Recommended

Goethe as a Scientist.

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References: Lewes - Book 5, chapter 9. (In English)
Bielschowsky - Volume II, chapter 15. (In German).

Goethe as a Scientist

All of Goethe's work in the field of Science was carried on with one underlying idea; namely, that there is unity in Nature. It was his firm belief that modern plants and animals, in themselves, and in their various parts and organs, were specialized, complex developments from simpler, prehistoric types. Thus, in a measure, Goethe enunciated the theory of evolution, and in this, as well as in other of his views, was far ahead of the scientists of his time.

While at the universities of Strassburg and Leipzig he first evinced his fondness for natural science by attending lectures on anatomy and medicine, and later by studying osteology and myology under Loder. But it was not until he came to Weimar, and, in the course of his official duties, was concerned with the management of the Ilmenau mines, that he began to ~~make~~ undertake scientific researches and studies on his own account. In this connection he became interested in

at Jena 1781 f

geology and mineralogy, and although he made no discoveries in these sciences, and held the erroneous ~~view~~ theory that granite made up the foundation, or central mass of the earth, nevertheless some of his views were of great importance. He was the first to believe that a glacial period had existed upon the earth, and was one of the first to recognize the important bearing of fossil remains on geology.

With regard to the time spent upon it, the science to which Goethe was most devoted, and which fascinated him most, was botany. His "Gartenhaus" near Weimar was an ideal place for the pursuit of this study, and he made excellent use of his opportunity. "While botanists and anatomists were occupied in analysis, striving to distinguish separate parts, and give them distinct names, his (Goethe's) poetical and philosophic mind urged him to seek the supreme synthesis, and reduce all diversities to a higher unity."*

After ten years of study along these lines, the fruits of all this labor ~~appeared~~ were made public in the

* Lewes - Bk. 5 ch. 9.

"Metamorphose der Pflanzen." The leading idea of this work is that the various organs of the plant, such as the bracts, calyx, ~~calyx~~ petals corolla, stamen, and pistil are modifications of one fundamental type - the leaf. "The metamorphosis of plants is taken ~~not~~ in the sense of the metamorphosis of insects, "but as a succession of repetitions of the original type variously modified." *

Although Goethe was not the first to discover this relation of the organs of plants to the leaves, his work was entirely independent of that of his predecessors, and the credit of discovery is assigned to him because he was the first to apply the theory. Long before Goethe, L Linnaeus had shown that plant organs are metamorphosed leaves, but was content with the mere demonstration of the fact. Moreover, Kaspar Friedrich Wolff, in his "Theoria Generationis" had laid down the same morphological principles re-demonstrated by Goethe. His theory was, however, based on physiological principles, and was merely used as an illustration to prove some hypothesis. Goethe, on the other hand, had as his

* Lewes - Bk. 5, chap 9

object the creation of a new botanical theory, based on his idea of ~~plants~~ the organs of the higher plants being variations of a primitive, typical leaf. In contradistinction to Wolff, he assigns elaboration of sap as the cause for the differentiation from the leaf, a view generally accepted at the present time. He says: "As long as there are any of the grosser fluids to be rejected, the organs of the plant are forced to employ themselves in this labor, which labor renders flowering impossible; but no sooner do we limit the nourishment, than, by diminishing this process of elaboration, we accelerate the flowering." * His researches enabled him to come to the conclusion that "the same organ which expands into a leaf upon the stem, and presents such varied forms, contracts to make the calyx, expands again to make the petal, to contract once more into the sexual organs, and expand for the last time into fruit," † and also convinced him that reproduction is a form of growth by which a plant gradually differentiates more and more from the primitive type and approaches its ideal form as determined by the surrounding

* Lewes - Bk. 5 ch. 9. (Quotation from "Nat. der Pflanzen.")

† Ibid.

conditions.

In 1820, the "Metamorphose der Pflanzen" and other botanical essays were reprinted under the title "Zur Morphologie." Thus Goethe named and created a new and exctremely important science. He defined morphology as treating of the form, formation, and transformation of organic bodies. In this work, among many other views, he maintains that existing plants had not been originally fixed in present forms, but possessed flexibility enough to adjust themselves to conditions of locality in which they are found. In this connection it may be said that Goethe considered man not as the completion of the process of creation, but as merely a step towards a higher goal.

The principal obstacles Goethe had to contend against in obtaining credence for his "Metamorphose der Pflanzen" were resistance to novelty and overcoming his reputation as a poet. As no scientist was willing to follow the scientific teachings of a poet, the work was looked upon by them merely as a pretty piece of fancy. When the theory set forth was finally accepted,

it was only because great botanists had made it acceptable.

Another science in which Goethe achieved important results, was osteology. In this branch of study he made two discoveries; namely, that of the ~~exis~~ existence of the intermaxillary bone in man, and that of the vertebral nature of the skull.

The intermaxillary bone is the center bone of the upper jaw, and contains the incisor teeth. Its presence in the human body was claimed by Galen and his followers, but was refuted by Caesalius and his followers, neither side trying to demonstrate its hypothesis anatomically. Goethe's idea of unity in Nature made him sure that, as man possessed incisor teeth, the bone existed in the human race, ~~man~~, and as a consequence of this idea, he started to <u>compare</u> the skulls of various animals and human beings in ~~diffe~~ various stages of development. By this method of comparative anatomy he found that "the bone varied with the nutrition of the animal and the size of its teeth. He found, moreover, that in some animals the bone was not separated from the jaw, and that in children the sutures were traceable."* He also found distinct traces of sutures on the interior of the fully devel-

*Lewes - Bk. 5 ch. 9.

oped human skull, thus demonstrating the existence of the bone in man. This has been since conclusively proved by the examination of the fœtal skull, and by other methods. Goethe made this discovery in 1784, but it was not generally accepted for forty years. His teacher, Loder, was the only well known anatomist to be immediately convinced by the discovery. Even Camper, after investigating the matter himself, denied the existence of the bone in the human skull, although he agreed with the poet in the other points made by him. The important principle indicated by the discovery, and which Goethe fully recognized, was that all living organisms are constructed on a uniform plan. In enunciating this, he says: "Und so ist wieder jede Kreatur nur ein Ton, eine Schattierung einer grossen Harmonie, die man auch im Ganzen und Grossen studieren muss; sonst ist jedes einzelne ein toter Buchstabe."*

The discovery of the vertebral nature of the bones of the skull was an application of this idea of a general type. The idea was suddenly brought to Goethe's mind by ~~a skull of a ram cut long~~ a longitudinally cut skull of a ram. The resemblance in general form to vertebra shown

*Quoted by Bielschowsky, II. chap. 15.

by the bones of the skull was so marked, that he was immediately convinced of their true nature. This idea was not published by him, and the credit for it naturally goes to Oken, who independently enunciated and explained it.

Next to Goethe's work in botany, his study of optics is the most important, although the conclusions he derived from it are false. His great interest in art, especially in painting, led him to study the science of colors. But, as he proceeded from insufficient knowledge of ~~elementary~~ mathematics and elementary physics, he made grave errors, and held to these in spite of the ridicule of ~~scorn~~ physicists, as his discovery of the intermaxillary bone in man, and the principles laid down in the "Metamorphose der Pflanzen" had also been ~~decried~~ derided.

For the purpose of starting this study, he borrowed some prisms and optical instruments from Prof. Büttner, of Jena. He looked through a prism at a white wall, and saw no colors except at the edges of the prism. When he looked through it at a dark body he saw colors, and there-

fore came to the conclusion that darkness was the essential component of colors. In the light of this ~~conclusion~~ assumption he misconstrued Newton's theory of colors, which is sufficient to explain the phenomena which he observed, and thus started upon his course of error. He also found that a white disc on a black background, viewed through a prism, gave him a spectrum, in accordance with Newton's theory, but also discovered that a black disc on a white background produced the same effect. Therefore he was confirmed in his suspicion that darkness resolved itself into ~~light~~ colors, and that colors were combinations of light and darkness, instead of composing white light, as in the Newtonian theory. After he had published the results of these experiments, he was agreed with by anatomists, chemists, authors and poets, and philosophers, but not by a single physicist, as, rightly interpreted, Newton's theory covered all these cases.

As a result of many investigations, Goethe finally announced that white light is a simple, homogeneous thing, and cannot be said to be composed of colors, as every white light after being colored becomes darker. That on

this account brightness can not be a compound of darkness. That there are but two pure colors- yellow and blue, both tending to become red. That the former is the nearest color to light, the latter the nearest color to darkness. In arriving at these conclusions, his principal mistake was that of treating darkness as a positive quantity, instead of absence of light. "Stripped of all ~~its~~ the ambiguities of language, the theory affirms that light is itself perfectly colorless until mingled with various degrees of nothing."* Nevertheless, the facts advanced in support of the argument are all perfectly correct, but are misinterpreted. Goethe's theory, and his treatise on the subject, being evolved from the viewpoint of the eye, and consequently dealing with the effects of light upon the eye, are of great service to painters, and to those who desire a knowledge of the phenomena of colors as perceptions. For scientific purposes, Newton's theory, besides admitting of ready proof, ~~combines the~~ also allows precise mathematical calculation that can be reconciled with observation, while the former theory depends entirely upon observation.

Another more modern science in which Goethe's in-

*Lewes- Bk 5 ch. 9.

fluence was felt was meteorology. His interest in this branch of study was probably aroused by his great sensitiveness to changes in the weather. After reading Howard's work on meteorology, he began to compare cloud formations with the height of the barometer, and found out to some extent their mutual relations. He was also instrumental in the erection of a number of weather stations in the Duchy of Weimar, and ~~made such~~ drew up instructions for the observers.

Considering Goethe's scientific activity as a whole, it may be said that he was the founder of the comparative method of scientific research. His theory of the metamorphosis of plants, his discoveries of the intermaxillary bone in man, and of the vertebral nature of the skull, were all evolved by the comparative method, then entirely new. This method was naturally the one to suggest itself to him, as he was convinced of the "Einheit des Alls." His intention in scientific work was to discern not the relations of objects to man, but to one another. "He was an observer and a thinker, rather than an in-

vestigator according to the strict procedures of science."* His belief was firm that Nature can only be studied by being revealed to the investigator, and he says in Faust:

"Und was sie deinem Geist nicht offenbaren mag,
Das zwingst du ihr nicht ab mit Hebeln und
mit Schrauben."

As a worker in natural science, he can best be described by his own definition of a great scientist: that he must have an imagination "die den wirklichen Boden der Erde nicht verlässt, und mit dem Massstabe des Wirklichen und Erkannten zu geahnten, vermuteten Dingen schreitet."†

* Lewes - Bk. 5 - ch. 9.
† Quoted by Bielschowsky, II, ch. 15.

A *a concise and excellent resumé.*