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The Wolffian Roots of Kant's Teleology

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Abstract

Kant's teleology as presented in the *Critique of Judgment* is commonly interpreted in relation to the late eighteenth-century biological research of Johann Friedrich Blumenbach. In the present paper, I show that this interpretative perspective is incomplete. Understanding Kant's views on teleology and biology requires a consideration of the teleological and biological views of Christian Wolff and his rationalist successors. By reconstructing the Wolffian roots of Kant's teleology, I identify several little known sources of Kant's views on biology. I argue that one of Kant's main contributions to eighteenth-century debates on biology consisted in demarcating biology from metaphysics. Kant rejected Wolffian views on the hierarchy of sciences, according to which propositions specifying the functions of organisms are derived from theological truths. In addition, Kant argued that organic self-organization necessitates a teleological description in order to show that self-organization does not support materialism. By demarcating biology and metaphysics, Kant made a small yet important contribution to establishing biology as a science.

Keywords

Christian Wolff, Wolffianism, Immanuel Kant, Teleology, Biology, Metaphysics

1. Introduction

In the 1980s, Timothy Lenoir argued that Kant provided the theoretical foundations of biological research conducted within the 'Göttingen School' founded by Johann Friedrich Blumenbach (Lenoir, 1980, 1981, 1989). Kant took biological explanations to be mechanical explanations, and assigned teleology a *heuristic* or *regulative* function in biology: although we cannot affirm or deny the reality of purposiveness in nature, we necessarily *conceptualize* organic nature in teleological terms. This view, as Lenoir and

others have claimed, was fundamental to the emergence of biology as a special science (Zumbach, 1984).

Lenoir's thesis has recently been rejected. Robert Richards and John Zammito have argued that Blumenbach and his followers affirmed the objective reality of natural purposiveness and therefore did not observe Kant's regulative interpretation of teleology (Richards, 2000, 2002; Zammito, 2006, 2009, 2012). According to Richards and Zammito, Kant's influence on the historical development of biology has been misunderstood both by Kant's contemporaries and by modern interpreters. If Kant's regulative teleology was hardly adopted by eighteenth-century biologists and philosophers, we are faced with the following question: why did Kant adopt his regulative interpretation of teleology?

Lenoir, his followers, and his critics have all interpreted Kant's teleology in relation to developments in late eighteenth-century biology. In the present paper, I show that this interpretative perspective is incomplete: it provides an incomplete understanding of the historical and philosophical context in which Kant articulated his ideas on teleology and biology. As such, it cannot fully explain why Kant adopted a regulative conception of teleology.

Understanding Kant's position requires, I shall argue, that one take into account the little known teleological and biological views of Christian Wolff and his rationalist successors. By thus considering together Kantian and Wolffian teleology, we can obtain a balanced account of the importance of Kant's teleology in eighteenth-century thought. Kant's main contribution, as shall become apparent, consisted in *demarcating* biology from various forms of metaphysics. His regulative conception of teleology was a means to demarcate biology from both theology and materialism. By demarcating biology from these metaphysical doctrines, Kant provided a small yet important contribution to establishing biology as a science.

I will show that Kant's teleology can be profitably interpreted as a critique of Wolffian teleology. Wolff adopted a view on the hierarchy of sciences according to which scientific propositions attributing purposes to organisms are demonstrated on the basis of propositions pertaining to the science of natural or rational *theology*. For Wolff, purposes can be attributed to nature only if one presupposes theological truths. I show that Kant's regulative conception of teleology implied a rejection of this view, and so must be interpreted as an effort to *demarcate* theology and biology. I further show how, in the middle of the eighteenth century, rationalist philosophers failed to integrate scientific theories of (organic) self-organization within their theistic framework. They criticized and rejected these theories because of their supposedly materialist implications. Kant, however, aimed to *harmonize* traditional teleology with eighteenth-century biology. Taking self-organization to be a fundamental biological concept, he argued that self-organization necessitates a teleological description. In this way, he sought to demarcate biology from *materialism*.

The present study examines a number of little known sources. Although Wolff coined the term 'teleology' and was the first to view

teleology as a special science (McLaughlin, 2001, p. 16), his views on teleology and the life sciences have been little investigated.[1] This is unfortunate, since, as I will show, Wolff's views on teleology and its place in the hierarchy of sciences were highly influential in the eighteenth century. One can often not understand eighteenth-century philosophical debates on teleology without taking into account Wolff's philosophy. I will argue that Kant rejected Wolffian views on the scientific status of teleology and on the place of teleology in the hierarchy of sciences. I do not wish to argue, of course, that Wolff was solely responsible for Kant's teleological agenda. Moreover, Kant's knowledge of Wolff was very likely mediated by the works of various rationalist philosophers who adopted (aspects of) Wollf's thought.[2] However, the Wolffian conception of teleology, which was textbook knowledge in Kant's time, was very important for Kant and should not be overlooked.

The reception of biological theories by mid-eighteenth-century rationalists, such as Reimarus and Crusius, is also little known. These sources are also of crucial importance, I argue, for understanding Kant's philosophy of biology. The study of these sources shows that developments within eighteenth-century biology posed considerable difficulties for rationalist and theistic philosophers. In general, we can say that, at least for the authors I will consider, eighteenth-century biological theories gave rise to vehement metaphysical debates between materialists and theists. These debates provide the historical background to Kant's own thinking about teleology and allow us to appreciate that it was a significant contribution of Kant's to demarcate biology from metaphysics.

The paper is structured as follows. In section 2, I treat Wolff's views on the science of teleology and teleological explanation. Section 3 offers an analysis of Wolff's so-called *German Physiology*, in which I show how, according to Wolff, theology grounds physiology. In section 4, I discuss the reception of eighteenth-century biological theories by German rationalists such as Reimarus and Crusius. It is shown how the latter authors struggled with theories of spontaneous generation, organic regeneration, and generation. Section 5 considers how Kant, in the Analytic of the Critique of Teleological Judgment, distinguishes teleology from theology. I show that Kant rejects the Wolffian conception of the place of teleology in the hierarchy of sciences. The Wolffian background elucidates what Kant means when he denies that teleological concepts can function as objective (a priori) concepts of determining judgment. It further explains, in part, why Kant adopted a regulative conception of teleology. Finally, section 6 examines Kant's account of why phenomena of organic self-organization

[1] A nice account of Wolff's teleology is given by Euler (2008). Yet Euler does not treat Wolff's physiology in detail. Wolff's physiology is central to the present paper. For a comparison between Leibniz's and Wolff's views on teleology, see Engfer (1983). The importance of Wolff's logic for Kant is stressed by Longuenesse (1998) and Anderson (2005). On Wolff's influence of Kant's philosophy of mind, see Dyck (2011). On Christian Wolff's influence on the embryology of Caspar Friedrich Wolff, see Roe (1981). Wolff's and Kant's views on mechanical explanation are discussed in van den Berg (2013).

[2] I identify several of these sources in the course of this paper.

necessitate a teleological construal of organisms. I show how Kant combines traditional Wolffian views on teleology with advancements in eighteenth-century biology.

2. Wolff's teleology

In the present section, I analyze Wolff's conception of teleology. Since Wolff is a relatively unknown figure, I first present some biographical information. I then discuss Wolff's views on scientific method and the hierarchy of sciences. This will enable us, finally, to determine his views on the science called teleology.

Christian Wolff was born in Breslau on January 24, 1679, the son of a tanner. He attended a Lutheran *Gymnasium*, where he studied the writings of scholastic philosophers such as Aquinas and Suarez. In 1699, he enrolled in the University of Jena to study theology. He switched to mathematics, became acquainted with the physicist and mathematician von Tschirnhaus, and received his master's degree from Leipzig in 1702. In 1703, he wrote a work on the application of mathematics to practical philosophy, which attracted the attention of Leibniz. With the help of Leibniz, Wolff became professor of mathematics and natural science in Halle in 1706 (Beck 1969, pp. 256-261; Drechsler 1997).

Wolff lectured and wrote on mathematics, logic, natural science, philosophy, law, theology and many other subjects. Many of his (German) works became popular textbooks and were used in various gymnasia and universities (Heilbron 1979, pp. 43-44).[3] In 1723, as rector of the University of Halle, Wolff delivered an address on the practical philosophy of the Chinese in which he argued that moral truths could be discovered independently of revelation. This offended the pietistic theologians at Halle. After much academic and political intrigue, Wolff was exiled from Prussia by King Friedrich Wilhelm I on November 8, 1723 (Beck 1969, 258-259). Wolff's exile increased his international fame. He became professor of mathematics and physics and professor of philosophy at the University of Marburg. In Marburg (1723-1740), he wrote numerous Latin works in which he presented his philosophy. In 1740, he was recalled to Halle by Frederick II. He became Professor of public Law and of mathematics, privy councilor of Prussia and, in 1745, Imperial Baron of the Holy Roman Empire. He died on 9 April 1754 (Drechsler 1997, pp. 116-121).

Wolff was an eighteenth-century academic superstar. He was a member of the academies of Berlin, St. Petersburg, Paris and of the Royal Society in London (Beck 1969, p. 258). Numerous books appeared that discussed Wolff's philosophy and (the history of) the so-called 'Wolffian school' (see, e.g., Ludovici 1977 [1737-1738]; Hartmann 1973 [1737]). These books often discuss similar topics and illustrate the position Wollfian philosophy enjoyed in the middle of the eighteenth century. I will provide one example that highlights the nature and content of these works.

[3] Kant himself used Wolff's works to lecture on mathematics (Naragon 2006).

Johann Heinrich Zedler's *Universal-Lexicon aller Wissenschaften und Künste* contains a 128 page long article on Christian Wolff (Zedler 1748) and a 349 page long article on Wollfian philosophy (Ludovici 1748).[4] The first article provides biographical information of Wolff, it attempts to list and summarize all of Wolff's writings (the article lists 138 publications), and it lists 284 books that Wolff reviewed for the *Acta eruditorum*. The article on Wolffian philosophy further discusses Wolff's views on scientific method, his style of writing and oral presentation, academic freedom, how one should read and study Wolff, Wolff's views on the hierarchy of sciences, his main doctrines, and various other topics. In addition, the article attempts to list *every* work somehow related to Wolff's philosophy (several hundred works are mentioned).

These articles show that in the eighteenth century Wolff's philosophy was often treated in a textbook fashion. Wolff's views on scientific method and the hierarchy of sciences were taken to be essential features of his philosophy. Since these two topics are important for understanding Wolff's conception of teleology, I will discuss them in the following.

Wolff believed that every science should follow a strict mathematical or axiomatic method (Wolff 1963 [1728], pp. 59-78). According to this so-called Wollfian *Lehrart* (Ludovici 1748, pp. 884-887), every (non-fundamental) term of a science should be accurately defined, every (non-fundamental) proposition should by syllogistically deduced from certain principles, and scientific demonstrations should proceed from premises (grounds) that explain why something is the case. This method was called a 'dogmatic method' by Kant, and he praised Wolff as having explicated "the way in which the secure course of a science is to be taken", i.e, through "the clear determination of concepts, the attempt at strictness in the proofs, and the prevention of audacious leaps in inference" (Kant 1998, p. xxxvii).[5]

Wollf's axiomatic method tells us that every individual science must be hierarchically ordered. He also provided a clear account of the hierarchical order that exists between *different* sciences. Wolff's views on the hierarchy of sciences were often visualized as follows:

[4] Here, the term 'philosophy' must be interpreted broadly. For eighteenth-century authors, 'Wolffian philosophy' comprises every topic he wrote about, i.e., everything.

[5] When referring to (translations) of Kant's works, I always refer to the pagination of the Akademie-Ausgabe.

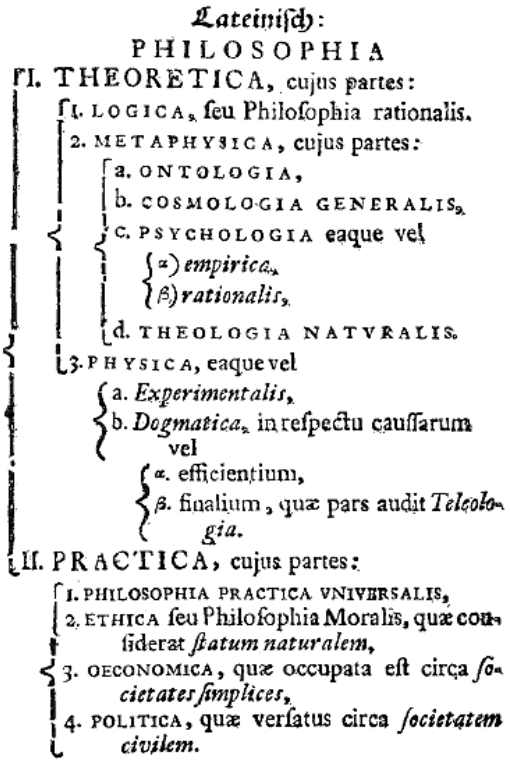
Lateiniſch:
PHILOSOPHIA
I. THEORETICA, cujus partes:
1. LOGICA, ſeu Philoſophia rationalis.
2. METAPHYSICA, cujus partes:
a. ONTOLOGIA,
b. COSMOLOGIA GENERALIS,
c. PSYCHOLOGIA eaque vel
α) empirica,
β) rationalis,
d. THEOLOGIA NATVRALIS.
3. PHYSICA, eaque vel
a. Experimentalis,
b. Dogmatica, in reſpectu cauſſarum vel
α. efficientium,
β. finalium, quæ pars audit Teleologia.
II. PRACTICA, cujus partes:
1. PHILOSOPHIA PRACTICA VNIVERSALIS,
2. ETHICA ſeu Philoſophia Moralis, quæ conſiderat ſtatum naturalem,
3. OECONOMICA, quæ occupata eſt circa ſocietates ſimplices,
4. POLITICA, quæ verſatus circa ſocietatem civilem.

Figure 1. Excerpt from Ludovici 1977 [1738], p.122.

This figure provides a simplified yet accurate account of the Wolffian hierarchy of sciences. Some sciences, such as ontology, are placed above other sciences, such as physics.[6] According to Wolff, higher sciences *precede* lower sciences, i.e., these higher sciences deal with concepts and propositions that are presupposed by lower sciences (Wolff 1963 [1728], pp. 33-58). For example, ontology deals with general concepts such as essence, space, and time. It provides definitions of these concepts and principles that are used in demonstrations given in lower sciences, such as physics. Below I provide examples of demonstrations in teleology and physiology which are based on propositions taken from higher sciences.

What is the place of teleology in the hierarchy of sciences? Wolff distinguishes three parts of physics: (i) experimental physics, (ii) dogmatic physics, and (iii) a part of physics that studies *final causes*. In experimental physics, we adopt the analytic method and attempt to establish principles of physics on the basis of experiment. In dogmatic physics, we proceed (synthetically) from these principles and provide explanatory demonstrations of phenomena. In dogmatic physics, moreover, we study *efficient causes*. The part of physics that studies final causes is called teleology by Wolff (Wolff 1963 [1728], pp. 43-44).[7] In the following, I will provide a detailed analysis of Wolff's conception of teleology.

[6] For Wolff, the term 'physics' always refers to *natural science as a whole*. In the following, I will adopt this use of the term 'physics'.

[7] Wolff's views on the hierarchy of sciences, as described above, are articulated in the first volume of his Latin Logic (Wolff, 1983 [1740]). Kant knew Wolff's logic and frequently discussed it in his lectures (Kant, 1992).

Wolff's most famous work on teleology is the so-called *German Teleology*.[8] The *German Teleology* has a bad reputation. It has been interpreted as an anthropocentric work of physico-theology, in which the usefulness of an object is constantly conflated with its purpose (Schönfeld, 2000, pp. 97-106; Cassirer, 1983, p. 338).[9] This reading is incorrect and incomplete. I will show that Wolff's teleology has the didactic function of making God's nature and attributes comprehensible. It does *not*, in contrast to many physico-theological works, aim to provide a strict proof for the existence of God (Euler, 2008, pp. 85-87). I further show that Wolff's teleological views are important for understanding his conception of scientific explanation. Wolff allows for teleological explanations in natural science by construing them as explanations of the existence of natural objects in terms of God's intentions.[10] Teleological explanations are thus allowed in natural science because we can be certain of the truth of theological propositions.

For Wolff, teleology is a distinct science. It has a particular object of investigation and a particular research method. The object of this science is God. Teleology provides demonstrations yielding insight into God's perfections (Wolff, 1980a [1726], pp. 2-3). Accordingly, Wolff describes teleology as a *Theologia experimentalis* (Euler, 2008, p. 86). This description indicates that teleology provides insight into God's perfections on the basis of the empirical study of nature. As such, it is distinguished from the a *priori* study of God undertaken in what Wolff calls natural theology.[11] Because teleology involves the study of nature, it is treated as a part of physics or natural science (see Figure 1). Teleology is thus what we may call a hybrid science.

The method of teleology can be understood if we consider the nature of Wolff's teleological demonstrations. These demonstrations take propositions from (dogmatic) physics and natural theology as premises.[12] In Wolff's terms, physics and natural theology *precede* teleology (Wolff, 1983 [1740], pp. 45-46). For example, Wolff refers to astronomical observations recorded in *physics* to argue that the universe contains an uncountable multitude of bodies (Wolff, 1980a [1762], pp. 38-39). In *natural theology*, it

[8] McLaughlin provides a brief history of Wolff's term 'teleology', noting that it was discussed in Zedler's *Lexicon* and the *Encyclopédie* (McLaughlin, 2011, pp. 22, 216).

[9] According to Schönfeld (2000, p. 268), there are no relevant philosophical differences between Wolffians and physico-theologians.

[10] In the following, I will not discuss Wolff's attempts to show that the *final end* of the world is the revelation of God's glory to human beings (Wolff, 1980a [1726], p. 492). My focus will be on the relationship in Wolff between teleology, theology, and natural science. On Kant's moral theology, partly presented in the third *Critique*, see Beiser (2006a) and Wood (1970).

[11] Wolff's 'natural theology' corresponds to what Kant calls 'rational theology'. It provides *a priori* demonstrations of the existence and attributes of God. Natural theology also contains what Wolff calls an *a posteriori* cosmological first cause argument (Corr, 1973, 1975).

[12] Wolff's demonstrations in teleology and physiology almost always proceed from propositions belonging to what he calls *dogmatic physics*, and not from propositions belonging to *experimental physics*. In the following, I will simply speak of physics.

has been established that God has complete knowledge of the entire world and all that it contains. On the basis of these propositions, Wolff argues in his *teleology* that the uncountable number of bodies in the universe provides a *sample* of the greatness of God's intellect (Wolff, 1980a [1726], p. 39).

The above demonstration has a didactic function: it illustrates the greatness of God's intellect. Wolff does *not* provide a strict proof of God's infinite intellect. It is doubtful, for example, whether the notion of 'uncountability' is identical to the theological notion of an infinite intellect. Moreover, Wolff stresses that demonstrations given in teleology *presuppose* the results of natural theology. The proper (*a priori*) proofs of the existence and attributes of God are contained in this latter science. Teleology is therefore a discipline that merely provides additional confirmation of the truths of natural theology, while further providing concrete examples that allow us to comprehend the abstract theological concepts of God's attributes (Wolff, 1980a [1726], pp. 3-5). For this reason, Wolff's teleology does not contain a proof of the existence of God. Such a proof would be blatantly circular.

Wolff assigns teleology an explanatory function in natural science. Peter McLaughlin has claimed that in the eighteenth century teleology was used strictly to infer God's attributes and intentions: the intentions of God were *never* used to explain natural phenomena (McLaughlin, 2001, p. 22). This claim is not true of Wolff. The *German Teleology* contains clear examples of teleological explanations in natural science. For example, Wolff takes the idea that sexual reproduction is a *means* for maintaining animal species to explain *why* animals are of two sexes (Wolff, 1980a [1726], pp. 488-489). Here, Wolff refers to an effect or final cause, the maintenance of species, to explain why one of the causes or means of this effect, the existence of a male and female sex, exist. [13]

How can an appeal to an effect explain the existence of its cause? Wolff does not allow for backwards causation. Rather, he reduces teleological explanations to explanations of the existence of objects in terms of God's *intentions*. Intentions are defined as objects agents try to obtain by their will (Wolff, 2003a [1751], p. 563). They are often identified with final causes (Wolff, 2003a [1751], pp. 566-567; compare Euler, 2008, pp. 89-93). We may, however, read Wolff as taking intentions to be representations of final causes, while construing final causes as *objects of intentions*. Hence, natural objects are final causes insofar as they are objects of God's intentions. According to Wolff, everything that follows from the essence and nature of things is an object of God's intentions. Accordingly, *all* effects of efficient causes are final causes. God *created*

[13] In Wolff's ontology, a *final cause* is defined as that for the sake of which an efficient cause acts or changes its state. Final causes are *effects* of efficient causes. Moreover, final causes and efficient causes are reciprocally dependent (Wolff, 2001 [1736], pp. 678-680). Wolff's discussion of final causality, illustrated by the example of an architect guiding the building of a house, is similar to Kant's discussion of the *nexus finalis* in the third *Critique* (Kant, 1790, pp. 372-373).

efficient causes in order to obtain these effects (Wolff, 2003a [1751], pp. 633-634).[14]

It is the certainty of these theological beliefs that justifies giving teleological explanations in natural science. *If* the maintenance of animal species is the object of God's intention (a purpose of God), and Wolff thinks we can *know* that this is the case, *then* we can refer to this effect or final cause to explain the existence of a male and female sex. The existence of a male and female sex is then construed as a means, created by God, for achieving the maintenance of species (Wolff, 1980a [1726], pp. 488-489). Teleological explanations in natural science thus presuppose knowledge of the intentions and existence of God.

In order to understand Wolff's views on teleology, therefore, we must pay close attention to his views on the hierarchy of sciences. Given that natural theology and physics provide us with true propositions, we can illustrate God's attributes in the subordinate science of teleology. Moreover, given that we can know God's intentions, we can provide teleological explanations in natural science. Wolff's confidence in the possibility of having knowledge of God also explains why he identifies the use of an object with its final cause or purpose. As noted, this identification is often criticized (Cassirer, 1983, p. 338). Yet Wolff argues for this identification explicitly. According to him, the distinction between 'purpose' and 'use' is purely epistemological. For human beings, the use of an object is often unforeseen. When we create something for a certain *purpose* (e.g., a baseball bat for playing baseball) we cannot anticipate all of its possible uses (e.g., in sports, for protection, etc.). Hence, we may distinguish the purpose for which an object was made and its variety of uses. For God, however, there is no distinction between use and purpose because God knows all the consequences of things and has created them for the sake of these consequences (Wolff, 2003a [1751], p. 634). For Wolff, *everything* in nature is intended by God.[15]

3. Physiology as a transcendent science

Wolff allows for teleological explanations in natural science since he thinks we can have knowledge of the intentions of God. How do we arrive at knowledge of God's intentions? Or, to put the question differently: how do we know the final causes or purposes of natural objects?

Wolff's most precise and clear account of how to infer the purposes of natural objects is given in the so-called *German Physiology*, a work that is almost completely unknown. In the present section, I analyze this work and show how Wolff employs propositions of *metaphysics* and *natural theology* to infer the purposes of organic beings and their parts. If we adopt Wolff's views on the hierarchy of sciences, physiology, in virtue of

[14] For a detailed account of the distinction between the notions of 'efficient cause', 'final cause', and 'usefulness' in Wolff and Baumgarten, see chapter 4 of van den Berg (in press).

[15] It follows that in order to counter the problem of evil, Wolff follows Leibniz in arguing that the actual world is the best of all possible worlds (Wolff, 2003a [1751], pp. 604-605).

being grounded in the sciences of metaphysics and theology, can properly be called a transcendent science.

The *German Physiology* was published in 1725. The goal of the work is to explain the *use* or *purpose* of parts in man, animals and plants (Wolff, 1980b [1725), *Preface*). Employing modern terminology, we might say that Wolff aims to demonstrate the *function* of organisms and their parts. The work is divided into two segments, one dealing with the parts of man and animals and the other with the parts of plants. To see how Wolff infers the purpose of organisms, we will consider his discussion of plants.

Wolff's demonstrations of the purpose or function of (parts of) plants, as given in his *physiology*, are based on propositions or premises taken from the sciences of metaphysics and natural theology. These propositions state: (a) that the essence of composite bodies consists in the *mode of composition* of their parts, and (b) that the essence and nature of things are God's *means* for executing his intentions (Wolff, 2003a [1751], pp. 378, 636).

Proposition (a) is a definition of 'essence' given in Wolff's *ontology*, equating structure and essence. Proposition (b) is a proposition proved within the science of natural theology, which provides *a priori* knowledge of God. Wolff argues for (b) as follows. God knows everything that follows from the essence of things and has created these things *because of* these consequences. Hence, the consequences of the essence of things are *intended* by God (Wolff 2003a [1753], p. 633). Insofar as the essences of things are created by God in order to obtain his intentions, these essences are *means* to obtain his intentions. In other words, the *structure* (essence) of objects is a means for achieving one of God's intentions.

Given (a) and (b), Wolff refers to descriptive (anatomical) propositions of physics concerning the *structure* (composition) and operation of plants to determine their purpose, i.e., to determine what God intended when he created plants.[16] For example, he concludes from the facts that (i) plants generally emerge from seeds, (ii) continue to grow for some time and maintain their growth through nutrition, and (iii) have a structure allowing them to take nutrition, that God *intended* plants to grow for a certain time and that he *intended* plants to have a structure enabling this process (Wolff, 1980b [1725], p. 610). The following schema illustrates the general structure of Wolff's arguments:

(1) Plants have a structure allowing them to take up nutrition (proposition of physics).
(2) The structure of bodies constitutes their essence (definition of ontology (a)).
(3) The essence of bodies is a means for executing God's intentions (proposition of natural theology (b)).

[16] Wolff's physics contains discussions of the structure, growth, nutrition, and generation of plants and animals (Wolff, 2003b [1723]). For a discussion of Wolff's mechanical (non-teleological) investigation of plants and animals, as presented in his dogmatic physics, see chapter 3 of van den Berg (in press).

(4) Hence, God intended plants to take up nutrition.[17]

The conclusion can also be read as stating that taking up nutrition is a *purpose* of plants and that their structure is a *means* for achieving this purpose. Of course, we take the inference to be problematic given that the structure of plants can have many effects. On what grounds do we construe one effect as a purpose? Wolff does not consider this difficulty, perhaps because of his belief that every effect is a purpose of God (see section 2). However this may be, he employs a similar procedure to conclude that God *intended* plants to grow, to remain in a single place, and to maintain the species they belong to (Wolff, 1980b [1725], pp. 610-611).

Having determined God's intentions with respect to plants, Wolff provides a general anatomical overview of plants and specifies the purposes of their parts. He notes that plants generally have (i) a root, (ii) a stem, (iii) branches, (iv) leaves, (v) flowers and (vi) seeds (Wolff, 1980b [1725], p. 643).[18] He then determines the purpose or function of these parts relative to previously established intentions of God. For example, having determined that God intended plants to grow, Wolff can be taken to argue along the following lines (Wolff, 1980b [1725], pp. 644-648):

(1*) God intended plants to grow (previously established proposition of physiology).
(2*) The roots of plants gather and transport nutrients required for growth (propositions of physics).
(3*) The purpose of roots is to gather and transport nutrients.[19]

Roots are thus a means for achieving the purpose of gathering and transporting nutrients. Turning to the next level of analysis, Wolff distinguishes three parts of plant roots: the bark, wood, and pith (Wolff, 1980b [1725], pp. 657-659). He again refers to the *structure* of these parts to infer their function. The bark, for example, is construed as the outermost part of the root. It is a spongy substance consisting mainly of membranes, which allows it to attract fluids. Given this description, Wolff refers to the function of the root, i.e., the gathering of nutrients (3*), in order to infer that the function of the bark is to attract fluids, which in turn is a *means* for gathering nutrients (Wolff, 1980b [1725], pp. 659-662).

To summarize: the method Wolff employs in his physiology is analytic. He starts by specifying the purpose of wholes and subsequently infers the purposes of parts (compare the progression from (1*) to (3*)). Wolff's entire physiological method is based on the conviction that *structure* provides us with a ground for coming to know *purpose* or

[17] Wolff's demonstrations of functions resemble Robert Boyle's views on teleological inference, which have been documented by James Lennox (Lennox, 1983). I have not been able to establish whether Wolff was influenced by Boyle.
[18] This analysis parallels Wolff's account of the structure of plants given in his physics, which contains a mechanical analysis of plants (Wolff, 2003b [1723], pp. 603-613).
[19] Here, I abstract from some empirical considerations and experimental results presented in Wolff's physiology.

function (compare the progression from (1)-(4)). This conviction is justified by accepting the *theological* proposition that the essences (structures) of things are God's means for executing his intentions. Given the truth of this proposition, we can employ anatomical knowledge of structures to infer purposes or functions. [20]

The above analysis shows that Wolff construes physiology as what we may call a transcendent science. The attribution of purposes or functions to organisms presupposes the *truth* of the propositions of ontology and natural theology. [21] More specifically, propositions of ontology and natural theology are used as principles to demonstrate the purposes of organisms and their parts. Wolff thus adopts a view of the hierarchy and structure of sciences according to which physiology is grounded in ontology and natural theology. In section 5, I show that Kant's regulative conception of teleology constitutes an attack of this view of the hierarchy of sciences. [22]

4. Teleology and biology in mid-eighteenth-century rationalist thought

In the previous sections, we have analyzed Wolff's views on teleology and physiology. In the present section, I discuss the views on teleology and biology formulated by the influential mid eighteenth-century rationalist philosophers Reimarus and Crusius. The study of Reimarus will show that he adopted the Wolffian method of inferring functions on the basis of ontological and theological propositions. Kant knew the works of Reimarus well, so we can be reasonably sure that he was familiar with this aspect of Wollfian teleology. The study of Reimarus and Crusius will further highlight the difficulties involved in reconciling the teleological and theistic beliefs of these rationalist philosophers with developments in the eighteenth-century life sciences. This is especially clear in the case of Reimarus, who, throughout his works, rejects materialistic theories of the likes of Maupertuis, Buffon, and La Mettrie. The problems that developments in

[20] E.S. Russell (1916) famously distinguished between a biology that takes the concept of form as primary (function is a mechanical result of form) and a biology that takes the concept of function as primary (function explains form). Huneman (2006) interprets Kant fruitfully on the basis of this dichotomy. Insofar as Wolff takes functions to be explanatory, he can be placed in the functionalist camp, although form provides an epistemic ground for knowledge of function.

[21] Wolff partly takes propositions attributing purposes to natural objects to be grounded in claims concerning God's intentions because he construes the former as *normative* claims (Wolff, 1980b [1725], pp. 1-4). If God intended something to be the case, then it *ought* to be the case. Here, we find the historical background of Kant's view that purposes express norms, a view investigated by Ginsborg (2001, pp. 248-254).

[22] Zumbach and Zammito take Kant to construe biology as a transcendent science (Zumbach, 1984; Zammito, 2006, pp. 762-764, 2009, pp. 234-236). However, as I argue in section 5, Kant rejects Wolff's teleology by arguing that teleological judgments in biology do not presuppose theological truths. Given Kant's strict notion of science (Kant, 1786, pp. 468-471), this does not establish that biology is a science. Nevertheless, it does show that Kant aimed to demarcate biology from theology.

eighteenth-century biology posed for rationalist teleology can be taken to define the background to Kant's own thinking about teleology.

Hermann Samuel Reimarus was born in Hamburg on 22 December, 1694. His father was a teacher at Hamburg's *Academic School of the Johanneum*, which Reimarus also attended. In 1714, he went to Jena to study theology, philosophy, and ancient languages. He received his Master's from Wittenberg and in 1723 became Rector in Wismar. In 1728, he was appointed Professor of Hebrew Oriental Languages at the academic Gymnasium of Hamburg, where he also lectured on philosophy, mathematics and natural science, He remained in Hamburg until his death on March 1, 1768 (Lötzsch, 1979).

Reimarus was an internationally renowned scholar. In 1756, he published an influential work on logic, the so-called *Vernunftlehre*. In 1755, he had already published his *Abhandlungen von den vornehmsten Wahrheiten der natürliche Religion* (hereafter: *Religion*), followed in 1760 by a work on animal instinct, the *Algemeine Betrachtungen über die Triebe der Tiere* (hereafter: *Betrachtungen*). The latter works were translated in multiple languages and went through many editions.[23] Kant knew the *Vernunftlehre* well, and in the third *Critique* he praised Reimarus' *Religion* as an "unsurpassed work" in physical teleology (Kant, 1790, pp. 476-477).

Reimarus was strongly influenced by Wolff (Mühlpfordt 1983, p. 250). In his *Vernunftlehre*, he praised and adopted the axiomatic *Wolffsche Lehrart* (Reimarus, 1979 [1756], pp. 21-24. Cf. Hinske, 1980). To illustrate the method of providing proper demonstrations in natural science, i.e., demonstrations based on definitions and fundamental principles (axioms), he cited a syllogistic proof for the elasticity of air that Wolff had discussed in detail in his *German Logic* (Reimarus 1979 [1756], pp. 350-352). In addition, Reimarus adopted Wolff's distinction between experimental physics, rational or dogmatic physics, and teleology, which is construed as a doctrine concerning God's intentions (Reimarus, 1979 [1756], pp. 10-13). Reimarus seems to have been familiar with the entirety of Wolff's philosophy, for his library contained almost all significant writings of Wolff, including Wolff's physics, his *German Teleology*, and his *German physiology* (Schetelig 1769).

If we study the *Religion*, it becomes clear that Reimarus' method of ascribing purposes to nature is almost identical to that of Wolff. According to Reimarus, demonstrations of the purposes of organisms are based on fundamental principles, among which are (a) living objects and their properties are *means* existing for the sake of some intention of God, and (b) the *aptness* (*Geschicklichkeit)* of an object for accomplishing some effect provides an indication of its purpose (Reimarus, 1755, pp. 286-287). The following demonstration illustrates Reimarus' method:

(1) Wings enable birds to fly (observational proposition)
(2) Living objects and their parts are means for achieving God's intentions (proposition of natural theology).

[23] On Reimarus' account of animal instinct, see Mayr (1982).

(3) Hence, God intended birds to fly.

Like Wolff, Reimarus thus adopts a deductive procedure in which we demonstrate functions on the basis of both propositions from natural theology and observational claims. Unlike Wolff, however, Reimarus denies that the conclusions of these demonstrations are *certain*. Objects can have many effects and are suitable for a host of things. For this reason, we often err in determining functions: while wings usually have the function of enabling flight, there are winged organisms that never fly (Reimarus 1755, pp. 233-234). The fact that we observe some object *a* to be appropriate for achieving *b* thus only *hints* at the fact that the function of *a* is to achieve *b*. Reimarus concludes that propositions ascribing functions are propositions that are never certain: they are propositions that are more or less *probable* (Reimarus 1755, p. 287).

The above views are clearly Wolffian in spirit. However, the scientific climate in which Reimarus operated differed considerably from that of the early eighteenth century. Reimarus was confronted with theories concerning what we may generally call *self-organization*, i.e., with (i) theories affirming the possibility of spontaneous generation, (ii) theories concerning organic regeneration, and (iii) epigenetic embryological theories of generation. These theories were highly problematic for Reimarus and other mid-eighteenth-century rationalist philosophers such as Crusius. They were taken to support the materialist or hylozoist view that matter can somehow organize itself. Such a view could not be reconciled with the teleological and theistic beliefs of Reimarus and Crusius. In the following, I discuss (i)-(iii) in turn and highlight various similarities between the views of Reimarus, Crusius, and Kant, who, like his rationalist predecessors, rejected all forms of materialism and hylozoism.[24]

(i) Spontaneous generation is discussed in the second chapter of Reimarus' *Religion*. The aim of this chapter is to show that man and animals are not generated by nature (Reimarus, 1755, p. 79).[25] Reimarus argues for what Kant would later call a principle of original organization (Kant, 1790, p. 424): the generation of an organized being always presupposes some *prior* and *similar* organization (Reimarus, 1755, pp. 83-86). To support this claim, *spontaneous generation*, the view that nonliving matter can generate living organisms, and *equivocal generation*, the view that organic matter can generate living organisms, are both rejected (Reimarus, 1755, pp. 84-97; cf. Farley, 1972).

[24] On Kant's struggle with materialism and hylozoism, see Zammito (1992). Kant took materialism to be the (Epicurean) doctrine according to which all objects of nature, including organisms (natural purposes), are merely the effects of the motion of matter or "blind chance", whereas hylozoism is a doctrine that ascribes life to matter and takes matter to be self-organizing (Kant 1790, pp. 390-395). The difference between these positions is that materialist deny the existence of causes in nature that act in accordance with purposes, whereas hylozoist affirm their existence (e.g., souls animating matter).

[25] Jonathan Israel (2011) has interpreted Reimarus' philosophy as a critique of Spinozism. I will focus on Reimarus' critique of the so-called French materialists and life-scientists.

Buffon and Needham are Reimarus' main targets of criticism. These latter authors claimed that microscopic organized beings, as found in seminal fluids, rainwater, and in the fluids of plants and roasted meats, are generated through the fermentation of matter.[26] Against this view, Reimarus argues that theories concerning the generation of microscopic organisms need not be taken to adequately explain the generation of macroscopic organisms (Reimarus, 1755, pp. 84-86). He further argues that the presence of microscopic organisms in various materials need not have come about through fermentation, but can be explained by exposure to some 'invisible living mother', e.g., to air containing organic germs (Reimarus, 1755, pp. 88-92).

The rejection of spontaneous and equivocal generation serves the greater good of arguing for the truth of theism. Reimarus refutes the Epicurean materialism of La Mettrie, arguing that the probability of nature hitting on organisms by blind chance is as good as zero (Reimarus, 1755, pp. 98-101). Apart from materialism, he considers the *hylozoist* doctrine of a world-soul organizing matter and the *Spinozistic* theory according to which nature brings forth organisms, both of which are rejected in favor of *theism* (Reimarus, 1755, pp. 101, 119-122). This juxtaposition of metaphysical views on the origin of natural purposiveness strongly resembles Kant's similar juxtaposition of materialism, Spinozism, hylozoism, and theism as given in the Dialectic of Teleological Judgment (Kant, 1790, pp. 391-392).

(b) Trembley's discovery of the regenerative powers of polyps, whose cut of parts transformed into completely new organisms (Roger, 1963), were also heavily debated in mid-eighteenth century Germany. These discussions can be found in Reimarus' *Betrachtungen* and already in Crusius' *Anleitung über Naturliche Begebenheiten ordentlich und vorsichtig nachzudenken* of 1749 (hereafter: *Anleitung*).[27]

Both Crusius and Reimarus took the regenerative capacities of polyps to be established without doubt. Crusius describes the asexual reproduction of polyps through budding, comparing it to the generation of offshoots from plant buds (Crusius, 1749, pp. 1226-1228). Similarly, Reimarus elucidates the regenerative powers of polyps by citing the

[26] Reimarus refers to microscopic observations of seminal fluids and spermatic animals recorded in the *Natural History* (Buffon, 1791, pp. 148-192). His interpretation of Buffon is basically correct (cf. Roger, 1989, pp. 193-207).

[27] Christian August Crusius (1715-1755) was a professor of theology at Leipzig. He is mainly known as a critic of Leibnizean and Wolffian metaphysics whose philosophical writings influenced Kant. Nevertheless, like his Wolffian contemporaries Crusius rejected materialist accounts of organic form. Kant read and owned Crusius' *Anleitung* (Kant, 1763, p. 169. Warda, 1922). The latter work contains several passages similar to passages found in Kant. When discussing generation, for example, Crusius distinguishes between the impossible *generatio equivoca* and the common *generatio univoca* (Crusius, 1749, p. 1151). He further distinguishes between a preformationist theory in which God creates all organisms at once at the beginning of time, and a theory in which God continuously guides the generation of organisms (Crusius, 1749, pp. 1159-1169). Kant calls these two variants prestabilism and occasionalism. Like Crusius, he rejects the latter (Kant, 1790, pp. 419-420, 422).

artificial multiplication of plants through cloning and grafting (Reimarus, 1762, pp. 321-322). These comparisons suggest that organic self-organization was considered to be a rather common phenomenon.[28]

The main aim of discussing Trembley's findings was to combat the view that they give credence to materialism. Crusius rejected the view that the regenerative powers of polyps imply the divisibility and materiality of their souls (on this topic, Vartarian, 1950). He argued that the *cunning* with which polyps obtain nutrition cannot be explained by materialists (Crusius, 1749, pp. 1226-1228). He further argued that the fact that parts of polyps regenerate as wholes indicates that they have multiple souls located in the body. At all times, one of these souls is dominant and coordinates the functioning of other souls. If the dominant soul is lost, a different soul takes on the dominant role (Crusius, 1749, pp. 1228-1230). By conceiving of the identity of the soul *functionally* in terms of the dominant role of a soul, Crusius thus aimed to uphold its identity and indivisibility. Reimarus approves of this account in his *Allgemeine Betrachtungen* (Reimarus, 1762, p. 322).

(iii) Finally, we will consider Reimarus' views on generation. In his *Religion*, Reimarus rejects preformationism, more specifically the theory of preexistent and encased germs. This theory is disconfirmed by Trembley's discoveries and is taken to imply, *per impossibile*, an infinity of actual physical parts (Reimarus, 1755, pp. 545-546). Interestingly, epigenetic theories of generation are also rejected. Reimarus takes Buffon's concept of an internal mould organizing living matter to be incomprehensible and notes that attractive forces cannot explain embryogenesis, given that the uniform action of such forces cannot generate differentially organized parts (Reimarus, 1755, pp. 547 – 548). Since the generation of organisms is fully inexplicable, Reimarus concludes that we must posit the existence of God. God *constantly* exerts an influence upon nature and renders the continual origination of new life possible (Reimarus, 1755, pp. 549-550). In this manner, Reimarus provides a proof of God's *providence*.

The present section has established that Wolff's demonstrative method of inferring functions on the basis of metaphysical (ontological and theological) propositions was adopted by Reimarus. We have further described how various eighteenth-century biological theories posed grave problems for theistic rationalists such as Reimarus and Crusius. These problems led Reimarus to reject spontaneous generation and epigenetic theories of generation, and to provide a purely *theological* account of organic reproduction. In order to combat materialist interpretations of Trembley's studies on polyps, Crusius argued that polyps have multiple souls. Apparently, the teleological and theistic beliefs of these rationalist philosophers *could not* be easily reconciled with eighteenth-century biological thought. This historical context provides the background to Kant's thinking about teleology. Like his rationalist predecessors, he rejected materialist and hylozoist accounts of organisms. However, the

[28] In the *Critique of Judgment*, Kant also cited cloning and grafting to illustrate the self-organizing powers of organisms (cf. Kant, 1790, pp. 371-372).

systematic challenge confronting Kant was to *harmonize* traditional teleology with the eighteenth-century life sciences.

5. Kant on teleology and theology

The study of Wolffian teleology has shown that teleology and theology are fundamentally intertwined. In this section, I show that Kant's reflections on teleology, contained in the Analytic of Teleological Judgment, must be interpreted as being in dialogue with the Wolffian tradition. On the one hand, Kant remains wedded to Wolffian views. On the other, Kant rejects Wolff's conception of the hierarchy of sciences, according to which ontology and natural theology ground the construal of organisms as purposes. By interpreting the Analytic of Teleological judgment as a critique of Wolffian teleology, we gain a novel perspective on several of Kant's well-known arguments.

The main similarity between Wolff's and Kant's teleological views can be summarized by noting that both explicate the concept 'purpose' in terms of intentional agency (on Kant, see Beiser, 2006b, p. 12). Wolff identifies purposes as the objects of God's intentions. For Kant, to conceive of an object as a purpose is to conceive it as an intentionally produced object of design (Kant, 1790, p. 220).[29] This is one of the reasons why Kant treats the concept of a 'natural purpose' as a regulative concept of reflective judgment. To treat it as constitutive is to affirm the reality of intentional causation in nature (Kant, 1790, p. 383). Kant thus weakens Wolffian teleology and interprets organisms *as if* they were products of intentional production (*ibid*).[30]

A fundamental difference between the two authors emerges if we consider on what *grounds* they construe natural objects as purposes. Wolff takes all objects of nature to be purposes of God. This follows from the fact that ontology and natural theology *prove* that God created all objects for the sake of obtaining his intentions. Kant cannot, given his rejection of rationalist metaphysics, accept this assumption. To adopt such a view is to establish the possibility of natural purposes *dogmatically* (Kant, 1790, pp. 391-392, 395-396). As Kant puts it in §75 of the *Critique of Judgment*, the concept of a natural purpose cannot be "treated dogmatically for the determining power of judgement", since "the objective reality of the concept of a natural end is not demonstrable by means of reason at all" (Kant, 2000, p. 396).

[29] Like Wolff, Kant thus adopted an interpretation of the concept of 'purpose' in terms of the concept of 'intentionality'. Wollf's notion of purpose, discussed in section 2, is explicated in his German metaphysics and his Latin ontology (Wolff 2003a [1751], Wolff 2001 [1736]). Kant owned Wolff's Latin ontology (Warda, 1922). He further knew of the definition of a 'purpose' as the object of (God's) intentions through the *Metaphysica* of the Wolffian Baumgarten (van den Berg, in press, chapter 4), which Kant used as a textbook for his lectures (Naragon 2006).

[30] On Kant's use of analogy in this context, see Steigerwald (2006) and Breitenbach (2009).

Wolff treated the concept of a natural purpose *dogmatically* since he proved the objective reality of this concept *a priori*, i.e., proved that objects of nature *are* purposes, on the basis of *metaphysical* propositions that affirm the existence of God. Kant rejects this procedure. In §75, he notes that the concept of an original ground of nature (God) "is not good for any dogmatic determinations", because we cannot strictly know whether God exists or not (Kant, 2000, p. 397). According to Kant, the objective reality of the concept of natural purpose simply cannot be proven a priori (Kant, 1790, p. 382).

Kant thus rejects Wolff's metaphysical grounds for construing natural objects as purposes. In §68 of the Analytic of Teleological Judgment, this criticism is made explicit and related to the problem of the hierarchy of sciences. Recall that Wolff adopted a conception of the hierarchy of sciences according to which ontology and theology *ground* natural science. Kant rejects this view on the hierarchy of sciences. In §68, he considers the relation of teleology to natural science and theology. He conceives of teleology as providing *internal* principles of natural science, which are described as follows:

> The principles of a science are either internal to it, and are then called indigenous (*principia domestica*), or they are based on principles that can find their place only outside of it, and are *foreign* principles (*peregrina*). Sciences that contain the latter base their doctrines on auxiliary propositions (*lemmata*), i.e., they borrow some concept, and along with it a basis for order, from another science. (Kant, 2000, p. 379)

Here, Kant provides an account of his views on the structure and hierarchy of sciences. In the *Prolegomena*, Kant argued that sciences can be distinguished in terms of (i) their *object* of investigation, (ii) their *source of cognition* (a priori or a posteriori), and (iii) their *method of proof* (Kant, 1783, pp. 265-267). These conditions are taken to be jointly sufficient to demarcate the sciences from one another. They also explain when a proposition is *internal* to a science. For example, propositions internal to geometry are for Kant *a priori* propositions concerning *space*, proven through *construction*.

In distinguishing internal from external principles, Kant alludes to the fact that propositions internal to one science can be applied within other sciences. To give an example: we may take Phenomenon 1 of Book III of Newton's *Principia*, which states that the satellites of Jupiter describe areas proportional to the times with respect to Jupiter, to be an *observational* proposition internal to natural science (Newton, 1999, p. 797). Given the *mathematical* (kinematical) proposition that bodies describing areas proportional the times around an unmoving or uniformly moving point are subject to a centripetal acceleration (Proposition 2, Book I), Phenomenon 1 allows Newton to deduce that the satellites of Jupiter are subject to a centripetal acceleration (Newton, 1999, pp. 446, 802). Proposition 2 of Book I would then be a principle *foreign* to natural science, while being *internal* to mathematics.

In §68, Kant argues that teleological principles must be *internal* to natural science. This is to say that teleological propositions, e.g., propositions concerning the functions of organisms, must be *a posteriori* propositions concerning *natural objects* based on *experience* (Kant, 1790, pp. 382, 386). In addition, Kant emphatically rejects the introduction of theological propositions into natural science in order to *derive* the purposiveness of natural forms (Kant 1790, pp. 382-383). Thus, while Kant allows for the use of mathematical propositions within physics, he rejects the demonstration of propositions of physics by means of propositions of theology concerning God. As Kant puts it, natural science must not "jump over its boundaries in order to bring within itself as an indigenous principle that to whose concept no experience at all can ever be adequate […]" (Kant, 2000, p. 382).

Let us now recall Wolff's method of demonstrating functions:

(1) Plants have a structure allowing them to take up nutrition (proposition of physics).
(2) The structure of bodies constitutes their essence (definition of ontology (a)).
(3) The essence of bodies is a means for executing God's intentions (proposition of natural theology (b)).
(4) Hence, God intended plants to take up nutrition.

Here, we have a demonstration of a purpose of plants on the basis of propositions of the problematic sciences of ontology and natural theology ((2) and (3)). It is *precisely* the use of (2) and (3) in physics that Kant rejects. Ontology and theology cannot *ground* natural science.

The above inference also elucidates what Kant means when he claims that the concept of 'natural purpose' is not an a priori constitutive concept of *determining judgment* (Kant, 1790, pp. 395-396). For Kant, 'determination' is a term used to characterize demonstrations proceeding from the general to the particular (cf. Kant, 1790, pp. 179-180). In the above demonstration, we proceed from proposition (3), which tells us that the essence of bodies *in general* is a means to achieve God's purposes. This proposition asserts the objective reality of purposes a priori and dogmatically. We subsequently apply this proposition to the observed structure of plants. This is a process of *determination*, which enables the inference to (4). In denying that the concept of a natural purpose is a concept of the determining power of judgment, Kant rejects the Wolffian method of demonstrating functions on the basis of metaphysical propositions asserting the reality of purposes.

Kant's final criticism of Wollfian teleology is contained in §79 of the third *Critique*, in which he considers the place of teleology in the "encyclopedia of the sciences" and asks whether "teleology must be treated as part of the doctrine of nature" (Kant, 2000, p. 416). Recall that according to Wolff natural science consists of three parts: (a) experimental physics, (b) dogmatic physics, and (c) teleology (see section 2). In contrast

to Wolff, Kant denies that teleology is a separate discipline that constitutes a part of natural science. For in natural science, we must specify *objective grounds* or causes of phenomena, i.e., we must provide *mechanical explanations* of phenomena (Kant, 1790, p. 417). According to Kant's regulative conception of teleology, however, purposes do not specify objective grounds of phenomena and are not properly explanatory. Rather, teleological concepts belong "only to the description of nature" (*Ibid*). A supposedly natural science in which we consider the purposes of natural things and do not provide mechanical explanations of phenomena, such as Wolff's teleology, is no real natural science at all.

In Kant's philosophy, there is thus no room for teleology as a separate part of natural science. Rather, Kant thinks that because we necessarily interpret organisms as natural purposes teleological concepts are internal to natural science and the proper method of scientists who study organisms consists in *combining* teleological and mechanical methods (Kant, 1790, pp. 417-419). This conception of natural science is foreign to Wolff, who strictly distinguished the part of natural science in which we study efficient causes and provide mechanical explanations of phenomena (dogmatic physics) from the part of natural science in which we study the purposes of things (teleology).

Our analysis has shown that interpretations of Kant's teleology must take into account his views on the hierarchy of sciences. When arguing that teleological principles and concepts must be *internal* to natural science, and thus cannot be derived from other sciences providing so-called external principles, Kant rejects the Wolffian view that metaphysical sciences such as ontology and natural theology *prove* the reality of purposes in nature and legitimate the use of teleological concepts in natural science. According to Kant, the concept of a 'natural purpose' is a concept of reflective judgment, ascribed to organisms on the basis of the *observation* and scientific study of organisms. Hence, in contrast to Wolff Kant denies that ontology and natural theology ground natural science and biology.

Moreover, although observation leads us to describe organisms as natural purposes, Kant denies that the teleological concept of a 'natural purpose' is constitutive of nature. To treat this concept as constitutive is to affirm the reality of intentional production in nature. In natural science, however, we must *abstract* from the *metaphysical* question of whether natural objects are intentionally produced (Kant, 1790, pp. 382-383). For Kant, the concept of a natural purpose can only be *internal* to natural science if it is a regulative concept, which is to say that it (merely) enables the identification and adequate description of organic phenomena and helps in the search for mechanical explanations of such phenomena. Although teleological concepts are an integral part of natural science, teleology is not, as was the case for Wolff, a separate natural science that allows us to know the intentions of God. Kant's regulative teleology is thus a means to *demarcate* biology from dogmatic metaphysics (including

theology), and by introducing this conception of teleology Kant rejected Wolff's views on the hierarchy of sciences.

6. Teleology and self-organization

Kant rejected Wolffian teleology because he denied that we construe natural objects as purposes on metaphysical grounds. Rather, *observations* of nature lead us to conceive organisms teleologically. In §§64-65 of the third *Critique*, he highlighted observable organic processes such as propagation, nutrition and growth, and regeneration (Kant, 1790, pp. 371-372). According to Kant, it is the observation and study of these processes that lead us interpret organisms in teleological terms. Kant thus focused on phenomena of organic *self-organization* that were problematic for the German rationalists because of their supposedly materialist implications (see section 4). This historical context is important, for it shows that Kant aimed to harmonize traditional teleology with eighteenth-century biology. Like contemporary biologists, Kant took self-organization to be a fundamental biological concept. However, he argued that self-organization necessitates a teleological description and does not imply materialism or hylozoism. As such, he again tried to *demarcate* the scientific study of organisms from metaphysical positions.[31]

In section 4, we have seen that Reimarus and Crusius were critical of theories of spontaneous generation, of materialist interpretations of the regenerative powers of organisms, and of epigenetic embryological theories. It is important to point out that a skeptical position towards biological theories that somehow emphasized the self-organizing nature of organisms was still adopted within the German rationalist tradition as late as the 1790s! For example, in the fourth edition of his *Anfangsgründe der Naturgeschichte* of 1791 (first edition 1768), Johann Christian Polykarp Erxleben argued against spontaneous generation and rejected epigenetic theories of generation. It will be useful to briefly consider his critique of epigenesis.

In his *Anfangsgründe*, Erxleben provided a classical preformationist critique of epigenesis, i.e., the idea that organs are progressively formed out of undifferentiated and homogeneous material (Smith, 1976, p. 264). He argued that epigenesis is false because the existence of and functioning every part of an organism *presupposes* the existence and functioning of other parts of the organisms. In other words, because the parts of organisms are reciprocally dependent on each other, the parts of organisms cannot come to be one after the other, as epigenetic theories of generation would have us believe (Erxleben, 1791, pp. 103-106). In the following, I will show that Kant adopted this originally preformationist argument in order to argue that the self-organization of organisms necessitates a teleological description.

[31] For influential discussion of these paragraphs, see McLaughlin (1990, pp. 44-51), Ginsborg (2004, pp. 37-39), Guyer (2006, pp. 264-266).

In §64 of the third *Critique*, Kant argues that the propagation, growth and nutrition, and regeneration of organisms must be interpreted in teleological terms. In §65, he specifies two conditions that must be met if a thing is to be construed as a *natural purpose* (Kant, 1790, pp. 373-374). The first condition states that an object is a purpose if we take the existence and arrangement of its parts to be possible only through a concept of this (whole) object. This condition is unproblematically applied to *artifacts*. The second condition identifies a characteristic of *organisms* that justifies the application of the first condition to organisms. It states that the parts of organisms must "be combined into a whole by being reciprocally the causes and effect of their form" (*ibid*.). This condition, as has often been stressed, identifies the *self-organizing* nature of organisms and the *reciprocal dependency* of organic parts.

Philip Sloan provides a nice example of reciprocal dependency: the heart cannot beat without nerves, while conversely the nerves cannot exist without the heart (Sloan, 2010).[32] How does this type of reciprocal dependency lead to construing organisms as purposes? Kant seems to argue that reciprocal dependency of organic parts points to the mechanical inexplicability of the origin and complexity of organisms. *If* any part depends for its existence and form on the existence and form of other parts, we cannot conceive these parts to come to exist gradually one after another. Rather, the parts must be viewed as parts of an already functioning whole.[33] As such, the fact that parts of organisms are reciprocally dependent on each other provides the basis for *conceiving* of these parts as being possible only in relation to the whole (now construed as final cause) and for interpreting organisms as purposes.

In short, Kant argued *from* organic self-organization and reciprocal dependency of organic parts *to* the inexplicability of the origin and complexity of organisms. This leads us, in turn, to interpret organisms teleologically and take organic and physiological processes as being *purposive*. In this manner, Kant reconciled the idea of organic self-organization with traditional teleological views. This position differs both from those of biologists such as Buffon, who took organisms to be self-organizing but excluded final causes from science (Buffon, 1791, pp. 28-29), and from those of the German rationalists, who associated self-organization with materialism.

[32] Sloan's example elucidates early modern pre-existence theories of generation. Followers of pre-existence theories took the mutual dependence of organic parts to imply that mechanical epigenetic theories of organic development through sequential development of organic parts were incorrect (the mutual dependency of organic parts required that organisms must somehow pre-exist). This argument is the same as the argument against epigenesis given by Erxleben.

[33] Kant's argument is somewhat similar to modern 'intelligent design' arguments. Michael Behe defines biological systems to be *irreducibly complex* if they are systems consisting of well-matched, interacting parts that cannot be produced gradually through successive modifications of precursor systems (Behe, 1996). For an evaluation of Behe's argument, see Ruse (2008).

To conclude, Kant rejected the Wolffian and rationalist view that the use of teleological notions in science is justified on the basis of a priori theological grounds. Rather, observations conducted *within* natural science lead us to interpret organisms teleologically. Kant highlighted phenomena of organic self-organization, i.e., growth, regeneration and reproduction, as necessitating a teleological description. In section 4, we saw that these phenomena were difficult to integrate within a Wolffian or rationalist philosophical framework. Crusius explained organic regeneration in terms of the existence of a multiplicity of souls, while Reimarus took divine providence to account for the inexplicable phenomenon of reproduction. In the hands of Crusius and Reimarus, biological theories became thoroughly mixed up with metaphysical speculation. One of Kant's main contributions to this debate was his attempt to demarcate biology from metaphysics. By arguing that organic self-organization must be interpreted teleologically, he blocked the inference from biological research to materialism. Conversely, he rejected the introduction of theology in biology, stressed the importance of treating organisms as natural objects, and emphasized the importance of providing mechanical and genuinely scientific explanations in biology.

7. Conclusion

In conclusion, we may return to the question of the relevance of Kant's eighteenth-century views on teleology. Throughout this paper, we have seen that eighteenth-century German philosophy of biology was drenched in metaphysical thought. On the one hand, Kant faced an influential Wolffian tradition which took the attribution of functions to organisms to be grounded in the truths of natural theology. On the other, he faced the view that biology supports the truth of materialism. In light of this specific historical context, Kant's main contribution must be located in the *philosophical* attempt to demarcate biological research from metaphysics. Kant's regulative teleology was partly a means to reject the Wolffian view on the hierarchy of science, according to which natural theology grounds biological research. Alternatively, he stressed the limits of purely mechanical and materialist interpretations of organic nature, and attempted to demarcate biological theories from materialist and hylozoist speculation.

It is true, as Zammito and Richards have stressed, that the relation between Kant's philosophy and his contemporary practicing life-scientists is often indirect and problematic. The present paper allows us to understand why this is the case. It establishes Kant's indebtedness to the Wolffian tradition and shows that Kant's philosophy of biology must be understood against the background of metaphysical interpretations of biology contained in the works of Reimarus and Crusius. Given this historical context, it is no surprise that Kant was so concerned with philosophical questions of demarcation. Kant often did not discuss contemporary biological theories in detail. Reimarus' *Religion* provides a

more extensive analysis of eighteenth-century biology than many of Kant's works. However, Kant's demarcation project was relevant in the context of eighteenth-century German discussions of biology, for many of these discussions simply *did* confound metaphysical and scientific questions.

It might be objected that Kant's regulative conception of teleology hardly differed from Wolffian teleology. Kant stressed that we treat organisms *as if* they are designed, and further admits that there is always an appeal to the supernatural in dealing with organisms (Kant, 1790, p. 424). If this is true, it may be argued that biology can never be a science for Kant. In my view, this objection underestimates the importance of Kant's rejection of Wolff's conception of the hierarchy of sciences. On the latter conception, we require metaphysical and theological *truths* to ascribe functions to nature: functions can be ascribed to nature *only if* we are able to prove God's existence and know his intentions. It is precisely this view of the hierarchy of sciences that Kant rejects. By providing a new conception of the hierarchy of sciences, according to which teleological judgements are *internal* to natural science, and by arguing that observable organic phenomena give rise to teleological descriptions, Kant furthered the idea that biology does not require theology.

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