Meetings

Fish Stocks: Biochemical and Serological Identification

The very great increase in recent years in the knowledge of fish polymorphisms is reflected in the meeting held in Dublin, 27–28 September 1969, and organized by the International Council for the Exploration of the Sea in connection with their 57th statutory meeting. The amount of work in progress was a surprise even to the organizers, and it was necessary at short notice to extend the meeting from 1 to 2 days and to limit the time devoted to each paper to 10 minutes.

It has long been realized that the stocks of fish in the sea are by no means unlimited, and that successful fishery management depends upon an intimate knowledge of the populations of fish from which the catches are being drawn and of their interrelationship. The first attempts to define such populations depended on tagging and recapture, and on the precise measurement of morphological characters. Both these methods remain essential but depend, for statistically valid results, on the examination of very large numbers of individuals. Moreover, the morphological characters used are of unknown genetic background and may in part be environmentally determined.

Meanwhile, blood-group studies had been extensively used in the study of human populations; their success had led to the use of similar methods in the study of domestic quadrupeds and poultry, and very recently of fish populations on which an increasing number of positive findings have been reported since 1956.

In blood grouping work, clear-cut positive and negative results can in general be obtained only if the reagents used are serums containing antibodies formed by the injection, into members of the species to be tested, of red blood cells from another member of the same species. The genetic significance of the results must then be tested by family studies. In fish, however, only in exceptional cases is it possible either to prepare serums by such immunization, or to study directly the genetics of serological reactions. The results of tests on fish, using human or other mammalian serums, or plant extracts, need careful quantitative evaluation, and the phenotypes so defined cannot easily be attributed to well-defined genes. Nevertheless, as this meeting showed, such methods have made a very substantial contribution to the study of fish populations.

Further advances in human and mammalian population genetics have arisen from the discovery that, in most species, hemoglobin and other functionally and chemically well-defined proteins show genetic polymorphisms. In the simplest case, a given protein exists in two forms, which are the products of a pair of allelic genes, and which differ in the substitution of a single amino acid for another at one point in the molecule. Each homozygote possesses one molecular species, whereas the heterozygote has both, in more or less equal amounts. If, as is often the case, the two varieties of molecule differ in electric charge, they are readily separated by means of electrophoresis in a gel of starch or other colloid and can then be visualized by appropriate chemical staining, thus defining three phenotypes, each coterminous with a single genotype.

If in a given population in genetic equilibrium the frequencies of the allelic genes are p and q, then the frequencies of the three genotypes are given, according to the Hardy-Weinberg law, by the terms of the expression $p^2+2pq+q^2$. The genetics of numerous systems of this kind have been very fully studied in man and in a number of animal species. Thus, if in a given species of fish the electrophoretic study of a particular protein shows the presence of three phenotypes in proportions corresponding to Hardy-Weinberg equilibrium, there can be virtually no doubt as to the genetic interpretation. Many species of fish have now been found to exhibit such polymorphisms, and in a large proportion of these the frequencies of the allelic genes differ widely between different breeding populations, so that it becomes possible to distinguish such populations by means of relatively simple tests on no more than a few hundred individuals of each.

Because of their outstanding importance as sources of food protein the herring (*Clupea harengus*) and the cod (*Gadus morhua*) have been intensively studied, and in each case numerous breeding populations have been distinguished. In the case of the hake (*Merluccius* spp.) electrophoretic study of proteins of the blood and other tissues have proved useful not only in distinguishing populations within a species but also in distinguishing between closely related species, which are sometimes sympatric.

The unusual breeding and feeding cycles of the eel and the salmon, especially those living in the Atlantic, have given them a special fascination for investigators. The problem of the eel (*Anguilla anguilla*) is whether the Atlantic breeding ground contains only one breeding population, comprising both the European and the American eel, the minor morphological differences being environmentally determined. Work now in progress on serological polymorphisms (which are undoubtedly genetic and not environmental) should before long demonstrate the existence of separate breeding populations if these exist.

The Atlantic salmon (*Salmo salar*) presents problems of more immediate practical importance. The frequent return of marked fish to the same river to spawn proves the existence of separate breeding populations. Here it is important to refine the serological methods so as to distinguish more clearly these separate populations, and then to recognize them in the feeding grounds, where rapidly developing marine fisheries are feared to be prejudicing the future of the established river fisheries. The salmon is also of particular interest because of the possibility of direct genetic studies and because of its unique and highly complex hemoglobin polymorphisms.

Papers were also presented on skipjack tuna, sprats, sardines, mackerel, albacore, whiting, pollack, trout, flatfish, redfish, carp, sciaenids, and marine mammals. A number of papers dealt with special laboratory techniques.

The final discussion stressed a number of the highlights of the meeting as well as guidelines to future work. One important point, a negative one, was the danger, especially in the case of the salmon, of prejudicing future population studies by the artificial transfer of fish from one area to another. Another, a positive one, was the need to validate the genetic basis of what are essentially studies of phenotypes, by carrying out breeding experiments with every species for which this is possible. The Council (ICES) resolved to publish the papers and the discussions following them in their *Rapports et Procès-verbaux des Réunions.*

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Bioelectrical Impedance

Because of the increasing use of electrical impedance to measure physiological phenomena, those interested in this technique convened under the chairmanship of S. E. Markovich (*1*) to present their findings in the use of impedance to measure blood volume changes in the head, thorax, abdomen, and limbs and to measure respiratory volumes. Intra-cerebral impedance values in a variety of brain lesions were also described. Thirty-three papers were presented in 2½ days; they will be published in the Annals of the New York Academy of Sciences.

There was much evidence of enhanced activity in three areas (clinical use, underlying physiological factors, and instrumentation). Increasing use is being made of transcranial impedance (rheoencephalography, REG) to characterize waveforms in normal persons in various age groups and in patients with known cerebrovascular disease and intracranial lesions. Studies were also reported in which the component extracranial circulation was reduced (by temporary bilateral occlusion of the temporal arteries); other reports described changes in the REG during the Valsalva maneuver. Direct-coupled systems have been used to obtain indicator-dilution curves made by injection of hyper- or hypoconducting solutions into a carotid artery. These studies indicate some promise of ability to study differences in perfusion of the regions supplied by these arteries. There were no reports of successful establishment of a quantitative relation between change in impedance (ohms) and the amount of blood flow (milliliters per minute) passing through the region between the electrodes.

The changes in transthoracic impedance which accompany the ejection of blood from the ventricles and those which accompany respiration are being used clinically to monitor stroke volume and tidal volume. The correlation between stroke volume (milliliters of blood ejected per heart beat) and the change in neck-abdomen impedance (in ohms) after the waveform is processed were described. In normal subjects, over a moderate range in cardiac output, the correlation is quite good. In relation to the left-to-right transthoracic impedance changes that accompany respiration, the amplitude of the impedance change is proportional to tidal volume but calibration with an air-volume measuring device (spirometer) is necessary in the individual subject. In general, the smaller the subject, the larger the increase in impedance per cubic centimeter of air inspired.

Chest-to-back changes in thoracic impedance which demonstrated differences in ventilation between the lungs were reported. Reduction in basal thoracic impedance with hydration and pulmonary edema were also described.

Much controversy still exists regarding the factors which underlie the basal impedance and its changes that can be recorded between electrodes on living tissue. Information in this area is urgently needed for a proper evaluation of the limits of ability to calibrate bioelectric impedance measurements. Both theoretical and practical studies to identify the pathway of current caused to flow through inhomogeneous living tissue were reported. Although electrode sizes and locations can be selected to permit optimum detection of desired physiological events, the important basic studies in the living organism in each area are slow in coming, despite the obvious need.

There is a considerable difference of opinion regarding the appropriate type of instrumentation for the study of a given phenomenon. There were advocates of the use of two, three, and four terminals, crusaders for low and high frequency, and adherents of either constant-current or constant-voltage. It is too soon to draw definite conclusions on the efficacy of any one method over another in obtaining the best measurement of a physiological event under all circumstances, which consider convenience and safety to the subject as well as time required to make the measurement. Fortunately, all agree that bioimpedance should be measured with a current that will not stimulate the subject or alter the event being measured.

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Note

1. The International Conference on Bioelectrical Impedance, held in New York City from 29 September to 1 October 1969, was sponsored by the New York Academy of Science. The 70 participants included delegates from Canada, Austria, Czechoslovakia, Finland, Bulgaria, and Italy in addition to workers from the United States.

Inelastic Behavior of Solids

If scientific progress thrives on controversy, the field of the inelastic behavior of solids is due for major advances. Fifty scientists, representing both the theoretical and the experimental viewpoints, were present at the recent Battelle Institute Colloquium on the Material Sciences, which was held in Columbus and Atwood Lake, Ohio, 15–19 September 1969. During the conference, inelastic behavior was discussed in terms of continuum, quantum, and statistical mechanics, of the classical reaction rate and the classical dislocation theories, of experimental metallurgy, and of phenomenological studies. Primary areas of controversy were identified, but little consensus was reached on the issues involved in treating any one aspect of inelastic behavior.

The conference was designed to bring together the leading proponents of each of the two fundamental approaches to the subject: continuum mechanics and dislocation dynamics. In applying continuum mechanics, the discrete mechanisms by which a material actually deforms in response to applied loads are ignored in the hope of interrelating the pertinent macroscopic parameters. The advocates of the microscopic viewpoint, on the other hand, are directly concerned with individual crystal defects and their interactions. Thus, material behavior is currently being described by (i) treating the material as a continuum that deforms according to some experimentally determined constitutive relation and by (ii) treating the deformation as the aggregate of the movement of each of the numerous discrete defects that it contains. Results necessary for the constitutive equations