ANTIMALARIA MEASURES IN ENGLAND.

BY

ANGUS MACDONALD, M.D., D.P.H., D.T.M.,
TEMPORARY CAPTAIN R.A.M.C.

THE record of the occurrence and control of malaria, imported and indigenous, in England will be published for the War Office by the consultant in malaria. Permission is granted for a brief summary to be given before the British Medical Association.

Carriers.

From various seats of war cases of malaria in all stages of the disease have returned to England during the years 1916-19. Necessity for control was anticipated, and was inaugurated by the War Office from the date of first return of infected troops. As malaria infection is consistent, both in officers and men, with "carrying on," infected troops returned to their units, where they were dealt with as variously required, and were thus distributed throughout the country.

Dangerous Areas.

Historical evidence and indigenous occurrences in 1917 determined the institution of special measures of control in areas of great anopheline incidence, especially in Sheppey, Sandwich, Romney Marsh, and Essex. Local conditions modify the effect of anopheline incidence; but in Sandwich and Sheppey abundance of anophelines coincided with large aggregation of troops and intimacy of infectivity.

*Indigenous Malaria.**Incidence and Distribution in 1917 and 1918.*

Situation.	1917. No. of Cases.	1918. No. of Cases.
Sheppey	68	31
Sandwich	69	6
Elsewhere	26	24
Total	163	61

Seasonal Distribution of Malaria Occurrence and Infection in 1918.

Occurrence.		Infection.	
Date.	No. of Cases.	Probable Date.	No. of Cases.
1918.			
May	3	May	4
June	2	June	2
July	1	July	3
August	22	August	47
September	29	September	4
October	4	October	1
Total	61		61

All cases in 1918 were specially investigated. Malaria was authenticated of all. Indigenous origin was established by the absence of possibility of foreign infection. The locality of infection was assumed by the demonstration of (1) the disease, (2) intimate contact with carriers, (3) the presence of anophelines.

In nine cases assumed to be indigenous and contracted in May, June, and July, protozoal incubation of resting mosquitoes (a notorious anopheline habit) in artificially heated premises, is postulated, to account for infection at a date when atmospheric temperature was probably not sufficiently high to cause "natural" infection. The other infective conditions were present. One occurrence in June it was preferred to accept as a latent infection from 1917. Some conditions were present, all were possible, in June; but undoubtedly all conditions had been present in August, 1917. The majority of infections, as might be expected, occurred in early August.

General Antimalaria Measures.

The general antimalaria measures were as follows:

- (a) Supervision by malaria expert.
- (b) Blood examination of doubtful pyrexia.
- (c) Supervision of troops from overseas.
- (d) Segregation and screening of carriers.
- (e) Special instruction of medical officers.
- (f) Quinine treatment of case and carrier.
- (g) Entomological investigation.

Of these provisions, (a), (b), (c), (e), and (g), aided detection and stimulated control and treatment; (d) and (f) are of direct preventive value, the former in diminishing the chances of biting and transmission, the latter by reducing the infective power of the individual, who in the vast majority of the cases dealt with was a carrier of the *Plasmodium vivax*.

Antilarval and Antimosquito Measures.

These measures, definitely sanitary, were adopted mainly in the "dangerous areas"—Sheppey, Sandwich, Romney Marsh. Labour difficulties were general, but least felt in Sandwich, where the most accurate work was accomplished.

Destruction of Mosquitos in their Winter Quarters.—*A. maculipennis* is the main domestic danger in England. She winters where the conditions obtainable are warmth, freedom from draught and disturbance, shade, and food. These are to be found within buildings where cattle (kine, horses, pigs, etc.) are housed. During summer months these conditions are to be found more readily in relation to human dwellings; cattle are rarely or but temporarily housed; *maculipennis* wanders and finds rest, shade, warmth (at natural temperature), quietness, and food in man's sleeping quarters. Farm steadings—stables, cowsheds, pigsties—have been cleared of mosquitos in winter months. Those not killed directly could not live exposed to winter temperatures outside. Repeated operations in these buildings were aided by thorough whitewashing, which enables ready detection. The common dense shroud of cobwebs conceals the mosquitos. The effect of this destruction has been obvious in districts operated. Where "myriads" were recorded on March 4th, 1918, six were with difficulty found on March 4th, 1919. In districts under observation, not operated, *maculipennis* prevalence in 1917, 1918, and 1919 has not varied.

Prevention of Larval Development.—For every wintering *maculipennis* destroyed there are probably hundreds of larvae kept from existence. But direct attack on breeding places so supplements the process of limitation that elimination locally is feasible. *Maculipennis* larvae depend for their chances of existence on the presence of vegetation in and on the surface of the waters. The whole aim of antilarval measures has been so to treat all breeding places as to maintain a clear exposed water surface, bottom and sides free of vegetation, and banks trained and devoid of overhanging growth. In Sandwich, besides operations on notoriously infested waters at wider range, more than twenty miles of dykes have been kept trained and free of weed, all within the camp area and in intimate relation to an aggregation of some 30,000 men, harbouring a carrier volume not readily ascertainable. The result of the combination of operations has been rarity of *maculipennis* within military quarters, absence of larvae from treated dykes, and a record of six indigenous cases in 1918 as against sixty-nine in 1917. These six also resulted from a local defect in detail. In Sheppey, where circumstances did not allow of so thorough measures being carried out, there is reduction from sixty-eight to thirty-one military cases, and from thirty-five to fourteen amongst civilians, owing to the protection of military operations.

GENERAL CONSIDERATIONS.

Attempts at the practical prevention of malaria have been threefold, and all over the world they have been tried separately and in combination.

1. Quinine treatment and prophylaxis.
2. Personal protection—by screening, netting, and repellants.
3. Direct limitation of mosquitos.

Notwithstanding theoretical and real minimal value, quinine as a preventive of malaria is practically valueless. For the individual netting is a sheet anchor; for the community it is valueless.

The direct limitation of mosquitos is the only proven measure of practical value; its application is direct and local, not vague and distributed; it is inexpensive, and can be effected by the existing personnel, rightly directed, of any and every sanitary establishment, and in sound practical hands its results are absolute. Its value has been demonstrated in the past twenty years all over the world, and is not to be set aside by the imaginative predictions of administrative propagandists and the unpractical *ipse dixit* of students of the *in vitro*. And now from the different seats of war reports show the valuable work done and obvious good results obtained. Every

practical sanitarian (and many health officers from this country have had their opportunity and made good) who has handled malaria prevention has received results, and knows that thus only is success to be achieved.

It may seem somewhat parochial in a subject of such universal interest to bring forward evidence from limited operations in England; but they have been unique, in that it is the first opportunity that has existed of studying indigenous malaria in England with the knowledge of its entity.

I briefly sum up the evidence of recent occurrences in England in proof of the value of definite sanitary operations in the prevention of malaria. And as far as England is concerned, while it would be absurd and uncalled for to institute antimosquito measures throughout the entire area of anopheline distribution, there may be parts of the country where the coincident distribution of vehicle and carrier may be intense. In these it may be incumbent on authority to adopt the proven measures of malaria prevention.

Summary.

1. Mosquito prevalence was similar in 1917 and 1918.
2. Conditions for indigenous infection existed both in 1917 and 1918.
3. Carrier population was increased in 1918.
4. Where general measures were adopted, but when control was more accurate, the scattered occurrences in 1918 were 24, as against 26 in 1917.
5. Where sanitary measures were added to the scheme of prevention, as in Sheppey, the cases in 1918 number 45, as against 103 in 1917.
6. Where more accurate operations were attained in Sandwich the number of indigenous cases fell from 69 to 6.

THE ELECTRICAL CHANGES IN ACTIVE TISSUES.

ABSTRACT OF THE SILVANUS THOMPSON MEMORIAL LECTURE
GIVEN BEFORE THE RÖNTGEN SOCIETY ON MAY 6TH, 1919.

BY

W. M. BAYLISS, D.Sc., F.R.S.,

UNIVERSITY PROFESSOR OF GENERAL PHYSIOLOGY, UNIVERSITY
COLLEGE, LONDON.

The phenomena of electrical changes in active tissues have been a favourite subject of investigation by physiologists, no doubt greatly on account of the accurate methods of measurement available, even at a comparatively early date. Although electric fish were known to the ancient world, and the effects of their discharges were described by Aristotle and Pliny, it was not until about 1780 that Galvani discovered similar properties in ordinary muscle, naturally much less intense, and requiring delicate methods to detect them. Matteucci in 1838 appears to have been the first to use the galvanometer in their investigation, and the work of Du Bois-Reymond was only a little later. Before long, these properties were shown to exist in nerve, in glands, and in smooth muscle.

It is not my intention to discuss the details of all these cases, but rather to direct attention to certain facts which throw light on their manner of production and their significance. It may be pointed out that electrical changes are not in themselves of great importance, but rather as indicating the existence of phenomena otherwise difficult or impossible to investigate.

Since the introduction of the theory of electrolytic dissociation of conductors in watery solution, it has been realized that we must look for the explanation of the facts before us on the basis of the movement and redistribution of ions. The body may be regarded as a framework of non-conducting material, immersed in and soaked by solutions of electrolytes. Evidence derived from many and various sources shows that living cells are surrounded by delicate membranes, which allow water and certain solutes, such as urea and the lower alcohols, to pass through freely, but refuse passage to the majority of salts, to sugars, etc. It was pointed out by Ostwald in 1890 that if a membrane is impermeable to one of the ions into which a salt is dissociated, it is indifferent whether the oppositely charged ion can get through or not, because this latter can only leave the neighbourhood of its fellow for a very small distance on account of the great magnitude of the electrostatic attraction between them. It will therefore form a layer on the outer side of the membrane,

while the opposite ions form a layer on the inner side. This is the "electric double layer" described by Helmholtz, and is clearly the cause of a difference of potential between the two sides of the membrane.

Now Bernstein in 1902 showed that if we suppose the membrane of the muscle cell to be impermeable to certain anions but permeable to certain cations, the latter will form an outer layer with a positive charge, while the interior of the membrane will have a negative charge. He showed, moreover, how all the facts of "muscle electricity" are explicable on this view. What the particular ions are it is as yet impossible to state; but those of potassium phosphate seem to be the most probable.

What, then, are the facts to be explained?

1. Since the whole of the surface of the cell is supposed to be possessed of the membrane in question, it is easy to see that application of electrodes connected to a galvanometer should show that it is equipotential at all points. This is the case with uninjured muscle and also with nerve.

2. Suppose that the two electrodes are placed at different points and that we injure the membrane under one of the electrodes, so that it becomes freely permeable to both ions. The double layer ceases to exist at the injured point, the ions freely mix, and the electrode is in connexion with the interior of the cell—that is, the negative component of the double layer at the normal parts of the surface. We have what is called the "current of injury" or "demarcation current," in which the injured spot is negative to the uninjured parts. It is to be noted that the older theories regarded the changes at the injured spot as the source of the current, while the new view regards the uninjured surface as the source. Bernstein was able to decide the question in the latter sense by warming locally. The demarcation current was unaltered by warming the injured spot, increased by warming the normal place. The effect of temperature was also used to decide between a physical theory, such as that spoken of, and those theories which attributed the phenomena to chemical reactions at the injured spot. The magnitude of the current of injury was found to be proportional to the absolute temperature and not to have the high temperature coefficient of a chemical reaction.

3. The current of injury disappears more or less quickly, as it should do if the electrolytes within the cell diffused away at the permeable injured place.

4. There is evidence that increase of permeability is a general characteristic of the state of activity. Details of this evidence are beyond the limits of this account, but, accepting them, we may examine what would happen if we led off from the normal surface and from an injured spot and then stimulated the muscle to contract. The normal surface would approximate more or less completely, as regards its permeability, to the injured spot, the double layer would disappear and with it the source of the current of injury. This was called the "negative variation," that is, the decrease, of this current.

5. If both electrodes are on uninjured spots and a wave of excitation passes along the muscle, as it passes one electrode it makes this one negative to the other, and then, leaving the former, it reaches the second and makes this negative to the first. We have a current first in one direction, immediately followed by one in the opposite direction. This is the "diphase variation."

Their impermeability to ions makes cells bad conductors of electrical currents. Their resistance thus decreases in the state of activity or when the membranes are destroyed. This is the basis of Stewart's method of determining the proportion between the corpuscles and the plasma in the blood. It also accounts for the high resistance of nerves in the transverse direction.

The main fact that an active spot in muscle or nerve is negative to one at rest is therefore accounted for satisfactorily on the "membrane theory" of Bernstein.

As instances of the use of the fact may be mentioned Lewis's localization of the pace-maker in the mammalian heart and the extensive use of the electrocardiogram in practice. It is beyond the object of this lecture to discuss the meaning of the components of the latter, but a word of warning should be given against hasty interpretation of details in the curve. Slight changes in the duration of the excitatory state at one electrode may produce fundamental alterations in the electrocardiogram, while the heart beat, as far as its essential mechanical effects are