

First record of *Chrysopelea taprobanica* Smith, 1943 (Squamata: Colubridae) from India

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Abstract: *Chrysopelea taprobanica* Smith, 1943 was previously considered to be endemic to the dry and intermediate zones of Sri Lanka. However, an adult specimen of *C. taprobanica* was collected from Seshachalam Biosphere Reserve of Andhra Pradesh, India, being the first record of this snake species from India, significantly extending the known range of distribution of the species. The dry zones of peninsular India were connected with Sri Lanka as recently as ca. 17,000 years ago, which probably allowed movement of species between these two regions.

Key words: Andhra Pradesh, *Chrysopelea*, India, new record

The flying snakes (*Chrysopelea*) are arboreal members of the family Colubridae, consisting of five nominal species distributed across South and Southeast Asia (Uetz and Hošek 2013). Two species of the genus occur in India: *Chrysopelea ornata* (Shaw, 1802) in the mainland (and several other south Asian countries) and *C. paradisi* Boie, 1827 in the Andaman group of islands (and several other south-east Asian countries) (Whitaker and Captain 2004).

Chrysopelea taprobanica Smith, 1943 was described based on a type series from Kanthali (=Kantalai) and Kurunegala in Ceylon (now Sri Lanka) (Smith 1943). It is considered endemic to Sri Lanka widespread in the dry and intermediate zones of the island, and is sympatric with *C. ornata* in part of its range (Derniyagala 1955; Somaweera 2004). The habitat in which *C. taprobanica* occurs in Sri Lanka is a dry-mixed evergreen forest (Sameera Karunarathna pers. comm.). *Chrysopelea taprobanica* differs from *C. ornata* and *C. paradisi* by the last ventral shield not being divided (vs. last ventral divided in *C. ornata* and *C. paradisi*), and an olive dorsal colour with black cross-bars (vs. red rosettes along the back green above, each scale with a black median line in *C. ornata* and in case of *C. paradisi* the colour is black above, each scale with a central yellow spot) (Smith 1943; Derniyagala 1955).

In 2000, an unidentified specimen suspected to be *Chrysopelea taprobanica* was photographed by Dr. Santharam in a deciduous forest patch in Rishi Valley, Andhra Pradesh, India (V. Santharam pers. comm.) but the specimen was not collected. On 28 November 2013, we collected a specimen of

Chrysopelea taprobanica in the dry deciduous forest of Chama-la, Seshachalam Biosphere Reserve (13°35'24" N, 079°15'28" E), Andhra Pradesh, India. The specimen (voucher BLT 076, collection permit: RC/11/2012/BLT issued by Andhra Pradesh Forest Department) is deposited in Bio-Lab of Seshachalam Hills, Tirupathi, India, and it represents the first-ever confirmed record of *C. taprobanica* from India and anywhere outside Sri Lanka (Figure 1).

Muscle tissues from the abdomen region were stored in 100% ethanol for genetic analysis and the specimen was fixed in 10 % formaldehyde and store in 70 % ethanol. DNA was extracted using a Qiagen DNeasy Blood and Tissue kit. Two mitochondrial genes were amplified using the polymerase chain reaction and sequenced for BLT 076: 16s rRNA (~ 493 bp) and NADH4 (~ 680 bp) following PCR conditions and primer combinations of Pyron *et al.* (2013). Eight other sequences of closely related species of snakes from Sri Lanka

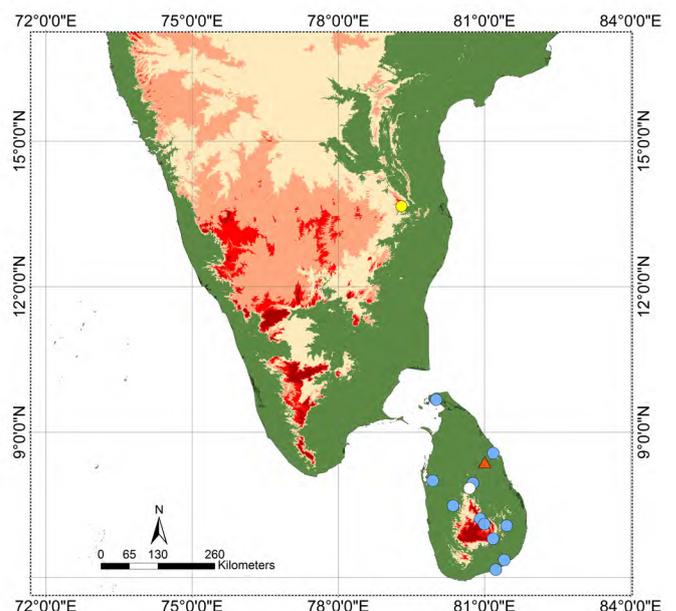


Figure 1. Records of *Chrysopelea taprobanica*. Red triangle = type locality; yellow circle = the new record (Chamala, Seshachalam hills, India); white circle = locality of the specimens used in the molecular phylogenetic analysis; blue circles = additional records, in Sri Lanka (based on Derniyagala 1955 and Somaweera 2006).

were downloaded from Genbank (*Chrysopelea* spp.: KC347508, KC347496; *Dendrelaphis* spp.: KC347497, KC347518, KC347509, KC347493; *Ahaetulla* spp.: KC347526, KC347512) and compared with the new record (BLT 076). The sequences were aligned in software MEGA 5.1 and uncorrected *P*-distances were calculated and compared (Tamura et al. 2011). The model of sequence evolution was determined using the program JModelTest 2.1.2 (Darriba et al. 2012). GTR+I+G model was chosen by hierarchical likelihood ratio test (hLRT) and support was assessed with 1,000 rapid bootstraps. The NADH4 mitochondrial sequences were used to build maximum likelihood tree using the software RaXML GUI (Silvestro and Michalak 2012).

Colour descriptions and images are discussed based on the live specimen, BLT 076. Ventral scales were counted following Dowling (1951), however the tip of the terminal scute was excluded from the number of subcaudals. Dorsal scales were counted at approximately one head length posterior to the head, at mid-body (corresponding to half the number of ventral scales) and at approximately one head length anterior to the vent, respectively.

Based on the colour pattern, morphometric comparisons, and genetic analysis, the identity of the specimen BLT 076 was confirmed as *Chrysopelea taprobanica*. It was clearly separated from *C. ornata* (the only other member of the genus present in mainland India) based on the presence of an undivided

pre-anal scale; and olive dorsal colour with black cross-bars. The specimen is a long, slender snake measuring 812 mm total length (589 mm snout-vent length and 223 mm tail length). It has 201 ventral scales; 106 subcaudal scales; and 17:17:15 dorsal scales. Snout broad and rostrum wide (5.0 mm). Internasals longer (3.5 mm) than broad (2.6 mm); prefrontals almost as long (4.3 mm) as wide (4.4 mm); frontal longer (8.8 mm) than wide (6.0 mm); supraocular single; a relatively large pair of parietals which are longer (9.3 mm) than wide (6.1 mm). The diameter of the eye (3.5 mm) is more than half its distance from the nostril (4.7 mm). Head length (23.7 mm), head width (9.0 mm), head height (7.9 mm), and body width (12.5 mm). Eye in contact with the 4th, 5th and 6th supralabials; one preocular touching the third and fourth supralabials; preoculars are in contact with loreal and prefrontal in front; loreal in contact with the 2nd and 3rd supralabials; nasal divided. Two postocular scales, first in contact with the parietal and the second in contact with two pairs of temporals (Figure 2). The head and neck are with six horizontal black and yellow cross bars with the horizontal stripes continuing to the lateral side of the head. In total of 57 black bands are present along the body and 14 on the tail (Figure 3). Comparison of BLT 076 DNA sequences (Genbank accession number KM673289 and KM673290) from India with sequences of *Chrysopelea taprobanica* and *C. ornata* from Sri Lanka showed a 100% match between samples of *C. taprobanica*. The relationship of *C. taprobanica* from Sri Lanka and India is well-supported in the maximum likelihood tree (Figure 4).



Figure 2. Ventral, dorsal, and lateral views of the head of *Chrysopelea taprobanica* (BLT 076, SVL 589 mm) collected from Seshachalam hills, Chamala, Andhra Pradesh, India.



Figure 3. Full body profile of *Chrysopelea taprobanica* (BLT 076, SVL 589 mm) collected from Seshachalam hills, Chamala, Andhra Pradesh, India.

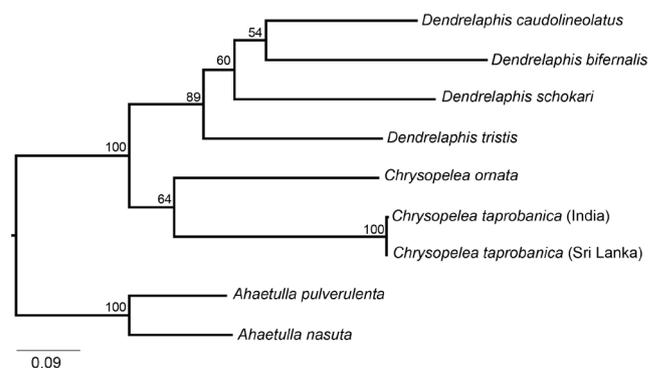


Figure 4. Phylogenetic relationships of *Chrysopelea taprobanica* from India and Sri Lanka, and related taxa, reconstructed using NADH4 mitochondrial gene; ML bootstrap support-values for each node is included.

Derniyagala (1955) noted that the dorsal scale counts (17:15:13) of the specimens of *Chrysopelea taprobanica* he collected (unknown vouchers) were different to those of the type series housed at the British Museum of Natural History [17:19:15 in BMNH 1906.7.21.1 (1946.1.9.75), BMNH 1915.5.3.19-11 (1946.1.9.65-66)]. Our specimen (BLT 076) has a count of 17:17:15 dorsals, indicating variations in these counts. Our recorded number of subcaudals (106) falls lightly below previous records of 107-123 but the number of ventral scales (201) falls within the known range (198-214) (Smith 1943; Derniyagala 1955). The identical genetic sequences of *C. taprobanica* sample found in India and Sri Lanka suggest that they probably dispersed to India from Sri Lanka or vice versa in the recent past.

Five other species of dry zone arboreal snakes of Sri Lanka have also been reported from southern India in the past, viz. *Ahaetulla nasuta*, *Ahaetulla pulverulenta*, *Boiga trigonata*, *Dendrelaphis tristis*, and *Dryocalamus nympha*. The Seshachalam hill range where we found *Chrysopelea taprobanica* is part of the Eastern Ghats in southern Andhra Pradesh. The Eastern Ghats are a chain of broken hills in Peninsular India and compared to the Western Ghats they are less explored for their biodiversity (Das 2001). Given that the dry zones in southern peninsular India and Sri Lanka had land connections in the recent past (ca. 17,000 years ago) (Voris 2000), it is not surprising that a species thought to be endemic to the dry and intermediate zones of Sri Lanka was found in the Indian dry deciduous forests.

ACKNOWLEDGEMENTS

We thank the Andhra Forest Department for their support to carry out this study. Dr. Praveen Karanth for his support and discussions, Aniruddha Datta-Roy for the discussions. Ishan Agarwal for bringing to our notice on the potential occurrence of *C. taprobanica* in Rishi Valley. Ashok Kumar Mallik for sharing the primers. Dr. Santharam (Rishi Valley seducation Centre) for sharing his observation and photographs. Dr. Abhijit Das and S. Harikrishnan for their comments. Sameera Suranjan Karunarathna for his help in verifying the list of dry zone snakes in Sri Lanka. We thank K. Madhu and T. Thulasiah for their help during the survey. We thank our supporting team members from Bio-Lab, Tirupati for their help. Finally we thank the editors of *Check List* for their effort and reviewers Dr. Ruchira Somaweera and Dr. Davi Pantoja for their valuable comments to improve this manuscript.

LITERATURE CITED

Boulenger, G.A. 1896. *Catalogue of the Snakes in the British Museum (Natural History)*. Volume III. containing the Colubridæ

(Opisthoglyphae and Proteroglyphae), Amblycephalidae, and Viperidae. London: British Museum of Natural History. 382 pp (doi: 10.5962/bhl.title.29427).

Darriba, D, G.L. Taboada., R. Doallo., D. Posada. 2012. jModelTest 2: more models, new heuristics and parallel computing. *Nature Methods* 9: 772 (doi: 10.1038/nmeth.2109).

Das, I. 2002. *A Photographic Guide to Snake and Other Reptiles of India*. Sanibel Island: Ralph Curtis books. 144 pp.

Deraniyagala, P.E.P. 1955. *A Colored Atlas of Some Vertebrates from Ceylon*. Volume III. Colombo: The National Museum. xix + 121 pp.

Dowling, H.G. 1951. A proposed standard system of counting ventrals in snakes. *British Journal of Herpetology* 1: 97-99.

Pyron, R.A., H.D. Kandambi, C.R. Hendry, V. Pushpamal., F.T. Burbrink and R. Somaweera. 2013. Genus-level phylogeny of snakes reveals the origins of species richness in Sri Lanka. *Molecular Phylogenetics and Evolution* 66: 969-978 (doi: 10.1016/j.ympev.2012.12.004).

Silvestro, D., and Michalak, I. 2012. raxmlGUI: a graphical front-end for RAxML. *Organisms Diversity and Evolution* 12: 335-337 (doi: 10.1007/s13127-011-0056-0).

Smith, M.A. 1943. *The Fauna of British India, Ceylon and Burma, Including the Whole of the Indo-Chinese Sub-region*. Reptilia and Amphibia. Volume III (Serpentes). London: Taylor and Francis. 583 pp.

Somaweera, R. 2004. Sri Lankan colubrid snakes. *Sri Lanka Naturalist* 6(03-04): 32-46.

Somaweera, R. 2006. *Sri Lankawe Sarpayin ('The Snakes of Sri Lanka')*. Sri Lanka: Wildlife Heritage Trust of Sri Lanka. 297 pp.

Tamura, K., D. Peterson, N. Peterson, G. Stecher, M. Nei and S. Kumar. 2011. MEGA5: Molecular Evolutionary Genetics Analysis using Maximum Likelihood, Evolutionary Distance, and Maximum Parsimony Methods. *Molecular Biology and Evolution* 28(10): 2731-2739 (doi: 10.1093/molbev/msr121).

Uetz, P. and Hošek, J. (eds.). 2013. *The Reptile Database*. Accessible at <http://www.reptile-database.org/>. Captured on 30 November 2013.

Voris, H.K. 2000. Maps of Pleistocene sea levels in Southeast Asia: shorelines, river systems and time durations. *Journal of Biogeography* 27: 1153-1167 (doi: 10.1046/j.1365-2699.2000.00489.x).

Wall, F. 1908. A popular treatise on the common Indian snakes. *Journal of the Bombay Natural History Society* 18(2): 227-243 (doi: 10.5962/bhl.title.13368).

Whitaker, R. and Captain, A. 2004. *Snakes of India: The Field Guide*. Chennai: Draco Books. Chennai. 479 pp.

Authors' contribution statement: BG collected the specimen from field. BG and VD collected data from the specimen. SM collected data from museum specimens. VD, SM, BG and NVSP wrote the text and VD did the analysis.

Received: March 2014

Accepted: December 2014

Editorial responsibility: Davi Pantoja