bacillus ; and I think we may conclude—though at present there is but a single observation—that the horse is liable to nasal and laryngeal diphtheria. The discovery is of practical importance, since it points out a hitherto unsuspected channel by means of which the infection may be carried to man. It is of scientific importance also, because it has a direct bearing on the question of the origin of antitoxin. As is well known the serum of normal man, both adult and infant,¹ and that of the horse which has never been immunised with the diphtheria bacillus or its products, have often the power of neutralising diphtheria toxin²; and it has been shown, in the case of the horse at least, that this protective serum unites with toxoids as well as with toxin proper, just as does the serum of an immunised animal—that, in a word, it contains true antitoxin.³ The diphtheria antitoxin found in man is probably due, as A. Wassermann has suggested, to some previous attack of diphtheria, possibly unrecognised, while that found by Fischl and Wunsheim in the placental blood of infants may have been derived from mothers who had had the disease. Now that the horse has been found to suffer naturally from diphtheria the presence of diphtheria antitoxin occurring naturally in this animal is easily explained.

Professor Ehrlich,⁴ however, has suggested another explanation of the natural occurrence of diphtheria antitoxin in man and horses which brings this fact into harmony with his most interesting *Seitenkette* theory of the origin of antitoxin. His argument may be shortly stated as follows : Foodstuffs must of necessity have a chemical affinity for some part of the substance of the cells which they nourish. He assumes that the molecules of the cells have “side-chains,” and that the molecules of the food have “haptophoric” groups of atoms, by means of which they bind themselves to these side-chains of the cell molecule. The bacterial poisons and certain other poisons, such as venom, ricin, abrin, &c., also have “haptophoric” groups of atoms in their molecules which enable them to bind themselves to the molecular side-chains of the cells which they destroy. Now the living cells do not possess special kinds of molecular side-chains merely that they may be susceptible to the action of certain poisons ; but it happens that the binding groups of each of these poisons are identical with the binding groups of some particular food-stuff, so that the poison is able to act by seizing on to a side-chain hung out, so to speak, to catch food. Experiment has shown that the injection of these toxins, or even of their binding groups alone (toxoids) into animals causes the appearance in their serum of a specific antitoxin ; and that the injection of certain food-stuffs also, such as globulin, peptone, &c., produces specific anti-bodies (precipitins) strictly analogous to the antitoxins, in the serum of the animals injected.⁵ From this it may be inferred that the injection of a food stuff which has binding groups identical with those of a certain poison ought to produce the same anti-body as the injection of the poison itself. Thus Ehrlich suggests that diphtheria antitoxin in apparently normal animals is present as a consequence of the assimilation of some food-stuff which has the same binding groups as diphtheria toxin.

I do not wish to enter into any general discussion of, much less to attack, the *Seitenkette* hypothesis, which knits together, and is supported by, so many observations ; but I must point out that the fact that the horse may suffer from diphtheria suggests a much easier explanation of the occurrence of diphtheria antitoxin in this animal than that put forward by Ehrlich. Moreover, the fact that all horses do not possess this natural antitoxin is more consonant with the view that it is present in those which have accidentally contracted the disease than with that which attributes it to the assimilation of a certain food, seeing that the food of all horses is so nearly alike. It is hardly necessary to mention

that up to the present time no food-stuff has been found the injection of which will lead to the appearance of diphtheria antitoxin, and, so far as I can ascertain, no normal animal, with the exceptions already mentioned, possesses an antitoxin of any kind in its blood.

The fact that diphtheria antitoxin is present in many horses⁶ in this country and on the continents of Europe and America suggests that diphtheria is a common disease among these animals ; and this is in accordance with the well-known susceptibility of some of them to the action of diphtheria toxin. It is therefore possible that the horse may be found to play a not inconsiderable part in the transmission of diphtheria.

Cambridge.

THE INCREASE AND DISTRIBUTION OF
CANCER IN EASTERN ESSEX.¹

BY GEORGE MELMOTH SCOTT, B.A., M.B.,
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SOME 1000 deaths from cancer occurred within the two unions of Chelmsford and Maldon in Eastern Essex between the years 1871–1898 inclusive. This period contained two complete intercensal periods of 10 years each (1871–1880 and 1881–1890) and an incomplete period of eight years (1890–1898). In order to compare the mortality of one period with another it was necessary to calculate this last incomplete period to 10 years—i.e., the figures shown are ten-eighths of the figures of those obtained from the registers. These figures are shown in Table I. :—

TABLE I.—Total Number of Deaths in each Decade.

	1871–1880.			1881–1890.			1891–1900.		
	Total deaths.	Proportion of males to females.	Deaths per 1000.	Total deaths.	Proportion of males to females.	Deaths per 1000.	Total deaths.	Proportion of males to females.	Deaths per 1000.
Persons ...	274	—	4·78	355	—	6·23	447·5	—	7·73
Males ...	93	51·38	3·22	135	61·36	4·74	203·75	83·59	7·05
Females ...	181	100	6·36	220	100	7·73	243·75	100	8·41

From this we see that the number of deaths per decade increased from 6·36 in the first, to 7·73 in the second, and 8·41 in the third. At first sight this would appear to be conclusive evidence of an increase but further investigation throws doubt upon it, for the same table shows that the increase is largely in the male population, while the female death-rate is much more nearly stationary. Thus to every 100 women dying from cancer in the first decade 51 men died ; in the second decade 61 men died to every 100 women ; and in the third 83 men to 100 women. A further analysis of the deaths among men is shown in Table II. Here the cases in which the cancer occurred in the lip, the tongue, the throat, the penis, and the testis, easily accessible parts, are separated from those in which it occurred in more deeply-seated organs. Perhaps the same results given in ratio will be more easily grasped and expressed in that way we may state that while in the three decades accessible cancer increased in the ratios of 1·0, 1·6, and 2·4, less accessible cancer increased in the ratios 1·0, 2·2, and 3·5—that is to say, the increase was much more marked in

¹ A. Wassermann : Deutsche Medicinische Wochenschrift, Leipsic, 1894, Band v., V.B., s. 120, and Zeitschrift für Hygiene, Leipsic, Band xix., s. 408. Orłowski : Deutsche Medicinische Wochenschrift Leipsic, 1895, s. 400. Fischl and Wunsheim : Prager Medicinische Wochenschrift, 1895, Heft 45 and Heft 51, and Zeitschrift für Heilkunde, Berlin, Band xvi., Heft 5 and Heft 6.
² Roux and Martin : Annales de l'Institut Pasteur, Paris, 1894, viii., p. 616. Meade Bolton : Journal of Experimental Medicine, New York, 1896, vol. i., p. 543. Cobbett : Journal of Pathology and Bacteriology, London, vol. iii., p. 328. THE LANCET, August 5th, 1899, p. 332. Centralblatt für Bakteriologie und Parasitenkunde, Jena, I. Abtheilung, xxvi., s. 548.
³ Cobbett : THE LANCET ; Centralblatt für Bakteriologie und Parasitenkunde, loc. cit.
⁴ Croonian Lecture, March, 1900 ; Proceedings of the Royal Society, London, vol. lxvi., p. 424.
⁵ Myers : THE LANCET, July 14th, 1900, p. 98.

⁶ Dr. Meade Bolton found it in three horses out of 12 examined by him in Philadelphia. I found it in nine out of 13. Of these 10 came from London and eight of these possessed an antitoxic serum, while the other three lived in Cambridge, and the serum of one only had an antitoxic action. Thus in a limited experience it was present in 80 per cent. of London horses and in only 33 per cent. of Cambridge horses. This corresponds with the much greater frequency of diphtheria in London than in Cambridge. Of course if I had examined another Cambridge horse and found antitoxin the percentage of those containing an antitoxic serum would have jumped to 50. One must, therefore, not attach much importance to this ratio. Moreover, in Meade Bolton's experience antitoxin was present in only 25 per cent. of Philadelphia horses, and diphtheria is twice as common in that town as it is in London.
¹ Abstract of a paper read before the section of State Medicine of the British Medical Association at Ipswich on August 2nd, 1900.

those parts of the body where it could be diagnosed by increased knowledge and skill on the part of the medical men certifying. Furthermore, only of recent years has the Registrar-General inquired as to the nature of the "tumours" and "growths."

On the whole, then, our figures tend to show that there has been some actual increase in the number of deaths due to cancer in the past 30 years, but my own impression is that the increase has been much more marked in the professional skill of the medical men certifying. The object was to test Mr. Alfred Havilland's theory by applying it to this part of the country. This theory postulates that (1) in the counties having a high mortality from cancer we

TABLE II.—Cancer in Accessible and in Inaccessible Parts of the Body.

	1871-1880.				1881-1890.				1891-1898.			
	Males.		Females.		Males.		Females.		Males.		Females.	
	No.	Proportion, total = 100.	No.	Proportion, total = 100.	No.	Proportion, total = 100.	No.	Proportion, total = 100.	No.	Proportion, total = 100.	No.	Proportion, total = 100.
External organs.	10	3.6	80	29.2	16	4.4	100	27.7	24	5.3	87	19.4
All other organs.	46	16.8	64	23.4	101	28.0	84	23.3	162	36.1	129	28.8
Not stated.	34	12.4	39	14.2	22	6.1	37	10.2	16	3.5	30	6.7

find that the tributaries of the large rivers rise from soft marshes or other easily-disintegrated rocks and these fall into sheltered valleys through which the main rivers flow ; (2) that these rivers invariably flood their adjacent districts during the rainy season and have generally their waters coloured by the suspension of alluvial matter ; and (3) that the districts " characterised by the tertiary and more recent clays and other retentive soils have a very high mortality from cancer." In order to test the soundness of the theory we must first get a clear conception of the contour, geology, &c., of the district which we are investigating. This consists of the two unions of Chelmsford and Maldon, the former of which lies to the west of the latter, the two together forming a tract of country extending inland some 25 miles from east to west, while from north to south the distance is roughly from 10 to 15 miles. The district forms an irregular parallelogram, being bounded on the east by the North Sea, on the south by the river Crouch, and on the west by a line running north and south some six miles to the west of Chelmsford. The northern boundary is more irregular. The area of the whole is 175,231 acres. (In future I shall refer to the two unions together as the " area.") In one respect the physical features of the two unions differ markedly, for while the Chelmsford Union is entirely inland and is watered by small rivers only the Maldon Union is cut in two from east to west by the great salt-water estuary of the Blackwater, and is bounded on the south by the very similar estuary of the Crouch. The country lying on each side of these estuaries, and the seashore lying between their mouths, is extremely flat, the water being kept out by sea walls, and the fields intersected with small creeks and ditches, while, as the map shows, in many places there are " saltings"—i.e., land which grows a rough species of grass, although covered with salt water at high tides. This part of the country used formerly to be the home of malaria. The geology of the whole district might fairly be summed up in the one word " clay." Excepting along the course of the rivers and on the seacoast, where there is a deposit of alluvium, the geological map is coloured one uniform tint over the whole area. In the higher parts of the south-western division the clay is capped with beds of Bagshot gravel and sand, while small deposits of a similar character are scattered irregularly and sparsely over a large part of the rest of the area. From this short description it may be gathered that we have to deal with a district in parts of which, at all events, one would presume a very high cancer mortality, if Mr. Havilland's theory be correct. I shall now proceed to put this presumption to the test.

The report of the Registrar-General for the period 1881-1890 shows that the cancer death-rate for Essex is by

no means high, although the soil of the county is largely clay, and although it bounds large estuaries and contains considerable tracts of low-lying land. Yet there are 32 counties in England and Wales with a higher mortality from cancer, as against 13 with a lower. This alone would tend to show that the geographical peculiarities of the county are not such as to promote the disease, and Table III.

TABLE III.—Death-rates per 1,000,000 calculated to Standard Population—1881-1890.

Areas.	Ages and proportion of persons.						Totals.
	25-	35-	45-	55-	65-	75-	
England	189	665	1311	1644	1393	524	5746
Essex	169	521	1140	1578	1410	619	5437
The two Unions ...	147	608	959	1231	1236	642	4823
Chelmsford Union...	208	603	1089	1204	1306	695	5105
Maldon Union ...	54	613	781	1266	1137	566	4417

emphasises the point, for there we see that not only is the cancer death-rate of Essex below that for England, but the rate for these two unions with their large amount of foreshore is below that of the county as a whole, and yet, further, the rate for the Maldon Union, which is bounded by two large estuaries and contains large marshes and saltings, is below that for the drier union of Chelmsford.

If now we divide up our area into smaller units we arrive at some interesting results. In order to eliminate error as far as possible the whole area has been divided into parishes and groups of parishes in such a way that the population in each group shall not be less than 1000 and the death-rate has been estimated from the returns for the years 1871-1898. Time will only allow me to give an outline of the results. The highest mortality (8.9 to 8.02 per 1000 per decade) occurs in the Waltham and Purleigh groups. Of these, Great Waltham is situated in the extreme north-west part of our area. The soil consists entirely of clay, which rises in one part to a height of 230 feet above mean sea-level, and is nowhere less than 130 feet. It may be considered a fairly elevated parish. Through it runs the Chelmer, which is here little more than a brook, but such as it is the houses are mostly aggregated in its vicinity. The floods in this and other parts are seldom serious, as the rainfall rarely exceeds 25 inches per annum. The Purleigh group also lies fairly high, a large part of the surface being above the 100 feet contour, while it rises in one part to 170 feet. The village of Purleigh comprises by far the largest collection of houses within the group and is situated on a sharp slope. The low-lying part of the parish is liable to be flooded when Purleigh Wash is swollen by very heavy rains, but there are few houses in the vicinity. The lowest mortality occurs in the groups of Tollesbury and Wickham Bishops. Tollesbury (with the lowest death-rate of all) is extremely flat, the village being situated at an elevation of 85 feet only. The outline of the parish is roughly triangular, two sides of the triangle being formed by muddy foreshore, creeks, and saltings; more than half the parish is under water at high tide; there are no fresh-water streams. In contrast with the above is the Wickham Bishops group. Here the largest collection of houses is the village of Wickham itself, situated on a patch of gravel at an elevation of 230 feet, the village church forming a conspicuous landmark. Although the (fresh water) river Blackwater, which is liable to floods, bounds the group on one side, yet there are very few houses in the vicinity of the water. But the most striking differences in cancer mortality under closely similar circumstances are shown in the contiguous groups of Burnham and Southminster. Both include saltings and a large extent of marsh land; one has a long frontage to a tidal river, the other a (shorter) frontage to the low seashore. In both the majority of the inhabitants live in small towns. And yet, although Burnham town is on the banks of the river and Southminster town is situated at a distance from the water the former has a low mortality and the latter a high.

These six instances serve to illustrate the results shown throughout the entire area—viz., that in this part of Essex cancer death-rate bears no evident relation to the variations in the physical features of the country.

Assuming the truth of Mr. Havilland's theory we should expect, if anywhere, to find a high cancer mortality along the course of our rivers, for although they cannot be said to

be subject to very frequent flood or yet to run through very sheltered valleys, yet they rise from, and run through, retentive soil and overflow their banks whenever the rainfall is especially heavy. The facts of the case, however, tend to point to an opposite conclusion for those groups which lie on the banks and shores of our rivers and estuaries have with only one exception a death-rate below the average of the whole area.

Taking first the river Crouch we have already seen that in the Burnham group, situated at the mouth of the estuary, the mortality is low (4.24 per 1000). The groups to the west of this latter are those of Latchingdon, Stow Maries, and Runwell, with death-rates of 4.96, 4.71, and 3.96 per 1000 respectively, all of which are decidedly below the average of 6.70 per 1000. The proximity of the river Crouch, therefore, cannot adversely affect the cancer mortality in its neighbourhood. And the same conditions obtain with respect to the river Blackwater, the north bank of which is formed from east to west by the groups of Tollesbury (a small slip of Tolleshunt d'Arcy), Goldhanger, Langford (Hatfield), Boreham, and Springfield. These have mortality rates of 3.41, 4.99, 5.56, 7.86, and 4.54 per 1000, all of which are below the average, with the exception of that for Boreham. On the south bank of the river lie the groups of Bradwell, St. Lawrence, Latchingdon, Maldon, Woodham Walter, and Little Baddon, with death-rates of 6.64, 5.43, 4.96, 6.14, 4.70, and 6.26 per 1000, all of which, again, are below the average of the whole area, although somewhat higher than the rates which obtain along the north bank of the river.

If, then, we may attach any weight to the results of this inquiry we must look for the causes of cancer in some other direction than in an alluvial and clayey soil, subject to floods, for, to sum up, (1) the disease is less common within the county of Essex, with its clay soil and numerous estuaries, than it is in England as a whole; (2) although the unions of Chelmsford and Maldon contain an excessive proportion of marshy land and estuary yet their death-rate is below that of the county; (3) those parts of the two unions which include the greatest extent of muddy foreshore, creek, and saltings have a mortality below that of the two unions taken together; and (4) the disease is not especially prevalent in those places which are situated on the banks of the fresh-water rivers.

Witham, Essex.

THE MICROSCOPIC APPEARANCES OF THE MOTOR GANGLION CELLS IN FIVE CASES OF PERIPHERAL NEURITIS.

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(From Dr. J. Lindsay Steven's Wards in the Glasgow Royal Infirmary.)

THERE now seems to be little doubt that motor ganglion cells undergo certain histological changes as a result of injury to their peripheral terminations. The investigations of Nissl, Marinesco, Lugaro, Van Gehuchten, and others have established this as being beyond dispute. Nissl tells us that after injury to a nerve chromatolytic changes appear in the ganglion cells within 24 hours and that by the end of from seven to 14 days these changes have become very marked. They reach a maximum from the twentieth to the thirtieth day and remain stationary at that for some time. In many of the cells recovery takes place, due either to regeneration of the nerve or to the tonic or trophic influence of adjacent or other ganglion cells, so that at the end of about from two to three months it is difficult to recognise these cells as having at any time been abnormal. Certain cells, or groups of cells, however, do not recover, but, on the other hand, undergo complete atrophy and disappear. It seems established, then, that even as by Waller's law degeneration of a nerve-cell causes degeneration in its nerve-fibre, so injury to the nerve-fibre causes corresponding changes in the nerve-cell. This leads to the discussion as to whether the poisons causing peripheral neuritis affect directly the peripheral nerve-fibres or act by first poisoning

its nerve-cell—whether, in other words, the peripheral part of the neuron displays a certain independence in presence of certain morbid processes or that a degeneration of nerves means a primary lesion, or at least some primary dynamic trouble in the cell, seeing that the cell constitutes the central part of the neuron. The question is difficult and it has led to much dispute. The truth would seem to be that the trophic function does not reside in one single part of the neuron but that the vitality of the whole depends on the vitality of each constituent part. The poison in peripheral neuritis being in the circulation will reach the whole neuron, and while it affects the vitality of the whole it is in its most outlying part—the distal end of the axon—that the histological changes are first recognised. That it is the peripheral part of the neuron which is chiefly or wholly so affected has been demonstrated in numerous cases of peripheral neuritis, for it has been shown in these cases that the proximal portions of the nerve, the nerve-roots, and in some cases the ganglion cells themselves, have remained apparently unaltered.¹ The onset, moreover, of the paralysis in the extremities of the limbs points to the conclusion that it is not only the terminals of the neurons but the terminals of the longest neurons that first show disintegration and are first to lose the power of conduction. It is not, however, the purpose of this paper to discuss in detail the pathology of peripheral neuritis, but rather to furnish an account of the microscopic examination of five cases of that disease, contrasting the appearances they present with those already referred to as having been produced experimentally in animals.

The spinal cord was examined in all the cases, but only in the last three could the medulla and pons be obtained. The cords and medullas were fixed and hardened in formol (10 per cent.), embedded in celloidin, and stained with (a) theonin, and (b) hæmatoxylin and eosin. The nerves examined were the median and radial in the arms, the anterior and posterior tibials in the legs, and in two cases the right vagus at the level of the clavicle. The terminal fibres of these nerves were chosen by preference for examination and many terminals in each nerve were examined. They were fixed and stained in osmic acid (1 per cent.) and the individual fibres carefully separated from each other in xylol. The anterior roots, which were fixed along with the spinal cords in formol, did not stain so as to show their myelin, but in the roots of the first three cases the axis cylinders and cone-like framework of the myelin could be made out to be intact, and I take it, therefore, that these roots had undergone little degenerative changes. Of the anterior roots in the other two cases I can give no opinion.

CASE 1. *Alcoholic neuritis affecting the lower limbs and associated with tuberculous pleurisy and peritonitis.*—A man, aged 30 years, a clerk, was admitted into the Glasgow Royal Infirmary on April 21st, 1899. The patient dated his illness from a sudden attack of breathlessness about six weeks before admission. He was going up stairs at the time and it was with considerable difficulty that he could get to his room. Since then he had been more or less constantly confined to his bed, the dyspnoea being at times very troublesome. Excess in alcohol for many years was freely admitted. On admission the patient was seen to be very ill. There was evidence of a large quantity of fluid in the left pleural cavity. There was double foot-drop and very little voluntary movement even in the flexor muscles of the feet and legs. Tactile sensation, as far as could be made out, was not involved, but the muscles of the feet and legs were painful on pressure. A bed-sore was present over the left trochanter. Dyspnoea was urgent. He died on the 27th.

At the necropsy the left pleural cavity was found to contain a large quantity of blood-stained fluid. Both surfaces of the pleura were studded with tubercles. The left lung was completely collapsed but otherwise healthy. The right lung was oedematous but free from tuberculous disease. The heart muscle was soft and pale. The omentum was much thickened and infiltrated with tubercles. The peritoneum was also studded all over with numerous small tubercles. The liver, spleen, kidneys, and alimentary tract appeared to be healthy, but there was evidence of atheromatous changes in the vessels. Microscopic examination of the nerves in the feet showed a well-marked parenchymatous neuritis. Scarcely a normal fibre could be found, and in many of the fibres the coagulated myelin had entirely disappeared, leaving nothing but the sheath and its nuclei.

¹ Allbutt's System of Medicine, vol. vi., pp. 685 and 715.