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First records of *Walchia lupella* and *Walchia rustica* (Arachnida: Trombidiformes) in southern India: insights into chigger mite distribution in the Western Ghats

Steny VALLOMKOTTU JOSEPH, Govindarajan RENU *, Philip Samuel PAULRAJ, Krishnamoorthy NALLAN, Ramkumar RAMALINGAM, Raja MOHANDOSS, and Paramasivan RAJAIAH

Department of Health Research (DHR), ICMR-Vector Control Research Centre Field Station, Division of Vector-Borne and Zoonotic Diseases, Madurai, Tamil Nadu, India.
* Corresponding author: G. Renu, E-mail: govindarajan1983@gmail.com

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Abstract. Chigger mites are important vectors of scrub typhus, but their distribution in India is not well studied. This study documents the first occurrence of *Walchia lupella* and *Walchia rustica* in southern India, specifically in the foothills of the Western Ghats, Dindigul district, Tamil Nadu. Small mammals, including *Suncus murinus* and *Rattus rattus*, were captured using Sherman traps, yielding 56 chigger mites across six species: *Walchia rustica*, *W. lupella*, *Trombicula hypodermata*, *Schoengastiella* spp., *Leptotrombidium deliense*, and *L. rajasthanense*. Morphological examination confirmed the presence of *W. lupella* and *W. rustica*, extending their known range from the north to the south of India.

Keywords: distribution, rodents, shrew, south India, Trombiculid mites, Western Ghats.

Trombiculid mites, commonly known as chigger mites, are tiny ectoparasitic arthropods belonging to the families Trombiculidae and Leeuwenhoekiidae within the subclass Acari (Govindarajan et al. 2021, Ren et al. 2014). Larval chiggers act as vectors for *Orientia tsutsugamushi*, the pathogen responsible for scrub typhus, while the adult stages may act as reservoirs through transovarial transmission (Govindarajan et al. 2021). These mites have gained significant importance in public health due to their role in the transmission of vector-borne diseases. Although chiggers were historically thought to be geographically confined to the "tsutsugamushi triangle," research has shown their presence well beyond these boundaries, with reports emerging from various regions of India, where a high chigger index has been documented (Kumar & Jakhar 2021).

Globally, over 3,013 species of chigger mites are recorded (Govindarajan et al. 2023, Nielsen et al. 2021). In India, 204 species have been identified, with notable abundance in tribal belts across nine states, including Rajasthan, Madhya Pradesh, Andhra Pradesh, Jharkhand, Gujarat, Chhattisgarh, West Bengal, and Odisha. Puducherry and Tamil Nadu are reported to have the highest chigger indices in the country. Vector chigger mites have also been documented in regions such as Jammu & Kashmir, Nagaland, Vellore, Darjeeling, Sikkim, and Manipur (Kumar & Jakhar 2021, Nielsen et al. 2021).

While the primary vectors of scrub typhus belong to the genus *Leptotrombidium* (Sungvornyothin et al. 2019), species from other genera, including *Ascoschoengastia*, *Neotrombicula*, and members of the subfamily Gahrliepiinae (such as *Walchia*), may function as intrazootic vectors, maintaining the pathogen within animal populations (Traub & Wisseman 1974). Pathogens associated with scrub typhus have been isolated from certain species of *Walchia* (Liu et al. 1999, Yu & Lin 1957), though there is no direct evidence that these species transmit the disease to humans or Rickettsia (Sungvornyothin et al. 2019). In this study, we report, for the first time, the occurrence of *Walchia lupella* and *Walchia rustica* in southern India, specifically from the foothills of the Western Ghats in the Dindigul district of Tamil Nadu.

Study site

The study was conducted in Dindigul district, in southern Tamil Nadu, India, characterized by diverse topography and a tropical climate influenced by the southwest monsoon. The research sites, Tennampatti (10°22'N, 77°55'E) and Vadamadurai (10°19'N, 77°56'E), represent distinct ecological zones within the district. Tennampatti, at a higher elevation, exhibits unique microclimatic conditions, while Vadamadurai lies in the foothills, supporting diverse habitats that provide valuable opportunities for ecological and biodiversity studies (Figure 1).

Collection of Chigger Mites from Rodents

Small mammals were captured from farmlands and scrublands near residential areas using Sherman traps (dimensions: 7.6 cm (L) x 18.4 cm (W) x 9 cm (H)). These traps were placed at dusk (5-6 PM) and retrieved the next morning (6-7 AM). Fried food coated with coconut oil was used as bait. Each trap captured a single animal, which was automatically captured upon entry (Philip Samuel et al. 2020, 2021a). The captured rodents and shrews were identified based on their external morphology (Shakunthala & Tripathi 2005, Dinesan et al. 2006, Philip Samuel et al. 2021b). A total of 30 traps were placed at the study sites, and captured animals were transferred to the laboratory for further examination.

Following anaesthesia according to established guidelines (Philip Samuel et al. 2020, 2021a), chigger mites were collected from the captured animals, primarily from the ear pinna and femur. A fine brush (2 mm) was used to extract the mites, which were initially preserved in 70% ethanol before being transferred to a lactophenol clearing solution. After clearing, the mites were mounted on slides using Hoyer's medium (Philip Samuel et al. 2021b). Species identification was

conducted under a Nikon ECLIPSE (E200) microscope, following the keys provided by Fernandes & Kulkarni (2003), Goff et al. (1982), and Nadchatram et al. (1974). The identified specimens were deposited at the Mite Museum at ICMR-VCRC Field Station, Madurai, Tamil Nadu. Approval from the Institutional Animal Ethics Committee (IAEC) of ICMR-VCRC, Puducherry, was obtained.

Photographic observation

The microscope with the Magnus MLXi camera (Magnus DC plus 10) was used in this study. Images were taken under phase contrast (objective: 5x; condenser mode: no.BF). By this method, images were combined to produce very sharp pictures of morphological and chaetotaxy characters.

A total of 30 traps placed in Tennampatti and Vadamadurai captured five rodents and shrews, representing the genera *Suncus* and *Rattus*, resulting in a trap positivity rate of 10%. From these animals, 56 chigger mites were collected, representing six species: *Walchia rustica*, *W. lupella*, *Trombicula hypodermata*, *Schoengastiella spp*, *Leptotrombidium deliense*, and *L. rajasthanense*. Notably, *Walchia rustica* and *Walchia lupella*, previously reported from northern India, were documented for the first time in southern India, specifically in the foothills of the Western Ghats.

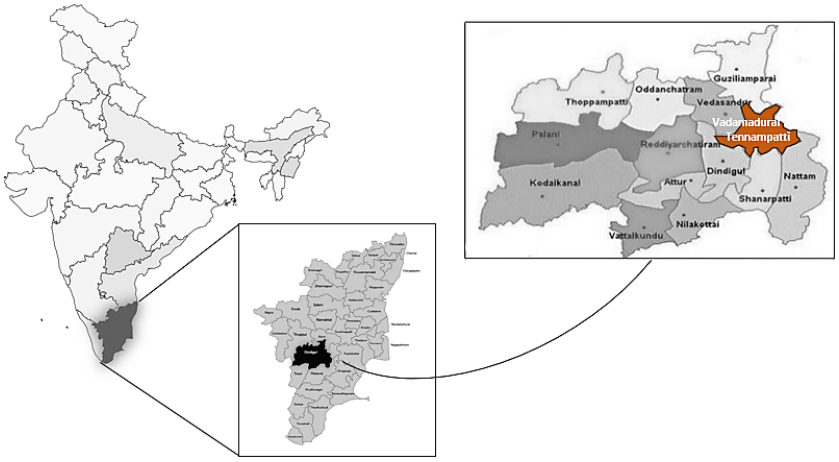

Figure 1. Map showing the mite collection sites in south India.

Walchia lupella

(Figure 2)

Idiosoma: Measures 317-335 µm in length and 208-232 µm in width for partially engorged specimens. Features two pairs of eyes on the ocular plate and 74-88 idiosomal dorsal setae arranged as 6-6-2.

Gnathosoma: The formula for the palpal setae is N/N/NNN/4B, accompanied by a 3-pronged palpal claw. The cheliceral blade measures 21-26 µm, featuring a subapical tooth. The gnathobase is sparsely punctate and features setae that are branched.

Scutum: It is subpentagonal, sparsely punctate, with a shallowly concave front edge. It is widest at the posterolateral bases, with PL setae longer than AL setae. The distance between the sensillary bases (SB) measures 28 µm, and the posterior width (PW) ranges from 0.69 to 0.80.

Legs: Similar in structure to *W. ewingi*, with ordinary and sensory setae; coxa III has 2 branched setae. Measurements: Leg I (171-194 µm), Leg II (143-164 µm), Leg III (166-190 µm).

Walchia rustica

(Figure 3)

Idiosoma: Measures 320-360 µm in length and 190-240 µm in width in partially engorged specimens. Has two pairs of eyes with larger anterior eyes on the ocular plate. Arrangement of setae includes one pair of humeral setae (28-32 µm), 34-42 dorsal idiosomal setae (21-40 µm), and a total of 86-104 idiosomal setae.

Gnathosoma: The setal formula palpae is N/N/NNN/4B, accompanied by a pronged palpal claw. The cheliceral blade measures 28-31 µm and features a distinct subapical tooth. The gnathobase is lightly punctate, with branched setae.

Scutum: The shape is moderately punctuated and subpentagonal, featuring a slightly concave front edge and posterolateral margins that narrow and curve beyond the PL bases. The anterior and posterior lateral setae are finely ciliated and of nearly equal length. An anteromedial cuticular ridge is present on the sensillary bases—average measurements: AW (42 µm), PW (54 µm).

Legs: Like *W. ewingi* with ordinary and sensory setae; coxa III has one branched seta (1B). Measurements: Ip (536-569 µm), Leg I (188-202 µm), Leg II (158-168 µm), Leg III (190-199 µm).

The identification of *Walchia lupella* and *Walchia rustica* in the foothills of the Western Ghats, specifically in Dindigul district, Tamil Nadu, marks a noteworthy extension of these species' range beyond their previously established northern Indian distribution (Traub & Morrow 1957, Vercammen-Grandjean 1968). Our study provides the first record of *W. lupella* and *W. rustica* in southern India, captured in *Suncus murinus*, highlighting the potential ecological and biogeographical factors influencing this distribution shift.

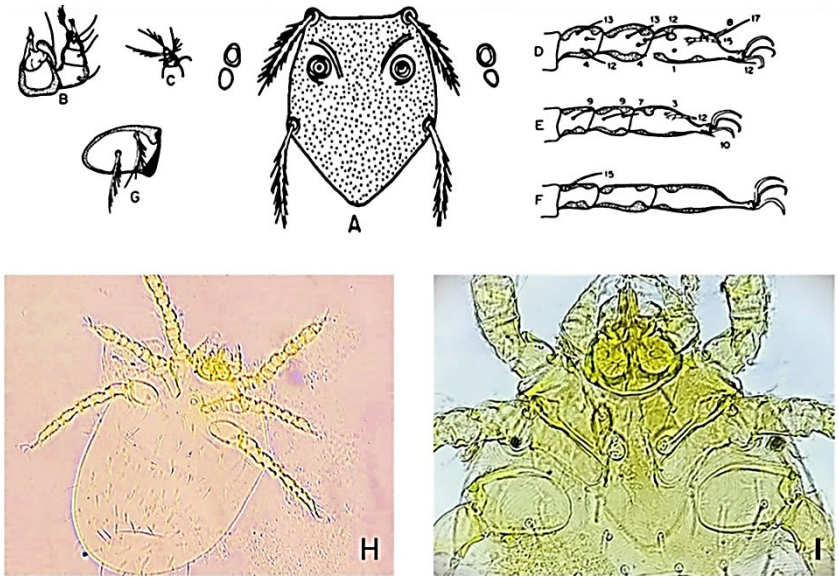

Figure 2. Reference (Fernandes & Kulkarni 2003) and microscopic image showing *Walchia lupella*. A - scutum of *W. lupella*; B - gnathosoma; C - palpotibia and tarsus; D-F - leg I-III; G - coxa III; H - dorsal view with idiosomal setae of *Walchia lupella*; I - scutum of *Walchia lupella* mite (Museum, Unit of Vector Borne Zoonotic Diseases, ICMR-VCRC Field Station, Madurai).

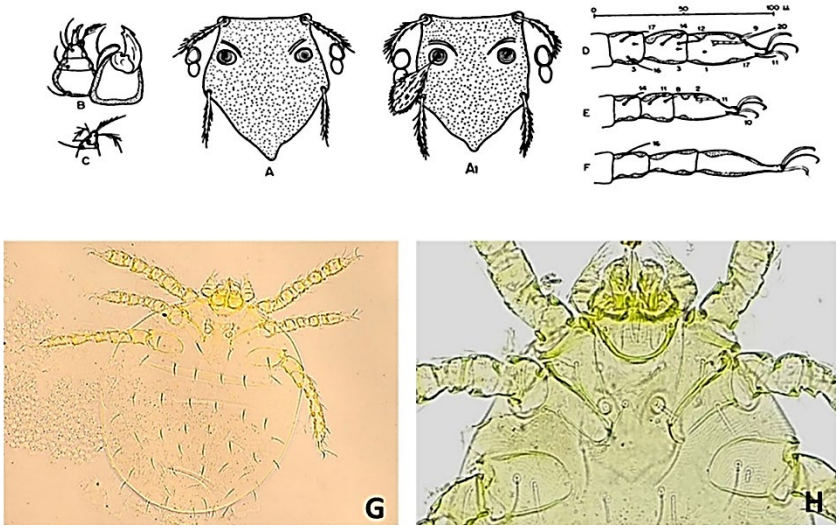

Figure 2. Reference (Fernandes & Kulkarni 2003) and microscopic images showing *Walchia rustica*. A and A1 - scutum of *W. rustica;* B - gnathosoma; C - palpotibia and tarsus; D - F - leg I-III; G - dorsal view with idiosomal setae of *Walchia rustica*; H - scutum of *Walchia rustica* (Museum, Unit of Vector Borne Zoonotic Diseases, ICMR-VCRC Field Station, Madurai).

The chigger species *W. lupella* was initially described as a subspecies of *W. ewingi* but was elevated to full species status due to distinct morphological traits, including two branched setae on coxa III, three pairs of eyes, and specific sensillary base dimensions (Vercammen-Grandjean 1968). These features, along with consistent measurements of scutal setae and leg dimensions, validate its recognition as a distinct species and contribute to the understanding of biodiversity within the *Walchia* genus. *W. rustica* is distinguished from similar species, such as *W. turmalis* and *W. cuspidata*, by its shorter scutum and unique scutal apex morphology, which has been reconfirmed through the examination of historical records and morphological re-evaluation of misidentified specimens (Fernandes et al. 1988, Traub & Evans 1957).

Previous findings record *W. rustica* primarily in northeastern India (Assam, North Burma, Darjeeling, Jalpaiguri), where it has been associated with hosts such as *Suncus murinus*, *Rattus rattus*, and *Tupaia glis* at altitudes ranging from 119 to 200 meters (Fernandes et al. 1988, Traub & Evans 1957). Notably, the expansion of *W. rustica* into warmer, lower-altitude regions in southern India, as evidenced in this study, suggests considerable ecological adaptability. This adaptability could be linked to climatic conditions that favor broader geographic dispersal, as

demonstrated by the species' successful colonization of the foothills of the Western Ghats (Kumar & Jakhar 2021).

Similarly, *W. lupella* was previously reported in the northern regions of India, including Ganjam District in Orissa and multiple locations in Himachal Pradesh and Uttaranchal, at altitudes of approximately 300 to 3,170 meters. Typical hosts of *W. lupella* in these regions include *Suncus murinus* and *Apodemus flavicollis*, with local climates characterized by relatively lower temperatures (Vercammen-Grandjean 1968). The discovery of *W. lupella* in southern India, at altitudes between 300 and 1,000 meters, where temperatures are notably warmer, suggests that these mites can survive across diverse climatic and altitudinal conditions.

The southward range shift observed for both *W. lupella* and *W. rustica* might be attributed to multiple interrelated factors. Variations in temperature, latitude, altitude, and habitat modification, potentially driven by climate change, can influence the ecological distribution of chigger mites. Previous studies have indicated that the tropics, including areas such as Tamil Nadu, present favorable microclimates for chigger survival and propagation, with conditions that may support the persistence and growth of populations outside their traditional ranges (Fernandes et al. 1988, Traub & Evans 1957). The presence of these chigger species in the Western Ghats also points to the adaptability of *Walchia* mites, potentially enabling the southward spread through intrazootic transmission among small mammal hosts (*R. rattus* and *S. murinus*), which may act as reservoir hosts for scrub typhus in the region (Traub & Morrow 1957, Fernandes et al. 1988, Gater 1932).

The discovery of *Walchia lupella* and *Walchia rustica* in southern India extends their known geographic range and underscores their adaptability to diverse environmental conditions. Although neither species has been directly implicated in the transmission of scrub typhus, other species in the genus *Walchia* are recognized as vectors of *Orientia tsutsugamushi*. Given their presence on known hosts of scrub typhus, *S. murinus* and *R. rattus* could play a role in maintaining the infection cycle in small mammals. Further studies are warranted to assess their vector potential and contribution to the epidemiology of scrub typhus in this region.

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