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A STUDY OF THE INFECTIVITY OF PATIENTS
TO MOSQUITOS IN THE ASYMPTOMATIC PHASE OF PARASITIC RELAPSES
OF INDUCED INJECTIONS WITH P. VIVAX
(MADAGASCAR STRAIN)

by

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This investigation was carried out on 11 male adults, only one of whom had previously suffered from malaria prior to the initial attack (case No. 10). All the subjects were infected for the purpose of malariatherapy with Plasmodium vivax (Madagascar strain).

They were under continuous observation from the termination of the primary attack until a relapse occurred. The primary attack in all patients was interrupted on or about the fifth day of fever by giving an intramuscular injection of thio-bismol (0.2 g) and was terminated by giving 0.75 g quinine (orally) daily for seven days.

It may be considered that the treatment given to terminate the primary attack was inadequate. This was done on purpose since we wanted the patients to relapse about two months after the primary attack.¹

¹ (Editor's note)

The present paper is a continuation of investigations carried out by the same authors on the infectivity of primary attacks of P. vivax malaria (Shute & Maryon, 1957).

The results of the previous publication were as follows: One hundred A. atroparvus were fed daily on each of the 54 patients during the early stages of the primary P. vivax malaria (Madagascar strain). The earliest infection in the mosquito occurred two days and the latest seven days after the commencement of fever or parasitaemia. Mosquitos became infected from 32 patients before gametocytes were detected in blood films; from 22 patients mosquitos became infected on the first day when male gametocytes were found. In primary untreated P. vivax infections maximum gametocyte density is reached on or about the tenth day. Nevertheless mature gametocytes may be present in the blood of primary cases in sufficient numbers to infect mosquitos as early as the third or even in one case, on the second day.

Method of investigation

Four thick and four thin films were examined daily from each patient, beginning on the seventh day after the last day of quinine treatment. The thick films were stained by Field's method and after drying they were counterstained with weak Leishman stain.

Both of us examined the thick films and when a parasite was found, a batch of 50-100 laboratory-bred Anopheles stephensi was fed daily on the patients during the asymptomatic phase. The fed mosquitos were incubated at 27°C and on the seventh day after the potential infective feed, 20 were dissected and the mid-guts examined for oocysts.

The results were as follows:

1. None of the patients infected mosquitos on either the first or second day of parasitaemia.
2. All the patients infected mosquitos at some time during the period when the appearance of parasites in the blood was not accompanied by any clinical symptoms.
3. The shortest asymptomatic period was three days and the longest six days.
4. The highest percentage of mosquitos which became infected on any given day of the asymptomatic period was 100% and the lowest 5%.
5. The number of oocysts per mid-gut of A. stephensi varied from one to 50.

As the present series is a small one we propose to give details of each patient. This is shown in Table 1.

Discussion

It is interesting to compare the scarcity of parasites in the early stages of a primary attack with their numbers in the same patient seen on the first day of a clinical relapse. This, of course, has an important bearing on the production of gametocytes. In a non-immune patient having a primary attack, and therefore devoid of any degree of tolerance, only a small number of parasites is necessary to produce clinical symptoms. The result of this is that frequently a long search is necessary in order to find a parasite. This helps to explain why gametocytes are seldom

numerous until the fifth to sixth day of fever, reaching their maximum on or about the tenth day. In a relapse, however, parasitaemia is frequently quite high on the first day of clinical symptoms and ripe gametocytes are often numerous. The above series show that parasites were detectable in the peripheral blood for several days before the appearance of clinical symptoms; this is obviously due to a certain degree of tolerance as the result of the primary attack. It also explains why, in the primary infection, mosquitos are not likely to become infected before the patient is ill with fever and why, in relapses, mosquitos readily become infected during the asymptomatic period. In other words, there was no asymptomatic phase in a primary attack in our series. It is also worthy of note that in one respect there is a similarity between the primary attack and a relapse. In both, mosquitos became infected on or about the third day of parasitaemia, the difference being that in the primary attack, by the third day the patient is ill but on the same day of the parasitic relapse, usually the patient is feeling well. Indeed, some of the patients in this series were feeling quite well even on the sixth day, three days after they were infectious to mosquitos.

REFERENCES¹

1. Shute, P. G. (1945) Trans. roy. Soc. trop. Med. Hyg. 34, 7
2. Shute, P. G. & Maryon, M. (1957) Trans. roy. Soc. trop. Med. Hyg. 51, 403

¹ (Editor's note)

The papers quoted below report on investigations which are in essential agreement with the results obtained by Shute & Maryon.

- (a) Watson, R. B. (1945) On the probability of soldiers with Pacific P. vivax malaria infecting Anopheles quadrimaculatus, J. nat. Malar. Soc. 4, 183
- (b) Eyles, D. E., Young, M. D. & Burgess, R. W. (1948) Infectivity to A. quadrimaculatus of asymptomatic P. vivax parasitaemia J. nat. Malar. Soc. 7, 125
- (c) Jeffery, I. M. (1952) The infection of mosquitos by P. vivax (Chesson strain) during the early primary parasitaemia, Amer. J. trop. Med. Hyg. 1, 612

TABLE 1. RESULTS OF THE INVESTIGATION ON THE INFECTIVITY TO ANOPHELES STEPHENSI OF PATIENTS RELAPSING WITH P. VIVAX

Case	Day when first found parasites	Day when first found gametocytes	Number of gametocytes in thick or thin film	Anopheles fed on day	Results of dissections for oocysts of 20 mosquitoes 7 days after the infective feed					Maximum number of oocysts per mosquito	Total number of oocysts in infected mosquitoes	Percentage of positive mosquitoes		
					Negative									
					1-2 oocysts	3-5 oocysts	6-10 oocysts	over 10 oocysts						
1	1st	3rd	" " " " Thick film females only 1 male per 500 leucocytes 3 males per 500 leucocytes 5 males per 500 leucocytes	1	-	-	-	-	-	-	-	-	-	
				2	-	-	-	-	-	-	-	-	-	-
				3	3	6	1	-	-	41	7	15/20 = 75%		
				4	3	6	2	-	-	80	20	13/20 = 65%		
				5	1	6	6	-	-	157	20	17/20 = 85%		
				6	-	4	3	11	-	-	390	50	18/20 = 90%	
2	1st	3rd	" " " " Thick film females only Thick film females only 1 male per 500 leucocytes	1	-	-	-	-	-	-	-	-	-	
				2	-	-	-	-	-	-	-	-	-	
				3	3	-	-	-	-	3	1	3/20 = 15%		
				4	1	-	-	-	-	1	1	1/20 = 5%		
				5	4	4	3	1	-	57	12	12/20 = 60%		
3	1st	3rd	" " " " Thick film females only	1	-	-	-	-	-	-	-	-		
				2	-	-	-	-	-	-	-	-		
				3	7	1	-	-	13	3	8/20 = 40%			
4	1st	3rd	" " " " 1 male per 500 leucocytes 1 male per 500 leucocytes	1	-	-	-	-	-	-	-	-	-	
				2	-	-	-	-	-	-	-	-	-	
				3	11	3	-	-	28	5	14/20 = 70%			
				4	4	7	5	1	111	20	17/20 = 85%			

TABLE 1. (continued)

Case	Day when first found parasites	Day when first found gametocytes	Number of gametocytes in thick or thin film	Anopheles fed on day	Results of dissections for oocysts of 20 mosquitoes 7 days after the infective feed					Maximum number of oocysts per mosquito	Total number of oocysts in infected mosquitoes	Percentage of positive mosquitoes						
					Negative	1-2 oocysts	3-5 oocysts	6-10 oocysts	over 10 oocysts									
5	1st	3rd	-	1	All	-	-	-	-	-	-	-	-	-	-	-	-	-
				2	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			2 males per 500 leucocytes	3	3	9	7	1	-	-	10	51	17/20 = 85%					
				4	10	5	3	2	-	-	8	31	10/20 = 50%					
			1 male per 500 leucocytes	5	-	-	1	-	-	19	695	20/20 = 100%						
6	1st	3rd	-	1	All	-	-	-	-	-	-	-	-	-	-	-	-	
				2	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			Thick film females only	3	14	5	1	-	-	-	3	9	6/20 = 30%					
7	1st	3rd	-	1	All	-	-	-	-	-	-	-	-	-	-	-	-	
				2	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			Thick film females only	3	11	8	1	-	-	-	3	12	9/20 = 45%					
			1 male per 200 leucocytes	4	7	3	2	3	1	-	25	103	9/16 = 56%					
8	1st	4th	-	1	All	-	-	-	-	-	-	-	-	-	-	-	-	
				2	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			1 male per 500 leucocytes	3	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			1 male per 500 leucocytes	4	9	7	4	-	-	-	4	22	11/20 = 55%					
9	1st	3rd	-	1	All	-	-	-	-	-	-	-	-	-	-	-	-	
				2	All	-	-	-	-	-	-	-	-	-	-	-	-	-
			1 male per 100 leucocytes	3	15	5	-	-	-	-	2	6	5/20 = 25%					

TABLE 1. (continued)

Case	Day when first found parasites	Day when first found gametocytes	Number of gametocytes in thick or thin film	Anopheles fed on day	Results of dissections for oocysts of 20 mosquitoes 7 days after the infective feed					Maximum number of oocysts per mosquito	Total number of oocysts in infected mosquitoes	Percentage of positive mosquitoes	
					Negative	1-2 oocysts	3-5 oocysts	6-10 oocysts	over 10 oocysts				
10	1st	6th	-	1	-	-	-	-	-	-	-	-	
			-	2	-	-	-	-	-	-	-	-	-
			-	3	-	-	-	-	-	-	-	-	-
			-	4	-	-	-	-	-	-	-	-	-
			-	5	-	-	-	-	-	-	-	-	-
			1 male per 500 leucocytes	6	2	-	-	-	-	1	2	2/20 = 10%	
			1 male per 500 leucocytes	7	3	-	-	-	-	2	5	3/20 = 15%	
			-	8	-	-	-	-	-	-	-	-	-
			-	9	-	-	-	-	-	-	-	-	-
11	1st	3rd	-	1	-	-	-	-	-	-	-	-	
			-	2	-	-	-	-	-	-	-	-	
			Thick film females only	3	7	1	-	-	4	13	8/20 = 40%		
			1 male per 500 leucocytes	4	6	7	1	-	6	41	14/20 = 70%		