

JOHN WESLEY POWELL.

V. THE INVESTIGATOR.

BY G. K. GILBERT.

THE last chapter leaves Major Powell at the mouth of the Rio Virgen in the autumn of 1869. The remainder of his life is to be reckoned in results, and the order of events is less important, but it is fitting to complement the preceding narrative in a few paragraphs before attempting to outline his scientific researches.

Although the adventurous voyage of the Colorado solved a geographic problem and added a volume of knowledge to the common stock, its results were far from exhaustive, for among its discoveries were a host of new and attractive problems to be attacked. Each river that came to the Colorado issued from a canyon of its own and invited exploration. Each climbing of a canyon wall gave a glimpse of a sculptured and tinted plateau land such as traveller had never described.

In no other part of the earth had there been revealed to the geologist a great desert so bare of vegetation and soil as to expose the naked rock, and at the same time so dissected by a ramifying system of trenches as to reveal its deep-lying anatomy. The idea of expanding the line of exploration into a belt of exploration was immediately conceived and this soon grew into a plan for the survey of the broad area of the Colorado Plateaus. It was first determined to repeat the voyage of the river in a more deliberate way, bringing supplies by land to various points demonstrated by the exploration to be accessible from the shore, making many excursions from the river, and complementing the river work by independent exploration on land. Up to this point Powell had depended on personal resources and those of private institutions, but his plans now outgrew these slender means and he appealed to the

General Government for aid. He was granted a first appropriation of twelve thousand dollars.

The line of the river was retraversed by boat in 1871 and 1872; and a survey of adjacent country was carried forward, with gradually expanding scope and organisation, until the reconstitution of western surveys in 1879.

Powell's personal work was in geology and ethnology. In 1873 he accepted a temporary commission from the Indian Bureau, because his duties as commissioner would require him to visit many tribes in Utah, Nevada, California, and Idaho, and thus enable him to extend his acquaintance with Indian languages, mythologies, and social institutions. In 1874 and 1875 he made a special study of the eastern Uinta Mountains and adjacent portions of the Green River basin. In later years the field work of the Survey was largely delegated to his colleagues, and his own attention was given to the publication of results and to new undertakings.

The most important new undertaking referred to the public lands. His many journeys in the states and territories of the Great Plains and beyond, gave him exceptional opportunity to observe the manner of development of the new country, and he was profoundly impressed with the vicious results of ill-adjusted land laws. Our laws, framed for the well-watered East, are not adapted to the needs of the arid West. In a dry country the soil yields crops only when artificially watered, and the ownership of the scant water of the streams should go with the ownership of the best farming land to which it can be conveyed by canals; but the common law gives the use of the stream to the adjacent land, whether it is suitable for farming or not. The arid land that cannot be watered is useful chiefly for grazing, but its herbage is so scant that a single stock raiser requires a large tract—much larger than our laws allow an individual to homestead or purchase. So there is no private title to the grazing lands, and there is no incentive to the improvement of their natural resources. The laws under which title is given to mineral lands assume that ores lie in regular sheets, dipping down into the earth, and as few ores are so disposed titles are uncertain and the mining industry is burdened with excessive litigation. Powell's attempt to procure the enactment of better laws has proved, up to the present time, the least successful of all his undertakings, but it is still possible that through the slow action of public opinion his endeavors may bear fruit.

In 1877 his corps prepared an economic map of Utah, showing

the distribution of irrigable timber and grazing lands, and this was published in conjunction with a volume by Powell in which he discussed the Western land problem so far as irrigation and pasturage are concerned. The book is entitled *The Lands of the Arid Region*. Subsequently Congress authorised the appointment of a "Public Lands Commission" to investigate the whole subject of the land laws, and Powell, being made a member of it, devoted much time in 1879 and 1880 to its work. Its report, in four thick volumes, is a monument to its industry, but the reforms it advocated have only in small part been made.

The survey developed as a sequel to the exploration of the Colorado canyons came eventually to be called the Survey of the Rocky Mountain Region. From similar small beginnings Dr. F. V. Hayden, likewise an explorer and geologist, developed the Survey of the Territories, and Captain George M. Wheeler, an engineer officer of the regular army, developed the Survey West of the 100th Meridian. All these were sustained by Congressional appropriations, their lines of investigation were largely the same, and they were rivals. The evils resulting from rivalry were many and were fully recognised, but for many years no reduction was made in the number of organisations because Congress could not agree which one to select for preservation. It was finally proposed to abolish all three and create instead a Geological Survey whose chief should be appointed by the President of the United States, and of this proposition Powell was the most active advocate. It was adopted by Congress in March, 1879, and the direction of the new-born United States Geological Survey was given to Mr. Clarence King, a geologist who had already won distinction as chief of the Fortieth Parallel Survey.

Zoölogic and ethnologic researches, which had been conducted by the Surveys just abolished, were not included among the functions of the new organisation, but Congress made a special provision for ethnologic work by establishing a Bureau of Ethnology. Major Powell was made the Director of this Bureau and he was thus enabled to continue one of the most important lines of investigation of the survey he had been willing to have abolished.

The direction of the Geological Survey was held by Mr. King less than two years; he resigned in March, 1881. President Garfield immediately named Major Powell as his successor, sending the nomination to the Senate. It is the custom of that body to refer each nomination to an appropriate committee and take action only after the committee has made its report; but when the nom-

inee is a senator his confirmation is considered immediately without asking the advice of a committee. It is one of the open secrets of the executive session of the Senate that Major Powell's nomination was paid the exceptional compliment of immediate consideration and confirmation.

He directed the work of both bureaus until 1894. During this period the appropriations for the work of the Geological Survey were greatly increased, and its functions were from time to time enlarged, especially by the addition of investigations and surveys connected with the utilisation of the waters of the arid region for irrigation. In 1888 the Survey was instructed to classify the lands of the public domain, and especially to set apart as agricultural those which might be redeemed by irrigation. The provisions of the law were such that the Secretary of the Interior felt compelled to withdraw all public lands from sale pending their classification by the Geological Survey. This withdrawal aroused a storm of indignation, leading to the repeal of the new law and the reduction also of the appropriations for other work of the Survey. The disaster indicated diminished confidence on the part of Congress in the Director of the Survey, and led him to resign his office as soon as he could be sure of the appointment of a properly qualified successor. He retired gladly, as impaired health had for several years made heavy executive responsibilities an onerous burden, and he afterward watched with great pleasure the successful administration of his successor, Mr. Walcott.

Immediately after his resignation he submitted to a third operation on his wounded arm, which had given him much trouble, and thereafter sedulously husbanded his physical resources, devoting the remainder of his life to the elaboration and publication of a system of philosophy to which he had already given much thought. He retained the directorship of the Bureau of Ethnology, but delegated the chief labor of administration to another. This work was carried on despite a complication of bodily ailments, and his health steadily declined until his death, which occurred on the 23d of September, 1902.

The study of nature falls logically into three categories: observation, classification, and explanation. One great part consists in the observation and description of phenomena, another in their classification and generalisation, the putting of like phenomena together and the substitution of summary statements for the enumeration of details. A third part furnishes the explanation of groups of phenomena, or constructs theories. The three interlock and in-

teract. Most good observation is guided by antecedent classification or theory; the observer either gathers facts within a specific category, or he seeks crucial facts to test an hypothesis. Before the discovery of satisfactory theories, classifications are artificial and tentative.

These interdependencies and others that might be named render it impossible always to discriminate the three kinds of scientific work, and it is still less possible to classify scientific workers under three corresponding heads; but it is nevertheless true that a large body of workers devote their lives to observation on selected subjects and generalise but little; and that others deal chiefly with generalisation and theory. The best observers are acquainted with competing hypotheses as to the phenomena under observation; and the observations of those ignorant of hypotheses are comparatively worthless. The best theorists are personally familiar with observation; and the theories of those who are not also observers are unsuccessful.

It results that the great investigators, those who contribute classifications and theories which are at once comprehensive and stable, are not merely men with great power of generalisation and analysis, they are also men whose training as observers enables them to sort the good from the bad in the recorded observations of others. The greatest investigators have begun with mere observation, or with the collection of specimens, have then discussed their own observations, and finally in full maturity have reared noble structures of philosophy on foundations far broader than the observation of an individual could compass.

Powell's early scientific work made no important literary record. He collected the mammals, reptiles, shells, plants, fossils, and minerals of his region, ascertained their names, and prepared faunal and floral lists, but in this he did little more than follow the tracks of others. Whether consciously or unconsciously, he was training his mind to habits of close observation and establishing an all-important respect for the facts of nature. His contributions to the world's knowledge and the world's philosophy began in later life and pertain to other fields of research. As an explorer he contributed to geography, geology, and ethnology; ethnologic study led him to the broader science of anthropology; and the evening of his life was given to the broadest of all generalisations and the most comprehensive of all theories,—a system of philosophy.

His contributions to physical geography and geology are chiefly contained in three treatises. In his volume on the *Exploration of*

the Colorado River the first part is a narrative of the voyage—the narrative quoted in the preceding chapter,—and the second part is a systematic account of the physical features of the river valley. The second treatise makes a volume by itself, and has for its theme the *Geology of the Eastern Portion of the Uinta Mountains*. In these works the details of observation are not recited. The features of the country and the geologic structure are set forth in comprehensive statements, and are treated as texts for the discussion of the departments of geologic philosophy to which their explanation belongs. The principal generalisations are: (1) a definition of the “plateau province,” (2) a classification of mountain types, (3) a classification of valleys, and (4) a classification of the forms of displacement of the plateau province, with a demonstration of the equivalence of the fault and the monoclinical flexure. The chief additions to geologic theory appear in discussions of the physics of erosion and of the production of topographic forms by the joint action of upheaval and erosion. The term “base-level of erosion,” first used in these discussions and now current wherever the forms of the land are studied, carries with it an idea of apparent simplicity but of far-reaching importance. A stream cannot wear down below its base-level, and the rate and manner of degradation of a region depend on the relation of the region to the base-levels of its streams.

It was shown that the degradation of mountains is many times more rapid than that of lowlands, and that mountains are therefore temporary elevations unless continuously renewed by uplift. All great mountains are young.

When the strata deposited by the sea are lifted into land, rivers begin to flow over them. The initial direction of the rivers is down the slope, and this is also the direction of the dip. It is found, however, that many drainage systems are quite independent of the direction of the dip, and, still more strange, that rivers often cut their way through mountain ranges instead of going around them. A generation of geologists observed this and wondered at it without finding an adequate explanation, but the present generation has discovered three different ways in which “inconsequent” drainage may arise and has arisen. Two of these ways were discovered by Powell, and to characterise them he introduced the terms “superimposed drainage” and “antecedent drainage.”

When a region of disturbed strata has in long ages been degraded nearly to base-level, then sinks below water level and receives a coating of sediments, and then is lifted into land, its new

drainage conforms to the overlying strata. With continued uplift and continued degradation the newer deposits are destroyed and the drainage system sinks into the underlying disturbed strata. The drainage is independent of the system of dips into which it is lowered and on which it is "superimposed."

If a mountain range is slowly uplifted athwart the course of a large river, the river wears its channel deeper and maintains its course. When the uplift is completed, the mountain stands in two parts, divided by the river. The direction of the stream's flow is independent of the dips of the rocks in the mountain, because the drainage is "antecedent" to the uplift.

His third important treatise on physical geography constitutes the first three chapters of a monograph by the National Geographic Society on the physiography of the United States. It sets forth the broader processes by which the surface of the earth is modified, characterises the features to which these processes give rise, and classifies the land of the United States into physiographic regions or provinces.

Anthropology is Powell's favorite science, and to it his greatest contributions have been made. Nor need his preference occasion surprise. Geology is young, and being young has had the advantage of modern inductive methods from its birth. Its growth has been so rapid that its great generalisations have been attained, and present progress is by slow stages, adding here a little and there a little. Great indeed must be the future geologist who can earn the reputation of Lyell. But the study of man was begun in the far distant past, and it accumulated by early methods so large a body of theory that when better methods became known it was at first unable to accept and use them. It has resulted that inductive anthropology is a less developed science than geology. Moreover, anthropology is the great science of the future, for its results are to guide the development of human institutions. It has barely discovered its high destiny, and is beginning to train its powers for serious work.

The days that Powell has spent in intercourse with Indians for the purpose of studying their languages, their modes of thought, their institutions, their arts and their philosophies, aggregate several years of time. On the material thus gathered many printed volumes of description might be based. But the time necessary to arrange and edit this material was never given because his energies were consumed by more important work. A small portion only was published. A sketch of the *Ancient Province of Tusayan*

appeared in *Scribner's Monthly* in 1875; an address read at the Boston meeting of the American Association for the Advancement of Science was devoted to the *Political System of the Wyandots*; a few myths of the Utes were recited in the first annual report of the Bureau of Ethnology; and the material has been frequently drawn on for purposes of illustration; but as a body the observations are recorded only in note-books. And yet the time devoted to them was neither lost nor misspent, for it gave him the foundation of personal observation necessary to sound generalisation. It rendered him a rare critic of ethnologic material,—able by what seemed an intuition to select the grain for use and reject the chaff. More than this, it gave him the breadth of view for which he was distinguished. The American differ so widely—in many respects so radically—from the Aryan races that their comparative study yielded him generalisations he could never have derived from a comparison of Aryan peoples with one another. With the aid of books he brought yet other ethnic stocks within his view, testing and extending his generalisations and developing a system of anthropologic philosophy.

The framework of this system of philosophy was mentally arranged before any of it was given to the world, but the different parts have been elaborated and published in a somewhat fragmentary way and without strict adherence to their logical order. A few have appeared in the annual reports of the Bureau of Ethnology; the greater number have been prepared and read as addresses to various scientific societies and printed with their proceedings. They are thus widely scattered, and their plan and order, though ever in the mind of their author, and frequently communicated in conversation, have never appeared in print. The central essay is entitled *Human Evolution*, and was read to the Anthropological Society of Washington in 1883. It begins by characterising the geologic, archæologic, historic, and ethnologic data through which the history of man's evolution is discovered. It then treats of the general character of that evolution. Human activities are then divided into five categories, and a brief sketch is given of the line of evolution within each category. The categories are: first, esthetic arts; second, industrial arts; third, institutions; fourth, languages; fifth, philosophy. Of the remaining essays of the series, two logically precede this, in that they treat of the relation of human evolution to other evolution and the relation of the science of man to other sciences; eight logically follow it and develop the philosophy in detail.

An address to the Philosophical Society of Washington, likewise in 1883, is entitled *Three Methods of Evolution*, and in this Powell characterises the processes of inorganic, biotic, and anthropic evolution as radically distinct. He gives special attention to the distinction between biotic and anthropic evolution, because he regards the prevalent theory that they are identical as one of the most insidious impediments to anthropologic progress. The following extract from the concluding portion of the address includes some of the fundamental elements of his philosophy :

“It has thus been shown that there are three stages in the combination of matter and motion, and that each stage is characterised by a clearly distinct method of evolution. These may be defined as follows :

“First, physical evolution is the result of direct adaptation to environment, under the law that motion is in the direction of least resistance.

“Second, biotic evolution is the result of indirect adaptation to the environment by the survival of the fittest in the struggle for existence.

“Third, anthropic evolution is the result of the exercise of human faculties in activities designed to increase happiness, and through which the environment is adapted to man.

“These may be briefly denominated : evolution by adaptation, evolution by survival of the fittest, and evolution by endeavor.

“Civilised men have always recognised to some extent the laws of human evolution,—that activities are teleologically developed, and that happiness is increased thereby. In the early history of mankind the nature of teleologic endeavor was so strongly impressed upon the mind that the theory was carried far beyond the truth, so that all biotic function and physical motion were interpreted as teleologic activity. When this error was discovered, and the laws of physical and biotic evolution established, vast realms of phenomena were found to have been entirely misunderstood and falsely explained, and teleologic postulates have finally fallen into disrepute. Men say there is progress in the universe by reason of the very laws of nature, and we must let them alone. Thus, reaction from the ancient false philosophy of teleology has carried men beyond the truth, until they have lost faith in all human endeavor ; and they teach the doctrine that man can do nothing for himself, that he owes what he is to physical and biotic agencies, and that his interests are committed to powers over which he has no control.

“Such a philosophy is gradually gaining ground among thinkers and writers, and should it prevail to such an extent as to control the actions of mankind, modern civilisation would lapse into a condition no whit superior to that of the millions of India, who for many centuries have been buried in the metaphysical speculations of the philosophy of ontology. When a man loses faith in himself, and worships nature, and subjects himself to the government of the laws of physical nature, he lapses into stagnation, where mental and moral miasma is bred. All that makes man superior to the beast is the result of his own endeavor to secure happiness.

“Man, so far as he is superior to the beast, is the master of his own destiny, and not the creature of the environment. He adapts the natural environment to his wants, and thus creates an environment for himself.”¹

The three methods of evolution correspond to a classification of the sciences in three groups: the sciences of matter, the sciences of life, and the science of man as a thinking animal. The individual sciences composing these groups, and their order among themselves, are set forth in an address to the American Association for the Advancement of Science in 1888.

The essays devoted to the amplification of the outline of human evolution constitute two series. The first series is based upon the recognition of three stages of progress—savagery, barbarism, and civilisation. One address to the Anthropological Society is entitled *From Savagery to Barbarism* (1885); a second is entitled *From Barbarism to Civilisation* (1888); a third *Evolution in Civilised Man* (1887).

“By the division of labor men have become interdependent, so that every man works for some other man. To the extent that culture has progressed beyond the plane occupied by the brute, man has ceased to work directly for himself and come to work directly for others and indirectly for himself. He struggles directly to benefit others, that he may indirectly but ultimately benefit himself. This principle of political economy is so thoroughly established that it needs no explication here; but it must be fully appreciated before we can thoroughly understand the vast extent to which interdependence has been established. For the glasses which I wear, mines were worked in California, and railroads constructed across the continent to transport the product of those mines to the manufactories in the East. For the bits of steel on the bow, mines were worked in Michigan, smelting-works were erected in Chicago,

¹ *Bull. Philosoph. Soc.*, Washington, Vol. VI., pp. li-lii.

manufactories built in New Jersey, and railroads constructed to transport the material from one point to the other. Merchant-houses and banking-houses were rendered necessary. Many men were employed in producing and bringing that little instrument to me. As I sit in my library to read a book, I open the pages with a paper-cutter, the ivory of which was obtained through the employment of a tribe of African elephant-hunters. The paper on which my book is printed was made of the rags saved by the beggars of Italy. A watchman stands on guard in Hoosac Tunnel that I may some time ride through it in safety. If all the men who have worked for me, directly and indirectly, for the past ten years, and who are now scattered through the four quarters of the earth, were marshaled on the plain outside of the city, organised and equipped for war, I could march to the proudest capital of the world and the armies of Europe could not withstand me. I am the master of all the world. But during all my life I have worked for other men, and thus I am every man's servant; so are we all—servants to many masters and masters of many servants. It is thus that men are gradually becoming organised into one vast body-politic, every one is striving to serve his fellow-man and all working for the common welfare. Thus the enmity of man to man is appeased, and men live and labor for one another; individualism is transmuted into socialism, egoism into altruism, and man is lifted above the brute to an immeasurable height. Man inherited the body, instincts, and passions of the brute; the nature thus inherited has survived in his constitution and is exhibited along all the course of his history. Injustice, fraud, and cruelty stain the pathway of culture from the earliest to the latest days. But man has not risen in culture by reason of his brutal nature. His method of evolution has not been the same as that of the lower animals; the evolution of man has been through the evolution of the humanities, the evolution of those things which distinguish him from the brute. The doctrines of evolution which biologists have clearly shown to apply to animals *do not apply to man*. Man has evolved because he has been emancipated from the cruel laws of brutality.”¹

In another place he shows that, though competition of plant with plant and brute with brute is the means of biotic progress, civilised man does not compete with plant or brute, but destroys what are hurtful to him and improves what are beneficial. When man competes with man in the struggle for existence no step in evolution results.

¹ *Trans. Anthropological Soc. of Washington*, Vol. III., pp. 195-196.

“Vestiges of brutal competition still exist in the highest civilisation, but they are called crimes; and, to prevent this struggle for existence, penal codes are enacted, prisons are built, and gallows are erected. Competition in the struggle for existence is the agency by which progress is secured in plant and animal life, but competition in the struggle for existence among men is *crime* most degrading. Brute struggles with brute for life, and in the æons of time this struggle has wrought that marvellous transformation which we call the evolution of animals; but man struggles with man for existence, and murder runs riot: no step in human progress is made.

“That struggle for existence between man and man which we have considered and called crime is a struggle of one individual with another. But there is an organised struggle of bodies of men with bodies of men, which is not characterised as murder, but is designated as warfare. Here, then, we have man struggling with man on a large scale, and here it is where some of our modern writers on evolution discover the natural law of selection,—‘the survival of the fittest in the struggle for existence.’ The strongest army survives in the grand average of the wars of the world.

“When armies are organised in modern civilisation, the very strongest and best are selected, and the soldiers of the world are gathered from their homes in the prime of manhood and in lusty health. If there is one deformed, if there is one maimed, if there is one weaker of intellect, he is left at home to continue the stock, while the strong and the courageous are selected to be destroyed. In organised warfare the processes of natural selection are reversed: the fittest to live are killed, the fittest to die are preserved; and in the grand average the weak, physically, mentally, and morally, are selected to become the propagators of the race.”¹

[TO BE CONTINUED.]

¹ *Science*, Vol. XI., p. 113.