On the Origins and Renaissance of Goethe's Morphology

João Felipe Ginefra Toni

Summary

The science of morphology proposed by Goethe was initially conceived as both an autonomous and auxiliary discipline within the still emerging field of biology of his time. By tracing morphology back to its origins, some historical aspects of its agenda and development are presented in order to reassess potential contributions of Goethe's morphological approach to contemporary botany. Additionally, I will argue, based on recent studies in floral evolutionary developmental biology (Evo-Devo), that Goethe's morphology is not only at the inception of such research, but also if rightly comprehended, it can be both descriptive and explanatory, since it provides a more process-oriented thinking with its unique notion of form and causality.

Zusammenfassung

Der von Goethe begründete Wissenschaftszweig «Morphologie» wurde ursprünglich in der sich neu entfaltenden Biologie sowohl als autonome als auch als Hilfsdisziplin aufgefasst. Einige historische Aspekte der Morphologie, ihre urprüngliche Agenda und ihre Entwicklung, werden vorgestellt, um potentielle Beiträge von Goethes morphologischem Ansatz für die moderne Botanik abzuschätzen. Ausserdem werde ich – gestützt auf neue Arbeiten aus der evolutionären Entwicklungsbiologie der Blüte – die Ansicht vertreten, dass Goethes Morphologie nicht nur am Anfang dieser Disziplin steht, sondern – wenn sie richtig aufgefasst wird – sowohl deskriptiven als auch erklärenden Wert hat. Mit ihrem besonderen Begriff von Form und Kausalität führt sie zu einem stark prozessorientierten Denken.

Keywords: history of botany, floral morphology, Goethe, process ontology, Morpho-Evo-Devo.

> *"Geschichte der Wissenschaften: der reale Teil sind die Phänomene, der ideale die Ansichten der Phänomene."*
>
> (*Goethe* 1833)

1. Introduction

Since *Albert Wigand's* seminal "Kritik und Geschichte von der Lehre der Metamorphose der Pflanzen" (1846), Goethe's morphological work and its scientific contributions as a whole have been subject of reappraisal by several historians of biology (*Hansen* 1919, *Schmid* 1935, *Arber* 1946, 1950,

Kuhn 1962, *Leonir* 1982, *Jahn* 2000, *Richards* 2002, *Levit et al.* 2015) and Goethean biologists (*Portmann* 1956, *Kranich* 1989, *Suchantke* 2002, *Wirz* 2008, *Holdrege* 2014, *Ginefra Toni & Richter* 2017). However, even though Goethe's morphology has received a considerable amount of attention by Goethean scholars, its conceptual foundations still remain poorly read in modern biology.

In the context of evolutionary developmental biology and phylogenetic research, where development and generative processes of organismal form are taken into account, the Goethean motto: "Form as Formation (*Bildung*) and Transformation (*Umbildung*)" provides morphology with a new meaning. In these terms, morphology has become a keyword among some contemporary biologists and philosophers of biology proclaiming its renaissance in our understanding of evolution (*Müller & Newman* 2003, *Richter & Wilkner* 2014, *Niklas & Kutschera* 2016, *Abzhanov* 2017, *Ledford* 2018, *Minelli* 2018). Moreover, Goethe has been cited by plant developmental geneticists, due to a number of findings that corroborate some of the ideas foreseen in his essay *An attempt to explain the metamorphosis of plants* published in 1790 (*Meyerowitz et al.* 1989, *Coen & Carpenter* 1993, *Bowman* 1994, *Coen* 2001). These findings are those of the ABC Model of flower development. The model explains the control mechanism of identity of floral organs. Some of the authors were surprised that such a model conformed with Goethe's concept of regular (normal) and irregular (abnormal) metamorphosis and his hypothesis that flower organs are transformed leaves (foliar theory). Goethe proposed these ideas more than 200 years ago, and of course, without any kind of molecular tool from plant developmental genetics. In their experiments, plant geneticists found that a triple mutant of *Arabidopsis thaliana* produced flowers bearing only vegetative leaves.[1] This would be an example of abnormal or irregular metamorphosis. Nowadays this type of metamorphosis is associated with the modern concept of homeosis[2], a term introduced by *Bateson* in 1894.

1 Actually Goethe did not mean that a petal, is homologous to a leaf, in a historical sense, but rather in a dynamic-typological one. Leaf and petal are related in the same way that leaves can be also related to shoots (partial shoot theory). *Classen-Bockoff* (2016) pointed out that the ABC model perhaps does not support Goethe's interpretation of the flower. As she wrote: "one should question how far the triple mutant in *Arabidopsis thaliana* indeed confirms the shoot concept of the flower. Does the loss of ABCDE function only affect the development of the lateral appendages or does it rather induce a reversal of the whole flower meristem into a vegetative stage?"

2 Homeosis: the total or partial replacement of one part by another of the same organism.