

Seasonal Prevalence and Insecticide Susceptibility Status of Phlebotomine Sandflies (Diptera : Psychodidae) in the North-Western Thar Desert (District Bikaner, Rajasthan)

S.K. Bansal, R.C. Chaudhary, Karam V. Singh and J. Lakshminarayana
Desert Medicine Research Centre,
Post Box 122, New Pali Road, Jodhpur 342 005, India

Abstract : A study was carried out on the seasonal prevalence and insecticide susceptibility status of phlebotomine sandflies in different villages of district Bikaner during 1994-1995. Five species of sandflies viz. *Phlebotomus papatasi* (71.1%), *Sergentomyia punjabensis* (19.0%), *S. babu babu* (7.3%), *S. clydei* (1.8%) and *S. baghdadis* (0.8%) were collected from indoor habitats like human dwellings, cattle sheds and rodent burrows. Maximum density of all the sandflies was observed during the monsoon and post-monsoon season (July-October) followed by spring (March and April), summer (May and June) and winter season (November to February). *P. papatasi* revealed that it is susceptible to fenitrothion and permethrin, resistant to DDT, dieldrin and propoxur while a verification was required with malathion. LC₅₀ values for DDT and dieldrin were 4.3 and 0.43%, respectively, while LT₅₀ values for fenitrothion, propoxur and permethrin were 42.6, 50.0 and 15.7 minutes, respectively.

Key words : *P. papatasi*, prevalence, insecticide, susceptibility, Thar desert.

Phlebotomid sandflies, the vectors of different types of leishmaniasis, have received considerable attention in recent years due to the resurgence of visceral and cutaneous leishmaniasis along with various sandfly fevers in India and several other parts of the world. Bikaner city in the thar desert of north-western Rajasthan is known to be endemic for oriental sore or cutaneous leishmaniasis (Srivastava *et al.*, 1987), a disease caused by protozoan parasite *Leishmania tropica*. A severe outbreak of the disease was recorded at Bikaner during 1971 (Bhardwaj and Joshi, 1971 and Sharma *et al.*, 1973). Since then many studies on the clinico-epidemiological features of the disease along with the bioecology of its sandfly vector (Kaul *et al.*, 1973; Namita *et al.*, 1991 and Joshi *et al.*, 1992) have been carried out in this region. Insecticide susceptibility studies on *P. papatasi* and *P. argentipes*, the vectors of cutaneous and visceral leishmaniasis, respectively, have also been carried

out in some parts of India by several workers (Kaul *et al.*, 1978; Joshi *et al.*, 1979; Rahman *et al.*, 1982; Mukhopadhyay *et al.*, 1990 and Singh and Bansal, 1996). However, studies on the seasonal prevalence, species composition and insecticide susceptibility status of different sandfly species have not been done in different villages of district Bikaner which still continues to be an acute endemic focus of cutaneous leishmaniasis.

Material and Methods

District Bikaner comprises of four tehsils viz., Bikaner, Loonkaransar, Kolayat and Nokha. Three to four villages were selected from each tehsil and monthly surveys carried out both during dusk and dawn hours. Collection was made from dark corners, cracks and crevices of the human dwellings, cattle sheds and rodent burrows located inside the premises. People generally live inside the

Table 1. Per cent distribution and relative abundance of phlebotomine sandflies during different seasons in district Bikaner

Sandfly species	No. of sandflies collected	Per cent relative abundance	Per cent distribution of sandflies			
			Monsoon & post-monsoon (July-Oct.)	Winter (Nov.-Feb.)	Spring (Mar.-Apr.)	Summer (May-June)
<i>P. papatasi</i>	1664	71.1	47.6 (792)	3.4 (57)	32.2 (536)	16.8 (279)
<i>S. pujabensis</i>	445	19.0	60.9 (271)	1.8 (8)	24.3 (108)	13.0 (58)
<i>S. babu babu</i>	172	7.3	54.7 (94)	2.3 (4)	27.9 (48)	15.1 (26)
<i>S. clydei</i>	42	1.8	54.8 (23)	4.8 (2)	30.9 (13)	9.5 (4)
<i>S. baghdadis</i>	18	0.8	50.0 (9)	11.1 (2)	27.8 (5)	11.1 (2)

mud plastered or semi-pucca houses while cattle are kept outside or in thatched huts in close vicinity of the human dwellings. Sandflies were collected with the help of a suction tube as prescribed by WHO and kept in Barraud cages provided with cotton pads soaked in 10% glucose solution. Relative humidity and temperature of the collection site was recorded during both dusk and dawn hours.

For determining the insecticide susceptibility status of *P. papatasi*, fully fed females were selected and tests conducted at temperature of $28 \pm 2^\circ\text{C}$ and RH 70-80% as per the prescribed procedure (WHO, 1981). DDT (0.5 to 4.0%), dieldrin (0.05 to 0.4%), malathion (5.0%), fenitrothion (1.0%), propoxur (0.1%) and permethrin (0.25%) impregnated papers supplied by WHO were used. In each test 20-25 females of *P. papatasi* were exposed to the above insecticide papers for different exposure durations. Three to five replicates were used. Percent mortalities were recorded 24 hr after the exposure. Whenever control mortality exceeded 5%, the corrected mortality was calculated by Abbott's formula. After the tests all the exposed and unexposed sandflies dead or alive, were confirmed by identification (Lewis, 1978). $\text{LC}_{50}/\text{LT}_{50}$ values, wherever possible, were calculated from the log concentration probit

regression lines. Susceptibility status was determined as per WHO criteria (1986) as follows:

Insecticides x maximum exposure period, viz., DDT (4% x 1hr), dieldrin (0.4% x 1hr), malathion (5.0% x 1hr), fenitrothion (1.0% x 2hr), propoxur (0.1% x 1hr) and permethrin (0.25% x 1 hr). Susceptibility status was determined by per cent mortality, viz., mortality 98% = susceptible (S), 80-98% = verification required (V) and 80% = resistant (R).

Results and Discussion

A total of 2341 sandflies representing five species were collected during the study (Table 1). *P. papatasi* was the predominant species (71.1%) followed by *S. punjabensis* (19.0%), *S. babu babu* (7.3%), *S. clydei* (1.8%) and *S. baghdadis* (0.8%). Of these, *P. papatasi* is the known vector of cutaneous leishmaniasis while some species of *Sergentomyia* genus are associated with various sandfly fevers in India and other tropical and sub-tropical regions of the world. Maximum density of all the sandfly species was observed in the monsoon and post-monsoon season followed by spring, summer and winter season (Table 1, Fig. 1). *P. papatasi* was found throughout the year with two population peaks, first during the month of April and second during the month of October with a density as high as 77 PMH.

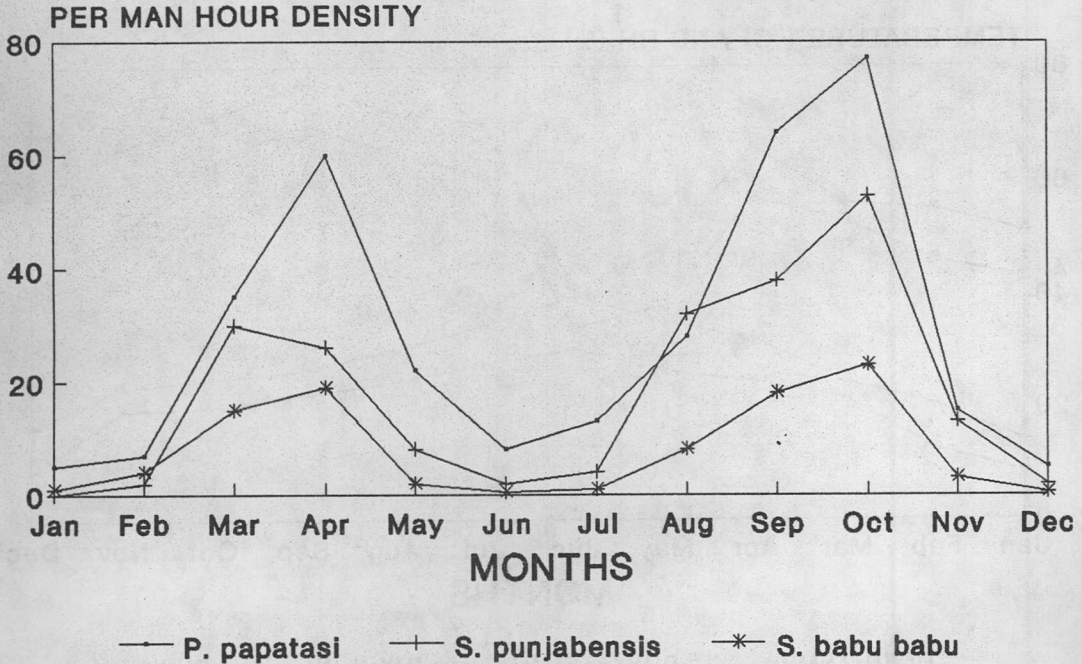


Fig. 1. Density of major indoor sandflies during dawn hours in district Bikaner.

High density and prevalence throughout the year of this species clearly suggest that how cutaneous leishmaniasis maintains itself in the endemic forms or sudden appearance in epidemic forms in district Bikaner. Extremes of temperature, both during summer and winter seasons (Fig. 2), however, keep the vector population at a very low ebb. Genus *Sergentomyia* was almost absent during the months of October, January and June (Fig. 1) while *Phlebotomus* was present in very low density. A high density of *P. papatasi* has also been reported by us in district Bikaner as compared to Jaipur and Jodhpur districts (Joshi *et al.*, 1992). Kaul *et al.* (1973) identified 14 species of phlebotomid sandflies representing two genera from six districts of Rajasthan state situated on the southern side of the Aravalli hill ranges. *S. bailyi* was the commonest species in their collection (39.2%) followed by a new species, *S. sirohi* (17.1%)

mainly from the outdoor collections. The results suggest that variations in temperature, RH, geographical location of a place and its fauna and flora have a great impact on the prevalence and seasonal distribution of different species in different areas.

Susceptibility tests conducted with six insecticides on *P. papatasi* are presented in Table 2. Per cent mortality was found to increase with the increase in concentration and exposure time. On exposure to different concentrations of DDT and dieldrin, mortality increased from 5.0 to 47.9% and 5.3 to 57.3%, respectively, suggesting that the species is more resistant to both the organochlorines (OCs) in the rural areas where insecticides are sprayed as compared to the urban areas where no insecticides are sprayed (Bansal and Singh, 1996). A high degree of resistance in *P. papatasi* has also been shown by several

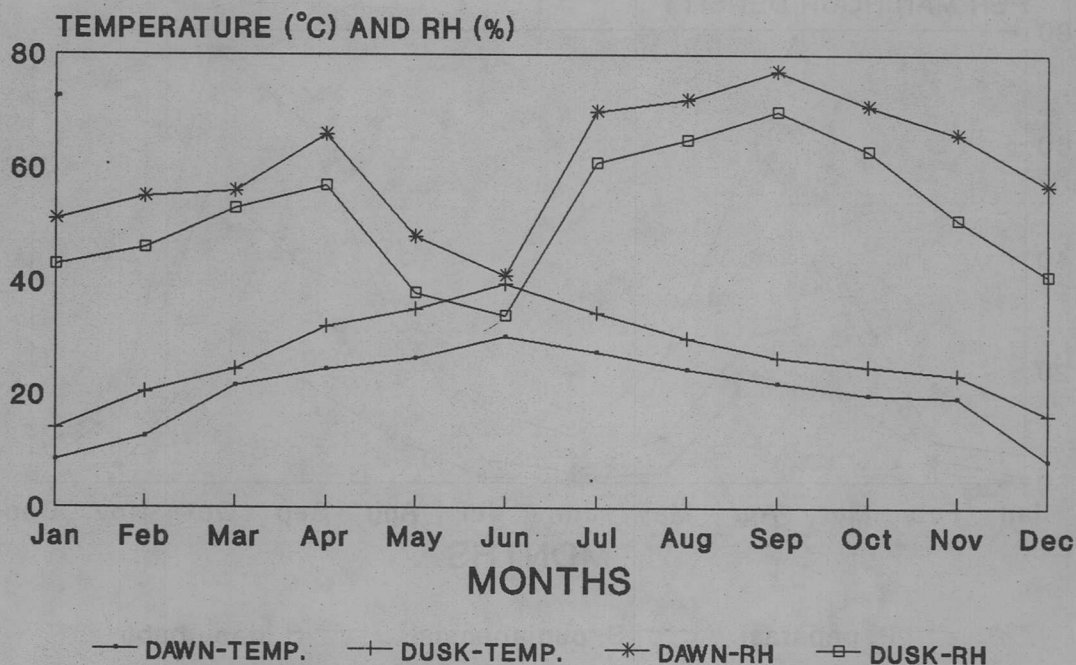


Fig. 2. Monthly and diurnal fluctuations in temperature and RH in indoor habitats.

Table 2. Per cent mortality and probit analysis of the susceptibility data of *P. papatasi* to different insecticides in rural areas of district Bikaner

Insecticide	Conc. used (%)	Exp. time (min.)	Per cent corrected mortality	Susceptibility status	LC ₅₀ /LT ₅₀ (fiducial limits)	Regression equation	X ² (DF)
DDT	0.5	60	5.0	R	4.3 (4.1-4.5)	Y = 0.32 + 1.78x	0.002(3)
	1.0	60	12.8				
	2.0	60	28.0				
	4.0	60	47.9				
Dieldrin	0.05	60	5.3	R	0.43 (0.23-0.63)	Y = 1.84 + 1.99x	2.1(2)
	0.2	60	20.0				
	0.4	60	57.3				
Malathion	5.0	60	93.8	V			
Fenitrothion	1.0	30	33.3	S	42.6 (40.6-44.6)	Y = -0.06 + 3.11x	1.2(2)
		60	67.9				
		120	100.0				
Propoxur	0.1	30	24.2	R	50.0 (48.0-53.9)	Y = -0.76 + 3.39x	0.6(2)
		60	56.6				
		120	96.4				
Permethrin	0.25	15	47.6	S	15.7 (13.7-17.7)	Y = 0.60 + 3.68x	0.04(2)
		30	84.0				
		60	98.8				

R - Resistant; S - Susceptible; V - Verification required.

LC₅₀/LT₅₀ - Lethal concentration or time in which 50% mortality occurs.

workers in different parts of India (Kaul *et al.*, 1978; Joshi *et al.*, 1979 and Rahman *et al.*, 1982). High resistance of *P. papatasi*, especially to DDT in rural areas of district Bikaner may perhaps also be due to its continuous use for the last three decades for malaria control. In contrary to this dieldrin and HCH has never been used in this area (except some border areas where BHC is sprayed), even though a high degree of resistance has been observed to this insecticide which may be due to the development of cross resistance. Tests conducted with two organophosphates (OPs) revealed that the species was completely susceptible to fenitrothion (mortality 100% x 2hr) while a verification was required with malathion (mortality 93.8% x hr), showing that OPs are much more effective as compared to OCs. However, with propoxur (0.1%), a carbamate, resistance was observed where a 56.6% mortality was recorded after one hour exposure. However, with permethrin, a synthetic pyrethroid, a 98.8% mortality was observed after one hour exposure suggesting that the species is fully susceptible to this insecticide (Table 2). Pyrethroids, therefore, can be the insecticides of choice in future when this species will develop resistance towards OCs and OPs. The findings of the study would be of great importance for controlling the disease in this remote desert land.

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