THE CONTRIBUTIONS OF MORPHOLOGY TO MODERN PLANT SCIENCE*

Bertram Donald Barclay, *Tulsa, Oklahoma*

Morphologists are often described by other botanists as disciples of a static purely descriptive subject, their principal goal being the minute description of the internal anatomy of some exotic species of plant in order to trace its phylogenetic relationship with some even more obscure species. Their subject is said not to be dynamic like that of the physiologist, of the geneticist and of the ecologist, but dry and uninteresing anatomy with no other purpose as a rule, than the one of adding to the sum total of abstract knowledge, or possibly clearing up some obscure phylogenetic problem. This is unfortunately still true of a goodly number of morphologists.

The reasons for this preoccupation of the morphologist are not hard to trace. Morphology came into its own and showed its greatest development in the era following the promulgation of the theory of evolution. As microscopic technique improved it was realized more and more that the minute structure of plants had a very close bearing on their phylogenetic relationships. The morphologist was in his glory and a great part of our present phylogenetic systems have been set up with his help. Problems of this kind have a great attraction for one who has tried to solve them and to this day this part of morphology has many adherents.

Later, certain morphologists breaking away from the classical school, began to study and describe the anatomy of economic plants such as corn, cotton and others. This constituted something of a revolution since pure science was not interested in such practical things as corn and beets. The story has been told of a student being asked to leave a botany laboratory because he had the effrontery to bring in a corn plant for study. He should have been studying *Equisetum or Selaginella*, no such common thing as corn. The extent to which botanists have graduated from this viewpoint is shown by the fact that in many laboratories elementary study now begins with the corn plant.

Those morphologists who left the classical study of evolutionary relationships to work on the structure of economic plants may be thanked for placing morphology in a better position to justify its existence in this practical age. Workers in such fields as applied botany, plant pathology, horticulture, agronomy and forestry owe much to the plant anatomist in the solution of their problems. How can the pathological structure of a plant be adequately described without a knowledge of the normal tissues? Innumerable examples of this kind might be cited from this and other fields.

These two phases of morphology, the phylogenetic and the economic, have their very definite place in the scheme of things and have helped the other fields of botany in their endeavors but they have not contributed much toward the solution of fundamental biological problems.

We may well ask, what is the fundamental problem facing biology today? The history of biology is marked by the pursuit of one lead after another and never until recent years has it centered upon any one common problem.

Several generations ago the main problem as seen by the biologist was the naming and classifying of plants and animals surrounding him. His enthusiasm was intensified by the theory of evolution and he saw as his goal the charting of the historical development of all organisms. He found,

*Presidential address.

however, that naming and placing each species in its phylogenetic pigeonhole was not going to solve the ultimate "why" of life. This was obviously a problem for the physiologist. All life processes can probably be reduced to physical and chemical terms and the physiologist has been very successful in analyzing many of these changes but his findings have only increased the complexity of the problem of life and have not brought us to our goal. The rediscovery of Mendel's Law stimulated the science of genetics into great activity. Here at last was a field of research that was going to get to the bottom of things. This early belief was justified by the discovery of the Chromosome Theory of Inheritance which demonstrated that the genes are separate physical entities occupying definite portions of the chromosome but little has been ascertained regarding the precise matter in which the genes control the development of individual traits.

None of these paths of investigation has reached the solution of what seems to be the central problem of biology today, called by some the problem of organization. Living things are well termed organisms since life as we know it is composed of a series of structures and activities working together in such a manner as to produce a functioning whole. We do not know how this takes place. The biologist has analyzed the structures and activities of the organism "breaking it down into organs, tissues and cells, chromosomes and genes, protein molecules and cellulose chains, axial gradients and morpho genetic fields." But a whole cannot be understood merely breaking it up into its component parts. It is necessary to have in addition a basic understanding of what holds these parts together and gives them unity. What is back of all these functions and activities of the organisms that tie them together to form a living whole? Many scientists today will agree that this problem of organization is the one toward which modern biology is steering its course.

How can this problem of organization best be approached? A growing point of a stem produces organ after organ according to a regular plan, and each organ in its development obeys the mechanics of cell division, growth and differentiation. The fertilized egg by a regular series of cleavages in given planes gives rise to an embryo oak or an embryo elephant as the case may be. Thus organization can be studied in terms of its clearest expression, that of form. Form can be studied in detail and with relative ease throughout the entire development of the organism.

Problems of this nature have always attracted the attention of the physiologist as shown by the work on hormones, axial gradients, morphological fields, mitotic indices and so forth. The geneticist is interested in the way genes cause the development of structures. The ecologist has studied the effect of environmental change upon plant structure. The morphologist, however, has the advantage in this field due to his special training in the study of form and structure and many of the younger morphologists are pursuing just such studies as these. When it is realized that only a few plants have had their developmental anatomy worked out from embryo, through seedling, to the adult, and that fewer still of these species are economic plants, it becomes evident that a vast amount of work is still to be done before a clear picture can be obtained of the organization of plants as expressed in their structural development. Some morphologists have made a start in the right direction by ceasing to put out purely descriptive work. They have been attempting to express development in terms of the mechanics of cell division and differentiation. Studies of this kind should continue with even greater precision and should be extended to the ontogeny of organisms not yet understood.

It is by increased effort in this field of experimental and developmental morphology that the morphologist of today can make his greatest contribution. If such methods of approach continue to be the aim of mor-

phologists in the future, this science will take its place among the dynamic divisions of biology which are working toward the ultimate clarification of the central problem of organization.