emulate him in the field of medicine will do well if they achieve as much as he, and for them Babinski leaves the memory of a great name and the inspiration of a great example.

Conclusions

If those who propose to study medicine have not yet decided whether research or practise attracts them most it is well to realize that scientific medicine in this country has been made attractive by a number of unusual, and probably artificial, circumstances. The munificence of certain individuals and of scientific foundations has made it possible for large numbers of men to devote their lives purely to biological science. For reasons which are only too obvious to any one who has studied the present world situation it is unlikely that the numbers of those who are able to pursue such research will increase; indeed, their numbers are likely to diminish sharply. There is no doubt, furthermore, that schools and universities of this country have trained far too many men who intend to devote their lives to research alone. Unless a man's aptitudes are of a very extraordinary character, or unless he is financially independent, it is far wiser for him to begin the study of medicine with the intention of entering practise, if possible, general practise. In so doing he will be in daily contact with the major problems of disease and if he brings to this task a well-trained mind, as well as broad and sympathetic understanding of human problems, he will be able to make, as other illustrious physicians have made before him, discoveries and contributions which will advance our common science. If, like John Wesley, he is a pragmatist, willing to try anything within reason, and holding fast only to that which is good, he may make discoveries which in the present state of knowledge he can not explain, but he will at least have the satisfaction of realizing that he has benefited one and perhaps many suffering human beings, and he may take even greater satisfaction in knowing that he has handed to his intellectual descendants of the next generation the stimulus of his achievement.

Finally, medicine has a good deal of the spirit of the guild with a strong tradition and consciousness of its continuity with the past. Many therefore resent the tendency among writers of the present generation to make light of the foibles of the men who early attempted to cope with disease. Kipling, with characteristic insight, sums up the spirit of medical tradition in his poem "Our Fathers of Old,"[11] which incidentally offers a healthy corrective for those who have not caught the spirit of continuity and loyalty that characterizes medicine.

Our Fathers of Old

Wonderful little, when all is said,
  Wonderful little our fathers knew.
Half their remedies cured you dead—
  Most of their teaching was quite untrue—
"Look at the stars when a patient is ill,
  (Dirt has nothing to do with disease,)
Bleed and blister him as oft as you please."
    Whence enormous and manifold
    Errors were made by our fathers of old.

Yet when sickness was sore in the land,
  And neither planet nor herb assuaged,
They took their lives in their lancet-hand
  And, oh, what a wonderful war they waged!
Yes, when the crosses were chalked on the door—
  Yes, when the terrible dead-cart rolled,
Excellent courage our fathers bore—
  Excellent heart had our fathers of old,
    None too learned, but nobly bold
    Into the fight went our fathers of old.

If it be certain, as Galen says,
  And sage Hippocrates holds as much—
"That those afflicted by doubts and dismays
  Are mightily helped by a dead man's touch,"
Then, be good to us, stars above!
  Then, be good to us, herbs below!
We are afflicted by what we can prove;
  We are distracted by what we know—
    So—ah so!
    Down from your heaven or up from your mould
    Send us the hearts of our fathers of old!

—*"Rewards and Fairies."*

EURYPTERID INFLUENCE ON VERTEBRATE HISTORY

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The general history of skeletal development in vertebrates was assumed until recent years to be a simple one. Since cartilage develops before bone in the embryo, and since the most primitive of living vertebrates have no bony tissues, it was believed that the phylogenetic story was similar—that the main line of early vertebrate evolution, as far as the stage represented by the highly developed bony fish, lay through a series of forms possessing a purely cartilaginous skeleton and lacking dermal defenses other than the shark type of denticles. The lamprey and

[11] Rudyard Kipling, "Rewards and Fairies." New York, Doubleday, Page and Company. 1925. xii + 344 pp.

the shark were thus believed to be primitive cartilaginous types. We knew that certain early groups, such as the ostracoderms and arthrodires, possessed a hard external armor, in many instances containing true bone; but it was generally assumed that they were aberrant forms which had separately attained this condition and that they had nothing to do with the main line of vertebrate descent.

Recent discoveries and investigations, particularly those of Stensiö, have tended strongly to show that the truth lies almost in the opposite direction—that bone is an exceedingly old structure in vertebrate history, and that living cartilaginous vertebrates are not primitive, but degenerate, as regards their skeletons. In many fish groups it is definitely known that skeletal degeneration has occurred, and the new evidence renders it probable that such degeneration has been a general trend in fish history. Stensiö[1] has brought forward convincing evidence of the descent of lampreys from Paleozoic forms with a bony skeleton; there is a growing body of evidence suggesting that the sharks have been derived from armored types[2]; even among the higher fishes degeneration has been at work, for only three living genera (the garpike and two African forms) retain the thick squamous armor of their Devonian ancestors, and many primitive existing types (lungfishes, sturgeons, paddle-fishes) are degenerate in their internal skeleton as well. Lower Devonian and Silurian vertebrates, as far as known, are invariably armored, and bony plates are present in the Ordovician forms known from fragments from the Harding Sandstone of Colorado. Bone is thus an ancient tissue. It now seems highly probable that the oldest vertebrates early acquired a hard external armor, which has been reduced or lost by most later groups.

Why was armor present in the early vertebrates? Its seeming universal presence can not well be considered an "accident" in evolutionary history. The later Professor Patten ably argued that the hard exoskeleton was an inheritance from the eurypterids, which he believed to be their ancestors, but recent detailed work on the structure of the older vertebrates fails to support the claim for a genetic relationship of the two groups. It has been suggested that the armor might have served as a protection against buffeting on rocky surfaces in fast flowing streams. But modern fishes in such environments seem to survive without such elaborate protection; and the frequent presence of spines and projecting "horns" in the earlier types would have tended to an increase in such encounters rather than to their avoidance. The only reasonable explanation is that the armor was a protection against living enemies. The presence in *Cephalaspis,* an ancient Silurian vertebrate, of presumed electric organs analogous to those of certain modern fishes, tends to confirm this assumption.

Against what enemies were the early vertebrates protected? Modern forms are usually armored in relation to escape from their own carnivorous vertebrate relatives. But in Silurian times none of the adequately known vertebrates possessed any hard biting jaws capable of rendering a predacious existence possible. The enemy must be sought among the invertebrate types.

At first one thinks of the larger marine invertebrates, such as the cephalopods. But the environmental surroundings of early vertebrates must be taken into account. Increasingly our fossil evidence tends to confirm T. C. Chamberlin's theory of the fresh-water origin of vertebrates. The higher bony fish are definitely known to have been almost without exception inhabitants of fresh waters when they appear in Middle Devonian times, and only later invaded the seas. The oldest sharks known are fresh-water forms. The known Silurian vertebrates are found in deposits which appear to be either of fresh-water origin, or, at the most, brackish. The Ordovician remains previously referred to are believed to have been those of stream-dwelling types.

Among invertebrates there is one group, and only one, in which a similar environmental history is known, the eurypterids, an ancient, extinct group of large aquatic scorpion-like Arachnids, of which the modern horseshoe crab, *Limulus,* is the nearest surviving relative. Their habitat has been much debated, but it is now generally agreed that during the later part of their history, at least, the eurypterids, in contrast to most of the older invertebrates, inhabited fresh waters.[3] Although dating back at least to the Cambrian, the eurypterids became common only in the Silurian, reaching a climax in size and abundance toward the end of that period. In the Devonian they rapidly declined, and survived only in limited numbers to the Permian, when they disappeared.

The eurypterids, with biting mouth parts and grasping jaws, were seemingly predaceous types, as are practically all arachnoids. They tended to large size, reaching as much as nine feet in length in one genus; on the other hand, the early vertebrates were comparatively small, the average Silurian form being but a few inches in length. The vertebrates thus appear to have been an appropriate food possibility for the

[1] "Skrifter om Svalbard og Nordishavet," No. 12, Norske Videnkaps-Akademi i Oslo, 1927.

[2] Stensiö in Field Mus. Nat. Hist. Publ. Geol. Vol. 4, 1923, pp. 89–198, and Smith Woodward in Livre Jubil. Cinquant. fond. Soc. Geol. Belgique, 1924, pp. 59–62.

[3] M. O'Connell, in *Bull. Buffalo Soc. Nat. Hist.,* Vol. 11, No. 3, 1–277, 1916; *cf.* R. Ruedemann, in *Amer. Jour. Sci.,* Vol. 7, pp. 227–232, 1924.

eurypterids. This possibility is strengthened by the fact that in almost every one of the localities of late Silurian and early Devonian age in which the earliest vertebrate faunas are found, eurypterids were also present, but almost no other invertebrate types are preserved with them. Such localities include, for example, the Shawangunk grits of New York, the Lower Devonian of the Maritime Provinces of Canada, the Ludlow and Downtonian of England and Scotland, the Downtonian of Norway, the Upper Silurian waterlimes of the Baltic and the Old Red Sandstone of Scotland. Eurypterids and vertebrates actually inhabited the same waters. Apart from the vertebrates little source of food supply is evident for the eurypterids.[4] Except for the eurypterids there is no obvious enemy against which vertebrates needed protection.

This hypothesis fits adequately many facts in the history of these two groups of organisms.

Two apparently unassociated facts in their history may be noted. (1) The eurypterids, as has been said, appear to have reached a maximum in size and numbers at about the end of the Silurian. Following this they rapidly declined into insignificance during the Devonian. (2) While all known early vertebrates were superficially well armored, a rapid increase in unarmored forms and a strong tendency for the thinning out and loss of dermal defenses appears to have been initiated during the Devonian.

It appears probable that these two phenomena are related and are explicable by a consideration of certain other characteristics of Devonian fish history. (a) During the Devonian there is a tendency toward a considerably greater average size in fishes. (b) Many forms, particularly shark-like types, appear to have been migrating from fresh into marine waters. (c) Although Silurian ostracoderms were almost universally depressed-shaped and obviously slow-moving forms, the Devonian fish fauna is characterized by the appearance and dominance of much faster-swimming types, the acanthodian sharks in the Lower Devonian, followed by the numerous true bony fish in the Middle Devonian. (d) Devonian fishes possessed jaws, for the most part, in contrast with the suctional mouths of the Silurian types.

It appears obvious that with increased size, increased speed and a partial migration to marine waters where eurypterids were absent, the vertebrates of the Devonian ceased in great measure to be a possible source of food supply for the eurypterids. Further, with the development of predacious habits and increased size in vertebrates, the tables might have been turned, and the eaters become the eaten. It would reasonably follow (1) that eurypterids would decline in numbers and (2) that armor, now no longer needed, would tend to disappear from the vertebrates.

It is possible that this early eurypterid "menace" may have been influential in vertebrate evolution in other respects than that of skeletal development. It seems not improbable that much of the locomotor activity which is so characteristic of vertebrates as a group may have developed in relation to escape from eurypterids. If we assume an early evolutionary stage in which vertebrates together with eurypterids inhabited the estuaries and the sluggish waters of lowland regions, it is obvious that a premium is placed on active movement. First, it would be an immediate aid in escaping from eurypterid attack. But of seemingly greater significance is the fact that increased mobility would allow of migration to the higher reaches of river systems, in whose swifter waters the eurypterids, with a radically different type of locomotor equipment, would find life much more difficult.

Again, this suggestion of development of more mobile types in higher land regions suggests an explanation for certain puzzling lacunae in our knowledge of early vertebrate history. I shall cite but one example.

The higher bony fish groups, the *Osteichthyes,* are the dominant fresh-water types from Middle Devonian times on. In the Middle Devonian they are very abundant, and already highly diversified; obviously they had already passed through a long evolutionary history which must have begun in Silurian days. But their appearance on the paleontological stage is a dramatically sudden one. In contrast to their abundance in the Middle Old Red Sandstone, almost no traces of bony fishes are found in Lower Devonian deposits and it has been assumed that the early evolution of these active and generally predaceous forms might have been undergone in some unknown continental area.

But it must be noted that, in general, fossiliferous deposits are not laid down in the higher courses of rivers, but only in lowland regions, in areas of lakes and slowly moving streams. It is highly probable that the early development of the *Osteichthyes* took place not necessarily in unknown regions of the earth but rather in highland areas for which no depositional record is preserved. In such an environment the sluggish, bottom dwelling mode of life of their ancestors would of necessity have been transformed into the active habits characteristic of bony fishes. Concomitantly may have occurred the evolution of jaws, permitting the development of a carnivorous mode of life in contrast to the mud-grubbing which alone was possible in the sedentary jawless ancestors. These changes accomplished, the bony fishes, now fit to

[4] C. Schuchert, in *Proc. Nat. Acad. Sci.,* Vol. 2, 1916, p. 731.

maintain themselves against the eurypterids, might return to the lowlands—and thus appear at last in the fossil record.

I would by no means claim that all the facts of eurypterid and early vertebrate history are to be explained as due to the interrelations of these two groups. It is probable that the eurypterids had other sources of food than that supplied by the vertebrates, and many other factors may have influenced their decline and fall. Nor do I believe that the early steps in vertebrate evolution are to be explained entirely and simply as related to a defense against eurypterids. But it is impossible to believe that these two groups could have existed in close contact for many millions of years without a considerable influence upon each other. And it is highly probable that many facts regarding the motility, habitat and particularly the skeletal development of the early vertebrates are intimately related to the necessity of escape from eurypterid enemies.

SCIENTIFIC EVENTS

THE BUCKSTON BROWNE SURGICAL RESEARCH FARM

ACCORDING to the report in the London *Times,* the new Buckston Browne Surgical Research Farm at Down, near Farnborough, was opened on July 12 by Sir Holburt Waring, president of the Royal College of Surgeons of England. The establishment has been endowed and given to the college, at a total cost of £100,000, by Sir Buckston Browne, R.C.S. It comprises a residential hostel for surgical and biological workers, a separate building containing laboratories and accessory rooms, and 13 acres of grounds.

The estate adjoins that of Down House, where Charles Darwin lived and worked for 40 years and died in 1882. Down House represents another great benefaction of Sir Buckston Browne, by whom, as a tablet there records, it was "acquired, restored, endowed and presented to the British Association as trustee for the nation" five years ago. Sir Buckston Browne attended the opening. Among others present were Sir Arthur Keith, the director of the establishment, Lord and Lady Moynihan, Sir John and Lady Bland-Sutton, Sir Charles Sherrington, Professor E. L. Kennaway, Professor G. Grey Turner and Mr. O. J. R. Howarth, secretary of the British Association.

Sir Holburt Waring described the research farm as a magnificent donation in the interests of the advancement of surgery by one of their own profession, and observed that it was to the association of the surgeon with the biologist that they looked for the great advances of surgery in the future. He said that during recent decades surgery had made most of its advances through improved technique and the application of Listerian principles. More recently, however, radiological methods (x-ray and radium), together with biochemical and biophysical processes, had played an increasing and very important rôle in the diagnosis and treatment of disease, and in the understanding of the associated biological factors. They hoped to solve there by experimental methods many of the fundamental problems which beset surgery to-day. It was possible that many might be solved; others would prove exceedingly difficult.

Sir Buckston Browne said that they were assembled upon a remarkable spot. On the other side of the hedge had lived and worked Charles Darwin, the great emancipator of the human mind; this afternoon they had the privilege and joy of bringing here the genius of John Hunter, one of the great emancipators of the human body. One of Hunter's pupils was Edward Jenner, who worked at the prevention and mitigation of smallpox. The world quickly forgot its benefactors and their benefactions, and few even of those present realized the enormous debt they owed to Jenner. Many of them would have been dead long ago had it not been for Edward Jenner; many would have been sitting there with horrible scars. The world nearly lost Lord Lister from smallpox.

He would like to say one word about those who opposed all experimentation on animals. He maintained that the whole of the animal kingdom was as precious to the medical profession as to any other collection of men. Their whole lives were spent in the alleviation of pain and the prolongation of life; and nearly all that was done for man—who was only the head of the animal kingdom—was now done in our veterinary colleges and hospitals.

Sir Arthur Keith thanked the donor of the farm for "the most generous benefaction and the best aid to medicine that has been made in my time."

THE DUTCH ELM DISEASE IN NEW JERSEY

THE Dutch elm disease has broken out anew in the United States. This time it has been found in the state of New Jersey. Sixty-nine infected trees have been found scattered among the elms of an area of perhaps a hundred and fifty square miles in Essex, Hudson and Passaic counties, according to a statement given out by R. Kent Beattie, of the Bureau of Plant Industry, who has returned to Washington after investigating the outbreak in New Jersey. The