

## Species composition of mites (Acari: Trombiculidae, Dermanyssidae, Laelapidae) on pest rodents and shrews in Madurai, India

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### Abstract

Trombiculid chigger mites were collected from pest rodents and shrews. This study was carried out in different habitats like urban, semi-urban, and rural sites in Madurai district, South Tamil Nadu, India during 2017-2018. A total of 3219 chigger mites comprising 12 different species under three families (Trombiculidae, Dermanyssidae and Laelapidae) and one sub order (Oribatida) were collected from 151 rodents and shrews, belonging to six different species in this study. The chigger infestation rate in these small mammals was 56.47. The following chigger mites and adult mite species were identified from the Madurai district: *Leptotrombidium deliense*, *L. keukenschrijveri*, *L. indicum*, *L. rajasthanense*, *Schoengastiella ligula*, *Microtrombicula* sp., *Neotrombicula microti*, *Trombicula hypodermata*, *Schoengastia* species (Chigger mites); *Dermanyssus gallinae*, *Laelaps echidninus*, *Liponyssoides sanguineus* and Oribatida (Adult mites). The predominant species recorded from these areas are *L. deliense* (65.94%), *L. indicum* (11.50) and *S. ligula* (15.27). Even though maximum chigger mites infestation rate was recorded in rodents and shrews from urban areas (65.5), followed by semi-urban (53.5) and rural (54.5) areas. Trap positivity rate (18.1%), rodents/shrew captures ( $5.42 \pm 2.97$ ) and chigger collection ( $118.08 \pm 188.9$ ) were observed significantly ( $P < 0.05$ ) more in rural clusters compared with urban clusters. This study showed the predominant trombiculid mites activity on small mammals of this place which can forewarn the public health officials to understand the ground-level situation to take up necessary control measures for the prevention of mite borne diseases.

**Keywords:** Mites, habitats, species composition, rodents, shrews.

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### Introduction

Chigger mites commonly known as chigger trombiculid mites, soil mites, grass itch mites, and scrub-itch mites, belong to the family Trombiculidae, Dermanyssidae, Laelapidae and Sarcoptidae, superfamily Trombidioidea, order Trombidiformes and Sarcoptiformes in subclass Acari of class Arachnida.

Scrub typhus is a vector-borne human disease caused by obligate intracellular bacterium *Orientia tsutsugamushi* which is transmitted by a species of the Trombiculidae family (Walker *et al.*, 1975; Chakraborty and Sarma, 2017; Elliott *et al.*, 2019; Prakash *et al.*,

2021). Larval stages of mites are ectoparasites harbored by rodents and shrews which in turn act as the reservoirs for this bacterium. A survey was carried out to investigate the prevalence of Trombiculid mites, the vectors for scrub typhus on pest rodents and shrews in Madurai district, Tamil Nadu at three different habitats such as urban, semi-urban, and rural sites to know the species composition and distribution pattern. The study sites were selected based on the areas with a nuisance of pest rodents as reported by the residents. This study helped to delineate the mite-infested areas to initiate the vector control

strategy.

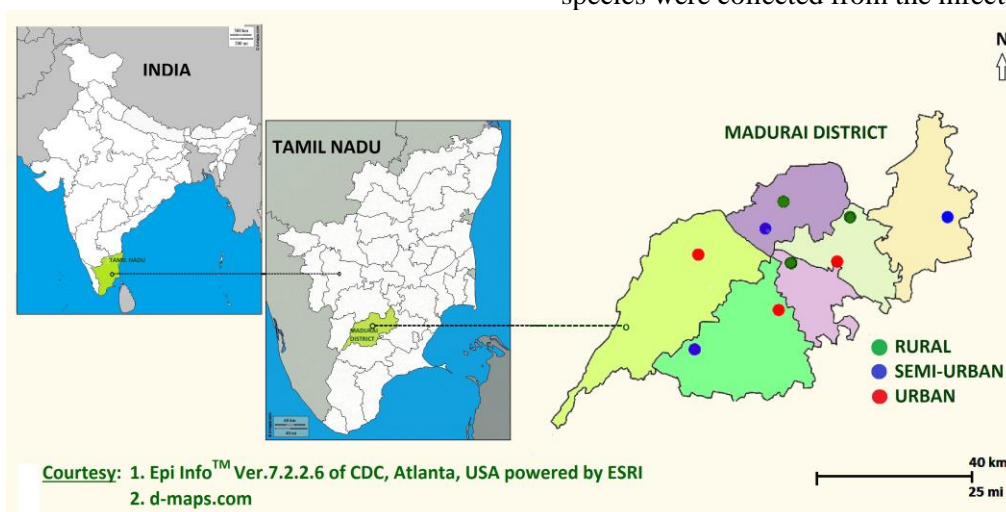
## Materials and Methods

### Study sites

Madurai district is located in south of Tamil Nadu State of India, lies between 9°33'30"N to 10°18'50"N Latitude, 77°00'00"E to 78°30'45"E Longitude and has an area extent of 3741.73 sq. km. (District Statistical Handbook, 2018). Nine study sites were selected, grouped into urban, semi-urban, and rural habitats with three sites each: B.B.Kulam, Tirumangalam, Usilampatti (urban habitats), Peraiyur, Keelaiyur, Sholavandan (semi-urban habitats), Vadapalanji, Katchaikatti, and Chatrapatti (rural habitats) (Fig. 1).

### Collection of trombiculid mites from rodents/shrew:

At every site, Sherman traps (width 7.5 cm; length 18.5 cm; depth 9 cm) (Samuel *et al.*, 2020) were kept in and around residential areas at indoor and outdoor households before dusk (5-6pm) and withdrawn after dawn (6-7am) the next day. All the rodents were attracted by fried eatables smeared with coconut oil kept within the Sherman traps and captured (Samuel *et al.*, 2020). Pest rodents and shrews were identified based on taxonomic keys of Shakunthala and Tripathi (2005) and Martin *et al.* (2011). 360 Sherman traps were placed in each urban, semi-urban and rural site during this study period. All the trapped rodents were placed in separate cloth bags and brought to the laboratory. Captured rodents were anesthetized for the collection of mites (Samuel *et al.*, 2020, 2021a). Six genera of pest rodents and shrews were trapped. A variety of mites belonging to different genera and species were collected from the infected rodents.



**Figure 1:** Map showing different study sites

### Trombiculid mites' collection & identification:

Chigger mites were collected from the pest rodents and shrews. Ear pinna and femur were the major sites of collection of mites (Fig. 2). Using a fine brush (size: 2 mm) and Burette, all chigger mites were collected from the host body. The collected mites were stored in 70% ethanol. After 6 hours, the collected chigger mites were transferred to lactophenol solution (lactic acid 50 ml, phenol 25 ml, and distilled water 25 ml) for clearing the specimens. After clearing, all mite specimens were mounted on

separate slides with Hoyer's medium (Samuel *et al.*, 2021b). Slides were studied under Nikon ECLIPSE (E200) microscope and identified up to species level using keys by Stan Fernandes and Kulkarni (2003), Goff *et al.* (1982) and Nadchatram *et al.* (1974). These slides were deposited in Mosquito Museum Entomology Laboratory under the Unit of Vector-Borne and Zoonotic Disease, ICMR-Vector Control Research Centre Field Station Madurai, Tamil Nadu. This study was approved by the Institutional Animal Ethics Committee (IAEC) of ICMR-VCRC, Puducherry.



**Figure 2:** A. Fixing Sherman trap; B, C. Collection of chigger mites from ear pinna and hind femur

### Data Analysis

Data were entered into Excel software (Microsoft Corp.) and analyzed using STATA software (version 15.0, Stata Corp. LLC). Categorical data are presented as frequencies and continuous data are summarized as mean ( $\pm$  standard deviation). Independent T-test and Chi-square test were used to compare cluster differences. For GPS-based spot mapping of the study site and distance measurements, Epi Map of Epi Info Ver. 7.2.2.6 of CDC, Atlanta, USA powered by ESRI was used. Maps of Indian states and districts were downloaded from d-map (2021).

### Results

Totally 1080 traps were fixed in the nine study sites (120 traps in each site) during one year and each cluster shared 360 traps. Five different pest rodent species and one shrew species were trapped in all urban, semi-urban and rural clusters, in the Madurai district. A total of 35(9.7%), 51(14.2%), and 65(18.1%) rodents and shrews were trapped at urban, semi-urban, and rural sites respectively (Fig. 3). Among the trapped rodents and shrews,  $65.47 \pm 107.79$ ,  $84.67 \pm 135.12$  and  $118.08 \pm 188.9$  chigger mites were collected at urban, semi-urban, and rural sites respectively (Fig. 4). A significantly more ( $P < 0.05$ ) number of positive traps and number of chiggers were collected in rural and semi-urban clusters compared with urban clusters (Table 1).

A total of 786 mites were collected from urban areas, of which 413 belonged to six different species, 648 out of 1016 mites from semi-urban areas belonged to seven different species and 1035 out of 1417 mites collected from the rural area represented eleven different species (Table 2). A high proportion of chiggers were collected from the *Rattus rattus* (79.1%).

In total 3219 chigger mites and 151 rodents and shrews were captured from urban, semi-urban, and rural habitats. A total of 2,096 individual trombiculid chigger mites belonging to nine species were collected from the Trombiculidae family. In our present study, *R. rattus* and *Suncus murinus* were more vulnerable than the rest of the rodent species. 1707 and 1168 chigger mites were collected from 32 *R. rattus* and 17 *S. murinus* respectively. From the rest of the rodent species *R. norvegicus* (190), *Tatera indica* (142), and *Bandicota bengalensis* (154) mites were collected. *Leptotrombidium deliense* was the predominant species (76%) followed by *S. ligula* (15%), *L. indicum* (5%), *L. rajasthanense* (2%), and *Schoengastia* sp. (2%) in urban sites. *L. deliense* was also the predominant species (67%) following *S. ligula* (17%), *L. indicum* (11%), *Trombicula hypodermata* (2%) and *L. rajasthanense* (1%) in semi-urban sites. *Leptotrombidium deliense* was the predominant species (62%) following *S. ligula* (14%), *L. indicum* (14.0%), *T. hypodermata* (2%), *L. rajasthanense* (2%), and *Microtrombicula* sp. (1%) in rural sites. *L.*

*deliense* was the most prevalent on all hosts (Table 2).

**Table 1. Comparison of rodent trap positivity, chigger collection and infection rate between the clusters in Madurai district, Tamil Nadu 2017-2018**

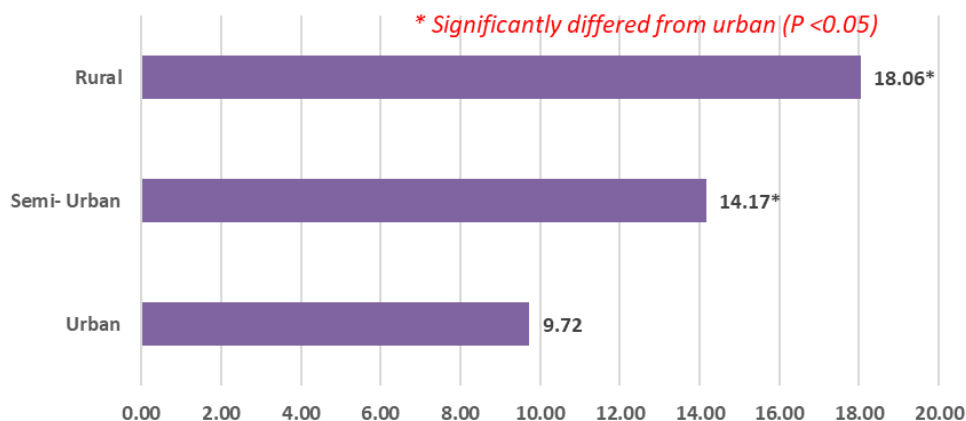
| Cluster type                                  | Trap Fixed (N) | Trap Positivity rate % (n) | Rodent/Shrews catches (Mean $\pm$ SD) | Rodent/Shrews infection Rate % (n) | Chigger infection rate (n) | No. of Chigger collected (Mean $\pm$ SD) | Chigger Index |
|---|----------------|----------------------------|---------------------------------------|------------------------------------|----------------------------|--|---------------|
| Urban   | 360            | 9.7 (35)                   | 2.92 $\pm$ 1.31                       | 34.3 (12)                          | 65.5 (786)                 | 65.47 $\pm$ 107.79                       | 22.46         |
| Semi-Urban                                    | 360            | 14.2 (51) *                | 4.25 $\pm$ 2.30                       | 37.3 (19)                          | 53.5 (1016)                | 84.67 $\pm$ 135.12 *                     | 19.92         |
| Rural   | 360            | 18.1 (65) *                | 5.42 $\pm$ 2.97 *                     | 40.0 (26)                          | 54.5 (1417)                | 118.08 $\pm$ 188.9 *                     | 21.80         |
| * Significantly differed from Urban (P <0.05) |                |                            |                                       |                                    |                            |  |               |

**Table 2. Chigger/Adult mite species collected from rodents/shrews captured at South Tamil Nadu, India**

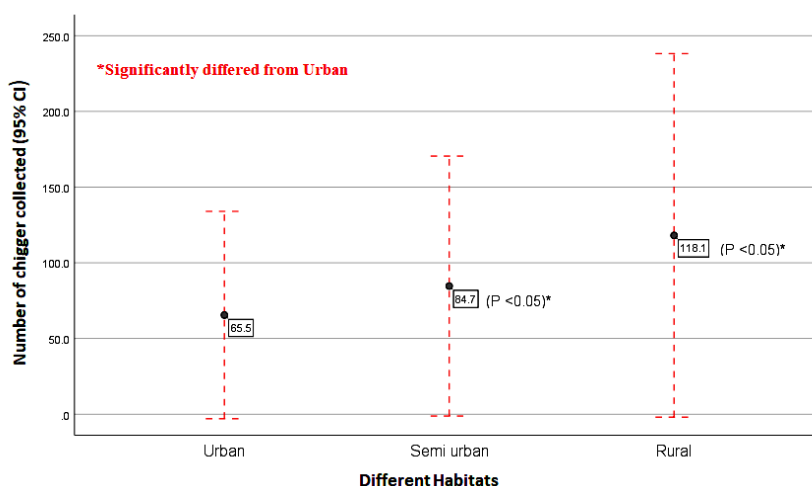
| S.No  | Mites species  | Urban | %     | Semi Urban | %     | Rural | %     |
|-------|--|-------|-------|------------|-------|-------|-------|
| 1     | <i>Leptotrombidium deliense</i> (Walch,1922)             | 311   | 75.54 | 431        | 66.82 | 640   | 62.13 |
| 2     | <i>L. keukenschrijveri</i> (Walch,1923)                  | 0     | 0.00  | 11         | 1.70  | 25    | 2.42  |
| 3     | <i>L. indicum</i> Fernandes and Kulkarni, 2003           | 21    | 5.08  | 71         | 10.96 | 149   | 14.40 |
| 4     | <i>L. rajasthanense</i> Fernandes and Kulkarni, 2003     | 9     | 2.18  | 9          | 1.39  | 24    | 2.32  |
| 5     | <i>Schoengastiella ligula</i> Radford, 1946              | 62    | 15.01 | 109        | 16.82 | 149   | 14.40 |
| 6     | <i>Microtrombicula</i> sp. Ewing,1950                    | 0     | 0.00  | 0          | 0.00  | 14    | 1.35  |
| 7     | <i>Neotrombicula microti</i> (Ewing,1928)                | 0     | 0.00  | 0          | 0.00  | 7     | 0.68  |
| 8     | <i>Trombicula hypodermata</i> Nadchatram and Traub,1966  | 0     | 0.00  | 15         | 2.31  | 23    | 2.22  |
| 9     | <i>Schoengastia</i> sp. Vercammen-Grandjean 1960         | 9     | 2.18  | 0          | 0.00  | 0     | 0.00  |
| 10    | <i>Dermanyssus gallinae</i> (De Geer, 1778)*             | 0     | 0.00  | 0          | 0.00  | 2     | 0.19  |
| 11    | <i>Laelaps echidninus</i> (Koch,1836)*                   | 0     | 0.00  | 0          | 0.00  | 1     | 0.10  |
| 12    | <i>Liponyssoides sanguineus</i> Lavine and Large (1984)* | 0     | 0.00  | 2          | 0.31  | 1     | 0.10  |
| 13    | Sub order: Oribatida; Duges, 1833*                       | 1     | 0.24  | 0          | 0.00  | 0     | 0.00  |
| Total |  | 413   |       | 648        |       | 1035  |       |

\*Adult mites

## Species composition of mites on pest rodents and shrews in Madurai, India



**Figure 3:** Details of trap positivity in different habitats



**Figure 4:** Trombiculid mites' collection details from different habitats

## Discussion

In the worldwide distribution pattern of Acarines, approximately 12% of 50,000 species live as parasites, and less than 100 species are reported to have medical and veterinary importance (Krantz, 1978; Krantz and Walter, 2009). Many Acarines act as vectors of zoonotic diseases and live very close to the animal host. Moreover, environmental degradation led to global climate changes in many places. This led to the proliferation of the vectors and in turn transmission of rodent-borne parasitic diseases (Paramasvaran *et al.*, 2009). Many ectoparasites of rodents play a crucial role in disease transmission to humans and animals. Thus, these studies on ectoparasites have invaluable data to take up appropriate control program. Medically important chigger mites, *Ascoschoengastia* sp.,

*L. deliense*, *L. jayawickremei*, *L. rajasthanense* and *S. ligula* are the powerful vectors of scrub typhus (Prakash *et al.*, 2021).

Fernandes *et al.* (1988) collected 11,883 chiggers belonging to 65 species in 14 genera from the Himalayan region. The collection included 5 genera, *Leptotrombidium*, *Neotrombicula*, *Microtrombicula*, *Schoengastia*, and *Schoengastiella* recorded from the present study. In 1966, *L. akamushi*, *L. deliense*, and *S. ligula* were collected from Eastern Himalayan foothills (Varma and Mahadevan, 1971). Except *L. akamushi*, the other 2 species of mites were collected in this study. A survey conducted between 1966 and 1970 in Western Himalayas, Sikkim, and hill districts of West Bengal showed 66 species of Ixodoidea, 15 species of Mesostigmatid mites, and a large number of

Trombiculid mites in addition to other hematophagous arthropods (Rao *et al.*, 1973). An outbreak investigation conducted in Kurseong, Darjeeling established *S. ligula* as the vector of scrub typhus due to its abundance (Tilak *et al.*, 2011).

Earlier studies have documented more than 3000 species of chiggers all over the world and over 400 mite species were recorded in China (Peng *et al.*, 2016). A total of 274 species of mites were collected from Yunnan Province, southwest China. Fujian Province documented 53 species of chiggers, Hubei Province recorded 41 chigger mite species and Beijing recorded 7 species of chigger mites (Peng *et al.*, 2016). In India so far 204 chigger mite species were recorded by Stan Fernandes and Kulkarni (2003). In our study conducted in Thiruvananthapuram district, Kerala, we reported 18 species of chiggers and one adult mite (Samuel *et al.*, 2020). Similarly our study carried in the scrub typhus affected areas in various districts of Tamil Nadu showed the presence of chigger mites and adult mites (Samuel *et al.*, 2017, 2021a). In the present study conducted in different habitats like urban, semi urban and rural areas, we collected 9 species of chiggers belonging to 6 genera and falling under family Trombiculidae and three adult mite species belonging to the 2 families (Dermanyssidae and Laelapidae) and one sub order (Oribatida). This study recorded seven genera, 12 species and one sub order Oribatida of mites from Madurai from six species of rodents and shrews. In Egypt, *Mus musculus* harbored fewer ectoparasites but the other species like *R. rattus frugivorus*, *R. norvegicus*, and *Meriones shawi* were vulnerable to ectoparasites (Kandy *et al.*, 2007) and in Tamil Nadu, India, *Rattus rattus*, *R. norvegicus*, *M. musculus*, and *S. murinus* were found vulnerable for ectoparasite infection (Samuel *et al.*, 2021a). This present study conducted during one full year explored the ectoparasitic mite fauna in the Madurai district of Tamil Nadu, India. We could demonstrate the rodent-associated ectoparasites present in all these study sites. *Leptotrombidium deliense*, *S. ligula* and *L. rajasthanense* collected aplenty in this present collection from Madurai were considered as the scrub typhus vectors from

India (Prakash *et al.*, 2021). Three adult *D. gallinae*, *L. sanguineus* and *L. echidninus* mite vectors of human pathogens reported worldwide were recorded from the rural collection (Azad, 1986).

A total number of the vertebrate host species play a very significant factor to influence the species composition of chigger mites from different places. From this study, 4 species of vector mites reported in India were recorded. The abundant collection of these species denotes the potential risk for the transmission of this emerging disease in these areas. Scrub typhus is the most common re-emerging Rickettsial infection in India and many other Southeast Asian countries. Monitoring of the rodent population and their trombiculid mites brings forth important data to facilitate arthropod-borne disease control strategies by the public health authorities.

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