

Evolving Morphology: 200 years of Goethe's *Zur Morphologie*.

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Abstract:

In the context of evolutionary developmental biology and phylogenetic research, where development and generative processes of organismal form are taken on board, the Goethean motto: Form as Formation (Bildung) and Transformation (Umbildung) provides morphology with a new meaning. The seminal research program that Goethe conceived under the rubric of Morphology does not include development; rather it is the science of development itself. It has become a keyword among contemporary biologists proclaiming its *renaissance* in our understanding of evolution. Consequently, it is also not surprising that Goethe has been cited by many plant developmental geneticists, due to a number of findings that could possibly, by way of molecular models and experimental tests, corroborate the foreseen ideas in his essay *An attempt to explain the metamorphosis of plants* published in 1790.

Moreover, the goethean concept of Bildung carries in its core an educational aspect, which invites the morphologist to engage, develop and evolve her/his cognitive capacities in a peculiar kind of process one could call Participation. Goethe himself proposed in one of his Maxims and Reflections, a *Delicate Empiricism* connecting with the conceptual content of a phenomenon. Thus, morphology is a participative science, in so far as it provides the possibility of recognizing the intrinsic correlation between mind and form. Therefore it is simultaneously a Morphology of Human Knowledge.

Beside celebrating the 200 years of the publication of Goethe's morphological notebooks; *Zur Naturwissenschaft überhaupt, besonders zur Morphologie* (On Natural Science in general, Morphology in particular), the aim of the paper is firstly to trace back Goethe's inceptions of the original dynamic way of seeing by revisiting the conceptual and empirical foundations of his morphology; secondly to prospect for its place and role in contemporary research and education in biology, and finally to point out its ethical implications in questions of environmental and ecological public awareness.

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Goethe and the morphological research back into context: an introduction.

One of the motivations to present this paper is to introduce the concept of the Evolving Morphology Conference to be held on the 4th-8th of October 2017 in Dornach, Switzerland. Moreover, in order to encourage the dialogue between biology on the one hand and humanities on the other side, there are three central aims of the Conference, which could promote such a dialogue.

The first aim of the conference is to offer a global platform for biologists, historians and philosophers of biology and Goethean scholars with a common interest in Morphology, seeking to contribute towards a reassessment of theories of organic form - since its foundation in 1817 with the publications of Goethe's *Zur Morphologie*³. Secondly, besides celebrating the 200 years anniversary of Goethe's morphological notebooks, we want to prospect the role of morphology in contemporary research areas like phylogenetic systematics and evolutionary developmental biology. The third aim is to address the potential of using the history, sociology and philosophy of biology in the teaching of biology. For example, biology high school teachers and university professors could use the historical episodes and the cultural context around the origination of problems regarding biological form in the 19th century in order to elaborate the lessons of subjects in which morphology has an explicit or implicit fundamental relevance such as botany, zoology, evolutionary biology and ecology.

As Michael Matthews suggests;

“The history of science, through the examination of the life and epoche of individual researchers, allows to humanize the scientific discipline, transforming it into something less abstract and more interesting to the students. It also favors conexions to be done within certain topics of the same scientific subject, as well as among different disciplines. Moreover, the historical, sociological and philosophical approaches promote a better understanding of scientific concepts, methods and the nature of science“ (Matthews 1994, p.5).

Hence we are motivated in organizing this conference, and in particular, in proposing a reappraisal of Goethes conception of morphology for the following reasons:

First, morphology has been interpreted in either a narrow or a broad sense (e.g. Sattler 1978). In the narrow sense, morphology refers only to external form or organography (see for example, Bell, 1991). In the broad sense, it comprises structure at all organizational levels, i.e the structure of whole organisms, organs, tissues, cell, organelles, molecules and domains. Thus Morphology *sensu lato* includes anatomy and even structural biochemistry. However, regardless if morphology is defined narrowly or broadly, *it deals primarily with the change of form during time*, during ontogeny and phylogeny. Morphology *sensu stricto* does not comprise morphogenesis

3 Compare Jahn (2000), Nyhart (1995), Kuhn (1962) and Hansen (1919) for some distinct views on the origin and history of morphology as a scientific discipline.

(the development of form), but rather it is, in its core and origin, the study of morphogenesis itself. Goethe had already explicitly made this point at the inceptions of Morphology by giving the title *Bildung und Umbildung organischer Naturen* for the opening of the first volume of his *Zur Morphologie* published in July of 1817. A couple of months later Burdach stressed and developed further that Goethean motto in his *Über die Aufgabe der Morphologie*.

Therefore, should morphologists and morphology *sensu stricto* be reconsidered at center stage in the synthesis of evolution, development, and relationships of form-function during ontogeny and phylogeny? For example, D. Wake (1982) proclaimed the “renaissance” of morphology in modern biology; M. Wake (1992) examined the field of “evolutionary morphology” and recognized five then-current subareas of analysis (functional morphology, biomechanics, ecomorphology, developmental morphology, systematics and phylogenetics of morphology) and predicted a sixth (integrative evolutionary morphology). Minelli and Schram (1994) and Koehl (1996) appraised morphology in various contexts; Sattler and Rutishauser (1997) and Endress et al. (2000) demonstrated that morphology understood as a “process morphology” have fundamental relevance to plant research. Kaplan (2001) offered a review of the concepts and definitions in the history of plant morphology and their roles in modern plant evolutionary biology; Stuessy et al. (2003) proposed a “deep morphology” as a renaissance of the morphological method in the plant systematics; Davidson and Ebach (2008), in their *Foundations of Systematics and Biogeography*, traced important morphological concepts in homology and classification from the 19th century to the present through the provision of a unique anthology of scientific writings from Goethe, Agassiz, Geoffroy St. Hilaire, Owen, Naef, Zangerl and Nelson, among others. Ronse De Craene and Wanntorp (2011) argued in favor of re-establishing morphology as center stage in contemporary botanical research and against the lack of support and interest for the formation and education of professional morphologists in the careers of biology and related areas dominated by molecular approaches. Riegner (2013) described a “new ancestor of an archetypal biology” by re-thinking the dynamic way of seeing in Goethe’s morphology and its compatibility with the conceptual framework of Evo-Devo, and also Wanninger (2015) in a similar gesture proposed a “Morpho-Evo-Devo” approach to molecular Evo-Devo and phylogenomics.

It will be a loss for the evolution of biology if morphology is to be understood only in an extremely narrow and static sense according to which it would refer only to mature form, i.e. *structure* (Gestalt), we would like to invite renowned morphologists from international recognized universities and research institutes to contribute and emphasize that dynamic aspect of form and structure which is of special concern for researchers working in the areas of history and philosophy of morphology, plant and animal morphology, evolutionary developmental biology and phylogenetic systematics.

The study and teaching of the history and philosophy of morphological thought creates also a possibility for striving to make scientific thinking better known and understood by the public at large. In this context, there are still some important aspects of the nature of morphology as a scientific discipline to be brought during the Evolving Morphology Conference 2017.

The Goethean morphological concept of *Bildung* carries in its core an educational aspect, which invites the morphologist to engage her/his cognitive capacities in an intentional process that Goethe called *exact sensorial imagination*. Goethe described its meaning in the following words:

“If I look at the created object, inquire into its creation, and follow this process back as far as I can, I will find a series of steps. Since these are not actually seen together before me, I must visualize them in my memory so that they form a certain ideal whole. At first I will tend to think in terms of steps, but nature leaves no gaps, and thus, in the end, I will have to see this progression of uninterrupted activity as a whole. I can do so by dissolving the particular without destroying the impression” (Goethe, 1795, in Miller 1995, p. 75).

So to begin to grasp the flow of life and its specific qualities in a plant or an animal, we have to work to make our thinking fluid (process-oriented) and dynamic (Holdrege 2005, 2013).

This is an exercise that involves a different philosophical attitude towards biodiversity and its practice brings forth an aesthetic appraisal (Steigerwald 2002). In this way, we find morphology having its place of birth exactly at the confluence of art and science, a necessary dialogue which can provide a heightened methodological awareness in biological research, and also epistemological alternatives concerning environmental educational issues.

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