In offering a discussion of Goethe as a Scientist one cannot avoid asking what a proper approach would be, for not only is there a large volume of writing by Goethe on important areas of 18th century science, but there is also over a century of interpretation with a story all its own. A study of Goethe as a Scientist in many ways mirrors trends during Goethe’s lifetime, as well as developments in science since then, and by way of introduction I might discuss the extent of the artifacts which comprise Goethe’s scientific culture.\(^1\) From about 1780 until his death in 1832 Goethe remained abreast in most fields of human and natural science. He exchanged over 500 letters with professional scientists such as Berzelius, Blumenbach, and the von Humboldt brothers and was elected to membership of scientific societies in 27 cities, including Edinburgh’s “Wernerian Natural History Society” and New York’s “Lyceum of Natural History.”\(^2\) His scientific writings comprise 11 volumes, which are being expanded by the Deutsche Akademie der Naturforscher (Leopoldina) as new materials are gleaned from the various Goethe archives.\(^3\) During his lifetime Goethe accumulated over 300 chests (kästen) full of manuscripts and contributed to German culture a museum of artifacts which include a 17,800 piece rock collection, 9,000 pages of graphic, as well as a respectable library and

---

collections of coins, signets, bones, plants, and technical instruments.\(^4\) Scholars have indeed had sufficient materials to investigate. By 1940 Günther Schmied was able to list 4554 items in his bibliography\(^5\) of Goethe as a Scientist and since then the Goethe Jahrbuch annually lists from 10 to 15 studies on Goethe’s science. In the years immediately following his death, many scientific and medical books were dedicated to Goethe by individuals important to the history of science such as Saint-Hilaire, Purkinje, Haeckel, and Alexander von Humboldt. Perhaps more interesting than significant are the various items in mineralogy, botany, zoology, and geography which have been labeled with Goethe’s name. One of the few retained today is the “Goethite” which the McGraw-Hill Encyclopedia of Science and Technology describes as “a mineral having a composition of iron, oxide, and hydroxide, comprising most of the material known as brown iron ore,”\(^6\) such as is found in Alsace-Lorraine. The breadth of Goethe’s scientific interests and affiliations, and the enduring fascination of scholarship with them, for a rather complicated, and at times, disjointed composition.\(^7\) The picture of Goethe as a Scientist changes in his attitudes over the years. In his lecture of 1852, Hermann Helmholtz, for example, found it difficult to evaluate Goethean science as anything other than a series of successes and failures; the former largely in botany, zoology, or in what

\(^4\) See Erich Trunz’s “Goethe als Sammler”, Goethe Jahrbuch, 89 (1972), pp. 13-61, for a lengthy discussion of Goethe as a collector of cultural and natural artifacts.
\(^7\) Also included in Heinz Kindermann’s Das Goethebild des 20. Jahrhunderts, (Darmstadt: Wissenschaftliche Buch-Gesellschaft, 1966) is a discussion of Goethe as a scientist. Kindermann has, however, ignored British and American studies and is somewhat narrow in this respect. For representative articles of the German tradition in Goethe scholarship see Goethe im XX Jahrhundert, ed. Hans Mayer, Hamburg; Wegner Verlag, 1967.
Helmholtz called the descriptive sciences, and the latter in physical optics. By 1892, in a lecture in Weimar,⁸ Helmholtz no longer asked about specific discoveries or theories, but focuses on Goethe’s phenomenological approach to nature studies and on the totality of Goethe’s language, science, and philosophy. A great deal of scholarship fluctuates between such holistic and individualistic interpretations,⁹ for Goethe’s synthetic views tend to carry the enquirer out of the sphere of science, which Goethe himself remarked, is a discipline which obtains results by limiting its scope and by being exhaustive.

Goethe’s contribution to science in the stricter sense has ceased to be an important question, although his empirical work is often forgotten as a complement to the more transcendental side of his science.¹⁰ What is important today is a better understanding of the empirical and philosophical balance achieved in Goethe’s science and the role which his technique of perception and use of ordinary language played in that balance. If there exists a trend in recent scholarship on Goethe as a scientist, it is in the study of his language as it relates to the perception of natural phenomena,¹¹ and as it relates to his communication with the scientific community. However, before looking at a particular

---


⁹ For a discussion on this point see Agnes Arber’s “Goethe’s Botany” in Chronica Botanica, 10 (1946), pp. 63-124. She also includes a translation of Goethe’s Metamorphosis of plants and the controversial Die Nature.

¹⁰ For a discussion of the empirical and philosophical balance achieved by Goethe and his contemporary German scientists see James W. Marchand’s article.

¹¹ Foremost in these studies is Dorothea Kuhn’s Empirische Und Ideelle Wirklichkeit: Studien Uber Goethes Kritik des französischen Akademiestreites. Köln: Böhlau, 1967. Other studies are less impressive since they depart from Goethe’s phenomenological approach to nature study and to language use. Franz Koch’s Goethes Gedankenform, Berlin: De Gruyter & Co., 1967, for example, lists over 100 examples of polarity which becomes a small dictionary in anthonyms. Christoph Gögelein has likewise made no distinction between Goethean thought. See his Zu Goethes Begriff von Wissenschaft, München, Hanser Verlag, 1972.
aspect of the latter area, we might have a closer look at Goethe’s scientific work, which has generated over a century of scholarly attention.

As I have pointed out earlier Goethe’s contribution to science goes beyond the identification and description of bones, plant parts, or physiological color phenomena. It also goes beyond the transcendental plans wherein the individual parts are united with the whole so that the totality of nature might be perceived. His landmark contribution lies in his subjective penetration into the world about him and in his ability to communicate this world in ordinary language, an important step toward understanding the human equation in science. It perhaps goes without saying that the study of the human equation in science begins with the study of language and in this I might appeal to authority when I cite from Sarton, who himself cites from Lavoisier:

One cannot improve the language without improving science, nor science without the language, and however certain the facts be, however just the ideas which those facts evoked, they would transmit only false impressions if we lacked exact ways of expressing them. (292)

Goethe finds it one of science’s great misconceptions that language or notation never completely represents the natural phenomenon, yet he adds, “how difficult it is to avoid

substituting the sign for the thing; how difficult to keep the essential quality (of nature) still living before us, and not to kill it with the word.” (Ele, 302)\(^\text{17}\) For Goethe the problem of language became very acute when he sought a terminology for color phenomena. Colors appear to be simple and homogeneous entities when abstracted and categorized. Yet, when found in the varying conditions of the real world, they ramify into innumerable individualities which all man’s languages cannot capture. In treating the personalities of scientists, Goethe also found a shortage of terminology for expressing differences in human character. He found a partial solution for this by turning to physics, where the laws of coherence allowed such language variations as firm, dense, heavy, elastic, pliable, malleable, flexible, rigid, glutinous, and fluid. He described Newton’s character, for example, as rigid. In Goethe’s later life he became concerned not only with the symbolism of language but also with the kinds of argumentation often used in scientific discourse.\(^\text{18}\) Goethe’s affiliations with scientists and scientific societies gave him ample opportunity to observe techniques of argumentation which he himself generously employed, especially later in his career when he devoted much of his writing to defending and expanding upon his work in comparative anatomy and morphology. Before discussing a few examples of the argumentation used by Goethe, I might cite from his 1790 essay on the philosophy of perception, in which he distinguished between his scientific method and the techniques of argumentation:

We can easily see the vast difference between a mathematical demonstration, which follows from primitive forms to so many connections, and the proof, which a clever orator can execute from arguments. Arguments can contain isolated


\(^{18}\) Although there are several books on Goethe’s rhetoric in theatrical work, there has not been a study of his use of, or acquaintance with, argumentation in scientific discourse. Argumentation in scientific discourse also is not mentioned in general studies such as Christian Winkler’s *Elements der Rede. Die Geschichte ihrer Theorie in Deutschland*. Halle: Max Niemeyer, 1931.
relations and through wit and imagination can be directed toward a specific point, wherby the appearance of justice and truth can be generated. In this manner one can set together and execute arguments and experiments to the advantage of a hypothesis and theory which then appear as dazzling proof. (LA, 8, 313, Versuch)\textsuperscript{19}

Before looking at Goethe’s pocket full of tricks we might mention that form his early school days he was fully aware of all forms of rhetoric, dialectic, and traditional devices of argumentation. Later, in the debates between Cuvier and Saint-Hilaire in the French Academy, Goethe observed how the latter changed levels of discourse and employed what we might label the \textit{argumentum ad exemplum}, arguing against a particular example rather than against the question itself.\textsuperscript{20} On October 11, 1830, Saint-Hilaire read a paper treating the special forms of the back of the crocodile skull, which Cuvier had ostensibly omitted in his observations. Cuvier was thus forced to speak to a specific observation or technique, when the issue at hand concerned the philosophical problem of Saint-Hilaire’s transcendental plan of unity versus Cuvier’s branching phylogeny. That is, the question central to the debates concerned the similarities versus the dissimilarities of organic structure. Throughout the history of science, Goethe found arguments which spoke to something other than the question itself. He accused Descartes of making bromide statements, calling the symbols with which he described matter flat, and an insult to living nature and to the human mind. Descartes’ various levels of matter, his vortices, his screws, spirals, and his hacking and chopping were accepted with applause by the populace, which Goethe credited to the use of the \textit{argumentum ad captandum vulgus}, an argument designed to capture imagination of vulgar mass. We might turn now to some

\textsuperscript{19} Goethe: \textit{Die Schriften zur Naturwissenschaft}, (see note 3), vol. 8, p. 313.

\textsuperscript{20} The labels for these kinds of arguments were taken form a handout of classical arguments distributed in Professor J.W. Marchand’s Privatissimum on “The Logic of the Science vs. the logic of the humanities” given in the Spring, 1975.
arguments which Goethe used to defend his own work. If these seem to lean heavily toward persuasion, we might recall that Goethe did not have the presumptions of science in his favor; that is to say, Goethe was not a professional scientist and his work usually required the burden of proof. A case in point is the novelty of his *Metamorphosis of Plants*, presented at a time when Linnean classification was in the saddle. I might cite from Hill on the difficulty of establishing a counter-presumption:

He upon whom the burden of proof rests, and against whom the presumption lies, must overcome the presumption against him by throwing enough evidence into the opposite scale to raise a counter-presumption. The amount of evidence required will vary according as the presumption to be rebutted is weak or strong. The presumption in favor of an established institution may be rebutted by evidence tending to show that the institution in question is an obstacle to the successful working of some other established institution the superior value of which is admitted. (Hill, 332)

Goethe did, indeed, raise notions such as the ideal leaf to the level of counter-presumption, and he lived to enjoy a following in morphology some forty years later.

Goethe frequently used the *Argumentum ad sodalitatem*, for he felt himself an outsider and was prone to attribute negative reactions to his work as typical of a guild.

He wrote:

Mathematicians are amazing people; through their significant accomplishments they have set themselves up as a universal guild and want to recognize only that which adjusts to their frame of mind and instruments. A first rate mathematician said when he was brought an essay in physics, ‘But there is nothing here which can be reduced to calculations.’ (LA, 11, 370, Fern. Math)

Goethe’s color theory was written in ordinary language and he was acutely aware of the reaction of physicists (mathematicians) to his work, for it, also, could not be “reduced to calculations.” Using the same argument, he pointed out that his contributions to optics

---


22 *Goethe. Die Schriften zur Naturwissenschaft*, (see note 3 above), Vol. 11, p. 370.
had met with failure because of the narrowness of the scientific guilds, but he admitted that by that time he was old enough to know better and should not have expected differently. (LA, 6, 425) With regard to his *Metamorphoses of Plants*, Goethe argued to the scientific guild rather than to the issue of his transformation of organic structure versus Linnean classification:

In a reputable German city there was formed a society of scientific men, who together founded much good through theoretical and practical means. In this group my booklet was zealously read as a peculiar novelty. **No one** was satisfied with it and unanimously they asked what is this supposed to be. (LA, 9, 65/66, Meta. Der Pflanze)\(^{23}\)

He argued that it is simply in the nature of “Männer vom Fach” to be confused by a work which was science, rat, and poetry in one. With a somewhat broader stroke Goethe also employed the *argumentum ad scholasticos*, aiming at academicians who like to see service performed uniformly and with algorithm, and who felt more comfortable when people remained assigned to a certain discipline. Before leaving the misfortune which Goethe’s science met in scientific and academic circles, we might call attention to his use of the *argumentum ad misericordiam*. He felt his work had suffered because of its appearance in the aftermath of the French Revolution, which left scientists primed with political self-conceit and self-importance, unwilling to unite their efforts with his. Chemists and physicists were too devoted to their work on Gases and Galvanism to take an interest in his color theory, and the mathematicians, whom Goethe saw threatened by his position, continued to decry his color theory for twenty years. At one point Goethe even employed the *argumentum ad populum*, calling his work on color theory a

revolution in the face of mathematical aristocracy. Goethe seems to glory in his appeal to
pity in this discussion of the fate of his study of the intermaxillary bone:

But still another misfortune befell me; an extraordinary man, Johann Friedrich
Blumenbach, who has been very successful in science and has also recently begun
work in comparative anatomy, took the side of Camper and in his compendium
failed to grant Man an intermaxillary bone. My embarrassment was intensified by
the fact that my views were rejected by such a trustworthy individual and were
not entered in such a valuable text-book. (LA, 10, 391, Akademiestreit)\textsuperscript{24}

In writing his conflict with Newton and a century of Newtonian tradition, Goethe
used a variety of interesting arguments. Voltaire, as we all know, was one of the most
famous popularizers of Newtonian science, but Goethe met him with the \textit{argumentum ad
hominem}, arguing against Voltaire’s character rather than about Newton’s science.

Goethe commented that facts, experiments, theory, hypothesis, and mathematics were all
heaped topsy-turvy in Voltaire’s presentation, all very entertaining, of course, but what
one would certainly expect of Voltaire. For the advocates of Newtonian science, Goethe
used the \textit{argumentum ad praeiudium}, an appeal to the scientific community’s male
\textbf{chauvinism}, in this case with regard to the writings of the long-time secretary of the
French Academy, Fontenelle:

The popularizer is not concerned with the value, worth, completeness, or the truth
of his subject; the main question is if it is interesting, or can be made interesting.
Science itself cannot hope to gain anything through such treatment as we have
observed in the recent feminizing and infantizing of profound matters. (LA, 6,
310, GdF)\textsuperscript{25}

Goethe often sidetracked an issue by arguing to the man, and in some cases it seems that
Goethe must have felt there was no other alternative, that is, there were occasions when
the issue was not longer the subject matter, but rather the individuals involved. Goethe
commented, for example, that an individual would accidently happen upon a scientific

\textsuperscript{24} \textit{Ibid.} Vol. 10, p. 391.
\textsuperscript{25} \textit{Ibid}, Vol. 6, p. 310.
text, buy it, read and study it, and even recommend it to others; but if a friend should present this same individual with a personal copy of his own work, it would as often as not, generate indignation and jealousy; his experience on several occasions with his booklet on plant morphology. This response to the work of others, *ipse dixit*, Goethe had found in the writings of other authors, although in his case, it was located in scientific as well as polemically inspired writings.

Argument based on authority is not uncommon in Goethe’s conflict with the Newtonian paradigm. In his work on colors we frequently see him standing “On The Shoulders Of Giants,” the foremost of these being Theophrast and Boyle, who like Goethe, were interested in collecting and classifying as many phenomena of color as possible. Of great importance to Goethe was the work of Rizzetti, an Italian who earlier in the 18th century had introduced the concept of “turbid medium” to color science, a concept which later became the cornerstone phenomenon of Goethe’s color theory.

Using the general framework of Goethe’s confrontation with the Newtonian paradigm, we might look at a few final arguments which he used in the heart of the conflict. Scholarship has often enough pointed out Goethe’s appreciation of pure mathematics on one hand, and his objections to the misuse of mathematics on the other. The symmetrical transformation of plant organs along an axis, as well as his ordering of physiological color phenomena in three pairs of juxtaposition, are examples of the form relations which Goethe found in nature. It was not mathematics but the mathematical guild against whom Goethe directed his subtle devices of argumentation. Mathematicians, he felt, were bent upon reducing the entire universe to quantitative analysis, appropriate perhaps for surface features, but ignorant of the inner processes of
organic life. It was the application of formal notation to immeasurables or imponderables which brought Goethe to employ, for example, the \textit{argumentum ad religionem}:

\begin{quote}
Everything appears rational, understandable, and mechanical to the mathematician and he becomes suspect of the mysterious atheism, in that he also believes himself capable of comprehending the immeasurable which we call God. (LA, 11, 367, Ferneres über Math)\textsuperscript{26}
\end{quote}

Goethe generally confronted the quantifying of nature with a \textit{cui bono}, that is, what good is it when light can only be understood in terms of the 11 conditions which it must meet before it is investigated. For Goethe, the Fruaenhofer line in the spectrum were yet another set of complicated and artificial conditions to which light was subjected and which removed man ever farther from the perception of nature as encountered in day to day experiences.

Goethe’s science is the attempt to seek the most common denominator between natural phenomenon, human perception, and ordinary language, and in this few have surpassed him. Goethe’s efforts to combat the growing gulf between man and Nature were much like his continued effort to communicate with the scientific community, despite the latter’s rejection of his work. His understanding of the human equation in science is remarkable and we might conclude with his use of the \textit{tu quoque}, a “thou too” retort in which he stated that the scientist could arrive at no greater truth than the humanist:

\begin{quote}
The historian can not and need not guide everything to certainty: Was it not the mathematicians who were unable to explain whey the comet of 1770, which was to return in 5 or 11 years, still has not been seen? (LA, 11, 369/70, Fernes über Mathe)\textsuperscript{27}
\end{quote}

\textsuperscript{26} \textit{Ibid}, Vol. 11, p. 367.
\textsuperscript{27} \textit{Ibid}, Vol. 11, p. 369/70