AN ADDRESS ON ELEMENTAL PATHOLOGY.

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THE resemblances which, in human pathology, we trace between the processes of repair and some of those of Inflammation are well-marked in plants. Of course, in speaking of inflammation in plants, we must be nearly limited to the essential parts of the process. In ourselves, we look to its so-called signs—heat, redness, pain, swelling, and disturbed function: but these are not of the essence of inflammation, and, even in ourselves, one or more of them may be absent when yet the real process of inflammation is active. For the elemental pathology of inflammation, as for that of decay and of repair of injuries, we must study the altered relations between the elemental formed parts and the varying formless materials about them; and these, let me repeat, may be seen more nearly in plants than in animals, in which it is hardly possible to isolate any parts from the influence of stagnant or wandering corpuscles or of circulating blood and nervous systems.

The signs of inflammation, I have implied, cannot well be observed in plants. Increased heat in the part has not, I think, been noticed; yet I suspect that, with so rapid organisation as sometimes ensues in gall-formations, it might be detected. Redness is often present, as in the galls and curled leaves of which I shall speak presently; but it is in a fallacious likeness to the redness of congestion of blood; it is only the colour of imperfection which one sees in many immature and many decaying leaves. Pain we cannot suppose in plants; and yet it may be through some change like to that of transmission of nerve-force that we must explain what I find told by Frank*; that in many green parts of plants there appears, some few minutes after wounding them, a change in the normal position of the chlorophyll-grains and the protoplasm in cells at a distance from the wound—a change which, as he says, must be regarded as due to the transmission of a stimulus of some not well known kind from the wounded to the intact living cells. Slight slowly ensuing swelling is often evident in the inflamed parts of plants, and is due, as in animals, to new formation and to increased afflux of nutritive matter—an afflux, be it observed, not due to any vaso-motor nerve-change. Disturbed function is evident enough.

But the likenesses between the inflammations in plants and in animals are best shown in their visible structural changes; and these have been admirably traced by Waldenburg.† He has applied various irritants to leaves, fruits, and stems—such as foreign bodies, setons, crushings, cauteries, and others. The results, speaking very generally, are that, as in ordinary wounds, the cell-structures actually involved in the injury perish and dry-up; that those most nearly adjacent suffer degeneration, indicated by their protoplasmic contents becoming turbid and their chlorophyll becoming yellow or brownish; while in those next to them, and within distances varying according to the injury and the texture of the part injured, enlargement of cells ensues, and increase by division and thickening of the cell-walls.

In these changes you may study, with comparatively easy experiments, imitations (as near as difference of texture will allow) of the most constant constituents of inflammation in animals, especially those of the least acute of the productive interstitial inflammations, leading to thickening, opacity, induration, and other such changes. The defective maintenance of some of the natural structures of the part is evident; so is an increased afflux of nutritive material; so is an increased production of lowly organised structures, not widely different from the natural structures.

But, of all morbid processes in plants, none, I think, are so suggestive as those produced by parasites, whether vegetable or animal. The whole subject would be far too large to speak of, even if I were familiar with it; it is, indeed, a subject of the gravest national importance; but, keeping to the design with which I started, and which was

only that of pointing-out where useful pathological knowledge may be gained, I will speak of only some of the changes which are produced by insects. The most remarkable of these are the galls;* and, among the many hundreds of them that have been described, I may assume that you know some in their natural mode of growth—such as the common oak-apple, with which some celebrate the restoration of our monarchy; and the bedeguar of the wild-rose; the bright crimson oak-spangle; the currant-gall, or the artichoke-gall, or the gall of pharmacy. But, besides the hundreds of different true galls, there are still more hundreds of changes of structure in leaves and stems and roots, all produced by the irritant secretions of insects, and all such as may justly be ascribed to processes of inflammation. In some, as in the “curl” of the leaves of the whitethorn, you find thickenings of leaves which are lifted, rolled, or curled into chambers which serve for defence of the aphides or other insects; in some, the thickened and distorted clusters of leaves, in buds or twigs, roll up and are mutually fastened so as to form the walls of similar defensive lodgings; in some cases, leaves become swollen as with a kind of oedema; in some, their layers separate as if with blistering; or leaves, or stems, or fruits, or clusters of flowers, buds, or roots produce variously shaped and variously constructed growths of cellular parenchymatous tissue and cork and, more sparingly, of woody tissue or of cells whose thick walls become as hard as wood. Besides, some of the monstrous growths of parts of plants, and some of the viviparous variations, and of the undue metamorphoses of leaves, are to be referred to the influence of parasites.†

It may seem bold to speak of so many hundreds of widely various morbid processes as having any essential character in common, or as fit to be included under one name; yet, I think we may regard the whole of these as being such as, in our pathology, we should call inflammatory hypertrophies or hyperplasiae. They all show a rapid increase of lowly organised structures, by derivation from, and in continuity with, those pre-existing. There is, as in the products of our inflammations, a general likeness among these new structures, whatever be the part of the plant from which they are derived, and all bear a general likeness to the structures formed after injuries of actively growing parts. In the morbid growths formed by these new structures, the deflection from the natural shape and construction of the part, in continuity with which they have grown, is often not complete; they often retain marks of characteristic normal forms, and sometimes acquire marks of natural variation from the species.‡ Moreover, all these morbid growths have their origin in what may justly be called “irritation” of the part on which they grow; and in all of them, I think, we may note signs of degeneracy from natural conditions, either in the absence of stomata or similar structures, or in the presence of the red, or yellow, or other colours commonly noticed in decay.

Here, I believe, are reasons enough for regarding all these galls and gall-like products of disease, generated in plants by insects, as analogous with a large group of the products of inflammation which we study in our own pathology; and the analogy is not the less because neither group can be circumscribed with any exact definition.

I will not be tempted to speak long, but I beg you to think long, of the marvellous facts of natural adjustment which we have here, in this intense example of the “*sic vos, non vobis*.” Here are the bare facts. Each species of these parasitic insects can compel some part of a plant into such disease as shall supply good food, or well-built and well-placed lodging, or both, for itself or for its eggs and larvæ, or even for part of the life of its complete offspring. Each insect selects, by instinct, the very part of the plant which is adapted to its purpose. The provision made at the cost of the plant is exactly adapted in quality to the welfare of the insect or its offspring, and in quantity as well; for

* Many growths like galls are produced by fungi and other parasitic plants; but those I omit. Many are described by Schroeter, *Beiträge zur Biologie der Pflanzen*, Band i, p. 4; and by Beijerinck. The best essays on the minute structures and modes of growth of galls are those of Lacaze-Duthiers in the *Ann. des Sciences Naturelles, Botanique*, 1853; of Prillieux, in the same, *Botanique*, 1876; and of Beijerinck, *Bijdragen tot de Morphologie der Plantegallen*; Utrecht, 1877. But I am most indebted to Miss E. A. Ormerod, who, by her admirable works on Entomology and Meteorology, sustains the scientific reputation of the name so well known to pathologists. Since the Address was sent to press, I have received the second part of Frank's essay in the *Encyclopædie der Naturwissenschaften*, containing a much fuller account of galls and gall-like growths than, I think, had before been published. With this, or with the soon-coming second part of his separate *Pflanzen-pathologie*, and with Beijerinck's essay, the whole subject may well be studied by any human pathologist. But, I hope that it will soon be yet more clearly illustrated by Dr. Arthur Ransom.

† Among them are the “witch-brooms” of the birch, pine, larch, etc. Miss Ormerod has described the “Phytoptus of the Birch-knots” in the *Entomologist*, 1877. A long list of the teratological forms due to parasites is in Beijerinck, *loc. cit.*, page 32; with this should be studied Dr. M. Masters's volume on Vegetable Teratology.

‡ As Darwin pointed out in the likeness of the mossy covering of the common wild-rose-gall to the calyx of the moss-rose. There are, also, instances in which galls imitate small cones or other structures of the plant.

* *Encyclopædie der Naturwissenschaften*, Abth. i, Lief. 12, p. 338, from a paper by him in Pringsheim's *Jahrb. für wiss. Bot.* viii, p. 220.

† Virchow's *Archiv*, Band 27, 1863, p. 145.

both the lodging and the food are made sufficient for any necessary time—for days or weeks, often for many months; in some instances, for two or even three years. Nay, more than this, the gall, of which the growth has been provoked by the virus of one insect, may be fit for the food and lodging of another, which, when all seems complete, can penetrate the gall-cavity, and there, as with theft or murder, obtain food and lodging perfectly suited to itself or its progeny.* And the whole process in the plant, though it be one of disease and, in a sense, unnatural, is yet so regular, so constant and specific, that the form and other characters of each gall or other morbid product are, usually, as constant and characteristic as are those of the insect itself, and the differences among the galls are at least as great as those among the insects. Is there, in all the range of natural history, a more marvellous group of facts than may here be studied? If you would like to work out a problem in evolution, find how it has come to be a part of the ordinary economy of nature that a gall-insect compels some part of a plant to grow in a manner which, while injurious to the plant, becomes useful to one insect not yet born, and to another who will, in due time, kill this one and feed on it.

But now, of the relation between galls and our specific diseases, such as our eruptive fevers, syphilis, cancer, gout, and others.

In these galls and other similar diseases in plants, we have, it seems, hundreds of specific diseases due to as many hundreds of specific morbid poisons;† for the most reasonable, if not the only reasonable, theory of these diseases is, that each insect infects or inoculates the leaf or other structure of the chosen plant with a poison peculiar to itself. The poison may be merely deposited; but, in the instances best for study, it is inserted in the plant-structure, whether leaf or any other; and the wound for inserting it, the poisoned wound, may be made either with part of the oral apparatus, or, as in most of the true galls, with the ovipositor through which one or more eggs are passed with the virus, and are left among actively living structures of the plant. The little wound closes; the virus, whether an oral or an ovarian secretion, remains; and the result of its influence on the plant structures and their contained protoplasm is the formation of the gall or other morbid product. The whole process may be compared with the local consequences of the insertion of vaccine lymph, or any such morbid poison, in ourselves or other animals. I say the local consequences, for we have no clear evidence of what might be called general infection or constitutional disease in the plants. In the absence of quickly moving fluid, such as lymph or blood, the virus infects only the part in or very near to which it is inserted. A single oak-leaf may have fifty "spangle" galls on its under surface, but the structures between them may be quite healthy; and when in any instance a general damage is done to a plant by gall-growths, it seems to be only as a remote consequence of the spoiling of considerable portions of its structures. And this appears to be true, even though the virus may continue active for a long time, as in the galls which begin to grow soon after the insertion of the virus with the ovum, and continue to increase during the whole—sometimes long—development of the larvæ; or even, in a few instances, after the larvæ have deserted them.

But, while plants supply no occasions for studying fever, or any other of the constitutional phenomena of specific diseases, they are all the more fit for illustrations of some of the local characteristics. Let me suggest some things for study in them, in addition to the inflammatory changes of structure.

We find hundreds of different forms of galls, and we may be nearly sure that there are as many kinds of morbid poisons produced by the gall-insects, each form answering to a different virus. This may suggest that we may be too grudging in thinking of the number of morbid poisons, or of their modifications in the blood, to which diseases in ourselves may, at least in part, be due.

It is true that the galls are produced by many species of insects on many species of plants; and that the differences among these species may be as wide as those between ourselves and any other mammalia. But, even among closely allied species, there are many and very different forms of galls. Mayr,‡ ten years ago, described and figured ninety-six kinds of galls found on the oaks of middle Europe, all but two of them being produced by different species of gall-wasps. Of those ninety-six kinds, thirty-two are formed on the leaves alone; and, even on similar parts of one oak-leaf, it is not rare to find three or four different forms of galls.§

* The Inquilinæ, Einmieter, lodgers, or (as they might be called) burglars, are usually described in the works on gall-insects, though not themselves "gall-makers".

† Karsch (abstract in the *Botanische Jahresbericht*, 1879, p. 150) gives the total number of the forms of galls at present known as about 1,250, of which one-fifth belong to the Cynipidæ.

‡ *Die mittel-europäischen Eichengallen*, 1870.

§ While writing, I have before me some oak-leaves from a sapling on which are 6 kinds of galls, three being, in several instances, on one leaf.

We have, thus, clear evidence of a very large number of morbid poisons, each of which is capable of producing, in an appropriate subject, a distinct specific disease with a characteristic morbid structure.

We may safely believe that, for each of these morbid poisons, there is no test yet possible except that of the disease which it may produce; and so we may as safely believe that there may be many morbid poisons or morbid conditions of blood in ourselves which may be indicated by very different products of disease, though they may be beyond detection by any other, even the most refined, method of research.

Further, though it may be impossible by any other means to detect any differences among these morbid poisons, yet the diseases which they severally produce may be widely different; as unlike as are a pustule and a goitre, or a vaccine vesicle and a carbuncle, or as any of the morbid changes due to gout or rheumatism.

It may be observed, however, that these great differences are marked in outer shape and construction much more than in minute structure. As, in human pathology, there are certain general characters and degrees of likeness in all inflammatory products, however differently they may be constructed—in pustules, vesicles, thickenings, opacities, adhesions, scars, fibroid, and other changes; so, in galls, there are certain likenesses in minute structures, even among those that are, in their construction, size, and outer shape, most unlike.

It may be well to learn from this a lesson on the imperfection of our methods of minute research. As we cannot doubt that the differences in outer shape and method of construction of the products of specific diseases are associated with differences of chemical composition and ultimately minute structure, so it must be in those yet greater differences on which we frame our distinctions of species in all living nature. The coarse, visible, and tangible distinctions may be well marked; the really material differences with which these are associated, and to which, probably, they are due, are beyond our reach.

Again, in the study of specific diseases in ourselves, we see many variations due to the differences in the parts, or even in the persons affected with them. In the study of galls, similar variations may be seen. As a general rule, each gall-insect lays its eggs in one part of one plant—as the leaf, leaf-stalk, bud, fruit, or root of this or that species; but if, as rarely happens, one lays in different parts of the same plant, there is usually a very close agreement in the characters of the resultant galls. A few exceptions to this rule are known, one of them being in the very different galls produced on the roots and on the leaves of vines by *phylloxera vastatrix*; but the rule is generally observed, and accords with the fact of certain features of general likeness being observed in the products of our several specific diseases, wherever they may be seated.

When the same insect lays in similar parts of different plants, the galls may be all similar;* but I believe that they more usually are different, and that their differences are such as bring them severally nearer to the distinctive characters of the plants on which they grow; just as, in ourselves, a specific disease may be modified by the personal conditions of each patient.

In similar analogy, the differences are yet greater when the eggs are laid in different parts of different plants.

Very rarely, the same insect may produce on one leaf different forms of galls.†

In all these points, you may, I think, find help in the study of specific diseases. I will add only one more. Usually, the gall begins to grow directly after the deposit of the egg; but sometimes there is a long delay, a long period of suspense, an "eiruhe",‡ which may last for many months before the growth begins. What is going on during this time? I believe we may see here an instance of events very difficult to study in our own pathology, in which two or more conditions must concur to the production of some disease, and one of them must wait for the complete efficiency of the rest. In the case of these long delayed galls, either the egg, after being laid, requires a long time for the completion of changes ending in the production of the necessary morbid poison, or the plant-structure in which it is laid requires the

* Fr. Löw, *Ueber Gallmücken*; in *Verh. der K. K. Zool.-botan. Gesellschaft in Wien*, 1877.

† Beijerinck, *loc. cit.*, p. 21, from whom, also, the two preceding sentences are quoted. He cites from Winnertz the case of *Cecidomyia tremula*, which may produce on the same leaf of the white poplar four different forms of galls: but I would suspect that there may be as many differences among the eggs, just as there are among those of some Lepidoptera, in which, out of the same brood of eggs, all laid in the same place, some are hatched in the next following season, others in one, others in two, seasons later. Of course, these eggs are not all alike, though no other difference besides that proved by the times of hatching may be discoverable in them, or in the insects produced from them.

‡ Schenck, *Beiträge zur Kenntniss der Nassauischen Cynipiden*, p. 24. He cites the case of *Trigonaspis megaptera*, which lays its eggs in May, and the galls do not appear till the next April; others lay in buds, and the galls appear at the time of opening of the leaves. Hartig mentions similar facts (*Zeitschr. für die Entomologie*, Band ii, p. 176, 1840).

time for changes to make it susceptible of the poison; or both egg and plant may need to change. So, in us, two or more conditions must concur. A tendency to gout may be inherited, and the blood may have slowly acquired the necessary morbid condition; but no structure may be susceptible of gouty disease till a blow, or a strain, or some disturbance of nervous force makes it so. So with cancer; a general tendency may be inherited, but it must wait till the material of some structure is, by age, or injury, or long continued "irritation", changed into fitness for concurrence in morbid action with the material on which the general tendency depends. Then, when the two materials meet in mutual fitness, the result may be a change so great, that we may compare it with that from an act of impregnation. I have often thought of this comparison, when seeing the almost sudden appearance of cancer in a breast or a tongue or in a scar long irritated. In the growth of these galls, the comparison may seem less far-fetched. At least, it may be difficult to suggest any nearer comparison for a process in which the meeting of two living materials from different organisms is immediately followed by such a change in the method of life of one of them, as ends in the production of a definite new growth exactly adapted to the method and purpose of the life of the other.

But it is more than time that I should have done with galls. If I have been tedious, let me assure you that I am myself ashamed to have gathered so little from the rapidly increasing records concerning them to which the botanists, and still more the entomologists, of our time are contributing. And, even for that little, I feel as if I deserved to be compared with one of those burglars of whom I spoke feeding on the results of others' labours. Let it be my apology to them, that I believe I have taken nothing they would have used. I have only taken, from their rich stores of facts, some that may be much more useful in pathology than in natural history. And I am sure, from all I know of naturalists, that they will gladly let any of you into their fields, though you may use them for your own purposes much more than for theirs. It would be difficult to find a field for the study of the very principles of pathology larger or richer than this offers to you. The objects are within easy reach; hundreds of morbid processes are at hand for deliberate study; experiments may be made at will; and, during many months, thousands of insects, as natural vivisectioners, will be at work for you; and it must yet be some years before they will be required to take out licences.

I will speak of only one more of the subjects of general pathology—that of tumours; and on this I may be very brief.*

I do not know if there be any morbid growths in plants which may justly be compared with our cysts or cystic tumours. Foreign bodies lodged in them usually give rise to such changes in the immediately surrounding textures as produce layers of cork-tissue, which may be compared with the capsules of connective tissue similarly formed around foreign bodies in animal structures;† but I do not know if there be any such diseases as cysts filled and enlarging by the increase of secretions or growths from their own walls.

Growths which may be coarsely—and only coarsely—compared with our cheloids are common on elms and other trees, especially on apple-trees. They are called cankers, or in Germany by the same name as cancers—*Krebs*.‡ They are usually rounded and coarsely nodular masses of wood covered with bark, sessile singly or in clusters on branches, and depressed at the middle of their projecting surfaces. Thus, in form, they are not far unlike masses of scirrhus cancer projecting from the breast or axillary glands; and the likeness is the nearer when, as is usual, the depression on their surface leads into a cavity bounded by decaying wood. The imitation of an ulcerating cancer may justify the use of the same name; but, in the canker of the trees, the central cavity usually indicates the beginning, not the advance, of the disease; for cankers, like most cheloids, are formed after wounds—whether from frost, or blow, or injury of parasite, or any other cause. Around these wounds, layers and bosses of wood are annually heaped-up, as if with an exaggeration of the process of repair, and with concentric growth they may close in and complete the likeness to the cheloid. But, more commonly, while the outer part of the canker is annually increasing, its inner part is constantly decaying, under the attacks of the parasites which the wound let in, and which plants seem to have no power to expel. Thus, within a kind of shell of laminated wood, outstanding like a tumour on the branch, you may find a great hollow space filled with rotten wood and other residues. It may look very like a mass of cancer with central softening and decay; and the like-

ness is even greater when, as not rarely happens, the central decay keeps pace with the formation of new wood. Then is formed what some call an open cancer, others gangrene or brand. In these, an uneven surface of rotting and dead wood is surrounded by an undulating, knotted, and everted or overhanging border of the wood annually formed, but in its turn destined to decay, and thus to imitate the constantly enlarging cancerous ulcer with its nodular uplifted borders.

It is impossible not to be struck by these likenesses between cankers and cancers; and I commend them to your study, though I fear they are much more apparent than real. The nearer, yet still distant, likeness seems to be that to cheloid growths; for these also appear as morbid troubled processes for repair, and they are so far like to tumours that no line of definition between them seems yet clear.

The growths in plants which may, I think, be deemed most nearly like to our tumours, are those which are called exostoses,* knours, or wens. They may, indeed, be regarded as only prominent examples of that disorderly growth of adventitious buds which produces the various strange and beautiful knots and veins in ornamental woods; but they are too like tumours for me to pass them by. You may find plenty of them on the trunks of the beech, hornbeam, ash, birch, holly, and cedar. The best specimens appear as ovate or nearly spherical masses of hard wood partly covered with bark, which is reflected on them from the continuous bark of the trunk on which they rest. They range from a few lines to many inches in diameter, and are attached sometimes broadly, sometimes by short narrow pedicles continuous with the wood of the tree. Some are without pedicles, and lie as free encapsuled masses in the growing wood.

In many of these conditions, there is a very strong resemblance between these growths and some of the bony exostoses after which they are named. Especially when one breaks them off the trunk of the beech, or the holly, or cedar, and sees their pedicle of attachment and the bark, like integument and periosteum, continued over them, one cannot but compare them with the narrow-based ivory-exostoses of the skull or the pedicled exostoses which are common on the femur and humerus, or with the sessile fibroid uterine tumours.

On section, they show themselves formed of very hard wood; and their pedicles appear as cylinders of wood passing from their centres into continuity with the normal wood of the trunk. Through these pedicles, while they last, the exostoses probably obtain some of their materials for growth; when detached, they wholly subsist and increase on materials derived from the cambium spread out over them. In this continued growth, when encapsuled, they resemble the typical tumours of our pathology more than do any other morbid growths on plants; and they may continue to grow so long as nutritive material is supplied to them.

Now, the history of these growths is very suggestive to us. They are derived from buds, which remain, as Trécul says, in a sort of lethargic state for several years, and then become active, and form either a little branch or a *loupe* or exostosis, which, in its increase, will project more and more beneath the bark. Surely, they may thus confirm that theory of tumours which regards those whose structure does not differ widely from the natural structures as growths derived from portions of germinal substance remaining, though one knows not why, for years "lethargic", and then becoming active, growing in their own method, and subsisting on materials derived from the living parts around them.†

Before I end, let me briefly say some things in apology and self-defence.

If I have seemed to speak as a botanist or any kind of naturalist, I have erred. It is more than forty years since I was a botanist, and any one familiar with the science as it now is may justly say that I know nothing about it. He may detect at once my ignorance even of the language in which I have tried to tell where, in the field of botany, good facts for pathologists may be found.

I have not tried to deal with the whole subject of the diseases of plants. It is far wider than I could learn, even if the duty of my life were not to study those of men. I have not tried to learn more from them than may help to give me, and perhaps you, a clearer and wider view of human pathology and the duties it imposes upon us.

In dealing with even this narrow range of the diseases of plants, and in referring to the vastly greater number of those which occur in them—especially in the plants which we, to our own not their advantage, cultivate—I may seem to have been giving evidence against belief in

* What is here said of morbid growths, and some of the deductions from the study of galls, were, for the want of time, omitted in delivering the address.

† See Arling in *Ann. des Sc. Nat.*, 1874, tome iv, p. 27.

‡ Sorauer, *Handb. der Pflanzenkrankheiten*, 1874, p. 199, etc.; Güthe, *Ueber den Krebs der Apfelbäume*; Leipzig, 1877.

* Berkeley in *Gardener's Chronicle*, 1855 and 1857; Trécul . . . des Loupes et des Broussins in *Ann. des Sc. Nat.*, t. xx, 1853. An excellent account of the knots and veins of wood to which they are related is given by Frank; *loc. cit. Maserbildung*, p. 394.

† I think that many examples of "club" on the roots and stems of cabbage and other species and varieties of the same order may illustrate the growth of tumours. But some are certainly insect-galls, and the parasitic origin of others is suspected.

the influence of nervous systems in the production and methods of organic diseases. I have had no such design against any reasonable belief of the kind; I have long held, and often declared, belief in the trophic influence of nerve-force. An alteration in the nervous force in a part can surely alter its method of nutrition, even without altering the condition of its blood-vessels, as much as an alteration of its temperature; and, to cite no others, the facts which Brown-Séquard and Hutchinson brought before us yesterday, tested as they have been, are beyond refutation. Only, let us learn from a pathology more nearly elemental than that which we can study in ourselves, that many processes of disease, even the most various, may occur when there is no nervous system; and that there are many processes of degeneracy, and of repair, and of disease, of which the essential features are alike whether in the presence or in the absence of a nervous system. The study of such processes in plants, and even in crystals, may help us towards learning the real relation between the nervous force and the processes of organic disease. A certain normal condition of nervous force abiding in each part accessible to it may be deemed a necessary condition of the healthy life of that part; as a certain normal temperature is a necessary condition, and perhaps even a certain electric state. But we are bound to recognise the distinctions between the conditions of life and the essential properties of living things; and, as I proposed when beginning, so now I hope I may have succeeded in showing that it will be very useful if you will study pathology in bodies less complex than our own, especially in such as are not subject to those conditions of our own elemental organic life, which are of all the most difficult to estimate—the conditions, namely, of a nervous system and a quickly circulating and quickly changing blood.

And now let me, only for a minute, claim the position of a senior in our profession, that I may tell how the study may be useful for something more than the direct advancement of knowledge.

I hold it to be very desirable that every one of us should, all his life long, study some science in a scientific manner. There seems to be no equally good method for maintaining the temper and the habits which, by making us always good students, will make us as good practitioners as we can be. There is no method so good for maintaining a constant habit of inquiry, with accuracy and perseverance in research, the power of weighing evidence, of calmly judging, and of accurately speaking; none better for cultivating the love of truth, the contempt for fallacies, whether others' or our own, the gentleness and courtesy which are appropriate to the consciousness of the imperfection of our knowledge.

You may say that we can study science in the practice of our profession. So we may: at least, some of those among us may, who, before getting into practice, spent many years in scientific pursuits, and acquired habits which it is very hard to lose; but, even for these, the study of science in their practice is too much like that which, I suppose, an astronomer may pursue in some stormy night on a railway-journey. For really scientific study, we need repeated observations in unchanged conditions, the right to watch deliberately the course of natural events, sometimes to change that course when and how we please, to set down our descriptions of the objects of our study, even while we watch them, sometimes to have them at home and readily at hand for revision and refreshment of memory. These and many other conditions for scientific study cannot be had in our practice, in which our first and never-ceasing duty must be to do, as soon as we can, all the good we can, though in doing it we may lose or spoil all the best opportunities of acquiring fresh knowledge.

If, then, I am thus far right, that we all are always bound to study a science in a scientific manner, and that it is very hard to do this in our practice, let me again commend to you this elemental pathology. In any fragment of it, studied in those fragments of time which we are all too apt to waste, you may find ample opportunities for observation and experiment, for recording, collecting, and comparing facts, for generalising, for imagining and testing; thus you may gain the happiness and reputation of discovery; and, without ever leaving the paths of duty, you may refresh and strengthen your minds in the study of stores of beauty, wonder, and utility, such as, in all ages, have attracted the wisest and the best of men.

BEQUESTS, ETC., TO MEDICAL CHARITIES.—Mr. John Skirrow Wright, M.P. for Nottingham, bequeathed £200 each to the General Hospital, and the Queen's Hospital, Birmingham.—The Hitchin Infirmary has become entitled to £50 under the will of Mr. Thomas Veasey of Baldock, and £300 further after death of his widow.—Mr. George Checkland of Hawkswick, bequeathed £100 to the Leicester Infirmary, and £50 to the Leicester Dispensary.—The Marchioness of Westminster has given £30 additional to the Royal Hospital for Women and Children.—The Great Northern Hospital has received £100 from "T. A."

THE DUTIES OF MEDICAL OFFICERS OF HEALTH IN RELATION TO THE PREVENTION OF DISEASE.

Being Abstract of an Introductory Address delivered before the Society of Medical Officers of Health.

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ANY intelligent layman, on becoming impressed with the fact that the mortality of a certain district was exceptionally high, would remark that the sanitary authority had neglected its duties, or its efforts had been paralysed by those on whom it devolved to carry his recommendations into effect. If it were shown to him that the deaths were due to diseases over which the medical officer of health had no direct control, he would probably acquiesce under protest, and take his final stand on the deaths from infectious diseases. Here, at any rate, he might say, How is it that the authorities have permitted so many deaths from small-pox, so many deaths from scarlet fever, cholera, diphtheria, enteric fever, measles, and whooping-cough? Here, surely, is evidence of neglect. I fear it would not be very easy to convince him that he was in error; and if he were convinced, he would say, I convict you of incompetence to deal with the essential matters of which sanitary science professes to take cognizance. I do not agree with his argument or conclusion.

I think it will be considered that sanitary science has done much to diminish the prevalence and mortality of at least three of these diseases. I mean small-pox, cholera, and enteric fever.

The practice of vaccination has reduced the mortality of small-pox, and the horror with which it was formerly regarded, to a degree which, at the present time, it is almost impossible to appreciate; and these benefits are maintained, even though weak-kneed politicians not only hesitate to make vaccination strictly compulsory, but actually seem to contemplate, in deference to ignorant and unreasoning prejudice, the granting (as Sir William Jenner puts it) of licences to contract and propagate the disease. But, much as vaccination effects for the prevention of small-pox, one cannot but deplore how utterly inefficient it is, as at present practised, to accomplish what was expected of it. As the law now stands, we have power to enforce a single effectual vaccination upon every infant, and nothing more; yet even this obligation may be evaded by any parent who chooses to pay a fine or undergo imprisonment. But all sanitary authorities are now agreed that, powerfully protective as one efficient vaccination is, there is a tendency for the protective influence to die out in course of years. It is essential for the maintenance of safety, that the operation be repeated at the age of puberty; and again, long experience has shown that even a second vaccination is not in all instances absolutely protective; and that, if it be required to check the disease effectually in a household of whom one is already suffering from it, the only effectual remedy is to revaccinate all those who are exposed to contagion. We have all witnessed how often, when small-pox appears in a crowded household, the disease spreads even to some of those who have been vaccinated; and yet it is a fact which is beyond dispute that, at the Small-pox Hospital, which has been established for nearly one hundred years, not one of the nurses has ever contracted the disease, because every nurse has to submit to vaccination at the time of her appointment. It is certain that, if infantile vaccination were made absolutely compulsory; if it were made absolutely compulsory that revaccination should take place not later than early puberty; and if, further, whenever small-pox has broken out in a house, revaccination were made compulsory on the members of the household, or with exceptions to be determined only by some competent authority, it is certain, I say, that such disappointing epidemics of small-pox as we have recently been battling with, would either never arise, or would be strangled in their birth. The carrying out of the Vaccination Act does not rest with us, and I do not pretend that we should administer this more effectually than it is done under the direction of boards of guardians; but it is, at any rate, disheartening that we, the officials on whom the public chiefly rely to prevent the outbreak and extension of epidemic disease, have no legal power whatever, when small-pox is raging, to enforce the only measure for its arrest which has any real efficacy.

With regard to enteric fever, again, sanitary science has made discoveries which are of great practical importance: that the poison of the disease is contained mainly in the alvine discharges of the patients who are ill of it; and that it is by the pollution of drinking-water and food by these poisonous evacuations that the disease is propagated. It