Uttar Pradesh J. Zool. 15 (1) : 51-57, 1995 *ISSN 0256-971X*

ON THE BIONOMICS OF *ANOPHELES THEOBALDI* GILES, 1901 (DIPTERA : CULICIDAE) IN BASTAR DISTRICT, MADHYA PRADESH, INDIA

ZAKIR HUSAIN HUSAINY
LITERATURE MUSEUM, P.O. BOX 62, G.P.O., RAIPUR-492001, INDIA.

Observations on the anopheline fauna of Bastar district, Madhya Pradesh, India revealed distribution of *Anopheles theobaldi* in 13 villages out of 105 surveyed in 1206 man/hrs. The species was noted in forests of five physiographical divisions and the elevation ranged between 152 and over 761 m. This mosquito appeared to rest out of doors in forest areas. The length and peak feeding hours varied in different seasons. The density and seasonal prevalence was noted in the North-eastern plateau with hot-moist climate having over 152 cm annual rainfall and mean temperature from 24 to 27°C and an elevation range of 609 to over 761 m. Females were not captured on human baits and human blood was also not detected in precipitin tests in mosquitoes collected from cattlesheds. None of the females dissected was infected with malaria parasites.

INTRODUCTION

The oriental element *Anopheles theobaldi* has so far been reported from India, Burma, Pakistan, Bangla Desh and Nepal (Puri, 1960; Aslam Khan, 1971). Westwards it has yet not been reported beyond Pakistan. Although this mosquito seems to be widespread in the central and western parts of India, however it does not appear to have been recorded in the northern and southern states such as Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Kerala and Tamil Nadu.

In the Bastar district, an area hyper-endemic for malaria, studies on the bionomics and epidemiological significance of the anopheline fauna were undertaken. In these surveys, *A. theobaldi* was also encountered alongwith 18 other anopheline species. Earlier in this series Prakash & Husainy (1974) discussed the distribution pattern of the adult anopheline mosquitoes and Husainy (1986) described the bionomics of *A. pallidus* in Bastar district. In this paper results on *A. theobaldi* are described and discussed.

MATERIAL AND METHODS

Physiography : The Bastar district lies roughly in the central part of India and extends from 17°46'N to 20°34'N latitude and from 82°15'E to 82°1'E longitude. It has an area of 39,086 sq km containing 3154 villages and three towns which falls into five main physiographical divisions (Fig. 1). Almost 70 per cent (22,167 sq km) of the area is covered with forests. The altitude ranges from 48.5 m (village Konta) to about 1275.5 m (village Bailadila). The main rivers are the Indravati, Mahanadi, Sabri and Godavari with their tributaries draining the district adequately.

Climatology : This district shares the monsoon type of climate with the general Indian landmass, although the diversity of its topography does not encourage a uniform climate. There are three distinct temperature divisions *viz.* 22 to 24°C, 24 to 27°C and 27 to 29°C. The period from June to October covers the general rainy season. There may be two annual rainfall divisions of 127 to 152 cm and 152 to 178 cm. With the three temperature and two rainfall divisions, the district surface seems to harbour five climatic patterns (Agrawal, 1968) *viz.* the moderately hot-moist; moderately hot-wet, hot-wet, hot-moist and very hot-moist regions respectively.

Surveys : Attempts were made to catch the mosquitoes during day and night time by general and routine collections made inside human dwellings and cattlesheds of selected villages. Collections were also made by the pyrethrum spray technique inside human dwellings to detect mosquitoes resting there. Outdoor collections were made in early morning hours in the area between the nearest potential larval habitat and human dwellings. A pit shelter was made in village of Bispur under a tree in a rice

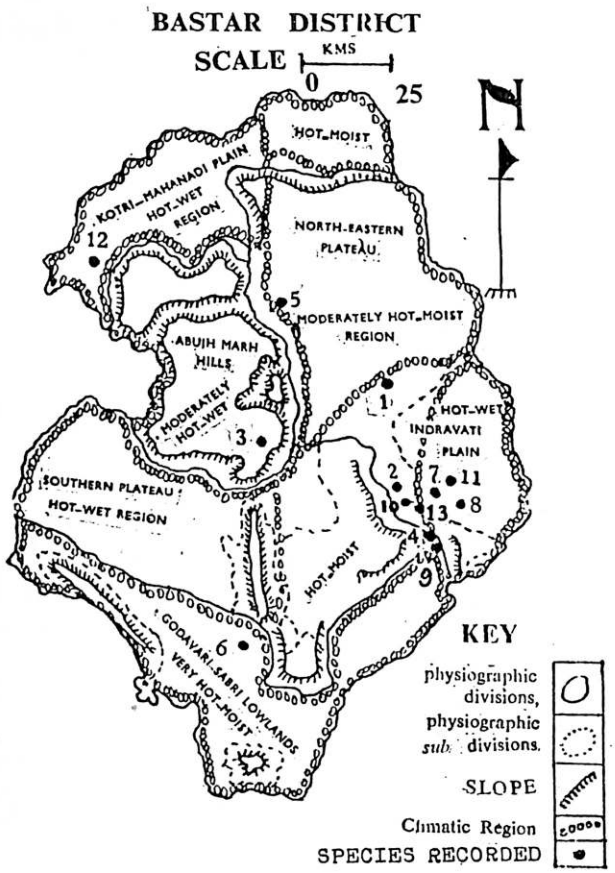

Fig. 1. Map of Bastar district showing physiographic, climatic divisions and distribution of *A. theobaldi*. For locality serials, please refer text.

field located in between a pond and a house. Its size was 2m × 1m × 2m deep. Two pits each of 0.5m × 0.5m × 0.5m deep were excavated on each wall of the pit and a ladder was placed on one side of the pit. A roof of mating was laid on this pit leaving a gap at the side of the ladder for entrance. Collections were made in this pit for 15 minutes every morning of catch.

In order to determine feeding times, density build up and the seasonal prevalence, whole night collections were made between 1800 and 0600 hr at intervals of two hrs for half an hr each time. The first sampling was made at sunset which normally occurred between 1800 and 1900 hr in different months. The remaining collections were made at fixed times. In each night 7 man/hrs were spent on anopheline collections. Man-biting rates were determined by placing a man as a bait and another collecting mosquitoes actually feeding this bait since landing rates do not always indicate biting. In all these samplings, only anopheline mosquitoes were collected by employing well trained insect collectors using the torch and aspirator tube. The mosquitoes were identified at the end of collection time on the spot in either sun or bright petromax light and their species, abdominal conditions and time and site of captures were noted.

The source of blood meal taken by the females was determined by the precipitin tests. Smears of mosquitoes with freshly engorged blood meals were made on the Whatman's filter papers which were sent for test to the National Institute of Communicable Diseases, Delhi. The females were dissected to determine the parity status and also the infection of malarial parasites.

OBSERVATIONS

Present investigations were made from August 1969 to January 1975. During the study 105 villages were surveyed in 1206 man/hrs which yielded 21,716 specimens belonging to 19 anopheline species. A total of 289 specimens of *A. theobaldi* was collected from 13 villages of the district. The numbers of specimens collected from each village are given in the parenthesis while the name of each village is preceded by a numeral which indicates its location on the map.

Specimens collected : (1) Ban Usri (2); (2) Bispur (4); (3) Burdum (3); (4) Darbha (249); (5) Gad Bengal (1); (6) Jagargunda (1); (7) Kamanar (8); (8) Kotamsar (4); (9) Kukalgur (1); (10) Mamadpal (5); (11) Mangnar (1); (12) Tahakwada (9), (13) Tirathgarh (1). Total 289.

Distribution : The species was recorded from the Kotri-Mahanadi plains, Abujh Marh hills, North-eastern plateau, Indravati plains and Godavari-Sabri lowlands. This *Anopheles* was present in all climatic belts in the altitude range from 152 to over 761 m.

Diurnal resting places : A. theobaldi was not found during 0500 to 1800 hr in houses or cattlesheds although 139 and 144 man/hrs were spent in collections. A total of 288 specimens (99.7 per cent) in 702 man/hrs was collected from cattlesheds in the night (Table I). In night time no specimen in 117 man/hrs could be collected from houses. Specimens in gravid state were never captured indoors. Out of doors one freshly fed female (0.3 per cent) in 104 man/hrs was encountered in village Darbha during the morning hrs in a bush near a perennial stream in the month of August.

Table I. Composition of *Anopheles theobaldi* captured at various sites in Bastar district, Madhya Pradesh.

S. No.	Habitat	Time of collection	Man/hr spent	Nos. collected	Per cent
1.	Cattlesheds	0500 to 1800 hrs	144	000	---
		1800 to 0500 hrs	702	288	99.7
2.	Houses	0500 to 1800 hrs	139	000	---
		1800 to 0500 hrs	117	000	---
3.	Outdoors	0600 to 1800 hrs.	104	001	0.3
	Total		1206	289	100.0

Feeding times of female adults : From August 1969 to October 1974, 78 routine whole night catches off hosts were made in a forest village of Darbha. A total of 213 freshly engorged females of *A. theobaldi* was collected in the rickety cattlesheds at different hours of the night. The biting cycles are prepared from the combined data in different months (Fig. 2). It may be seen that in August when this mosquito was most numerous, the feeding activity ranged between 1800 and 0600 hr with a peak around 1830 hr and declining gradually thereafter. In September and October no distinct peak was noted although the females were active between 1800 and 0600 hr. During the peak of winter (December-January) the feeding periods were shortest as freshly fed females were encountered between 1800 and 1830 hr while in summer no regular pattern of feeding was discerned as freshly fed females were found between 1830 and 2230 in March, 2000 and 2030 hr in April and 2200 and 2230 in May and in June this completed before midnight.

Density buildup : In village Darbha, 36 whole night regular catches were made between October 1969 and September 1970 so as to determine the density buildup pattern in different months. A total of 2866 specimens representing 18 anopheline species were captured in 252 man/hrs (Table I). In this

collection 46 specimens were identified as *A. theobaldi* of which 11 were collected in August, seven in September, three in June, two in October and one each in May and February were encountered. It appeared that with the onset of rains the density gradually rose attaining its peak in the period of heavy rains after which it declined. In summer and winter this mosquito was least numerous.

Table II. Density buildup pattern and seasonal composition of *Anopheles theobaldi* in Bastar district.

Month	Numbers taken During	
	Density buildup Surveys at Darbha	Seasonal Collections at other villages.
January	0	2
February	1	2
March	0	5
April	0	4
May	1	9
June	3	11
July	21	118
August	11	29
September	7	32
October	2	18
November	0	11
December	0	2
Total	46	243

Seasonal prevalence : In Table II monthly captures of *A. theobaldi* in other villages are also displayed. A total of 243 *A. theobaldi* was collected in 954 man/hrs with 118 in July, 29 in August, 32 in September, 18 in October, 11 in November and two in December. In rainy season (June-August) 158 specimens (65 per cent) were collected. In other seasons it was less numerous. The seasonal composition confirms to the density buildup pattern. This mosquito seems to be a species of rainy season in Bastar district.

Area of abundance : A total of 262 specimens (90.6 per cent) were found (Table III) in the North-eastern plateau with hot-moist climate having over 152 cm annual rainfall and the mean temperature from 24 to 27°C, and with dense forests and an elevation range from 609 to 761 m. This belt receives less rainfall than the hot-wet area which has 127 to 152 cm rainfall where only 22 specimens (7.6 per cent of the total) were collected. In moderately hot-wet, three specimens (1 per cent) and in very hot-moist climatic belts, one specimen (0.4 per cent) were encountered.

Man-Biting rate : During a total of 80 man/hrs spent on collecting biting mosquitoes on human baits placed in houses of three villages, no female *A. theobaldi* could be collected. However 67 females of five other anopheline species and 263 culicine females were collected in this campaign.

Anthropophilic Index : In precipitin tests none of six smears of the gut contents proved to be human blood as all of them were bovine blood. These females were captured in the cattlesheds of village Darbha.

Parity status : The results of the dissections of *A. theobaldi* females captured at various sites of the study villages are given in Table IV. It was seen that 10 unfed females were found nulliparous indicating their fresh arrivals from breeding places for feeding. Sacs were seen in the ovarioles of 21 females while retained eggs were encountered in four females. Females with one and two dilatations in the ovarioles numbered 55 and 45 respectively while only four females had three or more dilatations.

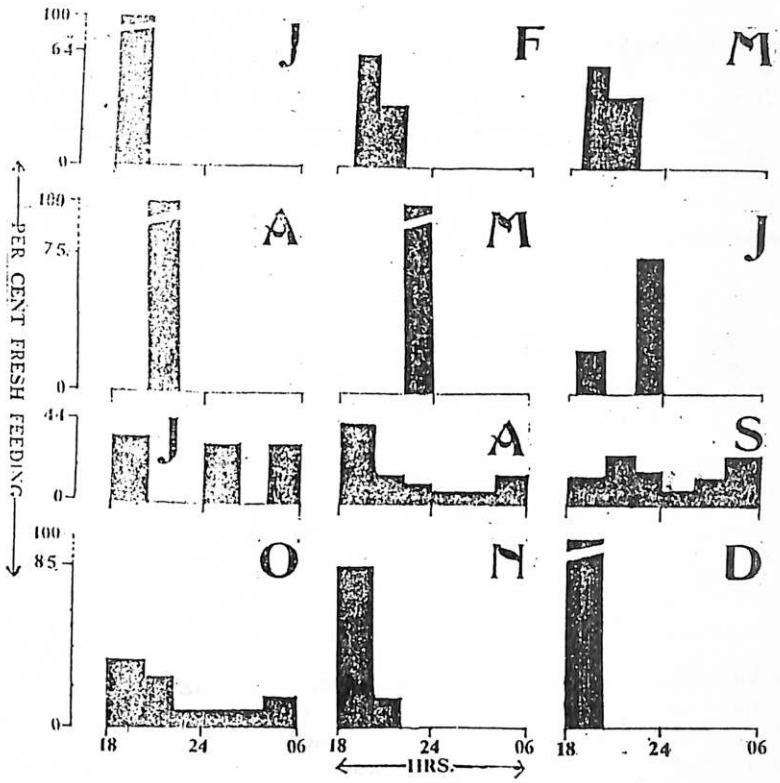

Fig. 2. Feeding times of *A. theobaldi* female adults at village Darbha, Bastar district.

Parasites : Mites were recovered from 40 (16 unfed, 24 fed) females. Infection of the sporozoites or any other stage of any *Plasmodium* sp. was not seen on the gut nor in the salivary glands of any female dissected.

DISCUSSION

The distribution of the oriental element *A. theobaldi* was noted in forest areas at higher altitudes only. In plain area villages it was never encountered. Goverdhan (1912) stated that *A. theobaldi* is rarely found in open parts of the plateau/district but is constantly encountered within jungle villages. Subramanian & Dixit (1948) collected very few specimens of *A. theobaldi* in Satpura ranges, Madhya Pradesh, and majority of them were encountered at the region where the range merges with the plains. The distribution ranged from 152 to over 761 m. In Goa *A. theobaldi* was found between 167 and 334 m (Borcar *et al.*, 1967).

Table III. Composition of *Anopheles theobaldi* in various climatic belts of Bastar district, Madhya Pradesh.

Climatic Regions	Nos. collected	Per cent
Moderately hot-moist Region	1	0.4
Moderately hot-wet Region	3	1.0
Hot-wet Region	22	7.6
Hot-moist Region	262	90.6
Very hot-moist Region	1	0.4
Total	289	100.0

This *Anopheles* appeared to visit cattlesheds in the night while in day time it took shelter out of doors. Büttiker (1958) described this behaviour as a complete deliberate type "A" exophily (endophagy of Senior White). In Thana district, Maharastra, 107 females of *A. theobaldi* were found in mixed dwellings as against 23 and 24 from human dwellings and cattlesheds respectively (Vishwanathan *et al.*, 1948).

Table IV. Physiological age of female *Anopheles theobaldi* captured at various sites of Bastar district.

Site of collection	Abdominal condition	Nos. dissected	Condition of ovarioles							Nos. positive	Nos. infected with mites
			Nulliparous	Sacs	Retained eggs	Nos. of dilatations					
						1	2	3	4 or more		
Cattlesheds	Unfed	32	10	2	–	9	11	–	–	00/00	16
	Fed	160	58	15	4	46	33	4	–	00/00	23
Outdoors	Fed	1	–	–	–	–	1	–	–	00/00	1
Total		193	68	17	4	55	45	4	–	00/00	40

The feeding periods were shortest in the peak of seasons *viz.*, December-January and April-May while during rainy season when this mosquito was more numerous the feeding activities were seen throughout the nights. Although this mosquito seemed to be a perennial species, however, it was more numerous in rainy season. The area of numerical abundance appeared to be the North-eastern plateau with temperature range of 24 to 27°C having annual rainfall of over 152 cm. In Tarai area of Nainital district which had 127 cm of annual rainfall and temperature range of 2.7 to 42.2°C, *A. theobaldi* proved so scarce that in this ecoclimate alongwith seven other species it formed only 0.7 per cent of the total collection.

This mosquito was neither collected on the human bait, nor human blood was detected in precipitin analysis. None of the females dissected had the infection of malaria parasites in the current studies. Wattal (1961) summarised the reports of 298 dissections of *A. theobaldi* at 14 places of India by various workers but none of the female was found positive for malaria parasite in nature.

ACKNOWLEDGEMENTS

The author is grateful to Dr. Ravi Prakash, Prof. Emeritus, Regional Research Laboratories, Bhopal for his constant encouragment in the present studies and to Shri D.R. Yadu, Late Shri N. Patnayak and Shri K.G. Gupta, Insect collectors for their hard work in the mosquito collections.

REFERENCES

AGRAWAL, P.C. 1968. In : *Human Geography of Bastar district.* Ist ed., Garg Brothers, Allahabad.

ASLAMKHAN, M. 1971. The mosquitoes of Pakistan. I. Check list. *Mosquito Systematic Newsletter.* **3** & **4**: 147-159.

BORCAR, P.A., SRIVASTAVA, H.M.L., ROY, R.C. & MUKHERJI, N.L. 1967. Malaria eradication programme in Goa. *Bull. Ind. Soc. Mal. Other Com. Dis.* **4** (1) : 45-54.

BRYDON, H.W., JOSHI, G. & PRADHAN, S. 1961. *Anopheles* distribution and its relation to the malaria eradication programme in Central Nepal. *Mosquito News.* **21** (2) : 102-105.

BÜTTIKER, W. 1958. Notes on exophily in anophelines in Southeast Asia. *Bull. Wld. Hlth. Org.* **19** : 1118-1123.

GOVERDHAN, G.R. 1912. In : *Report on the malaria investigations from October 1911 to April 1912.* Govt. Press, Nagpur.

HUSAINY, ZAKIR HUSAIN 1986. Observations on the bionomics and epidemiological significance of *Anopheles (cellia) pallidus* Theobald, 1901 (Diptera : Culicidae) in Bastar district, Madhya Pradesh. *Entomon.* **11** (4) : 319-327.

PRAKASH, R. & HUSAINY, ZAKIR HUSAIN 1974. Studies on the anopheline mosquitoes of Bastar district, Madhya Pradesh., Pt. I., Distribution pattern of adults. *Annals Zool.* **10** (2) : 13-52.

PURI, I.M. 1960. In : *Synoptic table for the identification of anopheline mosquitoes of India.* 5th ed. Hlth. Bull. **10** : 77

SENIOR WHITE, R. 1947. On the anthropophilic indices of some *Anopheles* found in east central India. *Ind. J. Mal.* **1** (1) : 111-122.

1948. Malaria transmission in the light of modern evolutionary theory applied to malaria carrying mosquitoes. *Ibid.* **2** (1 & 2) : 13-33.

SRIVASTAVA, R.S. 1950. Malaria control measures in the Tarai area under the Tarai colonization scheme Kichha district, Nainital. September, 1947 to December, 1948. *Ibid.* **4** (2) : 151-165.

SUBRAMANIAN, R. & DIXIT, D.T. 1948. Observations on the vectors of malaria in Khandwa Tehsil, Nimar district, Central Provinces and notes on the seasonal infectivity of *Anopheles. Ibid.* **2** (4) : 313-322.

VISWANATHAN, D.K., RAO, T.R. & JUNEJA, M.R. 1948. Further notes on the use of B.H.C. as a residual insecticide compared with D.D.T. *Ibid.* **4** (4) : 505-531.

WATTAL, B.L. 1961. Dissection records of wild caught anopheline mosquitoes other than the reputed vectors of malaria. In : *Vectors of malaria in India.*, 2nd ed. *(Nat. Soc. Ind. Mal. & Other Mosq. Borne Dis.*, Delhi). pp. 187-231.