Observations on the oviposition of *Blythia reticulata* (Blyth, 1854) with new distributional records from Mizoram State, NE India

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Abstract

The poorly known semi-fossorial snake *Blythia reticulata* is a small, oviparous, worm-eating species found in northeastern India and neighboring countries. Here we report on multiple new distribution localities that extend the known geographic range of the species. In addition, we provide new information on the reproductive biology of the species based on egg-laying behavior data from a captive gravid *B. reticulata* from Mizoram. The simultaneous presence of a second clutch of eight eggs in the oviduct of the female indicates the capacity of the species to exhibit multiple matings and egg clutches during a single reproductive season.

Key Words

*Blyth’s Reticulate Snake*, *Colubridae*, eggs, fecundity, oviparous, reproduction, semi-fossorial

Introduction

*Blythia* Theobald 1868 is a colubrid snake genus comprising two extant species *Blythia reticulata* (Blyth, 1854) and *Blythia hmuifang* (Vogel, Lalremsanga & Vanlalhurma, 2017). *B. reticulata*, commonly known as Blyth’s Reticulate Snake (Uetz 2019) or Iridescent Snake (Whittaker and Captain 2008; Das and Das 2017), is a small semi-fossorial snake, inhabiting evergreen forests at an elevation up to 1,040 m asl. (Whittaker and Captain 2008; Das and Das 2017). The known distribution range of the species includes parts of Bangladesh, China, Myanmar and India (the states of Mizoram, Assam, Arunachal Pradesh, and Manipur (Das 2008; Purkayastha 2013; Das and Das 2017; Vogel et al. 2017). Little has been published about its natural history and reproduction, except that this oviparous snake lays clutches up to 6 eggs (Whittaker and Captain 2008). Little is also known about the ecology, life history, and genetics of *B. reticulata*. Given the paucity of information about this species, its conservation status is currently listed as ‘Data Deficient’ in the IUCN Red List (Wogan and Vogel 2012). Elucidating the reproductive biology of a species is particularly important both for understanding its general life history patterns and also for informing conservation management actions (Siegel and Ford 1987; Holycross and Goldberg 2001). Here, we contribute new details on the reproductive biology of wild-caught *B. reticulata*, as well as new distribution localities for the species from Mizoram State (NE India).

Materials and methods

Reproduction. The reproductive observations reported here come from a captive gravid *B. reticulata*. This individual was spotted and collected while crawling towards a
homestead flower garden at Venghlui, Saiatul town, Saiatul District, Mizoram (23.674578N, 92.962397E; 1,130 m asl.; 8 Jul. 2019). The animal was subsequently transported to the facilities of the Developmental Biology and Herpetology Laboratory, at the Dept. of Zoology, Mizoram Univ. Aizawl. Environmental conditions were monitored with the help of a HTCC-1 LCD Digital Hygrometer Thermometer with a temperature accuracy of ± 1 °C, and a humidity accuracy of ± 5%. Eggs laid on 10 Jul. 2019, at ca. 8:30 hrs were weighed using an electronic balance to the nearest 0.001 g (Gem20 High Precision Digital Milligram Scale, Smart Weigh). We measured the snout-vent length (SVL) and tail length (TL) to the nearest 1 mm using a flexible measuring tape. Scales were counted following the methodology of Dowling (1951) used for taxonomic confirmations. Both laid and oviductal egg sizes were measured using dial callipers (Mitutoyo, 506–671) to the nearest 0.1 mm. The animal was provisioned with both earthworms and insects but refused to feed, although it was observed drinking some water. For the incubation of eggs, an approx. 20 mm thick layer of vermiculite (mixed with water in a 2:1 ratio) was provided for bedding in a 150 mm × 150 mm × 80 mm polypropylene container covered with a perforated lid. Temperatures in the incubation box were maintained between 26.5 °C–28 °C with humidity between 85%–90% °C. Fresh leaves provided were occasionally sprayed with water for maintaining a proper humidity level. Photographs were taken with a digital camera (Canon PowerShot SX430 IS).

**Distributional records.** To prepare a distributional map of *B. reticulata* we collected geographical coordinates of specimen collection sites from Mizoram (India) using a portable GPS unit (Garmin Montana 650-GPS navigator). Field survey methodologies largely followed Doan (2003) and Manley et al. (2004) and specimens were collected using a Visual Encounter Survey (VES) approach by checking ground, bushes, leaf litter, underneath tree-bark, logs, rocks, around water bodies (e.g. streams, canals and tanks), as well as crevices of rocks and boulders, and also by digging into soil. Individuals were collected with the help of tongs or by hand. Collected specimens were kept in snake bags and later catalogued and deposited at the Departmental Museum of Zoology, Mizoram University (MZMU).

**Results**

**Specimen collection.** During the course of this study (2017–2019), we made collections of *B. reticulata* from five different localities in Mizoram State: Lungdai (MZMU 941, gravid ♀, SVL = 332 mm, TL = 34 mm, ventral scales = 134, subcaudal scales = 17; 23.881210N, 92.740351E; 1,180 m asl.; 12 May. 2017, ca. 16:00 hrs; Lalrengpuii Sailo leg.; unearthed from construction site), Tanhril (MZMU 960, non-gravid ♀, SVL = 209 mm, TL = 31 mm, ventral scales = 121, subcaudal scales = 22; 23.738542N, 960, non-gravid ♀, SVL = 209 mm, TL = 31 mm, ven

**Discussion**

The present work provides new distributional records for *Blythia reticulata* from the NE Indian state of Mizoram (Saiatul, Khawzawl, Lungdai, Tanhril, and Thungvel) in addition to the previously recorded sites i.e. Hmuifang, Sawleng, Sihphir, Durtlang, Sihhmui, and Aizawl. The present study also expands the known elevational range of the species from the 949–1,040 m asl. zone up...
**Figure 1.** Map showing distributions of *Blythia reticulata*: (a) Map of NE India showing previous localities in red triangles (1. Hmuifang; 2. Sawleng; 3. Aizawl; 4. Shihmu; 5. Sihphir; 6. Durtlang; 7. Ukhrul; 8. Kohima; 9. Samagooting; 10. Upper Shillong; 11. Shillong; 12. Cherrapunji; 13. Orang National Park; 14. Dafla Hill; 15. Itanagar; 16. Chessa; 17. Dejoo, of North Lakhimpur; 18. Renging, Janakmukh and Rotung; 19. Gandhigram; 20. Lawachara Reserve; 21. Fort White; 22. Hakka; 23. Sumprabum; 24. Htingnam) (see Vogel et al. 2017), and (b) Map of Mizoram showing previous localities in red triangles and new localities in green dots (25. Lungdai; 26. Tanhrib; 27. Saitual; 28. Tlungvel; 29. Khawzawl).

The climate pattern of Mizoram is moist tropical to moist subtropical with temperatures ranging between 18 °C–29 °C in summer, whereas in winter temperatures vary between 11 °C–24 °C; average annual rainfall in the region is about 2,540 mm (Geological Survey of India, 2011). The specimens were encountered between the onset and the end of the monsoon season (late February to October); gravid specimens were encountered during the wettest part of the monsoon season (May to July). Consequently, we argue that reproductive and breeding activities in *B. reticulata* coincide with the rainy season in this region.

**Table 1.** Eggs measurements (in mm) and weights (in g) of *Blythia reticulata*. All three clutches are at different stages of development, with only the first one representing sizes at parturition.

| Eggs of MZMU 1424 | Oviductal eggs of MZMU 1424 | Eggs of MZMU 941 |
|-------------------|----------------------------|------------------|
| Length Width Weight | Length Width Weight | Length Width |
| 17.9 9.3 0.46 | 5.9 2.9 0.39 | 15.9 6.6 0.48 |
| 11.1 9.4 0.38 | 6.1 3.4 0.45 | 14.4 8.2 0.52 |
| 16.2 9.8 0.42 | 6.3 1.4 0.49 | 14.9 7.2 0.55 |
| 17.1 10.7 0.48 | 5.3 2.9 0.39 | 14.5 6.8 0.47 |
| 17.4 8.2 0.42 | 6.1 3.4 0.45 | 13.8 7.6 0.50 |
| 15.4 10.3 0.42 | 6.3 3.1 0.46 | 16.6 7.1 0.52 |
| 20.7 9.4 0.47 | 5.8 3.4 0.42 | 16.8 6.9 0.53 |

likely a crepuscular pattern of natural activity. The climate pattern of Mizoram is moist tropical to moist sub-tropical with temperatures ranging between 18 °C–29 °C in summer, whereas in winter temperatures vary between 11 °C–24 °C; average annual rainfall in the region is about 2,540 mm (Geological Survey of India, 2011). The specimens were encountered between the onset and the end of the monsoon season (late February to October); gravid specimens were encountered during the wettest part of the monsoon season (May to July). Consequently, we argue that reproductive and breeding activities in *B. reticulata* coincide with the rainy season in this region.

Recent herpetological insights signified that the reproductive cycles of almost all snake species can be considered to some extent seasonal, with a pronounced absence of truly continuous patterns of reproduction in snakes (Almeida-Santos et al. 2006; Mathies 2011). The simultaneous presence of a second clutch of eggs at such a short time after oviposition, suggests that *B. reticulata* is also capable of multiple matings and/or multiple clutch-
Figure 2. Observation on the oviposition of a female *Blythia reticulata*. A–C Initiation of the oviposition of third egg. D Female after termination of oviposition with a full, seven egg clutch.

Figure 3. Oviductal eggs of *Blythia reticulata* (MZMU 1424).

es during a single reproductive period. This phenomenon appears to be rare in snakes, with only a handful of observations in some Brazilian snake species in the family Xenodontinae (Pinto and Fernandes 2004) and especially, *Philodrys nattereri* (Mesquita et al. 2011), and *Philodrys olfersii* (Mesquita et al. 2013). The present study
represents the first-ever documentation of oviposition in *B. reticulata*, with a maximum fecundity of 8 eggs vs. the 6 eggs previously reported by (Whitaker and Captain 2008). Although the female laid a total of 7 eggs, we considered maximum fecundity based on the number of eggs found in the oviduct by following Mesquita et al. (2013). According to Mathies (2011), data from specimens with eggs in the oviduct is the best metric for analysing reproductive cycle. Thus, the present publication serves as a novel contribution for this species, which because of its rarity and the secretive lifestyle, remains poorly known (Bassi et al. 2019). Further reproductive studies are needed to improve understanding and delimit the reproductive cycle of the snake species *B. reticulata*.

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**References**

Almeida-Santos SM, Pizzato L, Marques OAV (2006) Intra-sex synchrony and inter-sex coordination in the reproductive timing of the Atlantic coral snake *Micrurus corallinus* (Elapidae) in Brazil. Herpetological Journal 12: 63–67.

Bassi EA, Coeti RZ, de Almeida-Santos SM (2019) Reproductive cycle and sperm storage of female coral snakes, *Micrurus corallinus* and *Micrurus frontalis*. Amphibia-Reptilia (Advance article). https://doi.org/10.1007/s00709-019-00764-3

Blyth E (1854) Notices and descriptions of various Reptiles, new or little known. Journal of Asiatic Society of Bengal 23: 287–302.

Conroy CJ, Papenfuss T, Parker J, Hahn NE (2009) Use of tricaine-methanesulfonate (MS222) for euthanasia of reptiles. Jounalof the American Association for Laboratory Animal Science 48(1): 28–32.

Das I (2008) A Photographic Guide to Snakes and Other Reptiles of India. Om books international, New Delhi, 144 pp.

Das I (2012) A Naturalist’s Guide to the Snakes of South-East Asia (Malaysia, Singapore, Thailand, Myanmar, Borneo, Sumatra, Java and Bali). John Beaufoyst Publishing, Oxford, 160 pp.

Das I, Das A (2017) A Naturalist’s Guide to the Reptiles of India, Bangladesh, Bhutan, Nepal, Pakistan and Sri Lanka. Prakash Books India Private Limited, New Delhi, 176 pp.

Doan TM (2003) Which methods are most effective for surveying rain forest herpetofauna? Journal of Herpetology 37: 72–81. https://doi.org/10.1610/0022-1511(2003)037[0072:WMAMEF]2.0.CO;2

Dowling HG (1951) A proposed standard system of counting ventrals in snakes. British Journal of Herpetology 1(5): 97–99.

Geological Survey of India (2011) Geology and mineral resources of Manipur, Mizoram, Nagaland and Tripura. Miscellaneous Publication No. 30, Part IV, Vol 1 (Part 2), 83 pp.

Holycross AT, Goldberg SR (2001) Reproduction in northern populations of the Ridgenose Rattlesnake, *Crotalus willardi* (Serpentes: Viperidae). Copeia 2001: 471–481. https://doi.org/10.1643/0045-8511(2001)001[0471:BRINOR]2.0.CO;2

Manley PN, Van Horne B, Roth JK, Zielinski WI, McKenzie MM, Weller TJ, Weckerly FW, Vojta C (2006) Multiple species inventory and monitoring technical guide. General Technical Report, U.S. Department of Agriculture, Forest Service, Washington, 204 pp. https://doi.org/10.2737/WO-GTR-73

Mathies T (2011) Reproductive cycles of tropical snakes. In: Alridge RD, Sever DM (Eds) Reproductive Biology and Phylogeny of Snakes. Science Publishers, Enfield, 511–550. https://doi.org/10.1201/b10879-13

Mesquita PCMD, Borges-Nojosa DM, Passos DC, Bezerra CH (2011) Ecology of *Philodryas nattereri* in the Brazilian semi-arid region. Herpetological Journal 21: 193–198.

Mesquita PCMD, Sá-Polídoro GL, Zanini-Cehin S (2013) Reproductive biology of *Philodryas ofersii* (Serpentes, Dipsadidae) in a subtropical region of Brazil. Herpetological Journal 23: 39–44.

Pinto RR, Fernandes R (2005) Reproductive biology and diet of *Liophis poecilogyrus* (Serpentes: Colubridae) from southeastern Brazil. Phylomedusa 4: 111–122.

Purkayastha J (2013) An Amateur’s Guide to Reptiles of Assam. EBB Publishers (India), Guwahati, 146 pp.

Siegel R, Ford NB (1987) Reproductive ecology. In: Siegel RA, Collins JT, Novak SS (Eds) Snakes: Ecology and Evolutionary Biology. McMillan, New York, 210–252.

Vogel G, Lalremsanga HT, Vanlalhrima (2017) A second species of the genus *Blythia* Theobald, 1868 (Squamata: Colubridae) from Mizoram, India. Zootaxa 4276(4): 569–581. https://doi.org/10.11646/zootaxa.4276.4.8

Whitaker R, Captain A (2008) Snakes of India: The field guide. Draco Books, Chennai, 385 pp.

Wogan G, Vogel G (2012) *Blythia reticulata*. The IUCN Red List of Threatened Species 2012: e.T190620A1955221. https://doi.org/10.2305/IUCN.UK.2012-1.RLTS.T190620A1955221.en [Accessed on 14.12.2019]