in muscle and nerve in all its characters, and, at the end of his work, had also disclosed the inadmissibility of vital force, then the venerable Humboldt formally and expressly renounced the dream of his youth, with the masterly submission of the true naturalist to the recognised natural law.

The hypotheses of a particular force of life had, however, in regard to Brown's theory neither a positive nor a negative value. Johannes Müller rescued for general physiology, in which it has ever since kept its place, that which was valuable in Brown's system, the doctrine of the integrating life stimuli. The occasional stimuli which produce disease have found their place in etiology; their significance has become more and more sharply defined, the more accurately we have learnt to distinguish between the causes and the essences of disease, a distinction which became more difficult as the "causæ vivæ" of diseases became known in ever-increasing numbers. And now a new task has arisen, namely, to draw into our sphere of observation the life of the causative agents themselves.

The way in which pathology has tried to approach the desired goal, to fathom the living substance in its diseased conditions, has led us a great step forward. Pathological anatomy, especially, has opened this road. The more numerous its observations, and the more it penetrated into the details of the lesions, the smaller became the field of so-called general diseases. The first steps of mediæval anatomists had the effect of drawing the attention to local diseases. In the first and longest period, which one may define as that of Regionism, the pathological anatomists sought the cause of disease in one of the larger regions or cavities of the body—in the head, chest, or abdomen. In the second period, ushered in by the immortal work of Morgagni, shortly before the time of which I last spoke—the time of Brown and Hunter—they endeavoured to find in a certain region the actual organ which might be considered as the seat of disease. On this foundation arose the Parisian school of Organicism, which, until late in this century, held a dominant position in pathology. In this school, already, they recognised that not the organ, nor even a portion of it, could be the ultimate object of research. Xavier Bichat divided the organs into tissues, and showed that in the same organ sometimes one and sometimes another tissue might be the seat of disease.

From that time forward the eye of the pathological anatomist was directed chiefly to the changes in the tissues, but it soon became apparent that even the tissues are not simple substances. Since the third decade of this century, the microscope has disclosed the existence of cells, first in plants, and very soon afterwards in animals. Only living beings contain cells, and vegetable and animal cells show so much similarity of structure that one can demonstrate in them the actual product of organisation. This conviction has become general, since through our embryologists, especially through Schwann, proof has been afforded that the construction of embryonic tissues was derived from cells also in the highest animals and in man himself.

In the fourth decade of this century the science of pathological anatomy had already begun to be directed towards cells. These researches very soon struck on great difficulties. Many tissues, even in their developed state, appeared to contain neither cells nor their equivalents; nevertheless, I have been able to demonstrate their existence in those tissues in which their presence appeared to be most doubtful, viz. in bone and connective tissues. At the present time we are so far advanced as to be able to say that every living tissue contains cellular elements. We go a step further even, for we require that no tissue should be called living in which the constant occurrence of cells cannot be shown.

A still greater difficulty then appeared, namely, to discover in what way new cells originated. The answer to this question had been very heavily prejudiced by the so-called cell-theory of Schwann. Inasmuch as this very trustworthy investigator asserted that new cells originated from unformed matter, from "cyto-blastema," there was opened up a wide road to the old doctrine of the "generatio æquivoca," which afforded all partisans of plastic materials an easy way of reviving their dogma. The discovery of cells of connective and allied tissues gave me the first possibility of finding a cellular matrix for many new growths. One observation followed another, and I was soon in a position to give utterance to the dictum, "Omnis cellula a cellula."

And so at last the great gap was closed which Harvey's ovistic theory had left in the history of new growth, or, to speak more generally, in the history of animal organisation. The begetting of a new cell from a previous cell supplements the reproduction of one individual from another, of the child from the mother. The law of the continuity of animal development is therefore identical with the law of heredity, and this I now was able to apply to the whole field of pathological new formation. I blocked for ever the last loophole of the opponents, the doctrine of specific pathological cells, by showing that even diseased life produced no cells for which types and ancestors were not forthcoming in normal life.

These are the fundamental principles of cellular pathology. In proportion as they have become more certain, and more generally recognised, they have in turn become the basis of physiological thought. The cell is not only the seat and vehicle of disease, but also the seat and carrier of individual life; in it resides the "vita propria." It possesses the property of irritability, and the changes in its substance, provided these do not destroy life, produce local disease.

Disease presupposes life; should the cell die, its disease also comes to an end. Certainly, as a consequence, the neighbouring and even far distant cells may become diseased, but as regards the cell itself the susceptibility to disease is extinguished with life.

Since the cellular constitution of plants and animals has been proved, and since cells have become recognised as the essentially living elements, the new science of biology has sprung up. It has not brought us the solution of the ultimate riddle of life, but it has provided concrete, material, anatomical objects for investigation, the structures and active and passive properties of which we can analyse. It has put an end to the wild confusion of fantastic and arbitrary notions such as I have just mentioned; it has placed in a strong light the immeasurable importance of anatomy, even in the most delicate conditions of the body; and lastly, it has made us aware of the close similarity of life in the highest and lowest organisms, and has thus afforded us invaluable means for comparative investigation.

Pathology has also its place, and one certainly not without honour, in this science of biology, for to pathology we are indebted for the knowledge that the opposition between healthy and diseased life is not to be sought in a fundamental difference of the two lives, not in an alteration of the essence, but only in an alteration of the conditions.

Pathology has been released from the anomalous and isolated position which it had occupied for thousands of years. By applying its revelations not only to diseases of man, but also to those of animals, even the smallest and lowest, and to those of plants, it in the best manner helps to strengthen biological knowledge, and to narrow still more that region of the unknown which still surrounds the intimate structure of living matter. It is no longer merely applied physiology; it has become physiology itself.

Nothing has more contributed thereto than the constant scientific union which has endured for more than 300 years between English and German investigators, and to which we to-day add yet another link. May this union never be broken!

APPLIED NATURAL HISTORY.

THE so-called experimental sciences—chemistry and physics—in their various branches, have hitherto been more extensively "applied" to the service of man, than the observational sciences of botany and zoology.

The various industries in which civilised man has naturally become engaged have induced a scientific study of the fundamental principles, and an eager search for such information as can lead, with the assistance of art, to a further advance towards the goal of perfection.

It is true, however, that the practice of medicine has much dependence on the science of botany.

Zoology, on the other hand, has never been considered as possessed of qualities serviceable to any bread-winning occupation, and although included, like botany, in all ordinary courses of medical study, has not until recently been considered of importance for the advancement of any industry.

Now, when the nineteenth century is in its last decade, we in this country are beginning to realise that a knowledge of the life-histories and habits of sea-fishes and other food-products of the deep is of paramount importance in regulating and bettering the fisheries around our coasts.

A few years ago the scientific aspects of this industry received but scant attention. Many outcries have indeed been always heard as to injurious methods of fishing, the wilful destruction of fish suitable for food, and the general depletion of certain fisheries, but in spite of Royal Commissions and Courts of Inquiry, we have been slow to grasp the truth that for want of proper knowledge with which to control our laws and regulations we have been timidly procrastinating, and allowing our chance of ready resuscitation to diminish. We have about 400,000 men dependent on our fisheries, and yet are at the present day lagging behind other and younger countries in our State Aid. In Scotland the proportion between fishermen and the rest of the population is 1 in every 76; in Ireland 1 in every 216; in England and Wales 1 in every 612. In a recent report of the Board of Trade it is also stated that "the sea fisheries of the United Kingdom appear to be of greater value than those of any other country in which fishery records are kept." The value of the fish landed annually in the United Kingdom is about six million pounds, and yet a large proportion of our fishermen eke out a miserable existence, and see the industry in which they are engaged becoming more and more unremunerative every year. In Scotland, where most is done for our fisheries, there is a Government Board where appeal can at all times be made by any persons desiring alterations in the existing state of circumstances. A Board which not only collects all statistics, but which has power and capabilities to inquire into all methods of fishing, whether from a biological or commercial standpoint, as well as to construct by-laws if necessary. In England the absence of such a body is much felt. Conference after conference is held, but although promoted under the most favourable auspices, the resolutions agreed upon can hardly be made to impress the House of Commons, because of this want of a proper channel. It would be quite out of place in an article such as the present to speculate as to the constitution of a Fishery Board for England, but without any doubt it should have not only a representative of biology, but a small staff of investigators.

The unfortunate antithesis which at present exists between so-called practical people and men of science results largely from the unknown altitude from which the latter choose somewhat exclusively to illuminate the world. Without desiring in any way to discount the pursuit of knowledge for its own sake, it seems apparent that the benefits to be derived for our fisheries are not to be obtained from the lovers of pure science, but rather from those who, having had the proper scientific training, are willing to occupy a position in which they will be intimately acquainted with the requirements of practice as their object, and yet be able to focus the theoretic rays of the specialists on the different sections of their work.

The history of the various Royal Commissions has thrown considerable light on the particular nature of the information needed. It has also shown how widely the investigations yet to be carried on must extend.

Take, for example, the old vexed question of beam-trawling in Scotland. Fishermen practising the time-honoured art of long-lineing appeared as witnesses before the Commission of 1883, and being keenly antagonistic to the trawler, described how this species of robber descended upon their old haunts, scraped and harrowed the bottom to the utter destruction of all spawn and fry, scooped up tons of fish (which should have lived to have been caught by hook and line in the proper manner), and glutted the market with what was quite unfit for human food.

It is often extremely difficult to separate political interests from fishery reports, but the fact remains that evidence of this kind, being inserted in the public press, led to much misunderstanding, and inclined people to support the line fishermen at the expense of the trawler. But the late Lord Dalhousie, as chairman of the Commission, was fortunate in having as one of his colleagues a naturalist who had for many years given special attention to fisheries. The statements, therefore, as to destruction of spawn and young fish were tried and found wanting. The evidence as to the natural history of fishes being most wild and conjectural, though given by men who had spent their lives at sea and were masters of their craft, was met by scientific accuracy and fell to the ground. We find in the official report of the Commission, published in 1886, very decided statements indicating that in the opinion of the Commissioners the injury done by the use of the beam-trawl is insignificant.

Much information has now been gained as to the eggs and embryology of sea fishes, and important observations published on such matters; for instance, as to the proportional numbers and sizes of the sexes, and the sizes at which the various food fishes become sexually mature.

Observations made on the last-named inquiry show that on different coasts where the conditions of life vary as to temperature, food, or ocean currents, the sizes at which any individual members of a species of fish spawn are distinctly different, and that the rate of growth is different. This is a matter of some importance to those who would prevent capture of fish till after some progeny has been allowed to remain. Fulton's experiments on the proportional numbers of the sexes show that out of 12,666 fish of twenty-one species examined, 3,858 were males and 8,808 were females—a ratio of 228 females to 100 males.

The flounder and the brill were, however, found to be exceptions, while the greatest inequality was found in the case of the long rough dab (*Hippoglossoides limandoides*), where the ratio was 842 females to 100 males, or nearly seventeen females to every two males. As regards the proportional size, the observations show that "Among all the flat fishes without exception, the female is longer than the male, the ratio varying with the species."

Mr. Holt, who has worked most extensively at the sexual maturation of fishes, in order to determine if possible a method of protecting fishes which have never spawned, discards the male sex altogether, and considers only the sizes of the females, since the males, being both smaller and less numerous, would be more highly protected than the females by any measures drawn up with a view to prohibiting the capture or sale of flat fishes under certain sizes. Others who have worked at the same subject pursue the same course.

These inquiries have been instituted not for their own sakes, but because, from studying the fisheries of the country, it has become obvious that knowledge of this kind is essential. The constant clamour kept up by fishermen who daily see their returns becoming smaller does not reach the ears of those who are busily occupied in commerce, or in science; it is appreciated only when special attention is paid to the history and present condition of some of the most important areas. Take the great industry of the Dogger Banks, which for other reasons has come before the notice of the public of late years. In 1828 the North Sea was practically an unknown fishing region. Boats of no very great size were in that year just beginning operations from Harwich. Before this date trawling was confined to the south coast, having commenced at Brixham about the year 1764. The Dogger Bank was found to be teeming with fish; there was plenty for every one, and an almost endless scope for fresh ventures. The "Silver Pits" were discovered in 1837, the name being significant of the value to the discoverer and his followers. So things went on, more and larger boats were built, heavier gear used, boats banded together in fleets, and remained out on the grounds for weeks at a time, steam was introduced, and the east-side of the North Sea visited. It was a "roaring trade," and many were made wealthy by it. Now things are changed, and every one cries out that the balance has been overturned, that the fish are being caught faster than the stock is being kept up: this, in spite of what was once said as to the amount of fish which could be taken from one acre of sea-bottom. It is possible to fix close times during which salmon and trout must not be taken from certain rivers, and to hatch fry which will remain in the one district. It is another matter to apply close seasons, or fix standard sizes for areas of the open sea. From what we know of life at the sea-bottom it is pretty certain that if one of the conditions necessary for keeping up a true balance of nature is removed or greatly lessened, the proportional arrangement of the remaining fauna is also interfered with, for since marine animals prey largely upon each other it follows that if one class of devourers is removed, the devoured become more numerous, which again seriously affects other classes.

For this reason an over-fished oyster or mussel bed if left to itself, or not properly regulated, will probably never regain its former condition, a fact brought out with great clearness in the course of the evidence taken before Lord Balfour of Burleigh, at the Board of Trade Conference last June. With free swimming round fish the condition is somewhat analogous, although more knowledge is required concerning their migratory movements. If the natural balance is interfered with, the result, although at first it may be only to increase certain other forms which are also of advantage to man, will eventually appear when useless or unprofitable fishes remain in the majority, or when the appearance of a once common and useful species is no longer present in the market.

If human interference can so alter the marketable productivity of the sea, and materially lessen the incomes of a large portion of a nation, surely it becomes a duty to study the application of such sciences as deal directly with the animals concerned. If by continual fishing the only available grounds became depleted, it is by a thorough study of the actual cause and effect, and the application of the principles of natural history involved, that the only true remedy is to be found.

W. L. CALDERWOOD.

THE SOUTH KENSINGTON LABORATORIES AND RAILWAY.

THE friends of science throughout the country may be congratulated upon the fact that work in the laboratories of the Royal College of Science and of the City and Guilds Institute is not to be rendered impossible by the building of a railway along Exhibition Road. Sir John Kennaway, the chairman, and the members of the House of Commons Committee deserve the best thanks of the community for their unanimous rejection of the scheme even if only partly on scientific grounds. When the evidence given before the committee comes to be published there will be some curious reading. Lord Kelvin, the President of the Royal Society, informed the committee of what was at stake, and gave his opinion as to the question both of mechanical and electrical disturbance. The paid "scientific experts" in their pleading on the side of the company promoters may be said to have almost eclipsed the usual "emphasis" of statement. We may refer to this evidence later, but in the meantime the following quotation from a leader in the *Times* indicates the general opinion as to the importance of the result which has been achieved:—

"What makes the history of this Bill novel and interesting is the second line of attack adopted by its opponents. On either side of Exhibition Road stand two of the most important scientific institutions in London. One of these—the Royal College of Science—is supported by the State; the other was founded by the City and Guilds of London for the promotion of advanced technical education. The former of these institutions, and the great collection of scientific instruments which is being formed at South Kensington, make an organised whole. This collection, which includes the earlier and the latest instruments, is invaluable both historically and practically; and is in close proximity to the lecture-halls and laboratories where use can be made of the instruments. The collection and the laboratories are used not only by many other students, but by the large number of national scholars and exhibitioners who, after the annual May examination of the Science and Art Department, are brought up from all parts of the country, chiefly at the public expense. These students, and the deserving lads who work at the City and Guilds Institute, form an important element in the situation; for to them the advent of an electrical railway was a serious peril. It was shown, and admitted, that the magnetic disturbances in the neighbourhood of the South London Railway are so great that no accurate magnetic work can be done within some hundreds of yards of it. Now the proposed Paddington and Clapham Railway would run, not some hundreds of yards from the South Kensington laboratories, but within forty feet of some of them; and there was a genuine fear on the part of the Professors that at such small distances it would be impossible not only to accurately neutralise the conflicting forces, but to prevent the astronomical instruments being affected by the earth-tremors caused by the passage of trains. This view was urged by Lord Kelvin, perhaps the greatest living authority on such matters, and by Profs. Norman Lockyer, Ayrton, Rücker, and Boys; and after a contest which lasted three days their view prevailed, and the committee found the preamble of the Bill 'Not proved.' The men of science are to be congratulated on the result. A year or more ago they successfully defended their South Kensington preserve against the invasion of Art; and it would be pitiful indeed if Science were now to be put in jeopardy by a practical application of herself. It appears that electricity cannot be studied in the neighbourhood of an electric railway; naturally, then, we cannot have an electric railway close to the great central institution where electrical science is taught at the public expense."

NOTES.

THE annual general meeting of the Institution of Naval Architects is being held this week in the rooms of the Society of Arts, which have been lent for the purpose. The proceedings began yesterday (Wednesday) morning, and will conclude to-morrow evening. The meeting is one of more than usual importance in the history of the Institution from the fact that the president, the Earl of Ravensworth, is resigning the position which he has so well filled for a period of fourteen years Lord Ravensworth is the second president the Institution has had, he having succeeded to the chair on the death of Lord Hampton, who first occupied the position. The new president is Lord Brassey, whose great interest in all maritime questions well qualifies him for the post. Lord Ravensworth will not sever his connection with the Institution, as he will accept the position of a vice-president. The following is the programme of the present meeting:—Wednesday, March 22.—Morning meeting, at twelve o'clock: Annual report of Council; address by the president (the Earl of Ravensworth); on the present position of the cruiser in warfare, by Rear-Admiral S. Long; on approximate curves of stability, by W. Hök. Thursday, March 23.—Morning meeting, at twelve o'clock: Some considerations relating to the strength of bulkheads, by Dr. F. Elgar; on the measurement of wake currents, by George A. Calvert; on the new Afonasieff's formulæ for solving approximately various problems connected with the propulsion of ships, by Captain E. E. Goulaeff. Evening meeting, at seven o'clock: Some experiments on the transmission of heat through tube-plates, by A. J. Durston; some notes on the testing of boilers, by J. T. Milton. Friday, March 24.—Morning meeting, at twelve o'clock: On an apparatus for measuring and registering the vibrations of steamers, by Herr E. Otto Schlick; on the re-