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Failure of Zooprophylaxis: Cattle Ownership Increase Rather than Reduce the Prevalence of Malaria in District Dir, N.W.F.P. of Pakistan

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Parasite prevalence survey was conducted in district Dir, N.W.F.P. (Pakistan) during the period of September 1995 in August 1996 in order to examine the possibility that domestic cattle kept in house courtyards might protect occupants against malaria through zooprophylaxis. Malaria parasite rate was greater among children of families which kept cattle (11.20%) than among those which did not keep it (7.10%). The present finding may be may be helpful in solving the dilemma of zooprophylaxis and supports the prediction of the Sota-Mogi theoretical model that domestic animals can increase rather than reduce malaria transmission when vectors are Zoophilic.

Key words: Malaria, school children, cattle, zooprophylaxis, zoophilic, mosquitoes

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Introduction

In malaria control, the use of domestic animals to shift mosquito bites from man has been called zooprophylaxis (Brumpt, 1945 and Macdoland, 1957). Zooprophylaxis has been defined by the World Health Organization (1982) as, "The use of wild or domestic animals, which are not the reservoir host of a given disease, to divert the blood-seeking mosquito vectors from the human hosts of that disease". Zooprophylaxis may be active or passive. Active zooprophylaxis is a reduction in malaria or human biting by mosquitoes resulting from the deliberate spread out of domestic animals as a barrier between mosquito breeding sites and human settlements (WHO., 1991). Passive zooprophylaxis is the serendipitous reduction in malaria purported to occur when cattle density increases within a community.

The host range of mosquito vector of human diseases is often broad (Tempelis, 1975). Domestic animals which are preferred and /or easily accessible by the mosquitoes may not only favour mosquito reproduction but also serve as reserviors and amplifiers of disease pathogens. Thus proper management of livestock, which are often of economic importance, is one aspect of the control of mosquito-borne disease (Bradley and Narayan, 1987). There have been a number of early reports from Europe and the former of the USSR to reduced prevalence of malaria resulting from the active deployment of cattle and pigs to form barriers between breeding sites and human settlements (Brumpt, 1945) .

There have also been reports of instances where the introduction of livestock has apparently reduced the prevalence of disease. For example the reduction in malaria that occurred in Europe and the United States earlier this Century has been attributed partly to the increase in livestock numbers (Bruce-Chwatt, 1985).

A higher incidence of malaria was recorded at health centers for Afghan refugees than at centers for local population in Pakistan (Bouma and Rowland, 1995). The Afghans have been less exposed to malaria and therefore less immune during the first years after their arrival in Pakistan (Suleman, 1988). And suggested that refugees kept less number of cattle than Pakistani (English, 1989) they are less able to take benefit from zooprophylaxis (Zuleta, 1989). A study from Philippines showed increased biting rate on the occupants of a house in the presence of two buffalo near the house (Schultz, 1989). The mosquitoes are highly zoophilic, so the conditions in Pakistan are highly conductive to successful passive zooprophylaxia. The mathematical model of Sota and Mogi (1992) has exposed problems with the theory that "introduction of cattle can lead to increased mosquitoes, increased human biting rates, and greater malaria transmission".

The present study was undertaken to observe the prevalence of malaria in school-going children in district Dir, in order to solve the dilemma of zooprophylaxis.

Materials and Methods

A total of 1873 blood samples were collected from school-going children aged 5 to 18 years during August, 1995 to September, 1996. Out of these, 1240 blood films were from students with cattle and 633 smears without cattle in their compounds. At the time of collection of blood smears, a printed data sheet was filled from each student to have a full information regarding the name, age, sex, occupation, previous history of ailment, drugs taken, and presence or absence of cattle. Thick and thin blood smears were prepared on the same slide. Blood smears were made by cleaning the finger tip of the concerned student with spirit followed by pricking with a disposable lancet. The slides were fixed with methyl alcohol, stained with Giemsa stain (Russel *et al.*, 1963) and examined for parasitemia. Onehundred microscopic fields of each film were examined under X 100 oil immersion before reporting a slide as negative. During each collection every child was asked in private whether his/her family kept cattle within the house compound. There are totals 2032 primary, 85 middle and 90 high schools in district Dir in which 128 primary schools

have co-education. Majority of the students kept cattle. For security reasons these cattle are kept inside the family compound at night. People commonly sleep very close to their livestock, particularly between May and September, when it is customary to sleep out side (in courtyards).

Results

After a careful study of all the blood films, 184 were found positive out of total 1873 blood films, thus showing an over all incidence of 9.82%. Malarial parasite rate among children of families which kept cattle was 11.20% and without cattle 7.10% (Table 1).

Out of 1240 blood smears collected from students who kept cattle, 139 were found positive thus showing an over all incidence of 11.20%. In these 139 positive smears, 117 (9.43%) were found positive with infection of *P. vivax*, 17 (1.37%) with *P. falciparum* and 5 (0.40%) with mixed infection (*P. vivax + P. falciparum*). Screening of 633 blood samples collected from those students who did not keep cattle, 45 were found positive thus showing an over all incidence of 7.10%. Out of these 45 positive smears, 36 (5.68%) were found positive with *P. vivax*, 8 (1.26%) with *P. falciparum* and only one (0.15%) with mixed infection (Table 2).

Table 1: Prevalence of malaria in students with and without cattle

Student's group.	No of slides examined.	Found positive	%age
With cattle	1240	139	11.20
without cattle	633	45	7.10
Total	1873	184	9.82

Table 2: Species-wise effect of zooprophylaxis

Species	Positive with cattle	% age	posite without cattle	% age
P. vivax	117/1240	9.43	36/633	5.68
P. falcifarum	17/1240	1.37	8/633	1.26
Mixed	5/1240	0.40	1/633	0.15

Table 3: School category-wise (primary, middle and high) effect of zooprophylaxis

School	Positive	% age	Positive with cattle	% age	Positive with-out cattle	% age
G.P.S.	77/848	9.08	57/556	10.25	20/292	6.8
G.M.S.	48/447	10.73	38/314	12.10	10/133	7.5
G.H.S.	59/578	10.20	44/370	11.89	15/208	7.21
Total	184/1873	9.82	139/1240	11..20	45/633	7.10

G.P.S(Govt primary school), G.M.S(Govt middle School), G.H. S. (Govt high school)

A total of 848 smears were collected from 15 primary schools out of which 77 (9.08%) were found positive. With livestock the incident was 10.25%, while without cattle was 6.80%. Total 447 blood smears were collected from 8 middle schools out of which 48 (10.73%) were found positive. With cattle it was 12.10% while without cattle was 7.50%. From 10 high schools, a total of 578 blood samples were collected out of which 59 (10.20%) were found positive with infection. With and without cattle the incidence was 11.89 and 7.21% respectively (Table 3).

Discussion

The basis for the investigation of this report was an epidemiological study was conducted by Bouma and Roland (1995) in the North West Frontier Province of Pakistan. Cattle ownership and parasite prevalence was associated in two ways. (I). A strong correlation between increased prevalence of malaria in villages and increased cattle: man ratio was found. Bouma and Roland (1995) called this phenomenon the "area effect " and postulated that, this was due to high vector densities which resulted from the easily available blood meals afforded by cattle. The possibility of performing a definitive study, which would determine the exact role of cattle in this respect, seems unlikely. The explanation suggested by Bouma and Roland, corroborated by the mathematical prediction of Sota and Mogi (1992) who modeled the epidemiological impact of changing host number where a two-host vector was responsible for malaria transmission. The families which kept cattle in their house recorded a higher prevalence of malaria than families which did not. Bouma and Roland called this phenomenon the "compound effect". The compound effect was the opposite of that predicted by classical zooprophylaxis theory according to which the use of domestic animals can control malaria by diverting mosquito bite on man (Brumpt, 1945).

Our results supports the proposed 'compound effect' of Bouma and Rowland (1995).The experiments of Hevitt *et al.* (1994) in a refugee village provided the explanation and showed that biting rates on sleeping people increases if cattle were kept in the vicinity. It seems that the mosquitoes are attracted to cattle being large in size, but instead of cattle hosts they feed upon sleeping humans along with cattle. It follows that, if the biting rate on cattle families is greater, malaria prevalence should also be higher in that group. The mere rearrangement of mosquitoes within a village is unable to explain the area effect. That would require an increase in the number of mosquitoes per person. In the model developed by Sota and Mogi (1992), mosquito densities increases when cattle are introduced because cattle constitute a source of blood. Besides the cattle, we were unable to identify any factor that might be responsible for the observed effects.

On reviewing the whole matter, it must be concluded that sleeping close to livestock at night increases the chances of people being bitten by zoophilic anopheline mosquitoes. So domestic animals increases rather than reduce malaria transmission when the vectors are zoophilic. It seems that however fascinating this theory of animal barrier may be in its potentialities, zooprophylaxis has not: yet been shown to be an effective direct weapon against malaria.

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