THE IMPORTANCE OF ZOOLOGY TO MEDICAL SCIENCE.*

BY

WILLIAM COLIN MACKENZIE, M.D.,

PROFESSOR OF COMPARATIVE ANATOMY AND DIRECTOR OF THE NATIONAL MUSEUM OF AUSTRALIAN ZOOLOGY.

DURING the past century the problem of human development has overshadowed all others in biology; round the question of human origin a great battle has waged. Zoologists, physicians, geologists, and theologians have entered the arena, but to-day from the conflict three great names emerge—namely, John Hunter, medical practitioner and founder of the Hunterian Museum at the Royal College of Surgeons of England; Jean Lamarck, comparative anatomist, the centenary of whose tragic death will be commemorated in Paris next year; and Charles Darwin, naturalist. Hunter and Lamarck based their principles on function, while Darwin was primarily a structural biologist.

What to-day do the problems studied by these great scientists mean to the man in the street regarding himself as healthy, to the sick person seeking hospital admission for treatment of his disease, or to the mother of the paralysed child faced with a lifelong crippledom? Our ultimate judgement on these problems, regarded unfortunately by many as purely academic, depends on their relation to bodily health and disease. It is to this aspect that I particularly wish to direct attention.

STRUCTURE AND FUNCTION.

It is undeniable that in the past too much attention has been paid to structure and too little to function, on which structure depends, and of which it is the register. As Sir Berkeley Moynihan, the President of the Royal College of Surgeons, said last year at King's College Hospital Medical School¹:

"At the time when I became a medical student, forty-four years ago to-day, we were taught anatomy as we should be taught the plan of a city, learning the names of houses, of main streets, of their branches and turnings. . . . But to the people who lived in the city, their industries, their way of life, the part they filled in the community, we were hardly expected to give a thought. For all we knew the city might be dead."

An explanation is to be found partly in the influence of Sir Richard Owen, who, having studied at the Jardin des Plantes under Cuvier, the bitter foe of Lamarck, subsequently became the curator of the museum housed in the College of which Sir Berkeley Moynihan is the distinguished president, partly in the doctrine of a chance spontaneous congenital variation commonly called "sport" associated with the principles of natural selection, and partly as the result of the introduction of antiseptic surgery—the evil accompanying the good, as is found everywhere throughout nature.

Much consideration in recent times has been given to the demonstration of prehistoric skulls in an endeavour to fill the gap between the anthropoid and man. To-day no one will deny that the positive evidence in this direction now accumulated is overwhelming. But just as we have prehistoric skulls, so also have we prehistoric brains, which show side by side with the modern characteristics primitive features. The man becoming inebriated, the patient passing under the influence of chloroform, the child losing the use of its muscles through infantile paralysis—these all illustrate the functional history of human development. Only along developmental lines can a true interpretation of human conduct be made. The human body is a complex machine, made up of entities, and these have a functional history. A study of the human body, whether from the point of view of health or disease, must include these factors, otherwise it is comparable with the study of a cathedral by an architectural student unacquainted with the principles of construction of a two-roomed house. The humble cottage affords the clue to the architecture of the majestic cathedral and the reason for

the use of the different parts. It cannot be too strongly emphasized that no country in the world offers such a field (unfortunately fast disappearing) for the study of the human body as Australia. Its lung-fish, reptiles, monotremes, and marsupials represent a living embryology—an embryology different from that of the human body; for not only can structure be studied, but also function as well.

THE LOWEST AND HIGHEST MAMMALS—A CONTRAST.

If in the study of function and structure we make a commencement with such a primitive type as the lowest mammal, the platypus, an animal corresponding to life on this planet aeons ago, and in which we see the genesis of the use of limbs not only for propulsion as in the lizard, but for support as well, we find little difference from a physiological point of view between the monotremes and man. The general structural scheme is similar in both. Each has a four-chambered heart, diaphragm, lungs localized to the chest; and the grey matter of the brain in both, unlike that of the reptile, is external to the white matter. Microscopically, we find that the organs of the platypus resemble those of man. What, then, constitutes the essential difference? It is really a postural one. We have the erect posture, the platypus has not. The principle we have to recognize is that the great advance from the reptiles through the mammals up to man is one in muscular action. The advantages, intellectual and otherwise, which the erect posture confers are actually dependent on this; to this everything would appear to be secondary. In the blue-tongued lizard (*Tiliqua scincoides*) we see progression on the belly wall, the four limbs being used for propulsion only. In the echidna we have an animal with its abdominal wall off the ground, and the four limbs used for bodily support as well as for bodily progression. In the kangaroo we find an interesting experiment, that animal having the erect posture by means of a tripod formed by the long feet and tail. In the orang, chimpanzee, and gorilla we find—thanks to an improved musculature at the hip-joint (the centre of motion of the body) and at the knee as indicated by strong patellar development—successive stages in which without the use of a tail there is lessened use of the fore limbs for support. Finally, in man we have the lower or hind limbs only used for propulsion and support, leaving the fore or upper limbs not merely hanging appendages, but structures free to obey the will of the higher brain, and capable of themselves being raised against gravity when the body is erect.

THE HUMAN ERECT POSTURE.

Of all mammals man, the most intellectual, is the most erect. Erect man alone possesses the prefrontal brain, associated with which is the development of the characteristically human forehead. In the lowly prehistoric type, as evidenced by the *Cohuna* skull, this characteristic forehead development is absent. On the erect posture depends human intelligence. This posture is not a matter of equilibrium, for, as we know, the vertebral column is not the axis of the human body. It is maintained and effected by muscular action, and is actually dependent on the improved functional development, along the vertebrate series, of the extending muscles of the hip and knee joints—the strength of the latter being aided by the patellar development. If we compare the skeleton of the living anthropoids and man, we find that the patella, or knee-cap, gives us an index of the degree of erect posture and intellectual development. The patella of modern man is the best developed, and between the patella of the gorilla and that of the Australian aborigine would be the types represented by prehistoric man. A child that has lost the power of these two extending muscles from infantile paralysis, although the brain be unaffected, is unable to stand—becoming quadrupedal. The living anthropoids are regarded by many as mammals arising from a stem common to both us and them; they developed physically, we intellectually.

But it is unscientific to speak of the anthropoid as a specialized muscular type. If we regard it from the point of view of chest, neck, and upper limb development, then it is, compared with man, a more muscular type; but if

* Presidential address delivered at Hobart before the Section of Zoology, Australasian Congress for the Advancement of Science, 1928.

we regard the comparison from the point of view of muscles supporting the body erect, such as those of the hip, knee, and calf, then it is an inferior type to ourselves. The living anthropoids simply represent failures to become erect; but as all human types, whether physically or intellectually, are not alike, so also among the early anthropoids there was one type in which, as the result of environment, the urge to become erect was marked. Little by little, over long periods of time, with bent body, sagging knees, and the lower limbs abducted to give a broad base, just as we see in an infant during the first two years of life, the effort was maintained by the prehistoric types we know to-day, resulting finally in the erect posture of modern man. Thus was accomplished the effort of throwing the body, unaided by a tail, from the quadrupedal to the bipedal stage. The whole of these facts were known to Lamarck. He knew that the erect posture was the ultimate goal, and also—that many scientists are only now learning—that the means were muscular. The common ancestors, the prehistoric types about which we hear so much to-day, were postulated by Lamarck over a century ago. He wrote, speaking of our prehistoric ancestors:

"If these same individuals were to give up using their jaws for biting, tearing, and grasping, or as nippers for cutting grass and feeding on it, and if they were to use them only for mastication, there is again no doubt that their facial angle would become larger, that their snout would shorten more and more, and that finally it would be entirely effaced, so that their incisor teeth would become vertical."

He knew the advantages of the erect posture and its instability; but we go further. Just as it was a struggle for the quadrumanous to become bimanous and finally erect, so also was it a struggle to the quadrupedal from the stage when the vertebrate crawled on its belly wall, and used its limbs for bodily propulsion only and not for bodily support. To-day the actual animals on the direct line are few (collaterals are numerous), but a definite sequence of animals possessing the necessary correlations for the ultimate erect posture—for example, muscular and intestinal—can be demonstrated. This I have termed the law of mammalian development. As regards these correlations, the retention, for example, of a hand with opposable pollex and foot with opposable hallux would be essential. In Australia we have in sequence the blue-tongued lizard (*Tiliqua scincoides*), the bearded lizard (*Amphibolurus barbatus*), and the common phalanger or opossum (*Trichosurus*). Then from the rodent series we pass on to the lemurs, platyrrhine or New World monkeys, catarrhine or Old World monkeys, anthropoids, prehistoric man, Australian aborigine, and the modern European. By means of these can be traced a definite sequence in nervous, muscular, and intellectual development. From the point of view of comparative study I regard the common Australian phalanger (*Trichosurus*) as a key mammal; its intestinal tract gives the clue to the complex human arrangement. The two Australian monotremes—platypus and echidna—are not actually on the line of human development; though showing us the relationship between reptiles, birds, and mammals, they are collaterals, highly specialized, and so have remained. They have sacrificed vital structures which can never be regained. Similarly the kangaroo is not on the direct line, being precluded by the absence of opposable thumb, atrophied upper limb, and the long narrow foot—apart from other specializations; nevertheless, it affords a remarkable attempt on the part of Nature to achieve the erect posture by means of a tripod.

ADVANTAGES OF THE ERECT POSTURE.

The immediate advantage of the erect posture, for example, to primitive man would be in defence against or attack on enemies. The stump-tailed lizard (*Trachysaurus rugosus*), crawling on its belly wall, lives within a limited horizon. It may be attacked from the air or behind. With the erect posture the horizon is extended. There is a view for miles in every direction; objects are seen at a distance. Vision and hearing are improved; memory arises—and memory precedes intelligence. With the erect

posture our primitive ancestors could easily signal to one another, and speech, which is a characteristic of erect man, was evolved in its simplest form—the child stands and walks before it talks.

With the hands free weapons for attack were fashioned and used, and the tactile sense was improved. It is a fact, with which orthopaedic nurses are conversant, that children, paralysed in the trunk and lower limbs and unable to walk, show an almost immediate improvement in mental outlook when placed in the erect position either by mechanical or operative means.

THE INSTABILITY OF THE ERECT POSTURE.

As scientists refer to man as *Homo erectus*, we are apt to think of the erect posture as a power old and permanent. On the contrary, it is a power but recently acquired, and in Borneo, within a few days' steam from Australia, lives the orang, differing primarily from the human type in the undeveloped function of muscles which extend the hip and knee joints. At its present stage the posture is unstable, and a period of three years is spent by the human infant in acquiring balance. The stage has not yet been reached when the child can stand and walk shortly after birth. The medical practitioner dealing with nervous or muscular diseases recognizes its experimental nature, and hence vulnerability to attack, especially during the early years of life. If we consider for a moment we realize how little of our time is really spent in the erect attitude. We spend as much of the day as possible sitting or reclining, and, when standing, we seek relief from the efforts the erect posture demands in supporting ourselves by any convenient object; nor can we regard the time spent by the human race to-day in the motor car as conducive to improvement in muscular function. It is worth remembering that the primary functions of the upper or fore limbs were body propulsion and body support, and that the biological price of disuse is atrophy. The great variation in the lengths of upper limbs is noteworthy.

As I mentioned previously, the instability of the erect posture was well known to Lamarck. Let me again quote from his *Philosophy of Zoology*. He writes:

"No doubt the erect posture attitude is alien to the orang since it adopts it less when moving about and its organization is hence less adapted to it; but does it follow that because the erect posture is easy to man it is therefore natural to him? Although a long series of generations has confirmed the habit of moving about in an upright position, yet this attitude is none the less a tiring condition in which man can only remain for a limited period by means of the contraction of some of his muscles; the erect position is a tiring one for man instead of being a state of rest."

With these pregnant remarks did the great Frenchman anticipate the principles governing the treatment of 80 per cent. of wounded men in the great war. They were the victims of injury to muscle, nerve, and bone, and for them scientific rest and re-education were indicated.

A GENERALIZATION FOR HEALTH AND DISEASE.

Throughout the Commonwealth of Australia to-day we find that hospital wards for medical and surgical treatment are everywhere on the increase, yet they seem unable to cope with the chronic patients who constitute the great problem in present-day hospital practice. With a perfect environment and so much attention paid to the so-called essentials—air, food, and water—why should this be? In spite of our hospitals, drugs, and preventive measures, it would seem that as old diseases disappear, or tend to lose their virulence, new ones take their place. Too much emphasis has been given to the attacker and too little to the attacked. Since human development has been on physiological and not on pathological lines, to obtain a knowledge of the factors that constitute health, as contrasted with disease, we must know the history of human development. This can only be obtained by a study of Nature's own experiments; only along these lines can a problem of cell multiplication, such as cancer, be attacked.

The great muscular epochs resulting in the erect posture and its accompanying superior intellectual development have affected every system of the body. Even the lizards of Australia are immediately divided into two great divisions,

one represented by the blue-tongued variety (*Tiliqua scincoides*), and the other, in which we see the attempt to use the limbs and long tail for support, by the bearded (*Amphibolurus barbatus*) and the frilled (*Chlamydosaurus kingii*) lizards.

Underlying so many apparently dissimilar phenomena is the really one great fundamental basis, that with the alterations in posture produced by the muscular system every other system in the body is correlated. As new functions of intelligence arise, necessitating brain enlargement, so also must the abdominal organs be hitched to the dorsal wall to prevent strangulation. The heart must accommodate itself to the altered posture, having to pump blood not horizontally, but upwards against gravitation. The treatment of cardiac disease should consider the history of the acquisition of cardiac muscle function. Cell function is a compound of entities. Those last acquired are most vulnerable to attack and most difficult to regain; and when, for example, we speak of failure in action of muscle, liver cell, or heart, we have to determine whether the loss is of some or all the entities. Thus, in the case of the loss of function of the extending muscle of the knee, is it a loss of all the entities necessary for the erect posture, or has it retained the function necessary for use in the lowest mammal, the platypus? This principle is the basis of the now universally accepted muscle re-education treatment in infantile paralysis and neuromuscular diseases and injuries, and was evolved in Australia from researches on its unique fauna. Numerous operations for displacement of the human uterus, on which so much ill health depends, are in use. This only shows how necessary it is for the gynaecologist to recognize the history of uterine support. Only along comparative lines involving a study of birth through the Australian reptiles, monotremes, and marsupials can midwifery be raised from an art to a science. The bandicoot, a marsupial animal of the greatest importance for placental study, is now almost unprocurable.

To-day we see the apotheosis of muscular development; but it is essential that physical culture should follow the lines along which the erect posture has been acquired, and be directed towards helping those muscles on which it particularly depends. To develop a sound muscular system we must not only have rational exercise, but rational rest as well. Such exercising as golfing, tennis, or long walks may, to the city man engaged in mental activities, act as an irritant, since more often muscular repose is indicated. The cause of dullness in the school child may be the result of faulty seating accommodation. The child is compelled to sit erect on seats without backs, and is forbidden to rest the head on the hands, with the result that mental effort is expended not only on lessons, but on balance as well. How often is our enjoyment of a play or lecture spoilt through a similar cause! Do we realize how the output of a factory can be lessened through faulty posture? The laziness of the Australian aboriginal has a physiological basis; with his long arm and poorly developed lower limbs he is nearer than we to those prehistoric types who walked with bent neck and with sagging knees.

Probably no game in the world, not even excluding tennis, exercises the erect posture functions more than the Australian game of football. It is founded on sound physiological lines and has been a no small factor in the physical development of our nation.

In conclusion, if we exclude specific infectious diseases, which are in the main preventable and due to segregation, we may define health as a correlation of all the bodily systems to the erect posture, and ill health as a failure of one or more systems to correlate to it. In any case of chronic ill health an analysis of the postural system should precede all other investigations.

In the hospital of the future a primary consideration in treatment should be given to Nature's methods. We are intent on surgical wards, theatres, and equipment; but an essential in any public hospital is a great department of myology wherein a scientific examination can be made for muscular defects, and their importance assessed.

REFERENCE.

¹ *British Medical Journal*, October 8th, 1927, p. 621.

Nova et Vetera.

THE CHINESE DOCTOR.

THE Chinese quack has been so written up and has become so well known that the Chinese doctor has been eclipsed; some notes about him may therefore be of general interest. The medical student is usually trained by being apprenticed to a man in practice; he has an extensive literature to study and a vast pharmacopoeia to employ. Some eventually gain a very high reputation, and are trusted by their patients. I have come to know several, and will mention some of their cases which have come within my ken.

Lobar Pneumonia.—This is well known as such to Chinese doctors. A woman in my hospital had a patch that would not clear up; she also had fatty heart. I sent for the woman's family physician, who lived thirty miles away; he was quite ignorant of Western methods and had never seen a stethoscope, but he told me, after going into the whole case with the patient, that she was weak inside and strong outside, which was his way of saying fatty heart, and that she had been insufficiently stimulated during a recent pneumonia. I asked, "Is there pus?" He said, "Not yet, but a needle would do no harm." I tapped for pus and drew only blood. He gave her three prescriptions and the patient rapidly recovered. He felt the pulse most carefully and went into the history minutely. The methods were seemingly crude, but his deductions were correct and his treatment was effective.

Enlarged Spleen.—A man had been tapped twice and sent home as the spleen reached the umbilicus (I do not know the cause of the enlargement). He went home and bought his coffin, but a friend suggested that arsenic pills should be taken, increasing by one daily up to twenty-six and then diminishing daily by one. I saw him after this course of treatment, and the spleen could only just be felt under the rib.

Pulmonary Tuberculosis.—A very advanced case of tuberculous lung was successfully treated by a Chinese doctor expert in physical culture by graduated exercises and drugs, the patient living for many years subsequently. At the time he was so ill that the father had to kowtow and beg the doctor to undertake the case before he would consent, as it seemed hopeless.

Anthrax is common. A boy, aged 8, was brought to hospital with a sore on the upper lip and a temperature of 101° F.; he had fainted twice on the road while being carried. The microscope verified the diagnosis. I was very "uncheerful," but a Chinese assistant said to me, aside, that he had an uncle, an anthrax specialist, and he himself knew the treatment; so we treated the boy by stewing three herbs, using the stewed leaves as a poultice, while the infusion was drunk. The lad went home perfectly recovered on the fifth day. The herbs were verbenas, sorrel, *Carpesium abrotanoides*, and enough rhubarb root to keep the bowels acting. These herbs are very common in that locality; I had them identified at Kew. That summer we treated six bad cases of anthrax; one patient had a face swelled beyond all recognition.

"Stroke."—I spent two hours in a sedan chair reading up in a copy of the *British Medical Journal* an illuminating article on "stroke," and arrived at the patient's house well primed in the differences between cerebral thrombosis and apoplexy. The patient, aged 35, had kala-azar, and had been going the pace, so I concluded it was thrombosis causing left-sided hemiplegia. An old country Chinese doctor, who was there, and knew the condition, said that purgatives must be avoided, as it was the weak variety of stroke—his way of saying that it was cerebral thrombosis and not cerebral haemorrhage.

These doctors are much respected when they have acquired their reputation, and I think they deserve respect from Westerners. To class Chinese doctors and quacks together, and ridicule them all, makes enemies. By cultivating friendly relations with the native doctors we shall learn some of their secrets, which are of real worth. Livingstone, though he lived among very primitive people, always treated the native doctors with respect, and so won their friendship. In surgery, of course, we are supreme, and they know it; they have no anaesthetics and no antiseptics. Rockefeller has seen the value of a friendly gesture, and has contributed lavishly to found in Peking a first-class hospital. During the recent upset in China the Americans have escaped the systematic boycott which