The percentage cancer mortality for the L— district for ten years is 0.62. Dr. F. M. Rowland remarks that E—, Ch—, and C— are the districts with the highest mortality, namely, 1.87, 1.5, and 1.52 respectively. The two former are very low-lying, and practically on the water subject to floods. The small village of C—, on the other hand, is hilly and high above sea level. It has, however, a stream which, though rapid, some two years ago fell under suspicion of pollution which was supposed to be the cause of the loss of some cattle.

The percentage for the neighbouring district of R— is 0.71, and for the town of R— 0.77, and the town of A— 0.79. From interesting reports on the physical conditions of these districts, kindly supplied by Dr. Hubbard and Mr. W. E. Rogers, we find that A— lies between the rivers Trent and Tame, and is very flat and low. Water can be reached anywhere at from 4 to 5 feet down. The soil is a black sandy peat. The town of R— lies low, and is skirted on one side by the Trent; the meadows close to the river are generally flooded after heavy rains. The soil is a loose-washed gravel, with line of saturation 12 to 14 feet below surface.

The rate for the C— urban district is 0.35, just half that of the contiguous district of R—. Dr. J. N. Phillips's excellent report gives the geological character of the district as "generally a gravelly subsoil of the new red sandstone formation with a mixture here and there of clay beds. The surface consists of a series of undulations, sloping gradually down from Castle Ring, which is 800 feet above sea level. The surface formation, together with the gravelly subsoil, renders it peculiarly adapted for the efficient filtration of surface waters."

Dr. Murray, in an interesting report of the T— Union, says: "The parishes which have the highest rate of mortality from malignant disease are, with one exception, those which lie in the Teme Valley and on the south bank. The subsoil, I believe, is gravel. The river receives untreated the sewage of L— and T—, and all the valley is very liable to ground fogs almost nightly.....The parishes which are free, as a rule, lie on higher ground."

It is not possible to give extracts from all the reports received, but the above have been selected as being good instances, and as being specially interesting. It has not been forgotten by the Committee that in order to insure complete accuracy in the statistics relied upon, correction should be made for both age and sex incidence. With regard to the latter, it does not appear that in any case dealt with so far the figures would have to be materially altered in consequence. With regard to the former, however, such corrections would probably raise the proportionate cancer death-rate in most of the centres of industry and lower it in country districts, but it would scarcely affect the figures when two contiguous country districts were compared.

As far as this investigation has at present gone there seems to be a very large balance of opinion in favour of the following conclusions:

1. Districts in which malignant disease occurs with a frequency much above the average often lie side by side with other districts in which it rarely occurs.

2. The districts in which malignant disease occurs with the greatest frequency are usually ill drained, low-lying or flat, or border on streams; while those districts where it is less common are usually higher, drier, and more open, with the possibility of more rapid drainage of surface waters.

That certain physical conditions influence the prevalence of malignant disease is suggested by the figures published in the supplement to the Fifty-fifth Annual Report of the Registrar-General, Part I. Here it is seen that the cancer death-rate (uncorrected for age or sex), which averages in the decade 1881-1890 0.53 per 1,000 per annum, rises in the case of Cambridgeshire to 0.78, and in that of Huntingdon to 0.91, and falls in the cases of Durham, Staffordshire, Lancashire, Derbyshire, and Monmouth to from 0.44 to 0.48. This variation was also noticed in the same counties in the two previous decennia.

Dr. Tatham remarks in his excellent comments on these returns, "An examination of the uncorrected cancer-rates in the separate registration districts within and around the counties of Huntingdon and Cambridgeshire shows a fairly well-defined area in which cancer would appear to be excep-

tionally prevalent. This area consists of the districts of Stamford, Bourn, Spalding and Holbeach in Lincolnshire; Oundle and Peterborough in Northamptonshire; and the entire counties of Huntingdon and Cambridge, with the exception of the registration districts of Caxton, Linton, and Newmarket." A glance at the map will show that this particular area is a low-lying piece of land through which slowly meander the various rivers and streams which terminate in the Wash.

Mr. Alfred Haviland in a paper published in 1879 says: "The mortality.....is highest in those districts which skirt the rivers of our country which are seasonally flooded..... Throughout England and Wales there does not exist an important river subject to seasonal floodings that does not flow through high mortality districts." He adds that all those districts where cancer does not thrive "are characterised by being high and dry, and geologically composed of non-retentive soils, permeable soils and subsoils in fact."

Dr. W. H. Symons published in the December number of *Public Health* a careful and interesting paper on Cancer in Relation to the Dwelling. After tabulating the cases of malignant disease occurring in the city of Bath for a number of years he comes to the following conclusions: "In Bath there are no cancer houses, and I find no evidence that locality has any influence upon the prevalence of malignant disease. The cause of cancer appears, as far as this investigation affords information, to be generally personal or intrinsic." But it is unnecessary to point out that the problem in Bath, with its "large nomadic senile population," is a far more complex one than is the case in country districts or in towns with a more "fixed" population. This characteristic, while helping to explain the high cancer mortality of Bath, must also greatly increase the difficulty of drawing any correct conclusions from the results of an inquiry into the local incidence of cancer.

Whether the character of the immediate subsoil apart from its humidity, or perhaps the stagnation or contamination of the water which it contains, has any influence on the prevalence of cancer, seems at present very doubtful. Some returns point very strongly to a greater prevalence on clay soils, others again suggest a greater frequency on sand. In this connection it should not be forgotten that a shallow sand bed overlying impervious clay, a not uncommon condition, may be even more damp and waterlogged than where the subsoil is entirely clay. Again if the clay is only a thin layer and overlies sand, sandstone, or other porous material; then a much drier condition of subsoil obtains than where the reverse is the case. It also seems more than doubtful if the variations in cancer mortality are in any way dependent on the quality of the water used for drinking purposes, or on overcrowding *per se*. What, however, seems almost certain, is that there is a direct connection between the presence of subsoil water within a certain distance of the surface and the prevalence of malignant disease.

It is hoped that the returns for the four counties will be sufficiently complete by next autumn to enable the Committee to present to the Branch a full report dealing, as far as possible, with each district. The Committee should then be able to add some valuable information to what is already known on this subject, of the importance of which there can be little doubt.

The Committee wish to take this opportunity of thanking all those who have been good enough to aid in the work by supplying reports and returns, and without whose assistance the work of course could not have been even attempted.

In conclusion, the Committee asks permission to continue its investigations for another year with the approval and sanction of the Branch.

THE TOPOGRAPHICAL DISTRIBUTION OF CANCER.

By E. LLOYD JONES, M.D.,
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DURING the last decade numerous observers have pointed out that cancer¹ has its predilection for certain districts and certain sites, and yet their observations—laborious and painstaking

¹ For the purposes of the present paper I find it convenient to include under the term cancer all malignant neoplasms.

as they often were—have been by no means generally accepted, nor have they perhaps received so much attention as they deserve.

This reluctance to accept the conclusions of these investigators—(most conspicuous among them are Haviland, Pfeiffer, Fiessinger, and Noël)—is doubtless attributable in part to the fact that their observations are not entirely consistent between themselves; hence the hypotheses of the topographical distribution of cancer have fallen into neglect. Further, the acceptance of such a supposition seems to imply a readiness to place cancer among the infective processes, and there is in many minds a great reluctance to appear to accept or to favour a surmise which has, as yet, hardly one fact in its favour.

In the present research I have, first of all, sought to determine in what manner cancer is distributed in the borough of Cambridge and in the surrounding country, in the hope both of showing whether the results obtained by previous workers are supported by the facts of its distribution in this district, and also of clearing away some of the difficulties which delay the general acceptance of their proposals.

Briefly, the following are the points upon which, in each case, several of the most trustworthy authors are agreed:

1. That cancer picks out certain districts, and that there are areas of immunity and cancerous areas (Shattock, Noël, Guelliot, Behla).
2. That immune areas may lie close beside cancerous areas (Pfeiffer, Noël).
3. That malignant disease is most common along the banks of rivers or streams (Pfeiffer, Haviland, Fiessinger, Noël, Nason, Blake).
4. That elevated districts or plateaux are more free from cancer, while low-lying districts carry more liability to its inroads (Pfeiffer, Noël, Haviland, Fiessinger, Nason).
5. That isolated "cancer houses" or groups of such houses occur in certain districts (Pfeiffer, Fiessinger, D'Arcy Power, Scott, Chapman, Noël, Ogle, Guelliot).
6. That cancer houses often occur near to woods (Fiessinger, Noël), orchards (Fiessinger), or forests of firs (Noël).
7. That persons living upon flooded and clay districts and retentive soils are especially liable to its ravages (Haviland, Butlin).
8. That limestone districts are comparatively free from cancer (Haviland), but do not confer absolute immunity (Butlin).
9. That cancer may be disseminated by means of water (Fiessinger, Noël, Haviland, etc.); that it depends upon the presence of decaying animal or vegetable matter or sewage (Haviland, Noël).
10. Lastly, the suggestion is thrown out by three observers that insects may play a part in the dissemination of malignant disease (Morau, Fiessinger, Noël). Of these three the first is the only one who adduces anything like proof of his assertion.

Apparent exceptions to these arguments are not lacking. Butlin has pointed out some of them, and others have also found that cancer occurs in situations where apparently those observers would not expect it. For instance, in some cases cancer districts occur at relatively high altitudes (Butlin), the two banks of the same river show differing aptitudes for its occurrence (Butlin); some consider cancer more frequent in towns (Finkelnburg), others in the country (Noël, etc.). Again, most authors speak of "cancer houses," but Symons states that in Bath there are no cancer houses, and that he finds no evidence that locality has any influence upon the prevalence of malignant disease. Although most observers agree with Haviland that limestone and chalky districts are comparatively free from cancer, Blake speaks of its "frequent occurrence in chalk valleys and districts containing periodical springs and rivulets."

In spite of these differences of opinion there is, on the whole, a remarkable unanimity regarding the appearance of malignant disease in certain houses, districts, soils, or rocks, and under certain conditions of moisture, of elevation above the sea level, of the neighbourhood of woods. The discrepancies arise, I believe, from the fact that the several areas have not been sufficiently thoroughly investigated. This, I believe, because in this district, at any rate, the exceptional cases become less puzzling, when the history of the illnesses and the peculiarities of the district are taken into account.

In the present investigation I have made a record of all the cases of cancer occurring in the borough during 19 years. The method adopted consisted in copying out, first of all, the death-certificates, dividing the names into classes:

1. Persons who died in their own house, divisible into two classes;
 - (a) Taken ill in their own houses; and (b) who were taken ill elsewhere.
2. Persons who died in Addenbrooke's Hospital, but who came from the outlying country districts.
3. Persons who died in Addenbrooke's Hospital, but who were taken ill in the town.
4. Persons who died in the workhouse, divisible into:
 - (a) Natives; and (b) immigrants.

5. Persons of classes (1), (3), and (4b), who had removed from one part of the town to another after the onset of the disease.

By duly regarding these distinctions a list was, with some trouble, compiled of all the houses in which persons have been taken ill with cancer during the 19 years. Any error due to the pulling down or rebuilding of houses I have met by finding out the date when each house (over 5,000 of them), in the parts of the borough concerned, was built. All houses which had not been standing for the whole of the 19 years, whether affected by cancer or not, were neglected; and thus I gained a map showing upwards of 5,000 houses, standing and inhabited for 19 years, and showing the number of cases of cancer in each. Another possible source of error lay in the difficulty of ascertaining exactly the "age of the population" in the different parts of the town. Although I have no exact information, yet this point has not been overlooked, and I believe that differences in the age of the populations in different districts will not account for the differences in the number of cases of cancer. In streets quite similar in character I find wide differences in the extent to which the inhabitants are attacked by cancer.

Further, I have begun to investigate the cases of cancer which have occurred between this town and the loftier ground above Royston. The same method was adopted, the investigation of each case proved often a long task, but from my point of view a very remunerative one.

Having obtained the list of houses in which persons had been taken ill with cancer, I proceeded to visit the houses and to mark each one on an Ordnance map—scale of 10 feet to a mile—showing the affected and the non-affected houses in red and black respectively. This map of the borough showed at once that certain districts were fairly free from cancer, while other regions were far more extensively affected. The areas most affected of all showed 1 case in every 2 to 5 houses; the most healthy areas, from this point of view, showed only 1 case (or no case) in every 60 houses. The figures obtained were as follows:

Total number of houses concerned	...	...	5,685
Unaffected houses...	...	...	5,247
Affected houses	...	...	438

Showing a mean of 1 affected house to every 12.9 unaffected houses.

Multiple cases in the same house divisible into:

- (1) Double cases, 7.
- (2) Triple cases, 3.

Space forbids me to enter into details, so I must at present content myself with stating the conclusions to which I have been drawn, which are as follows:

1. That some parts of the town are comparatively free from cancer; while other parts, often contiguous to the former, suffer severely.

Thus, on the neighbouring sheets of the Ordnance Survey, the relation of which to each other is shown in the diagram on p. 815, the number of affected houses increases in proportion to the unaffected as one passes from west to east, until it suddenly diminishes in Sheet xlvii, 2, 5. On Sheet xlvii, 3, 7, the ratios of houses affected to the unaffected are 31, 10, and 2 in the three quarter sheets marked. The Quarter-sheet xlvii, 3, 7, L. 2, however, only contains 13 squalid, filthy hovels, shut in by high walls and without proper ventilation; and if we may rely on such scanty data the mortality among those 13 houses has been greater than in any other part of the town.

2. That elevated sites are, other conditions being the same, less liable to the inroads of cancer than low-lying districts.

But although, generally speaking, elevation confers some degree of immunity, it is but one of other factors which play a part in producing the net result; and residence at a considerably elevated site, as Butlin has already pointed out, does not confer immunity. The reasons for this and the other influences at work must be considered in the latter part of this paper.

3. That underlying chalk occurred sometimes in parts of the town and neighbouring country most free from cancer.

4. That proximity to the river is not always attended by a greater death-rate from cancer; though damp situations are more apt as a rule to harbour cancer than dry ones.

In Sheet xlvii, 2, 12 (R. 2), showing houses bordering on the river, with large trees close to windward, cancer is very common (1 in 5); in Sheet xlvii, 2, 2, showing a part of the town also on the river bank, cancer is much less common.

5. That proximity to trees, especially large ones, is con-

XL.14.2.2.									
L.1.	R.1. Unaffected Houses 62 1 to 62 Cancer 1.								
L.2.	R.2 Unaffected Houses 13 Cancer 0.								
XLVII.2.2.		XLVII.2.3.		XLVII.2.4.		XLVII.2.5.		XLVII.3.7.	
L.1. Unaffected Houses 27 1 to 13 Cancer 2.	R.1. Unaffected Houses 125 1 to 17.8 Cancer 7.	L.1. Unaffected Houses 49 1 to 8.1. Cancer 6	R.1. Only about 2 Residences.	L.1. No houses. (Common land.)	R.1.	L.1. Few houses.	R.1.	L.1. Unaffected Houses 62 1 to 31 Cancer 2.	R.1. Unaffected Houses 30 1 to 10 Cancer 3.
L.2.	R.2. Unaffected Houses 61 1 to 7.6 Cancer 8.	L.2. Unaffected Houses 83 1 to 9.2 Cancer 9.	R.2. Unaffected Houses 45 1 to 11.2 Cancer 4.	L.2. Unaffected Houses 31 1 to 5.1 Cancer 6.	R.2. Unaffected Houses 80 1 to 6.1 Cancer 13.	L.1. Unaffected Houses 121 1 to 30.2 Cancer 4.	R.2. Unaffected Houses 128 1 to 16 Cancer 8.	L.2. Unaffected Houses 13 1 to 2.1 Cancer 6.	R.2.

nected in some way with the prevalence of cancer. The part of the town which is most free from cancer is singularly devoid of trees or vegetation; while the disease is very prevalent in well-wooded parts of the town, and among houses hemmed in by trees.

6. That decaying vegetation, filth, and collections of manure, etc., are often found in cancer districts.

Yet, curiously enough, some of the poorest and dirtiest districts are the most free from cancer, and we may suppose that the inhabitants die without living to an age when they may be liable to malignant disease. This explanation, however, cannot be sufficient, for some of the poorest parts of the town are most affected by it. Dr. Symons explains the difference in incidence of cancer by difference of age and character of population; but I think that such differences cannot account for the distribution of the disease in Cambridge.

Applying the same method to another district between here and Royston—an investigation only partly completed—I find that the elevated chalk districts above Royston, which I have so far studied, are remarkably free from cancer; the cases which do occur are often of immigrants, or they occur in small damp ravines between the chalk hills. These isolated cases occurring in hollows in the chalk, would have made a discrepancy in my results, perhaps, had I not personally visited every house. Unless the houses are actually seen and the cases investigated as to (1) place of onset of the disease: (2) peculiarities of the site—whether in a hollow or otherwise, and other details—discrepancies between different observers have arisen, of course, and will arise.

The conditions most conducive to cancer are, I should say, a damp site, low elevation, and proximity to large trees.

Dampness exerts a marked influence on the manifestation of cancer. To give an example, a clay subsoil disposes to cancer; it is also damp; a chalk subsoil carries some immunity from cancer, it is comparatively dry. But a clay subsoil under certain conditions may be dry—as when there is a clay capping to a slope, in which case the site is dry, and cancer is rarer than it would otherwise be: and a chalk subsoil may be damp if it lie in a hollow.

In a section near Royston, the cottages in two parts of the section are quite free from cancer—imported cases excepted; two other parts, however—the one a ravine and the other a slope leading to a large valley—are marked by the prevalence of cancer.

If I had not visited the district I should only have been made aware of the existence of a hilly chalk district with an undue amount of cancer, but having seen the place and and inquired about the cases I can say that the cases of cancer occurring in the hollows of this chalk do not afford exceptions to the generalisation regarding the influence of a

chalk subsoil, but show that it is dampness of soil which possibly encourages the prevalence of cancer.

A low altitude favours the manifestation of cancer in the same way as dampness, perhaps by causing dampness, but this is, I believe, not invariably the case. This exception to Haviland's dictum is understood if we bear in mind that a high elevation does not always confer immunity, because a site in a hollow at a high elevation is usually damp, be the soil or subsoil what it may. Butlin noticed this exception, and I think that I have given the explanation of it. Large trees, in the next place, predispose to cancer, a point upon which I have, perhaps, sufficiently enlarged.

Bath has afforded Dr. Symons little proof of the correctness of the views of the Haviland school; but I think Bath is a town where deductions are rendered very difficult by the complex features of the site; not knowing the town well, however, I am unable to suggest an explanation of our differences. Space alone forbids my criticising this very valuable contribution to the subject; on the whole, it appears to me that Dr. Symons's facts are rather in favour of our views than contrary to them.

I have been unable to render these observations as complete as I should have liked, but, in the main, they appear to me to corroborate the opinions of previous observers. The complete explanation of these facts remains for the future. Whether cancer be due to a microparasite or not, whether it be airborne, or conveyed by soil, water, food, or insects, is to enter the sphere of pure speculation. Nevertheless, the matter is one of great importance, and such facts as these, which I have considered, afford the strongest of all arguments which can be adduced in favour of the parasitic origin of cancer.

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