

GARLAND E. ALLEN

## THE CHANGING IMAGE OF BIOLOGY IN THE TWENTIETH CENTURY

### INTRODUCTION

The changing image of the life sciences in the twentieth century can be charted as the conscious attempt to introduce rigorous experimental, analytical and reductionist methods from the physical to the biological sciences. This change brought biology from being a largely descriptive to an experimental science that included both the laboratory and field. Of all the natural sciences, biology underwent the most profound sequence of changes during the twentieth century. (Biology is defined here initially in the nineteenth-century sense, as the study of the structure and function – including aspects of general physiology – of living systems, excluding medicine and medically-related subjects such as pharmacology, epidemiology and public health.) During the first half of the nineteenth century biology was dominated largely by issues of natural history: taxonomy, new discoveries relating to geographic distribution, fossils and extinction, and of course comparative anatomy. Physiology was largely separate from Lamarck's general term of *Biologie* at the time, and was housed institutionally within medical schools and hospitals, as opposed to museums and botanical or zoological institutions. The connection of physiology to general biology was clearly recognized, but it shared a largely different intellectual and social base until at least the 1840s.

The "image" of biology at the turn of the century is captured in the illustrations shown in Figure 1. It is of biology as largely natural history, concerned with the life histories of organisms, with comparative anatomy and taxonomy among the major activities in which naturalists were engaged. Laboratories were largely given over to microscopical work or dissection, with observational skills and drawing ability often honed to a fine degree. Who, over the age of 50, does not associate biology with dissecting and drawing images of frogs, earthworms and flower parts? The tools of biology, right up to the period just before World War II, were also relatively descriptive and simple, not unusually expensive, and did not require highly developed analytical skills.

By the end of the century however, the images of biology had changed so dramatically they would have been unrecognizable to even the most advanced investigators



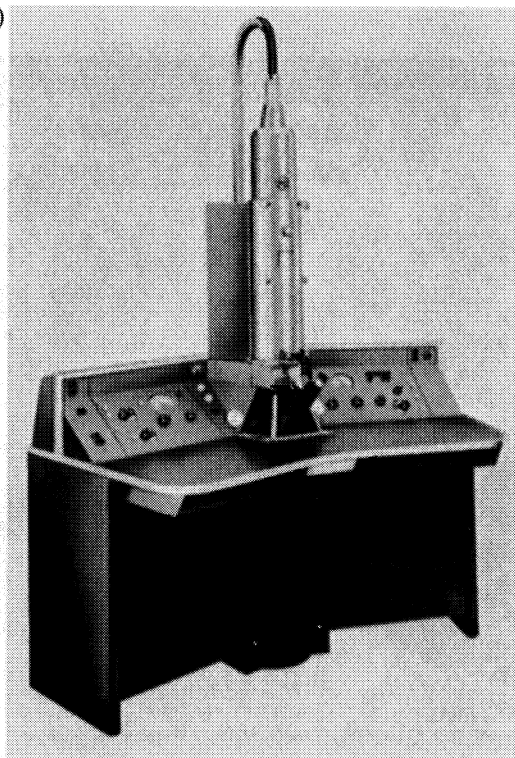
Figure 1. As the century opened, the prevailing image of biology was that of natural history, concerned with describing and cataloging organisms in nature. As shown in this 1890s collecting trip at the Marine Biological Laboratory in Woods Hole, Massachusetts, biology was closely tied to field experience and most biologists knew a great deal about the structure and life histories of the organisms with which they worked. Woods Hole, MA: Courtesy, Special Collections, MBL/WHOI Library.

in 1900 or 1920 (Figure 2). Today's images include electrophoretic gels, x-ray diffraction patterns, high-resolution electron micrographs, sedimentation coefficients, and evolutionary lineages based on molecular rather than anatomical data. The modern biology research laboratory presents a totally different appearance – dominated by large and expensive equipment such as ultracentrifuges, confocal microscopes, spectrophotometers and an endless array of computers. The eye is no longer the major point of contact between the biological system and the investigator. What has brought about this profound change in the way biology “looks” in the course of the past century? How does this change reflect the way we think about living systems, how we depict them, manipulate them and understand their history?

The outcome of this widespread dissemination of experimental methods into biology, however successful in investigation of certain problems, was the failure to develop a sophisticated method of dealing with complex, interactive systems. By mid-century, certain areas of biology, notably general physiology and embryology, were struggling to find more holistic methods for investigating biological processes.

In this chapter I will trace the changing image of biology as driven by several dialectical imperatives: (1) Philosophically, between mechanistic and holistic (including

(a1)



(a2)

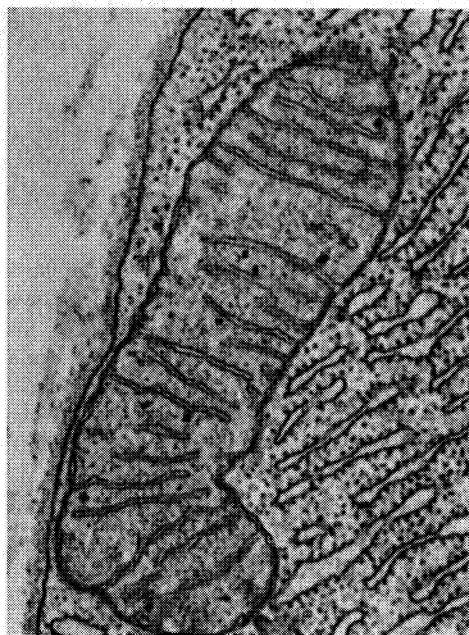


Figure 2. *Cont.*

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