

ECOLOGY OF *ANOPHELES PULCHERRIMUS* IN BALUCHISTAN, IRAN¹

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ABSTRACT. Studies were conducted on the ecology of *Anopheles pulcherrimus* over a period of 20 months in the village of Zeineddini, Sistan and Baluchistan Province, southeastern Iran. The species was active throughout the year with 2 peaks of activity, April–May and August–September. Light traps captured the highest number of *An. pulcherrimus* females (65%) as compared to cattle bait collections (19.3%), pyrethrum space spray catches (14.2%), pit shelter (1%) and human bait collections (0.6%). However, 95% of the females captured in light traps were unfed or freshly fed females as opposed to about only 44% of those collected in pyrethrum space spray catches and pit shelter collections. The species was mainly exophilic as shown by the gravid/fed ratio of 0.4 obtained in outlet window traps.

INTRODUCTION

Anopheles pulcherrimus Theobald has a wide distribution in western Asia, extending from Lebanon, Syria and Iraq in the west, through Iran, Afghanistan, Pakistan and India in the east. It is also found in Turkey and Turkmenistan (central Asia) and Caucasus in the north and Saudi Arabia and Bahrain in the south (Christophers 1933, Zahar 1974, Knight and Stone 1977). In Iran, it occurs mainly in Khuzistan, Boshehr, Hormozgan and Sistan and Baluchistan provinces (School of Public Health 1970, Saebi 1987²).

Slow moving streams, ditches, rice fields, pools, marshes and other types of waters with or without vegetation have been reported as the breeding sites for *An. pulcherrimus* larvae (Al-Tikrity 1964). However, rice fields, weedy irrigation channels, marshes and any kind of clean stagnant water, overgrown with vegetation, but not too heavily shaded, have been reported as the most favorable sites (Macan 1950, Pringle 1954, Dhir and Rahim 1957, Dukhanina and Quadeer et al. 1974).

In Iraq, Al-Tikrity (1964) reported that adults of this species were found in large numbers in human dwellings and animal shelters, while Abul Hab and Al-Kassal (1986) described *An. pulcherrimus* as an indoor and outdoor resting species. Dispersal in great distances by wind has been cited for this species in Saudi Arabia (Daggy 1959).

The species has been reported to actively bite man and cattle, indoors as well as outdoors in northeast Afghanistan (Onori et al. 1975) and has been incriminated as a vector of malaria in Iraq on epidemiological grounds (Rishikesh 1972) and in Central Asia (Christophers 1933) and the Kunduz area of northeastern Afghanistan through natural infection (M. S. Badaway, in Zahar 1974 and 1990).

In this study, the ecology of *An. pulcherrimus*, the second most common species in the District of Ghassreghand, Baluchistan, Iran, is described.

MATERIALS AND METHODS

Study area: The investigation was carried out over a 20 month period (May 1990–December 1991) at Zeineddini (60° 44' 30'' E longitude, 26° 40' 15'' N latitude), in the district of Ghassreghand, Sistan and Baluchistan Province, a small village of about 570 inhabitants. This village lies about 5 km from the city of Ghassreghand, center of the district, and about 108 km from the coast of the Oman Sea. The village is about 495 m above sea level. Rice fields, palm irrigation plots and pools are the major sources of mosquito breeding in the area. The average maximum and minimum temperatures in summer are 39.7 and 26.2°C and in winter 24.1 and 11.8°C, respectively. The average yearly rainfall is about 100 mm.

The village had not been under indoor residual spray programs during the study period, but larviciding was performed during the first year of the study (1990).

Study on seasonal activity: Pyrethrum space spray catches were performed, once a month, in 8 fixed shelters (4 human and 4 animal shelters), located in different parts of the village, by the standard method (World Health Organization 1975), using 0.2% pyrethrum spray.

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² Saebi, M. E. 1987. The spatial distribution of anopheline mosquitoes of Iran. Ph.D. Dissertation, School of Public Health, Teheran University of Medical Sciences.

Comparing the efficacy of different adult collection techniques: In 13 rounds of study, the efficacy of pyrethrum space spray catches, human and animal biting collections and collections from pit shelters and by light traps were compared. Light trap collections as well as human and animal biting collections were performed on the same nights. Pit shelter collections and pyrethrum space spray collections were performed the following day, early in the morning.

The biting collections on human and animal baits were conducted outdoors (as all people and domestic animals slept outdoors during most of the study period) from 1800 to 0500 hours. Two local men were used as human bait and they exposed their arms, faces and feet. A cow tethered outside its shelter, about 15 m from the human baits, was used as animal bait. An experienced technician collected the biting mosquitoes from the 2 human baits and another technician collected mosquitoes from the cattle bait for 2 h, after which they were replaced by 2 other technicians. The assignment to bait and time of collection was done randomly.

Collections from pit shelters were done early in the morning by aspirators. Four pits, 120 × 90 × 150 cm deep, were dug under trees in different parts of the village. About 45 cm from the bottom of the pit a small cavity, about 30 cm deep, was dug out horizontally from each of the sides. Collections were made from these cavities as well as from the walls of the pits themselves.

Six CDC light traps were used in the program. Three traps were suspended from thatched ceilings in 3 fixed animal shelters, two were suspended from the ceilings in 2 fixed human houses and one was suspended from a tree in the middle of the village. Pyrethrum space spray catches were performed in 8 fixed shelters, as described before.

Study on entry into and exodus from houses: Four inlet and 4 outlet window traps, Muirhead-Thomson type (Service 1976), were set up in houses and animal shelters, operating from 1800 to 0600 h, in 17 rounds of study. The traps were examined every 3 h (2100, 2400, 0300, and 0600 h), and all mosquitoes were removed, using aspirators.

Collections made from houses, pit shelters, window traps and light traps were classified according to the blood digestion stages (abdominal conditions).

RESULTS

The monthly mean indoor resting density of *An. pulcherrimus* from May 1990 to December 1991 is presented in Fig. 1. The species had been active throughout the year with 2 peaks of activity, one in April–May, and the other in August–

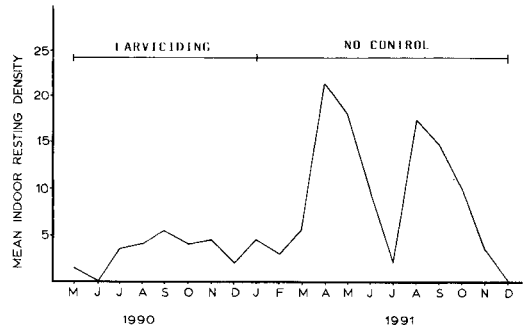


Fig. 1. Temporal changes in the mean indoor resting density of *Anopheles pulcherrimus* in Zeineddini (Ghassreghand) Baluchistan, where in 1990 larviciding and in 1991 no control program has been carried out.

September. The peaks were clearly shown in 1991 since no anopheline control program was carried out at Zeineddini.

The number and mean density of *An. pulcherrimus* females captured in 11 rounds of study by different collection techniques are presented in Table 1. Of the 1,843 females collected in that program, 65% were obtained by light traps, followed by 19.3% in cattle bait collections and 14.2% from pyrethrum space spray catches in human and animal shelters. Only 0.6% of the females were captured by human bait collections, which is about 3% of the number obtained from cattle bait collections. In both collections feeding continued throughout the year. About 56% of the *An. pulcherrimus* females captured in pyrethrum space spray catches or in pit shelters were semi-gravid and gravid (Table 2), whereas the majority (81.3%) of the females captured in light traps were unfed and with a much smaller proportion of freshly fed individuals (13.9%).

The number of *An. pulcherrimus* females caught at different time intervals (1800–2100, 2100–2400, 2400–0300 h and 0300–0600 h) in the inlet and outlet traps are presented in Table 3. Almost half of the catch by window traps (inlet + outlet) occurred during the first quarter of the night. The peak entrance time of freshly fed females into indoor resting sites was in the fourth quarter of the night and the peak exit for unfed and gravid females was noticed in the first quarter of the night. The ratio of gravid to freshly fed females in outlet traps was 0.4.

DISCUSSION

In the province of Sistan and Baluchistan, *An. pulcherrimus* is most abundant in the districts of Ghassreghand and Nikshahr (300–900 m above sea level), where the area is largely under rice cultivation during May to October. It

Table 1. Number (No.) and mean density (MD) of *Anopheles pulcherrimus* females captured by different collection techniques at Zeineddini (Ghassreghand), Baluchistan, 1990-91.

Date	Light trap (6)		Pit shelter (4)		Pyrethrum space spray catch (8)		Human bait (2)		Animal bait (1)
	No.	MD	No.	MD	No.	MD	No.	MD	MD
May 8	3	0.8	NO	—	6	0.8	1	0.5	12
May 15	3	0.5	NO	—	15	1.9	0	0	11
July 17	9	1.8	0	0	23	2.9	2	1	45
July 24	3	0.5	1	0.3	33	4.1	2	1	25
Sept. 11	252	50.4	0	0	24	3.0	0	0	27
Sept. 17	130	32.5	1	0.3	17	2.1	0	0	29
Sept. 23	431	71.8	3	0.8	14	1.8	4	2	59
Nov. 5	87	14.5	NO	—	20	2.5	1	0.5	57
Nov. 12	83	13.8	6	1.5	41	5.1	1	0.5	44
Nov. 17	96	16.0	6	1.5	47	5.9	0	0	35
Jan. 21	101	16.8	1	0.3	21	2.6	0	0	11
Total	1,198		18		261		11		355
%	65.0		1.0		14.2		0.6		19.2

NO: not operative.

Table 2. Abdominal conditions of *Anopheles pulcherrimus* females captured by different collection techniques at Zeineddini (Ghassreghand), Baluchistan (1990-91).

Source of collection	No. studied	Unfed %	Freshly fed %	Semigravid %	Gravid %
Light trap	1,198	81.3	13.9	3.6	1.2
Pit shelter	18	37.5	6.3	43.7	12.5
Pyrethrum space spray catch	261	8.1	35.5	38.8	17.6

Table 3. Number of *Anopheles pulcherrimus* females caught at different time intervals, based on their abdominal conditions, at Zeineddini (Ghassreghand), Baluchistan, 1990.

Type of window trap	Hour/abdominal conditions*																Total
	1800-2100				2100-2400				2400-0300				0300-0600				
	U	F	SG	G	U	F	SG	G	U	F	SG	G	U	F	SG	G	
Inlet	0	3	4	3	3	3	7	0	0	2	1	0	2	8	2	0	38
Outlet	11	12	3	9	1	0	2	1	2	6	0	0	1	3	3	1	55
Total	11	15	7	12	4	3	9	1	2	8	1	0	3	11	5	1	93

* U: unfed; F: freshly fed; SG: semi-gravid; G: gravid.

is the second most common anopheline species, in the named areas, after *An. culicifacies* Giles.

The species has shown 2 peaks of activity in Baluchistan, one in April-May and the other in August-September (Fig. 1). Two peaks of activity have also been reported by Macan (1950) from Iraq, where the highest seasonal prevalence of *An. pulcherrimus* has been reported to be in May-June and October-November. In the province of Herat, Afghanistan, Dhir and Rahim (1957) observed only one main peak of activity for this species during the latter half of July and throughout August.

Macan (1950) and Al-Tikrity (1964) mentioned that adult *An. pulcherrimus* in Iraq were found in large numbers in human dwellings and

animal shelters during the spring, summer and autumn. However, Abul Hab and Al-Kasal (1986) have described the species as an indoor and outdoor resting species. In this study pit shelter collections constituted only 1% of the total *An. pulcherrimus* females as compared to almost 15% captured in pyrethrum space spray catches of human and animal shelters (Table 1). However, the ratio of gravid to freshly fed individuals (0.4) obtained in outlet traps suggests exophilic behavior for *An. pulcherrimus* in Baluchistan (Table 3). Almost 55% of the 18 females captured in pit shelters (Table 2) were semi-gravid and gravid individuals. It is believed that there are many suitable outdoor resting sites present in the locality with which pit shel-

ters may not have competed well. On the basis of the present results we believe that the species is mostly exophilic, but a part of the population also uses indoor resting sites.

Daggy (1959) and Ward (1972) have successfully used light traps for capturing *An. pulcherrimus* females in Saudi Arabia and Afghanistan, respectively. Light traps in this study captured the highest number of *An. pulcherrimus* females (65%) as compared to pyrethrum space spray catches, biting collections and collections from pit shelters. Nevertheless, light traps mostly captured unfed (81.3%) and freshly fed (13.9%) individuals in contrast to almost 56% semi-gravid or gravid females captured in pyrethrum space spray catches or from pit shelters (Table 2).

Mowlaii et al. (1991) have reported 2 peaks of feeding activity for *An. pulcherrimus* in Ghassreghand during the night, one at the beginning and the other (main peak) around 2100–2400 h, with 75% of the feeding activity occurring before midnight. The peak exit time of unfed females from resting sites as observed in outlet window traps (Table 3), in this study, as well as the peak entrance time of freshly fed individuals into indoor resting sites is in agreement with such feeding activities reported in this area.

Mowlaii et al. (1991) also reported only 1.1% of blood smears of *An. pulcherrimus* females obtained from different sources in Zeineddini reacted with human antiserum, where the man to cattle ratio has been 2.9:1. This correlates well with the much greater numbers of *An. pulcherrimus* females which were collected on cattle as compared to human bait collections. Despite this fact, preliminary observations on the natural infection of *An. pulcherrimus* in the study area, using immunoradiometric assay (Zaim, unpublished data), implicates this species as a potential vector of malaria in Baluchistan, Iran.

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