count in a purely mechanistic way for the progressive trend of organic evolution toward greater adaptiveness of structure and function. We need not assume that a new type of energy, a vital force or entelechy, appears in the universe when organisms come into existence. The age-long causal principles still hold in the organic realm. But we may properly concede this much to the vitalists—they are right in suggesting that we must seek a new and broader view-point when we come to deal with organic phenomena. The organism may well be regarded as a new kind of system, whose distinctive characteristic is an ability to maintain its organic unity through dynamic interplay with the environment. The inherited similarity among organisms, and their variability, taken together, give rise to natural selection. And the result of the selective process is to improve the relations between the organism and its environment. Natural selection therefore should be considered not merely as a process, but as bringing about a very definite end-result: adaptation. The process of selective adaptation, then, should be recognized as a new factor which appears in connection with organic life. It is in no sense an exception to the causal principle of the unvarying total, but it does supplement this principle. It would appear impossible to have predicted in preorganic ages, from any knowledge of causal principles, the extraordinary variety and complexity of the organisms that have actually arisen, their manifold activities and tenacity of existence, or their numerical abundance. The principle of selective adaptation seems capable of accounting for all these facts. It explains the course of organic evolution without assuming the advent of a new kind of energy to operate these changes.

The same line of argument may be applied to the teleological psychology. This theory is useful in suggesting that a new and broader view-point is required when we come to deal with the phenomena of anticipatory behavior and prevision. But the assumption of a new kind of force to account for these activities seems needless and redundant. The universal causal principle and the principle of selective adaptation seem sufficient to explain the rise of preparatory responses and conscious purpose. The processes by which organic beings act with reference to future stimuli and coming situations may be described in purely mechanistic terms. But the significance of these phenomena must be sought in something that lies beyond these fundamental principles: their real meaning is summed up in the principle of anticipatory adjustment. There is no novelty involved in this principle, except that we have adopted a broader view-point.

And now we have reached the point where we can appraise the truth and error in the doctrine of emergent evolution. Many, if not all, of the so-called emerging properties which appear in the higher aggregations of matter could be predicted, I believe, from an intimate knowledge of physical principles. They are not really novel. They emerge only as new groupings or systems come into being. But we do find two new kinds of process developing at certain stages of evolution on the earth. With the advent of organic life the trend of progress is determined by the principle of *selective adaptation,* which seems to be a distinct novelty and not a mere corollary from the general principles of physics. At a later stage the responsive behavior of certain organisms to forces and situations in the environment is determined in part by a second novel principle—that of *anticipatory adjustment*—which assumes enormous importance in human life. These two principles, based upon the fundamental causal principle of the *unvarying total,* form a hierarchy. I believe they are needed to account fully for the organic stages of evolutionary progress. At least they lend new significance to this unique development. If the doctrine of emergent evolution means the recognition of general principles such as these, I believe it can be defended. If it means that new properties appear with the formation of new aggregations of matter, it is either a truism or it is open to grave question as implying an exception to the general uniformity of nature.

# SCIENTIFIC EVENTS

## THE WORLD PRODUCTION OF GOLD

SINCE the discovery of America, world production of gold has only slightly exceeded a billion ounces, approximately 1,003,500,000 ounces being indicated by study of available records, according to an economic review of gold production in the period 1493–1927, recently concluded by Robert A. Ridgway and the staff of the common metals division of the U. S. Bureau of Mines. Scattered production, of which there is no record, would probably add no more than one per cent. to this estimated total.

Mr. Scott Turner, director of the bureau, points out that more than half the grand total of gold production for the past 435 years, or 516,273,000 ounces, was produced in the first 27 years of the present century. Of the cumulative world production of gold since 1492, 467,000,000 ounces are estimated to exist in the form of monetary stocks, while 536,563,329 ounces represent the balance of gold lost or absorbed in other than monetary uses.

The scarcity of gold may be illustrated by the fact that if the entire world production since the discovery of America were cast into a cube its edges would measure only 38.5 feet. It might well be questioned whether this gold, considered merely as a metal characterized by certain properties, could be worth the toil and sacrifice required for its production; but as a basis of exchange, greatly facilitating the development of commerce among the peoples of the earth, its value to civilization exceeds all reckoning.

In spite of a superficial claim often made that gold does not pay its cost of production, it can hardly be doubted that United States gold production, amounting to more than $4,500,000,000 when reckoned roughly at $20 an ounce, must have been an important factor in assisting the development of other sources of national wealth. The British Empire production from the Transvaal (1901 to 1927), of more than 198,000,000 ounces; from Australasia, of more than 168,000,000 ounces; from Canada, of nearly 32,000,000 ounces; from India and Rhodesia, together, 32,000,000 ounces; and from other parts of the British Empire, of 12,000,000 ounces, amounting in all, since 1801, to 442,994,369 ounces, or about $9,000,000,000, should be reckoned an important factor in the prosperity of that empire.

During the first half of the nineteenth century nearly three times as much gold was produced in the fifth decade as in the first; yet the production of the first decade of the next half century was almost four times that of the preceding decade and nearly twice that of the first half of the nineteenth century. A gradual decline is noted during this half century up to the last decade, which showed an increase of 94 per cent. over the preceding decade. During the last half of the nineteenth century nine times as much gold was produced as during the first half. During the first decade of the twentieth century the average annual production increased over 8,000,000 ounces, or 81 per cent., over the preceding decade's production. The second decade showed an increase in average annual production of over 2,000,000 ounces, or 12 per cent., more than during the first decade.

In the world production of gold from 1493 to 1927, North America was the largest producing continent, contributing 281,056,639 ounces, or 28 per cent., with Africa a close second, contributing 270,127,146 ounces, or 27 per cent., of the world total. Australasia produced nearly 169,000,000 ounces, or 17 per cent.; South America nearly 125,000,000 ounces, or 12 per cent.; Asia 112,000,000 ounces, or 11 per cent., and Europe nearly 44,000,000 ounces, or 4 per cent.

## THE ANNUAL EXHIBITION OF THE BRITISH PHYSICAL AND OPTICAL SOCIETIES

THE twentieth annual exhibition of the Physical and Optical Societies opened on January 7 at the Imperial College of Science and Technology, South Kensington.

The London *Times* gave the following description of the exhibition: There were two main sections devoted respectively to trade exhibits of electrical, optical and other physical apparatus, and to research and experiment, and smaller sections showing apparatus used for the teaching of physics in schools and universities, a group of historical exhibits and competitive exhibits made by apprentices and learners. The last of these was introduced this year for the first time. It is realized that scientific instruments are now used so extensively that the makers have had to turn to methods of mass production. No one man to-day makes a complete instrument, and there is a danger of skilled craftsmanship dying out. The new section had for its object the encouragement of craftsmanship, and the display represented the individual work of apprentices and learners employed by scientific instrument manufacturers who took part in the exhibition. The two classes included practical examples of electrical, optical, engineering and metal work, tool-making and pattern-making, and examples of designs, drawings or tracings for scientific instruments. Eight prizes were offered, and there were 50 entries.

All the leading makers of instruments and accessories contributed to the trade section, and the exhibits covered a very wide range. There were cameras and lenses, valves, microphones, thermometers, meters of many specialized types, accumulators, timing mechanisms, spectrographs, magnetic compasses, echo sounding machines, aircraft direction finders, a tobacco moisture tester, binoculars, telescopes, rain gauges, theodolites, electric furnaces and scores of other instruments and machines.

The research and experimental section was particularly attractive, though it is hoped that in future years its scope and utility will be further extended by the cooperation of fellows of the societies and others who may be able to contribute. Government institutions, such as the National Physical Laboratory, and the Royal Air Force Establishment, South Farnborough, sent exhibits. From the laboratory came a distant reading resistance thermometer outfit for cold storage work, experimental transmitting and receiving apparatus for ultra-short waves, apparatus for the measurement of the over-all performance of radio receivers and a method for indicating turbulence in airflow.

Exhibits of the research laboratories of the Gramo-