

Notes on broodcare by *Hindumanes* and updated distribution of the genus from published records and citizen science observations (Araneae: Salticidae: Lyssomaninae)

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Abstract. This paper presents the first photographic record of a *Hindumanes* (Logunov 2004) with its egg sac. The genus *Hindumanes* bears a close morphological resemblance to the Neotropical genus *Lyssomanes*. In addition to the morphological similarities, the brood nests of *Hindumanes* and *Lyssomanes* appear very similar with widely spaced eggs beneath sparse layers of silk. An adult female *Hindumanes* appeared to be guarding her brood nest as she was seen either directly on top or within touching distance of it. This paper also consolidates all 11 publicly available records of the genus *Hindumanes* across published literature and verified observations on citizen science platforms to form an updated view of the geographic distribution of the genus. *Hindumanes* is distributed across the entire Western Ghat ecoregion with one citizen science observation coming from Yercaud, located in the Eastern Ghat ecoregion.

Key words. broodcare, citizen science, distribution, India, jumping spider, *Lyssomanes*

Introduction

Lyssomanes karnatakaensis was first described from a single female collected in southwestern India (Tikader & Biswas 1978). Later, Logunov (2004), after examination of a single female *L. karnatakaensis* (not the type) collected at the type locality, decided that this species should be transferred to a new monotypic genus, *Hindumanes* Logunov 2004. According to Logunov, the generic name consists of two parts: "Hindu", referring to the country in which the main religion is Hinduism, and the second half of the generic name *Lyssomanes*, in which the type species was originally described. Logunov considered this genus to be closest to *Pandisus* Simon 1900 and *Lyssomanes* Hentz 1845, and placed it in the subfamily Lyssomaninae with those genera. Later both *Hindumanes* and *Pandisus* were moved to the newly-created subfamily Asemoneinae, with *Lyssomanes* remaining in the subfamily Lyssomaninae (Maddison, 2015).

H. karnatakaensis was the only species in the genus *Hindumanes* until the description of *H. wayanadensis* from Wayanad, Kerala (Sudhin, Nafin & Kumar 2017). In the same paper the first male *H. karnatakaensis* was described, the female *H. karnatakaensis* was redescribed, and the genus was returned to the subfamily Lyssomaninae (Figure 1). *Hindumanes* was seen as morphologically similar to *Lyssomanes*, with a similar body type, paired ventral spines on tibia and metatarsus, and common features of the male pedipalp. The eye arrangement, although a characteristic feature of *Hindumanes*, was found to be similar to that seen in some *Lyssomanes* species.



Figure 1. Male (1) and female (2) *Hindumanes karnatakensis* from Wayanad Wildlife Sanctuary, Kerala (31 MAY 2015). These are the individuals described by Sudin, Nafin & Sudhikumar (2017), and also appear as records (5) and (4), respectively, in Table 2. Photographs © K. S. Nafin (nafin_ks on iNaturalist), used under a [CC BY-NC 4.0](https://creativecommons.org/licenses/by-nc/4.0/) license.

A total of seven species from India have been placed in either *Hindumanes* or *Lyssomanes*, and presently only two of these (*H. karnatakaensis* and *H. wayanadensis*) are considered to be valid names (Table 1).

Table 1. Indian species originally placed in either *Hindumanes* or *Lyssomanes*.

♂♀	original name	original reference	revised name	revision references
♀	<i>Lyssomanes sikkimensis</i>	Tikader 1967	<i>Telamonia festiva</i> Thorell 1887	Roy, Saha & Raychaudhuri 2016
♂♀	<i>Lyssomanes andamanensis</i>	Tikader 1977	<i>Asemonea tenuipes</i> (O. Pickard-Cambridge 1869)	Wanless 1980
♀	<i>Lyssomanes bengalensis</i>	Tikader & Biswas 1978	<i>Asemonea tenuipes</i> (O. Pickard-Cambridge 1869)	Wanless 1980
♀	<i>Lyssomanes karnatakaensis</i>	Tikader & Biswas 1978	<i>Hindumanes karnatakaensis</i> (Tikader & Biswas 1978); type species for <i>Hindumanes</i> Logunov 2004	Logunov 2004; ♂ described by Sudhin, Nafin & Sudhikumar 2017
♀	<i>Lyssomanes chilapataensis</i>	Biswas & Biswas 1992	<i>Epeus chilapataensis</i> (Biswas & Biswas 1992)	Logunov 2004
♀	<i>Lyssomanes santinagarensis</i>	Biswas & Biswas 1992	<i>Asemonea cristata</i> Thorell 1895	Sudhin, Nafin, Caleb & Sudhikumar 2020
♀	<i>Hindumanes wayanadensis</i>	Sudhin, Nafin & Sudhikumar 2017	no revision	

Over the years, broodcare has been studied in several spider families, to include the Theridiidae, Lycosidae and Salticidae. One salticid species, *Toxus magnus* (Saitō 1933), was found to provide advanced broodcare, to include "milk" provisioning and extended maternal care, previously thought to be exclusive to mammals (Chen et al. 2018). One commonly observed form of broodcare in jumping spiders involves the production of a protective egg sac within a brood nest, closely attended by the female, apparently to ward off predators and parasites. The nest structure of *Lyssomanes* is relatively simple by comparison, as the eggs are deposited on the underside of a leaf and covered with a thin fabric of silk strands, and no distinct egg sac is produced. Tedore & Johnsen (2015) suggested that *Lyssomanes viridis* Hentz 1845 could have an immunological dependence on plants like *Liquidambar styraciflua* that are known to be high in volatile and potent broad-spectrum antimicrobial compounds, based on a strong chemical preference for this plant as substrate for its nests, and a higher hatching success on this plant. Tedore & Johnsen also suggested that the wide separation of eggs under sparsely woven silk lines could maximize exposure of the eggs to these volatile antimicrobial compounds.

Here we present the first record of broodcare by *Hindumanes* and highlight its similarity to the broodcare seen in *Lyssomanes*. We also provide a new account of the known distribution of *Hindumanes* in India, based on both published records and publicly available observations posted on the citizen science platform *iNaturalist*.

Materials and Methods

Location and habitat. The site of the observation was a residential garden that adjoined a plantation in the town of Gudalur, Tamil Nadu (Table 2; Figure 2; Map Figure 3, record 10). This small garden was surrounded by a mixed plantation of avocado, plantain and areca palm. A single female *Hindumanes* was observed with her brood nest on the underside of a *Colocasia esculenta* planted directly outside of a residential complex.

Equipment. Photographs of this *Hindumanes* were taken using a Nikon D7100 equipped with a 40mm lens and a diffused external flash.

Record searches. Internet searches using the keyword *Hindumanes* were made on *Google Scholar* to look up published literature on the taxonomic position of *Hindumanes* and to consolidate published records of the genus. Searches using the same keyword were also carried out on two citizen science platforms, *iNaturalist* and *India Biodiversity Portal*, to find additional records of the distribution of this genus.

Results and discussion

The overall morphology of *Hindumanes* bears a striking visual resemblance to *Lyssomanes*. However, *Hindumanes* can be distinguished from *Lyssomanes* by a comparatively smaller width of the eye field and the positioning of ALE directly behind the AME. The female can be differentiated from *Lyssomanes* by the presence of a distinctive female epigynum, with large spermatheca and the absence of apparent glandular ducts (Logunov 2004; Sudhin, Nafin & Sudhikumar 2017).

A *Hindumanes* sp. female was seen with her brood nest, containing 52 individual eggs on the underside of a *Colocasia esculenta* leaf (Figure 2). The eggs were found to have wider spaces between each other compared to the tightly-packed egg deposition patterns seen in most salticid genera. Sparse mesh-like silk formed a thin protective covering, keeping the eggs in place. The female was present around her eggs and at times was seen standing on top of the silken covering, guarding her brood nest. This behaviour bears a close resemblance to behaviour seen in *Lyssomanes* (Richman & Whitcomb 1981).

The striking similarities in both morphology and egg deposition patterns between *Lyssomanes* and *Hindumanes* suggest the two genera could be closely related. Considering that this *Hindumanes* female had deposited her eggs on the underside of *Colocasia esculenta* leaf, a plant with leaves that are known to contain volatile antimicrobial compounds (Chakraborty et al. 2015), it could be hypothesised that *Hindumanes* broods, like those of *Lyssomanes* (Tedore & Johnsen 2015), have an immunological dependence on the substrate. This, however, requires further research into the chemical interactions between the spider, its brood nest, and the substrate.

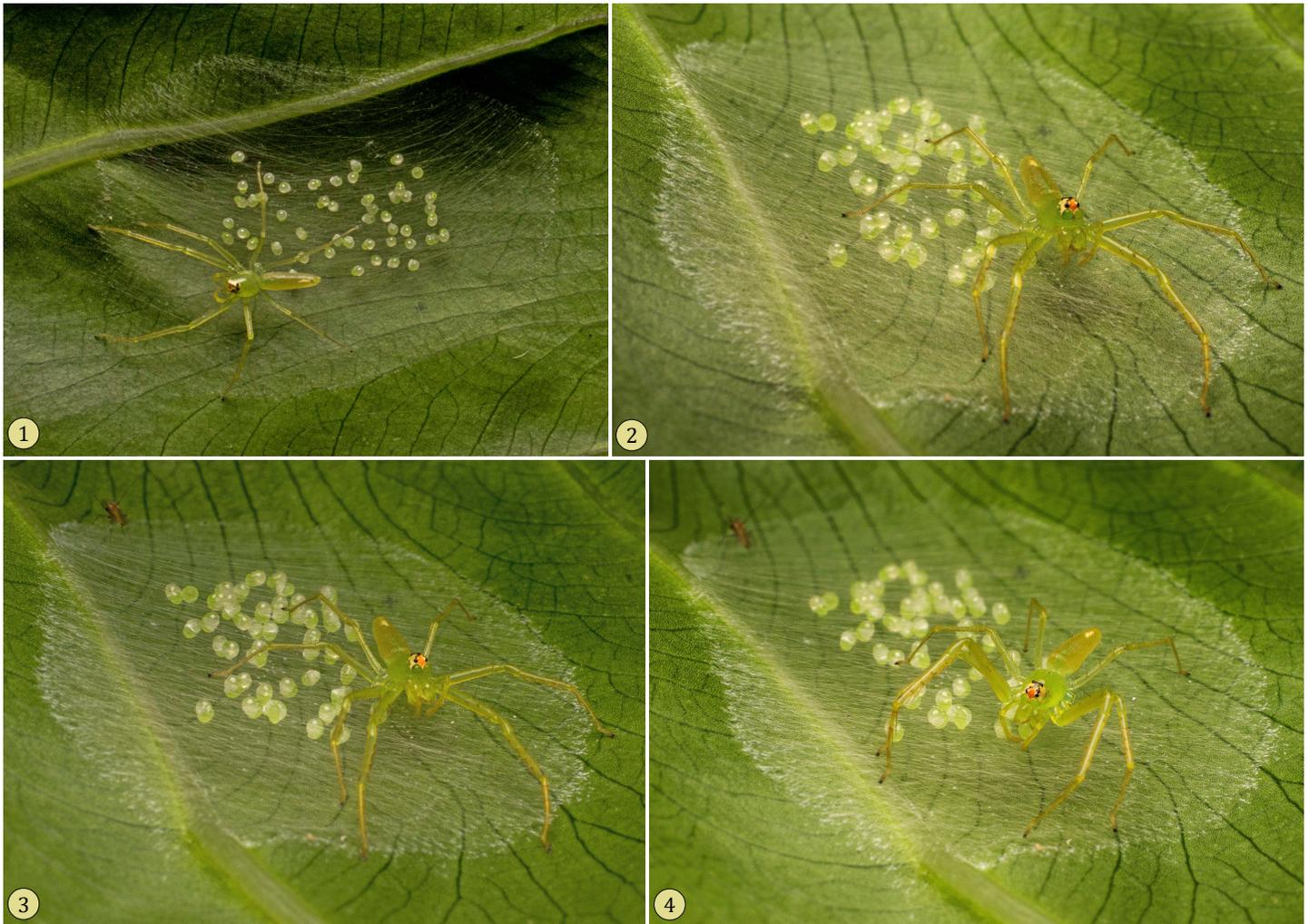


Figure 2. Female *Hindumanes* guarding her brood nest under a *Colocasia esculenta* leaf in a residential garden, Gudalur, Tamil Nadu (10:47-10:52, 17 AUG 2019). The young were just beginning to hatch. This is record 10 in Table 2 and Map Figure 3.

Based on published literature, *Hindumanes* was known only from the southern Western Ghat regions of Karnataka and Kerala (Logunov 2004; Sudhin, Nafin & Sudhikumar 2017). However, observations recorded on citizen science platforms suggest a wider range of distribution, extending to the Western Ghat ecoregions of other states to include Tamil Nadu and Goa (Table 2; Map Figure 3). The single observation outside of the Western Ghats, from Yercaud (Table 2, record 9) could potentially be a vagrant that was transported out of the Western Ghat region. Most (7/11 or 64%) of the observations took place at altitudes between 866-956 m above sea level. While a sample size of 11 is too small to conclude an altitude range of occurrence for this genus, we hope that this consolidation of records provides guidance for future studies into the ecological distribution of *Hindumanes*. With only 11 records across published literature and citizen science platforms combined, there is a need for more observations of this genus to throw light on its ecological distribution. With 5 out of 11 known records of *Hindumanes* coming from citizen science platforms, the ability of these platforms to inform us of the distribution of a species or genus cannot be overstated. In addition to citizen science reports, natural history information like brooding behaviour collected by serious enthusiasts can pave the way for further scientific inquiry. Future studies could explore the chemical ecology of the genus to test its dependence on anti-microbial substrates. A phylogenetic study to understand the proximity between *Hindumanes* and *Lyssomanes* could unlock further areas of inquiry with respect to their global distribution.

Table 2. Distribution of *Hindumanes* species in India based on published records and citizen science platforms.

record	genus or species of record	region	locality	altitude	habitat	reference
1	♀ <i>Lyssomanes karnatakaenis</i>	Kotigehar, Chikmagalur, Karnataka (type locality)	13°07'17.0"N 75°31'25.3"E	956 m asl		Tikader & Biswas 1978
2	♀ <i>Hindumanes karnatakaenis</i>	Karnataka (type locality)				Logunov 2004
3	♀ <i>Hindumanes</i>	Kommethode, Karnataka	12°12'54.2"N 75°49'40.7"E		on a leaf	Baliga 2012 (iNaturalist)
4	♀ <i>Hindumanes karnatakaenis</i>	Wayanad Wildlife Sanctuary, Kerala	11°42'01.7"N 76°20'28.1"E	866 m asl	leaves of <i>Chromolaena odorata</i>	Sudhin, Nafin & Sudhikumar 2017; Nafin 2015b (iNaturalist)
5	♂ <i>Hindumanes karnatakaenis</i>	Wayanad Wildlife Sanctuary, Kerala	11°42'09.8"N 76°20'39.6"E	868 m asl	leaves of <i>Chromolaena odorata</i>	Sudhin, Nafin & Sudhikumar 2017; Nafin 2015a (iNaturalist)
6	♀ <i>Hindumanes wayanadensis</i>	Wayanad Wildlife Sanctuary, Kerala	11°45'01.3"N 76°24'43.2"E	746 m asl	leaves of <i>Chromolaena odorata</i>	Sudhin, Nafin & Sudhikumar 2017
7	♂ <i>Hindumanes</i>	Kakkabe Kodagu, Karnataka	12°15'23.8"N 75°38'35.9"E	896 m asl	underside of a leaf	Abhijith APC 2019 (iNaturalist)
8	♀ <i>Hindumanes karnatakaenis</i>	Mollem, Goa	14°56'08.1"N 74°21'38.1"E	358 m asl	underside of a leaf	Parab 2019 (iNaturalist)
9	♂ <i>Hindumanes</i>	Yercaud, Tamil Nadu	11°46'30.9"N 78°12'33.3"E	1413 m asl	on a wall	Agarwal 2019 (iNaturalist)
10	♀ <i>Hindumanes</i>	Gudalur, Tamil Nadu	11°30'17.6"N 76°29'44.0"E	920 m asl	underside of a <i>Colocasia esculenta</i> leaf	Rele & John 2022 (this paper)
11	♂ <i>Hindumanes karnatakaenis</i>	Belur, Karnataka	13°09'44.3"N 75°52'04.5"E	954 m asl	on a leaf	Kumar 2021 (iNaturalist)

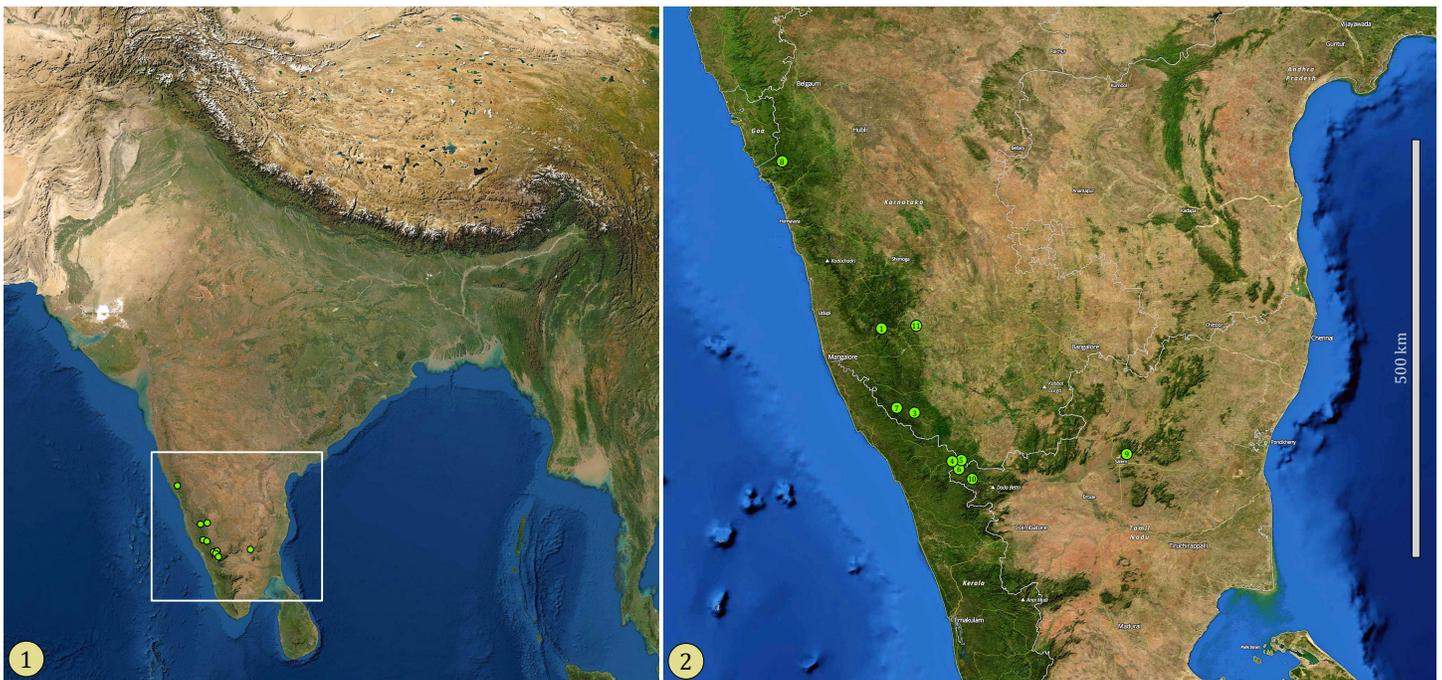


Figure 3. Known distribution of *Hindumanes* species in southern India. Numbers associated with each locality correspond to records listed in Table 2. Based on available records, this genus is endemic to southern India, and no other lyssomanines are known from India. Map credits: 1-2, Enhanced satellite images courtesy of NASA; 2, Overlay of borders, towns and roads courtesy of OpenStreetMap, © OpenStreetMap contributors (<https://www.openstreetmap.org/copyright>).

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