STUDIES IN RELATION TO MALARIA.

I.

THE GEOGRAPHICAL DISTRIBUTION OF ANOPHELES IN RELATION TO THE FORMER DISTRIBUTION OF AGUE IN ENGLAND.

(Two Maps.)

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Grassi has repeatedly asserted that the geographical distribution of the genus *Anopheles* in Italy coincides with that of malaria. Even in his most recent publication he lays special stress upon the coincidence, and considers that what he claims will probably hold true all over the world.

Grassi (1900, p. 35) writes, "Confrontando i resultati, ottenuti nelle più differenti parti d'Italia, ho potuto facilmente rilevare che *nei luoghi malarici vi sono dei mosquitos particolari che mancano nei luoghi non malarici. La loro quantità è in complesso in proporzione diretta col numero dei casi di malaria.*"

"*Non trovai, per quanto io abbia accuratamente cercato, alcun luogo di pianura in Italia dove prosperino i mosquitos propri de' luoghi malarici e non si dia malaria.*" Another passage (p. 50) reads, "*Nei luoghi malarici vi sono veramente degli animali speciali succhiatori di sangue che non si trovano nei luoghi malarici*[1]." Still another passage reads (p. 51), "Tutto ciò che riferii per le regioni malariche d'Italia vale probabilmente per tutte le plaghe malariche del mondo[2]."

[1] The italics are Grassi's.

[2] See Bibliography at the end of the following paper by Nuttall and Shipley (p. 75).

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Basing his deductions upon this statement which he makes, as he says after careful investigation, he proceeds on the strength of their wider geographical distribution to exclude a number of blood-sucking animals: *Gnathobdellidae, Ixodinae, Argasinae, Muscinae, Tabanidae, Simulidae, Phlebotominae, Ceratopogonidae, Pulicidae, Pediculidae, Acanthiadae* and *Culicidae* (genus *Culex*) from being possible carriers of the parasites of malaria. He states that there are 23 species of *Culicidae* known in Italy, 19 of which belong to the genus *Culex*, and 4 to that of *Anopheles* (*A. pseudopictus*, Grassi 1899, *A. superpictus*, Grassi 1899, *A. claviger*, Fabr. 1805 vel *maculipennis*, and *A. bifurcatus*, L. 1758, the last-named species being identical according to Ficalbi and Grassi with *A. villosus* 1827, *A. plumbeus* 1828, and *A. nigripes* 1839)[1].

The statement of Grassi seemed to gain support from the observations of Macdonald (16 Sept. 1899) in southern Spain. He searched for *Anopheles* in 12 districts, 9 of which were malarious. In the 3 healthy districts he only found *Culex*, in all of the others he detected *Anopheles*. (*A. maculipennis* in all cases, *A. pictus* in three, and *A. bifurcatus* once.)

We do not doubt but that the *number* of *Anopheles* present in a district will be found to agree with the extent to which malaria prevails, but the investigations which we are about to report show very clearly that Grassi's claim has no general application, for we have found *Anopheles* in many parts of England where there is no record of malaria having previously existed, and where there is certainly no malaria to-day[2].

General observations upon the geographical distribution of Anopheles, and their mode of dissemination.

Members of the genus *Anopheles* are being found all over the world, and a number of observers are reporting their presence in malarious districts in various countries. In a monograph which will shortly appear from the pen of Mr F. V. Theobald some 42 species or more will be described. Confining ourselves to the three species which are known to occur in England we find that *Anopheles maculipennis* is by far the most prevalent species in this country and in other parts of Europe, and apparently in America. This species has been found in England, Scotland, Wales and Ireland, as will be seen by reference to the following

[1] See footnote [3] on p. 47.

[2] *Note whilst going through the press:* Celli (*Centralbl. f. Bakteriologie*, Vol. XXVIII. p. 534, 5 Nov.) reports observations in Italy which confirm ours. He found *Anopheles* in healthy and elevated situations where there has never been malaria.

tables. It has been found in Scandinavia (Zetterstedt), Germany (Meigen, Koch, and one of us), Austria (Schiner), Russia (Gimmerthal), Holland (van der Scheer), Denmark (Meinert), in many parts of Italy and the adjacent Islands (Ficalbi, Grassi, etc.), as also in the United States (Howard, etc.) and Canada. *Anopheles bifurcatus*, which is less numerous, has been found in Great Britain, Lapland (Zetterstedt), Russia and Italy (Ficalbi), though it will probably be found elsewhere when searched for. *Anopheles nigripes*, which is the least frequent of these species, is found in Great Britain and Italy, and will doubtless be also found elsewhere.

In referring to *A. maculipennis* Grassi (1900, p. 58) states that it may be considered almost a domestic species because of the fact that the imago is frequently found in houses, sheds, stables, and chicken-coops in Italy. This is especially the case in the cooler season, when the flies which seem to prefer the warmth of the house congregate there with a view to hibernating. When the weather grows cool in autumn the flies are also not infrequently found beneath bridges in northern Italy. In a letter to one of us (31 May, 1900) Theobald states that most of this species have been taken by him in England in outdoor closets and sheds, especially in spring, when the insects come from their winter quarters. We have on several occasions found the fly in houses, and thrice in an outdoor closet and cellar respectively in Cambridge during July, October and December. As the result of his experience in collecting *Anopheles* in Scotland and Herefordshire this last summer Lieut.-Colonel Yerbury, F.E.S. writes to one of us (Oct.) that "The natural home of *Anopheles* seems to be damp, swampy ground but not necessarily so wet as marsh or fen." According to Grassi and Ficalbi *A. maculipennis* occurs most frequently in flat land in Italy, the larvae generally requiring clear water rich in vegetable food. The imago feeds upon plant juices, as also upon the blood of man and the domesticated animals. Grassi (1900, p. 93) states that it is hard to catch *A. bifurcatus* and *A. superpictus* except when they are in the act of sucking blood. *A. pseudopictus*, which is found in Italy but not in the adjacent islands, is rarer than *A. bifurcatus*, and prefers the open country, especially land covered with rushes. This species is not encountered in houses and is difficult to catch except when biting. *A. superpictus* is found in houses etc. like *A. claviger*.

Other species of *Anopheles* have been observed to frequent dwellings. Christophers and Stephens (Aug. 1900, p. 6) found an undescribed species of *Anopheles* in huts in Sierra Leone, its numbers gradually

diminishing with the drying up of the adjacent pools, this dropping off in numbers being especially noticeable two weeks after the pools had dried. The flies exhibited a preference for dark, native huts. Stephens and Christophers (July, 1900, p. 56) found that these insects were apparently attracted by the odour emitted by the natives, for it was observed that when natives slept in a tent previously used by Europeans the insects congregated there. In a tent occupied by Europeans usually 2 *Anopheles* were found on inspection in the morning. On the first morning after this tent was occupied by natives 19 insects were captured, and on the second morning no less than 62. The number of *Anopheles* rapidly fell after the tent was disused by natives. Returning to Italy we find Grassi (31 Aug. 1899) reporting the following with regard to the influence of elevation upon the local distribution of *Anopheles*. He found fewer *Anopheles* in the upper stories of a house situated in a malarious district. (This summer one of us made a similar observation in a country house on the Rhine, the same being situated in a district where there had been no malaria for 23 years.) Grassi found *Anopheles* to be frequent in low-lying huts, whereas they were absent in neighbouring huts situated at an elevation but 2—3 meters higher than the others. He states that this distribution is less evident where the insects are numerous and hungry. The observation that persons living in the upper stories of a house are relatively exempt from malaria is an old one. Grassi (17 Sept. 1899) found *Anopheles* in houses at Sermoneta and Sezze, especially those situated in low ground and facing the Pontine Marshes. Sermoneta lies at an elevation of 257 meters and is supplied with *Anopheles* from pools below situated at an elevation of 16 meters. The *Anopheles* (imago) at Norma (343 meters) were bred at Ninfa (24 meters). Similarly at Sezze (319 meters) the flies were bred in marshy pools at Le Fontane (230 meters) and in other places below the town. Christophers and Stephens (Aug. 1900, p. 6) believe that the *Anopheles* observed in Sierra Leone may fly to a distance of a quarter of a mile or more. In Freetown they however found the flies scarce in dwellings situated at a distance of 100—200 yards from breeding-pools. They believe that in certain cases (p. 10) the insects must have flown a distance of 300—600 yards. During the dry season Stephens and Christophers (p. 48) found very few flies in houses, and could only determine their presence in Freetown by constructing artificial test pools in which eggs were promptly laid. In the bush along the Sierra Leone Railway (p. 51) the flies were found to congregate in native huts and villages, though

there were no breeding-places distant less than a quarter of a mile. *Anopheles* were also found in the bush (p. 53) during the dry season, breeding-places being situated at considerable distances.

In Nuttall's monograph (1899) reference is made to the probable influence of winds, railways and ships in the dissemination of mosquitoes. It is stated therein that Roe once observed about a dozen foreign species of mosquitoes on board a ship lying at quarantine in New York. The occurrence of *Anopheles* in railways has since been observed by Grassi in Italy, and Howard (1900, p. 15) dwells upon this mode of dissemination, stating that he knows of one instance in the Catskill Mountains in New York "where the infestation of a previously uninfested place could have been brought about in no other way." It is certain that trains passing through mosquito-infested districts will aid in the dissemination of these insects. Grassi (1900, p. 223) moreover relates how he caught some 200 *Anopheles* on the inside of a coach during a drive lasting two hours through the plains of Capaccio, many *Anopheles* resting within the vehicle and being thus transported. Referring to *Culicidae* in general, Howard (p. 13) cites Smith as stating that the flies would not rise and take flight when a stiff breeze is blowing, and that even a comparatively slight breeze will keep them from the upper stories of a house. On the other hand he writes that Fernald (at a meeting of the Am. Soc. of Economic Entomologists) describes an observation to the contrary. Fernald saw no mosquitoes at Cold Spring Harbour, Long Island, whilst a north breeze blew, whilst they appeared with a gentle south wind after it had blown five or more hours, which led him to conclude that the mosquitoes had been blown 15 miles from the south shore. That some species of *Culex* are limited in their power to disseminate themselves solely by their flight is indicated by an observation of Reese in Baltimore, who found that the number of mosquitoes in his house was greatly reduced after he had treated his privy vault with kerosene, breeding-places being situated close by. Moreover Osborn noted at Ames Harbour that mosquitoes disappeared from the College buildings when small pools within a radius of one quarter to half a mile became dried. In the latter case there were pools at about a distance of a mile which did not cease to be breeding-places. It is evident from this brief summary of what has been observed that it will be necessary to make more exact studies of the methods of dissemination of these insects. What applies to one species may not apply to another. There is one mode of distribution which one of us thinks of considerable importance,

though it does not seem to have struck others. We refer to the dissemination along the course of rivers down which eggs, larvae, and pupae, may be carried, as we shall see from the following tables. If present at the head waters of a stream the insects certainly are carried even down to the estuary, coming to maturity all along the course of the river wherever there is a backwater, a recess in the bank containing still water and frequently accumulation of weed, or wherever the river water overflows into neighbouring ditches.

It seems in place here to mention the little that is noted in the literature with regard to the numbers of *Anopheles* observed to be present in various localities. Here again we shall see that rough numerical estimates would be of value. We have noted above that Grassi caught no less than 200 *Anopheles* inside a coach during a drive lasting two hours, the road leading through a malarious region in Italy. An editorial in the *British Medical Journal* (27 Oct., 1900, p. 1266) states that Sambon counted as many as 20 *Anopheles* larvae in 1 c.c. of water taken from a pool on the Roman Campagna. Though Celli and Delpino (Oct. 1899, p. 8) give no numbers, they state that the number of fresh cases of malaria in Italy coincides with an increase in the number of *Anopheles* (flies) found in and about the houses. They found larvae in March, blood-filled insects in July and August, during which time the number of flies increased. The first infected flies were caught in June. Stephens and Christophers (July 1900, p. 43) working at Freetown, Sierra Leone, found that coincident with the decrease of malaria "there occurs a diminution in the numbers both of the breeding-grounds and the adult insects of *Anopheles*." They draw especial attention to the fact (p. 47) that *Anopheles* are frequently present in enormous numbers in overcrowded native dwellings in Freetown. Christophers and Stephens (Aug. 1900, p. 9) found that *Anopheles* (flies) would appear to be absent during the dry season in Freetown, though they were actually there as proved by the eggs that were promptly laid in the experimental pools. At the Houssa Cantonment and elsewhere the flies were numerous about native dwellings during the dry season, although this lasted several months and the breeding-places were situated at the distance of a mile. The flies persist in the houses and lay their eggs as soon as the rains give rise to pools in the immediate vicinity.

As shown above we have scarcely any exact figures with regard to the number of *Anopheles* encountered in malarious localities. It is usually stated that mosquitoes are numerous without any reference to

the species. We are able however in a general way to conclude from the writings of various authors that *Anopheles* may be very numerous at times. In our search for *Anopheles* in England, when we exclude the observations made by the entomologists who have favoured us with information, we confined ourselves to looking for larvae. At an early date in our investigations we found that this was by far the most rapid method of detecting the presence of these insects in a given district. It is quite evident from what we have found that *Anopheles* are much scarcer in England than in the malarious countries named, for during our search for larvae we were never molested by the winged insect, although the larvae abounded in certain waters. Mr Theobald, who has given especial attention to the *Culicidae*, wrote to one of us that he had never known *Anopheles* to bite in England, and this statement in a manner corroborates what we have noticed in the field. We made no attempts at collecting the flies by means of a net, and we never noticed a single winged insect in the open, though we in a few instances succeeded in capturing them in dwellings. Though we might very well have found the flies if we had searched more closely, the mere fact of our never seeing a single fly in the open country is distinctly suggestive. Though our observations show that *Anopheles* persist in districts formerly malarious, we have noted their presence in localities where as far as we can ascertain there never was malaria. Owing to the greater expanse of suitable waters in the low land which was formerly malarious we believe that *Anopheles* are still most numerous in those regions. That the English *Anopheles maculipennis* is just as fond of human blood as its continental *confrères* has been amply proved by experiment during July and August. Our investigations show that Grassi's generalizations are incorrect. *Anopheles* may occur in non-malarious regions, and consequently his whole deduction whereby he excludes all other blood-sucking insects from being hosts of the parasites of malaria on the ground of their more general geographical distribution, is proved to be premature and fallacious. It is quite possible that there may be other hosts than the *Anopheles* already experimented upon, and it remains necessary to exclude these by actual experiments, such as Grassi himself has made with various species of *Culex*, whereby he has proved that these species are not suitable hosts. It might be added here that Howard (1900, p. 18) suggests the advisability of thus experimenting with the genera *Psorophora* and *Megarhinus*, and there seems no other way of excluding other blood-sucking insects except by experimenting with all of them.

The investigations here recorded were undertaken primarily with the view of determining whether or no *Anopheles* still existed in previously malarious districts, and if this was the case we desired if possible to further investigate whether there was any interrelation between the more or less remote date of the disappearance of malaria and the present numerical distribution of *Anopheles*. For this reason the distribution of *Anopheles* and ague respectively as figured in the accompanying maps may seem to coincide more closely than it should. In other words, we have by no means searched as diligently in regions where malaria was absent as we have searched in those where malaria prevailed. There are many parts of Great Britain which still remain to be investigated. The task is however so extensive that it can only be accomplished with the aid of numbers of trustworthy investigators interested in the subject. Another matter has to be considered in examining the map relating to *Anopheles*, and that is that in certain places where the collectors have resided for some time the positive findings are much more closely aggregated, a fact which would make it appear as if the *Anopheles* were more numerous about the particular region. When as in the table it is noted that many larvae were found in a given pond, it does not follow that *Anopheles* were numerous in the particular region because the pond may be the only breeding-place for a large area. We know that there are more suitable waters for the development of *Anopheles* in the low-lying parts of England, where malaria used to prevail and where of necessity *Anopheles* is most numerous to-day. The fact that we have observed *Anopheles* in out of the way places has also its significance, for it explains how malaria might arise without the introduction of these insects provided an infected man visited the district, other conditions were suitable, and the insects sufficiently numerous. It will also explain how in certain years malaria has been known to spread beyond its endemic centres to regions previously free from the disease. Enough has been done to show that *Anopheles* are to be found in regions where there is no reason to believe malaria was ever endemic.

Regarded from the point of elevation above sea-level we find that we have collected *Anopheles* at 74 places at or near sea-level (50 feet or under), at 46 places below 100 feet, 32 places between 100 and 200 feet, 12 places between 200 and 300 feet, 4 places between 300 and 400 feet, 1 at 400 feet, 2 at 500 feet, and 2 at 600 and 700 feet respectively.

When we come to consider the nature of the water in which the larvae occur we find that they have been captured 41 times in ponds

(9 times together with *Culex*), in ditches in which the water had a scarcely perceptible flow 36 times (3 times with *Culex*), in ditches containing flowing water 15 times, in rivers and canals (Derwent, Orwell, Ouse, Thames, Lee, Cam, Mole, Ex, etc.) 26 times, and 3 times in the backwaters of rivers. Larvae were moreover captured 6 times in brackish water (twice in ditches, four times in pools), twice in waterlogged boats (once with *Culex*), and twice in stone troughs (once with *Culex*). In only 9 cases was it noted that the water was dirty. Altogether *Anopheles* larvae were found 14 times together with those of *Culex* and 10 times with fish. It might be of interest to add here that one of us (G. H. F. N.) found the larvae of *A. maculipennis* 3 times in Germany in August and September: at Godesberg on the Rhine in a fountain basin together with *Culex* and apparently in the absence of algae; at Treves on the rapidly flowing Mosel, in a dirty puddle, containing *Ulva*, beside the river; near Mölln in Mecklenburg in permanent pools containing *Spirogyra* (no malaria in this district for 25 years as at Godesberg). As in other countries the larvae in England are usually found in water containing algae, usually *Spirogyra*, frequently *Ulva*. They have also been found in water covered by a moderate amount of *Lemna* (duckweed), whereas, as Grassi noted in Italy, they are absent when the water is entirely covered with this plant. At other times the larvae were found in accumulations of aquatic plants which had been torn up from the bottom of rivers and accumulated in little bays and inlets along the banks of the stream. Finally larvae were on several occasions found in waters which appeared to contain no algae, though doubtless they were not entirely absent.

Referring to our notes we find that *A. maculipennis* has been much more frequently found than *A. bifurcatus* and that *A. nigripes* is rare. Of 156 lots of insects collected whose species was determined 123 were *A. maculipennis*, 27 *A. bifurcatus*, and only 6 *A. nigripes*. We have been unable to note any differences in the geographical distribution of these species considered separately.

Methods of Investigation.

In collecting the larvae of *Anopheles* we have found the following simple apparatus fully sufficient. (1) Some wide-mouthed bottles of medium size with cork stoppers; (2) a white enamelled dipper, which can when required be tied with a piece of twine to a light bamboo rod about four feet long; (3) a small pipette with a rubber bulb; (4) small vials containing dilute alcohol, which is subsequently concentrated, serve for the preservation of larvae when it is not necessary to keep them

alive; (5) the collector should be provided with labels, note-book and pencil. The larvae as Grassi has pointed out (1900, June 4) can be distinguished from one another by the character of the setae on the head, as will be mentioned in the following communication. We have found a bicycle an almost indispensable adjunct in collecting. The larvae contained in the bottles, which should be about half filled with water and wrapped in soft cloths placed in a bag on the bicycle-frame, can be transported for several hours on the machine without injury. It was noted that the large larvae and pupae did not withstand the shaking as well as did the smaller larvae, but a sufficient number could always be brought back to Cambridge for breeding purposes. On expeditions lasting a couple of days it is well to loosen the corks occasionally to give the insects fresh air. The use of the white dipper has the advantage of making it easy to quickly detect the eggs or larvae upon the white background, the pipette being used for transferring them to the collecting bottles. Only rarely could larvae be detected by direct inspection of the surface of the water, which in any case is very fatiguing. On account of a similarity existing between the imago of *A. bifurcatus* and that of *A. nigripes* the determination of these species was left to Mr F. V. Theobald, who has very kindly aided us, not only in the matter of identification, but also in generously placing valuable notes at our disposal, these notes being included in our tables. As will be seen in the tables, we are moreover indebted to the following gentlemen for kind and ready aid in our investigation, and we take this occasion for expressing to them our cordial appreciation: Mr Ralph C. Bradley of Moseley, Birmingham; Mr F. G. Binnie of Cambridge; Mr G. H. Carpenter of the Science and Art Museum, Dublin; Mr Eric Gardner, who collected for us in Wales, and has furnished us with ordnance maps showing the result of his investigation; Dr J. R. Garrood of Huntingdon; Mr Percy H. Grimshaw, F.E.S., of the Science and Art Museum, Edinburgh; Mr H. M. Lefroy of the Imperial Department of Agriculture, Barbados; Mr Claude Morley, F.E.S., of Ipswich; to repeat Mr Frederick V. Theobald, M.A., F.E.S., of Wye in Kent; Mr Alfred Thornley, M.A., F.L.S., F.E.S., President of the Notts. Naturalists Society, and Mr George H. Verrall, F.E.S., of Newmarket. We are indebted to these gentlemen chiefly for data concerning the winged insects. Finally we wish to state that we were very ably assisted throughout our investigation by Walter Mitchell, our Laboratory Assistant, who has shown much enthusiasm and interest in the work to the success of which he has materially contributed.

Distribution of Anopheles in England.

In the following table the counties are roughly ordered, beginning with the northern ones and going south. The abbreviations L. or l. and F. or f. signify respectively "larvae" and "fly"; + indicates that attempts to raise the fly failed, or that the larvae died or were lost, and that the species could not be determined. The elevation above the sea was determined by reference to Ordnance Maps both large and reduced (Bartholomew's Tourist and Cyclist's Maps, scale 2 miles to an inch) and are mostly given approximately. The sign – before a number, as in "–100" signifies that the place mentioned is situated at an elevation of 100 feet or under, above sea-level. The letters *b.*, *m.* and *n.* in the column "Species" signify *bifurcatus*, *maculipennis* and *nigripes*. The collector's initials in the last column refer to Dr Nuttall (G. H. F. N.), Dr Cobbett (L. C.), Mr Strangeways-Pigg (T. S. P.) and Walter Mitchell (M.) our Laboratory Assistant. The collecting was all done in 1900. The names of other collectors are given in full.

County	Place	Height above sea in feet	Species	Notes	Collector and date
Yorkshire	Filey	100—200	*b.*	L. in pond half way down mud-cliff 1 m. S. E. with Culex, also found ½ m. N. W. (flies hatched out)	L. C. 28 . VIII
			m.	F. (one) caught near Filey	Theobald IX . 1896
	Cayton Bay	50	*m.*	L. in pond situated as at Filey, with Culex. No algae[1]. Grass growing up through water, small horse-trodden pools	L. C. 29 . VIII
	Speeton	40	+	L. in cliff-pond with grassy margins as above, with Culex	L. C. 29 . VIII
	Robin Hood's Bay	50	+	L. found as above	L. C. 30 . VIII
	Gristhorpe Bay	50	+	L. found as above	L. C. 1 . IX
	Harwood Dale (on the moors between Scarboro' and Whitby)	over 200	*m.*	L. in pond by a stream in upland grassy valley, with Culex	L. C. 30 . VIII
	Aysgarth	600	*b.*	L. absent June and July (water cold), present in Sept. (water warmer) in little spring-fed pools overhung by vegetation in rocky river-bed between bridge and middle fall N. side of River Ure. Numerous	L. C. 9 . IX
	Jervaulx	300—400	+	L. in large fish-pond with grassy margins. Fair number	L. C. 8 . IX
	Flamboro' Head	170	*m.*	L. in horse-trodden grass-bordered ponds on top of chalk cliffs (covered with glacial drift) between Danes Dyke and Light House. (*a*) Small pond near cliff edge ½ m. N. of Light House, many larvae. (*b*) Roadside pond 1 m. N. of Flamboro' Village, many. (*c*) Roadside pond inside Danes Dyke	L. C. 31 . VIII 5 . IX
	Buckton	250	*m.*	L. together with Culex, both numerous at head of large pond with grassy horse-trodden margin	L. C. 31 . VIII

[1] That is none such as Spirogyra, Ulva, etc., in quantities visible to the naked eye.

County	Place	Height above sea in feet	Species	Notes	Collector and date
Yorkshire (*cont.*)	Muston (on road to Filey)	150	*b.*	L. in horse-pond as before. Flies raised in laboratory	L. C. 3 . IX
	Muston-Hunmanby road	150	+	L. in two horse-ponds as before	L. C. 3 . IX
	East Heslerton	100—200	*m.*	L. in little village pond in middle of road. No weed nor grass	L. C. 4 . VIII
	Cayton Village	140	*m.*	L. in stone trough. Slow running water, algae. (Fly raised)	L. C. 8 . IX
	Cayton-Seamer road	110	+	L. in little grassy roadside pond	L. C. 8 . IX
	Sessay (Vale of York)	50—100	+	L. in grassy horse-pond	,,
	Baldersby (Vale of York)	100	+	Same as above	,,
	Hertford River Marsh near Muston	90	*b.*	Many l. in one ditch, few in another (flowing water). None in grassy puddles by chalk-stream	L. C. 4 . IX
	Yedingham Abbey	75	+	L. in River Derwent and communicating ditch. Slow flowing water. Fair number	,,
	West Ayton	100	+	Very many l. in Old Castle fish-ponds, near River Derwent. (Maximum 12 per "dip.") Pond overgrown with flags, grassy borders, algae. No l. in river close by, nor at Forge Valley	L. C. 6 . IX
	Howden	– 50	+	L. in slow flowing ditch (duckweed) 1 m. W. of Howden on road to Hemingborough. Fair number, i.e. 1–2 per "dip"	G. H. F. N. 11 . VIII
	Hull	– 50	+	L. found along grassy borders of rapidly flowing Barmston Drain, at Newland. Broad deep stream. Clumps of floating green weed and Spirogyra along banks. One l. per five dips. Also Culex	G. H. F. N. 12 . VIII
Derby	Beauchief Abbey	400	+	No particulars	Lefroy
Lancashire	Carr Hoo	– 50	+	Very few l. in cattle-pond	M. 10 . IX
	Walmer-Bridge	– 50	*m.*	Very few small l. with those of Culex in cattle-pond	,,
	Preston	– 100	*m.*	Only three l. caught in pond by canal on road to Fullwood	M. 11 . IX
	Kirkham	– 50	*m.*	Only two l. caught in duck-pond	,,
	Lytham	– 50	*m.*	A few small l. in ditch on road to Kirkham	,,
	Morecamb (and road to Lancaster)	– 50	*m.*	L. fairly numerous in some ditches	M. 12 . IX
	Bay Horse	– 100	*m.*	L. fairly numerous in ditch, flowing water, in one place only. Algae	M. 14 . IX
	Catterall (near Garstang)	– 100	*m.*	L. plentiful in ponds at Catterall, none at Garstang in ponds and streams. (Fly raised)	,,
	St Ann's-on-the-Sea	– 50	*m.*	One l. caught	Swainson 1900 (comm. by Theobald)
Cheshire	Aldford (near)	– 100	*b.*	L. in one pond only	M. 9 . IX
	Mickle Trafford	– 100	*b.*	L. in roadside ditch	,,

County	Place	Height above sea in feet	Species	Notes	Collector and date
Lincolnshire	Cadney, Brigg	– 50	*b.*	One ♀ f. caught	Grimshaw v. 1898
	Gainsborough (near)	– 50	*b.*	L. very numerous in roadside ditch between Morton and Walkerith Ferry. One Culex larva. No algae, only Lemna	G.H.F.N. 12 . VIII
	Boston	near sea-level	+	(*a*) Few small l. in Maud Foster Canal, Horncastle Road, algae, water dirty (*b*) Same in 45-foot Canal	G.H.F.N. 13 . VIII
	Grantham	– 200	*m.*	F. caught	Thornley
	Long Sutton	– 50	*m.*	L. and pupae numerous in ditches both E. and W.	M. 21 . VII
	Gedney	– 50	*m.*	L. numerous in ditches all along road to Eye Green	,,
	Holbeach	– 50	*m.*	,, ,, ,, ,,	,,
	Spalding	– 50	*m.*	,, ,, ,, ,,	,,
	Cowbit	– 50	*m.*	,, ,, ,, ,,	,,
	Crowland	– 50	*m.*	,, ,, ,, ,,	,,
	Eye Green	– 50	*m.*	,, ,, ,, ,,	,,
				(Here Culex but no Anopheles-l. found in a water-butt)	
Nottingham-shire	South Leverton	– 100	*m.*	One ♀ f. caught. (Highest land 280 ft above sea)	Grimshaw 10 . II. 1898
			m.	F. occurs sparingly on the windows of the house: often during winter. Caught two ♀ 10. II and 7. IV. 1898 and one ♂ IX. 1900	Thornley 1898—1900
Norfolk	King's Lynn	sea-level	*m.*	(*a*) L. plentiful in large and small ditches near station. Water deep, cool, algae present. Larvae mostly small (*b*) Eggs l. and pupae very numerous in brackish pool to E. of River Ouse estuary. Contained algae chiefly Ulva (Tetraspora)	G.H.F.N. 14 . VII
	Norwich	– 50	*m.*	F. caught	Theobald IV . 1897
	Cromer	– 100	*m.*	One f. caught	Theobald IX . 1897
	Diss	– 100	*m.*	F. caught	Verrall 19 . VII and 21 . VIII
	Acle	– 50	*m.*	L. numerous in roadside ditches (fen drains) containing Spirogyra	G.H.F.N. 3 . VIII
	Billockby	– 50	*m.*	ditto	,,
	Great Yarmouth	sea-level	*m.*	L. numerous in ditch near Volunteer Encampment containing Spirogyra. (Flies raised)	,,
	St Olaves	near sea-level	*m.*	Ditch near station. Water brackish and contained algae. (Fly raised)	,,
Suffolk	Newmarket	– 200	*m.*	Five to six f. caught each year in collector's house	Verrall 1 . I to 27. XII. 1899
	Mildenhall	– 50	*b.*	F. caught	Verrall 8 . IX ...
	Halesworth	– 50	*m.*	L. in ditches containing Spirogyra	G.H.F.N. 4 . IX
	Southwold	– 50	*m.*	Fly (one)	Morley 1 . VIII

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County	Place	Height above sea in feet	Species	Notes	Collector and date
Suffolk (*cont.*)	Wickham Market	– 50	*m.*	L. in ditches containing Spirogyra	G.H.F.N. 4 . IX
	Southwold	– 50	*m.*	F. caught several times in bedrooms during the night	Morley 1 . VIII . 1900
	Bury St Edmunds	– 100	*m.*	L. very plentiful in algae-containing ditches near station on the right coming from Cambridge	G.H.F.N. 28 . VII
	Blakenham	– 50	*m.*	L. plentiful in River Orwell alongside Mill, amongst algae near bank. Deep, slow flowing clear water—river above and below looked likely	,,
	Felixstowe-ferry (near)	almost and at sea-level	*m.*	(*a*) Few l. found with Culex in dirty water of small pool containing algae (*b*) Many l. in clear ditches (Spirogyra) near River Deben	G.H.F.N. 29 . VII
	Buckleston's Mill (near Newbourn)	– 50	*m.*	L. numerous in clear, deep, slowly flowing water of mill-pond	,,
	Foxhall	– 50	*b.*	F. "swept from nettles on the side of a stagnant pool." One ♂	Morley 19 . V . 1900
Cambridge-shire	Cambridge	– 50	*m.*	F. caught	Theobald II to VI 1889—1894
	,,	,,	*m.*	(*a*) Shallow ditch on Grantchester Meadow near University bathing house. Five l. caught, together with small fish, tadpoles, Assellus, etc. A week later no l. there and did not reappear later	G.H.F.N. 10 . V . 1900 kindness of E. Bles.
	,,	,,	*m.*	(*b*) L. in ditch leading to mill-pit on Sheep's Green, algae, fish, water shallow. 150 l. caught. 19. VII. caught 191. In August ditch dry	G.H.F.N. 29 . VI
	,,	,,	*m.*	(*c*) One ♂ f. caught in outhouse at Pathol. Laboratory	G.H.F.N. 7 . VII
	,,	,,	*m.*	(*d*) Three ♀ f. caught in two private houses on Adams and Cranmer Roads	G.H.F.N. Sept. Oct.
	,,	,,	*m.*	(*e*) Two l. in River Granta near Newnham	M. 20 . X
	Cambridge-Histon road	– 50	*m.*	L. in small pond, bordered with grass and rushes, near road, ¾ m. from corner of Huntingdon Road. Five l. and one pupa caught, also Chironomus, water not pure	G.H.F.N. 24 . VI
	Cambridge-Ely r.r.	– 50	*m.*	22 l. caught in pools near railroad just N. of River Cam	M. 19 . VII
	Girton (near)	– 50	*m.*	L. in ditch crossed by bridge 3¼ m. from Cambridge on Via Devana. Water two inches deep, stagnant, muddy, no green algae. Only two small l. and two Culex caught	G.H.F.N. 21 . VII
	Waterbeach	– 50	*m.*	(*a*) 53 l. caught in ditch (*b*) L. in ditch near railway crossing, fair number	M. 6 . VII L. C. 22 . VIII
	Clayhithe (near Water-beach)	– 50	+	(*a*) L. in fish-pond containing small pike, and inch-long roach and dace, algae (Ulva). Very many l. 6–10 per dip the maximum (*b*) L. in dead water at bend of river, weed, many l. (12 a dip or none, irregularly distributed). None in ditch alongside of river though water suitable	L. C. 22 . VIII

County	Place	Height above sea in feet	Species	Notes	Collector and date
Cambridge-shire (*cont.*)	Ely	– 50	*m.*	212 l. caught in long ditch E. and close to Ely station on road to Newmarket. Water at midday 24° C., green algae, slow running peaty tinted water, 1 foot deep, no fish, Assellus plentiful	G.H.F.N. 14 . VII
	Littleport	– 50	*m.*	91 l. caught in small roadside ditch filled with much yellowish-green, dead weed and algae. Water 24° C. (Littleport is 6 m. N. of Ely)	G.H.F.N. 14 . VII
	March	– 50	*m.*	(*a*) L. in shallow pools along almost dried ditch on high road to Wisbech, few with much Culex (*b*) L. numerous in ditch where road turns N. to Wisbech (*c*) L. in ditches all along road to Sutton	M. 21 . VII
	Wicken Fen	– 50	*m.*	F. caught	Verrall 11–19 . VII
			+	L. found in water-logged boat in ditch, no algae. Very many, also Culex. Few in ditch	L. C. 19 . VIII
	Wicken Village	– 50	+	Very few l. found with countless Culex in very dirty, almost dry, ditch in middle of village. Six rain-water tubs only contained Culex	L. C. 19 . VIII
	Burwell	– 50	*b.*	F. caught	Verrall 5 . V
	Exning	– 100	*b.*	F. caught	Verrall 11 . VIII
Huntingdon	St Neot's (and district)	– 100	*m.*	F. abundant in spring time. Caught during a number of years	Theobald (1900)
	Alconbury Hill (near and N. of Huntingdon)	– 100	*b.*	♂ and ♀ f. caught by lamplight in house and sent to us. Species determined by Theobald	Garrood 12 . VIII 1900
	Fen Stanton	– 50	*m.*	L. very numerous in broad ditch 3 feet deep, flowing water containing algae (at 6 mile post from Godmanchester)	G.H.F.N. 21 . VII
	St Ives	– 50	*m.*	L. in small ditch estuary into Ouse on Houghton path	,,
Bedfordshire	Sandy (near)	– 100	*m.*	On road to Biggleswade. A few small l. with many of Culex, found in a ditch fed through overflow from small stream, in which Anopheles were plentiful, but Culex absent	M. 4 . VIII
	Bedford (near)	– 100	*m.*	On road from Sandy, 3 miles from Bedford. L. in small stream	,,
	Bedford	– 100	*m.*	A few small l. in River Ouse (in patches of algae) along town promenade	,,
Hertford-shire	Broxbourne	– 100	+	L. in backwater of River Lea near railway station	M. 5 . VIII
	Rye House	– 100	+	One l. caught in ditch near toll-house	,,
	Bishops Stortford	200—300	*m.*	L. found in stream	,,
Essex	Lexden (near Colchester)	– 100	*m.*	Very few small l. in stream	M. 2 . IX

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County	Place	Height above sea in feet	Species	Notes	Collector and date
Essex (*cont.*)	Bottle End (near Colchester)	-- 200	*m.*	A few small l. in pond (Bottle End is on road to Maldon)	M. 2 . IX
	Heybridge (near Maldon)	- 50	*m.*	L. plentiful in ditch containing brackish water	,,
	Rochford and near the River Crouch	- 50	*m.*	L. fairly numerous in a stream, the Cam. Small l. plentiful, in brackish pond	,,
	Pitsea	- 50	*m.*	L. plentiful in ditch and pond	M. 3 . IX T.S.P. 18 . IX
	West Tilbury	- 50	*m.*	Very few l. in a ditch	M. 3 . IX
	Corringham	- 50	*m.*	Many l. in ditches situated ½ mile from church. Water brackish	T. S. P. 18 . IX
	Onger (near to, on road to Brentwood)	200—300	*m.*	L. fairly numerous in pond	,,
	Matching Green and Hatfield Heath	200—300	*m.*	L. fairly numerous in roadside ditch	,,
	Bulvan	- 50	*m.*	Very many l. in ditch in Fenland. F. raised	,,
	Vange	50	+	L. plentiful in pond	,,
	Ockenden	50—100	+	A few l. in pond	T. S. P. 19 . IX
	Hornchurch	50—100	+	,, ,,	,,
	Rainham	- 50	+	L. in marsh ditches	,,
Sussex	Hastings	- 100	*m.*	F. caught	Theobald IV and IX 1883—1890
	Rye	- 50	*m.*	,, ,,	Theobald V . 1885
	Laughton	- 100	*m.*	,, ,,	Verrall 17 . IV ...
	Plashet Woods	500	*b.*	,, ,,	Verrall 3 . VII ...
	Barcombe	- 100	*b.*	,, ,,	Verrall 21 . VI ...
	Lewes	- 100	*m.*	,, ,,	Verrall 2 & 8 II ... 15.X & 6.XI .. ...
	Seaford	- 50	+	No particulars	Lefroy
Kent	Wye	- 150	*m.*	F. abundant in January to May and again in autumn	Theobald 1895—1900
			n.	Rare, only one f. caught	Theobald 1898
	Folkestone	- 150	*m.*	One f. caught	Theobald IV .....
	Tenterden	- 200	*m.*	F. caught	Theobald IV . 1899
	Canterbury	- 100	*m.*	,, ,,	Theobald IV . 1898
	Gravesend	- 50	*m.*	Many l. found in one ditch only	M. 6 . IX
	Queenboro'	- 50	*m.*	L. fairly numerous in a pond	M. 5 . IX
	Queenbridge	- 50	*m.*	A few l. in ditch, water not clear	,,

County	Place	Height above sea in feet	Species	Notes	Collector and date
Hampshire	Lyndhurst	– 150	*n.*	(In the New Forest) comparatively rare. F. caught	Verrall 10 . VI to 20 . VIII
	Lymington	– 100	*b.*	F. caught	..... Verrall 22 . VI.....
	Odiham	200—300	*m.*	Many l. in ditch	T. S. P. 31 . VIII
	Fareham	– 50	*m.*	Very many l. in pond	,,
	Portsmouth	near sea-level	*m.*	F. caught end of August in a garden among thick ivy bushes. L. eggs and pupae found in small stone tank fed occasionally from tap and containing algae. Together with Culex	Bassett-Smith (see biblio.) 1900
	Sandford (Isle of Wight)	– 200	*m.*	L. in pond	T. S. P. 31 . VIII
Surrey	Chertsey	ca. 40	*m.*	Four l. found after long search along grassy marshy margin of a little Thames backwater	L. C. 25 . IX
	Weybridge	38 and 200	*m.*	A few l. along bank of Thames opposite Docket Point. Also at Weybridge Brickfields in St George's Hills, in a little puddle in clay with sparse vegetation about a fallen branch. Fair numbers. One ♀ f. caught in a house on the common	,,
	Esher	48	*m.*	F. common	Theobald IV . 1888
			+	L. caught in River Mole	L. C. 18 . IX
	Wisley	– 100	*m.*	L. fairly numerous in small pond at head of Hut Pond. Water covered with brown, floating weed	L. C. 20 . IX
	Chobham	100—200	*m.*	L. fairly numerous in small pond, "The Springs," situated in large expanse of heather. Small rushes and moss on bank, water covered with brown floating weed. None found in similar "Gracious Pond" a ½ mile away	L. C. 21 . IX
	Peaslake (Greensand hills near Leith Hill)	407	*m.*	A few l. and pupae found in little rapid, grassy margined, clear stream at roadside in village	L. C. 23 . IX
	Friday Street (Leith Hill)	500	*m.*	L. fairly numerous along margins of large pond	,,
	Kingston-upon-Thames	– 50	*m.*	F. abundant	Theobald IV . 1887
	Richmond	50—100	*b.*	(*a*) A few l. in one (middle pond) of the Pen Ponds in Park. Absent in upper pond though conditions similar: margins mossy, short rushes (*b*) L. fairly numerous in a similar pond in Park near Ham Gate (*c*) Many pupae and few l. in a little grass-bordered stream near Roehampton Gate. (Flies raised)	L. C. 18 . IX
	Godalming	– 200	*m.*	F. recently caught, one ♀	Theobald 1900
	Denmark Hill London, S.E.	– 50	*m.*	F. caught	Verrall 23 . X .....

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County	Place	Height above sea in feet	Species	Notes	Collector and date
Middlesex	Ladbroke Grove, London, W.	−150	*m.*	F. caught	Theobald x. 1900
	London, N.W.	−250	*m.*	,, ,,	,,
Oxfordshire	Oxford	190	*m.*	A few l. found after long search in ditches in Port Meadow. Many little fish present	L. C. 12. IX
	Culham	150	+	Anopheles and Culex l. plentiful in grassy horse-trodden ditch. One Anopheles l. caught in lock-cut	L. C. 13. IX
	Clifton Hampton	140	*m.*	A few l. in flowing water in ditch communicating with river	L. C. 13–14. IX
	Whitchurch	105	*m.*	L. fairly numerous in a small shallow bay in River Thames one mile below W. Plenty of algae	L. C. 17. IX
	Mapledurham	100	*m.*	Very many l. in middle of River Thames between island and shore. Slow flow, flags and much Ulva	,,
Warwickshire	Sutton Coldfield	300—400	*b.*	F. caught in "a Park of 2000 acres with several streams and pools and boggy ground." Nine species of Culicidae, including Anopheles, caught. A. bifurcatus, not uncommon, caught in collector's garden near small pools in May, June, Aug.—Oct.	Bradley 1891, 1894, 1897
Herefordshire	Tarrington	200—250	*b.*	One f. ♀ caught ("probably on damp marshy ground")	Yerbury 1. v. 1899
Buckinghamshire	Hurley (opposite)	90	+	Very many l. just below the big weir in floating weed and Spirogyra. Little water flowing over weir	L. C. 18. IX
	Bletchley	200—300	*m.*	L. in little grassy margined lake containing small fish, swans and ducks. Fly raised	L. C. 12. IX
Berkshire	Sandford	170	*m.*	(*a*) Few l. above weir among weeds and rushes, on both sides, as also in neighbouring ditches (*b*) Plentiful below weir. Much algae	L. C. 12–13. IX
	Day's Lock	130	*m.*	L. plentiful in water-logged punt in weir stream	L. C. 14. IX
	Cleeve	115	+	Few l. in ditch (rushes and flags) communicating with river. Water flowing	L. C. 15. IX
	Streatley	110	*m.*	Few l. in over-shadowed ditch on Mill-Island fed by river-water only at flood-times. None found in backwaters after long search	L. C. 16. IX
	Hambledon Lock	−100	*m.*	L. fairly numerous just below lock on Berks side in open River Thames, amongst floating debris and weed	L. C. 17. IX
Dorsetshire	Creekmoore (near Poole)	50—100	*m.*	Very many l., boggy	T. S. P. 1. IX
	Tolpiddle	50—100	*m.*	L. fairly numerous in farmyard pond with Culex. Water not clear. No drainage into pond	,,

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County	Place	Height above sea in feet	Species	Notes	Collector and date
Dorsetshire (*cont.*)	Axminster	50—100	*b.*	L. fairly numerous in roadside pond	T. S. P. 2 . IX
	Yeovil	100—200	*m.*	L. fairly numerous in drain ditch	T. S. P. 7 . IX
	Polsham (near Wells)	50—100	*m.*	L. plentiful in drain ditch	T. S. P. 6 . IX
	Netherbury near Beaminster	100—200	*m.*	L. caught (species identified by Prof. L. C. Miall)	Lefroy [1]
Somerset-shire	Taunton	50—100	*m.*	L. plentiful in mill backwater	T. S. P. 5 . IX
	Bridgewater	– 50	*m.*	L. plentiful in ditch in the town	,,
	Weston-super-Mare	50—100	*m.*	Many l. in pond	,,
	Bristol	50—100	*m.*	L. in pond in waste ground near colliery on railroad	T. S. P. 6 . IX
Devonshire	Teignmouth	– 100	*m.*	Two f. caught in June	Theobald 1884
	Cornwood	300—400	*m.*	F. caught	Verrall 1 Sept. ...
	Slapton-Leigh	200—300	*b.*	F. caught	Verrall 8 Sept. ...
	Ugbrooke (10 m. S.W. of Exeter)	– 300	*n.*	F. caught	Verrall 20 . VIII ...
	Barnstaple	– 50	+	Very few l. in ditch near railroad	T. S. P. 6 . IX
	Exeter	50—100	*m.*	Few l. in River Ex, near St David's station	T. S. P. 5 . IX
Cornwall	Penzance	– 200	*n.*	F. caught	Theobald 1900

[1] Letter to A. E. S., 22 Oct. 1900, wherein no date is given regarding when they were collected, though this was done of late years.

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ISOLATED DATA RELATING TO THE DISTRIBUTION OF ANOPHELES IN WALES, SCOTLAND, AND IRELAND.

WALES.

County	Place	Height above sea in feet	Species	Notes	Collector and date
Carnarvonshire	Criccieth	−50	*m.*	A few f. caught in September	Theobald 1895
	Beddgelert	−200	*n.*	"Beaten from a shady garden in front of the Goat Hotel"	Theobald IX. 1900
Glamorganshire	Oxwich village (¼ mile from)	sea-level	*m.*	One l. caught in stream running through marsh, and containing many prawns	Gardner 25. VIII 1900

SCOTLAND.

Lanarkshire	Possil Marsh (N. of Glasgow)	100	*b.*	Several f. caught ♂ and ♀ (species identified by Theobald)	Binnie 7. IX. 1875
Invernessshire	Nethy Bridge	ca. 700	*b.*	F. caught. One ♀ 22. VI, and two ♂ 24. VI, on damp, swampy ground. Two ♀ 15. VI and 9. VII, on windows of hotel verandah, Culex pipiens being very troublesome in the evening	Yerbury 1900
Sutherland	The Mound (Junction for Dornoch)	sea-level	*b.*	F. caught. One ♀ 8. VIII, two ♂ 4 and 10. VIII, on damp, swampy ground	,,
Aberdeenshire	Torphins	−300	*m.* and *b.*	F. caught. 18 specimens sent to British Museum by	Dr M. J. Wright (comm. by Theobald 1900)

IRELAND.

Dublin	Harold's Cross (suburb of Dublin)	−150	*n.*	One ♀ f. caught in Sept., now in Science and Art Museum, Dublin	Carpenter 1899
Down	Holywood	−200	*m.* *b.* *p.*[1]	F. caught F. caught F. caught. The author notes "probably a small variety of A. bifurcatus"	A. H. Haliday (Ent. Mag. vol. I. p. 148 1833)

[1] plumbeus.

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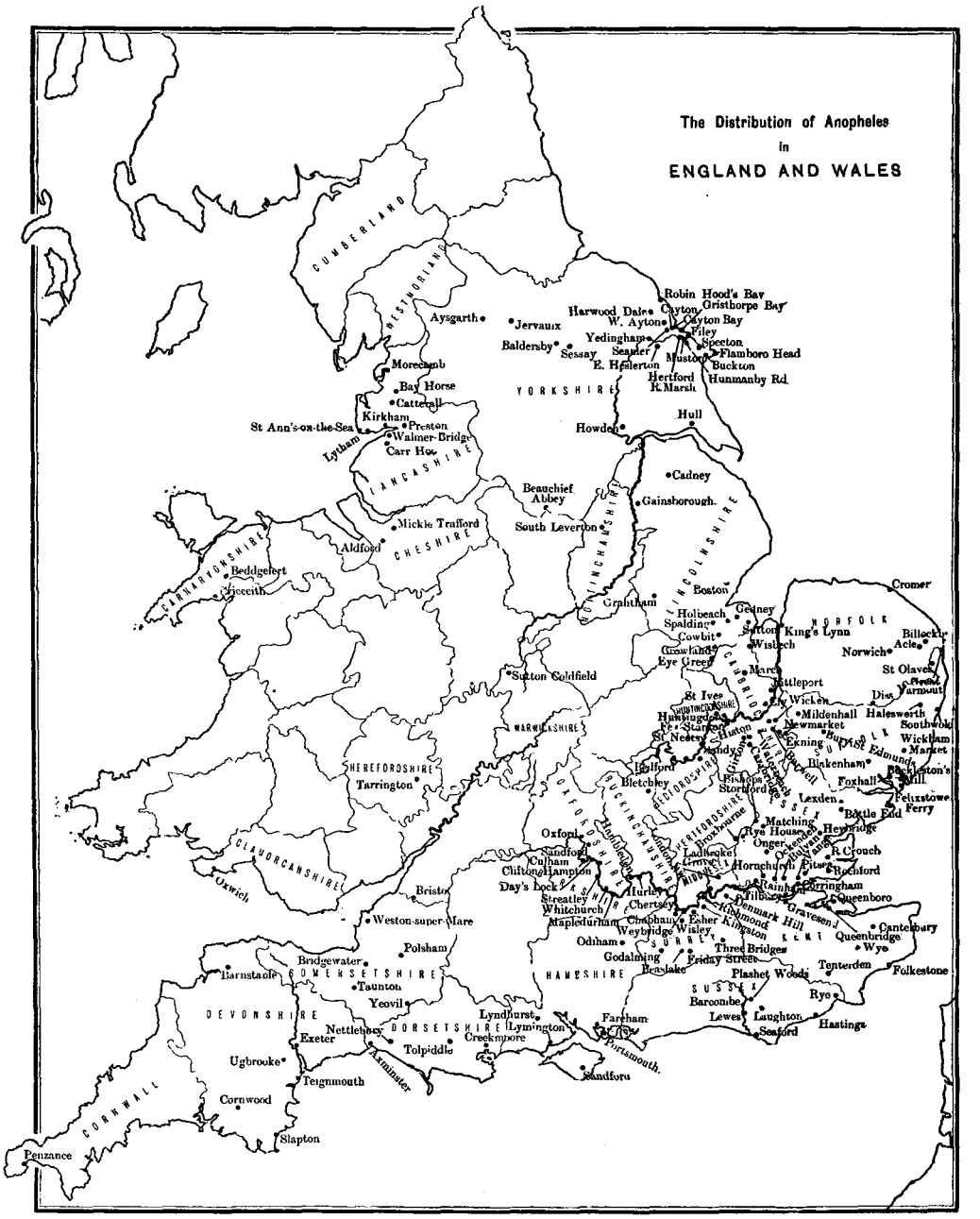

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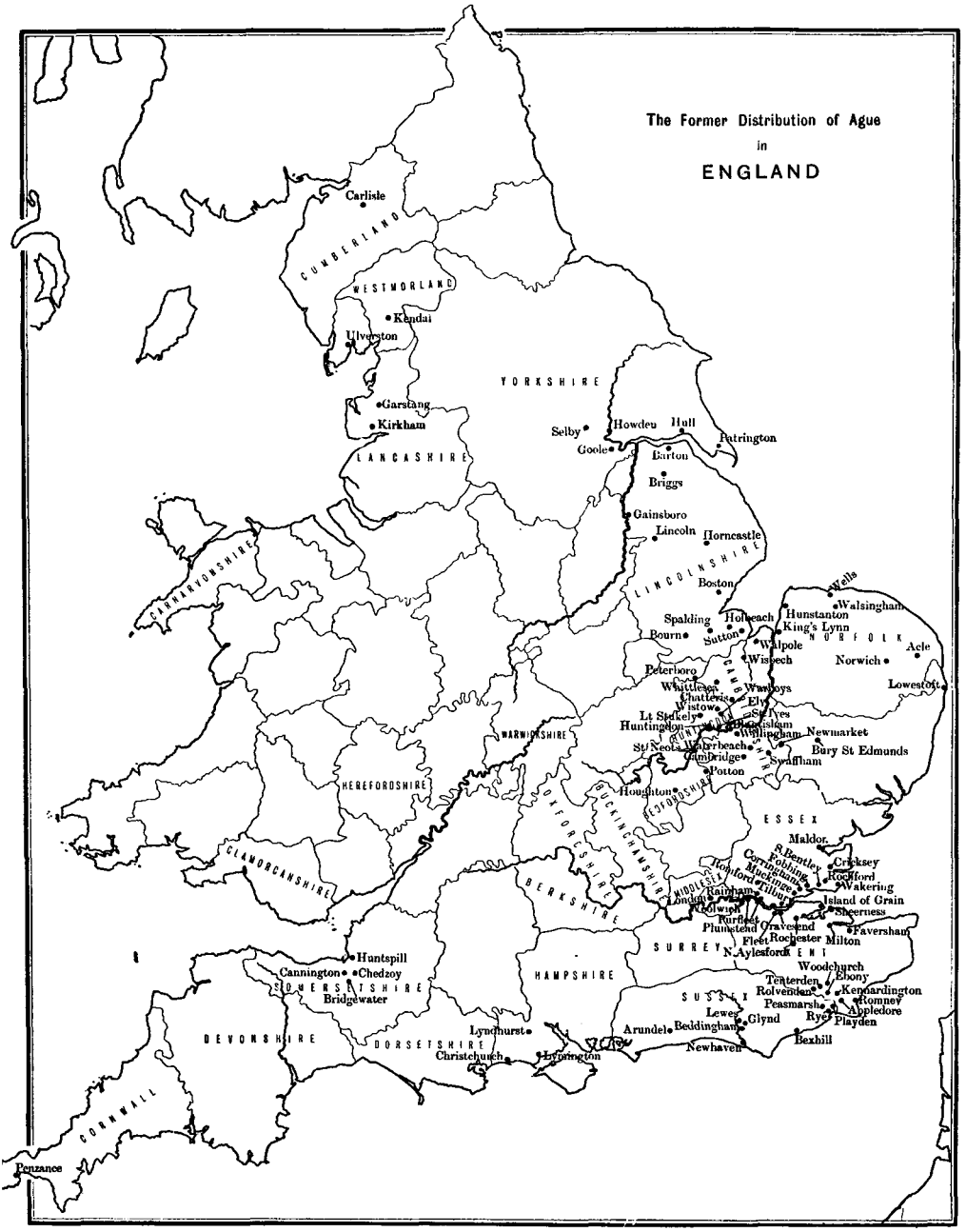

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The Former Geographical Distribution of Ague in England.

"And danger like an ague subtly taints even then when we sit idly in the sun."
Troilus and Cressida, Act III. sc. 3.

The history of malarial disease in England almost up to the beginning of the present century is involved in much obscurity. We read of epidemic after epidemic sweeping over this country destroying in its course sometimes half the population of a town. Many of these epidemics were known as the "plague ague," or by some other name which suggests a malarious origin. But Creighton[1] warns us against supposing that the word ague, as used in bygone times, had this significance. Originally he tells us it meant simply an acute illness, being the "adjective of *febris acuta* used as a substantive." In Ireland it was applied until a comparatively recent period to the indigenous typhus of that country. Even the terms tertian, quartan, and the like, as used by old writers, are according to him misleading, and seem to have been borrowed from classical writers, and applied inaptly to the continued fevers of this country. (Creighton, vol. I. p. 411, vol. II. p. 304.) On the other hand Sir Joseph Fayrer[2], writing of the former prevalence of malarial diseases in this country, tells us, that we have lost two Kings and a Queen, a Cardinal, a Lord Protector, and many other great people from this cause. Creighton however says that "the ague of which Cromwell died in the autumn of 1658 was one of those which raged all over England from 1657 to 1659 so extensively that the country was one hospital," and implies that this was not a malarial epidemic; and he states that "the malarious parts of England have been tolerably well defined at all times, and at all times the greater part of the country was as little malarious as it is now."

Whatever views may be held as to the kind of disease which caused these pestilences, there can be no doubt at all that ague was once very prevalent in certain parts of this country.

In England, malarial disease seems to have been endemic only in the low-lying, ill-drained swampy districts where there was abundance of stagnant or slowly flowing shallow water. Among such places, the principal were the Fens of Cambridgeshire, Lincolnshire, and the sur-

[1] Creighton, C., *A History of Epidemics in Britain.* Cambridge (University Press), 1891 and 1894.

[2] Sir Joseph Fayrer, *Trans. of the Epidemiol. Soc. of London, n. s.* Vol. I. p. 20, 1881—1882.

rounding counties, the marshes on either side of the estuary of the Thames in Kent and Essex, the marshes of Romney and Pevensey on the south coast, and those around Bridgewater near the Bristol Channel. In such places malarial disease was never absent, but there is good reason to think, as we shall presently show, that it differed greatly in prevalence and severity in different years and occasionally spread thence over the neighbouring country.

There is much difficulty in tracing the earlier history of the disease, owing to the very imperfect knowledge of fevers in general and to the imperfect diagnosis which then prevailed. Conscious of the fallacy of attributing to malaria all diseases which were formerly called by the name "ague" variously qualified, we have limited ourselves in drawing up the list of places where malaria is known to have been endemic, to evidence derived from modern sources, and chiefly to a "Report as to the Quantity of Ague and other Malarious Diseases now prevailing in the principal Marsh Districts of England," drawn up by Dr George Whitley at the request of, and presented to, the Privy Council in 1863[1], and to Dr Peacock's paper on "The recently prevalent malarial affections[2]." However imperfect this list may be, and we are conscious that it is no more than a bare outline of the more important districts where malarial diseases were once endemic, we may claim with some confidence that the diseases referred to are true instances of malarial fever.

That ague was once much more prevalent than at the time when the authorities quoted wrote, is to be gathered from these authorities themselves, as well as from older writers. Defoe in "An Account of a Tour through the Eastern Counties of England in 1722" gives a grim picture of the agues then prevalent in the marshes around the mouth of the Thames. And, though the humorous character of his description should warn us to take his statements with a grain of salt, there can be no doubt as to the general truth of his description. He tells us on the authority of "a merry fellow whom he afterwards found fibbed a little," that the men being bred in the marshes and seasoned to the place, did pretty well with it, but they always went into the uplands for a wife, and that the women coming from these parts into the fogs and damp presently changed their complexion, got an ague or two, and seldom held it more than a year, and then the men go to the uplands again

[1] Whitley, G. "Residence in Marsh Districts." *Reports from Commissioners.* Vol. XXVIII. 1864, p. 430.

[2] Peacock, "On Recent Malarious Affections." *Med. Times and Gazette.* Vol. XIX. 1859, pp. 399, 453, and 478.

and fetch another, so that it was very frequent to meet with men who had had from 5 or 6 to 14 or 15 wives." And in a more serious vein he goes on to say, that in these places the inhabitants do not hold out as in other countries, and you very seldom meet with very ancient people among the poor as in other places, so that take it one with another not one half of the inhabitants are natives of the place. It is curious to find that when he comes to describe the fens of Cambridgeshire, though he speaks of the "fogs and vapors which so universally overspread this country" he goes on to say "yet notwithstanding this the people, especially those which are used to it, live unconcerned and as healthy as other folk, except now and then an ague which they make light of, and there are a great number of very ancient people among them."

From early times the Fens had the reputation of being unhealthy. Thus Camden speaks of Ely being situated on a marshy soil and in unhealthy air, and says that there is a prodigious fen beginning from the banks of the Roman Granta and extending a great way north as far as the sea. But William of Malmesbury (1100 A.D.) speaks of some parts of the fen, for instance Thorney, being favourable to health and a very paradise, and Dugdale concluded that in the 11th century "the outfalls were clear and open to the sea, and this argueth a greater care in the people inhabiting this flat country in those days than has been for several years since[1]."

Passing over the epidemic agues of the 17th century of which Sydenham wrote, for it will be necessary to refer to them again, and coming at once to modern times we find that ague was still very prevalent in London as late as 1859. Peacock (*loc. cit.*) gives the proportion of ague cases to the total number of in- and out-patients treated at St Thomas's Hospital from 1852—1859 as follows:

1852	... ...	18·4 per 1000.
1853	... ...	23·7 „
1854	... ...	16·6 „
1855	... ...	12·3 „
1856	... ...	20·7 „
1857	... ...	40·2 „
1858	... ...	46·5 „
1859 (9 months)		56·7 „

He remarks that 56·7 per 1000 in the first 9 months of 1859 is a higher rate than we learn from Sir Gilbert Blane existed when he was physician

[1] Quoted by Miller and Skertchley, *The Fenland Past and Present.* London (Longmans), 1878.

to the hospital, namely 50·01 per 1000 from 1783—1794. In the towns of Huntingdon, Wisbech, and North Aylsham much ague still existed and caused a good many deaths. Peacock gives the following figures showing the proportion of deaths attributed to ague to those from all causes:

PROPORTION OF DEATHS FROM AGUE PER 1000 DEATHS FROM ALL CAUSES.

	Huntingdon	Wisbech	N. Aylsham
1850		4·5	19·1
1851	7·2	0·0	31·2
1852	11·6	5·7	19·5
1853	34·09	3·4	37·3
1854	7·5	1·05	9·07
1855	7·7	0·0	0·0
1856	5·4	2·94	15·2
1857	12·1	9·1	25·2
1858	2·3	6·4	23·3

From the greater prevalence of ague at North Aylsham than at either Huntingdon or Wisbech, it may be inferred that ague was more fatal at that time in the low-lying lands of Kent bordering on the estuary of the Thames than in the fen country around Huntingdon and Wisbech. And this is in substantial agreement with what Defoe wrote, a century earlier.

When Dr Whitley made his report to the Privy Council in 1864, ague had already much decreased in England. He thus sums up his inquiry: "Intermittent and remittent fevers and their consequences can no longer be regarded as affecting the health of the population in many of the districts in which those diseases were formerly of a formidable character. Thus in Norfolk, Lincolnshire and Cambridgeshire, counties in which those diseases were both formidable and severe, all the evidence, except that furnished by the records of Peterborough Infirmary, and in a somewhat less degree in Spalding, tends to show that they are at the present time comparatively rare and mild in form. In several of the places visited, however, it was stated that accessions take place from time to time, and there was a striking agreement generally as to the year in which those accessions occurred.

"The same holds good for the marshes in Hampshire and for all the places visited on the West Coast north of Liverpool.

"In the south part of Essex, in north and south Kent, in the neighbourhood of Lewes and of Bridgewater, a somewhat greater number of cases occur than in the counties mentioned above, but these are

rarely severe. Tertian is the form usually met with, quotidian less frequently, and quartan appears to be almost unknown. Instead of the well-marked paroxysmal ague (once) so prevalent in the marsh districts, an irregular form has succeeded which interferes but little with the usual occupations of those affected.

"It may therefore be safely asserted as regards England generally that the diseases which have been made the subject of the present inquiry have been steadily decreasing both in frequency and severity for several years, and this decrease is attributed in nearly every case to one cause, improved land drainage.

"Of the districts where malarious influence has of late times decreased, but where there still remains much to be accomplished in order that they shall be rendered free from malaria, the most important are Sheppey, Hoo, Spalding, Hull, New Romney, and Lewes.

"Districts where there has not been in late times much, or any lessening of malarious influence are Huntspill, and the marshes on the banks of the river Swale."

Dr Lionel Beale wrote to one of us (Oct. 20, 1900), stating that he used to see many cases of ague at King's College Hospital from about 1845—1865, coming from the marshes about Woolwich, Purfleet, Plumstead, and the neighbourhood, and he used to hear of many cases in Cambridge and the Fen country. Dr J. F. Payne has also written to us (29 Oct. 1900), as follows: "The distribution of ague in place and time in former centuries is rather obscure. The old writers never seem to have taken the trouble to mention the precise districts where it was most common, except quite incidentally. So while certain districts such as the Fen country, Essex, north of Kent etc. got a reputation for malaria the absence of notices of ague in other places does not prove that it did not occur there. There is very little doubt that in the 17th century and even in the 18th ague was endemic in London. Lambeth marsh was notorious, also Westminster and what is now Pimlico. At the beginning of the century it was equally clear, or at least generally believed,—and Murchison believed, that up to the time he saw out-patients at St Thomas's 1850—60,—there were cases of ague in London, not imported. He told me this himself more than once, but I cannot say he ever brought convincing evidence. When I saw out-patients at St Thomas's there used to be a good many cases of ague, chiefly among hop-pickers who had been in Kent in the autumn and whose ague was often latent until the spring. I heard of cases apparently arising in London but never got definite proof of it. But I strongly suspect

that ague lurked in the south of London until the middle of the century."

The only case of ague known to us arising in England, and in which the parasites were found in the blood, is one of which Dr Burton Fanning of Norwich has told us. The patient was in the Norwich hospital from 11th December 1897. to 5th February 1898. He lived at Acle and had never been out of Norfolk. There was no doubt about the nature of the case and the plasmodium was found in his blood by Dr S. Long. Dr Burton Fanning wrote that this was the only Norfolk case in Norwich hospital for many years, but the doctor at Acle had assured him that he saw one or two bona-fide cases every year. Such cases must however be very rare for Dr R. J. Mills of Norwich has written to G. H. F. N. November 1900, saying that he has heard of no instance of this disease within ten years; he had two cases under his care about twenty years ago. He has drawn our attention to the fact that Lord Nelson suffered from ague during his youth, which was spent in Norfolk. Southey[1] remarks that "ague which at that time (1758—1770) was one of the most common diseases in England had greatly reduced his (Nelson's) strength."

On the borders of Scotland ague was formerly very prevalent; and Graham[2] writing of the 18th century says that this was the one ailment to which the people were most liable. "Terribly prevalent and harassing this malady proved to the rural classes, for every year a vast proportion of the people were prostrated by it, so that it was often extremely difficult to get the necessary work of the fields performed in many districts." From the Scottish Register we learn that ague was very common about Berwick and at Roxborough in 1715. In the records of the Kelso Dispensary[3] for the latter part of the eighteenth century are to be found the annual number of cases treated there. They range from 17 in 1777 to 161 and 103 in 1780 and 1781 respectively, and then gradually fall, and after 1796 do not exceed 10. In 1807 they completely disappeared from the books. These figures not only fix the date of the disappearance of ague from this part of Great Britain, but also illustrate the great variation in the prevalence of the disease in different years.

Ireland has had the reputation of being exempt from ague, the

[1] *Life of Nelson.*

[2] Graham, H. G., *The social life of Scotland in the eighteenth century* (London 1900), Vol. I. p. 185.

[3] Christison, *Edinb. Med. Journ.* 1863, p. 427.

peat-bogs being especially stated to be free from this disease, but Wylde[1] speaks of ague in Ireland and of the occurrence of an epidemic in Dublin in 1805, and says that since that time cases have always been met with in Dublin and its neighbourhood. Dr William Stokes[2] has drawn attention to an epidemic of ague in Ireland in 1829, but considered it to have been imported from the English fens.

It is evident that in places where malarial diseases were endemic the prevalence of the disease varied greatly at different times. And in certain years assumed the proportions of an epidemic. The most recent example of this is afforded by the years 1858 and 59. And a reference to the following table will show that in these years ague was remarkably prevalent in 16 of the places mentioned there; and these include places so far apart as Hull, the Fens of Cambridgeshire, the Thames estuary, and the marshes around Bridgewater in Somersetshire. It is worth noting that these years were described as being remarkably dry. One can now easily believe that this variation in the prevalence of malaria in different years was associated with a similar variation in the numbers of *Anopheles;* for every entomologist knows how greatly the numbers of certain kinds of insects vary in different years, and it is probable, though not as yet an ascertained fact, that the *Anopheles* undergo a like variation in numbers.

Now that we know that *Anopheles* in England are not limited to the low-lying districts though doubtless more numerous there, it will easily be understood that, in seasons which are very favourable to them, the disease which they transmit may spread from the marshes to surrounding districts where they are usually scarce. Examples of such epidemics have occurred in modern times. Maculloch[3] wrote in 1827 of "numerous villages in Lincolnshire, Essex, Sussex and Kent, and indeed almost everywhere, in which the autumn used to pass over with a few insulated cases of fever, having been ravaged by epidemics which might well compare with those of many parts of France and Italy. And in the same manner those fevers have appeared where they were formerly unknown, and even their possibility unsuspected; a fact which in many cases seems to have excited considerable surprise among those who resorted to them as formerly to seek for health. That all these have been cases of marsh fever, and not of typhus as commonly supposed, is incontestable."

Another modern instance of an epidemic of malaria was reported by

[1] Wylde, *Edinb. Med. and Surg. Journ.* 1845, p. 263. [2] Cited by Wylde.

[3] Maculloch, *An Essay on Malaria.* London, 1827, p. 346.

Haviland[1] to have occurred at Cannington, a little village in Somersetshire in 1858. The place is situated on the border of the alluvial plain of the river Parrett three miles N.W. of Bridgewater. Ague once prevalent here, had given but little trouble in recent years, only 1·5 % of the cases admitted to the local dispensary in the previous 12 years having been attributed to this cause. In 1858 the number of ague cases at the dispensary amounted to 19 % of the total. And at two of the friendly societies to 29 %. In all there were 94 cases in a population of 800. It is notable that this little epidemic should have followed an exceptionally dry winter and spring.

Having shown that malarial disease sometimes spreads as an epidemic from those places where it was always present to others where it was usually unknown, we may now return to the "plague agues" of the time of the Restoration of which Sydenham and others wrote. The nature of these diseases is involved in some obscurity, which can only be removed by comparing the accounts of contemporary writers with those of modern authors, who have had the advantage of being able to base their diagnosis on the presence or absence of the plasmodium. Creighton nowhere definitely states whether he believes these epidemics to have been caused by malarial disease or not, but he frequently implies the latter belief. He thinks that "Sydenham was much influenced by the example of Hippocrates in giving prominence to the intermittent type of fevers" (vol. ii. p. 10). Moreover he remarks that Sydenham "had much to say of agues and intermittents prevalent in town and country, for a series of years, and then disappearing for as long as thirteen years at a stretch. But he does not count these as the agues of the marsh; his single reference to the latter is in his essay on Hysteria, where he interpolates a remark that if one spends one or two days in a locality of marshes and lakes, the blood is in the first instance impressed with a certain spirituous miasma which produces quartan ague, and that is apt to be followed, especially in the more aged, by a permanent cachectic state. If Sydenham had intended to bring all the intermittents of his experience into that class he would not have left the paludal origin of them to a casual interpolated remark....On the other hand he refers the epidemic agues which occupy his pen so much to emanations from the bowels of the earth, according to a theory of his friend Robert Boyle....Sydenham and his learned colleagues were not ignorant of the endemic agues of

[1] Haviland, A., *Journal of Public Health and Sanitary Review* 1858, IV. p. 266 et seq.

marshy localities, but they made little account of them in comparison with the agueish or intermittent fevers which came in epidemics all over England."

That Sydenham was really well acquainted with ague the following extracts from his writings[1] will show.

"All agues begin with shiverings and rigors, succeeded by heat and terminated by sweats....The symptoms decline in proportion as the sweats come on, when these have broken out copiously the fit seems to have gone off. He that was just now sick becomes a healthy man....Soon or late however the paroxysm repeats its attack, the intervals being as follows, for the quotidian twenty-four hours, for the tertian eight-and-forty, for the quartan sixty-two" (vol. i. p. 72). "Intermittents are of two kinds, vernal and autumnal. They may occur indeed at any intermediate period but may for the most part be referred to the months of February and August. True it is that the fevers of the two seasons have some common characters between them....In the meantime I am sure they wholly differ from one another essentially. The vernal ones are always quotidian or tertian, neither long nor dangerous....The autumnal intermittents are very different. They may engender a multiplicity of symptoms, scurvies, indurated bellies, dropsies. They may begin as early as June in years when the disease is epidemic. They are either tertians or quartans. In the beginning it is no easy matter to detect their intermittence in the first few days, since they may commence with the superaddition of continued fever. It is also difficult at first, unless you observe with great minuteness to detect anything beyond slight remission of the disease. By degrees however they end in perfect intermission, and take the type that answers to the season of the year" (vol. i. pp. 73—78)[2].

In these disorders he speaks of Jesuits' bark as his sheet-anchor and in another place he says that Peruvian bark "bears the bell," and he frequently refers to it as the great remedy for intermittents. "When occasion requires," he naïvely remarks, "we give it even to our wives and children"; again, "It has been famous in London for over five-and-twenty years. The disease in question was seldom or never cured by any remedy before it, hence agues were justly called the *opprobria medicorum*" (vol. ii. p. 12). "Since 1664 intermittents had been

[1] *The Works of Sydenham*, by R. G. Latham, M.D. 1850. Sydenham Society, London. Two Vols.

[2] Compare Thayer and Hewetson quoted later.

nearly banished from London for thirteen years. In 1678 they were again epidemic, and by the end of the summer and beginning of autumn they were pre-eminently prevalent, so much so as to exclude all other diseases from the name of epidemic. First I must note that although quartans were at first most common, tertians or quotidians are the commoner now. In like manner then tertians and quotidians, setting in with chills and shivers, followed by heat, and closing in sweats ended for awhile in complete apyrexy, only attacking the patient again after a stated interval." He goes on to say—and this is one of the passages which Creighton takes as showing that the disease in question was not malarial fever, "Nevertheless they kept this course only until the third or fourth fit, especially if the patient took cordials, kept his bed, and so, as the saying is, added fuel to fire, afterwards they so far assumed a severity foreign to their nature, that instead of an intermission there was only a remission. From this they went on to the type of continued fever, and at length affected the brain and proved fatal to many."

If we compare this with modern accounts we find that all the symptoms which Sydenham mentioned are recognised to-day as those of malarial fever.

Prof. Osler[1] gives the following definition of malarial fever. "An infectious disease characterised by (*a*) paroxysms of intermittent fever of quotidian, tertian or quartan type, (*b*) a continued fever with marked remission, (*c*) certain pernicious rapidly fatal forms. And (*d*) a chronic cachexia, with anæmia and an enlarged spleen." Osler recognises the following clinical forms:—(1) *Intermittent fever.* This form is characterised by recurring paroxysms of what are known as ague, in which as a rule chill fever and sweat follow each other in orderly sequence. (2) *Continued and remittent forms* of malarial fever, known as bilious remittent fever, and typho-malarial fever. The fever is continuous with remissions more or less marked. Intestinal symptoms are not present. A slight haematogenous jaundice may develop early. Delirium usually of a mild type may occur. (3) *Pernicious malarial fever;* (*a*) the comatose form, in which the patient is struck down with the most acute cerebral disturbance, either acute delirium, or more frequently a rapidly developing coma. (4) *The Algid form.* Characterised by vomiting, intense prostration, and feebleness out of all proportion to local symptoms. (5) *The Haemorrhagic form,* with haemorrhage from the mucous membranes, and Haematuria.

Osler mentions the following types of fever as prevalent in the South of the United States, (1) Typhoid fever, (2) Typho-malarial fever,

[1] Osler, W., *Practice of Medicine.* New York, 1892, pp. 140—156.

(3) Malarial remittent fever, (4) Continued thermic fever. He is inclined to think that, except the last, these fevers will ultimately fall into two classes only, Typhoid and Malaria. The presence or absence of the plasmodium he says must be the criterion of diagnosis.

Since this was written ten years ago much work has been done on malarial fevers, especially in Italy and America. And the presence or absence of the parasite has made it possible to distinguish accurately malarial from other types of fever. And it has been clearly shown that in what is now known as aestivo-autumnal malarial fever, definite intermissions may be absent. Marchiafava and Bignami[1] describe cases of malignant fever often of a sub-continued form, accompanied by coma, delirium, ecclampsia, hemiplegia, cerebral irritation, tetanic symptoms or haemorrhages, in all of which the characteristic parasites were found. They sum up their experiences with regard to irregular forms of malarial fever thus: "There is no group of fevers which is naturally and *per se* irregular, but fevers of every class may become irregular." Some types are more or less liable to this change, while in others like the aestivo-autumnal type it takes place very frequently.

Thayer and Hewetson[2], speaking of aestivo-autumnal fever in Baltimore say that there were many instances where overlapping of the paroxysms caused continued fever. "For instance," they say (p. 66), "one may see a typical summer tertian in the recurrence, while in the original infection the fever was irregular or sub-continued. But it is in the quotidian especially which in the majority of cases are observed to be distinctly intermittent only in the relapses."

These quotations will we think show that the epidemic agues of which Sydenham and others after him wrote may well have been true instances of malarial fever. Very serious pestilences they were. Thus Sir George Baker (quoted by Creighton) describes one of them:

"These agues were first noticed in London in the spring and autumn of 1780, but they infested various parts of England a little earlier. In the more inland countries the agues were often attended with peculiarities extraordinary and alarming. For the cold fit was accompanied by spasm and stiffness of the whole body, the jaws being fixed, the eyes staring and the pulse very small and weak. When the hot fit came on, the spasms abated and ceased in the sweating stage, but sometimes the spasm was accompanied by delirium, both lasting to

[1] Marchiafava, E., and Bignami, A., *On Summer-Autumn Malarial Fevers*. Translated by J. H. Thompson, M.D., New Sydenham Soc., London, 1894.

[2] Thayer, W. S., and Hewetson, J. (1895), *The Malarial Fevers of Baltimore*. Johns Hopkins Hospital Reports, Vol. v. pp. 3—218, 2 plates and bibliography.

the very end of the paroxysm. This fever had every kind of variety and whether at its first accession it were a quotidian, a tertian, or a quartan it was very apt to change from one type to another. Sometimes it returned two days successively and missed the third day and sometimes it became continual. I am not informed that any died of this fever while it intermitted. It is however certain that many country people whose illness had at its beginning put on the appearance of intermission, becoming delirious sank under it in four or five days." "It is a remarkable fact, and well attested, that in many places, whilst the inhabitants of the high grounds were harassed by this fever in its worst form, those of the subjacent valleys were not affected by it. The people of Boston and of the neighbouring villages in the midst of the Fens were in general healthy at a time when fever was epidemic in the more elevated situations of Lincolnshire. Women were nearly exempt, but few male labourers in the fields escaped it." "The distinguishing character of this fever was its resistance to Peruvian bark; nor indeed was the prevalence of the disease more observable than the inefficacy of the remedy[1]." Barker of Coleshill (cited by Creighton) writes of the same epidemic of 1781 as follows:—"This spring that very peculiar, irregular, dangerous and obstinate disease, the Burning—or as the people of Kent properly enough called it the Plague-ague made its appearance, became very epidemical in the eastern part of the kingdom, and raged in Leicestershire, the lower part of Northamptonshire, Bedfordshire, and in the Fens throughout the year....This strongly pestilential disease had such an effect upon them that the complexion of their faces continued for a time as white as paper and they went abroad more like walking corpses than living subjects."

From all this we may conclude that ague, always endemic in the marshes, was wont to spread in suitable seasons from its usual haunts and invaded large areas of this country and to rage so extensively that, in the words of Sir Joseph Fayrer, "England was one large hospital."

We have already referred to the probable association of these epidemics with an increase in the number of *Anopheles;* and it is curious to note that Sydenham held "that when insects do swarm extraordinarily and when fevers and agues (especially quartans) appear early, as about midsummer, then autumn commonly proves very sickly[2]."

[1] Thayer and Hewetson, as also other authors, state that aestivo-autumnal fever is much more resistant to quinine than are tertians and quartans.

[2] *Life of Sydenham* by R. G. Latham, Introductory to Sydenham's works already cited, Vol. I. p. xxviii.

The Distribution of Ague in England in the Nineteenth Century.

(*Places marked * are excluded from the map for want of space.*)

(*Authorities with* (W) *added are cited by Whitley.*)

County	Place	Observation	Date	Authority
Westmorland	Kendal	P. gives returns in Kendal Hospital for 1795—1821 and states 118 cases of intermittent fever occurred among 28,700 patients. In 1798 and 1799, 12 and 13 respectively, 19 in 1809, since which they diminished rapidly, only 6 cases in 8 years, 1813—1821	1795—1821	Proudfoot[1]
Cumberland	Carlisle	Ague not endemic. In 1859 of 2580 patients treated at the dispensary, only three entered as suffering from intermittent disease	1864	Whitley[2]
Lancashire	Ulverston	No intermittent disease during 30 years' practice, but had heard from others that a good deal had existed at the beginning of the century	1864	Dickinson (surgeon) (W)
	Garstang	There was some intermittent disease at Eccleston in 1826—1827, but none since	1826—1827	Dr Bell (W)
	Kirkham	Saw much ague prior to 1831, having sometimes 40 cases at one time	ante 1831	Dr Gradwell (W)
Yorkshire	Selby	Severe and frequent, especially in surrounding villages about 1823	1823	Burkitt (surgeon) (W)
	Howden	Common among adults and in schools in 1827. Almost unknown in 1864	1827	The schoolmaster (W)
	Hull	Very common many years before 1848—1863 when an average of 10 in-patients and 10 out-patients at the infirmary annually. The maximum occurred in 1857 and 1858	1848—1863	Whitley
	Patrington	Rare, except among inhabitants of Sunk Island, a low-lying district on the coast about two miles south of Patrington	1864	Dudley (surgeon) (W)
	Goole	Very frequent, but not often severe, in the early years of his practice ca. 1827. No well-marked cases in recent years (1864)	1827	Cass (surgeon) (W)
Lincolnshire	Brigg	Scarcely any, except imported cases	1864	Whitley
	Barton	Ague not endemic since he came to Barton, but currently believed to be common prior to drainage	1837	Morley (surgeon) (W)
	Gainsborough	Scarcely any cases on dispensary books. Dr Mackinder had seen none himself during 10 years	1864	Whitley
	Lincoln	Rare, but a few patients from surrounding districts treated in hospital. 12 cases, 1836—1853. 26, 1856—1859	1836—1859	Whitley
	Horncastle	Little known for many years	1864	Whitley
	Boston	Had seen much ague about 1819, now scarce, 1864. There was an accession of intermittent disease in 1858, 1859	1819—1864	Coupland (surgeon) (W)

[1] *Edinburgh Med. and Surg. Journ.* 1822, p. 386.

[2] Whitley, *loc. cit.*

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County	Place	Observation	Date	Authority
Lincolnshire (*cont.*)	Bourne	Declining in frequency and severity. Occasional outbreaks of intermittent and remittent fever	1824—1864	Nicholls (surgeon) (W)
	Spalding	(*a*) Still frequent, but less severe than formerly	1864	Whitley
		(*b*) Most frequent in 1808, 1826, 1827, 1858, 1859. His books showed 300 cases in private practice alone	1808—1859	Dr Cammack (W)
		(*c*) In a school of 85 as many as five absent from ague at a time. Of 75 boys questioned, 11 said they had had ague	1858 1864	Whitley
	Holbeach	Comparatively little ague and that mild tertian. There was an increase in 1859	1859	Dr Harper (W)
	Long Sutton	Intermittent fever frequent and severe when he came to Sutton (1829), and again in 1858 and 1859	1829, 1858—1859	Ewen (surgeon) (W)
Norfolk	King's Lynn	Severe ague prevalent in 1844, sees scarcely any cases now (1864)	1844, 1864	Deck
	Walpole-St Peter			Kendall (surgeon) (W)
	Terrington-St John's*			
	Wootton*	Extremely rare, though very common about 1814	1814	Rev. Clark (W)
	Norwich	Uncommon, 19 cases of ague treated in Norwich Hospital, 1820—1860	1864	House-surgeon (W)
	Acle	Treated a case of ague from Acle, Dec. 1897 to Feb. 1898, parasites found in blood by Dr S. Long, patient had never been out of Norfolk. The only case admitted "into Norwich Hospital for many years." Doctor at Acle stated he observed 1—2 bona fide cases annually	1897	Dr Burton-Fanning of Norwich[1]
	Wells	Formerly frequent as stated in 1864, but rarely if ever fatal	——	Rump (surgeon) (W)
	Walsingham	Some cases in 1859. Otherwise rare	1859	Whitley
	Heacham near Hunstanton	See note about Bluntisham below	ca. 1864	Deck
Suffolk	Lowestoft			
	Bury St Edmunds			
Cambridgeshire	Peterborough	Gave a table of admissions into infirmary, most of the cases being from surrounding fens	1816—1863	Dr Paley (W)
	Ely	Where there was one case about 1864, there had been 20 about 1859. Ague generally present up to 1864 in three or four cottages in Witchford on the edge of the fen	1859—1864	Muriel (surgeon) (W)
	Wisbech	Formerly common but now scarce	1864	Groom (surgeon) (W)
		Peacock gives mortality tables (see text)	1850—1858	Peacock
	Whittlesea	Saw moderate number of mild cases about 1850 to 1864	1850—1864	Crisp (surgeon) (W)
	Swaffham Bulbeck	Very prevalent in 1823, less frequent subsequently	1823—	Rev. Jennings[2]

[1] Letter to G. H. F. N. dated Aug. 1900.

[2] Cited by Miller and Skertchly, *The Fenland Past and Present*, Longmans, 1878.

County	Place	Observation	Date	Authority
Cambridgeshire (*cont.*)	Bluntisham, Willingham, Chatteris, Newmarket	Mr Deck, chemist in Cambridge, informs us that his father supplied quinine pills for ague in these places, and has shown us a list of testimonials. This note applies to the other places where Mr Deck's name is cited	ca. 1864	Deck
	Waterbeach, Cambridge (vicinity)	In the memory of older physicians ague prevailed here		
Huntingdonshire	St Ives	Saw a good deal of ague about 1834, scarcely any during next decade	1834—1844	Girling (surgeon) (W)
	Warboys, Little Stukely, Wistow	See note above relating to Bluntisham	ca. 1864	Deck
	Huntingdon	Peacock gives mortality tables (see Text)	1851—1858	Peacock
Bedfordshire	Potton, St Neots	See note above relating to Bluntisham	ca. 1864	Deck
Essex	Rochford	Ague formerly extremely common and severe, but gradually decreased	1817, 1864	Dr Grabham (W)
		Very common among the children about 1849	1849	Schoolmaster (W)
	Mucking, Bulpham, Corringham	Still not uncommon though no longer very severe	1864	Corbet (surgeon) (W)
	Maldon	The greatest prevalence of late years was in October, 1859. Not $\frac{1}{100}$ of the ague in 1864 that existed 20 years earlier	1859	Tomlinson (surgeon) (W)
	Tilbury	"Tilbury fort has long been regarded as unhealthy, and the troops have of late years been relieved every six months." In 1873 there were 12 admissions for ague among 102 men quartered at the fort during the first six months, and in the same period in 1872 there were 34 admissions for ague among 103 men stationed there	1872—1873	Faught[1]
	Romford	The neighbourhood was peculiarly exempt from ague about 1864, but one or two cases occurred in the town itself in 1859	1859	Deck, Davey (surgeon) (W)
	Rainham	Several cases	,,	,,
Surrey	London	(*a*) Gives the proportion of cases of ague to total number of patients admitted to St Thomas's Hospital (see Text)	1850—1859	Peacock
		(*b*) Refers to existence of ague on the Surrey side of London	1847	Hicks[2]
Kent	Sheerness	Ague prevailed to an unusual extent during 1858—59 in most of the districts where it was still met with in 1864. It appeared in those years in places, especially elevated ones, where it was previously almost or entirely unknown. It decidedly decreased after 1860	1858—1860	Whitley

[1] Faught, Surgeon-Major J. G., "Report on the Prevalence of Ague at Tilbury Fort." *Army Med. Depart. Report*, 1874, XVI. p. 35 and 1875 (London, 1877), XVII. pp. 212—216. Two plates.

[2] Hicks (1847), "On Malaria, with a few cases illustrative of its existence on the Surrey side of the Thames." *London Med. Gazette*, n. s. Vol. IV. p. 121.

County	Place	Observation	Date	Authority
Kent (*cont.*)	Milton	Intermittent disease rather common	1864	Ray (surgeon) (W)
		In spring and autumn one-eighth to one-sixth of the children are usually affected with ague		Schoolmaster (W)
	Faversham	The house-surgeon stated, 1864, that there was then scarcely any ague, but it was common and severe when he first came (1838), and in the dry summer of 1859 many severe cases occurred	1838—1859	House-surgeon (W)
	Ospringe*	One mile from Faversham. Many children suffered from ague in 1859	1859	Whitley
	Woolwich Purfleet Plumstead	Many cases of ague were treated among the out-patients of King's College Hospital, London	1845—1860	Lionel Beale[1]
	N. Aylesford	Gives mortality tables (see Text)	1850—1858	Peacock
	Hoo and Island of Grain	(*a*) Cases of ague occurred among the navvies working in the marshy neighbourhood of Grain. In the Hoo Union, 347	1864	Wright (surgeon) (W)
		(*b*) Cases occurred between 1852—1863	1852—1863	Whitley
	Gravesend	(*a*) The dispensary records show 678 cases of intermittent and remittent fever between 1856—1862, including 371 in 1859	1856—1862	Whitley
		(*b*) Ague greatly on the decrease about this year	1864	Armstrong (surgeon) (W)
	Wittersham* Stone* Ebony Tenterden Appledore Brookland* Kennardington Woodchurch	Mr Robert A. W. Stevenson, chemist at Wittersham during 1867—1875, said there were hundreds of cases in the places named, and in others in Sussex (see below). He used to supply quinine to the people in the neighbourhood, and remembers when there were "7—8 patients of a Sunday morning." When he returned there in 1882 ague was very rare	1867—1875	[2]
	New Romney	Had seen much regular ague when he began to practise about 1833	1833	Adamson (surgeon) (W)
Sussex	Arundel	See note above under Bluntisham		
	Rye	Saw much ague (tertian) when he began to practise in 1824. There was a considerable increase in 1859	1824—1859	Deck
	Bexhill	Not much ague when he came to the neighbourhood (1844), and very little in 1864. The cases he saw were mostly on high ground at the edge of Pevensey Marsh	1844—1864	Wallis (surgeon) (W)
	Lewes	Very common	1826—1827	Sanby (farmer) (W)
	Glynde	St C. himself and several members of his family stated that they had suffered much from ague, but less of late years	ante 1864	Rev. St Croix (W)
	Beddingham	Intermittent disease very prevalent and in surrounding country	1864	Holter (surgeon) (W)
	Piddinghoe near Newhaven	Whitley was informed that a severe form of ague, not uncommonly quartan, formerly prevailed	ante 1864	Whitley
	Peasmarsh Snargate* Iden* Playden	See note to Wittersham in Kent above	1867—1875	

[1] Letter to L. C. dated 20th Oct. 1900.

[2] Stated by Mr Stevenson to G. H. F. N. 1900.

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County	Place	Observation	Date	Authority
Hampshire	Lymington	In the early years of his practice, 1829—1864, had seen at one time a considerable amount of well-marked tertian	1829—1864	Adams (surgeon) (W)
	Christchurch	Much ague in 1827—1830 in the lowlands of the Avon and Stour	1827—1830	Welch (surgeon) (W)
	Lyndhurst	Ague lingered on somewhat longer than at Christchurch	1831	,,
Somerset	Cannington	Ague endemic 1823—1828, the land being badly drained. This succeeded by 10—12 years, when only about 1·5 % of dispensary cases were malarious. In 1858 increased to 19 %, 94 cases occurring in a population of 800	1823—1858	A. Haviland[1]
	Chedzoy	Quartan ague occurred about Chedzoy	1864	Hurman (surgeon) (W)
	Bridgewater	The records of Bridgewater Infirmary show no case of ague amongst the in-patients for 1854—1855, three in 1858, two in 1861	1858, 1861	Whitley
	Huntspill	Told Whitley that this was always an ague locality. He had about 100 cases of ague, chiefly quotidian. He believes it had rather increased during his experience	1826—1864	Poole (W)
Cornwall		Lands End district hilly, dry and almost devoid of marsh-land and stagnant water. About 1796 many cases in this district, after which progressively diminished		
	Penzance	Only three cases reported in Penzance dispensary in period of 17 years amongst 8800 patients. Only one case during 11 years of Forbes' residence there, subsequently not a single case. Oldest practitioner had not seen a single case at Penzance during 50 years, nor in Cornwall for 12—20 years. Penzance dispensary register for 1810—13 gives two cases, 1819—22 gives one case, and none during 1823—33. Considerable decrease due to drainage, better houses, but admits something else is wanting for the explanation of the change there[3]	1796—1822	Forbes[2]

[1] Alfred Haviland, "Ague Epidemic at Cannington." *Journ. of Publ. Health and Sanit. Rev.* Vol. IV. 1858, p. 266.

[2] Forbes, J. (1836), "Medical Topography of Lands End and the Hundred of Penrith." *Trans. of Prov. Med. and Surg. Assoc.* Vol. IV.

[3] The wanting element is possibly to be found in the decrease of ague in its marshy home and to the consequent cessation of foreign cases, thus rendering it impossible for the few local mosquitoes to become infected.

It having been incontestably proved in Italy, Holland, England and the United States that at least two species of *Anopheles* occurring in Great Britain are capable under certain conditions of transmitting malarial infection to man, we on the strength of our investigations have reached the following

Conclusions.

1. The disappearance of ague from Great Britain does not depend upon the extinction of mosquitoes capable of harbouring the parasites of malaria.

2. Three species of *Anopheles* (*A. maculipennis*, *A. bifurcatus*, *A. nigripes*) are to be found in Great Britain in all districts which were formerly malarious, but also in places concerning which there is no record of the former prevalence of ague.

3. The *Anopheles* to-day are most numerous in low-lying land containing many ditches, ponds and slowly flowing water, suitable for their habitat, and corresponding to the districts where ague was formerly prevalent.

4. Since the disappearance of ague does not depend upon the extinction of *Anopheles* it is probably due to several causes operating together:

(*a*) A reduction in the number of these insects consequent upon drainage of the land, this being in accord with all the older authors who attributed the disappearance of ague largely to this cause.

(*b*) Reduction of the population in infected districts as the result of emigration about the time when ague disappeared from England. This would naturally reduce the number of infected individuals and thus lessen the chance of the *Anopheles* becoming infected.

(*c*) It is possible that the use of quinine has reduced the chances of infecting the *Anopheles* through checking the development of the parasites in the blood of subjects affected with ague.

Of these, the first-mentioned cause seems to have been chiefly operative. The possibility is not yet excluded of there being another intermediary host besides man capable of harbouring the parasite, and, assuming that this were so, this host may have become extinct in the lowlands where it is known that the fauna and flora have altered.

5. The coincidence of the geographical distribution of ague and *Anopheles* as claimed by Grassi for Italy, and as probably holding good for other parts of the world, is hereby disproved for England, and

consequently the generalizations are proved to be premature whereby he excludes other blood-sucking insects from being possible hosts of malarial parasites on the strength of this supposed geographical agreement.

6. Since the geographical distribution of *Anopheles* in England is wider than the former distribution of ague in this country, we are forced to conclude that it is not a matter of the geographical distribution of *Anopheles* as much as of their *numerical distribution.*

7. Our observations having proved the existence of *Anopheles* in non-malarious districts, we believe that they will explain the occasional occurrence of ague in out of the way places, without making it necessary to assume that malaria-bearing mosquitoes have been freshly imported, for given suitable conditions of temperature and the requisite number of *Anopheles,* a malarious subject coming from other parts might well infect the local insects, which in turn would spread the infection to healthy persons.

8. We would suggest to those engaged in the investigation of malaria in other countries to search as carefully for *Anopheles* in non-malarious as in malarious regions. More data as to the number of these insects in various localities are certainly required, though we are fully aware that numerical estimates permit of a considerable degree of error. Nevertheless they would always possess a relative value.