

Biodiversity of rodent fleas in plague endemic areas of India

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Abstract: Rodent fleas have been considered as the main vector for plague transmission in the rodent population and human plague outbreak usually occur due to the close association of infected rodent fleas with the human being. A total of 910 fleas were retrieved from the 2128 rodents collected from the different areas like Kolar, Palamner, Pune, Surat, Rohru and Chennai. Mainly two types of rodent fleas i.e. *Xenopsylla astia* and *X. cheopis* were found in these areas except the Dodra Kwar area of H.P. state. In Dodra Kwar area *Neopsylla kwar* species were found and it was very sensitive to the temperature variation. Dodra kwar area usually remains under snow for about nine months and even in the rest of period the maximum temperature does not go more than 20°C. The distribution of *X. astia* and *X. cheopis* were found uneven. In surat of Gujarat state *X. cheopis* was predominantly high, whereas in rest of the area *X. astia* were found more. In Chennai the main species found was *X. astia* only. The female percent of rodent flea may be considered as a good indicator for the fast propagation of rodent flea. The breeding season for the fleas mostly depends on the climatic condition like temperature below 22°C-25°C, humidity more than 70% even if the outside temperature is more still the shady area the favorable and do help in the survival of fleas. The rapid urbanization and mass use of pesticide in agriculture sector has got significant impact on the rodent flea population and development of resistance to pesticides.

Keywords: Biodiversity, Flea index, Plague, Rodent fleas, *Xenopsylla* spp.

INTRODUCTION

Plague is a zoonotic disease, its pneumonic form spread very fast in human beings. Natural cycle of plague occurs and remains in rodent population and continues mostly through the infected rodent flea bite. Rodent fleas are the main vectors responsible for its transmission from rodent to rodent and rodent to human being (Rathnaswamy, 1974). It is highly fatal in human being if not treated early. The third pandemic of plague started in 1890's and caused a heavy death toll throughout the world (Samuel and Cohn, 2008). A century ago, there were more than 25 million of deaths In India, (including Bangladesh and Pakistan) alone in two decades period (1898-1918). The development of antibiotics such as Streptomycin and Sulphonamide after the Second World War, led to dramatic reduction in the plague cases. Moreover it was also attributed to the universal use of DDT spray in rural areas for mosquito control, because the rodent fleas were also sensitive to DDT at that time (Biswas *et al.*, 2011). The mortality rate of plague came down from 183 to 1.8 per population and finally reached to zero level during 1967. In 1966 Mulbagal area of Kolar district reported a last case of plague. Sporadic cases of plague were also reported after 1967 from Himachal Pradesh, Attebele Karnataka in 1983 and 1984. The

sylvatic plague incidences were detected and reported by plague surveillance unit of National Institute of Communicable Disease in the tri-junction area of Karnataka, Andhra Pradesh and Tamil Nadu. After a quiescence period of 28 years, plague re-emerged in 1994. Both types of plague (Bubonic and Pneumonic) cases were reported from Beed district of Maharashtra and Surat of Gujarat. The probable reason for this was the discontinuation of plague surveillance and control unit in these states. A lesson was learnt from this outbreak and plague surveillance and control units were re-started in both these states. Again after 8 years of long quiescence localized pneumonic plague outbreaks were reported from Hatkoti, Shimla (Himachal Pradesh) in 2002 and 2004 in Dangud village, district Uttarkashi (Uttarakhand). The seriousness of plague was well documented by W.H.O. Twenty six countries had reported 53,417 cases 4060 (7.6 %) deaths to W.H.O. Though it is well known fact that the under reporting is always there due to various factors which are beyond the control of administration (Bulter, 1989 and Biswas *et al.*, 2011). Baltzard and Bahmanyar (1958) studied and concluded that plague is not localized but time to time it shifts from one place to other due to the rodent migration and the vector too. The rodent fleas as main vector are responsible for its continuity. Various biotic and abiotic

factors are also responsible for the outbreaks of plague. The containment of plague was well done with the vector control by the use of DDT. But now the scenario has changed. In the beginning the rodent fleas were very sensitive to DDT and now it has developed resistance (Biswas *et al.*, 2008). This is posing a threat and generates a need to find the other ways or means to contain the development of rodent fleas. The high population growth, rapid transport system and fast development of various pesticides/insecticides and antibiotic and their uncontrolled uses in agriculture sector and in health sector will have some impact in almost all sphere of life and it might have affected the nature of the plague vector. Therefore the present study has been made to find out, the biodiversity of the plague vector in India particularly in the plague endemic areas.

MATERIALS AND METHODS

The study area was in Kolar district of Karnataka, which is bordering to both Tamil Nadu and Andhra Pradesh which lies between 77° 21' to 78° 35' east longitude and 20° 46' to 130° 58' north latitude. This area is most significant because the last human case was detected from the Mulbagal area of this district in 1966. The seropositivity for plague in rodents was also detected in this district in the past. Other plague endemic areas from where the study samples were collected, were Chittoor district (AP), Chennai (TN), Surat (Gujarat), Pune (Maharashtra) and Rohru (HP).

Rodents were collected by digging from the wild situation and by using wonder traps (live multiple catch trap) from the domestic and peri-domestic situations. The fleas were retrieved from the live rodents collected, by combing and

then sucking with the help of flea suction apparatus. The fleas so collected were transferred into a larger test tube and plugged with cotton. These were then transported to laboratory in a proper container whose temperature is maintained to 20°C-25°C and then preserved in small tubes containing 70%-80% alcohol and for further processing. The fleas were processed for proper identification as per the standard method described by Iyengar, (1973).

RESULTS

The rodent fleas collected from the various places of different states were processed and identified. The data generated is presented in the tables mentioned Tables 1 to 4 and Figs. 1 to 3.

DISCUSSION

Plague is one of the most complicated vectors born zoonotic disease. Rodent act as reservoir and efficient vector i.e. rodent flea results in the active transmission of the causative agent plague bacilli (*Yersinia pestis*). There are 2500 species of fleas in the world belonging to order Siphonaptera, and out of it 46 species described by Sharma (2012) were found to be in India alone. Among these 46 species, *Xenopsylla spp.* like *X. astia* and *X. cheopis* were found predominantly in many areas. The other species were not found on the rodents collected from most of the plague endemic areas. The findings on rodent collected and the type of species of the ectoparasites are presented in the table. It indicate that the vector density of female fleas has gone >50% in the months of June to December in Kolar district (KA). The climatic condition during these months like mean

Table 1. Data of plague vector in Kolar (KA) area for the period of 2009-2010.

Sl. No.	Period 2009-2010	Temp. °C		Relative humidity %	Ppt. mm	Rodent collected	Fleas collected	Absolute Flea Index	Male fleas	Female Fleas	Percent female
		Max.	Min.								
1	Jan	33	10	60	2	105	64	0.61	30	34	53
2	Feb	37	11	52	4	87	30	0.34	22	8	27
3	Mar	38	10	46	20	0	0	0	0	0	0
4	Apr	38	18	54	82	51	15	0.29	6	9	60
5	May	38	15	64	122	66	14	0.21	8	6	43
6	Jun	38	14	74	112	50	12	0.24	3	9	75
7	Jul	37	11	77	139	50	5	0.10	2	3	60
8	Aug	38	9	79	148	23	8	0.35	5	3	37
9	Sep	33	11	76	188	31	6	0.19	1	5	83
10	Oct	39	12	78	202	65	14	0.21	1	13	93
11	Nov	33	12	73	62	82	21	0.26	9	12	57
12	Dec	32	12	68	17	100	26	0.26	11	15	58
		Total				710	215	0.30	98	117	54

Table 2. Data of plague vector in Palamner (AP) area for the period of 2009-2010.

Sl. No.	Period 2009+10	Temp. °C		Relative Humidity%	Ppt. mm	Rodents Collected	Fleas Collected	Absolute Flea Index	Male Flea	Female Flea	Female Percent
		Max.	Min.								
1	Jan	35	12	74	21	95	39	0.41	23	16	41
2	Feb	40	13	72	15	110	77	0.7	37	40	51
3	Mar	39	18	71	23	148	85	0.57	31	54	63
4	Apr	43	18	72	24	115	45	0.39	25	20	44
5	May	45	20	65	53	100	30	0.3	14	16	53
6	Jun	43	19	63	87	110	40	0.36	13	27	67
7	Jul	40	20	65	109	87	34	0.39	16	18	53
8	Aug	40	21	69	137	125	48	0.38	20	28	58
9	Sep	39	20	72	134	81	28	0.34	9	19	68
10	Oct	37	18	80	336	70	31	0.44	10	21	68
11	Nov	39	18	81	374	127	43	0.34	8	35	81
12	Dec	39	17	77	152	82	29	0.35	10	19	66
Total						1250	529	0.42	216	313	56

Table 3. Bio diversity of rodent fleas in plague endemic areas.

Place	Rodent collected	Fleas collected	Absolute flea index	Male	Female	Female Percent	Type of fleas
Kolar (KA)	710	215	0.30	98	117	54	<i>Xa, Xc</i>
Palamner (AP)	1250	529	0.42	216	313	59	<i>Xa, Xc</i>
Surat (Gujarat)	41	10	0.24	1	9	90	<i>Xc, Xa</i>
Pune (Maharashtra)	25	45	1.76	10	35	77.7	<i>Xa, Xc</i>
Rohru (HP)	44	24	0.54	4	20	83	<i>Neopsylla kawar</i>
Chennai (TN)	58	87	1.5	56	31	35.6	<i>Xa</i>
Total	2128	910	42.76	385	525	57.6	<i>Xa, Xc, Nk</i>

Xa - *Xenopsylla astia*, *Xc* - *Xenopsylla cheopis*, *Nk* - *Neopsylla kawar*

KA - Karnataka; AP - Andhra Pradesh; HP - Himachal Pradesh; TN - Tamil Nadu

temperature (22°C-25°C), humidity >70 % and two monsoon rains also favored for their multiplication. Thus the breeding season in this area may be mainly January and June to December months. Whereas in the adjoining state AP, the female flea percent showed that the breeding of fleas may be less in the months of January, February, April, May and July. The female percent of rodent flea may be considered as a good indicator for the fast propagation of rodent flea. The precipitation and humidity as well as the temperature do have major role in the survival and multiplication of rodent fleas. The absolute flea index i.e. the indicator of flea concentration was found more (0.40) in A.P. state than (0.32) Karnataka.

Seal, 1960 and 1969 made epidemiological studies on plague and described the distribution of plague vector in Bombay, Madras and Calcutta. It was reported that

the rodent flea species were mainly *X. astia*, *X. cheopis* and very few as *X. brasiliensis*. The *X. astia* species was 65.6% in Calcutta, 94.3% in Madras region, where as *X. cheopis* was 76.3% in Bombay. The present study revealed that there was not much change in the type of species occurring in the plague endemic areas when compared to the observations made about 60 year back.

There is a significant decrease in the absolute flea index ranging (0.32-0.40) in Kolar and Palamner areas when compared to the position (1.23-2.63) described by Krishnamurthy *et al.* (1965). It was in the range of 6.3 in 1930 in Bombay. This also came down in the year 1953 to a level of 1.58 (Seal, 1960 and 1969). This downward trend may be attributed to the modernization; rapid urbanization and use of pesticides in the agriculture sector. A rapid survey done by Kumar *et al.* (1996) in and around Delhi

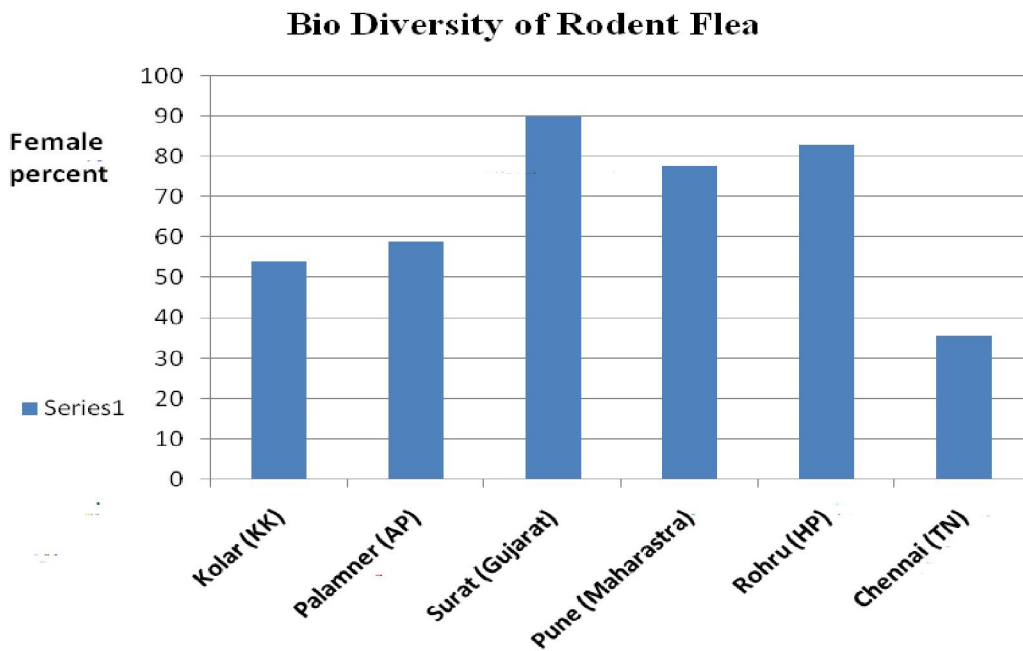


Fig. 1. Bio-diversity of rodent flea.

in September 1994 at the time of plague outbreak in Surat does indicate the range of absolute flea index from 0.08 to 4.0. It was further stressed that it varies from place to place and the number of factors were responsible for this.

The comparative assessment of rodent fleas absolute index in different states do indicate that the load of rodent fleas was more in, Rohru (HP) and Pune (Maharashtra) and Chennai (TN) areas than that of Surat (Gujarat), Kolar (KA), Palamner (AP). However the importance lies

with the specific vector species critical index (>1) in that region and the various factors which favours the transmission of the causative agent from the reservoir to the human being. The rodent flea species like *Neopsylla kawar* which was found in Dodra Kawar area of HP state may or may not be the efficient vector because the evidence of plague organism in this flea was not available. In Dodra Kawar area *Neopsylla kawar* species was very sensitive to the temperature variation. Dodra kawar area usually remains under snow for about nine months and

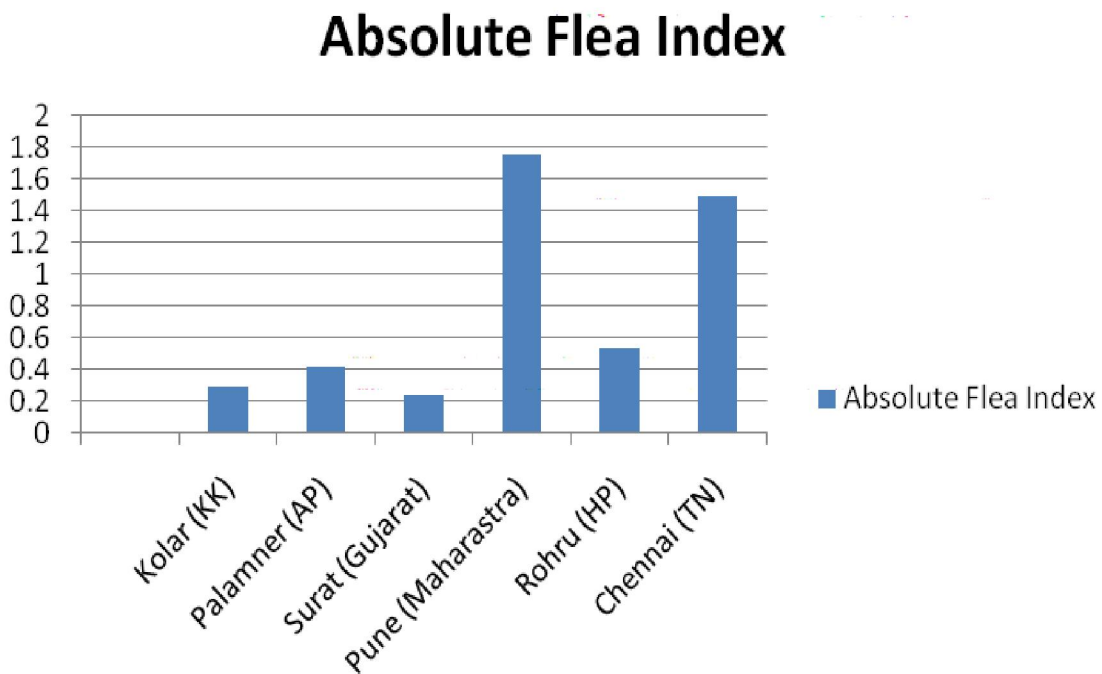


Fig. 2. Absolute flea index of various places.

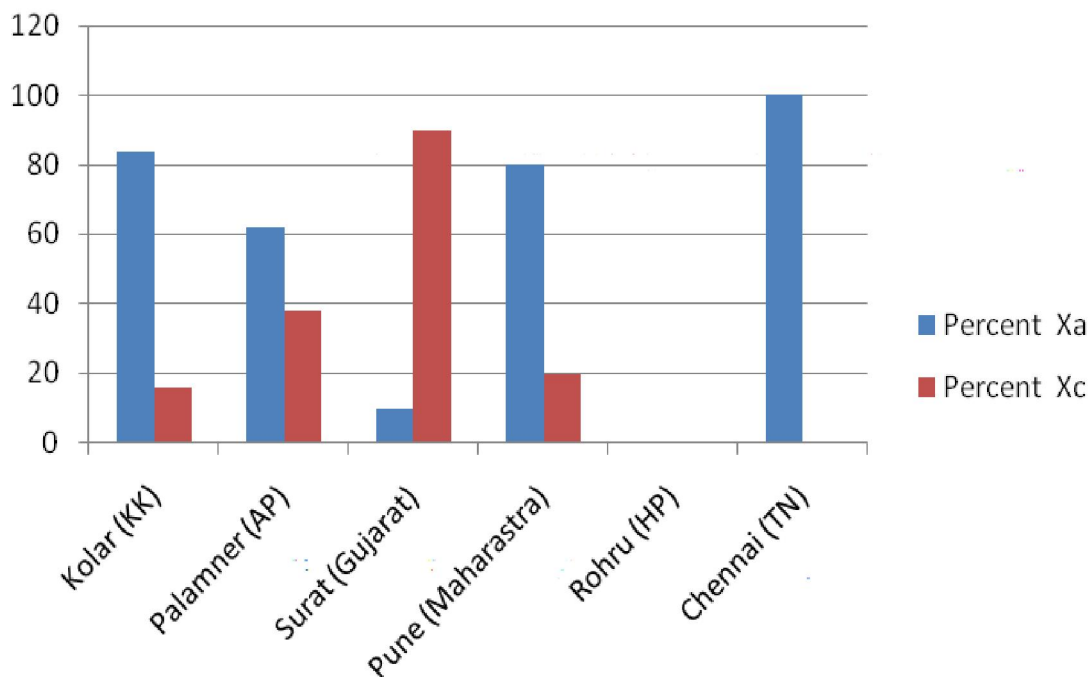


Fig. 3. Biodiversity of plague vector species in different areas.

Table 4. Data on biodiversity of plague vector in different areas.

Places	Types of Fleas			Total	Percent (%)	
	Xa	Xc	<i>Neopsylla kawar</i>		Xa	Xc
Kolar (KA)	180	35	0	215	84	16
Palamner (AP)	328	201	0	529	62	38
Surat (Gujarat)	1	9	0	10	10	90
Pune (Maharashtra)	36	9	0	45	80	20
Rohru (HP)	0	0	24	24	0	0
Chennai (TN)	87	0	0	87	100	0
Total	632	254	24	910	69	28

even in the rest of period the maximum temperature does not go more than 20°C.

X. species like *X. cheopis* and *X. astia* were considered as the efficient vector for plague. It may be concluded that the *X. cheopis* may be playing a major role in Gujarat state and *X. astia* in Karnataka and AP state. The fleas collected from the peri-domestic and wild situation were found almost same such as *Xenopsylla* spp. in most of the places except the Dodra Kaware area of HP state. The mass use of pesticide in crop cultivation does have impact on the flea population. It was observed that those areas where the pesticides were used, the rodents were found but no fleas were found on their body. This may result into resistance development in rodent fleas in the near future.

Conclusion

In most of the plague endemic area the rodent fleas were found. The species prevalent were *Xenopsylla cheopis* in Surat (Gujarat) and in Maharashtra, Andhra, Karnataka and Tamil Nadu it was mainly *X. astia*. *Neopsylla kawar*

was found in Dodra Kaware area of HP state which may or may not be the efficient vector because the evidence of plague organism was lacking. The female percent of rodent fleas may be considered as a good indicator for the fast propagation of rodent flea. Uses of Pesticides have got impact on rodent flea population, as the rodents were found but no fleas were found on their body. This may result into resistance development in rodent fleas in the near future.

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