blue) and regional borders (in white) are shown.

100 km west, close to the river Ob. It is highly unlikely that *G. halys* occurs west of the Ob river since the landscapes to the west of the river represent a very flat plain covered by grassland with small forest patches and lack river valleys with steep or rocky slopes. Notably, the Ob river in this area serves as a biogeographical border for some other rare species often co-occurring with *G. halys*, such as forest-steppe marmot *Marmota kastschenkoi* Stroganov et Yudin, 1956 (Brandler 2003). Two out of three populations were first discovered by shed skins and out of the pit vipers activity season, once again underlining the usefulness of such approach, especially for rare and elusive snake species.

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