Professor E. B. Wilson, the retiring president of the New York Academy of Sciences, has recently addressed that body upon 'The Problem of Development.' The paper reached me just three days ago. It contains most interesting information on the question of vitalism and mechanism. "In so far as development may be conceived as the outcome of an original material configuration in the nucleus, and a secondary configuration in the protoplasm, it may be conceived as a mechanical process."

This leaves unsolved, however, certain fundamental elements of the problem, for example, 'the manner and order in which the protoplasmic stuffs are formed and assume their characteristic configuration,' or 'how the wonderful phenomena of the regeneration of lost parts in the organism can be explained.' Advances have been made in the solution of the problem on the mechanical basis, hence Dr. Wilson asks, 'by what right does the vitalist demand that we shall adopt his hypothesis for the portions still unsolved?'

I am fully aware that sufficient experimental data have not been obtained to reduce the complicated phenomena to our familiar physico-chemical terms. But as a result of his work on the amphioxus and the dentalium, Professor Wilson remarks, 'It is possible, probable, that living bodies may be the arena of specific energies that exist nowhere else in nature.'

Our survey of the development of natural philosophy has forced upon us one fact, which we can not avoid. It is that man's knowledge of nature has been a growth, an evolution. Just as Francis Bacon thought, truth in science can only be obtained by progressive generalizations. This is true whether we accept the teaching of Darwin or the opposing atavism of de Vries. The means whereby we have gained that extended knowledge are too numerous even for enumeration here. I doubt not the ancient Greek philosophers would have had some merriment in their pity for him who might have suggested the existence of such a substance as the torch of Satan (phosphorus), which was exhibited at the continental courts of Europe.

I am almost overcome with the thought of what I may see, when I consider the immensity of the panorama presented to my venerable predecessors, who happily survive this day. Their half century of greater experience than mine brought them to the light of radium, the penetrating energy of Röntgen, and the phenomena of parthenogenesis. Nations whisper their wonders thousands of miles through the pulsations of energy, which gives life.

Acceptance of this philosophy does not preclude man's reaching a higher state of perfection; nor does it obviate man, as he is, being the highest type this world may ever know. It will depend entirely upon the factors in the systems. When equilibrium of energy has come about, none will be available and life, all life, inorganic as well as organic, will cease. Our world will have come to an end. The degradation will be as imperceptible as the growth. That which is and was returns to that which has been forever—the quiescent ocean of energy in equilibrium, the source and recipient of all life, which we are pleased to name as God. Creation's chorus is stopped, 'hid in death's dateless night.'

"Gone—all gone—like the light on the clouds at the close of day."

Charles Baskerville.
College of the City of New York.

Interpretation of a Water Examination.

Interpretation of a water examination may be considered from two quite different points of view. It may mean the private

weighing of evidence by the investigator himself, a procedure which finds expression in his final opinion, or, it may be his attempt, often a desperate one, to make analytical data intelligible to an unscientific audience. The first is, of course, necessary and legitimate, the second is always of questionable policy, and frequently is an undeniable mistake. In former days, when 'standards' were still much in vogue, and when the dictum of Wanklyn, that such and such limits should not be passed in the several items of water analysis, it was indeed a difficult matter, for the analyst to escape from 'explaining' the analytical results to the assembled council of city fathers, and deep was the irritation felt by those people that the figures given could not be explained as clearly as they might have been were the case one involving the composition of an iron ore. Of course, those were times when the chemical data alone were considered sufficient whereon to formulate a pronouncement as to the quality of the water, and it is to be admitted that the chemist himself frequently found before him a very complex problem when he attempted to fit the results of his analysis to the sanitary facts known to relate to the water in question. Bacteriology was as yet undeveloped and its bearing upon the 'sanitary survey' had not as yet seen the light. A sample of water taken anyhow, in any kind of vessel and by anybody, was packed off to the chemist; all knowledge as to where it came from was intentionally withheld and a complete report of its sanitary qualities was confidently expected. The writer once received a sample of a town supply in a two-ounce Lubin extract bottle which still contained some of the original perfumery. Is it to be wondered at that in those early days a good share of discredit was cast upon a water examination? With the advent of bacteriology upon the scene, interest was greatly awakened. The new science promised much, and it seemed that the time had come for very positive and ready answers to the perplexing questions which had bothered us so long. Not so many years ago there met in the city of New York a sizable number of men who had gathered for the purpose of discussing the merits of a chemical *versus* a bacteriological examination of water. Advocates of the two methods advanced arguments in support of their special views and offered illustrations calculated to expose the weak points of their opponents. Unfortunately some remains of that spirit of rivalry still exist; but those who have the widest knowledge of the broad field of 'water supply' readily admit that a competent investigation suitable for determining as to the purity of a city's water service can not be undertaken in the laboratory of either the chemist or the bacteriologist or the microscopist alone, but must be the product of a draft upon the sciences represented by all three of those men, and must, furthermore, include the findings derived from what may be termed the 'sanitary survey.' I am speaking to scientific men, who need no instruction, but perhaps over their heads a few laymen may be reached who need it sadly. And now let it be asked, who are to be classed as the laymen? There is but one answer, to wit, all who have not given special study to this particular subject. The field is so wide, is increasing at so rapid a pace and covers such variety of topics, that even those interested in this line of work have all they can do to keep in touch with the changes taking place about them. The writer well remembers the great risk he once ran of making himself unpopular with the medical profession. While addressing a city council upon the advisability of erecting a special form of filter for the purification of the public water supply, he was interrupted by a council-

man, who stated that all of the physicians in the city were opposed to such a plant, and therefore how could the council, composed, as they were, of laymen, run counter to such weight of professional opinion. The answer was simple and emphatic, namely, that upon such a subject the physicians were no less laymen than were the councilmen themselves, and that the paper prepared by them was of no greater worth than it would have been had it been signed by all the lawyers or all the clergymen of the town.

Referring to what has been touched upon above, it is a mistake to underestimate the value of the 'sanitary survey,' by which we mean a thorough knowledge of the source whence a water comes and of the opportunities for pollution, both constant and occasional, to which it may be exposed. In the writer's judgment it is not too much to say that if but one form of examination be possible, the 'sanitary survey' should be the one selected.

Then why not rest satisfied with such examination and permanently exclude chemistry and bacteriology from water cases; and why is not the city engineer an authority competent to express final judgment upon the matter in hand?

In reply it may be said that because of the greatly increased public interest in 'water supply' which has developed during recent years, there has arisen a class of men who have devoted nearly their whole time to the consideration of water questions and who have brought to their aid a sufficiency of chemistry, bacteriology and microscopy to satisfy the requirements of their calling. Such men are, because of their special training and experience, enabled to view the question from more than one side, and their conclusions have, in consequence, greater scope.

Although the writer believes that, taken alone, the 'sanitary survey' is, in the majority of cases, the most important form of examination, he begs not to be misunderstood.

No amount of inspection could be substituted for the bacterial count in testing the efficiency of a filter plant, nor would it be of value in warding off danger to a ground water arising from the presence of an unsuspected cesspool.

As showing the utility of the chemical examination, take the following instance for example:

A well which was most highly prized because of the cool, pleasing taste of its water was found loaded with chlorides and nitrates. Bacteriology gave no indication of pollution, and inspection of the surroundings was spurred into energy by the chemical results alone. Sewage, completely oxidized, from neighboring vaults was found to account for the abnormal items in the analytical results. At the time of the examination no harm was being done, but would the owner of the well be justified in continuing to use such a water and take his chances of the purifying action of the soil being always effective?

It is possible that some objection may be raised to the condemning of a water which shows as its only objectionable feature a chemical evidence of 'past pollution.' If the pollution be truly past and all of the nitrogenous organic matter be represented by nitric nitrogen; and, further, if bacterial examination result favorably, then wherein lies the objection to the use of a water which, although once polluted, has regained its potable qualities? All pure waters, it may be contended, might be classed under such a head; for, after all, we are bound to use water over again sooner or later, contrive matters how we may. All this is true enough, but there is surely a preference as to the length of time between the date of present use and the period of 'past pollution.'

It is true that every time we drink filtered river water we are imbibing a purified sewage of greater or less concentration, and, with a continued growth of our great cities, and the increased pollution of our water-sheds, it would seem that the day is not far distant when a naturally 'safe and suitable' water shall become a thing of the past, and we shall be forced to employ a purified water as our only source of supply.

Let it be remembered, however, that we can control the artificial purifying devices of which we make use, and we can repair them, should they at any time refuse their work.

The case is quite different, however, when our safety lies upon the proper operation of those natural processes of purification which are beyond our power to direct. Such purification, to be satisfactory, must appeal to us as being continuously effective.

We know very well that the raising of water vapor by solar heat will leave objectionable material behind, and we are satisfied that the result is perfect and that it will continue to be so during all time. We also know that the filtering and oxidizing power of the soil is very great, and in general we are willing to pin our faith upon its efficiency. But we can not avoid a feeling of uncomfortable doubt when we note that a small amount of soil has been given a large quantity of work to perform, and we naturally ask, can not the purifying powers of such soil be overtaxed, with the result that our protective filter will become damaged at a point beyond reach of repair? Let an English case be quoted here:

A certain farm-house was notoriously unhealthy. The inmates had suffered at various times from diphtheria and typhoid fever. The water had been examined, and was reported to be satisfactory. Upon examining the premises it was found that there was a water-closet in the house, which was in good order, but where the contents were discharged was unknown. The drains were said to be satisfactory and never to get blocked, and upon tracing them, it was found that they discharged into a dry-steyned cesspool without overflow about four yards from the well, both sunk in the gravel, which here was twenty feet or more in thickness. This well yielded an unfailing supply of water, which was used for all domestic purposes, and upon analysis it was found to be remarkably free from organic matter. It was said to be always cool, bright and sparkling, probably due to its containing a very excessive amount of chlorides and nitrates derived from the sewage percolating into the subsoil and the opinion was expressed that the water was a concentrated purified sewage. This was not believed at the time, but when the cesspool was filled in and the sewage carried elsewhere, the well ran dry. There is no doubt that in this case the same water was used over and over again. After being defiled by the closet, slops, etc., it ran into the cesspool, then filtered through the soil, in its progress the organic matters becoming completely oxidized, and ultimately it found its way back to the well, to be utilized again for domestic purposes. Doubtless at times, possibly after heavy rains, the cesspool contents filtered too rapidly for complete purification to be effected, and this impure water may have been the cause of the ill health amongst those who consumed it.

In this instance, as in the one quoted by the author, the danger signal was held out by the chemical side of the investigation alone, the other methods of inquiry failing to detect any trace of evil.

It would seem that bacteriology deals with the present and that chemistry, besides throwing light upon the past, does to some degree, prophesy what may happen in the future.

Many a water which the bacteriologist has pronounced harmless has been condemned by the chemist because of what it might unexpectedly become at some future time; and, on the other hand, the bacteriologist has time and again shown the presence of unlooked-for pollution when the chemist might search for it in vain.

A good instance of the saving of the situation by a 'sanitary survey' when both chemistry and bacteriology show adverse

reports is to be found in the examination of water from a new well or a recently 'developed' spring. Given an old and well-situated spring upon a hillside, the desire of the owner to 'improve' the property with a view of placing the water upon the market will commonly result in a disturbance of the immediately surrounding soil. From a sanitary outlook no harm has been done the water, and one familiar with the situation will offer no objection to continuing its use, but both the chemist and the bacteriologist will secure analytical results which will require to be explained to avoid an adverse report. The writer has seen many cases of this kind.

Wells which are newly dug likewise furnish water of temporary apparent pollution. Distinction must here be made to allow for actual pollution arising from foreign substances being left at the bottom of the finished well. In such instances the evidence pointing to contamination will be found to persist.

The tying up of pollution through the action of frost is another fruitful source of error, if the judgment be controlled by the laboratory data alone. Swamp waters commonly improve in winter, and samples of them will mislead the analyst who is unfamiliar with the districts whence they come. Again, the same agency will solidify surface sources of contamination like those which produced such havoc at Plymouth and New Haven, and the laboratory examination, whether chemical or bacteriological, will, throughout a northern winter, utter no prophecy of what is to be expected during the coming thaws of spring. Nothing short of a thorough sanitary survey can be depended upon in such instances.

The water in a tidal river may be unimpeachable during ebb flow and quite the reverse at periods of flood. How could an analytical examination at the former stage of the stream predict what might be expected at change of tide.

Instances very often arise when public clamor is heard loudly complaining of the taste and smell of water supplied to the people. Much irritation is felt whenever the senses are offended by its physical condition, although gross pollution by pathogenic organisms will be complacently accepted. This tendency of the public to be their own judge as to the suitability and safety of the water they are asked to drink reminds one of the decision of a Mississippi court in a case with which the writer had to do about a year ago. His honor said: "It is not necessary to weigh with tenderness and care the testimony of experts. An ordinary mortal knows whether water is fit to drink and use."

Would that the ordinary mortal did know. Typhoid fever might then be relegated to the list of rare diseases, and much money and many precious lives be saved.

When odors in water occur, what is the analyst to do? By the time the laboratory is reached all smell may have left the sample and great discredit of the scientist will follow should his statement be that the water is sound, when the users thereof know to their sorrow that something is the matter with it. An examination *in situ* is what is needed in cases of this sort, and a view of the storage reservoir backed by microscopic detection of the offending organisms will do vastly more good than any amount of chemical analysis.

A man now deals with the data of water examination in a broad-gauged fashion, feeling that the day has gone by for blind adherence to cut and dried standards. He approaches his decision pretty much as does the medical practitioner frame his diagnosis at the bedside. It may be that the symptoms of the patient do not accord with the description of the disease as found in the books, and the practitioner's atten-

tion may be called to those discrepancies by a coadjutor more recently from the schools, nevertheless the breadth of his experience assures the more mature man that his judgment is not at fault and it is experience that is of value in the end.

In conclusion, a word may be pardoned concerning a matter which has received more or less attention of late from the public press, namely, the treatment of reservoir water with copper sulphate for the purpose of destroying suspended organisms. No doubt whatever exists that a sufficiency of the salt will destroy aquatic life, and the amount required to dispose of such as produce objectionable taste and smell is certainly very small.

What the public are anxious about, however, is whether or not the salts of copper are to be classed with those of lead as cumulative poisons. Unfortunately, the answer to that question is not very satisfactory at the present moment. We do not possess as much light upon the point as we should wish.

Copper is eliminated by the liver and kidneys, and some hold that there is a tendency towards an accumulation of the metal in the liver, and that 'elimination is only complete when eliminating organs are sound.' This appears reasonable. On the other hand, we should be reminded that the use of copper sulphate for preventing algal growth is but occasional, and that no necessity is at hand for asking the people to constantly use a water treated with the salt.

A dose of the chemical is administered to the reservoir water; the objectionable plants are killed thereby and no further dosing is required during a considerable interval of time. Let it be noted, therefore, that the amount of copper used is minute, that all of it does not remain in solution, and that its use is not continuous.

As to the employment of copper sulphate for the killing of pathogenic bacteria the case is quite different. Under such conditions the amount of the sulphate required has to be greatly increased, and, what is still more objectionable, its addition to the water supply must be constant, because of the continual presence of the organisms which require removal. It may well be urged that the use of a 'disinfected' water supply would be opposed by the average citizen upon pretty much the same ground that he would object to the use of embalmed beef.

Some modification of the copper process for the killing of disease germs may yet be suggested which will excite the prejudice in the popular mind against 'chemicals' to no greater degree than does the employment of alum in mechanical filtration, but that day is scarcely here as yet. Let it not be forgotten, however, that its use for removal of those algal growths which have given us so much trouble in the past is to be encouraged, and that the authors of the process are deserving of much praise for their contribution to the growing field of 'water supply.'

W. P. MASON.

SCIENTIFIC BOOKS.

A NEW INTRODUCTION TO THE STUDY OF FISHES.

I.

A FULL fourth of a century had passed since the publication of a general work in English* on systematic ichthyology before a new one appeared to take its place. It was in 1880 that 'An Introduction to the Study of Fishes by Albert C. L. G. Günther' appeared. That work, however, by no means represented the condition of science at the time of its issue, and was replete with errors as well as anachronisms of all kinds. Its author was

* E. Perrier's corresponding portions of his French work (Traité de Zoologie) were mostly published less than a year before (1903), and, if put in the same typographical dress, would cover nearly two fifths more space.