PREFACE

In the present period, since the discovery of the structure of DNA in 1953, genetics has developed explosively. Today the sequence of the four million base pairs in the bacterium of tuberculosis is known and the functions of many of the genes contained in it are recognised. Genes are now being patented as information and have become private property to be bought and sold, just as the common land was enclosed in the 18th–19th centuries in Britain and became private property. The complete human genome, the blue-print for a human being, is in sight, as dimly envisioned in Goethe's "Faust".

However, the proteins synthesised according to the sequence of base-pairs in a gene are synthesised in an environment, itself created by previous living activity. The environment has shape and form changing in time. It is geometrical, consisting of surfaces, fibres, membranes and fields in space—chemical, gravitational and electromagnetic. Thus heredity and environment both influence life at all scales. For the last 40 years the emphasis of research has been on the genetic sequences but now the complementary aspect of shape, growth and form is again at the cutting edge of scientific research. Genetics and morphology act on each other dialectically, operating and evolving together to produce novelty, while incorporating the basic physics and chemistry of inorganic growth processes.

It is now time to turn afresh to the appearance of form and shape in organisms. With the "soft matter" of P. de Gennes', where the liquid crystal phenomena which so fascinated Haeckel are predominant, isotropic solution chemistry is passing on to the chemistry of the formation of geometrical structures at a variety of scales.

Thus, the pioneering work of Ernst Haeckel (1834–1919) on the shapes of single cell organisms can now be seen in perspective. His first book, "The General Morphogenesis of Organisms", was written in 1866 at the height of his powers, long before there was any idea of the material mechanism of genetics but greatly stimulated by Darwin's "Evolution of Species" which had appeared in 1859. Later, Joseph Needham's book "Biochemistry and Morphogenesis" of 1942 began to take into account for embryology the new knowledge of molecules. D'Arcy Thompson, in his classic application of basic physical ideas, "Growth and Form" (1916), had mentioned atoms only once in passing. James Bell Pettigrew, writing in 1908 on "Design in Nature" was still pre-Darwinian and believed in divine creation. The great progress in the 1930s made by William Astbury with the study of fibrous proteins showed the complexity and beauty of some of the highly ordered but non-crystalline arrangements of molecules in materials of life such as silk, cotton and wool and pointed the way ahead.

Biologists today find it worthwhile to attack Haeckel's mistakes, having absorbed his many positive contributions. It is still important to see how Haeckel, lacking the concept of software, pointed to problems of morphogenesis, most of which are still unsolved, he having only the tools of the time and being embedded within the political and intellectual climate of 19th century Europe.

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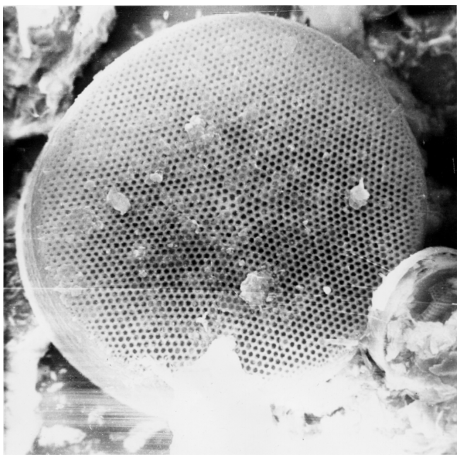
Alan L. Mackay,
Department of Crystallography,
University of London

A. L. Mackay



SEM picture of a diatom, taken by A. L. Mackay.