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The Darwinian revolution in Germany: from evolutionary morphology to the modern synthesis

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The Darwinian revolution in the German speaking lands was the result of a variety of influences and disciplinary convergences. One of the paths led from pre-Darwinian comparative morphology via Darwinian and Lamarckian evolutionary morphology to the Modern Synthesis. Our research demonstrates that there was no immediate replacement of one paradigm by another as described in the classical work of Thomas Kuhn. Rather, the development of novel conceptual structures looked like a Russian 'matryoshka doll' consisting of an over-arching 'meta-paradigm' embracing conceptual structures of ever smaller scale. Such a meta-paradigm for German life sciences was initially established by Johann Wolfgang von Goethe, which determined the specificity of German evolutionism throughout the 2nd half of the 19th and well into the 20th century.

Introduction

In the early 1960s Thomas Kuhn[1] contributed to the 'crisis of rationality'[2] with his hypothesis that science develops by means of paradigmatic shifts. He challenged the positivist concept of cumulative and continuous scientific progress. According to Kuhn, the relation between two succeeding scientific traditions 'separated by a scientific revolution' is characterized by the concept of incommensurability that constrains the interpretation of science as a cumulative, staidly progressing enterprise.[3] The most fundamental aspect of incommensurability is that 'the proponents of competing paradigms practice their trades in different worlds'.[4]

Peter Galison[5] opposed both positivists and anti-positivists, introducing the term 'trading zone' to demonstrate the way science and innovation correlate. As nicely summarized by Collins et al. (2007): 'His purpose was to resolve the problem of incommensurability between Kuhnian paradigms: How do scientists communicate if paradigms are incommensurable? Galison's approach has two legs. The first leg denies that scientific paradigms are as monolithic as Kuhn says. The second leg uses the metaphor of the trading zone to explain how communication is managed where there is a degree of incommensurability'.[6] Galison, first of all, studied the relationships between theoretical science and experimental work and came to the conclusion that the laboratory is a place where 'the local coordination between beliefs and action takes place'.[7] In other words, Galison described the interaction between the level of theory and 'lower' experimental and even instrumentals levels.

By contrast, we are interested in the relationships between theoretical and metatheoretical levels. We will argue that the Darwinian theory (theories) interacted with national research traditions (metatheoretical level) and the resulting conceptual body represented an amalgamation of a metatheoretical framework with the 'purely scientific' theoretical beliefs such as the theory of natural selection. We will demonstrate this using the example of the German research tradition in evolutionary biology.

There are two important assumptions underlying our considerations. First, we do not support the idea that the Darwinian revolution is a homegrown phenomenon to be analyzed exclusively in terms of British intellectual history. The very fact of the rapid spread of Darwinism

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[1] Kuhn T. The Structure of Scientific Revolutions. Chicago: The University of Chicago Press, 1996.
[2] Hacking I. Representing and Intervening. Cambridge: Cambridge University Press, 1983, p. 1.
[3] Hoyningen-Huene P. Three Biographies: Kuhn, Feyerabend and Incommensurability. In: Harris RA (ed.) Rhetoric and Incommensurability. West Lafayette, Indiana: Parlor Press, 2005, p. 152.
[4] Kuhn T. The Structure of Scientific Revolutions. Chicago: The University of Chicago Press, 1996, p. 150.

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[5] E.g.: Galison, P. *Image and Logic: A Material Culture of Microphysics*. Chicago: Chicago University Press, 1997; Galison, P. In: Biagioli M. (ed.) Trading Zone: Coordinating Action and Belief. The Science Studies Reader. New York: Routledge, 1999, pp. 137–160.
[6] Collins H., Evans R., Gorman R. Trading zones and interactional expertise. *Studies in History and Philosophy of Science, Special Issue – Case Studies of Expertise and Experience*, Vol. 38, No. 4, pp. 657–66, 2007.
[7] Galison, P. In: Biagioli M. (ed.) Trading Zone: Coordinating Action and Belief. The Science Studies Reader. New York: Routledge, 1999, pp. 137–160.

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in such different cultural-political landscapes as the German lands[8] and the Russian Empire[9] demonstrates that the continental intellectual culture was ready to accept fundamental changes in the life sciences. The concept of the Darwinian Revolution as an intercultural and international movement can be approached from various perspectives. Robert Richards[10] famously argued that German romanticism shaped Darwin's worldview to a very significant extent. Richards concentrated on how continental influences guided the theoretical evolution of the Englishman's ideas. Our perspective differs from that of Richards. We claim that German romantic biology strongly influenced the paths of Darwinian revolution in the German lands. The impact was so strong that it can be traced right into the time of the Modern Synthesis. Our perspective is supplementary to Richard's conclusions. Both approaches suggest that 'the Darwinian Revolution' goes far beyond Down, and that intercultural influences are parts of the same narrative and are obligatory for an understanding of the growth of Darwinism both inside the English-speaking world and outside of it. Second, we propose that meta-paradigms can exist in various national intellectual traditions. These meta-paradigms remain invisible when we constrain our analysis to one tradition (e.g., British), but become visible in the light of a comparative analysis.

We will demonstrate that the change of the world-view, which took place during the Darwinian revolution in Germany, corresponded rather to a cumulative model than to Kuhn's incommensurability model. However, this is not a positivist cumulative model. Crucial architects of German Darwinian evolutionism built on pre-revolutionary developments not only in terms of empirical data and conceptual details, but most importantly in terms of consequent development of coherent fundamental methodological and ontological assumptions. In other words, many of the pre- and post-Darwinians shared a common worldview, which served as a basis for the evolution of their research programmes (a meta-paradigm). Second, we will show that this worldview, initially outlined by Goethe, persisted until the completion of the Modern Synthesis and beyond in the German-speaking countries. Third, we will argue that crucial figures of the First and Second Darwinian revolutions in Germany (Ernst Haeckel, Victor Franz, Bernhard Rensch) saw themselves as bearers of the Goethean tradition in biology. Since German evolutionism initially developed mostly within the field of morphology, we will concentrate on the growth of evolutionary morphology, before moving on to the Modern Synthesis in the German-speaking lands.

Goethe's morphological revolution

The explosive growth of Darwinian thought in Germany after the publication of the *Origin of Species*[11] and its German translation[12] was enabled by pre-Darwinian developments. Arguably the most important of these was the growth of pre-Darwinian morphology and allied fields such as embryology. Johann Wolfgang von Goethe played a paradigmatic role for the science of biological form. In fact, the very term 'morphology' was first employed in 1796 by Goethe to denote a sub-discipline of the science of living beings, although Goethe was not the first to bring the term to print.[13] Goethe defined morphology as a science of morphing: metamorphosis (*Verwandlungslehre*). As a 'low Church', his morphology was a comparative science studying differences and similarities between various organic structures. Yet morphology as a 'high Church' had as its subject a moving, emergent and disappearing Gestalt: 'The doctrine of Metamorphosis is the clue to all signs of Nature [*Zeichen der Natur*]'.[14] For Goethe, morphology was a fundamental enquiry into the most essential features of life and ultimately of the universe. The 'high Church' methodological principles guided empirical research and principles of the 'low Church'.

Considering that distinction, one can outline several fundamental methodological principles which guided Goethe's morphology.

The first such principle is the idea of the type (archetype). The search for a vertebrate type resulted, for example, in the discovery of the intermaxillary bone in man.[15] Goethe's intention was to compare various vertebrate 'osteological' structures to search for the general vertebrate archetype: 'Goethe tried to reach a clear idea of the vertebrate archetype not only from wide induction but also from a study of function. A bone which is not only present in most vertebrates but also obviously serves a very important function is likely-for both these reasons-to belong to the archetype'.[16] The 'archetype' ('*Der Typus*', the term usually translated as 'archetype') was for Goethe a 'main thread' running through the labyrinth of Gestalts, a general scheme to be found as a result of empirical generalisations. In the works of 1790s devoted to the structure of animals, Goethe put forward the idea of the archetype as a pattern to be used in comparative morphology, but most importantly he saw the archetype as 'a dynamic force actually resident in nature',[17] as a potentiality: '...an anatomical archetype will be suggested here, a general picture containing the forms of all animals as potential, one of which will guide us to an orderly description of each animal. [...] The mere idea of an archetype in general implies that no particular animal can be used as our point

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[11] Darwin Ch. On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. 1st Ed. London: John Murray, 1859.

[12] Darwin Ch. Über die Entstehung der Arten im Thier- und Pflanzen-Reich durch natürliche Züchtung, oder Erhaltung der vervollkommneten Rassen im Kampfe um's Daseyn. Trans. Heinrich Bronn. Stuttgart: E. Schweizerbart, 1960; Gliboff S. The Case of Paul Kammerer: Evolution and Experimentation in the Early Twentieth Century," *Journal of the History of Biology* 39: 525–563, 2006.

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[15] Goethe J.W. Scientific Studies. Ed. by D. Miller. N.Y.: Suhrkamp, 1988, pp. 111–116.

[16] Wells G.A. Goethe and the Intermaxillary Bone. *The British Journal for the History of Science*, 3(4): 348–361, 1967.

[17] Richards R.J. The Romantic Conception of Life: Science and Philosophy in the Age of Goethe. Chicago & London: The University of Chicago Press, 2002, p. 440.