INCRIMINATION OF *ANOPHELES ACONITUS* DONITZ AS A VECTOR OF EPIDEMIC MALARIA IN BANGLADESH

NP Maheswary[1], MA Habib[1] and M Elias[2]

[1]Malaria and Parasitic Diseases Control Division, Directorate General of Health Services and [2]National Institute of Preventive and Social Medicine Mohakhali, Dhaka-12, Bangladesh.

Abstract. In 1989-91, post-monsoon epidemics of vivax malaria occurred in the central flood plain near Dhaka. *Anopheles philippinensis,* the usual vector in the paddy field habitat, was not present, but 1.4% of parous *An. aconitus* were infective. This is only the second time *An. aconitus* has been incriminated as a vector in Bangladesh. We speculate that the surprising increase in lowland malaria may have been caused by environmental change that favored the survival of *An. aconitus.*

INTRODUCTION

Among the 34 *Anopheles* species recorded from Bangladesh (Ahmed, 1987) four are considered relatively important vectors: *An. dirus,* Peyton and Harrison, *An. minimus* Theobald, *An. philippinensis* Ludlow, and *An. sundaicus* (Rodenwaldt) (Elias *et al,* 1982). Of these, only *An. philippinensis* occurs in the vast flood plain areas of the country, where most of the population lives (Elias *et al,* 1989). Historically, transmission in this lowland area has been sporadic and weak. During the eradication campaign (1961-1976) the flood plain was classified as a maintenance zone and DDT interior spraying was done only in the event of epidemics. In 1989, normal surveillance mechanisms recorded a sharp rise in *Plasmodium vivax* cases in an area about 20 km southeast of Dhaka, the national capital. On investigating the cause of this epidemic during 1990-1991 we were surprised to discover that *An. philippinensis* was absent but that a high proportion of *An. aconitus* were infective. Although *An. aconitus* had once before been incriminated in the Gangetic delta (Das, 1943), it has never been considered an important vector in mainland Southeast Asia (Horsfall, 1955). In this report we present our preliminary findings.

MATERIALS AND METHODS

The study villages, Bagadi and Barakanda, are situated 1-2 km east of the Araihazar Upazila (sub-district) Health Complex of Narayanganj (Dhaka) District; it is about 20 km southeast of Dhaka City. The people are generally poor and live mainly by cloth weaving and farming. Both males and females work in the weaving factories during nighttime as well as daytime. Mosquito nets are seldom used. Most dwellings have thatched roofs and bamboo walls; many of the weaving factories resemble house construction. The predominating topographic feature are "beels" (marshy lands) and low-lying cultivated rice fields. The villages are recorded to have been last sprayed with DDT (2 g/m^2) during malaria eradication activities about 25 years ago.

The mosquito collections were carried out 11-20 November 1991, several weeks after the end of the annual rains. The biting and landing *Anopheles* were collected from sunset to midnight by human baits both outdoors and indoors. Day and night resting mosquitos were collected from human and animal (cow and goat) shelters using aspirators. Collected *Anopheles* were identified, dissected, and examined microscopically to determine parity and the presence of sporozoites in their salivary glands (parous only) using standard keys and manuals.

Parasitological information on malaria cases were obtained from the laboratory records of the Upazila Health Complex, Araihazar; district laboratory reports from the Civil Surgeon's office, Narayanganj; and Central Malaria Reference Laboratory records of the Malaria and Parasitic Disease Control (MPDC) Unit of the Directorate General of Health Services, Dhaka. All these records of malaria cases were obtained from Giemsa-stained thick blood smears collected from fever

cases and suspected cases found through monthly house visits and special surveys (active case detection), as well as cases attending the out-patient department of the Health Complex (passive case detection).

RESULTS AND DISCUSSION

The number of malaria cases increased about four-fold in 1989 and another six-fold in 1990; most the cases in Narayanganj District were confined to Araihazar Upaliza (Table 1). Some of the increase in 1990 can probably be attributed to more conscientious surveillance techniques instituted in late 1990, but there is no doubt from records for 1989 and early 1990 that incidence rose sharply. The highest prevalences were in those older than 15 years (Table 2). Patient histories confirm that little human migration took place and that nearly all the cases were indigenous. The higher prevalence in older people therefore suggests, that they were at increased risk, possibly while working at night. Notably, there was virtually no *P. falciparum* (Table 1).

The result of the entomological investigations of the 2 study villages is shown in Table 3. Five species or species groups of *Anopheles* were collected during the investigation and *An. aconitus* was the predominant species at both villages. On dissection, 6 of 433 parous *An. aconitus* (1.39%) were found positive with malaria sporozoites in their salivary

Table 1

Malaria positive cases at Narayanganj District and Araihazar Upazila between 1986-1991*.

Year	Narayanganj District			Araihazar Upazila		
	Slides collected	Number positive	Positivity rate (%)	Slides collected	Number positive	Positivity rate (%)
1986	23,379	519	2.22	4,506	167	3.71
1987	16,593	216 (1)	1.30	1,030	13	1.26
1988	13,524	275 (3)	2.03	1,939	100	5.16
1989	11,293	577 (1)	5.11	1,732	483 (1)	27.89
1990	16,441	2,919	17.75	8,399	2,675	31.85
1991	17,867	3,123	17.48	11,648	2,657	22.81

* Figures in parenthesis indicate number of total cases that were *P. falciparum;* all others were *P. vivax.*

Table 2

Malaria positive cases at two villages in Araihazar Upazila, January-November, 1991.

Age group	Bagadi village			Barakanda village		
	Slides examined	Number positive	Frequency distrib (%)*	Slides examined	Number positive	Frequency distrib (%)*
0-1 years	13	4	3.1	12	4	7.8
2-4 years	34	8	6.2	18	8	15.7
5-9 years	32	16	12.3	17	8	15.7
10-14 years	33	24	18.5	5	3	5.9
15+ years	113	78	60.0	163	28	54.9
Total	225	130	100.1	215	51	100.0

* Proportion of position cases in each age group.

Table 3

Anopheles collections and dissections at two villages of Araihazar Upazila, 11-20 November 1991.

Village	Species	No. collected	No. dissected	No. parous	% parous	Infectives (%)
Bagadi	*aconitus*	933 (86.6%)	405	303	74.8	4 (1.3%)
	annularis	44 (3.8%)	38	24	63.2%	0
	barbirostris Grp	1 (0.09%)	-	-	-	-
	hyrcanus Grp	58 (5.1%)	49	28	57.1%	0
	vagus	51 (4.4%)	47	23	48.9%	0
Subtotal	-	1,147 (100%)	-	-	-	-
Barakanda	*aconitus*	179 (53.8%)	178	130	73.0%	2 (1.5%)
	annularis	45 (13.5%)	36	20	55.6%	0
	barbirostris Grp	2 (0.6%)	2	1	50.0%	0
	hyrcanus Grp	45 (13.5%)	37	19	51.2%	0
	vagus	62 (18.6%)	57	27	47.4%	0
Subtotal	-	333 (100%)	-	-	-	-
Total		1,480				

glands. By November, breeding places had begun to shrink; the relatively high parous rates and numbers of *An. aconitus* suggest that it had a relatively high rate of daily survival, as can be calculated from the parous rate (Davidson, 1954) using the formula $p = \sqrt[n]{\text{parous}}$, where n is the length of the gonotrophic cycle in days. Using an average parous rate of 74% for *An. aconitus* (Table 3), daily survival for a 2 day cycle would be about 86.0%; for 3 days between blood meals, 90.4%.

Obviously, in this situation *An. aconitus* is not only confirmed to be a vector but is a highly potent one; sporozoite rates of 1.4% are rare in Asia among rice habitat vectors. What is surprising is that prior to this investigation *An. aconitus* had only once been found infective in Bangladesh: Das (1943) reported that 2 of 24 collected from an area not far from our site were sporozoite positive, also a high proportion. *An. aconitus* which is closely related to *An. minimus,* is one of the most widely distributed *Anopheles* in Asia (Harrison, 1980) and it has been incriminated in Thailand (Gould *et al,* 1967), India (Rao, 1984), and Indonesia (Sundararaman *et al,* 1957). It breeds in a wide variety of habitats, but seems to prefer emergent vegetation and a slow current, so it is often found in and around lowland cultivation, such as rice fields. Generally it is exophilic, exophagic, and prefers to feed on bovines to man at ratios of 5 : 1 or higher (Harrison, 1980). Consequently, its role as a vector is not so consistent as that of the usually more homophagic *An. minimus.*

A strong implication of our findings is that there is a direct connection between the unusual occurrence of a malaria epidemic near Dhaka and the unusual occurrence of *An. aconitus* as a vector. Possibly conditions in 1989 - 1991 favored breeding and survival of *An. aconitus,* thereby increasing its vectorial capacity. We do not yet know what those conditions might have been, but are currently conducting a longitudinal study in the hopes of discovering them. Our findings emphasize the unpredictable danger from malaria and the constant need for good surveillance.

ACKNOWLEDGEMENTS

We are indebted to FR Molla, Chief Entomological Technician, and to TA Howlader, ZA Khandaker, Md AA Khan, Md N Islam, Md SI Chowdhury, Md S Faruque, SR Roy and Md Motiur Rahman, Entomological Technicians, for their hard work in the field. Dr MS Islam (Director, PHCDC), Dr Md I Haq (Deputy Director, MPDC), A Wadud, Dr Md Hasan, Dr A H Khan, Dr A Hossain, and Md NA Prodhania generously aided the investigation. We also thank Dr RS Giri and Dr ANA Abeysundere (WHO Bangladesh), Dr RK Jung (WHO, New Delhi), and Dr MH Birley

(Liverpool) for their kind support and encouragement.

REFERENCES

Ahmed TU. Checklist of mosquitoes of Bangladesh. *Mosq Sys* 1987; 19 : 187-200.

Das BK. *Indian Med Gaz* 1943; 78 : 327-30.

Davidson, G: Estimation of the survival rate of anopheline mosquitoes in nature. *Nature* 1954; 174 : 792.

Elias M, Dewan Z, Ahmed R. Vectors of malaria in Bangladesh. *J. Prevent Social Med* 1982; 1 : 20.

Elias M, Rahman AJMM, Ali MM, Begum J, Chowdhurry A.R. The ecology of malaria carrying mosquito *Anopheles philippinensis* Ludlow and its relation to malaria in Bangladesh. *Bangladesh Med Res Council Bull* 1989; 13 : 15-28.

Gould DJ, Esah D, Pranith U. Relation of *Anopheles aconitus* to malaria transmission in the central plain of Thailand. *Trans R Soc Trop Med Hyg* 1967; 61 : 441-2.

Harrison, BA. The *Myzomyia* series of *Anopheles (Cellia)* in Thailand, with emphasis on intra-interspecific variations (Diptera: Culicidae). *Contr Am Entomol Inst,* 1980; 17 : 195 pp.

Horsfall WR. Mosquitos. Their bionomics and relation to disease. New York; The Ronald Press, 1955: 723 pp.

Rao TR: The Anophelines of India. Indian Council of Medical Research, New Delhi, 1984; 518 pp.

Sundararaman S, Soeroto RM, Siram M. Vectors of malaria in mid-Java. *Indian J Malariol* 1957; 11 : 321-38.