

Ectoparasite of Rodents Collected from International Seaport, Gujarat (India) with Special Reference to Plague & Scrub Typhus

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Abstract

Background: Rodents are well established at port areas and their arthropod ectoparasite can be vectors of many diseases. Ships play an important role in spreading disease by transporting infected vectors.

Objective: In view of the seriousness of the problem the present study was undertaken to assess the prevalence of rodent–ectoparasite association at KPT, Kandla (India).

Results: Four species of rodents: *Tatera indica* (Hardwicke), *Bandicota indica* (Bechstein), *Rattus norvegicus* (Berkenhout), *Rattus rattus* (Linnaeus) were trapped from the port area. Rodent infestation rate was 84.9 per cent. Lice (46.5%) were the predominant ectoparasites retrieved from the rodents followed by mites and fleas. The rodent ectoparasite index was 13.6 per rat. A total of 32 vector larval trombiculid chigger mite (*Leptotrombidium deliense*, Walch) were collected from various species of rats. Chigger infestation rate was found to be 8.0 per rat. A total of 96% chigger mites were retrieved from *R. norvegicus* trapped from canteen area. A total 234 fleas were retrieved giving an overall flea index of 2.5 per rat. The flea species collected from rodents were *Xenopsylla cheopis* (Rothschild) and *X. astia* (Rothschild). Serological & bacteriological examination of rodent samples showed no *Orentia* and plague bacilli activity.

Conclusion: Result of the study suggests routine surveillance for rodent and their arthropods ectoparasite to apply appropriate control measure to prevent the spreading of rodent borne diseases.

Keywords: Kandla Port, *Leptotrombidium deliense*, *Rattus rattus*, Scrub Typhus, *Tatera indica*, *Xenopsylla cheopis*

Introduction

Rodents ectoparasites are an important vector for zoonosis and rodents can act as reservoirs or carriers of more than 200 infectious diseases in man and animals. Ectoparasitic arthropods that infest mammals are either insect or acarines.¹ Some ectoparasites such as chewing and sucking lice are permanent, whereas most adults' fleas and ticks are temporary.² Rats are known to harbour four groups of arthropods ectoparasite: fleas, ticks, mites and lice. These ectoparasites are biological vector of pathogenic organism

(virus, bacteria, protozoans, and helminths) among their hosts.¹ These rodents with their ectoparasites causing diseases such as plague, leptospirosis, salmonellosis, rat-bite fever, leishmaniasis, Chagas' disease, Omsk hemorrhagic fever, murine typhus and Lassa fever,³ Crimean Congo Hemorrhagic Fever^{4,5} etc. They can also transmit disease to human by: feces, urine, saliva, milk and blood.^{6,7}

Human dispersal and colonization over the last few millennia have spread different species of rodents to many of the world's islands. These rodents are: *R. rattus*, *R. norvegicus*,

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R. exulans (Peale) and *Mus musculus* (Linnaeus). This spreading of rodent adversely affects native biodiversity and these exotic rodents carry diseases that may affect native animals and human.⁸ Sea ports are the places where transportation and spreading of rodents and their ectoparasites are possible. Now this spreading of rodents has become an international problem and creating health problems in the cities, especially in port and coastal areas.⁸ In India, scrub typhus is emerging as important infectious diseases.⁹ Therefore, this study was carried out for the first time in Kandla Port Trust, Kandla (Gujarat) in January 2014. Prevalence of rodent–ectoparasite association was investigated with the following objectives: i. To determine the prevalence of rodents and their ectoparasite species in sea ports area ii. To know the presence of *Orentia* and plague bacilli infection in rodents if any present iii. To review the ectoparasite - rodents control strategy undertaken by the port health authorities.

Materials and Methods

Description of Study Area

Kandla Port is a seaport in Kutch district of Gujarat state in western India, near the city of Gandhidham. Located on the Gulf of Kutch, it is one of major ports on west coast. Kandla was constructed in the 1950s as the chief seaport serving western India. It is situated at 23° 01'N, 70° 13'E. Kandla has a desert climate. There is virtually no rainfall during the year in Kandla. The average annual temperature is 26.9 °C and about 388 mm of precipitation falls annually in Kandla. The port of Kandla Special Economic Zone (KASEZ) was the first special economic zone to be established in India and in Asia. Established in 1965, the Port of Kandla SEZ is the biggest multiple-product SEZ in the country. Kandla is the first Export Processing Zone in India. Covering over 310 hectares, the special economic zone is just nine kilometres from the port of Kandla. Today, the port of Kandla is India's hub for exporting grains and importing oil and one of the highest-earning ports in the country. Major imports entering the port of Kandla are petroleum, chemicals, iron, steel and iron machinery, but it also handles salt, textiles, and grain. A town has grown up on the port with a school and hotel etc. To see the magnitude of problem related to rodents and their ectoparasite different sites at seaport area were selected for trapping rodents.

Trapping Locations

Different spots at Kandla port were surveyed and trapping of rodents was conducted in six different sites with the intention to trap maximum number of rodents. Following sites were selected to trap rodents: i. Canteen, ii. I.M.C. Building, iii. Bansal Hotel, iv. Wheat go down, v. Railway track and vi. Slum Colony.

Trapping and Processing of Rodent Collected

The live trapping was carried out to capture the rodents. Traps were baited with fried eatables smeared with butter

and laid in the evening at pre-selected sites. The traps were collected on the next morning and brought back to the laboratory. Rodents collected were anaesthetized and identified after recording their different morphological characteristics. To detect *Orentia* and plague bacilli infection rodent blood was drawn, serum was separated and tested by Weil Felix method and plague antibody test.^{10,11} Dissection of 71 rodents was done and organs impression smear of rodent heart, lung, liver and spleen were made and fixed for microscopic identification of plague bacilli. These organs were also placed in K.B. culture medium for isolation of *Y. pestis*. Serological and bacteriological investigations were carried out at Zoonosis Division.

Examination and Processing of Ecto-parasites

The ectoparasites were recovered by combing the rodents against the fur of rodents over a white tin pan. The snout, ears, limbs and axillary region of individual rodents were combed and ectoparasite were collected and preserved in 70% alcohol for further processing. The contents of the enamel tray were examined carefully with a hand lens and any ectoparasites seen were recovered. All preserved ectoparasites were later mounted in Hoyer's media using clearing, dehydration and mounting procedure for identification using the standard method described earlier by Kumar et al.¹²

Results

During the investigation a total of 320 rodent traps were laid in the different sites. The overall traps positivity rate was recorded as 29 per cent. A total of 93 rodents trapped during survey which belongs to two orders viz. *Rodentia*: *T. indica* (34.4%), *B. indica* (31.1%), *R. norvegicus* (18.3%), *R. rattus* (15.1%) and *Insectivora*: Asian house shrew *Suncus murinus* (Linnaeus) was also trapped from railway track. Male were 71.7% and female 28.2%. The overall infestation rate of ectoparasites was recorded as 84.9 per cent (Table 1 and 2). Area wise number of traps laid, rodent collected and ectoparasites retrieved are shown in Table 1.

The ectoparasites found were mainly from the Order Siphonaptera (fleas), Acari (tick and mite) and Anoplura (sucking lice). All ectoparasites retrieved from the trapped rodents were preserved in 70% alcohol for identification and further processing. As a result of combing of the rodents, lice (46.5%) were the predominant ectoparasite retrieved from all the six sites followed by mites and fleas. Overall rodent ectoparasite index was 11.2 per rat. A total 32 vector larval trombiculid chigger mites (*L. deliense*) and 242 mesostigmatid mites (*Laelaps* sp.) were collected from the rodents (Table 2). Chigger infestation rate was found to be 8.0 per rat. The chigger infestation was found on *R. norvegicus* & *T. indica* collected from canteen and railway track. After combing of these rodents 234 fleas were retrieved giving an overall flea index as 2.5. Two species of *Xenopsylla* were found. *X. cheopis* (oriental rat flea) was found on all four species of rodent while *X. astia* was found

on *R. norvagicus* & *T. indica*. Maximum fleas were collected from railway track area. The flea index recorded during the present studies was above the critical index of one, which requires anti fleas measure in the port area. Two species of ticks (*Haemaphysalis spp.* & *Rhipicehalus spp.*) were found on *T. indica*, *B. indica* and *R. rattus*. A total of fifty-eight serum samples taken from various rodents' species

captured alive were processed for detection of *Orentia* (Scrub typhus) and plague antibodies and all the samples were found non-reactive. Examination of organs impression smear of 71 rodent heart, lung, liver and spleen showed no plague bacilli activity. Similarly, inoculation from the tissue of 37 rodents could not show isolation of *Y. Pestis*.



Figure 1. Map showing location of Kandla Seaport

Table 1. Locality and sex wise collection from Kandla Port Trust, Kandla, Gujarat

Locality	No. of traps laid	Collection (per cent)											
		Total		TI		BI		RN		RR		SM	
		M	F	M	F	M	F	M	F	M	F	M	F
Canteen	157	31		-		18		11		2		-	
		23	8	-	-	11	7	10	1	2	-	-	-
IMC Building	8	3		-		2		-		1		-	
		1	2	-	-	1	1	-	-	-	1	-	-
Bansal Hotel	20	7		-		4		-		3		-	
		5	2	-	-	3	1	-	-	2	1	-	-
Wheat Go down	25	2		-		2		-		-		-	
		1	1	-	-	1	1	-	-	-	-	-	-
Railway track	95	40		32		-		-		7		1	
		28	12	23	9	-	-	-	-	5	2	-	1
Slum Colony	15	10		-		3		6		1		-	
		8	2	-	-	3	-	4	2	1	-	-	-
Total	320	93		32(34.4)		29(31.2)		17(18.3)		14(15.1)		1(1.1)	
		66	27	23	9	19	10	14	3	10	4	-	1

TI-*T. indica*, BI- *B. indica*, RN- *R. norvagicus*, RR-*R. rattus*, SM- *S. murinus*, M-Male, F-Female

Table 2. Ectoparasite collected from different site of Kandla Port Trust, Kandla, Gujarat

Site	Rodent species	Ectoparasite collected (No. of Infested Rodent)						Lice	Total
		Mites		Fleas		Ticks			
		<i>L. deliense</i>	<i>Laelaps</i> spp.	<i>X. cheopis</i>	<i>X. astia</i>	<i>Haemaphysalis</i> spp.	<i>Rhipicehalus</i> spp.		
Canteen	RN	31 (3)	54 (6)	6 (3)	1 (1)	-	-	-	413 (25)
	BI	-	39 (10)	12 (5)	-	-	-	168 (12)	
	RR	-	-	2 (2)	-	-	-	100 (1)	
IMC Building	BI	-	2 (1)	18 (2)	-	-	-	21 (2)	46 (3)
	RR	-	2 (1)	-	-	-	-	3 (1)	
Bansal Hotel	BI	-	-	11 (4)	-	1 (1)	-	9 (3)	48 (7)
	RR	-	3 (1)	8 (2)	-	9 (2)	-	7 (3)	
Wheat Go down	BI	-	14 (2)	6 (2)	-	-	8 (1)	-	28 (2)
Railway track	TI	1 (1)	116 (15)	124 (22)	2 (1)	29 (8)	1 (1)	161 (21)	491 (36)
	RR	-	9 (4)	32 (6)	-	-	-	15 (3)	
	SM	-	1 (1)	-	-	-	-	-	
Slum Colony	RR	-	1 (1)	1 (1)	-	-	-	-	14 (6)
	RN	-	1 (1)	6 (3)	-	-	-	-	
	BI	-	-	5 (2)	-	-	-	-	
Total	RR	-	15 (7)	43 (5)	-	9 (2)	-	125 (8)	1040 (79)
	RN	31 (3)	55 (7)	12 (6)	1 (1)	-	-	-	
	BI	-	55 (13)	52 (15)	-	1 (1)	8 (1)	198 (17)	
	TI	1 (1)	116 (15)	124 (28)	2 (1)	29 (8)	1 (1)	161 (21)	
	SM	-	1 (1)	-	-	-	-	-	
	Total	32 (4)	242 (43)	231 (54)	3 (2)	39 (11)	9 (2)	484 (46)	

TI-*T. indica*, BI-*B. indica*, RN-*R. norvegicus*, RR-*R. rattus*, SM-*S. murinus*

Discussion

Prior to this work, no information was available on ectoparasites of rodents from Kandla Port Trust, Kandla. So, present study was done in port area to obtain data on the distribution of rodents and their ectoparasitic arthropods for future planning of prevention and control measures for zoonotic diseases in the area. During the present study it was observed that canteen, railway track and slum colony are the potential sites for propagation and multiplication of rodent and their ectoparasites. It may be due to availability of enough food and shelter for rats. The rodent species captured in present investigation, the Indian gerbil, *T. indica*, the great bandicoot, *B. indica*, the brown rat, *R. norvegicus* and the black rat, *R. rattus* were also reported in other studies that have been conducted previously in other parts of India including Gujarat. Though the density of rats was varying but rodents were collected from all the collection sites. Maximum numbers of rodents were collected from railway track. Results of this study indicated that there was a significant relation between type & condition of building and detecting rodent. More than 70% rodent infestation was observed in and around buildings with human

activities such as Canteen, I.M.C. Building, Bansal Hotel, Wheat go down, and Slum Colony. This study found that building structure, poor structural maintenance, structure material, lack of hygiene and sanitation especially in and around canteen & wheat go down support the breeding and survival of rodent. In this situation rodents can be control by environmental manipulation and mechanical method. This is confirmed by Murphy and Oldbury¹³, who stated that domestic mouse infestations were increased with poor structural maintenance in the buildings. About 84.9% rodents were found to be infested with at least one ectoparasite (mite, tick, flea or lice). Amongst the trapped rodent, about 71.7% were male and 28.2% female. No association between sex of rodents to the infestation rate was noticed. This result is accordance to the report of Paramasvaran et al.¹⁴ in Kuala Lumpur, Selangor, Negeri and Sembilan States of Malaysia. Captured rodents in our study, *R. norvegicus* (sewer rat) were reported in some studies in Iran as a vector of some ectoparasites.^{15,16} Other studies in some countries have similar results.¹⁷⁻¹⁹ Study in Bandar Abbas after control program showed four rodent species: *R. norvegicus*, *R. rattus*, *T. indica*, and weasel, their ectoparasites were *X. buxtoni*, *Rhipicephalus* spp, *polyplax*

gerbili, *Hoplopleura captiosa*, *Ornithonyssus bacoti*, *Laelaps nuttall*, *Dermanyssus americanus*, *Dermanyssus sanguineus*, *Haemolaelaps glasgowi* and *Echinolaelaps echidninus*.²⁰



Figure 2. Rodent burrow near railway track inside seaport

In the current study, trombiculid chigger mite (*L. deliensis*) recovered from two rodent species (*R. norvegicus* and *T. indica*) collected from canteen and railway track. *L. deliensis* is an established scrub typhus vector. These mites are habitat specific and found in abundance with forested terrain with long grasses.²¹ Area behind canteen has enough food and shelter for the survival of *R. norvegicus* and chigger mites. In the present study the chigger index found to be 0.34, which was below the critical level of chigger load i.e. 0.69 per rodent.²² Earlier during an outbreak investigation in Himachal Pradesh, Kumar et al.²³ calculated the chigger index as 2.46. *R. rattus*, *B. indica*, *S. murinus* were found free of chigger mites. A total of 242 *Laelaps* sp. of mesostigmatid mites were also recovered from all the rodent species collected from all the sites. *Laelaps* sp. are found worldwide and are important parasite for commensal and wild rodents and its bite to man can cause irritation and dermatitis.²⁴



Figure 3. Improper use of rat guard at seaport

In the present study *T. indica* and *R. rattus* were captured from railway track (Figure 2) and both the species were found infested with fleas. Therefore, they are potentially dangerous rodent in port area. The presence of wild and domestic rodent from the same area enhances the possibilities of transfer of fleas from *T. indica* to *R. rattus*

and in the similar study Kumar et al.²⁵ noted the transfer of fleas from wild to domestic rodent, and their responsible role in transmission of bubonic plague in and around India. The oriental rat flea, *X. cheopis*, was most frequently found on *T. indica*. *X. cheopis* has been identified as the main vector for plague and endemic typhus (murine typhus) and as a possible intermediate host of the tapeworm, *Hymenolepis diminuta*.²⁶

The flea index is used to estimate human and epizootic risk for plague²⁷, a flea index >1 represents an increase plague risk in human.²⁸ The flea index found in the present study was 2.5, more than the threshold for plague transmission. So, routine surveillance of flea indices on rodent should be conducted. Earlier at different seaport of Indonesia the flea-index was calculated as 8.4 in *R. norvegicus*, 4.9 in *R. diardii* and 0.7 each of *R. exulans* and *S. murinu* (Semarang seaport), 9.4 in *R. norvegicus* (Soekarno seaport) and 10.3 in *R. norvegicus* (Hatta seaport).²⁹ In Kolkata Port Trust, Kolkata (India) a total 26 fleas were retrieved giving an overall flea index as 1.53 and two fleas species viz. *X. cheopis* and *Ctenocephalides felis* were collected.³⁰ During present surveillance, it was observed that rat guards were not installed properly on some ropes which showed negligence of ship staff (Figure 3). These rat guards are very essential to impede the entry of rat into ship. Inside port area rodent control is being done by private staff while no antiflea measure is being undertaken during rodent killing. Staff working at port is not trained to collect and control rodent/flea. *T. indica* is one of the largest species in the murid subfamily Gerbillinae. They prefer sandy plains and grasslands that allow extensive burrowing with chamber for resting, food storage, and sleeping. The area around railway track was found suitable for survival of this species. So, special attention is required to monitor the activity of this species around railway track. In the current investigation all the four ectoparasites were found on *T. indica*. In India, the wild rodent *T. indica* has been incriminated as the main reservoir for plague.¹⁰ Kumar et al.²⁵ carried out an entomological and rodent surveillance of five districts of Maharashtra and two districts of Gujarat revealed that *T. indica*, was a natural reservoir of plague and vector flea species was *X. cheopis* and a total of 214 *T. indica* and three *B. bengalensis* were collected with flea index calculated ranged from 0.26 to 1.0. The examination of blood serum samples, contact tissue impression smears and tissue organs (heart, lung, liver and spleen) of these rodents did not reveal any evidence of plague activity. Presence of rodent and ectoparasites that were identified in this study are potentially vectors of plague and scrub typhus. So, port health authority has to aware people to prevent close contact with rodent and their ectoparasite. It is necessary to train people about public health significance of rodent, rat proofing the building, rat control inside ships and doing a continuous control of rats, fleas, mites and ticks with suitable method.

Finally, we concluded that regular and continuous rodent and ectoparasite surveillance should be carried out to maintain rodent, flea and mite density below critical level and this kind of study provide a clue for prevention and control of zoonotic diseases in and around port area for the post health authority and in the emergency situations.

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Conflict of Interest: None

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