SCIENCE

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RUDOLF VIRCHOW'S ANTHROPOLOGICAL WORK.

IN Rudolf Virchow science has lost one of its great leaders, Germany one of her great citizens, the world one of its great men. For sixty years Virchow has devoted his strong mind and his indefatigable energies to advancing the work of mankind. The science of medicine, anatomy, pathology and anthropology count him as one of their great men. For long years he has been a power in German political life, always upholding the cause of personal freedom.

The beginnings of his anthropological work almost coincide with the beginnings of modern physical anthropology in Germany. Among the men who laid the foundation of this science no one has done more to shape, guide and foster it than Rudolf Virchow. His interest in anthropology, which was destined to impress the mark of his personality upon the young science, developed during the time when he investigated the causes of cretinism and the conditions determining the growth of the skull. The similarities between pathological forms of the skull and those found among different races of man probably led him to researches on the variations of form of the human body. The scope of his anthropological interests expanded rapidly and the impetus which he gave to anthropological work, particu-

larly in physical anthropology and in prehistoric archeology, was so great that the development of these two branches of science in Germany may be said to center in Virchow's activity.

At the time when Virchow took up his work, anthropology was still in its first beginnings. During the eighteenth century Von Sœmmering and Blumenbach in Germany, and Camper in Holland, had directed their attention to a study of the anatomical characteristics of the races of man, but the new anthropology did not arise until the second half of the past century. The strong impetus which the theory of evolution gave to all sciences, combined with the immediate interest in the early history of European nations, and the increasing knowledge of foreign races were the principal factors that contributed to the formation of modern anthropology.

Virchow, through his eminent faculty for organization, has advanced the whole field of anthropology. He took a leading part in the formation of the German Anthropological Society, of the *Berliner Gesellschaft für Anthropologie, Ethnologie und Urgeschichte,* and in the establishment of the monumental *Archiv für Anthropologie* which occupies a high rank in anthropological literature. The two societies soon became the centers of anthropological activity in Germany. The German Anthropological Society devoted its energies to the study of the physical characteristics and of the earliest history of the Germans. Under Virchow's lead this society undertook to collect statistics relating to the distribution of the color of skin, eyes and hair in Germany, and observations were collected in all the public schools of the country. The results of this extended inquiry, which include a cartographic representation of the distribution of types in Germany and a discussion of their probable history, were published by Virchow.

The *Berliner Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte* soon became a center to which flowed a flood of anthropological material from all parts of the world, and where important scientific questions were discussed by the most competent authorities. Through its intimate relations with German travellers the society became of valuable assistance in the development of the Berlin Ethnographical Museum, which owes its origin and greatness to Adolf Bastian. Owing to Virchow's influence the society gradually acquired a large and valuable collection of human crania and skeletons. Among the subjects discussed before the society European archeology always held a prominent place, and Virchow took a lively part in this work which has contributed much to the growth of the prehistoric collections in Berlin.

As director of the Pathological Institute and Museum of the University of Berlin, Virchow had further opportunities to advance our knowledge of the anatomy of races, and he accumulated much valuable anthropological material in this Institute. His studies of prehistoric archeology brought him also into close contact with students of folk-lore and he became one of the founders of the *Museum für Volkstrachten.*

It will thus be seen that Virchow took the leading part in the organization of anthropological work in Germany. Therefore, it is no wonder that his views have wielded a far-reaching influence, so much so, that without a knowledge of his work the peculiarity of German physical anthropology and of German prehistoric archeology can hardly be understood.

Most important is his attitude toward the theories relating to the descent of man. His views regarding this question were determined by his fundamental researches on the functions of the cell in the animal organism. He formulated his views in the

words that every cell is derived from another cell. No matter how much the forms of the cells may vary, every new form is derived from a previous form. Cells, in the course of their lives, may change their forms according to age and according to the influences to which they are subjected. Such changes take place both in the healthy and in the sick organism, and often it is impossible to draw a sharp line between normal or physiological, and abnormal or pathological, changes. Virchow himself expresses these views in the words that in reality there is no distinct line of demarcation between physiological and pathological processes, that the latter are only physiological processes which take place under difficult conditions. The cell which changes its form during its lifetime may, therefore, be said to be variable; or, in Virchow's words, it possesses mutability. From his point of view the whole question of the origin of species centers in the problem of the relation between the mutability of the organism and the mutability of the cell. The comparison of the forms of organisms and organs may form the starting point of researches on variability, but the study of the variations of the whole organism or organ must be based on the study of the variations of the constituent cells, since the physiological changes of the whole body depend upon the correlated physiological changes that take place in the cells. Without a knowledge of the processes that take place in varying cells, it is impossible to determine whether a deviation from the normal form is due to secondary causes that affect during their period of development organs already formed, or if it is due to primary deviations which develop before the first formation of the varying organ.

Two questions, therefore, arise: the first, if secondary deviations may become hereditary. For this no convincing proof has been found. The second question is whether primary variations do occur, and if so, whether they are hereditary.

Led by these points of view Virchow demands that researches on the origin of species be based on researches on the mutability of cells and groups of cells, and he declines to speculate on the origin of species, until through researches on tissues a sound foundation has been laid. Sometimes it would seem as though Virchow doubted the scientific value of the theory of evolution. I do not think this is the case. He merely emphasizes again and again the methodological point of view, that the understanding of the forms of the body must be based on a knowledge of the forms, mutual relations, and functions of the cells and that, therefore, the question of 'mutability' must be settled by researches on these lines.

Furthermore his position rests on the general scientific principle that it is dangerous to classify data that are imperfectly known under the point of view of general theories, and that the sound progress of science requires of us to be clear at every moment, what elements in the system of science are hypothetical and what are the limits of that knowledge which is obtained by exact observation. To this principle Virchow has adhered steadfastly and rigidly, so much so that many an impetuous student has felt his quiet and cautious criticism as an obstacle to progress. On this account he has suffered many hostile attacks—until generally the progress of research showed that the cautious master was right in rejecting the far-reaching conclusion based on imperfect evidence. There are but few students who possess that cold enthusiasm for truth that enables them to be always clearly conscious of the sharp line between attractive theory and the observation that has been secured by hard and earnest work.

There are two anthropological problems which are important in their relation to the

theory of evolution; the one that of the antiquity of man, the other that of the interpretation of anatomical characteristics of the lower races. The evidence in regard to the anatomical form of early man is very scanty, and for many years the discussion centered in the interpretation of the Neanderthal skull, which possesses a number of peculiar characteristics, particularly an exceedingly low head and very large superciliary ridges. Virchow demonstrated that the skull had undergone many pathological changes, and he took the position that it was unsafe to base on this single specimen a new race which might be considered a precursor of man. He preferred to consider the skull as an individual variation until other similar finds would give corroborative evidence. Virchow was equally cautious in the interpretation of theromorphic variations in the forms of the human body. He maintained that such forms are not necessarily cases of atavism, but that they may be due to peculiar physiological processes; and that without special investigation of their origin they cannot be considered as proof of a low organization of the races among which they are found with particular frequency. There is no proof that such forms are connected with a low stage of culture of the people among whom they are found. They occur, for instance, among the Malays and among the ancient Peruvians, both of which races have attained high stages of culture.

We cannot, in the scope of these notes, enter upon Virchow's numerous investigations bearing upon the anatomy of the races of man. Many of them contain discussions of general principles. His researches on the physical anthropology of the Germans and his description of American crania may be mentioned as specially important.

His investigation of the anatomical characteristics of the Germans led him naturally to studies in prehistoric archeology to which he devoted much of his time and energies. For a long time forms of the body were considered a characteristic of nationalities. Forms of skulls were described as Teutonic and Slavic; there were Turanian and many other kinds of skulls. Nobody has done more than Virchow to show that this view is untenable. The question of the history of the Slavic settlement of eastern Germany has received much attention on the part of German archeologists and is still far from being entirely cleared up. While methods of burial, prehistoric objects, names of places, plans of villages and houses are good indications for ancient Slavic settlements, the anatomical forms of the present population and of ancient skeletons do not allow us to draw any inference regarding the nationality of the ancient inhabitants, because neither Germans nor Slavs present a uniform and characteristic anatomical type. Virchow has always maintained that the limits of human types do not coincide with the dividing lines of cultures and languages. People who belong to the same type may speak different languages and possess different forms of culture; and on the other hand—as is the case in Germany—different types of man may be combined to form one nation.

These phenomena are intimately connected with the intricate migrations of the races of Europe; with the invasions of southern Europe by Teutonic peoples and the development of north European culture under the influence of the cultures of the eastern part of the Mediterranean Sea. The gradual introduction of metals and the disappearance of the culture of the stone age is one of the phenomena that are of great assistance in clearing up the relations between the ancient inhabitants of Europe. The change of culture indicated by the introduction of bronze indicates that the new culture arose in the far East. This is the reason which induced Virchow to under-

take extensive prehistoric studies in Asia Minor and in the region of the Caucasus. His studies in prehistoric archeology, which apparently are so remote from his original anatomical work, are in reality closely connected with his researches on the early history of the races of Europe. Anatomical data alone cannot solve these intricate problems, and Virchow's extensive activity in the field of prehistoric archeology is another proof of his thorough and comprehensive method which utilizes all the available avenues toward the solution of a scientific problem.

Physical anthropology and prehistoric archeology in Germany have become what they are largely through Virchow's influence and activity. His method, views and ideas have been and are the leading ones. His greatness as a scientist is due to the rare combination of a critical judgment of greatest clearness and thoroughness with encyclopedic knowledge and a genius for grasping the causal relation of phenomena. His critical judgment was so strong that, in an address delivered in the summer of 1900, he was even led to doubt the desirability of the strong preponderance of his influence upon current opinion. With profound admiration and gratitude we regard his life's work which has determined the course of a new science.

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SCIENTIFIC RESEARCH: THE ART OF REVELATION AND OF PROPHECY, II.

XI.

Collaboration of all sciences, physical and metaphysical, must ultimately be the task of the investigator and the end of research. The several sciences are the formulated expressions of nature's law of a universe, and all are functions of force, movement, energy, of life and its material foundations. To discover the relations of the sciences and to reduce them all to departments of one all-comprehending system will prove, if it can be achieved, the highest result of research. Already, the thermal, luminiferous, electrical, mechanical, chemical, and to a certain extent the biological, sciences are known to be divisions of the more comprehensive science of energetics; all treat of manifestations of energy and its conversion from form to form and its transfer from point to point. Already it is known that other manifestations of force and energy, if not still-disguised illustrations of familiar forms, are existent in the animal machine, and it is suspected by some, believed by others, admitted to be possible by yet others, that those energies which pervade the more ethereal atmospheres, the vital and perhaps other energies, are transformations of the familiar kinds. The question has even been seriously and honestly asked whether spiritual life and energies may not have definite relations of quantity, and even of transformability, with those characterizing the physical world. Vital energy, moral force, the efforts of genius, exhibit themselves in the individual in larger or lesser degree as his supply of potential energy in form of food varies from excess to deficiency and as his physical powers fluctuate.

Are there two universes, the seen and the unseen? How is the seen related to the unseen? Are there definite quantitative equivalences among the forces and the energies of the one and of the other? What are these equivalences among the energies of the unseen, if they exist, and what the facts and laws, the algebraic statements of law, and the values of the constants representing facts at the points, the surfaces, of junction?

These and other questions constitute problems for the coming investigator, familiar with the phenomena of the seen and