



Distribution pattern of chigger mites in south Tamil Nadu, India

R. Govindarajan, V. Rajamannar, R. Krishnamoorthi[#], Ashwani Kumar[#] and P. Philip Samuel^{*}

ICMR - Vector Control Research Centre Field Station, Division of Vector-Borne and Zoonotic Diseases, Department of Health Research (DHR), Madurai 625002, Tamil Nadu, India;

[#]ICMR - Vector Control Research Centre, Puducherry, India.

Email: philipsamuelpaulraj@gmail.com

ABSTRACT: Chiggers, the larval Trombiculid mites are the vectors for scrub typhus. Rodents and shrews are the preferred host. Study made at different habitats of chiggers collected in rodents and shrews, revealed more number to *Rattus rattus* 95(63%) and *Suncus murinus* 33(22%). *Rattus rattus* 31(54%) and *Suncus murinus* 17(30%) alone contributed more in chigger positivity. Chigger mites belonged to eight species under five genera. *Leptotrombidium deliense* (66%), *Schoengatiella ligula* (15%), and other chiggers (9%) were collected from 57 positive rodents. Seasonally, there was a significant difference in rodent positivity, and there was no significant difference in the number of chiggers collected. The study indicated the prevalence of chiggers in the various hosts and their variation in rodent/shrew hosts. *R. rattus* 31(54%) and *S. murinus* 17(30%) contributed more in chiggers infestation and seasonally wet-cool months favored more chiggers and host positivity from different habitats.

KEY WORDS: Trombiculidae, larval mites, abundance, rodents, shrews

INTRODUCTION

There are 700 harmful species of mites described worldwide (Goddard, 2012) and 250 species are recognized in public health importance (Hoy, 2012). All mites are hemimetabolous, very tiny, microscopic parasites showing with four pairs of legs, but larvae have three pairs (Johnston, 1982; Evans, 1992). Trombiculoidea, superfamily of mites (Acari: Acariformes) are more medically-important (Shatrov and Kudryashova, 2006). In the subfamily trombiculinae of trombiculide family, 195 species in 24 genera of mites have been recorded in India

which is being associated with animal hosts includes tribes Trombiculini, Schoengastiini, and Gahrlepiini (Stan Fernandes and Kulkarni, 2003). Larval stage of Trombiculide mites known as chiggers a vector for scrub typhus, which is transmitted through the rodent hosts (Pratt, 1963) and chiggers are parasites to mammals, reptiles, birds, and occasionally arthropods (Azad, 1986). Chiggers are usually found on parts of the animal hosts that have been in contact with the ground and are also localized in and around the ears (Azad, 1986). The chiggers are habitat-specific and host-specific (Nadchatram, 1970; Sasa, 1961) and occur on multiple host taxa,

* Author for correspondence

but rodents and shrews are the most commonly infested (Lawrence, 1951; Goff, 1979; Dong *et al.*, 2009; Mariana *et al.*, 2000). Goff (1979) confirmed that trombiculids are more adopted in habitat-specific rather than host-specific. A large number of chiggers that are found as a group usually attack the host, resulting in multiple grouped bites on infested hosts (Traub and Wissernan, 1974).

Leptotrombidium deliense is a species of chigger mite, the main vector of scrub typhus (tsutsugamushi disease) found in many parts of the world, particularly in the Asia-Pacific region called the Tsutsugamushi triangle with the countries, South Korea, Japan, China, Thailand, India, Indonesia, Taiwan, the Philippines, and northern Australia (Oaks *et al.*, 1983; Xu *et al.*, 2017; Kelly *et al.*, 2009). In India, among the various species of chiggers recorded, *L. deliense* is the dominant species for the spread of scrub typhus (Chakraborty and Sarma, 2017). *Schoengastiella* sp. has also been suggested as a vector for the spread of scrub typhus, but remains controversial (Santibanez *et al.*, 2015; Tilak *et al.*, 2011). Philip Samuel *et al.* (2021a) reported in the scrub typhus reported areas in Madurai District. A follow up longitudinal study was made at different habitats to observe the seasonal distribution and host preference of chiggers collected in rodents and shrews and results reported here..

MATERIALS AND METHODS

Study sites: The Madurai district is located in south Tamil Nadu of India, lies between 9°33'30"N to 10°18'50" N Latitude, 77°29'10"E to 78°28'45"E Longitude and has an area extent of 3710 sq. km (<https://madurai.nic.in/district-profile/>). The selection of different habitats was made based on surrounding agro-ecosystem and nine study sites each as B.B.Kulam, Tirumangalam, Usilampatti (Urban), Peraiyur, Keelaiyur, Sholavandan (Semi-urban), Vadapalanji, Katchaikatti, and Chatrapatti (Rural).

Seasonal classification of the study sites: The Madurai district is experienced with four different seasons which are South-West Monsoon, North-East Monsoon, winter, and summer. Continuous

southwest and northeast monsoons in the region for a period of 7 months from June to December was the main water resource, used for agriculture and drinking purposes, led to the increased vegetations by agronomy practices developed fertile soils and the abundance of rodent pests. For data analysis, all monthly data was grouped according to seasons. Madurai district received a total annual rainfall of 848 mm from July 2017 to June 2018 with 74% rain (626 mm) and very low total rainfall of 13.4 mm during winter (January to March 2018) and 115.6 mm during summer was notice. The mean temperature during from wet-cool to dry-cool months (January-February 2018) was 26.2°C (Statistical Hand Book, 2019) (Fig.1).

Collection of mites from rodents: At every site, before the dusk hours (5-6 pm), Sherman traps (width 7.5 cm, length 18.5 cm, and depth 9 cm) were kept in and around residential areas in indoor and outdoor households and withdrawn after dawn time (6-7 am) in the next day. All the rodents were attracted by fried eatables smeared with coconut oil kept within the Sherman traps and captured. The design of the Sherman trap was made to capture only a single rodent at a time and, after trapping a single rodent, the door of the trap will close automatically (Philip Samuel *et al.*, 2020, 2021a). Captured pest rodents and shrews were identified based on external morphology (Shakunthala and Tripathi, 2005; Dinesan *et al.*, 2006).

To collect various small rodents, 1080 Sherman traps were placed in the study sites during the study period from July 2017 to June 2018, as a total of 360 Sherman traps were placed in each urban, semi-urban and, rural habitats (i.e., 120 traps were placed/site/year in the 9 study sites). For every month, 9 visits were made with three sites each from the urban, semi-urban, and rural habitats selected, for the collection of rodent chiggers. All the trapped rodents were placed in separate cloth bags and brought to the laboratory and the captured rodents were anesthetized for the collection of mites as per the guideline followed by Philip Samuel *et al.* (2020, 2021a). Collected mites and other ectoparasites were mounted in Hoyer's medium (Philip Samuel *et al.*, 2021b), examined under the

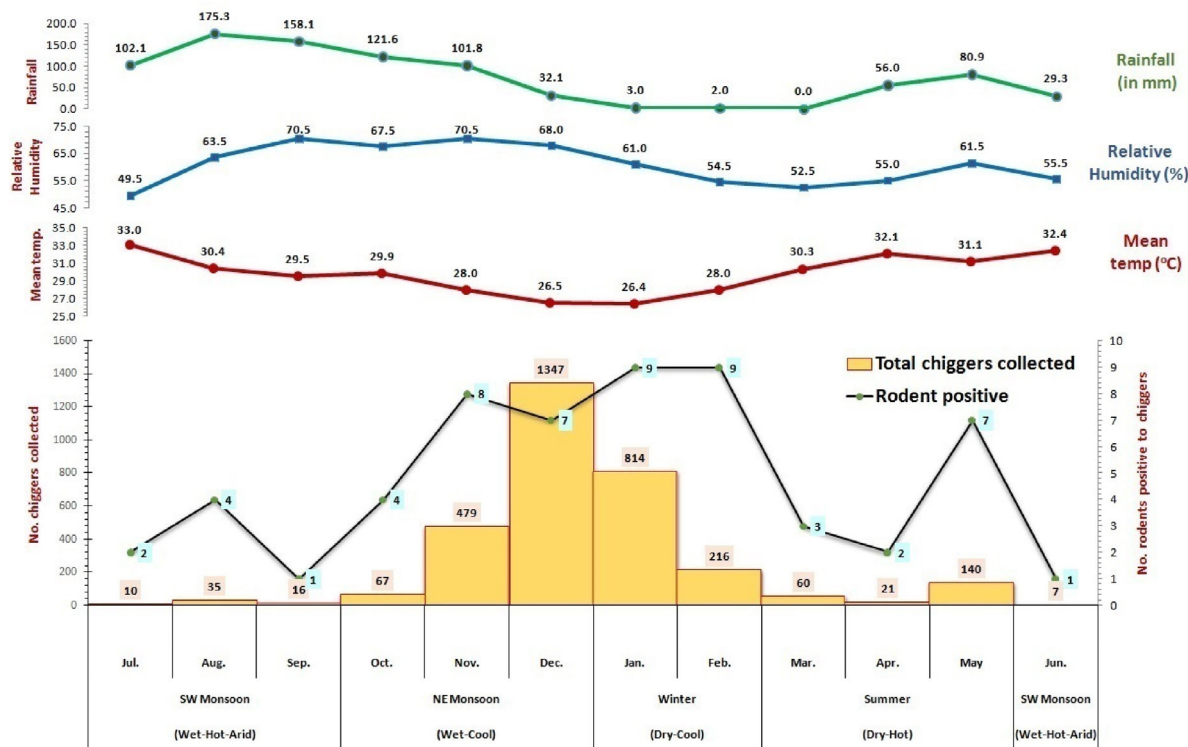


Fig. 1. Season wise positive rodents trapped and number of mites collected from study sites

microscope, and identified up to species level, following standard taxonomical keys (Stan Fernandes and Kulkarni, 2003). All collected specimens were deposited in the Mosquito and Ectoparasites Museum, Entomology laboratory of ICMR-Vector Control Research Centre Field station, Madurai, Tamil Nadu, India. This study was approved by the Institutional Committee (IAEC) of ICMR-Vector Control Research Centre, Puducherry.

Data analysis: The computer software IBM SPSS Ver.25 was used to analyze statistical data. For spot mapping and location measures, GPS-based Epi Map - Epi Info Ver. 7.2.2.6 of CDC, Atlanta, USA (powered by ESRI) was used. The website www.d-map.com was helpful to download Indian states and district-level politically. To estimate Trap Positivity Rate (TPR) for the trapped rodents, the following formula was used (Philip Samuel *et al.*, 2020, 2021a).

$$\text{Trap Positivity Rate} = \frac{\text{No. of positive trap collected}}{\text{No. of traps fixed}} \times 100$$

$$\text{Chigger Infestation Rate} = \frac{\text{No. of chigger mites collected}}{\text{No. of rodents/shrew collected with chigger mites}} \times 100$$

$$\text{Chigger Index} = \frac{\text{No. of chigger mites collected}}{\text{No. of rodents/shrew collected}}$$

RESULTS AND DISCUSSION

A total of 1080 Sherman traps were placed in the 9 study sites of three different habitats. Only 151 rodents/shrews were trapped. The overall trap positivity rate was 14 per cent, and rural habitat was showing with high trap positive rate (18.06%) and there was a significant difference ($\chi^2=10.409$, df 2, $p<0.05$) in the trap positivity for the rodents trapped at the different habitats, which means there was no equality of rodents trapped at all the habitats

Table 1. Host positive, number chiggers and indices calculated month-wise during 2017- 2018

Month	No. hosts trapped (R/S)			No. hosts positive			Chigger collected			Chigger Infestation Rate			Chigger Index		
	U	SU	R	U	SU	R	U	SU	R	U	SU	R	U	SU	R
July 2017	2	2	3	0	1	1	0	7	3	0.00	0.00	3.00	0.00	3.50	1.00
August	3	2	3	1	2	1	10	11	14	10.00	5.50	14.00	3.33	5.50	4.67
September	2	3	2	0	1	0	0	16	0	0.00	0.00	0.00	0.00	5.33	0.00
October	2	3	3	1	1	2	13	23	31	13.00	23.00	15.50	6.50	7.67	10.33
November	4	6	7	1	3	4	43	125	311	43.00	41.67	77.75	10.75	20.83	44.43
December	4	7	9	2	2	3	324	402	621	162.00	201.00	207.00	81.00	57.43	69.00
January18	6	9	11	2	3	4	250	321	243	125.00	107.00	60.75	41.67	35.67	22.09
February	3	6	9	2	2	5	85	47	84	42.50	23.50	16.80	28.33	7.83	9.33
March	1	3	5	1	1	1	33	6	21	33.00	6.00	21.00	33.00	2.00	4.20
April	3	3	4	0	1	1	0	12	9	0.00	0.00	9.00	0.00	4.00	2.25
May	3	5	6	2	2	3	27	44	69	13.50	22.00	23.00	9.00	8.80	11.50
June	2	2	3	0	0	1	0	0	7	0.00	0.00	7.00	0.00	0.00	2.33
Total	35	51	65	12	19	26	785	1014	1413	65.42	53.37	54.35	22.43	19.88	21.74

Note: R/S- Rodents/ Shrews; U-Urban; SU- Semi Urban; R-Rural

Table 2. Host-wise chigger mite species examined at different habitats in Madurai, India

Habitat	Chigger mite species	Host/ number of chiggers					Total chiggers
		Rr	Rn	Sm	Bb	Ti	
Urban	<i>Leptotrombidium deliense</i>	122	11	155	23	0	311
	<i>Leptotrombidium indicum</i>	8	0	11	2	0	21
	<i>Leptotrombidium rajasthanensis</i>	0	0	9	0	0	9
	Oribatida mites*	1	0	0	0	0	1
	<i>Schoengastia</i> sp.	3	0	6	0	0	9
	<i>Schoengatiella ligula</i>	20	2	31	9	0	62
Semi Urban	<i>Leptotrombidium deliense</i>	191	3	225	12	0	431
	<i>Schoengatiella ligula</i>	43	0	60	6	0	109
	<i>Leptotrombidium indicum</i>	26	1	44	0	0	71
	<i>Trombicula hypodermata</i>	3	0	12	0	0	15
	<i>Leptotrombidium keukenschrijveri</i>	0	0	9	3	0	12
	<i>Leptotrombidium rajasthanensis</i>	0	0	9	0	0	9
	<i>Liponyssoides sanguineus</i> *	0	0	0	2	0	2
Rural	<i>Leptotrombidium deliense</i>	320	5	250	23	42	640
	<i>Leptotrombidium indicum</i>	114	2	27	0	6	149
	<i>Schoengatiella ligula</i>	40	0	85	0	24	149
	<i>Leptotrombidium keukenschrijveri</i>	25	0	0	0	0	25
	<i>Leptotrombidium rajasthanensis</i>	11	0	13	0	0	24
	<i>Trombicula hypodermata</i>	9	0	12	0	2	23
	<i>Microtrombicula</i> sp.	3	0	11	0	0	14
	<i>Neotrombicula microti</i>	0	0	4	0	3	7
	<i>Liponyssoides sanguineus</i> *	1	0	0	2	0	3
	<i>Echinolaelaps</i> sp*	1	0	0	0	0	1
	Total	941	24	973	82	77	2097

Note: *-Adult mites; R/S- Rodents/ Shrews; R-Rural; Rr - *Rattus rattus*; Rn - *Rattus norvegicus*; Sm - *Suncus murinus*; Bb - *Bandicota bengalensis*; Ti - *Tatera indica*

studied. Only 57(37.7%) rodents were positive for chiggers and 12(21.05%), 19(33.33%), and 26(45.61%) positive rodents were trapped from urban, semi-urban, and rural habitats respectively. However, there was no significant difference ($\chi^2=0.3241$, df 2, $p>0.05$) in chigger infestation for the rodents trapped in the different habitats. A total of 3212 chiggers including 7 adult mites were collected in all the habitats and only 2096 (65%) mites were identified. Out of 3212 mites collected, 785(24.44%), 1014 (31.57%), and 1413 (43.99%) were respectively from urban, semi-urban and rural habitats. However, the urban habitat was showing with high chigger Infestation rate of 22.43 (Table 1 and 2).

Among the 151 trapped rodents/shrews, 95 (63%) were *Rattus rattus* and 33 (22%) *Suncus murinus* and only 31 (15%) were other rodents (Fig. 1). *Tatera indica* was trapped only in rural sites. Out of 151 trapped rodents/shrews, 57(37.75%) rodents/shrews were positive to chiggers. *R. rattus* 31 (54%) and *S. murinus* 17(30%) contributed more in chigger positivity. Other rodents contributed less in chigger positivity 9 (16%) and *Mus musculus* was negative in chiggers. From a total 2096 mites identified, 413 (19.70%), 648 (30.92%), and 1035 (49.38%) were collected from urban, semi-urban, and rural sites respectively. Among the 2096 mites, 2089 were chiggers and 10 were different species of mites. There were 1382 *L. deliense* (66%), 320 *S. ligula* (15%), 241 *L. indicum* (12%), 42 *L. rajasthanensis* (2%) and 104 other chiggers (5%).

There was a significant difference among the seasons in rodent positivity ($F=7.093$, df 3, $p<0.05$), and there was no significant difference among the seasons in the number of chiggers collected ($F=2.262$, df 3, $p>0.05$). A total of 2437 chigger mites (76%) were collected during cool months (wet and dry cool months) from November 2017 to February 2018, indicating wet and dry cooler months favored chiggers. The total rodents trapped during these four months were 81 (53.64%). Among these 17 (48.57%), 28 (54.90%) and 36 (55.38%) rodents/shrews were trapped at urban, semi-urban and rural

sites respectively, during wet and dry cool months (Fig. 1). The lowering temperature was positively correlated with increasing density of chiggers and rodent positivity. However, *M. musculus* was negative to chiggers. The primary scrub typhus vector *L. deliense* collected more during cooler months. Moist soil after rainy seasons and cooler temperature favored rodent mite contact.

Temperature affects development of *L. deliense*. Optimum temperature for the growth and activities of chiggers was 23–25°C, and for scrub, typhus transmission required temperature was 18–30°C (Traub and Wisserman, 1974). The cooler months in south India was favored to scrub typhus cases and increase chiggers' density (Mathai *et al.*, 2003). During the cooler months of September 2012 to March 2013 in south India, more scrub typhus cases were recorded (Stephen *et al.*, 2015). In Tamil Nadu and Puducherry, more scrub typhus cases occurred during cooler months (October 2013-January 2014) and chigger mites were more from October to December 2013 (Sadanandane *et al.*, 2016). Scrub typhus cases were reported in the Madurai district during 2016, but the distribution pattern of chiggers on rodents/shrews were limited and chigger positive *R. rattus*, *R. norvegicus*, *M. musculus*, and *S. murinus* trapped were more (Philip Samuel *et al.*, 2021a).

In the present study the density of chigger mites increased during cooler months followed by a rainy north-east monsoon, and the temperature was lower after rainy seasons. In Thailand, Burma and India, scrub typhus is most common from June until November, but present throughout the year (Elliot *et al.*, 2019). Except in May, scrub typhus cases were reported in all the months in Tamil Nadu and Puducherry (Philip Samuel *et al.*, 2021c; Sadanandane *et al.*, 2016; Devaraju *et al.*, 2020). The study indicated the prevalence of chiggers in various hosts and their variation in rodent/shrew hosts.

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