

THE GEOGRAPHICAL DISTRIBUTION OF ANOPHELES AND MALARIAL FEVER IN UPPER PALESTINE.

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Late of Acca, Palestine.

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THE observations here recorded were made, for the most part, during a journey through Upper Palestine and Lower Syria, in June and July, 1901. The country traversed is indicated upon the accompanying map. Its character is so well known as not to need detailed description, being for the most part very hilly and rocky or level plain.

The chief rainfall occurs from November to April; December, January, and February being the wettest months. The annual rainfall amounts to between 20 and 30 inches, being heaviest on the coast. From May to November the weather is dry and fine, rain very seldom falling; when it does, however, its rapid absorption by the parched ground precludes the formation of pools.

Malarial fevers are most prevalent from June to November, reaching their maximum in October.

Last year (1900) during June and July, though constantly on the look-out for mosquitoes of all kinds, I failed to come across *Anopheles* at any place visited, except at Shibáh, high up (at least 5000 ft.) on the western slopes of Hermon. This was no doubt due to our avoidance of places where we ran risk of malarial infection: our only visits to marshy spots being made in the daytime. We then ascertained that at many of the most elevated villages malaria is almost, if not quite, unknown, and we were hardly ever asked for quinine. In view of this fact we informed ourselves among persons who knew the country well, regarding the most malarious localities. These naturally were for the greater part low-lying or marshy, but one of the most

malarious villages visited, viz. Baniás (Cæsarea Philippi), is over 1000 ft. above sea-level, and *Anopheles* was found at Shibáh, quoted above, where the springs of water are icy cold, and the nights often of the same character, even in midsummer.

I have assumed no place to be malarious without either the opinion of the medical men of the place, or evidence obtained on the spot, chiefly in the direction of enlarged spleens. Without this precaution one can easily be deceived as to the character of many places.

Whilst travelling a month in malarious localities I used a tent for protection during the day, sleeping always at night in the open with no other protection than that afforded by mosquito netting. I might add that in order the better to convince those living in the country, of the part which it does *not* play in the etiology of malaria, I drank the water at every place visited where there seemed to be no danger of contamination from surface drainage. My attendants were a cook and a man to look after the horses, both of whom after a little grumbling consented to sleep under mosquito netting. None of us took quinine and we have all escaped malarial infection. A small shallow net of muslin stretched on a wire ring which could be mounted on a stick was used for catching *Anopheles* larvae. The imagines were as a rule caught in thick test-tubes, which I found most convenient: four or five specimens can be secured in each by inserting a small ball of paper after each insect is caught. Three or four tubes thus suffice for 15 to 20 mosquitoes, and the tubes can easily be carried in a box in the pocket. Imagines were rarely caught by means of a net, the latter being found to be clumsy and far less efficient. A torn net hung up loosely at night proved to be a most effective trap, and mosquitoes thus caught were in excellent condition. We thus, on one occasion, caught over 230 imagines in a single night. Test-tubes also served as receptacles for larvae, which like the imagines were quickly killed when carried in larger glass jars: especially was this the case when driving in a carriage over rough roads.

Specimens of *Culicidae* from each locality were secured and pinned in the usual way, and have since my return been examined very kindly at the British Museum by Mr F. V. Theobald, who considers two of the *Culices* to be hitherto undescribed. I have also to acknowledge the help given me by Lieut.-Col. Giles, I.M.S., in my entomological outfit.

I should here like to call attention to an excellent substitute for fine entomological pins, should these run short, in the shape of the spines of the *Centaurea calcitrapa*, var. *pallescens*, the thistle-like weed

found so abundantly in hot countries. Specimens mounted on these have travelled as well as those on pins, and are of course not liable to verdigris.

The accompanying map shews the route traversed, the more distinctly malarial foci being shaded. The large black dots indicate the presence of *Anopheles*, mostly *A. maculipennis* Meigen or *A. superpictus* Grassi: the former most common as imagines in houses, the latter as larvae: so much was this the case that almost all the mosquitoes hatched from larvae proved to be of this latter species.

Four species of *Anopheles* in all have been identified by Mr Theobald, *A. annularis*, sub-species *pseudopictus* Grassi so common in Italy, being enormously abundant in the papyrus marshes of the Upper Jordan valley, but not at any great distance from the marsh proper. The three species above mentioned are for the most part European, but an African species described by Mr Theobald as *A. pharoensis* (first found at Zomba in East Africa, near the Zambesi) proved to be the most interesting of all. Only five specimens of a variety of this very distinct and well-marked species were caught by us in Palestine.

I quite failed to find *Anopheles* at several points where malaria occurs sporadically, *i.e.* at Sidon and Acca and some villages on the edge of the plain, situated but slightly above sea-level. Near all of these places intensely malarial foci exist where *Anopheles* is easily found.

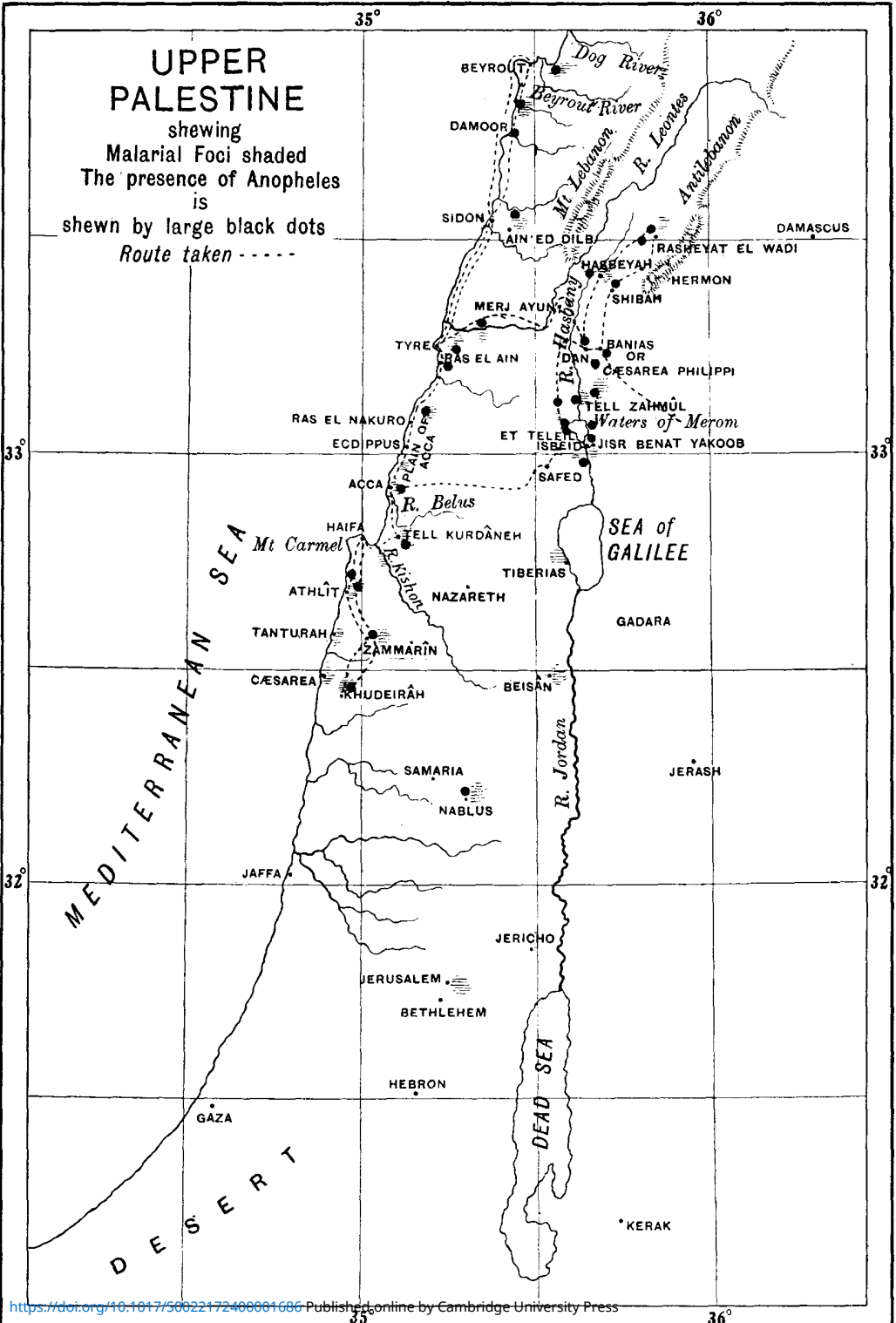
A few details regarding the places marked on the map will illustrate what I have said above: these being considered in the order in which they were visited.

Beyrout. This is for the most part healthy, being well drained and hilly, the soil dry and sandy. *A. superpictus* larvae were abundant on June 9th in a runnel of water containing *Spirogyra*, near the Beyrout river, though the latter was free from larvae. This was at the end of a fruitless search of some hours in company with Prof. E. Day of the American College in Beyrout, whose help I gladly here acknowledge. The unhealthiness of this district is indicated by the name Nahr el Môt, or River of Death, given to a stream not far distant. We had not time to examine other similar places nearer the Dog River. None of the open stone cisterns used for irrigation contained other than *Culex* larvae.

Damoor. Passing down the coast *Anopheles* larvae were found (in July) at the mouths of the rivers Nahr el Aweli and Nahr Damoor, in sandy channels, within reach of the waves at any rate in winter. These

UPPER PALESTINE

shewing
Malarial Foci shaded
The presence of Anopheles
is
shewn by large black dots
Route taken -----



channels contained *Spirogyra*, as in every other locality where *Anopheles* was observed.

Sidon. Here I failed to find *Anopheles* in the town, but *Culex pipiens* and *C. fasciatus* were, as everywhere on the coast, abundant. At Ain ed Dilb, a narrow valley or *wadi* in the chalk, I found *A. superpictus* larvae in great plenty, the imagines being caught on rocks on the edge of the stream at sunset. On our return, six weeks later, *A. superpictus* was still more abundant, being found together with *C. mimeticus*, which mimics this fly in its markings.

An outbreak of fever occurred amongst the workmen employed last year in building an American Orphanage near Ain ed Dilb, and malaria occurs yearly in the two villages a quarter of a mile up the hill, which obtain their water entirely from this "Ain" or spring: the turning up of the soil was of course blamed for the outbreak.

I shall shew elsewhere that, in all probability, the larvae and pupae of *Anopheles* have been taken into the houses with drinking water in many cases. They may thus become disseminated and give rise to malaria at points situated a mile or two from their breeding-places. I have not as yet seen this possible mode of dissemination of *Anopheles* referred to.

Tyre. The town itself is practically free from fever, though there are several places a few miles away where infection only too easily occurs. At the mouth of the river Leontes or Kasmiyeh, early in June, I found several boys with fever and enlarged spleens, and on my return on August 3rd the number was still larger, though the population here is very small. Time did not allow of adequate search being made here, but *Anopheles* larvae were found further up the river the day before.

It was at Ras el Ain, four miles south of Tyre, however, that I found the largest percentage of infection. Here amongst 19 children of 12 years and under, I found the spleen markedly enlarged in every case, though two of the children were only 5 and 7 months old respectively. The average enlargement of the spleen in 9 children of 6 years and under was 10 cm. below the ribs; of 10 children over 6 and under 12 years, somewhat less, viz. 9.2 cm., and two of the former were, as I have said, only 5 and 7 months old at the time of our visit in August.

This bears out the observations made in Africa by Christophers and Stevens¹ as to the relative frequency of infection in children, though they enjoy no immunity from fever, from which I have known them die.

¹ *Reports to Malaria Committee of the Royal Society*, 3rd series, 1900.

Any case of doubtful enlargement was excluded as not evidently malarial. I used the enlargement of the spleen as the most reliable test of the relative unhealthiness of any given place. It was rarely found possible to obtain blood-films from children, not ill at the time, owing to the objections of their parents.

A. maculipennis (3 specimens) was found in a native reed hut at Ras el Ain, from which two malarial patients came, and their breeding-place was probably not far distant in marshy pools, formed amongst the sand, as the water of the Ras el Ain runs to the sea.

Several young men from this place were evidently suffering from malarial anaemia, and a few of the older people who came round had splenic enlargement or were as the Arabs say "*mathooleen*" or "*spleened*." A few of the boys in the crowd were found to have no evidence of malaria, but on enquiry these in every case came from Tyre or villages on the hills.

Plain of Acca. Near the Ras en Nakûra, a native house furnished *Anopheles maculipennis* abundantly (20 or 30) with a few *A. superpictus*, and in the green slimy ditch outside the corresponding larvae were found at once by Dr Gould of Acca, who had come to meet me. On a subsequent occasion the other houses were all found to contain *Anopheles*. The guard of soldiers placed here is changed every month, for as they explained everyone gets fever after 10 days. Time did not allow of the examination of many villages of this district known to be malarious, but in the houses situated in gardens on the banks of the river Belus imagines of *A. maculipennis* were found 10 to 30 in a room, hanging as is frequently the case from cobwebs, with which the ceilings are freely adorned. The only cases of enlarged spleen which, during four or five years' work in Acca, came from the neighbourhood of the town, were from this spot or from similar gardens called El Bahjeh.

Near here there is much uncultivated ground and six of the houses are deserted because the "air is bad." The man in charge of the flour-mill protects himself by lighting a nightly bonfire before retiring to rest; the blackened beams and his bleared eyes bear eloquent testimony to the fact, but otherwise he seemed healthy enough.

At Tell Kurdaneh, near the source of the river Belus, *A. maculipennis* was most abundant in the living-room of the mill, probably an old Crusading fort—the miller, a former patient of mine there, is apparently outgrowing his fever, his spleen being however still very large.

Haifa. This place like the town of Acca is mostly free from malaria, nor could I detect *Anopheles*, but time did not allow of an

examination of the banks of the Kishon to the east, from near which most of the cases come.

Athlit. By the kindness of Dr Coles of the English Hospital at Haifa, I was enabled to drive down the coast. At Athlit, from which place many malarial patients come to Haifa, after a long search I found one *Anopheles* but no other *Culicidae*. The only person who applied to me for medicine was a woman whose spleen was enormously enlarged. The marshes near this wretched village, built amongst the ruins of the Crusading Castellum Peregrinorum, are now almost dried up.

Zammarin. Though on an elevated site malaria is endemic here, and in the water trickling from the well on the road-side below the colony two *Anopheles* larvae were found. The water supply of this Jewish colony (founded by Baron Rothschild) is excellent, being pumped up by steam from deep wells.

Khūdeirah. On June 29th driving on from Zammarin along the Jaffa road, in two hours we came to springs of water flowing slowly through marshy ground past Khūdeirah towards the sea—the colony lying on a sandy hill to the south-west. Two million *Eucalyptus* trees have been planted here. In puddles formed by feet of buffaloes in the black mud larvae of *A. maculipennis* were found abundantly, amongst *Spirogyra* and *Lemna*. Further on I found more larvae, and on reaching the colony *A. maculipennis* was found hanging from the roof of the very shed used for potting the young *Eucalyptus* trees raised from seed. They were also found in a stable close by.

Even before reaching the deep (50—70 ft.) well in the centre of the colony we could see that the houses are built far apart (50—100 yds.), the ground being planted with rows of *Eucalyptus*, twelve deep, now of large size, *i.e.* fully grown.

The soil here is very dry, red and sandy, and the nearest marshes are from $\frac{1}{4}$ to $\frac{1}{2}$ a mile distant. The colony is half deserted, malaria is rife, and blackwater fever occurs here yearly, and is said to have caused the death of 150 Jews in the last 20 years.

In my opinion, it is plain that the *Eucalyptus* trees have not done the slightest good, and perhaps only harm. Had half the money spent on planting these been used in carrying out hydraulic works the place could not fail to be much healthier. The natives suffer much less from malaria than the Jews, and hardly at all from blackwater fever. I could not hear of any cases of this disease when we were there, but in

some years 15 to 20 cases have occurred in a very limited population, chiefly Jews emigrated from Europe.

The colony of Tantura on the coast is now deserted on account of the severe malaria and blackwater fever, of the occurrence of which I obtained good proof from Dr Weiss, now of the colony at Zammarîn, and from Dr Kaufmann, formerly of Haifa, who also treated cases of the disease.

From Acca I proceeded to Safed, and thence to Isbeid, another Jewish colony, which was described as the most unhealthy place in the district. Isbeid (or Issôd) lies practically at sea-level and has a mixed population of Jews (in the colony), Fellaheen natives and emigrants from the village of El Khiam, Bedaween (several tribes), encamped on the plain on either side of the colony, and Moorish Arabs from Tunis, living in huts of reeds or papyrus matting. The Jewish colony has been founded about 20 years, and during the whole of this time malarial fevers have proved a great scourge: blackwater fever also occurring commonly in some seasons. In one year there were 19 cases in six weeks: its incidence is chiefly from October to January. Last year there were only four cases. Most of these facts I obtained from Dr Weiss. At the present time the dispenser affords medical advice, and in his opinion 90 % of the population have enlarged spleens. I was unable to take a census of the population.

Here the breeding-ground of *Anopheles* larvae was, in summer at any rate, entirely in the water oozing out of the pebbly beach of the lake, above its present level. The lowness of this is partly caused by the light rains of last winter, but more especially by the lowering of the bed of the Jordan at the end of the lake by the Sultan, to whom most of the land near here belongs. Further measures for deepening and widening the bed of the river are shortly to be undertaken, which will in time bring large tracts of land under cultivation, but at the same time certainly result in fresh breeding-places for *Anopheles* larvae. Near the native village of Et Teleil is a piece of typically marshy ground covered with water in the winter, but the oozing margin of the lake is the source of *Anopheles*, for the colony itself is quite dry all summer.

Our tent was pitched for 12 days under the *Eucalyptus* trees, *E. rostrata* and *resinifera*, the climate being unsuitable for *E. globulus*. Mosquitoes, almost entirely *A. maculipennis* and *A. superpictus* with very few *Culex*, were common, and could nearly always be found in our tent, the dark navy blue lining of which formed a shelter, as did the

dry herbage under the *Eucalyptus*, where they were always to be found.

Until this year quinine has been given free to the colonists: now it is sold at cost price, under the new management by the Trustees of Baron Hirsch.

If ever quinine has had a good trial amongst a far from savage people, it is here, and I was informed by Dr Weiss of the incredible doses of quinine formerly given to patients ill of blackwater fever: 20 grammes in a single day in one case, in another 12 grammes a day for a week, and with subsequent recovery. Pernicious attacks are frequent, and the parasite most commonly found by me was of the aestivo-autumnal type.

At various places round the lake-side and along the course of the river, such as the Jisr Benât Yakoob *A. maculipennis* and *superpictus* were abundant, *A. pharoensis* being present but in small numbers.

Banias. Of 36 children examined at this place 86 % had enlarged spleens, a higher percentage than at Isbeid, and here as there malarial cachexia with splenic enlargement is by no means infrequent in grown-up people. *A. superpictus* larvae were found in semi-stagnant pools in the rocky river bed, and imagines of both species were found in the houses and in our tent. As at Isbeid the malignant form of the parasite was common, and crescents were found in two cases, but not in large numbers. The Bedaween tents in the valley contained as many mosquitoes as the native houses: 15 *A. maculipennis* being caught in one tent. The tribes who live permanently in the valley of course suffer much less than those only recently arrived.

From Banias we made a short journey to Shibâh, which lies over 5000 ft. above the sea. Here, as also last year, I found *A. maculipennis*, though the nights are far from warm. For the most part the population of this village is very healthy, but we saw two cases of cachexia, probably of malarial origin.

Rasheyat-el-Wady. This place, about 4000 ft. above sea level, is usually free from malaria, but from time to time it has been visited by extremely severe epidemics of ague. The last outbreak occurred 9 or 10 years ago, and in it eleven people are said to have died in one day. Making full allowance for exaggeration, there is no doubt that a severe epidemic of malaria occurred, the nature of the disease being well known to every native.

After long search one of the springs of water below the town was found to contain *Anopheles* larvae and *Spirogyra*. The other collections

of water, mostly of rain-water, only contained *Culex*. The spring in question, named the 'Ain en Nijmi, is used for drinking when the larger public well has run dry, which happens every autumn, and one can easily understand how larvae and pupae may be carried in jars of drinking water to every house in the town. In dry seasons the water has often to be brought from much greater distances on the heads of women. It seems to me that not much credence need be placed in the assertion that a marsh in the valley nearly two miles away which is flooded every winter is the cause of fever. I found *Anopheles* larvae also in two springs on the side of the road leading to Hasbeyah, where too in the pools of the Hasbâny river *Anopheles* larvae occurred in plenty. In the town we had not time for a thorough examination of likely places. An English lady in charge of the British Syrian schools was suffering from malaria at the time of our visit.

From Baniyas we also made an excursion into the papyrus marshes of the Huleh¹ Valley, three or four hours distant. Our camping place for the night was probably two miles distant from any human habitation, and here we found that the sole species of *Anopheles* was *A. annularis*, subsp. *pseudopictus* Grassi. Other species of *Anopheles* were conspicuous by their absence. A species of *Culex*, *Toeniorrhynchus richardii*, was also found, but of 230 Culicidae caught, over 80% proved to be *Anopheles*.

Owing to the trouble given by an unruly horse all three of us were bitten severely during the night by hundreds of *A. pseudopictus*, and on two other occasions one or both of us were bitten freely in similar places in or near the marsh: none of us have since suffered from ague. I might add here that we never observed *Anopheles* to bite during the daytime, when *Culex fasciatus* bit freely.

In conclusion I would cite the following observations made by others:—

Dr Gould found *Anopheles* larvae in a cistern in a garden at Nablus in June 1901. Dr Masterman writes to me from Jerusalem that tertian and quartan fevers are common there, and that in August these form $\frac{3}{4}$ of the patients treated by him, excluding ophthalmia. At Silwân (Siloam) malaria is rife, and almost all the children of the Yemen Jews there have enlarged spleens. Dr Masterman has not as yet searched for *Anopheles*.

¹ "El Hûleh" in Arabic means the terrible or frightful, probably with reference to its unhealthy character.

Conclusions.

The observations I have made in Palestine would appear to warrant the following conclusions :—

1. Malaria is rife in every place where *Anopheles* represents the majority of the mosquitoes present in native dwellings.
2. Malaria occurs mainly but not entirely amongst children, and these shew definite signs of infection in enlarged spleens and fever.
3. Malaria occurs sporadically or not at all in places where an unsuccessful search was made for *Anopheles*.
4. Blackwater fever only occurs in the most malarial districts and chiefly amongst Europeans, *i.e.* immigrant Jews.
5. Æstivo-autumnal fevers, shewn by the unpigmented ring forms, greatly predominate, though quartan, a few tertian, and mixed infection also occur.