ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 12, Issue 3, pp: (28-32), Month: July - September 2024, Available at: www.researchpublish.com

Sexual Dimorphism in Bhupathy's Shieldtail Snake

[1]Debanik Mukherjee, [2]M. Vijay, [3]Pulkit Sharma

[1]Centre for Environmental Management of Degraded Ecosystems, University of Delhi, Delhi – 110 007, India

[2]Regional museum of natural history, Siddarthanagar, Mysore, Karnataka – 570011, India.

[3]GuruJal 1600, Patel Nagar, Gurugram, Haryana – 122001, India.

DOI: https://doi.org/10.5281/zenodo.13823060

Published Date: 21-September-2024

Abstract: **The Sexual dimorphism in Shieldtail snake *Uropeltis bhupathyi* an endemic to Anaikatty hills, Southern Western Ghats of India, has been morphometrically analyzed with respect to variations such as Snout-Vent Length (SVL), Tail Length (TL), Caudal Disc Length (DL) & Width (DW), ventral and subcaudal scale counts. Females (mean SVL = 299.2 $\pm$ 93.92 mm, n = 19) were found larger as compared to males (230.3 $\pm$ 61.24 m, n = 13) and variation was statistically significant (F = 5.387, P = 0.027). Significant variations being also observed in TL, DW and in ventral and subcaudal count. The principal Component Analysis (PCA) showed that SVL, DW and DL had high loadings in factor 1, and these may be important parameters in identifying sexes.**

Keywords: **sexual dimorphism, Bhupathy's Shieldtail Snake, Anaikatty hills, Western Ghats.**

1. INTRODUCTION

Theodosius Dobzhansky's 1977 remark **Nothing in Biology makes any proper sense except in the light of Evolution** perhaps had less understandings in modern taxonomists and ecologists to address that geophysical activities along with various evolutionary and ecological factors are the main driving forces of speciation. However, Dobzhansky's concept perhaps again triggered evolutionary biologists to rethink about the theory of Darwinian natural selection, which is largely based on favoring the most adapted individuals by eliminating deleterious mutants those are not fittest within the population, whereas the theory of sexual selection or mate choice is a part of natural selection (Guttman 2005).

The sexual dimorphism is a phenotypic trait resulted from evolutionary consequence of sexual mate selection which is largely biased on females to find the strongest mate and in many instances, it happens through territorial combat between males where the defeated are rejected or sometimes escape in search for a new mate; however, it has some ecological aspects to reduce spatial and trophic resource competition within a population (Shine et al. 1999; Shetty and Shine 2002).

As compared to birds and mammals relatively less sexual dimorphism has been reported in snakes which perhaps attribute to their simplified external morphology which is a consequence of strong selection pressure (Shine 1994). The snout-vent length (SVL) among many snakes is variable with respect to sex, but the tail is mostly longer in males as compared to females (Pough et al. 1998).

Around 44 species of Shieldtail snakes (Family: Uropeltidae) are distributed in India and are largely endemic to the Western Ghats whereas *Uropeltis shorttii* has been reported from Eastern Ghats (The Reptile Database http://www. reptile-databae.org). A reduced ocular shield, pointed head with keratinized thick rostral shield, the caudal disc and development of strong musculature in the anterior trunk supports typically characteristic subterranean mode of life. McCann 1924 stated that traits such as development of caudal disc at tip of the tail perhaps evolved through natural selection which is to obstruct the entrance of burrows when they are active beneath the soil. These snakes are largely ovoviviparous and seasonally active only during monsoons (Smith 1943; Rajendran 1985). Published articles on the sexual dimorphism in Indian snakes are too sketchy. Hence, we provide information on sexual dimorphism in *Uropeltis bhupathyi* in terms of variations in Snout-Vent Length (SVL), Tail Length (TL), length (DL) and width (DW) of the Caudal Disc and ventral and subcaudal count.

The present study was conducted during April 2021 – April 2022, an ecological survey at Anaikatty Hills (11^{o}05' N, 76^{o}47' E), Nilgiri Biosphere Reserve, Western Ghats, India. General altitude of the Anaikatty sanctuary is about 650 m asl, and it receives over 650 mm of annual rainfall. Climate of the area is semi-arid with maximum temperature of 36^{o}C during summer. Predominant forest cover of these hills is Southern mixed dry deciduous forest (Champion and Seth 1968; Mukherjee 2012; Mukherjee et al. 2023).

2. MATERIALS AND METHODS

A section 4 Km stretch of State Highway (SH No. 63) that passes through the Anaikatty forest was fortnightly monitored at 07:00 and 17:00 hrs for reptiles. All road kills of *Uropeltis bhupathyi* found during these surveys were collected and fixed in 8% formaldehyde. Prior to preservation, intact specimens were probed for male sex organ. SVL and TL were measured using a flexible nylon line and metal scale (accuracy- 0.1 mm), and DL and DW were measured using Mitutoyo dial vernier calipers (accuracy- 0.02 mm). In addition, ventral and subcaudals were counted. The preserved specimens were dissected later to confirm the sex. One way Analysis of Variance (ANOVA) was performed to find out the significant difference in the above parameters between males and females. Extraction method of the Principal Component Analysis (PCA) was performed using statistical package SPSS version 10 to identify the parameters that separated sexes in this species.

3. RESULTS

Road kills of *Uropeltis bhupathyi* were observed and collected during October-December, the only primary monsoon season of the area. This augments the view that Shieldtails are highly seasonal in activity and largely found on tar roads for thigmothermic thermoregulation during monsoon. A total of 45 road kills were recorded during the present study of which 32 (19 females and 13 males) were intact specimens and used in the current analysis. Mean SVL was 271.2 mm (STD $\pm$ 88.06 mm), and the largest individual measured 434 mm, which may be the largest specimen hitherto reported for this species. Female snakes were larger (mean SVL = 299.2 + 93.92 mm, n = 19, Table 1) than males (mean = 230.3 + 61.24 mm, n = 13). One-way ANOVA showed that the variation in SVL between male and female was significant (F = 5.387, P = 0.027). Sex ratio of *U. bhupathyi* in the area was largely female biased (1:1.5).

Males of *U. bhupathyi* had longer tail (TL) (mean = 10.7$\pm$ 2.81 mm, n = 13) than females (mean = 8.63$\pm$ 2.17 mm, n = 19). Variation in tail length (TL) between males and females was also significant (F = 5.488, P = 0.026). Number of ventral scales of females ranged from 206 to 212 (mean = 209.32$\pm$ 1.49), whereas it was 190 – 200 (mean = 195.38 $\pm$ 2.33) in males. Number of subcaudals was higher in males 9-10 compared to females (only seven). Variation in ventral and subcaudals between male and female was highly significant (P = 0.000). Caudal disc dimension (length and width) of male and females were length (DL) 7.42 $\pm$ 1.79 mm & width (DW) 3.78 $\pm$ 0.70 mm and (DL) 7.2 $\pm$ 1.64 mm & (DW) 5.02 $\pm$ 1.15 mm respectively. Variations between male and female with respect to caudal disc length was almost significant but the disc width was highly significant (F = 11.96, P = 0.002).

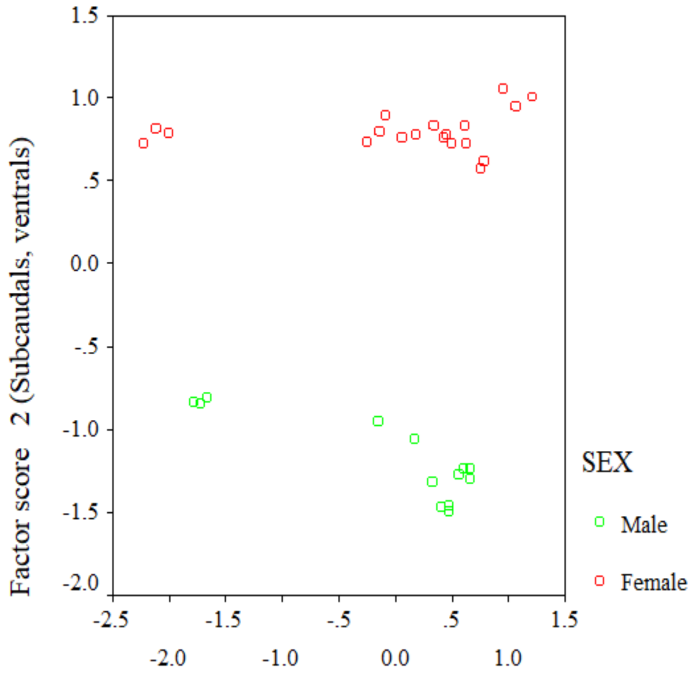
4. DISCUSSION

Smith 1943 and Rajendran 1985 reported a total maximum length of 250 mm and 247 mm respectively in *U. ellioti* a taxonomically closely related species to *U. bhupathyi*. Which highlights a long-term ecosystem monitoring to obtain large sample size while dealing with size structure in snakes.

Generally, sex ratio of most reptiles may be close to one; however, variations or a biased sex ratio perhaps related to spatio-temporal changes in ecosystem, which impacts on their breeding biology as most reptiles are ectothermic in thermoregulation, other factors such as genetic and random inbreeding within population may be other reasons for a biased sex ratio in many species of snakes (Hamilton 1967; Shine and Bull 1977). Feaver 1977 hypothesized that deviation in sex ratio may be related to the faster growing sex, as faster growing snakes may feed more, which perhaps cause a high predation pressure on it and thus the larger sexes may not be well represented in field samples. However, later researchers could not find supports for Feaver's hypothesis, and believed that the reverse of this would be true (Parker and Plummer 1987). The present study augments the later, view Table 1.

Table 1. Morphometric comparison of male and female *Uropeltis bhupathyi*

Parameter	Male (n=13)	Female (n=19)
Snout vent length (SVL)	230.3 ± 61.24	299.2 ± 93.92
Tail length (TL)	10.7 ± 2.81	8.63 ±2.17
Caudal disc length (DL)	7.42 ±1.79	7.2 ±1.64
Caudal disc width (DW)	3.78 ± 0.70	5.02 ± 1.15
No. of ventral	195.38 ± 2.33	209.32 ± 1.49
No. of subcaudal	9.23 ± 0.44	7 ±0



Factor score 1 SVL, TL, DW & DL

Figure. 1 Principal Component Analysis showing sexual dimorphism in *Uropeltis bhupathyi*

Males in many snakes may be under strong selection pressure to combat with other males for mating with a receptive female, hence strengthening and elaboration of skeletal musculature in males might have been favoured through natural selection which also enhancing the chance of a successful copulation after defeating its rival. Females always prefer a successful and stronger mate to carry on genetically superior progeny. However, the selection pressure may be more intense on females as they have to produce gametes which are rich with nutrients for the developing embryos and to be retained till reproduction. The disproportionate external or internal enlargement of female body parts possibly related to forced allometric shifts to support fecundity. To investigate how evolutionary forces have shaped male and female morphology snakes may provide an excellent example (Shine 1994). The larger body size in females also attributed to retain maximum clutch size. Sexual size dimorphism (SSD) is also related to selection pressure on one sex and fecundity perhaps enabled an enlarged body size in female biased species. For instance, studies on the South African colubrid *Crotaphopeltis hotamboeia* showed that number of eggs laid by a female was directly depended on its body size (Fitch 1970; Keogh et al. 2000). Fitch 1981 documented a trend for larger female body size in viviparous or ovoviviparous reptiles as compared to oviparous taxa.

The life history traits of viviparity among many species may be largely associated to consistent evolutionary shift to a larger body size in females as compared to males perhaps an ecological adaptation in a comparatively cooler or variable climatic regions (Shine 2014). The present study supports the view of Fitch (1981) as *U. bhupathyi* is an ovoviviparous species where females attain larger body size as compared to males and occupied a particular niche in the hilly folding slopes covered by thick leaf litter providing a moist and atmospherically cooler microclimate.

However, where the sexual combats among males are more intense, males may attain a larger body size than females. It may also be anticipated that longer tails in males perhaps being evolved to accommodate copulatory organs (hemipenes) in the tail base and a longer tail may be helpful for tail twisting between rival males. It is reported that males with partial tail loss or mutilation due to predation pressure may experience a reduction in mating success (King, 1989; Madsen and Shine, 1994).

Rajendran 1985 stated that differences in ventral counts, caudal length and diameter and nature of the caudal disc in many Uropeltid species may be largely due to clinal variation. But the conclusion on disc-shape difference between male and female *Uropeltis bhupathyi* from Anikatty hills contradicts the view and signifies sexual dimorphism.

Principal Component Analysis (PCA) showed that the first two components explained 95.4% variations. The first component clearly separated the males and females Fig. 1, using the parameters studied such as SVL, DW and DL which had high loadings in factor 1, they are important parameters in identifying sex. Parameters such as the number of subcaudals, ventral counts and TL had higher loadings in factor 2. This clearly indicates sexual dimorphism in *U. bhupathyi*, especially with respect to SVL, TL, caudal disc width, number of ventral and subcaudal counts. Future studies may also reveal the applicability of the present findings with respect to other species of Uropeltids.

A long and narrow caudal disc in males may be helpful to accommodate copulatory organ at the base of tail and to easily insert it during copulation whereas a short and wider caudal disc in females may be associated with ovoviviparous nature of this species. However, in both sexes caudal disc functions as a soil plug, a defensive mechanism for a non-venomous subterranean snake against burrowing predators which generally attacks from back. However, it is also possible that a blunt tail tip may appear as false head where excessive growth in the bony structure at the caudal end and disproportionate growth rate of the external soft tissues modified the shape of the tail tip to confuse or misdirect a predator, a survival strategy largely known as automimicry which is also reported in adult Boid snake *Eryx johnii*.

ACKNOWLEDGEMENTS

The special Thanks to our senior Dr. M. Nixon, California, US, We are thankful to the Director SACON Anaikatty, Coimbatore, TN and the Director National Museum of Natural History, New Delhi for encouraging our endeavour. Also, we would like to thank Coimbatore Division, Tamil Nadu Forest Department, Dr. J.R. Bhatt (Scientist-G) Adviser, Ministry of Environment Forest and Climate Change and Prof. CR Babu (Professor Emeritus CEMDE, Dept. of Environmental Science, and University of Delhi) for providing us this opportunity of such scientific pursuits. Last but not the least we are thankful to DDA (Delhi Development Authority) for their valuable support.

REFERENCES

[1] Champion, H.G. and Seth, S.K. (1968). *A revised survey of the forest types of India*. Government of India Press: Nasik: India.

[2] Dobzhansky, T. (1977). "Nothing in biology makes sense except in the light of evolution." *Journal of Heredity* 681, 3-10.

[3] Feaver, P.E. (1977). *The Demography of a Michigan population of Natrix sipedon with – discussions of Ophidian growth and reproduction*. PhD dissertation, University of Michigan, Ann Arbor.

[4] Fitch, H.S. (1970). *Reproductive cycles in lizards and snakes*, Miscellaneous Publication, University of Kansas Museum of Natural History.

[5] Fitch, H.S. (1981). *Sexual size differences in reptiles*. Miscellaneous Publication, University of Kansas Museum of Natural History.

[6] Guttman, S.B. (2005). *Evolution a beginner's guide*. England: Oxford: Oneworld Publications.

[7] Hamilton, W.D. (1967). Extraordinary sex ratios. *Science* 156, 477-488.

[8] Keogh, J.S. Branch, W.R. and Shine, R. (2000). Feeding ecology, reproduction and sexual dimorphism in the colubrid snake *Crotaphopeltis hotamboeia* in South Africa. *African Journal of Herpetology* 49, 129-137.

[9] King, R.B. (1989). sexual dimorphism in snake tail length: sexual selection, natural selection, or morphological constraint? *Biological Journal of the Linnean Society* 38, 2, 133-154.

[10] McCann, C. (1924). A note on the habits of Large-scaled Earth Snake (*Silybura macrolepis*). *Journal Bombay Natural History Society* 29, 1062-1063.

[11] Madsen, T. and Shine, R. (1994) Costs of reproduction influence the evolution of sexual size dimorphism in snakes Evolution. *Evolution* 48, 4, 1389-1397.

[12] Mukherjee, D. (2012). *Community Ecology of Reptiles in Anakatty Hills, Western Ghats, India* Saarbrucken, Germany: LAPLambert Academic Publishing AG &Co. KG DudweilerLandstr.

[13] Mukherjee, D. Sharma, P. and Vijay, M. (2023). A New Species of Cnemaspis (REPTILIA: SQUAMATA: GEKKONIDAE) from the Western Ghats of Tamil Nadu, India. *International journal of life Sciences Research* 11,3, 44-50.

[14] Parker, W.S. and Plummer, M.V. (1987). Population Ecology. In *Snakes: Ecology and Evolutionary Biology*: 253-301. Seigel, R.A. Collins, J.T. and S.S. Novak. (Ed.). New York: McGraw- Hill Publishing Company.

[15] Pough, F.H. Andrews, R.M. Crump, M.L. Sevitzky, A.H. and K.D.Wells. (1998). *Herpetology*. New Jersey: Upper Saddle River: Simon & Schuster A Viacom Company.

[16] Rajendran, M.V. (1985). *Studies in Uropeltid Snakes*. India: Madurai: Madurai Kamaraj University.

[17] Shetty, S. and Shine, R. (2002). Sexual divergence in diets and morphology in Fijian sea snakes, *Laticauda colubrina* (Laticaudinae). *Australian Ecology* 27, 77-84.

[18] Shine, R. and Bull, J.J. (1977). Skewed sex ratios in snakes. *Copeia* 2, 228-234

[19] Shine, R. (1994) Sexual Size Dimorphism in Snakes Revisited. *Copeia* 2, 326-346.

[20] Shine, R. Olsson, M.M. Moore, I.T. LeMaster, M.P. and R.T. Mason. (1999). Why do male snakes have longer tail than females. *Proceedings of the Royal Society Series B* 266, 2147-2151.

[21] Shine, R. (2014). Evolution of an evolutionary hypothesis: A history of changing ideas about adaptive significance of viviparity in Reptiles. *Journal of herpetology* 48, 2, 147-161

[22] Smith, M.A. (1943). THE FAUNA OF BRITISH INDIA CEYLON AND BURMA, including the whole of THE INDO-CHINESE SUB-REGION SERPENTES. London: Taylor & Francis Ltd.