Ritson, F.R.C.S.; Captain S. Lyle; and Major R. H. Paramore, F.R.C.S. My warmest thanks are due to these officers for their never-failing skill, devotion, care and resource and for their accurate records from which brief notes have been compiled.

OBSERVATIONS ON MOSQUITOES AT SANDWICH DURING THE YEARS 1918-19.
BY GEORGE TALBOT, F.E.S.

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1.—INTRODUCTION.

WHilst engaged as laboratory assistant in the Royal Army Medical Corps, I was sent to Sandwich to help with the antimalarial work which was being carried on there. The War Office had established the nucleus of an entomological laboratory at Stonar Camp and some good practical work resulted. This has been described by the proper department, and much credit has devolved upon the officers concerned with the work.

A new and efficient laboratory has now been established where previously we had a small shed, sharing the work of the bacteriological section of the hospital.

Thus we laboured under many difficulties as regards laboratory work, and I shall always remember the regulation stove, which served either to freeze or to scorch, and which deposited dust like a volcano.

2.—THE PREVALENCE OF ANOPHELES IN THE MILITARY AREA.

Since the main object of the antimalaria work was to clear the camp of anophelines, it was thought that some record should be made of the occurrence of adults after the summer. A thorough war had been waged against larve and pupae in the waterways during the spring and summer of 1918. Previous to my taking up duty here, records had been made of the mosquitoes found in certain huts in each of the camps.

This did not appear to me to yield reliable results and I obtained the necessary sanction to make a detailed investigation. This work was carried on mostly during the month of December.

In December a number of men were selected from the antimalaria staff, and these were instructed how to catch the insects, where to look for them, and how
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to distinguish *Anopheles*, *Theobaldia*, and *Culex*. These men worked through most of the buildings in the five camps, and entered their catches in a book. I examined each catch at the close of each inspection, and verified the notes made. The results are tabulated in the following table.

**TABLE I.—Record of Mosquitoes Captured in the Different Camps of the Sandwich Military Area during December, 1918.**

<table>
<thead>
<tr>
<th>Camp</th>
<th>Number of buildings inspected</th>
<th><em>Anopheles maculipennis</em></th>
<th><em>Theobaldia annulata</em></th>
<th><em>Culex pipiens</em></th>
<th>Totals</th>
<th>Percentage of total number of buildings inspected</th>
<th>Percentage of total number of mosquitos</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowan</td>
<td>110</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Construction</td>
<td>52</td>
<td>2</td>
<td>7</td>
<td>10</td>
<td>1</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Kitchener</td>
<td>252</td>
<td>2</td>
<td>10</td>
<td>11</td>
<td>1</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Haig</td>
<td>111</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Stonar</td>
<td>132</td>
<td>9</td>
<td>7</td>
<td>14</td>
<td>116</td>
<td>9</td>
<td>130</td>
</tr>
<tr>
<td>Totals</td>
<td>657</td>
<td>23</td>
<td>54</td>
<td>123</td>
<td>198</td>
<td>11</td>
<td>182</td>
</tr>
</tbody>
</table>

It will be seen from Table I that the percentage of buildings bears no relation to the percentage of mosquitoes in any one area. We find also that the insects were most numerous in Stonar Camp, occurring in decreasing numbers in Kitchener, Cowan, Construction, and Haig Camps, in the order given.

These facts may be explained by the existence of certain shelter and of water close to the camp. With the exception of Stonar, where many trees and bushes were distributed, the camps were in open country.

The proximity of numerous dykes was a feature of Stonar, Kitchener, and Construction Camps, and to a less extent of the other two where filling-in had been done. The entire area, with its eighteen miles of dykes, had received an equal share of treatment in each section, on the approved antimalaria lines, and we must look to the existence of water in conjunction with bushes and trees, and to the prevailing winds, to explain the distribution of the insects.

Stonar Camp or Depot, which was always most infected, lies to the south near Sandwich. It is bisected by a road running west to east, with the southern portion thus cut off, constituting the most infected part in any of the five camps. This section is nearest the meadows and numerous dykes. The many trees and bushes give shelter from the prevailing winds. Stonar Camp is bounded on the east by the River Stour, on the north by a large artificial lake, and on the west by the main Sandwich to Ramsgate road. [We were struck by the fact that in the southern and more heavily-infected zone, one of the antimalaria screened huts had been placed.]

Kitchener Camp represented the largest area of hutments. It was bounded on the west by meadows traversed by numerous dykes, and was exposed to all winds.

Cowan Camp was adjacent to Kitchener Camp on the north, and exposed to all winds. There were fewer dykes here.
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Construction Camp was adjacent to Cowan Camp on the north, and exposed to all winds. There were more dykes in this area than in Cowan Camp.

Haig Camp was adjacent to Stonar Camp on the north, and was bounded by the lake on the east. There were few dykes here.

The lake was not a breeding place in 1918. It harboured no weed and was exposed, being frequently much agitated by the wind. It was also probably too deep to permit of larvae developing properly under these conditions.

It was not found practicable to make a daily inspection in each of the five camps. The days spent in Kitchener Camp numbered 13, in Stonar Camp 11, in Haig Camp 7, in Construction Camp 6 and in Cowan Camp 5. The time spent in each area was therefore in some proportion to the number of buildings contained in it. The buildings inspected included living huts, store huts, Y.M.C.A. huts, canteens, bath houses and latrines.

Every female specimen taken in the camps was examined for signs of having fed, but in only one instance was this observed. A specimen of *Theobaldia annulata* was taken in a living hut on the morning of December 4, fully distended with blood. Many specimens of *Culex pipiens* were quite plump in the body and the gut contents were yellowish. No male of this species was found during December, and neither is there any record of a male *Anopheles* at this time.

The small number of *Anopheles* captured points to the success attending the treatment of the dykes during the spring and summer of 1918.

3.—The Occurrence of Mosquitoes in Conjunction with Meteorological Factors.

The occurrence of mosquitoes on each day of the month, in conjunction with meteorological factors, is shown on the accompanying chart. The chart indicates a certain increase in catches at the periods of marked rises in temperature.

The meteorological records were taken in a Stevenson screen, kindly lent by Dr. J. J. Day, O.B.E., of Sandwich. Observations were made at 8 a.m. daily.

4.—The Occurrence of Anopheles in Sandwich.

An inspection was made of the principal stables and cowsheds in the town of Sandwich, nineteen in all. *A. maculipennis* was sparsely distributed in the town itself. The most notorious habitat, a certain cowshed, was found to be the resort of but a few. This cowshed was reported to be greatly infested in September, 1917, and to a less extent in February and April, 1918. It was visited by us on January 5, 1919.

Large and airy stables were freer from *Anopheles* than smaller and warmer ones. Where lofts existed above the stables it was there that most individuals were found.

A farm on the Sandwich Bay road, known as Hooker's Farm, was found to be the resort of large numbers of *A. maculipennis*. They congregated in a small and warm stable where two horses were usually kept. The mosquitoes clung to the cobwebs which covered the rafters. A few *C. pipiens* and *T. annulata* were also found in this stable. A certain number of the *Anopheles* were found to have fed, about eighteen per cent of those captured on each occasion.

In the town only one recently-fed anopheles was taken during the search. It
cannot be said with any certainty that these mosquitoes were hibernating. Hibernation may occur when the conditions are cool enough and in the absence of suitable hosts.

**Record of the Occurrence of Mosquitoes in the Military Area of Sandwich During December, 1918.**

| Day of Month | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| No. of Buildings inspected | 25 | 30 | 42 | 45 | 24 | 24 | 0 | 51 | 41 | 23 | 34 | 41 | 41 | 26 | 77 | 77 | 16 | 8 | 15 | 17 | 23 | 20 | 15 | 24 |

Anopheles maculipennis
Theobaldia annulata
Culex pipiens

5.—The occurrence of the Larvae of Anopheles and Culicines from October to January.

The larvae of *A. maculipennis* and *bifurcatus* were to be found during October in Hooker’s Dyke on the Sandwich Bay road about half a mile from the town. Larvae taken later could not be brought to the adult stage, and it was not possible to differentiate the two species among those collected from November to January.

October 14.—Larvae very common in the dyke.

October 18.—Larvae scarcer, perhaps owing to the area having been cleared of weed, and the pipe connected with an adjacent dyke cleaned out. Larvae and pupae were found along the margin on the side bordered by a hedge.

October 22.—No larvae were found in the dyke. A search was made in a lane near by. The ditch on each side was choked with sedge and reed, but was found
to harbour many larvæ of Anopheles, especially on the east side. A larva taken this day pupated on November 13, and emerged as a female *A. maculipennis* on November 24.

November 26.—About 100 anopheline larvæ were obtained in the lane. They appeared to be in the second and third instars, but some of the former had hardly developed since the first ecdysis. Some in the third instar were well developed and near the period of ecdysis.

January 14.—Larvæ scarcer in the lane. Those obtained were found near the bank. Some mud from the bottom was examined with negative results. The bottom was well stirred up but no more larvæ were to be found.

No anopheline larvæ were found in the military area during the period. The nearest habitat was a dyke about half a mile west of Kitchener Camp, beyond what is known as the Monk’s Wall. One female of *A. bifurcatus* emerged from larvæ obtained here on October 23. The only culicines noticed were *T. annulata* and *O. pipiens*. Larvæ of both were found in the above dyke on October 23. A second visit paid here on November 23 was unproductive, the only find being one dead pupa of *C. pipiens*. At the northern end of the area was a small ditch running behind the “Red Lion” public house. Larvæ and pupæ of *Theobaldia* and of *C. pipiens* were common here on October 30.

6.—**HIBERNATION OF LARVÆ.**

Anopheine larvæ, presumably of *bifurcatus*, were found in January. Larvæ taken in October and November, and kept in jars in the laboratory, did not appear to undergo any development. During December and January not more than three cast skins were found.

The larvæ were kept in dyke water in jars on a window shelf. They were constantly feeding, and under the microscope defaecation was observed. All these larvæ, however, differed from those in active growth by the absence of food in the thoracic ceca. It seems that food is taken in and passed directly to the gut where it is probably digested very slowly.

A larva placed in tap water on December 11 remained active, and was transferred to distilled water on January 16. It lived until January 31, and the gut contents showed no apparent sign of diminution at the close. The gut contents was probably food debris. The tap-water used was the ordinary camp supply, and was very hard in character.

The larvæ were seen to be in a state of true hibernation, and we obtained no evidence that they remained on the bottom or entered the mud. Perhaps with a prolonged period of severe weather hibernation may take place.

7.—**RESISTANCE OF LARVÆ AND ADULTS TO FROST.**

During February some low temperatures were recorded, with as much as twelve degrees of frost in the screen. The jars containing larvæ in the laboratory were frozen on four nights. Ice formed around and above, a certain amount of water being left in the centre where the larvæ could be seen moving about. Some were caught on the surface and frozen in the ice; these did not always survive. Altogether very few larvæ died.

The jars buried in the ground outside were of course frozen more solidly, and had cracked. The smaller jar had lost most of its water, which had escaped
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through a fracture of the glass, a layer of ice at the top alone remaining. The bottom of this came off and the mud was washed from it under the tap; three larvae were recovered and found to be alive.

The cage in the laboratory containing about sixty adult Anopheles was exposed to the severe cold at night, but no more than a dozen deaths were recorded. During the day these insects were exposed to a warm atmosphere owing to the stove being used.

The lowest temperatures recorded were on February 11, 20° F.; 12th, 19° F.; 5th, 23° F.; 9th, 24° F.; 10th, 28° F. I take this opportunity of recording the following from the laboratory notebook. This note was made by Serjt. Hill, of the Sanitary Section, Richborough, on December 29, 1917:

"A mosquito pupa and one larva taken from the dyke at the roadside near "Red Lion" on November 30, 1917, had lived through several hard frosts with water in a sample bottle frozen over. They showed no inclination to bury themselves in the mud, but were very sluggish in movement, and had not changed their stage on December 29, 1917 (twenty-nine days). Frozen solid January 10-11, 1918. Dead after thaw."

8.-HIBERNATION OF ADULTS.

We could obtain no conclusive evidence that A. maculipennis hibernated during the winter in the adult stage. It is possible that individuals may hibernate where the shelter is cold and no opportunity for feeding can occur. Specimens taken from stables in Sandwich town were quite active, and in one case an individual had recently fed. Those inhabiting the stable at Hooker's Farm were certainly not hibernating. An experiment was tried here with a view to ascertaining for how long the insects would go without food.

One hundred and fifty A. maculipennis (females) were collected in the stable and placed in a Lepidoptera breeding-cage on a shelf in the stable. On December 13, fifty females were taken and transferred to the cage. Of these eighteen per cent had fed recently, and most of the others showed signs of having fed a day or two before.

On December 14 fifty more females were added to the cage. Of these twenty per cent had fed recently. On December 18 fifty more females were added. Of these twenty per cent had fed recently and eighteen per cent some time previously. In these latter specimens the abdomen appeared to be distended with partly digested blood, which was not bright red as in the more recently fed individuals. We note, therefore, that only thirty-eight per cent had fed during the preceding forty-eight hours or so. Where the abdomen was but slightly distended the lateral sclerites were clear and showed no dark coloration within. Others, which apparently had not fed for a long time, showed no sign of abdominal distension, the abdomen in these individuals being no larger than in newly-hatched specimens.

No deaths were observed among the 100 individuals taken on the 13th and 14th.

January 13.—The cage was found to contain dead specimens to the number of 118, which left thirty-two living. Out of the total number of 150 there were twenty-nine which, at the time of capture, had fed recently. We may, perhaps, conclude that these were to be numbered among the survivors. It is probable that a recently-fed mosquito would survive longer than one which had not fed for some time, but this may still require confirmation by experiment. Most of
these individuals were probably fertilized, as was the case with some I dissected, and in this event a continuous supply of food would tend to more early development of eggs (and a vitalizing of the organism, rendering it less able to withstand hunger).

On December 13 thirty-six Anopheles were taken in the stable and seven of these had fed recently.

Some cold weather was experienced at the latter part of December and beginning of January, the lowest recorded minimum being 27° F. on December 25. Specimens kept in the laboratory cage during this time remained alive, though the room must have been very cold at night. Honey and water were supplied to these but very rarely were any observed to feed.

We had no further opportunity of repeating the hibernation experiment, as more cages were necessary for a proper test under different conditions, and these cages were not forthcoming.

9.—The Clypeal Hairs of Anopheles Larvae.

Grassi was the first to study the clypeal hairs and to point out that they were of specific importance in some species. He was able to identify the larvae of A. maculipennis and bifurcatus by the differences in structure presented by their clypeal hairs. Very few observations have been made by later workers, and apparently it is still uncertain whether the larva of the two species above noted can be distinguished in every stage by the clypeal hairs. It seems also uncertain whether all A. maculipennis larvae in the fourth instar always have the outer pair of hairs dendroid, and whether in A. bifurcatus the hairs are always unbranched.

With the object of throwing some further light on this question, I made an examination of about 200 larva. All these would be probably bifurcatus according to present knowledge, as they were obtained between the end of September, 1918, and middle of January, 1919.

None of these larva presented typical dendroid hairs such as were observed in mounted specimens of A. maculipennis obtained in August. Whilst perhaps not more than fifty per cent of the larva had simple hairs, the remainder exhibited much variation in branching.

The following variations were to be distinguished:—

(A) Larva taken at Hooker's Dyke, half a mile from Sandwich, on the Sandwich Bay Road.

1. All simple.
2. All branched.
3. Lateral pair 2-branched, middle pair simple.
4. Left lateral hair 2-branched, others simple.
5. Left lateral hair 3-branched, others simple.
6. Right lateral hair 2-branched, others simple.
7. Right lateral hair 3-branched, others simple.
8. Right lateral hair 4-branched, right lateral 2-branched, middle pair simple.
9. Right lateral hair 3-branched, left lateral forked at tip, middle pair simple.
10. Right middle hair 2-branched, others simple.
11. Middle pair branched, lateral pair simple.
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(12) Right middle hair 3-branched, others simple.
(13) Middle pair 3-branched, lateral pair absent.
(14) Left lateral and middle pair 2-branched, other simple.
(15) Right lateral and middle pair 2-branched, other simple.
(16) Left lateral and left middle 3-branched, right lateral simple, right middle 2-branched.
(17) Left lateral simple, others 2-branched.
(18) Right lateral simple, others branched.
(19) Lateral hairs 2-branched, middle pair 3-branched.
(20) Left lateral 3-branched, right 4-branched, left middle 2-branched, right simple.
(21) Left lateral 2-branched, right 3-branched, left middle 3-branched, right simple.
(22) Left lateral 2-branched, right 3-branched, left middle 2-branched, right simple.
(23) Left lateral 3-branched, right 2-branched, right middle 4-branched, left simple.
(24) Lateral hairs 3-branched, right middle 4-branched, left middle 5-branched.
(25) Right middle hair simple, others 2-branched.
(26) Left middle hair 2-branched, others 3-branched.
(27) Right lateral absent, others simple (one specimen).
(28) Left lateral absent, others simple (one specimen).
(29) Middle pair absent, right lateral 3-branched, left 2-branched (one specimen).

(B) Larvae taken at Sheppey.

(30) Laterals and right middle 2-branched, others simple.
(31) Left lateral 3-branched, right simple, middle pair forked at tip.
(32) Left lateral forked at tip, left middle 2-branched, others simple.
(33) Left middle 2-branched, others simple. Also variations 1, 2, 4, 6, 8, and 10.

The two posterior clypeal hairs were observed in a number of cases. These were found to be mostly 2-branched, but were frequently 3-branched.

10.—Feeding Experiments with Anopheles maculipennis.

A large cage in the laboratory contained numerous females captured on November 25 and 27. These were supplied with honey and water.

(1) December 6.—Arm inserted for ten or fifteen minutes. None settled.
(2) December 10.—Cage containing forty-seven insects. Arm inserted for ten minutes in morning. None settled. At 4 p.m. the insects became lively and the arm was inserted for twenty minutes. Three bites were recorded but only two took their fill.
(3) December 11.—Would not feed.
(4) December 12.—Would not feed.
(5) December 13.—One fed.
(6) December 17.—Fifty-four females in the cage. Would not feed.
(7) January 3.—Arm exposed for five minutes. Five individuals settled on it at different times; one bit on hand but did not take a full meal; the others settled on arm and made unsuccessful attempts to suck and then flew off.
The failure of these trials was probably due to the absence of the necessary warmth and humidity.

11.—LATEST RECORDS OF ADULTS AND LARVAE.

Anopheles maculipennis.—Larva: October 22, pupated November 13; Male: October 10, 1917; Female: Throughout the winter.

Anopheles bifurcatus.—Larva: Throughout the winter; Pupa: October 23; Adults: None seen between October and January.

Theobaldia annulata.—Larva: October 23, pupated November 13; Adults, male and female: Through the winter.

Culex pipiens.—Pupation: November 20; Male: November 11, 1917; Female: Through the winter.

12.—NOTE ON EARLY EGG DEVELOPMENT IN Theobaldia annulata.

A female of this species was taken in Hooker’s stable on December 18. It was dissected by me and found to have developed an egg mass. The eggs were white and opaque. Examined with 1-inch objective, an oval and densely granular mass was seen surrounded by a thin transparent envelope externally thickened. At the micropylar end was a transparent area containing numbers of globules. The gut contained a small quantity of digested blood.

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Lecture.

PHYSICAL TRAINING.

By E. P. CATHCART, M.D., D.Sc., F.R.S.

Advisor in Physiology, Army Hygiene Advisory Committee.

If the phrase “survival of the fittest” be applicable in a wide and general fashion, it might with all propriety be applied to the subject of physical training. Surely no subject has suffered so severely at the hands of its devotees. Its survival of its many ordeals speaks volumes for the fundamental truths and values it represents.

As a recognized item in the development of the people, in this country at least, it has spent a most unhappy and precarious childhood, the beloved child of the fanatic, the toy of the up-to-date educationist and the sport of the charlatan. The ideas or doctrines which have been held at one time or the other about it have been many and varied, and speaking generally, the main aspect—the physiological one—has been badly treated. Physiology has been Cinderella in the pre-princess period and the violation of physiological principles apparently the main object of those who had to deal with the subject.

It is a sad history but the truth is now dawning upon those in high places. The Army Gymnastic Staff have played a very important and very enlightened part in the later development and, in my opinion, have evolved a system which, for soundness and efficiency, would be difficult to beat. The reading of the various manuals issued by them and the practical work I had the good fortune to see and study closely in the various training camps during the last two years of the war.