In this relatively new field there is opportunity and need for many investigators to explore the range within which artificial cultivation of hybrid embryos is feasible, to improve the technique of such cultivation and to adapt it to the different forms investigated and to study the factors which limit crossability with the aim of still further increasing the possibilities of hybridization.

It should be stated that others have also cultivated hybrid embryos on artificial media. Our contribution to the hybridization problem lies in the use of the "embryo factor" and the application of the technique of van Overbeek and Conklin which enable embryos to be excised and cultivated at an earlier stage, at least in Datura, than has heretofore been possible, and in the use of malt extract as a more convenient source of the "embryo factor" than coconut milk.

Further study of regulatory factors involved in fertilization and embryo differentiation should lead to a conscious control of a wider range of life processes.

USING ELECTRONS FOR MICROANALYSIS

By Dr. V. K. ZWORYKIN

RADIO CORPORATION OF AMERICA, PRINCETON, N. J.

THE past decade has seen an exceedingly rapid growth of the development and use of electronic tools in all sciences. One of the most spectacular of these is the electron microscope which, with its extremely high resolving power, is able to project man's vision further than was ever before possible towards the direct observation of the building blocks of nature. While our vision has been greatly extended and now enables us to see things in the size range 20 to 10,000 × 10^{-7} millimeters, the type of information that we obtain through the sense of vision has not changed in any way; that is, we see the size, shape and structure of the finer details of a specimen but nothing else. Such information is sufficient for the solution of innumerable research problems but it does not represent in any way a complete exploitation of the electron microscope or of the electron optical method. If we are to make full use of what we observe with the electron microscope we must supplement it by the proper application of controlled experiments or by the development of new tools which provide additional information in this same size range.

One of the most specific types of information that would be of immediate use in the field of electron microscopy is that pertaining to the nature or composition of the entities observed. In a large part of the work being carried on with the electron microscope pure samples are used so that the information with regard to shape, size and structure can be tied up immediately with the chemical and physical properties of the material. However, when the electron microscope is applied to problems in which complex or organized structures are present, the different entities observed are spread out in the image and there is no direct way of correlating the composition of a specific particle with a chemical analysis made on the specimen in bulk. A number of methods of attacking this problem have already been suggested and some preliminary work has been done.

One method is the correlation of the intensities of image points with the mass densities of corresponding object points. While the theory of the electron microscope shows that there is a relationship between the mass density of the object and the intensity of the image, it is difficult to obtain an accurate measure of density in this way because of the necessity of knowing accurately the thickness of any given object point. Another discouraging feature of this method is that more often than not intensity anomalies occur in the image as a result of electron interferences which take place if the particles being investigated are crystalline.

Electron diffraction has always been a very useful method of analysis—particularly of powdered chemicals. Unfortunately, like most other methods, it gives an analysis of the whole specimen. Recently, there have been attempts to apply electron diffraction to point analysis. In these methods the irradiating beam is confined to the small areas of the specimen under investigation. While this method shows some promise, it can be applied only in the case of crystalline particles and even in this its usefulness is limited by the fact that the individual particles are almost invariably single crystals. This requires that they have the proper orientation in the specimen before a pattern can be obtained and the pattern produced is that of a single crystal which in itself is not always sufficient for the identification of a compound. The third method which may be applied for identifying the chemical nature of particles is the use of specific reagents which change the mass density of the particles in question. While this method appears to be tedious and not too certain of success in any particular case, some exploratory work in connection with the selective staining of bacteria has been done.

Recently, in a paper to the *Physical Review*, J. Hillier of this laboratory has described a more direct electronic method of attacking the problems outlined above. The paper described a new type of instrument which is named the electron microanalyzer and in which a fundamentally different method of obtaining a chemical analysis is used.

Throughout the development of the electron microscope it has been realized that the electrons, on passing through the specimen, often lose small amounts of energy due to inelastic collisions with the atomic electrons of the specimen. X-ray theory predicts that if in an inelastic collision one of the electrons from an inner shell of an atom of the specimen is removed, the colliding electron must lose an amount of energy equal to or greater than that found in the subsequently emitted x-ray photon. While this was realized sometime ago, it was only recently that the phenomenon was observed experimentally. Since for each type of atom it takes a discrete and different amount of energy to remove one of the inner electrons, it appears that this phenomena can be used to identify the atoms in a specimen.

The experimental method of doing this is quite straightforward. The specimen is bombarded by a beam of electrons of one velocity and the velocity distribution in the transmitted electrons measured by a suitable means. The position of the peaks on the resulting velocity distribution curve is sufficient to identify the elements present in the specimen. However, in itself, this is not satisfactory for direct application to the problem of identifying individual particles on electron microscope specimens because it gives no information regarding the location of the particles. It is the ability to identify both the elemental composition and the location of an area in a specimen that characterizes the electron microanalyzer.

In the electron microanalyzer electron lenses are used to confine the electron beam to only that area of the specimen which is to be analyzed. Moreover, the area being analyzed and the specimen as a whole can be observed by means of an electron microscope which is incorporated in the instrument. Since both modes of operation of the instrument use the same lens system, the instrument is extremely compact.

As a result of the use of the "probe" method and a high quality electron optical system, it has been possible to greatly enhance the resolving power of the conventional electron velocity analyzer. In fact, in this new instrument, practical limitations on the resolving power are almost completely removed. In the present experimental model the velocity of the transmitted electrons can already be measured to one part in 5,000. Moreover, this resolving power can be increased or decreased at will; the only limitation being in the degree of homogeneity of the incident beam.

At the present time the instrument is being carefully tested using thin films of known materials in order that its possibilities and limitations may be better understood. The velocity distributions which are characteristic of a number of elements have been obtained proving that all the elements up to atomic number 26 can be detected with the present experimental model of the instrument. There seems to be no theoretical reason why this list can not be extended throughout the periodic table.

It is apparent that the major limitation of the instrument at the present time is its inability to differentiate between organic compounds, though there are indications that quantitative measurements on the heights of the peaks in the velocity distribution curve will yield some information in this regard. As in all radically new types of instruments, it is extremely difficult to predict the future uses and applications. It is evident that the microanalyzer is worthy of further investigation. Already the high resolving power which is obtained in this method of velocity analysis points to the possibility of applying it to obtain direct information with regard to collision problems in quantum physics. Added to this is the attractive possibility of obtaining direct elemental analysis of supermicroscopic structures, particularly in biological problems where the location of elements other than carbon, nitrogen and oxygen in the specimen is important.

OBITUARY

WILLIAM EMERSON RITTER: NATURALIST AND PHILOSOPHER[1]

Professor Ritter had entered his eighty-eighth year at the time of his death a few months ago (January 10). His advanced age must have come as a surprise to many, for as recently as 1938 he had brought out an impressive volume of biological fact and interpretation, and he had contributed to some of our scientific journals even later than that. Ritter got a somewhat delayed start in his scientific career, but he more than compensated for this by exceptional productivity at an age when most of us lapse into silence.

William Emerson Ritter was born in Hampden, Wisconsin, on November 19, 1856. Much of his boyhood was spent on a farm, and to this period of his life he was fond of referring later. It was here, no doubt, that his life-long love of nature commenced. He graduated from the State Normal School at Oshkosh in 1884, and engaged in public school teaching in his native state before carrying his education to higher levels. In 1888 he received his B.S. from the University of California, and his doctorate was attained at

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[1] Contributions of the Scripps Institution of Oceanography, New Series No. 223.