J Vect Borne Dis 42, March 2005 pp 25–29

Entomological studies on malaria in irrigated and non-irrigated areas of Thar desert, Rajasthan, India

Vinod Joshi, R.C. Sharma, Manju Singhi, Himmat Singh, Keerti Sharma, Yogesh Sharma & Sandeep Adha

Desert Medicine Research Centre, Indian Council of Medical Research, Jodhpur, India

Background & objectives: Malaria is the major health problem in western Rajasthan yet its vector fauna and transmission dynamics thereof is not understood properly. The present investigations report complete profile of qualitative and quantitative aspects of anopheline species occurring in different settings of desert ecosystem.

Methods: Area with irrigation through canal for more than 20 years (setting I), area with irrigation through canal for 10 years (setting II) and area without any irrigation (setting III) have been selected for studies. Species identification and their densities (per man hour) was made as per standard methods.

Results: In village of setting I, during rainy season, *An. subpictus* and *An. stephensi* were present while during winter season four species—*An. subpictus, An. stephensi, An. culicifacies* and *An. annularis* were collected. In all the villages of setting I, II and III no *Anopheles* mosquito was observed during summer season. In the villages of desert region without any irrigation facilities through any canal, the anopheline species were present only during rainy season.

Interpretation & conclusion: An. stephensi is the major malaria vector of desert irrespective of whether the area is canal irrigated or not. During summer season absence of vector species in all the villages require further studies on micro-ecology of the species under desert conditions.

Key words *An. stephensi* – desert – IG canal – malaria vectors

Malaria is a major public health problem in northwestern desert part of Rajasthan. Despite number of epidemics reported in the past from this region[1,2], transmission dynamics of desert malaria is not yet fully understood. As a result, disease continues to be rampant in this region. Lack of enough entomological information is one reason for the poor epidemiological understanding of the disease transmission in this desert ecosystem.

Earlier studies on malaria vectors from desert[1-3] were based on observations of one point investigations in some settings. However, to profile this arid ecosystem of country from malaria vector point of view, longitudinal studies covering representative settings and the seasonal fluctuations across the year are required. Moreover, in view of the development of irrigation through Indira Gandhi (IG) canal which resulted in transformation of ecological conditions, studies on species compositions, abundance and introduction of new vector species in the area are also to be studied.

In view of this, detailed entomological studies have been done in three different settings in desert part of

Rajasthan. Studies have been done in all the seasons (rainy, winter and summer) undertaking three point investigations in each season in 26 study villages to provide a complete reference to anopheline fauna occurring in the region.

Material & Methods

Study areas

For the present investigation three areas, one with irrigation through canal for more than 20 years (setting I), other with irrigation through canal for 10 years (setting II) and the third without any irrigation (setting III) were selected. Periodic investigations were undertaken from August 2001 to July 2002. Details of each study setting are given below:

Setting I (Canal irrigated area): This area represents Jaisalmer district situated at 26°18' N latitude and 73° 04' E longitude which receives irrigation through Indira Gandhi (IG) canal for the past 20 years. The area is characterised by extremes of temperature, lowest relative humidity and sparse far flung population pockets in the vicinity of sand dunes. Ambient temperatures ranges from as low as 1–2 °C in winters (January) to as high as 45 °C in summer (April to June). Soil is sandy composed of silica quartz predominantly and is lose and shifting type along with flow of winds. Ten study villages have been selected from this area.

Setting II (Lift canal irrigated area): This area also represents a desert area called Phalodi region situated at about 26°55' N latitude and 70°57' E longitude. From irrigation point of view this area is supplied with branches of main canal present in setting I. Eleven villages have been chosen from this area. In comparison to setting I, presence of canal system in this area is for about ten years only. With regard to other characteristics, area represents desert ecology with less degree of desertification as compared to setting I. This area also exhibits extremes of ambient temperature and relative humidity like that of setting I.

Setting III (Non canal area): This area is also a desert ecosystem but unlike other settings, does not have any irrigation through canal. From this area called Balesar region, five study villages have been chosen. This area is also a desert ecotype of erratic rainfall, extremes of temperature and low relative humidity. No irrigation system has been introduced in this area.

In all the 26 villages, three point investigations were conducted as first study, first follow-up and second follow-up within each season with a gap of 15 days. The observations for rainy season were recorded during August to October, for winter during December to February and for summer during April to July.

Mosquitoes were collected with the help of suction tube and a torch during early morning and evening hours. The resting and bait collections were made from human dwellings as well as from cattlesheds. Density of mosquitoes was expressed as adults caught per man hour (PMH). Field collected specimens were preserved dry and brought to the laboratory for species identification using standard keys[4].

Results

Details of different anopheline species reported in different seasons in all the settings and their PMH densities are presented in Table 1. During winter four species — *An. subpictus, An. stephensi, An. culicifacies* and *An. annularis* were collected. In all the villages, no *Anopheles* mosquito was observed during summer. It is interesting to mention here that in one (Tejpala) of 10 villages of this setting close to IG canal, *An. culicifacies* made its appearance only during winter. Quantitative trend of all the four species across three seasons in (Tejpala) village as observed during all the study points is shown in Fig. 1.

Village-wise analysis of data collected with respect to this show no difference for the anopheline species present in different seasons. *An. stephensi* was consistently present, while *An. culicifacies* was reported only in one of the four villages of this category. In one

Table 1. Seasonal profile of anopheline fauna in the study villages

Study area (No. of villages)	Study point	Species (PMH density)		
		Rainy season	Winter season	Summer season
Setting I (10)	First study	*An. subpictus* (80.99) *An. stephensi* (27.28)	*An. subpictus* (10) *An. stephensi* (29.64) *An. annularis* (43.96) *An. culicifacies* (25.9)	—
	First follow-up	*An. subpictus* (59.47) *An. stephensi* (34.23)	*An. subpictus* (25.35) *An. stephensi* (25.6) *An. annularis* (13.1) *An. culicifacies* (45.8)	—
	Second follow-up	*An. subpictus* (35.47) *An. stephensi* (13.99)	*An. stephensi* (17) *An. annularis* (45.67) *An. culicifacies* (54.5)	—
Setting II (11)	First study	*An. subpictus* (62.78) *An. stephensi* (21.3)	*An. subpictus* (20.35) *An. stephensi* (35.73) *An. annularis* (14)	—
	First follow-up	*An. subpictus* (82.03) *An. stephensi* (22.79)	*An. subpictus* (30) *An. stephensi* (26.2) *An. annularis* (48.7) *An. culicifacies*	—
	Second follow-up	*An. subpictus* (52.07) *An. stephensi* (26.86)	*An. stephensi* (47.05) *An. annularis* (34.25) *An. culicifacies* (44.95)	—
Setting III (5)	First study	*An. subpictus* (73.58) *An. stephensi* (10.15)	*An. stephensi* (16)	—
	First follow-up	*An. subpictus* (74.66) *An. stephensi* (15.65)	*An. stephensi* (30)	—
	Second follow-up	*An. subpictus* (71.4) *An. stephensi* (42)	—	—

of the villages of setting II, *An. culicifacies* was observed, while in the rest of villages, this species was not collected.

In the villages of desert region without any irrigation facilities (setting III) through any canal, the anopheline species were present only during rainy season. Unlike villages of two irrigated settings (settings I & II), in these villages, only *An. stephensi* limited to rainy season was present. No other anopheline species such as *An. culicifacies* or *An. annularis* could be collected from these villages.

Discussion

The results of the present study clearly showed the prevalence of *An. stephensi* in all the ecotypes studied

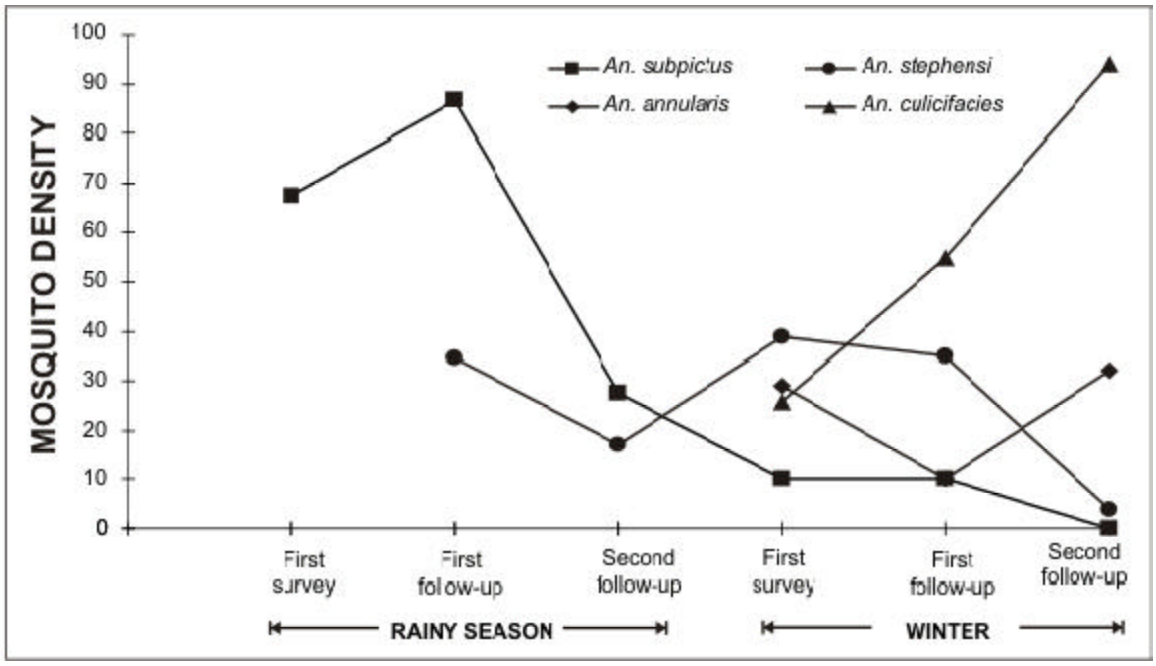

Fig. 1: PMH density trend of all four species in different seasons in village Tejpala

irrespective of the irrigation sources. Sustenance of this species in rainy season is also same in all the 26 villages studied in different ecological settings. *An. stephensi* which is regarded as the major urban malaria vector[5-8], is a common rural vector species in desert, a fact which is not yet known in many parts of country (Personal discussion with Sh. N.L. Kalra). In desert villages irrespective of the fact whether villages are irrigated or not, their rainy seasonal transmission of malaria will be accomplished through this species only and control measures have thus to be accordingly oriented. Earlier workers have reported that *An. stephensi* is the major species in dry areas of this region only[2], while the present observations show that *An. stephensi* is the vector species prevalent in desert areas whether they are irrigated or not.

In the villages which are just attached to canal or those which are in close vicinity, *An. culicifacies* has been encountered in two villages, that too during winter season. The observations indicated that presence of IG canal is neither encouraging any vector nuisance of *An. culicifacies* and/or *An. annularis*, nor it is ensuring prolonged survival of mosquitoes in desert. However, rain water flowing in canal and its seepage from canal is likely to facilitate breeding of species such as *culicifacies* in some villages. Since *An. culicifacies* is appearing only in early winter season, its role in epidemic outbreaks can not be substantiated, rather it could help to maintain residual malaria if parasitised population is present in a setting during this period.

Malaria is a "local and focal problem" which need to be studied as a system of interaction of man mosquito and environment[9-14]. The regional epidemiology of malaria thus depends greatly on the reference knowledge available in each ecologically distinct regions such as desert. The earlier authors have mentioned[15] that history of malaria control in India is in fact history of control of *An. culicifacies*. Realising this, present findings offer a comprehensive and complete profile of anopheline fauna of different villages of Thar desert, Rajasthan including the details of possible impact of IG canal irrigation on species composition.

References

1. Mathur KK, Harpalani G, Kalra NL, Murthy GGK, Narasimham MVVL. Epidemic of malaria in Barmer district (Thar Desert) of Rajasthan during 1990. *Indian J Malariol* 1992; *29:* 1–10.
2. Tyagi BK, Yadav SP. Bionomics of malaria vectors in two physiographically different area of the epidemic-prone Thar desert, northwestern Rajasthan. *J Arid Environment* 2000; *47:* 161–72.
3. Verma KVS, Joshi V, Bansal SK. Studies on mosquito vector species in indoor habitats of desert and non-desert region of Rajasthan. *J Com Dis* 1991; *23*(4): 263–9.
4. Christophers SR. *The fauna of Brithish India including Ceylon and Burma*, v IV (Diptera : Culicidae). London : Taylor and Francis 1933; p. 1–371.
5. Bentley CA. Report on malaria in Bombay. Bombay: Government Press 1911.
6. Covell G. Notes on control of mosquitoes and malaria in Delhi. *Rec Mal Surv India* 1934; *4:* 273–89.
7. Sweet WC, Rao BA. Notes on malaria in Mysore state. Pt V. The control of anopheline breeding in Bangalore city and its cost in Mysore state. *Rec Mal Surv India* 1934; *4:* 95–110.
8. Barber MA, Rice JB. Malaria in Poona and its vicinity. *J Mal Inst India* 1938; *I:* 37–55.
9. Banerja AC. Some observations on an unusual epidemic of malaria in the city of Lucknow. *Indian Med Gaz* 1930; *65:* 149–53.
10. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem. Pt I. General concept. *J Com Dis* 1987; *20:* 79–86.
11. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem. Pt II. Diversity of malaria infection subsystem. *J Com Dis* 1988; *20* : 349–59.
12. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem. Pt III. Diversity of MAES. *J Com Dis* 1989; *21:* 62–70.
13. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem. Pt IV. Adaptations of elements of MAES. *J Com Dis* 1989; *21:* 171–82.
14. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem (MAES). Pt V. Self regulations and stability of MAES. *J Com Dis* 1990; *22:* 12–22.
15. Kondrashin AV, Kalra NL. Malaria as anthropo-ecosystem. Pt VI. Demographic subsystem (DSS). *J Com Dis* 1991; *23:* 89–99.

Corresponding author: Dr. Vinod Joshi, Desert Medicine Research Centre, Indian Council of Medical Research, New Pali Road, Jodhpur–342 005, India.
e-mail: vinodjoshi@dmrcjodhpur.org