

Unusual early parturition in temperate region viviparous snakes during the atypically hot summer of 2007

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Abstract. Environmental factors, especially temperature, have a particularly strong influence on most aspects of the life history of ectothermic organism. Gestation time and post-reproductive survivability in female viviparous snakes from the temperate regions (typical capital breeders) has been shown to be strongly influenced by temperature. This and other similar information has obviously attracted much attention to investigating the possible effects of climate change (global warming) on various reptiles. Here, we present several observations of unusually early parturition time (probably corresponding to a short gestation time) in four viviparous snake species (*Coronella austriaca*, *Vipera berus*, *V. ursinii* and *V. ammodytes*) during the summer of 2007, the second warmest summer in Romania in the past century.

Key words: reproduction, ectotherms, climate change,
Coronella austriaca, *Vipera* sp., Romania

Human mediated global climate change and its actual and potential effects on the world's biodiversity have been in the centre of attention for many ecologists and conservation biologists, especially during the past two decades (e.g. Thuiller 2007). The effects of climate change on ectothermic organisms such as reptiles have been broadly discussed and debated but the results are variable. Thus, Gibbons et al. (2000) and references therein mostly argue that the current trends of globally

increasing temperatures are detrimental to the persistence of many reptiles species while Deutsch et al. (2007) propose a more complex model where temperate region ectotherms could benefit from climate warming whereas those from tropical regions would mostly suffer. Indeed, specific geo-ecological modelling studies have shown that some rare reptile species would lose a significant percentage of their current bioclimatic niche (e.g. Penman et al. 2010). In contrast, other modelling studies have shown that, under certain scenarios of climate warming, many amphibian and reptile species, given unlimited dispersal, would enlarge their ranges (e.g. Araujo et al. 2006).

Environmental factors, especially temperature determines the rate of most biological processes in reptiles, including many reproductive traits such as reproductive frequency, gestation or incubation time and post-reproductive survivability (e.g. Lourdais et al. 2002, Shine and Bonnet 2009). Reproductive characteristics have been shown to be especially influenced by temperature in viviparous snakes from temperate regions, such as the frequently studied species of the genus *Vipera*. For example, reproductive frequency of female Asp vipers (*Vipera aspis*) has been shown to follow an annual breeding cycle in the southern parts of its range and a biennial or even triennial cycle in the northernmost ones (Saint-Girons and Kramer 1963, Zuffi et al. 2009).

Three viper taxa, all viviparous (the Nikolsky's viper - *Vipera berus nikolskii*, the Moldavian meadow viper - *V. ursinii moldavica* and the nosehorned viper - *V. ammodytes montandoni*), as well as one viviparous colubrid species (the smooth-snake *Coronella austriaca*) can be found in certain parts of Eastern Romania, in the historical regions of Moldavia and Dobrudja (e.g. Iftime 2005, Zinenko et al. 2010). These are small sized snake species, with maximum total lengths recorded in the region of between 65 and 80 cm (Fuhn and Vancea 1961, Zamfirescu et al. 2008, Zinenko et al. 2010, Strugariu et al. 2011, unpublished data). In this paper, we present some observations of unusual early parturition in all these species during the summer of 2007, the second warmest summer recorded in Romania (Busuioc et al. 2007), and compare the data from this year to those collected in subsequent years in which there were no extreme temperatures for longer periods of time.

Several populations of the previously mentioned species of snakes were monitored during routine field surveys, as follows: *Vipera berus nikolskii* and *Coronella austriaca*: the Bârnova forest, Iași County, N-E Romania, monitored since 2006; *V. ursinii moldavica* and *C. austriaca*: two steppic habitats near the city of Iași,

N-E Romania, since 2006; *V. ammodytes montandoni*: the Măcin Mountains National Park, Tulcea County, S-E Romania. For the studied populations from Romanian Moldavia, investigations were mainly conducted in the field but snakes were occasionally taken into the lab for data collecting and released one to several days after capture. For the *V. a. montandoni* population from the Măcin Mountains, specimens were occasionally kept in cloth bags for 1-2 days during fieldwork. The study areas are located at altitudes between 50 and 350m and all of them are regions with a strong continental climate pattern: hot and dry summers and very cold winters (Tufescu et al. 1995).

Throughout the summer of 2007, detection rates for all the species discussed here were notably smaller than in previous or subsequent years despite similar search efforts (personal observation). Only one adult female *V. b. nikolskii*, *C. austriaca* and *V. u. moldavica* and just three adult females *V. a. montandoni* were captured between June and September. The observed parturition dates for these taxa are shown in Table 1. These are compared with parturition dates observed for the same taxa from the same populations in subsequent years (unpublished data). The *V. b. nikolskii* and the *C. austriaca* individuals gave birth in captivity, just a few days after they were captured. The Nikolsky's viper had a litter of 4 offspring, 2 of which were stillborn while the smooth snake had a litter of 16 offspring, all of which were of typical size (personal observation). The single observation for the Moldavian meadow viper refers to a female encountered in the field on July 25th. The female appeared emaciated, displaying the typical characteristics of a post-partum viper. One of the three nose-horned vipers captured during this summer gave birth to 5 live offspring of typical sizes while being held in cloth bags.

There were notable differences between the parturition dates observed in 2007 and the ones recorded in subsequent years (Table 1). Thus, parturition for the same species in subsequent years took place 28-46 days later than in 2007. Although earlier parturition dates do not necessarily correspond to a shorter gestation time, we consider, based on similarity of spring activity, that average starting dates of gestation for Eastern Romanian viviparous snakes in 2007 was not different compared to subsequent years (unpublished data). Therefore, we believe that, at least in the cases presented here, the very early parturition dates recorded were also linked to a much shorter gestation time. Indeed, previously published detailed investigations on the reproductive ecology of viviparous snakes have shown that gestation time is considerably shorter in warmer summers (e.g. Lourdais et al.

2002, Shine and Bonnet 2009) and this also appears to have happened with the discussed populations during the hot summer of 2007.

Table 1. Dates of parturition of viviparous snakes from Eastern Romania during the hot summer of 2007 and comparison with data from subsequent years.

Taxon	2007 parturition date (n=1 for all cases)	Parturition dates in subsequent years (n)
<i>Coronella austriaca</i>	July 12	2008-2011: August 21 – 28. (6)
<i>Vipera berus nikolskii</i>	July 15	2008-2011: August 20 - September 7 (13)
<i>Vipera ursinii moldavica</i>	Before July 25	2010-2011: August 24 - September 26 (8)
<i>Vipera ammodytes montandoni</i>	August 16	2011: September 13-24 (2)

Although our documentation of these events was mostly accidental and based on a small sample size, we believe that information regarding the ecological influence of such atypical temperature conditions is important for a better understanding of the effects of climate warming on this group of ectotherms. Temperate region viviparous snakes are capital breeders which normally present a less than annual breeding cycle (e.g. Shine & Bonnet 2009) and the taxa discussed here follow the same patterns (e.g. *Coronella austriaca* – Reading 2004, *Vipera berus nikolskii* – unpublished data, *V. u. moldavica* – Strugariu et al. 2011, *V. a. montandoni* – unpublished data). Capital breeders present a temporal separation between the accumulation of energy reserves and the consumption of these reserves for reproduction (e.g. Houston et al. 2007). Thus, in temperate region viviparous snakes which, for example present a biennial reproductive cycle, one year is used for energy reserve acquisition and in the subsequent year, the reserves are consumed through reproduction (e.g. Shine and Bonnet 2009). The fact that viviparous snakes from temperate regions are only active for about one half to three quarters of the year and that parturition is normally reached in late summer or in autumn, implies that there is physically not enough time for post-partum females to acquire sufficient reserves for another gestation in the following year.

However, if under the predicted trends of climate warming, parturition would normally take place at dates similar to the ones observed by us in 2007, female snakes would have more than an extra month post-partum activity and this might be sufficient for at least some individuals to acquire the reserves needed for a gestation in the following year, therefore increasing the overall reproductive success. Thus, under this scenario, temperate region viviparous snakes might benefit from the effects of climate warming. However, Lourdais et al. (2002) has shown that during warmer summers, female asp vipers (*Vipera aspis*) which reached parturition earlier were also more emaciated and were therefore less likely to survive for a future reproductive event.

Further, more detailed field investigations into this subject as well as experimental research would shed more light on the influence of climate warming and reproductive success and future dynamics of the populations. Long term studies are also needed in order to understand the potential adaptive response of viviparous snakes to climate warming, this being a highly important variable which is not usually taken into consideration when discussing the effects of climate change on various organisms (Shine & Bonnet 2009).

ACKNOWLEDGEMENTS. This work was supported by CNCSIS-UEFISCSU, project PNII-IDEI 2098, No. 1041/2009. We are grateful to the Nature Conservation Committee of the Romanian Academy for issuing research permits. We also thank A. Mizeruș and C.M. Strugariu for their help and assistance in the field and in the lab. Two anonymous reviewers are thanked for their comments on a previous version of this manuscript.

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