Biology as an Industrial Science

By W. H. Cook

MAY biology be called an industrial science? An attempt will be made in this article to prove that the title chosen for it is well justified although few people have so far looked at biology from this angle. It will also be explained how the industrial application of biological principles will be facilitated by the proposed Regional Laboratory of the National Research Council to be constructed on the campus of Dalhousie University, and to what extent the Maritime economy may be expected to profit from that work.

Science covers a very wide field, and to do effective work in this modern age, specialists in different branches of science, such as physics, chemistry and biology, must be associated. Atomic energy has stolen the scientific show for the physicist during recent years. Now, the object is to harness it for peaceful uses. This is not as novel an idea as it appears, since all life on this planet has always been dependent on atomic energy. It is well accepted that the sun's heat is obtained from this source. But, as such, it would be of little use to us were it not for photosynthesis in the green plant on which we still depend for all of our food, the great majority of our clothing, and our paper, while the stores provided by this source in the past give us our fuel. This is sufficient to indicate the importance of the biological sciences.

INDUSTRIAL BIOLOGY

In their applications to practical purposes, the biological sciences fall into three large classes, agricultural or aquacultural, medical, and industrial. Each branch has so many ramifications and all are so dependent on fundamental biological knowledge that an exact definition defies the imagination. Gross differentiation between them can be made by considering the class of people who ultimately use the discovery. Scientific information on how to increase the food supply must be applied by the farmer or fisherman. This is agriculture or aquaculture. Similarly, discoveries eventually applied by the practising doctor belong to medical science. Industrial biology is then that portion of the biological sciences that is used eventually by industry rather than by the farmer or doctor.

Food Preservation

Food preservation, storage, and transport, is an important branch of industrial biology. As soon as the crop is harvested, the fruit picked, the animal killed, or the fish caught, it starts to deteriorate. Preserving these perishable products, transporting them to world markets, storing them for use at home, and utilizing the resulting wastes are essentially the responsibility of industry, although they benefit the primary producer.

The foundation of successful food preservation is the application of bacteriology. Remarkably few of the known bacteria are harmful to man. Most of them merely use the food for their own purposes and thereby cause spoilage and putrefaction. Pasteur's studies on bacteriology laid the fundamental basis for modern methods of food preservation.

Food may be preserved by retarding the growth of micro-organisms, by stopping their growth completely, or by destroying them. The four general methods used are: refrigeration, curing, dehydration, and canning. Refrigeration retards the growth of microbes by providing an environment that is too cold for their normal development. Curing also retards bacterial growth. Dehydration arrests the growth of micro-organisms since they cannot grow in the absence

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of sufficient water. Canning destroys all or nearly all of these organisms by the application of heat, and their re-entry is prevented by sealing the container. The National Research Laboratories have made extensive investigations in all of these fields of food preservation.

Fermentations

Since micro-organisms are responsible for most of the spoilage of foodstuffs, it is evident that they cause a great deal of trouble and expense. Can anything be done to make these microbial passengers pay their way on our economic train? True, they are valuable and essential for the maintenance of soil fertility and agricultural production. Can they make a similar contribution to industrial biology? The answer is yes. When they are controlled and used in this way, the processes developed are usually referred to as industrial fermentations.

There are many examples of industrial fermentations. The production of potable alcohol is probably one of the oldest. The production of penicillin and streptomycin, while hardly fermentations in the true sense, are among the most recent developments. Many others are known, including butanol, acetone, and acetic, lactic, citric and other acids. Considering the thousands of micro-organisms that exist, however, we have hardly scratched the surface in the domestication of these microbes, and in making them work for us. Isolation of the proper organisms, and the discovery of their proper growth conditions could result in the profitable utilization of many waste products. The National Research Laboratories are very active in this field and have already produced 2, 3-butanediol on a pilot-plant scale. This is a versatile chemical, containing four carbon atoms, and with many possible uses either by itself or as raw material for other substances.

THE MARITIME REGIONAL LABORATORY

Science is international: in other words, scientific findings published by one group or nation will eventually benefit all. However, we are often in danger of carrying this line of thought too far. The scientific achievements of the more advanced nations have not always benefited poorer nations, and even within a single country there may be marked discrepancies in the application of new scientific findings. Local resources, for instance, which are characteristic of a particular region, may remain undeveloped or be developed very slowly if scientific information from other countries or other regions is depended upon. This is particularly true of biological materials that reflect in their make-up the local conditions and environment. Processing methods for a given material that are economically feasible in one region may be impossible in another, and *vice versa*.

The purpose of a regional laboratory is to provide scientific information to industry or other groups requiring such information. This will involve dissemination of existing information, solution of problems of local industry, and fundamental research on materials or processes peculiar to the region The ultimate aim is to benefit existing industry and to get background information for etsablishment of new industries.

The location of such a research laboratory should obviously be on a university campus. This provides for a mutually beneficial exchange of information and facilities between the teaching and research staff of the university and the staff of the regional laboratory. Since the resources of the sea, as well as those of the land, contribute to the income of maritime regions, the laboratory should also be situated on the coast if it is to study both types of problems effectively. For these reasons, the Government has accepted Dalhousie University's offer to provide a site for the building on the campus. It is intended that construction will be started early in 1948.

The new regional laboratory must have sufficient staff to deal effectively with the more urgent problems that are likely to come up. Obviously no one laboratory can undertake studies in every field of science: the projects and problems to be undertaken must be carefully screened from the huge number of possibilities. However, the laboratory must be large enough to permit men trained in various fields of science to be brought together for the solution of difficult problems. The recommendations for the initial establishment are 21 professional scientists with supporting technical and clerical personnel to provide a total continuing staff of 50.

RESEARCH PROJECTS

Most important of all is the kind of research to be undertaken in the new laboratory. Basically, the duties of a regional laboratory are to apply the available results of scientific research to local or regional requirements. This will not preclude fundamental work being undertaken in the Maritime Regional Laboratory provided it is necessary to obtain information of regional interest. Although work on fuels, metals, agriculture and fisheries fall within the orbit of other Federal Government agencies, the new laboratory will cooperate with these bodies in the solution of urgent problems. It will also cooperate with the Universities, Provincial research agencies, and with industry. In other words, the laboratory should add to the present research facilities, rather than duplicate or replace existing institutions.

The opening of the new laboratories will see the initiation of some new research projects. Certain activities now under way in the National Research Laboratories demand regional units to get the required information, for instance, research on housing. The higher humidity and other characteristics of a maritime climate affect structures and heat transfer through insulation, and give rise to other problems that can only be studied on the spot.

In the field of industrial biology, a number of problems that should be of interest can be suggested: the manufacture of various pectin products from the residues of the Maritime fruit juice industry; the production of such enzymes as pectinase and diastase, required for clarifying fruit juices; the conversion of sulphite liquor through special yeasts into high protein feeds needed in the area. Another problem that I believe should be undertaken in the new laboratory may be singled out for more detailed consideration; research on the utilization of seaweed.

Seaweed Research

The Maritime seaweed industry has grown to sizable proportions during the war years. It supplements the fisherman's income and the product is exported in an unprocessed form to the U. S. A., who previously obtained their supplies from Europe.

Speaking generally, seaweeds fall into two classes: (1) those used primarily in food products, such as Irish Moss, or the red seaweeds (extracts of Irish Moss form the basis of the present Maritime industry) and (2) seaweeds used almost entirely for manufacturing purposes, such as *Laminaria* or other alginate-bearing seaweeds.

Irish Moss. The water extract from dried Irish Moss is at present chiefly employed as a stabilizing agent, although new uses for this versatile material are being found continually. It will suspend chocolate in milk, stabilize ice-cream and certain pharmaceutical preparations, and can serve other related purposes. If this war-borne industry is to withstand competition from foreign materials, we must establish quality standards for the product comparable with those which have given Canadian wheat its fine position in world markets. The present grading of seaweed merely places limits on moisture content, sand, feathers, etc. in the raw material. This is not enough. We must know what the quality of the extract is, i.e. its suspending power, and how this property is affected by region, season, and other factors. We must develop means for measuring quality and for determining if there are other valuable materials in the residues from the extractions. This is a most useful field of research, aimed at maintaining an existing industry and expanding it in a more profitable form to an even greater number.

Alginate-bearing weeds. Regarding the industrial or alginate-bearing seaweeds, we know all too little. To what extent does this class of seaweed exist along the shores of the Maritime Provinces? Before an industry could be established it would be necessary to conduct adequate and competent surveys. Work of this type cannot be the sole responsibility of the new laboratory, but in co-operation with the Nova Scotia Research Foundation and other Provincial organizations, it can assist by determining the quality and composition of the material. Little has been done in this field in Canada, but recent work throughout the world, Britain in particular, has shown that alginates are exceedingly useful industrial products.

Sodium alginate forms insoluble films or threads when it is treated with calcium salts. The materials produced are non-inflammable and have many uses. Some of the more promising are in the textile industry. By the incorporation of a calcium alginate thread, which can subsequently be removed, less spinning is necessary on the wool fibres before weaving than is done at present. In this way, woollen goods have been produced that have the fineness of silk.

With the object of intensifying Canadian scientific effort on the study and utilization of seaweeds, the National Research Council is convening a scientific conference in Halifax in September, 1948.

Apart from the scientific and technological possibilities, the project is valuable because it will bring about cooperation between all the scientific and industrial institutions in the Maritimes which are interested in the problem. It is such team-work that makes for the best scientific results.

Cancer Research

By J. Llew. Little

THE death toll from cancer is not declining. Surgery has made technical advances; X-ray and radium therapy has been improved; organized education of the lay public to seek early diagnosis has been extended; expert care in new, modern cancer clinics is becoming increasingly available and the medical schools are devoting special attention to the teaching in this subject. Nevertheless, it is still a fact that no cancer centre in Canada has yet been able to arrest the disease in more than one-third of the total cases applying for treatment.

True it is that cancers of the skin, lip, tongue and other sites where the disease is noticeable or accessible can be almost invariably cured with surgery, radium or X-rays. On the other hand, cancers of bone, lung, uterus, brain and gastro-intestinal tract are difficult to diagnose in the early stages and these account for the high death rate. Early cancer in the deeper recesses of the ody is often slow to manifest itself. Even doctors die of cancer. Few people

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