



Research Article

Is Delhi an Emerging Scrub Typhus Hotspot? An Entomological and Zoonotic Exploration of a Scrub Typhus Outbreak

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A B S T R A C T

Background: Scrub typhus is an emerging public health challenge in India with increasing evidence of its activity being reported from all over the country. An outbreak of scrub typhus was reported from an area of South West Delhi, India hitherto not known for scrub typhus activity which prompted this zoonotic and entomological investigation.

Methods: Zoonotic and entomological investigations were undertaken in five residential areas of South West Delhi, India located in the vicinity of the reporting hospital to determine the rodent hosts, vector mite diversity, and rickettsial activity in rodents. The rickettsial activity was ascertained using Weil-Felix test.

Results: Palam area of Delhi, India is a hotspot of scrub typhus with evidence of tick and endemic typhus activity as well. This study reports the presence of known vectors of scrub typhus viz. *Leptotrombidium deliense* and *Schoengastiella ligula*, besides enriching the database of mite fauna of Delhi with an addition of a total of five new records, three of *Leptotrombidium - vietzi*, *bhattipadense*, *fulmentum*, and two records of *Ascoschoengastia indica* and *Walchia lupella*.

Conclusion: The study reports Delhi as a scrub typhus hotspot. In Delhi, Palam was the most affected and had the highest number of cases and deaths, presence of the vectors of scrub typhus and evidence of tick and endemic typhus activity amongst rodents. The mite database of Delhi has been updated with the addition of five new trombiculid mite records.

Keywords: Scrub Typhus Outbreak, Tick Typhus, Endemic Typhus, *Leptotrombidium*, *Schoengastiella*, *Ascoschoengastia*



Introduction

Scrub typhus is a poorly recognised but serious public health problem. Around one billion people are at risk of this infection and one million new infections are reported each year.¹ Till recently, the transmission of scrub typhus in India was considered limited to the Himalayan belt and certain states of South India, however, increasing numbers of cases of scrub typhus have been reported from states like Punjab, Haryana, Rajasthan, and Delhi over the past few years.² A recent multicentric study conducted across 34 ICUs in India found scrub typhus to be the second most common aetiology for ICU admissions in the post-monsoon season.³ A study published by the All India Institute of Medical Sciences, New Delhi, carried out over 03 years reported 33 confirmed cases of scrub typhus from around 200 fever cases.⁴ Another study in Delhi by Mittal et al. reported the seropositivity for scrub typhus in suspected patients to be around 16.05%.⁵ Delhi has been consistently reporting scrub typhus cases each year leading to a realisation of heightened mite activity in and around Delhi.⁶⁻⁸ Though various authors have brought out the clinical spectrum of the disease, the same has not been corroborated with entomological surveillance in the affected areas.

Several studies have in recent years, reported an outbreak of scrub typhus, including reports from hospitals on clustering of cases in various parts of the country, but, very few studies have brought forward any corroborative evidence regarding the presence of infection in rodents from an area reporting human cases. Several cases of scrub typhus were sporadically reported each year from South West Delhi. In the year 2016, cases were reported from a tertiary care hospital in South West Delhi, which included four deaths. Hence, an entomological and zoonotic study was undertaken with the objectives to explore the vector and rodent host's diversity and abundance, ascertain rickettsial activity with special reference to scrub typhus amongst rodents, and draft targeted administrative guidelines for the prevention and management of scrub typhus outbreaks in the study areas.

Materials & Method

Study Setting

The study was conducted at five residential locations of South and South West Delhi - Palam, Sadar bazaar, Mehram Nagar, Dhaula Kuan and Mehrauli-Badarpur area in the vicinity of the reporting hospital, from where all the cases of scrub typhus were reported. The study was carried out from Aug to Sep 2016.

Methodology

Live Rodent Capture & Processing

Live rodent capture was undertaken using Sherman

traps in the five study areas. The captured rodents were anaesthetised and blood was collected by direct heart puncture method. The sera were separated and subjected to serological studies. The rodent was dissected and any gross pathological changes in organs (liver and spleen) were noted. The impression smears of both spleen and liver were also taken for microscopic examination for the presence of rickettsiae-like organisms. The slides were stained with Giemsa stain and screened by pathologists for the presence of rickettsiae.

Ectoparasite Fauna Studies

The rodent/ shrew ear and rump were examined for mite infestation under a stereomicroscope. All the trombiculid mites sampled from a rodent were mounted in Hoyer's media for identification (when the number of mites was less than 50) or else if the number exceeded 50, only 10% of the mites were mounted and identified. The mites were identified using Phase Contrast Microscope following the standard key as given in 'Trombiculids of India' by Stan Fernandez.⁹

Rickettsial Sero-surveillance

The rodent sera samples for each rodent were independently tested (when blood collected was up to 5 ml) or else were pooled when the collected blood was less than 5 ml as per the guidelines followed for serological testing by Weil-Felix to determine rickettsial activity. Care was taken to ensure that whenever pooling of blood was undertaken, the rodents were from one area only or at the most from contiguous areas.

Results

Trap Positivity, Rodent Infestation Rate and Chigger Index

A total of 118 traps were laid in the five study sites and 22 rodents were trapped giving an overall trap positivity of 18.64% (ranging from 4.16% to 35.71%), with the highest recorded at Palam and lowest at Mehrauli-Badarpur neighbourhood (Table 1). The overall rodent infestation of the study sites was 77.3% with nil infestation recorded from Mehrauli-Badarpur study area. The overall chigger index of the study areas was found to be 116.4 with a very high index of 216.75 at Palam (Table 1).

Trombiculid Mite Abundance and Distribution

About 63% of all mites collected from the five study areas were *Schoengastrella ligula* (Table 1). *Leptotrombidium* mite species were most abundant in Palam, which also recorded the highest number of *Leptotrombidium deliense* (90% of the total) followed by Sadar Bazar (10%). The existing database of Delhi documents the presence of only two trombiculid mites i.e. *Leptotrombidium deliense* and *Schoengastrella ligula*; this study reports additional

five new records of trombiculid mite species thereby enriching the existing trombiculid mite fauna of Delhi. The additional records of trombiculid mite species at Delhi are *Leptotrombidium vietzi*, *Leptotrombidium bhattipadense*, *Leptotrombidium fulmentum*, *Ascoschoengastia indica*, and *Walchia lupella*.

Table 1. Entomological Indices at the Study Sites in Delhi

S. No.	Study Areas	No. of Traps laid	Rodents trapped (Trap rate (%))	Rodents Infested with chiggers (Rodent Infestation rate (%))	No. of Chiggers (Chigger index)	L d	S I	L(E) v*	L(E) b*	L f*	A i*	W l*
1.	Palam	44	11 (25)	8 (72.72)	1734 (216.75)	89	161	32	6	3	10	0
5.	Sadar Bazaar	14	5 (35.71)	4 (80)	92 (23.0)	10	53	0	1	0	0	0
6.	Mehram Nagar	20	3 (15.0)	3 (100)	25 (8.3)	0	17	0	0	0	1	7
7.	Dhaura Kuan	16	2 (12.5)	2 (100)	129 (64.5)	0	38	0	0	0	1	0
8.	Mehrauli Badarpur	24	1 (4.16)	0 (0)	0 (0)	0	0	0	0	0	0	0
Total		118	22 (18.64)	17 (77.27)	1980 (116.47)	99	269	32	7	3	12	7

Note L d - *Leptotrombidium deliense*, S I - *Schoengastiella ligula*

*New records of mites: L(E) v - *Leptotrombidium (Ericotrombidium) vietzi*, L(E) b - *L(E) bhattipadense* Lf - *L fulmentum*, A i - *Ascoschoengastia indica*, W l - *Walchia lupella*

Table 2. Corroboration of Rodent Serology, Pathology, Ectoparasite Presence, and Distribution of Cases

Study Area	Rodent Hosts	Weil Felix Result			Splenomegaly/ Hepatomegaly in Rodent & Microscopic Findings	Distribution of Scrub Typhus Cases	Presence of Trombiculid Mite Species & Tick
		OXK	OX2	OX19			
Palam	<i>R r rufescens</i>	1:80	1:160	-	N	7 (4 deaths)	<i>Leptotrombidium deliense</i> <i>Schoengastiella ligula</i> <i>Ascoschoengastia indica</i> <i>Leptotrombidium vietzi</i> <i>Leptotrombidium bhattipadense</i> <i>Leptotrombidium fulmentum</i> Tick (<i>Rhipicephalus sanguineus</i>)
	<i>R r rufescens</i>	-	-	-	N		
	<i>R r rufescens</i>	-	1:320	-	N		
	<i>R r rufescens</i>	1:320	1:1280	1:640	N		
	<i>Suncus murinus</i>	-	-	-	Y (Coccobacilli seen)		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		

	<i>Suncus murinus</i>	-	-	-	N		
Sadar Bazaar	<i>Suncus murinus</i>	-	-	-	Y (Coccobacilli seen)	1 (No death)	<i>Leptotrombidium deliense</i> <i>Leptotrombidium bhattipadense</i> <i>Schoengastiella ligula</i> Tick (<i>Rhipicephalus sanguineus</i>)
	<i>Suncus murinus</i>	-	-	-	Y (Coccobacilli seen)		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
Mehram Nagar	<i>Suncus murinus</i>	-	-	-	N	3 (No death)	<i>Schoengastiella ligula</i> <i>Ascoschoengastia indica</i> <i>Walchia lupella</i>
	<i>Suncus murinus</i>	-	-	-	N		
	<i>Suncus murinus</i>	-	-	-	N		
Dhaura Kuan (pooled sera)	<i>Suncus murinus</i>	-	-	-	N	0	<i>Schoengastiella ligula</i> <i>Ascoschoengastia indica</i>
	<i>R rufescens</i>	-	1:160	-	N		
Mehrauli-Badarpur	<i>Suncus murinus</i>	-	-	-	N	1 (No death)	Nil

Note: *R r rufescens* - *Rattus rattus rufescens*

Rickettsial Sero-surveillance amongst Rodents

The rodent blood was pooled for serological testing; a total of 13 pooled sera (09 from Palam and one each from the other four study sites) were tested for rickettsial serology. No rickettsial activity with Weil-Felix was evidenced at three of the five study areas viz. Sadar bazaar, Mehram Nagar, and Mehrauli-Badarpur area (Table 2). Of the 9 pooled sera at Palam, 03 tested positive (1 for OXK and OX2, 1 for all three - OXK, OX2, OX19 and 1 for OX2 only) indicating the presence of scrub typhus, tick typhus, and endemic typhus in Palam, whereas, the serum from Dhaura Kuan tested positive for OX2 indicating Indian tick typhus activity in the area.

Rodent Pathology, Microscopic Findings and Distribution of Cases

The rodent pathology and the microscopic findings reveal splenomegaly and hepatomegaly amongst the rodents trapped in Palam and Sadar bazaar areas (Table 2).

Intracellular coccobacillary forms were seen in macrophages in impression smears of spleen and liver from rodents collected from Palam and Sadar Bazaar area. The findings are suggestive of rickettsial activity in these two study areas which is also evidenced by the presence of vector species and occurrence of cases.

Intervention Measures for Scrub Typhus

The following intervention activities were undertaken in the study areas:

IEC on Prevention and Containment

Resident Population of the Study Areas: Intensive information and education campaigns were undertaken to raise public awareness. In all the affected areas, the local population was educated regarding proper disposal of food waste, measures to control and reduce rodent nuisance, use of barrier clothing, application of repellents on exposed parts of the body during outdoor activities especially while sitting in gardens or any other leisure activity undertaken in high vegetation areas. The local populations were advised to clear areas like backyards, gardens etc. of bushes and weeds and to cut the grass as low to the ground as possible to make the area less survivable for ticks and mites. People were advised to avoid sitting, lying, or putting personal belongings on the grass. The importance of prompt reporting to the hospital in case of fever was stressed for the prevention of morbidity and mortality.

Public Health & Medical Professionals: Civil administrative authorities, as well as public health professionals, were advised to maintain garbage bins and keep areas like public

parks, and other general areas clean to prevent rodent infestation. Application of insecticide was recommended if removal of vegetation was not possible. Doctors and physicians were explained the importance of keeping a high index of suspicion in all cases reporting fever. In keeping with the ICMR guidelines, for all patients suspected of having scrub typhus (based on clinical judgment), it was advised that treatment be initiated at the earliest without any delay for want of laboratory diagnosis.

Surveillance

The authors recommended a targeted area-specific surveillance strategy for the scrub typhus affected areas to be implemented on a priority basis. The surveillance strategy comprised rodent trapping using Sherman traps in the pre-monsoon and monsoon seasons. The trapped rodents were recommended to be screened for the presence of trombiculid mites. If found positive, the following guidelines were implemented:

- If less than 10% of the rodents were positive, active IEC was recommended to be initiated in the affected area and activities enlisted in IEC for residents were strictly enforced
- If more than 10% of rodents were found infested, the entire area was recommended to be put under treatment with insecticide (Malathion 5%). The clinicians to be immediately appraised of the situation and advised to keep a high index of suspicion for scrub typhus due to the potential of a likely outbreak in their area
- In the case of a single rodent having more than 200 mites, measures recommended in para b were to be implemented

Discussion

The resurgence of rickettsial diseases in the northern states of India is a cause of concern. However, there is limited information on the vector mites involved or the presence of other rickettsial pathogens, besides scrub typhus, amongst rodents in Delhi.

The trap positivity in our study (18.64%) was much higher than that reported in similar studies in Puducherry, West Bengal, Meghalaya, Himachal Pradesh, and Kerala.¹⁰⁻¹⁵ The rodent catch in the study was found to be the lowest in Mehrauli-Badarpur neighbourhood and also no ectoparasite infestation was noted in this area. This probably could be due to the study site being in the higher socioeconomic neighbourhoods of South West Delhi which had better waste disposal and urban planning.

The trombiculid mite fauna of Delhi is diverse with the presence of two vector species of scrub typhus i.e. *Leptotrombidium deliense* and *Schoengastiella ligula* along with 5 additional trombiculid mite species. The maximum

diversity amongst the trombiculid mites was recorded from Palam, which recorded a total of six species out of seven species recorded from all the five study areas. Although *Schoengastiella ligula* was found to be present in all study sites, *L deliense* was not recorded from Mehram Nagar and Dhaula Kuan. On corroborating with the specific areas of occurrence of human cases, we found that three human cases were reported from Mehram Nagar which highlights the role of vector *Schoengastiella ligula* in the transmission of scrub typhus in this area.

The rickettsial sero-surveillance results of three (Sadar bazaar, Mehram Nagar and Mehrauli-Badarpur) out of the total five study areas though are negative, nonetheless, it should be viewed with caution as the vectors of scrub typhus - *Leptotrombidium deliense* and *Schoengastiella ligula* are present in these areas. The argument is further strengthened by the fact that human scrub typhus cases occurred at all these rodent serologically negative sites. The evidence of tick and endemic typhus activity is also clearly witnessed in the rodent serological findings of Palam and Dhaula Kuan. Palam as evidenced has emerged as a hotspot of rickettsial activity and it is of utmost importance to appraise the medical specialists working in this area to keep a high index of suspicion for rickettsial diseases. There is a need for the public health professionals to institute surveillance and an early warning system to prevent outbreaks and the resultant morbidity and mortality due to scrub typhus.

The interesting finding of the presence of *Ascoschoengastia indica* in both the areas reporting a higher number of cases is worth noting (Table 2). Does this trombiculid mite contribute to enhancing the magnitude of scrub typhus outbreak? This facet needs further deliberation and evidence in the Indian context, especially in the light of it being found positive for rickettsia in Thailand¹⁶ and the report of its likely role in the transmission of rickettsiae between rats.¹⁷

One of the noteworthy findings of the study is that hepatomegaly/ splenomegaly was evidenced only in shrews i.e. *Suncus murinus*, whereas Weil-Felix serology positivity was noted amongst rats (*Rattus rattus rufescens*). Shrew is considered to be an index animal for scrub typhus and thus its role, not only in the transmission of scrub typhus but also in surveillance, may assume significance if pathological changes are found to be exclusively or more associated with them in rickettsial active areas. The fact that only rats tested positive in Weil-Felix test and not shrews, although pathological changes, as well as the presence of rickettsia, were seen in the spleen and liver impression smears of shrews, is an interesting finding and needs further exploration as well as validation.

The study, however, suffers from a major limitation

that no effort was made to additionally test the vectors for the presence of rickettsia which would have added tremendously to a better understanding of the epidemiology of scrub typhus in the area. The authors also acknowledge that efforts should have been made to determine the circulating strain of *Orientia tsutsugamushi* in Delhi to correlate the clinical presentation with the circulating highly virulent strain of *O tsutsugamushi* in the current outbreak as evidenced by the number of deaths (Table 2). The study uses Weil-Felix test for determining rickettsial activity amongst rodents which is an outdated test, nonetheless, certain studies support the use of this test as a cheap and fairly indicative test especially when positive.^{18,19} The authors accept the limitation of not undertaking specific microbiological and serological tests which would have been more accurate and conclusive.

The study has enriched the trombiculid mite fauna of Delhi by the addition of new records as per the mite fauna records of India.⁹ The addition of five species - three of *Leptotrombidium* (*vietzi*, *bhattipadense* and *fulmentum*), one of *Ascoschoengastia* (*indica*), and one of *Walchia* (*lupella*) to the existing trombiculid database of Delhi, has been a significant contribution of the study to the trombiculid mite database of India and for future researchers in the field.

Conclusion

Delhi is undoubtedly an emerging hotspot of scrub typhus with evidence of additional activity of tick and endemic typhus. Palam, New Delhi was the most affected study site with scrub typhus activity evidenced by rodent serology and the presence of vector trombiculid mites. The study emphasises the need to institute a scrub typhus surveillance system with stringent implementation of preventive measures (prompt waste disposal to prevent rodent infestation) especially in the identified hotspots in the present study or previously established scrub typhus active areas of Delhi.

It is recommended that the identification of circulating strain(s) of *Orientia tsutsugamushi* in Delhi be undertaken and the prevalence of the virulent strains be mapped so that high-risk areas may be further delineated and prioritised for implementation of stringent measures to prevent further outbreaks and preventable deaths.

Conflicts of Interest: None

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