REPTILES & AMPHIBIANS

First Record of Mating and Dichromatism in the Himalayan Pitviper, *Gloydius himalayanus* (Günther 1864)

Jignasu Dolia and Abhijit Das

Wildlife Institute of India, Dehradun, India (jdolia@gmail.com)

The Himalayan Pitviper, *Gloydius himalayanus* (Günther 1864), is endemic to the western Himalayas, with a geographic range potentially stretching from the Indus River in the west to the Brahmaputra River in the east (Wall 1910). Detailed information published in recent years establishes its range in four countries, from Pakistan in the west (Khan and Tasnim 1986) through India (Whitaker and Captain 2004), Nepal (Whitaker and Captain 2004; Wagner et al. 2016), and Bhutan in the east (Das and Das 2017). In India, it has been reported from the states of Jammu and Kashmir, Himachal Pradesh, Punjab, Uttarakhand, and West Bengal (Whitaker and Captain 2004; Chaudhuri et al. 2018; Manhas 2020).

Gloydius himalayanus is a subtropical montane species that has been recorded at elevations of 1,500–4,877 m asl (Whitaker and Captain 2004), with a preferred range suggested to be 2,134–3,048 m asl (i.e., originally reported by Wall 1910 as approximately 7,000–10,000 ft). This snake has reportedly been found at an elevation of 4,877 m (or approx. 16,000 ft from near a glacier in Dharamshala, Himachal Pradesh, India; Wall 1910) making this the highest known

Fig. 1. A copulating pair of Himalayan Pitvipers (*Gloydius himalayanus*) photographed on 12 July 2014 near the Himalayan Darshan viewpoint, Nainital, Uttarakhand, India, a substantially disturbed site on the outskirts of this hill town. Photograph by Pankaj Verma.

Reptiles & Amphibians ISSN 2332-4961
https://doi.org/10.17161/randa.v30i1.18095

location for any snake worldwide (Whitaker and Captain 2004). Two congeneric pitvipers (*G. rubromaculatus* and *G. rickmersi*) also are known to inhabit similar high-elevation habitats at 4,770 m and 3,000 m asl, respectively (Wagner et al. 2016; Shi et al. 2017), suggesting that snakes of this Asian Palearctic genus (Orlov et al. 2002) are well adapted to living in cold environments.

The Himalayan Pitviper has a rather stout body, with average and maximum total lengths of 60 and 86 cm, respectively (Whitaker and Captain 2004). Its large dorsal head scales, unlike those of sympatric pitvipers, are an important diagnostic character. The body coloration is quite variable with the dorsum being various shades of olive brown, dull brown, blackish brown, or gray, with dark blackish-brown spots or wavy bars (Wall 1899, 1910; Daniel 2002; Whitaker and Captain 2004). Newborn *G. himalayanus*, which are 16–19 cm in length (Whitaker and Captain 2004), are similar in appearance to adults but more brightly marked (Dattatri 1985), their dorsal blotches being more distinct and reddish-brown (Telford 1980). These snakes usually are found in and around coniferous forests, often under timber or boulders, in pine needles, and in clefts between rocks (Whitaker and Captain 2004). The known diet consists of mice, skinks, toads, and centipedes (Wall 1899; Whitaker and Captain 2004). A rather lethargic snake of mild disposition, perhaps reflecting its cold environment, *G. himalayanus* is unlikely to bite unless provoked. It is known to vibrate its tail vigorously as a warning signal (Wall 1910; Whitaker and Captain 2004). The venom of *G. himalayanus* is not particularly toxic, and no human fatalities have been reported from its bite (Whitaker and Captain 2004).

Between 2020 and 2021, the first author (JD) was shown a few photographs of mating pairs of *G. himalayanus* from Nainital District, Uttarakhand, India. Despite being a fairly common snake, no published records document its mating season, although brief notes describing pregnant females and litter sizes are available. Pregnant females have been found from July–September, and captured pregnant females bore 3–7 live young from August–October (Wall 1899, 1910; Telford 1980; Dattatri 1985).

Wall (1910) stated the following with regard to the mating season of *G. himalayanus*: "I do not know the exact mating season, but it is probably in the spring - April or May." Daniel (2002) provided an alternative suggestion: "The mating season is not known but probably occurs during hibernation." Such contrasting speculations likely are complicated for cold-climate species, as a study of a northeastern Asian congener, *G. intermedius*, reportedly has two mating seasons per year, a post-hibernation mating season in April–May and another in August–September (Orlov et al. 2002).

Given the lack of previously published records of observed mating in this species, as well as the contradictory speculations by earlier naturalists, identification of the mating season in *G. himalayanus* was an intriguing question. We first examined the available literature to try and infer a likely mating season from the published records of gestation interval and birth season. Then, we checked to see if the dates of the mating pairs photographed by local residents matched our expectation based on the available limited data.

No accurate reports on gestation in *G. himalayanus* exist, but the usual gestation period in viviparous snakes is approximately 30–90 days (i.e., 1–3 months; Blackburn and Stewart 2016). In *G. himalayanus,* two published reports provided indirect information from captured gravid females that later gave birth in captivity. One study reported a minimum observed gestation interval of approximately one month between capture of the female and birth of her live young (Dattatri 1985: 16 September to 17 October), whereas the other reported approximately one and a half months (45 days) between female capture and birth of her live young (Telford 1980: 11 July to 27 August). As the actual dates of mating in these two studies are unknown, we conservatively infer that

Fig. 2. A pair of Himalayan Pitvipers (*Gloydius himalayanus*) photographed on 3 August 2020 in Nainital, Uttarakhand, India. Photograph by Ratna Sah.

a minimum gestation interval is at least 45 days for *G. himalayanus*. The actual average gestation interval in cold-climate species may be quite long, as shown by a high-elevation captive-bred viviparous pitviper, *Trimeresurus karanshahi*, which had a gestation interval of 7–8 months (Orlov et al. 2002).

Extrapolating from the published records of *G. himalayanus* giving birth during August–October and using a conservative estimate for gestation of 1.5–3 months, we speculate that the mating season for Himalayan Pitvipers likely occurs during July–September. Mating 'during hibernation' in the winter months of December–February seems less likely, unless we are willing to accept the possibility of two mating seasons per year or an exceptionally long gestation of 7–8 months.

Herein we report for the first time three photo-documented instances of mating in this species. These observations were made by local residents during July–September (in 2014 and 2020) in the Nainital District of Uttarakhand, northern India. Moreover, these photographs also suggest dichromatism in *G. himalayanus*, because a distinct color difference (brownish vs. grayish) can be seen between both individuals of each pair.

On 12 July 2014, a local amateur photographer, Pankaj Verma, photographed a mating pair of *G. himalayanus* that he and other local residents had observed over a period of approximately one hour (1100–1200 h) at the Himalayan Darshan viewpoint on the outskirts of Nainital (29.403 N, 79.451 E; elev. 2,267 m asl). He took a series of 25 photographs of the entwined, presumably copulating pair of snakes (Fig. 1) over a 10-minute period. To our knowledge, this is the first documented case of mating in *G. himalayanus.* Pertinent details include that the two snakes were clearly adults and not juveniles, based on size and dull coloration; they remained entwined throughout the hour-long observation by Mr. Verma, during which the snakes did not raise the anterior parts of their bodies or display any aggressive movements (e.g., chasing each other, biting, pushing each other down, downward thrusting of heads, etc.), which might have suggested male-male combat, as documented in some pitvipers (Strine et al. 2015). Despite the disturbance of people and vehicles passing by or watching from the road approximately 3 m away, the two snakes remained in this entwined position on the ground for at least an hour.

In a second sighting, at 0925 h on 3 August 2020, Ratna Sah photographed a pair of *G. himalayanus* (Fig. 2) near Van Niwas Ashram, Nainital (29.388 N, 79.442 E; elev. 2,159 m asl). She took a series of four photographs spanning about a minute. According to her, the vipers were not engaged in any sort of combat and were seen together even after about an hour of her initial sighting. Although mating per se was not noticed by her, this very likely was a copulating pair.

In a third sighting, at 0854 h on 10 September 2020, Kartikeya Mehrotra photographed a mating pair of *G. himalayanus* near the relatively less disturbed area of Tiffen Top, Nainital. He took three photographs of the snakes (Fig. 3) but no other behavioral observations were made on this pair. This recorded mating in early September suggests that the birth of Himalayan Pitvipers can occur as late in the year as November and potentially later in the year, depending on the actual gestation period, which currently remains unknown.

Interestingly, these observations do not support the speculations of Wall (1910) and Daniel (2002), who expected mating in *G. himalayanus* to occur in late winter or spring. Clearly, many gaps remain in our knowledge of the reproductive biology of this 'common' highland Himalayan snake.

Based on the photographs of the three pairs presented herein, a distinct color difference (i.e., yellowish-brown vs. grayish) between paired individuals was noticeable. However, whether these color morphs indicate sexual dichromatism is unknown (Shine 1993), as has been reported in other snakes, including the Indian snake *Ahaetulla anomala* (Mohapatra et al. 2017). The two color morphs observed in *G. himalayanus* include a light gray dorsal ground color with dark brown to blackish rosette-like blotches and markings and a white or light gray ventral background with dark gray spots versus a light yellowish-brown dorsum with brown blotches and markings and a creamy yellowish venter with brown spots.

According to Shine (1993), adults of one sex may be longer than the other in species with sexual-size dimorphism (SSD), so high-resolution copies of these photographs were analyzed using ImageJ software (version 1.53o) to determine

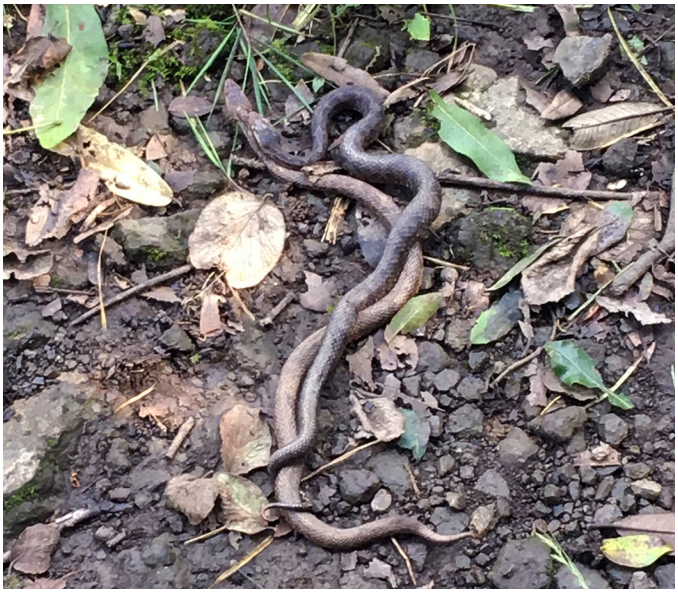

Fig. 3. A copulating pair of Himalayan Pitvipers (*Gloydius himalayanus*) photographed on 10 September 2020 near Tiffen Top, Nainital, Uttarakhand, India. Photograph by Kartikeya Mehrotra.

the relative total and head lengths of the grayish snakes compared to those of the brownish color morphs in each photo. Measurements were repeated multiple times. The individual snakes were measured along their backs using the segmented measurement tool, with spline fit to better match body curvature for total length and the line tool for measuring head length. The ratio of the larger individual to that of the smaller one for each of the three snake pairs was then calculated and matched to the respective color morphs.

In Figures 2 and 3, the gray individual (presumed male) was 1.05–1.07 times longer than its brown (presumed female) counterpart; however, in Fig. 1, the results were the opposite (i.e., the brown individual was approximately 1.08 times longer than the gray individual). For all three pairs, the head length of the gray-colored individual was on average 1.1 times the length of its brown counterpart. Based on the very limited data on mating pairs of *G. himalayanus* photographed here, we cannot conclude that the observed color dimorphism was linked to sexual dimorphism. Additional data need to be collected to resolve whether color dimorphism in this species is related to sex.

Sexual dichromatism in snakes, although relatively subtle compared to that seen in lizards, has been documented in several species, including vipers, most notably in the Old-World genus *Vipera* (Shine 1993; Shine and Madsen 1994). According to Shine (1993), this characteristic often shows considerable phylogenetic, seasonal, and geographic variation. Whether the dichromatism observed herein represents sexual dimorphism, seasonal variability, and is limited to this population of *G. himalayanus* (or is more widespread across this snake's distribution with some adaptive significance), remains to be determined.

Acknowledgements

JD thanks Pankaj Verma, Kartikeya Mehrotra, and Ratna Sah for sharing their photographs and observations, without which this note would not have been possible. K.S. Sajwan and Anup Sah first brought these observations to JD's attention and helped procure supporting evidence, for which the latter is very grateful. Cheryl Nath substantially improved the manuscript.

Literature Cited

Blackburn, D.G. and J.R. Stewart. 2016. Viviparity and placentation in snakes, pp. 119–181. In: R.D. Aldridge and D.M. Sever (eds.), *Reproductive Biology and Phylogeny of Snakes*. CRC Press, Boca Raton, Florida, USA.

Chaudhuri, A., S. Mukherjee, S. Chowdhury and J. Purkayastha. 2018. Geographic Distribution: *Gloydius himalayanus* (Himalayan Pitviper). *Herpetological Review* 49 (3): 505.

Daniel, J.C. 2002. *The Book of Indian Reptiles and Amphibians*. Bombay Natural History Society and Oxford University Press, Mumbai, Delhi, Calcutta, and Chennai, India.

Das, I. and A. Das. 2017. *A Naturalist's Guide to the Reptiles of India, Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka*. John Beaufoy Publishing, Oxford, UK.

Dattatri, S. 1985. A note on reproduction in the Himalayan Pit Viper (*Agkistrodon himalayanus*). *Journal of the Bombay Natural History Society* 83: 224–225.

Khan, M.S. and R. Tasnim. 1986. Notes on the Himalayan Pit Viper, *Agkistrodon himalayanus* (Günther). *Litteratura Serpentium, ser. English edition* 6*:* 46–55.

Manhas, A. 2020. Observations of Himalayan Pitvipers, *Gloydius himalayanus* (Günther 1864), in the Doda District, Jammu and Kashmir, India. *Reptiles & Amphibians* 27: 476–478. https://doi.org/10.17161/randa.v27i3.14887.

Mohapatra, P.P., S.K. Dutta, N.B. Kar, A. Das, B.H.C.K. Murthy, and V. Deepak. 2017. *Ahaetulla nasuta anomala* (Annandale, 1906) (Squamata: Colubridae), resurrected as a valid species with marked sexual dichromatism. *Zootaxa* 4263: 318–332. https://doi.org/10.11646/zootaxa.4263.2.6.

Orlov, N., N. Ananjeva, and R. Khalikov. 2002. Natural history of pitvipers in eastern and southeastern Asia, pp. 345–360. In: G.W. Schuett (ed.), *Biology of the Vipers*. Eagle Mountain Publications, Eagle Mountain, Utah, USA.

Rasband, W.S. 1997–2018. *ImageJ*. U. S. National Institutes of Health, Bethesda, Maryland, USA. <https://imagej.nih.gov/ij/>.

Shi, J., G.Wang, Y. Fang, X. Chen, L. Ding, S. Huang, M. Hou, J. Liu, and P. Li. 2017. A new moth-preying alpine pit viper species from Qinghai-Tibetan Plateau (Viperidae, Crotalinae). *Amphibia-Reptilia* 38: 517–532. https://doi.org/10.1163/15685381-00003134.

Shine, R. 1993. Sexual dimorphism in snakes, pp 49–86. In: R.A. Seigel and J.T. Collins (eds.), *Snakes. Ecology and Behavior*. McGraw Hill, New York, New York, USA.

Shine, R. and T. Madsen. 1994. Sexual dichromatism in snakes of the genus *Vipera*: A review and a new evolutionary hypothesis. *Journal of Herpetology* 28: 114–117. https://doi.org/10.2307/1564692.

Strine, C.T., C. Barnes, I. Silva, B. Nadolski, T. Artchawakom., J.G. Hill, and P. Suwanwaree. 2015. First record of male combat in a wild Malayan pit viper (*Calloselasma rhodostoma*). *Asian Herpetological Research* 6: 237–239. https://doi.org/10.16373/j.cnki.ahr.140040.

Telford, S.R. 1980. Notes on *Agkistrodon himalayanus* from Pakistan's Kaghan Valley. *Copeia* 1980: 154–155.

Wagner, P., A. Tiutenko, G. Mazepa, L.J. Borkin, and E. Simonov. 2016. Alai! Alai!–a new species of the *Gloydius halys* (Pallas, 1776) complex (Viperidae, Crotalinae), including a brief review of the complex. *Amphibia-Reptilia* 37: 15–31. https://doi.org/10.1163/15685381-00003026.

Wall, F. 1899. Notes on 26 specimens of the Pohur or Himalayan viper (*Ancistrodon himalayanus*). *Journal of the Bombay Natural History Society* 12: 411–414.

Wall, F. 1910. A popular treatise on the common Indian snakes, Part 13. *Journal of the Bombay Natural History Society* 20: 65–72.

Whitaker, R. and A. Captain. 2004. *Snakes of India. The Field Guide.* Draco Books. Chennai, Tamil Nadu, India.