The Lloyd Roberts Lecture

ON

THE NATURE OF MAN'S STRUCTURAL IMPERFECTIONS.

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BY

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BETWEEN the activities of Archdeacon Paley and those of Elie Metchnikoff lies the greater part of the nineteenth century. At the beginning of that century we find the Archdeacon extolling the perfections of the human body—just as Celsus had done sixteen centuries before him.¹ By the close of the nineteenth century the alert and fearless brain of Elie Metchnikoff had discovered, or he believed he had discovered, that the human body was blemished by many imperfections. The evangelist of this new and startling doctrine approached the study of man's body by an untrodden pathway, one made possible by the advancing science of his day. On his arrival at the Institut Pasteur in 1888, being then 43 years of age, he set himself to investigate the means by which the human body combats and keeps at bay such swarming hosts of micro-organisms as find a natural habitat in its internal passages and recesses. He saw man's body as a battlefield—the scene of a perpetual warfare; and as his investigations proceeded the conviction grew on him that the chances of the body's success were imperilled by a heritage of structures which had become out of date and useless. In the Wild Lecture given before the Literary and Philosophical Society of Manchester, on April 22nd, 1901, he declared that man "was being killed by his intestinal flora," and that his great intestine had not only become useless, but was a positive and continual menace to the rest of his body. He believed that the stomach itself, and also part of the small intestine, could be dispensed with. Early in 1903 appeared *Etudes sur la Nature Humaine*,² in which Metchnikoff greatly extended the list of man's structural imperfections.

Between the times of Paley and of Metchnikoff lie three great discoveries, and we must take note of them if we are to understand how it was possible for the one to praise the perfection of man's structure at the beginning of the nineteenth century and the other to condemn its imperfections at the end.

There was first the discovery that man's body was an aggregate or society of living microscopical units; it was Metchnikoff's fortune to approach the study of man's highly complex body through the simpler societies represented by the bodies of the lower invertebrates; it was thus he came by his discovery that certain units of such societies retain their freedom, thus permitting them to serve as scavengers or phagocytes.

In the second place there was Darwin's discovery; Metchnikoff was a convinced evolutionist. He therefore presumed that the alimentary outfit which served in an anthropoid phase of human evolution must be ill adapted to deal with the dietary of civilized man.

There was in the third place Pasteur's discovery, and so far as Metchnikoff's outlook was concerned this was the most potent of the three. It was under the influence of Pasteur's discoveries that Metchnikoff came to think that the destiny of man lay in the issue of the everlasting contest which went on between the living tissues of the body and the invading hosts of micro-organisms which threatened them.

It is noteworthy that of the three men—Darwin, Pasteur, and Metchnikoff—who revolutionized in the nineteenth century our conception of man's body, and of the struggles to which it is subjected, not one of them was a professed anatomist; the anatomist stood too near to the subject of his study to see it in its true perspective.

Twenty-two years have come and gone since Metchnikoff's

studies on *La Nature Humaine** first appeared, and I propose in this lecture to ascertain how far his doctrines of man's structural imperfections and functional disharmonies have stood the test of time. His thesis presumed that Darwin's theory of man's origin was true; that presumption has been supported by every discovery of the present century, and such evidence as we now have justifies us in believing that the rate of man's evolution has been more rapid than has hitherto been supposed.³

We realize to-day, more precisely than was possible when Metchnikoff wrote, that the most critical chapter in man's long history opened with the discovery of agriculture—a discovery of but yesterday if we reckon time on a geological scale. Agriculture revolutionized the conditions of human life; it made modern civilization possible. We have reason to believe that this revolution in the condition of man's life was initiated either in Mesopotamia, Egypt, or adjacent lands, not more than 8,000 years ago. It is certainly not more than 5,000 years ago since agriculture began to be practised in Western Europe. The vast majority of the people of these islands, probably 90 per cent. of them, are the descendants of men and women who, two hundred generations ago, were dependent on the natural but precarious harvest which is provided by shore, river, forest, and moorland. City life is a new experiment for Europeans; most of us who live in London, if we could go back twenty generations, would find an ancestry which was living on the soil and of the soil. And now the poorest of us can add to our dietary produce brought from the ends of the earth. The alimentary system which was evolved to meet the needs of our primitive ancestors has now to accommodate itself to a modern dietary.

Beyond a doubt civilization is submitting the human body to a vast and critical experiment. It is not only the alimentary system which is being subjected to new conditions—the bony and muscular framework of our bodies is being subjected to novel stresses. Of the present manhood of Britain one-half earns its bread by muscular labour; the other half lives sedentary lives. Our forefathers, when they arrived in Western Europe, were hunters; their bodies were unaccustomed to either manual labour or an indoor life; under the stress of civilization the hunter's body has to serve modern needs. It says much for the adaptability of the human body that it stands these stresses so well as it does. Dr. J. D. Comrie,⁴ on examining 10,000 recruits for the army, found that 363 of them suffered from hernia and 113 from flat-foot. Such breakdowns in the supporting system of the body do not occur with this frequency among hunting peoples. Civilization has laid bare some of the weak points in the human body, but the conditions which have provoked them are not of Nature's ordaining but of man's choosing.

If modern civilization is making new demands on our bones, muscles, and nerve controls, it is otherwise with another important system of our bodies. As our manner of living increases in comfort the calls on our heat-regulating mechanism become fewer in number and less urgent in character. Our primitive forefathers lived in the open; their bodies, unhoused and scantily clad, were exposed to sun, rain, wind, and storm. Such a mode of life throws an increasing burden on the machinery which regulates body temperature—on skin, on respiratory mucous membrane, and on that elaborate system of reflexes which control the rate of internal combustion. Modern civilization, so far as temperature is concerned, tends to make the human body a hot-house plant.

Metchnikoff perceived that civilization had plunged man's body into a new environment and that the rate of its progress had far outstripped the power of adaptational response which had carried man so far beyond the anthropoid stage. A belief grew within him—almost a grudge—that Nature was letting man down. He brought against the evolutionary powers which preside over the destiny

* In 1907 Metchnikoff published a further work, of which an English translation appeared in the same year, edited by Dr. P. Chalmers Mitchell, under the title *The Prolongation of Life*. In this Metchnikoff replied to his critics and produced more evidence in support of his thesis. Sir W. Arbuthnot Lane formed the opinion that the great intestine was a useless and dangerous structure independently of Metchnikoff; so also did Professor Baraley Smith (see an article on the nature of the caecum and appendix by the present lecturer in the *BRITISH MEDICAL JOURNAL*, 1912, vol. ii, p. 1539).

of man both sins of omission and sins of commission. We shall deal with a sample of each.

The first complaint on his list of omissions is that we have not shed from our skins the last remnants of an anthropoid pelage; hair on the body, he held, was useless and a source of disease. Whether or not a completely hairless body is desirable we may leave as a moot point; a hairless breed of dogs has been produced, and no doubt a hairless race of man could be evolved. In this matter the Caucasian has been outstripped by the negro and by the Mongol, the most hairless of races.

It is more to the point to inquire how man has come by a comparatively hairless skin, and in the solution of this problem we have been making some advance. A hairless condition became possible with the evolution of the higher vertebrates; a foetus in the womb draws its heat from the mother's body; it has no need of a hairy covering until the period of birth arrives. There is in the Museum of the Royal College of Surgeons of England a chimpanzee foetus in the eighth month of development; the hair of its head and body has reached a stage identical with that of a newly born child. A stage of development which is evanescent in the foetal anthropoid has become permanent in us. We have come by a new character through the inheritance of one evolved in foetal life. Many of our structural features have come to us in this way.⁵ The base of the human skull is greatly flexed. In the foetal stage of all mammals the basi-cranial axis is bent, but in man only has this character been carried into adult years. Foetal inheritance becomes more and more possible for man because civilization tends to make man's world into a protective womb.

As an instance of a sin of commission, the introduction of a new and useless structure to the human body, Metchnikoff cites the case of the hymen. It is scarcely true to describe, as he does, the hymen as a new structure; it is present at a certain stage in the embryonic life of every higher mammal; it is only in the human species that it persists and forms a definite and substantial structure in the fully formed body. The hymen provides another example of the human body coming by a new character by retaining and modifying a structure which made its first appearance during embryonic or foetal life. When we seek to explain its use we must enter the purlieus of psychology, for around man's sense of sex has grown up a strange hinterland in his subconscious mind. Metchnikoff described the hymen as "an unpleasant impediment"; but love, as the world has long recognized, thrives on impediments. The human prepuce, although not a new structure, was, in Metchnikoff's opinion, a useless and dangerous one; circumcision in one generation does not diminish the completeness of its development in the next. In this the prepuce resembles the hymen. Indeed, Metchnikoff said of the latter structure that the only purpose it had ever served was "the overthrow of the dogma of the inheritance of acquired characters."

The examples of the failure of man's body to adapt itself to present requirements which I have cited above are of little more than academic interest, but when Metchnikoff applied his analytical genius to the problems of man's alimentary system he carried us into the realms where thought becomes the guide to action.

"It would be no longer rash to say" (so he wrote in 1903) "that not only the rudimentary appendix and the caecum, but the whole of the human large intestine is superfluous, and that their removal would be attended with happy results."

Since Metchnikoff penned this sentence the operation of complete colectomy has been performed on many thousands of men and women, but I do not think that even the surgeons who have performed this operation most frequently and most successfully would maintain that a man or woman who has been rendered colonless enjoys that moderate share of health which falls to the average intact individual. If a finger becomes permanently fixed in an awkward position, the hand is improved by the amputation of the offending digit, but the relief thus gained does not restore the hand to its original capacity. The relief afforded by colectomy is of the same kind; the results of that operation in no wise bear out Metchnikoff's doctrine that

the colon has become a superfluous organ in man's body. On the other hand, we have only to consult the pages of the medical press, to listen to tales which reach our ears daily, to note the ever-growing demand for patent purgatives, to be convinced that there is, as Metchnikoff maintained, a grave disharmony between the functional capacities of our great intestine and the dietary which modern civilization has compelled us to adopt. The way out of our difficulties is not to call the colon a useless organ, a "sewage pipe," a "cesspool," but to discover its original purpose and ascertain how far we can modify our mode of living to suit its inherited capacity. What that capacity is we have yet to discover, for we have no complete or exact knowledge of the uses of the great intestine in any animal whatsoever. So far as the human organ is concerned surgery has stepped far in advance of physiology.*

Since Metchnikoff first promulgated his belief that the appendix, caecum, and colon had become superfluous organs in man's body our knowledge concerning the evolution of these structures, and of certain conditions which regulate their action, has increased. That increase of knowledge rehabilitates the ancient belief that Nature in her evolutionary mood exercises not only a surprising ingenuity but also the strictest economy. The ferments and catalysts, elaborated by plants for their own use, were made to serve in the animal body as vitamins. How necessary such substances are for the proper working of the great bowel has been shown by the recent researches of McCarrison⁶ and of Cramer.⁷

It was for the purposes of economy that the great bowel came into existence. In fishes, the earliest vertebrate forms known to us in the living state, potent digestive juices have to be produced at the expense of body tissues; with the evolution of land-living, air-breathing forms much of this expenditure was saved by the utilization of bacterial digestion. The great bowel was added to the original intestine for this purpose, the oldest part of this annexe being the caecum and appendix. The great bowel as we know it in fishes is a mere diverticulum from the hinder end of the gut; it takes no part in the digestion of food. Its epithelium forms a glandular structure which has all the appearance of an organ designed for the supply of an internal secretion.⁸ That secretion, whatever it may prove to be, is carried to the liver by the inferior mesenteric vein. In the mucous membrane of the human great bowel there is set embedded in a stratum of reticular tissue (or reticulo-endothelium) some 15 million of minute test-tube glands—the glands of Lieberkühn. No one who has noted the structure and setting of these glands and the finer changes which their cells undergo in the course of action can believe that their sole function is to supply a lubricating fluid for the intestine; they have all the appearance of also supplying an internal secretion, and the evolutionary history of the colon favours such an inference.[†] The reticular stratum of the colon, which Dr. Scott Williamson⁹ regards as the most important constituent of its mucous membrane—and in this I agree with him—represents a spleen of considerable size. Indeed, just as the liver and pancreas represent extrusions of highly specialized parts of the intestinal epithelium, the spleen represents a specialization of the reticulo-endothelium of the alimentary canal: in Cyclostomes¹⁰ the spleen is still intra-intestinal. Nor must we forget how closely the great intestine is linked to the central nervous system—both by afferent and efferent pathways. When we take all these considerations into account we must conclude that the great bowel of man is not a useless or superfluous organ, but one which we, in our ignorance, are maltreating.

Darwin regarded the appendix as one of man's vestigial structures, and Metchnikoff accepted this verdict without demur, although there were then anatomists, particularly Professor R. J. Berry,¹¹ who refused to regard the appendix as a useless structure. Every child is born with a fully and well developed appendix which varies in length round a

* The reader will find a summary of the anatomical evidence relating to the nature of the appendix, caecum, and great bowel by the lecturer in the BRITISH MEDICAL JOURNAL, 1912, vol. ii, p. 1599.

† I have not mentioned the excretory function of the colon. This has been investigated by Dr. Owen T. Williams. See BRITISH MEDICAL JOURNAL, 1912, vol. ii, p. 1281.

mean of 35 mm. Ribbert's investigations¹² showed that amongst the Swiss the appendix has reached its maximum length—97 mm.—by the twentieth year; thereafter the average length falls slowly, so that by the sixtieth year it has become reduced to 85 mm. Professor Berry¹³ found in the population of Edinburgh that the appendix did not attain its full length—89 mm.—until the fortieth year, falling to 83 mm. by the sixtieth year. Drs. Garcia and Salloza¹⁴ measured the length of the appendix amongst Filipinos—a people living chiefly on a vegetarian dietary. By the twentieth year the appendix of this people had attained a length of 81 mm.; its maximum length, 96 mm., was not reached until the fiftieth year, while the average length fell to 82 mm. by the seventieth year. An organ which increases in length until the twentieth year, or even until the fiftieth, does not merit the name "vestigial."

The size of the appendix at birth in the various forms of anthropoid apes we do not know, but in adult gorillas, chimpanzees, and orangs, the appendix usually attains a length of 150 or 160 mm.—nearly double the length of the human appendix. In the most primitive form of anthropoid known to us, the gibbon, the appendix is most variable in length. In six animals which I dissected fresh from the jungle, all of them adult, the appendix varied in length from 75 to 175 mm. In two of the animals the caecum contained, as part of its contents, numerous fruit stones as large as those of a cherry; the appendix in these two cases held a row of fruit stones showing that it shared in the digestive work of the caecum. There is no evidence to lead us to believe that anthropoid apes suffer from appendicitis in their natural habitat; they become subject to this disease when kept in confinement. Of sixty-one chimpanzees dying in captivity, ten of them suffered from appendicitis.¹⁵ The evidence, such as it is, leads us to believe that when the appendix breaks down under the conditions of modern civilization it does so, not because it is "vestigial," but because of its inability to withstand the conditions to which it is being exposed.

To express the real nature of the structural and functional imperfections seen in the human appendix it is convenient to use a term coined by the late Sir William Gowers. He noted that in some families certain structures, such as the hair on the crown of the head, was apt to be shed as the result of a premature atrophy of the scalp. To such instances of premature senility on the part of any organ or structure he applied the term "abiotrophy."* In this sense the appendix is an abiotrophic structure, one which is apt to suffer from a disordered life-history; in a large proportion of Europeans it becomes atrophic or senile when other parts of the body are in full vigour.

On the evidence collected by anatomists and pathologists it is permissible to infer that if we could follow the life-histories of a thousand modern Europeans from birth to their seventieth year the following would be the fate of their appendices. By the end of the tenth year the lumen of this structure would be partially or completely obliterated in 40 of them; by the twentieth year the same fate would have overtaken 70 more; by the thirtieth year 60 others would have been added to the list; by the fortieth year 80 further cases of obliteration would have occurred; by the sixtieth year there would be 110 additional cases. Of the thousand people who reached the age of 70, only 500 of them would retain their appendix in an unblemished functional state; in the other 500 the appendix would have undergone a premature atrophy at succeeding stages in the journey through life. In this the appendix keeps company with all structures which are of a lymphoidal nature. The tonsils, the thymus, lymphatic glands, and Peyer's patches have similar life-histories, but no one would describe them as vestiges or rudiments. There is much in the name we apply to structures; when we name them "vestigial," "congenital," or "useless," we shut the door on all further inquiry. As Paley declared a century ago, our list of "useless" structures decreases as our stock of knowledge increases.

The eye, which is man's chief organ of sense, has, under the stress of civilization, become the subject of a wrong growth or abiotrophy. If we take a thousand men or

women over the age of 25 we shall find that about 150 of them suffer from a degree of myopia which prevents them from seeing distant objects clearly. And yet in all of them, just as was the case of the appendix, the eye was normal at birth. The incidence of the disorder is somewhat similar to that which befalls the appendix; myopia appears during the period in which the eye is undergoing growth—a process of the most complex kind*; in a few, myopic changes appear by the fifth year, the highest rate of incidence taking place as puberty is reached and passed. We cannot believe that among our hunting ancestors, for whom distant sight was so vital, every seventh man was myopic.

Myopia we must regard as a structural disharmony occasioned by the conditions which civilization has entailed on us. Short sight, as Dr. John Kirk has stated,¹⁶ is certainly a disorder of growth, and the essential problem is to discover, not why 15 per cent. of our population suffer from it, but why it does not occur in the remaining 85 per cent. Children may be fed on the same food and undergo the same school tasks, yet only in certain individuals does the eyeball undergo abnormal elongation. They only are affected by modern conditions, the others are not.

Perhaps no structure in the human body illustrates abiotrophic changes so well as the lens of the eye. By the age of 45 the elasticity of the lens has become so reduced in most of us that we have to seek the aid of spectacles. Some time ago Mr. Ernest Clarke¹⁷ examined the eyes of 1,200 people of all ages and charted in graphic form the condition of the lens. From that chart we can see that some individuals at the age of 45 retain the elasticity of lens which is normal to those of 35 years of age, while others have reached a stage usually found in men and women of 60. It is with the lens of the eye as with the appendix—abiotrophy sets in prematurely in some; in others the change is delayed.

The consideration of the functional failure of the lens of the eye brings us to a problem which fascinated Metchnikoff. What is the term of life which was natural to man in his primitive state? Metchnikoff inclined to place it at a hundred years—that if we escaped accident and disease the inherent vitality of our tissues was sufficient to make a centenarian of everyone. At the age of 45 the lens of the normal man is already old; it has reached the term of its full utility. We have no reason to suppose that civilization has shortened or is shortening its period of usefulness. The indication it affords supports the belief that Nature has worked out the evolution of the human family on a mean life tenure of 45 years; she has, until recently, run the human army on a short-service system. Unfortunately we have no vital statistics of our nearest allies, the anthropoid apes. Micky, a chimpanzee which died lately in the Zoological Gardens, lived there for twenty-six years, and was 3 or 4 years of age when he became an inmate.

Thirty years ago I made an intensive study on the age changes of the teeth and skulls of the great anthropoid apes, and came to the conclusion that very few of them reached the fifth decade of life. The elastic tissue and cartilage of our body keeps the lens company in their rate of ageing; they lose their resiliency by the middle of the fifth decade. The age of 45 sees the end of the term of child-bearing which is normal for women. When we consult the rates of mortality which now prevail we find that a sudden rise sets in during the fifth decade, and this rise assumes a steeper and steeper gradient with every subsequent decade. All of these facts seem to show that 45 was the span allotted to man when he was the blind slave of Nature. Civilization now permits many men and women to live the span of two such lives, but whether it would be an advantage for civilization that all should live to be centenarians, as Metchnikoff believed, is a moot point. We must take civilization in the round; if it has searched out the weak points in our inherited organization it has also added incalculably to the span and comfort of life.

All the structural imperfections of man's body which have been discussed up to this point are of a kind which perish in the grave. We have no means of telling whether or not

* Subsequently the reader will see that I use this term in a somewhat wider sense—one which includes irregular as well as reduced growth.

* I have dealt with the incidence and nature of myopia in the *British Journal of Physiological Optics*, 1925, vol. 1, p. 369.

our remote ancestors suffered from appendicitis or were the victims of myopia. Fortunately from this point of view there are certain of the durable parts of man's body which manifest abiotrophic changes—the teeth and jaws. During the last twenty years I have had an opportunity of examining the facial parts of over 300 individuals who lived in England more than a thousand years ago, some of them as much as eight or ten thousand years ago. Seven years ago I made an elaborate comparison between 50 of these ancient skulls—25 of which were adjudged to be those of men and 25 of women—with equal numbers of individuals who had lived in England within the last two centuries.* In only 3 of the 50 ancient skulls did the upper and lower teeth fail to meet in an edge-to-edge bite; in all of the 50 modern skulls the bite was of the overlapping or scissors type. Our teeth are in an abiotrophic state; the failure of the wisdom teeth or third molars to form, or to erupt if they are formed, is but one symptom of this abiotrophic change; it affects crown, cusp, and root development. In the 50 ancient skulls, instead of 100 upper wisdom teeth, there were only 82, 13 being absent from non-development and 5 from non-eruption. In the 50 modern skulls, instead of 100 upper wisdom teeth, there were only 59; 30 of these were absent from non-development, 11 from non-eruption.

Such evidence shows that although abiotrophic changes had overtaken the dental system of the Western European as early as the Neolithic period, yet these changes have been accelerated during the more recent centuries. Dental abscesses were nearly as common in the ancient skulls as in the modern; carious teeth, on the other hand, were three times more frequent in modern skulls than in the ancient. The researches of the Mellanbys¹⁸ have proved that the quality of enamel and of dentine, particularly of secondary dentine, has a relation to the vitamin content of a dietary. Equally important for the proper formation of teeth, as McCollum and his colleagues¹⁹ have demonstrated, is the presence in food of a due proportion of certain mineral salts. Nevertheless, although a school of children are exposed equally to unfavourable conditions it is only in a certain number that dental defects will occur; in this respect the dental system behaves as do all structures which are liable to abiotrophic changes.

In not one of the 50 ancient skulls was the palate contracted, whereas in the 50 modern skulls there were 13 in which this condition was present to a recognizable degree—in more than half of them to a marked extent. No matter on which stratum of our population we make observations, we shall find that every fourth or fifth child or adult we examine possesses a palate which, compared with the older type, may be described as both deformed and reduced in size and in shape. I have never seen this defect and irregularity of palatal growth except in skulls from cemeteries of the eighteenth and nineteenth centuries. It may be thought that this irregular growth, with reduction in the size of palate, and the defects in the formation of the jaws and face which usually accompany them, are merely the results of the soft and highly prepared kinds of food we eat; with such a dietary the teeth, jaws, and chewing muscles are deprived of the work which fell to them in more primitive times. That this is not the true explanation is proved by this fact: when children are fed, clothed, and exercised exactly alike all are not affected; only some of them develop irregularities of the palate and jaws. There is a special susceptibility to these imperfections in certain races and in certain families.

Amongst modern British people are to be observed various facial characters, seen particularly in the orbits, in the cheek bones, and in the bony supports of the nose, which are never to be noted in the facial framework of people who lived in Britain during the pre-Norman period. When a Continental cartoonist seeks to represent John Bull he always emphasizes these new facial characteristics. Such changes in the form of the facial bones, like contraction of the palate, which they usually accompany, are not the result of a nasal obstruction such as might be caused by enlarged adenoids or tonsils; the cause lies deeper. The incidence of irregularities in the growth of the face follows the same laws as hold for all abiotrophic structures—such as the appendix, the sclerotic coat of the eye, the

thymus, and the tonsil. Further research will likely prove that the disorders of growth which overtake all of these structures are linked to a disturbed action of lymphocytes and of all the constituent elements of the lymphoid tissues. Dr. W. Cramer has become convinced that lymphocytes are actively concerned in assimilation of food and in the nutrition of tissues, and that the nature of the dietary does directly affect their activities. It seems to me very probable that a fuller knowledge of the life-histories of lymphocytes, particularly of the office they perform in growing tissues, will go far to explain the disharmonies which civilization is producing in the bodies of some of us. But the problem of explaining why some members of our community are highly susceptible to these new conditions, while others are less so, and why the majority remain unaffected, will still remain.

I have touched only the fringe of a great subject; I have left undiscussed the numerous imperfections and disharmonies which civilization has made manifest in structures concerned in the maintenance of posture,* and in those which are concerned with the circulation of blood and with the duties of respiration. I have said enough, I believe, to convince you that Metchnikoff was right when he declared that civilization had launched man on a great experiment. From this experiment there is no turning back. We cannot return to the conditions of human life which prevailed in this country six thousand years ago; there are more people in one of the lesser back streets of London than could find an existence in the whole length and breadth of the Thames valley if they returned to the manner of living of our distant ancestors. We cannot go back; we must go on. Seeing how differently we are now circumstanced in every relationship of life—in food, in drink, in shelter, in warmth, in occupation, and in amusement—the wonder is, not that structural imperfections and functional disharmonies should develop in a proportion of our numbers, but that so many of us should escape harm altogether and enjoy good health. It says much for the adaptational reaction which is inherent to the human body that it withstands the artificial conditions of modern civilization as well as it does.

How are our bodies to be protected against these ills with which civilization threatens them? Metchnikoff, a declared and open rebel against Nature, hoped that science might discover some short cut for man's escape, some way of speeding up the evolutionary machinery of his body, and of so making it perfectly fitted for the life which ever-advancing civilization is forcing on mankind. I also believe that science will find a means of escape, but not by Metchnikoff's way. The solution of our problem is a fuller knowledge of the use and working of those parts of our bodies which are most apt to give way under our modern ways of living—the use of such structures as the great bowel; and when we have replaced our ignorance by real knowledge we shall then be in a position, not to adapt our bodily structures to our mode of living, but our mode of living to our bodily structures. This seems to me the best way out.

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* Some details of this comparison were published in *Five Lectures*, issued by the Dental Board of the United Kingdom, 1924.

* I have discussed the imperfections of man's postural structures in the *BRITISH MEDICAL JOURNAL*, 1923, vol. i, pp. 451, 493, 545, 587, 642, 669.