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XV. Biology and the Rise of the Social Sciences

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XV. Biology and the Rise of the Social Sciences

Abstract
Modern science, it has been said, has undergone three revolutions: the Copernican, the Newtonian, and the Darwinian. This oversimplification is valid if our standard of judgment is social impact. The Newtonian synthesis, which absorbed the Copernican, had convinced men that the physical universe behaved in accordance with inviolable natural laws and that these laws could be expressed mathematically. With the confidence inspired by this world picture, science sought to find those natural laws under which the animate and inanimate aspects of the world operated. Equally influential was the tradition which cherished the ideal of the conquest of nature through the utilization of scientific knowledge. The many discoveries and inventions of the eighteenth century lent assurance and optimism to the prevailing attitude. The present chapter relates some of the divergent influences which merged into the Darwinian synthesis: biological evolution. [*excerpt*]

Keywords
Contemporary Civilization, Copernicus, Newton, Darwin, chemistry, geology, biology

Disciplines
History | History of Science, Technology, and Medicine

Comments
This is a part of Section XV: Biology and the Rise of the Social Sciences. The Contemporary Civilization page lists all additional sections of *Ideas and Institutions of Western Man,* as well as the Table of Contents for both volumes.

More About Contemporary Civilization:

From 1947 through 1969, all first-year Gettysburg College students took a two-semester course called Contemporary Civilization. The course was developed at President Henry W.A. Hanson's request with the goal of "introducing the student to the backgrounds of contemporary social problems through the major concepts, ideals, hopes and motivations of western culture since the Middle Ages."

Gettysburg College professors from the history, philosophy, and religion departments developed a textbook for the course. The first edition, published in 1955, was called *An Introduction to Contemporary Civilization and Its Problems*. A second edition, retitled *Ideas and Institutions of Western Man*, was published in 1958 and 1960. It is this second edition that we include here. The copy we digitized is from the Gary T. Hawbaker '66 Collection and the marginalia are his.

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XV. BIOLOGY AND THE RISE OF THE SOCIAL SCIENCES

Modern science, it has often been said, has undergone three revolutions: the Copernican, the Newtonian, and the Darwinian. This oversimplification is valid if our standard of judgment is social impact. The Newtonian synthesis, which absorbed the Copernican, had convinced men that the physical universe behaved in accordance with inviolable natural laws and that these laws could be expressed mathematically. With the confidence inspired by this world picture, science sought to find those natural laws under which the animate and inanimate aspects of the world operated. Equally influential was the tradition which cherished the ideal of the conquest of nature through the utilization of scientific knowledge. The many discoveries and inventions of the eighteenth century lent assurance and optimism to the prevailing attitude. The present chapter relates some of the divergent influences which merged into the Darwinian synthesis: biological evolution.

The latter half of the eighteenth century witnessed the birth of two modern sciences, chemistry and geology, both of which developed from the empirical craft tradition. For almost two hundred years chemists had sought to unravel the mystery of combustion and its relation to the smelting of metals. A deep prejudice assuming the existence of a combustible element (subsequently named phlogiston) and the technical inability to distinguish the gases in air prevented a solution to the problem. Several kinds of "air" were known, but they could not be purified or isolated. Joseph Priestly (1733-1804), an English Unitarian minister who later sought asylum in the United States and whose laboratory apparatus is preserved at Dickinson College, increased the number of known gases from three to fourteen, and began to determine their properties. Anton Lavoisier (1743-1794), an amateur French chemist who was guillotined during the Revolution, carefully studied the history of experiments on combustion and devised many of his own. He recognized the existence of a gas in air which supported combustion and which was also involved in animal respiration. To this element he gave the name oxygen. Within a few decades the fundamental similarity between combustion, plant and animal respiration, and the nature of photosynthesis in green plants was demonstrated.

Meanwhile, the geological sciences were maturing in the mining districts of Germany and Scotland. The empirical procedures for locating and recovering coal, iron, lead, mercury,

16 & 17 century — Physics, math, astronomy.
18th " — Chemistry
end of the 18th " — historical sciences.

and other metals were superseded by systematic observations of earth processes and structures. The orderly succession of strata in the earth's crust gradually established the fact that the earth possessed great age, extending perhaps through millions of years. Countless fossil animals and plants found in sedimentary rocks attested to the existence of extinct races of strange creatures. So long as these bygone races were taken as merely antediluvians buried in the silts and muds deposited during Noah's flood, no real issue was apparent. But the fact that different strata contained different fossils in orderly succession soon forced the conclusion that there were a number of eras of earth history. Several naturalists attempted to interpret these perplexing data in terms of evolution. Borrowing from the prevailing idea of progress, they found evidence for a grand parade of progression through earth history.

fossils brought the scientists to unbelief
(Tennyson "In Memoriam"

The most suggestive expression of this new view is to be found in Époques de la Nature (1779), written by Georges Buffon (1707-1788). Buffon theorized that the earth was formed by a collision between a comet and the sun, the incandescent mass thereby released gradually cooling. The earth slowly passed through a succession of epochs: consolidation, formation of the atmosphere, condensation of the oceans, appearance of continents, origin of life, and finally the appearance of man and his assumption of supremacy over nature. These epochs, he believed, spanned many thousands of years. Georges Cuvier (1769-1832), who was primarily a zoologist, realized that the succession of animal forms during geological history was really the record of vast numbers of species living during different epochs of time. Periodic extinction, Cuvier argued, was due to catastrophes, the last of which was the flood of Noah.

Meanwhile, man's interpretation of himself had undergone profound change. For several hundred years, it had been recognized that the human body was fundamentally like that of vertebrate animals. Indeed anatomists since Galen (130-200) had used apes and monkeys to demonstrate the muscles, organs, and skeleton of man. It was Andreas Vesalius (1514-1564) who, upon repeated skillful dissections of human bodies, challenged the accuracy and authority of medieval texts and reopened the direct observational and experimental approach to human biology. During the sixteenth and seventeenth centuries such investigators as Andrea Cesalpino (1519-1603) and William Harvey (1578-1657) demonstrated the circulation of the blood and proved the heart to be a muscle, a mechanical pump. The application of the microscope to the study of minute forms of life, tissues of the body, and the growth of embryos rapidly opened new vistas of biological thought.

A very different area of biology, however, provided a basis for the intellectual revolution of the nineteenth century. Explorations throughout the world revealed the existence of many thousands of kinds of plants and animals hitherto unknown to naturalists. In fact, these novelties outnumbered the forms

Lyell - systematic evaluation of the earth (search for the age of the earth)
4004 B.C. - Lyell disagreed with this. Said it must be older.
Linnaeus - a "Newtonian" biologist. He thought the number of species was fixed.

occurring in western Europe. Some of these were strange or unusual, yet others were unmistakably similar to common indigenous European species. This wealth of new forms interested biologists, particularly in England and France, which had extensive colonial possessions.

The taxonomists, who were engaged in naming and classifying this multiplicity of forms distributed over the face of the earth, found the prevailing Aristotelian concept of species almost useless in solving problems of kinship or distribution. Partly on philosophical grounds and partly because of religious conviction, species had been assumed to have been created immutable entities. Discovery of additional species thus increased man's knowledge of the created world, of God's handiwork.

Jean Baptiste Lamarck (1744-1829), a French naturalist, argued that species were constantly undergoing change through the inheritance of modifications caused by changes in the environment. Lamarck believed that the environment had a direct influence on an organism, forcing it to adapt itself to new conditions or perish. The term "inheritance of acquired characteristics" is usually applied to his theory of evolution. Species which graded into one another posed a difficult problem. Could larger categories of related forms be rationalized into a natural system? Just how this colossus of descriptive data could be arranged into natural groups was uncertain, but Cuvier's attempt to define the major groups of the animal kingdom was a vision of things to come.

During the first three decades of the nineteenth century a number of spectacular discoveries vitalized the study of biology and transformed it into an experimental science. One which was to influence all subsequent biological thought was the cell theory, which visualized all living things as composed of minute units of structure and function, called cells. Almost before this discovery could be appreciated, it was recognized that all living processes were confined to the gelatinous substance in cells. This substance was named protoplasm. It is the physical basis of life.

Here were two interrelated ideas, really a single concept, which implied a unit of life throughout the living world. The cell concept in biology was comparable to the atomic concept in physics and chemistry. Its logical consequences include the germ theories of fermentation, disease, and inheritance (the egg and sperm are cells) as well as more adequate interpretations of blood, endocrine glands, antibiotics, and the nervous system. The universality of the cell concept is such that it has come to be accepted essentially without reservation.

The more experimental aspects of biology, such as physiology and biochemistry, established the basic facts of animal nutrition and photosynthesis in plants. The transformations of matter and energy in the cell processes were similar to those observed in the inorganic world. Thus the living world came to be considered as an extension of the non-living. In 1833 urea was synthesized. Urea was a substance hitherto known to occur only as a product of the animal body. By this event the barrier between organic and inorganic chemistry had been broken down.

Yet the nineteenth century scientific revolution did not stem directly from chemistry, geology, or experimental biology. It remained for a quiet naturalist educated for medicine and the ministry to develop a synthesis of biological knowledge in terms of evolution.