Joseph Henry Woodger

Introductory article

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Joseph Henry Woodger (1894–1981) was one of the foremost theoretical biologists of the twentieth century. Starting out his career as an experimental embryologist and cytologist, Woodger became increasingly interested in the conceptual foundations of biology. Eventually, he abandoned all empirical research so that he could devote himself fully to studying the structure of biological theories. Perhaps his major accomplishment was the 500-page treatise *Biological Principles: A Critical Study* (1929), which systematically investigated the epistemological basis of biological knowledge through an analysis of its central concepts. Today, he is mostly remembered for his audacious monograph *The Axiomatic Method in Biology* (1937), which remains the most ambitious attempt to reformulate the propositions of biology (especially genetics, embryology, and taxonomy) using the tools of symbolic logic and pure mathematics. Woodger is also known for establishing the Theoretical Biology Club, and for introducing the 'Bauplan' concept into Anglophone biology. The insect *Terpandrus Woodgeri* (Woodger's Gumleaf Katydid) is named in his honour.

Figure 1 Joseph Henry Woodger with his son Christopher, September 1949 (from the authors' private collection).

The intellectual career of Joseph Henry Woodger (**Figure 1**) comprises three distinct periods: an empirical period (1914–1925), a critical period (1926–1930) and a formal period (1931–1978). Woodger began his experimental research after he graduated from University College London with a degree in Zoology and Comparative Anatomy. During the First World War, he served in Mesopotamia and later worked as a protozoologist at the Central Clinical Laboratory in Amarah. Following his discharge from the military, he conducted embryological experiments with J. P. Hill and cytological studies with J. B. Gatenby. In 1922, he became Reader in Biology at the Middlesex Hospital Medical School (later renamed UCL Medical School) where he taught until his retirement in 1959. Shortly after his appointment, he wrote a 500-page textbook for his medical students (Woodger, 1924) which emphasised the importance of an organism's organisation over its constituents and made use of related ideas like morphological and physiological types. The book was one of the earliest of its kind to feature a chapter on 'theoretical biology', which discussed the need to supplement the gathering of empirical data with the clarification of the concepts used to describe results, and which emphasized the importance of analyzing the presuppositions underlying biological theories.

In 1926, Woodger was granted leave to study the experimental techniques developed by Hans Przibram at the 'Vivarium' in Vienna, but he ended up spending most of his time talking to Przibram and his students about the epistemological foundations of biology. These discussions had a profound impact on Woodger. Upon his return to London, he began studying the writings of all the major theoretically-minded biologists of the time, and he familiarized himself with the pertinent philosophical literature. The outcome of his critical inquiries was *Biological Principles* (Woodger, 1929), which presented a detailed examination of the major theoretical disputes of early twentieth-century biology, and earned Woodger a D.Sc. in Principles, Methods and History of Science from UCL. This book, remarkable both for its breadth and for its depth, depicted biology as a worryingly fragmented science, exceedingly rich in facts but severely lacking in unifying principles. Woodger identified six core antitheses preventing the

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theoretical unification of biology: mechanism vs vitalism, structure vs function, organism vs environment, preformation vs epigenesis, causation vs teleology and body vs mind. In the course of the book, he attempted to resolve all of them using a combination of conceptual analysis and Whiteheadian process philosophy. Overall, *Biological Principles* set a new standard for theoretical and philosophical discussions of biological problems.

After *Biological Principles*, Woodger published a triad of related papers (Woodger, 1930a, 1930b; 1931), in which he argued that the concept of the organism, understood as an integrated hierarchical system, may hold the key to the unification of embryology and genetics. According to Woodger, the properties of the parts of an organism are dependent on their relationships within the whole. Whereas in a machine relations between parts are externally imposed by the designer, in an organism the relations between parts reflect the fact that they are endogenously generated, and they are therefore crucial for understanding the activity of the whole. Moreover, as organisms are four-dimensional entities (i.e. they are temporally as well as spatially extended), the hierarchical relations within the organism change as it develops through time. Woodger criticized geneticists for wrongly assuming that organismic variations can be ultimately explained in terms of intrinsic properties found in the fertilised egg, given that differentiation prompts sequential changes in the relational properties of the parts of the embryo that can only be accounted for by studying the developmental process. This was an important argument at the time, as it constituted one of the first critiques of genetic preformationism.

The publication of the 'organism papers' marked another turn in Woodger's career. His meticulous analyses of the biological antitheses, as well as the apparent incommensurability of different biological disciplines, led him to become more and more frustrated with the vagueness and ambiguity of scientific terminology, eventually reaching the point where he no longer felt that natural language could supply an adequate theoretical framework for biology. What Woodger felt was needed to make biological ideas clear and precise was a rigorous means of expressing and relating propositions, and he came to believe that symbolic logic offered the necessary tools for this task. Thereafter, he would devote most of his intellectual efforts to the formal articulation of biological concepts and theories. The first fruit of Woodger's labours came with *The Axiomatic Method in Biology* (Woodger, 1937), which presented a 'bio-logical' meta-language in the form of an axiom system constructed on the basis of 10 primitive (i.e. undefined) 'biological constants'. Woodger's axiom system and its sophisticated examination of part-whole relations was further developed by philosophers like Rudolf Carnap, but it had little impact among practicing biologists. The reason is that most of them were unwilling or unable to acquire the advanced training in logic needed to understand it, or even appreciate its significance.

Woodger went on to author two additional monographs related to his formal work. The first was published as part of the influential *Encyclopaedia of Unified Science*, and it attempted to illustrate how formalisation enables connections to be drawn between seemingly disparate theories and research programs (Woodger, 1939). The second was based on his Tarner Lectures at Trinity College, Cambridge, and employed a host of logical tools to resolve a number of longstanding debates in biological theory (Woodger, 1952). For example, with regards to the controversy over the relative developmental influence of genetic and non-genetic factors, Woodger suggested to replace vague terms like 'inheritance' and 'acquired characters' with a formal classification of phenotypes in relation to their relative sensitivity to environmental influences. Similarly, in the context of evolutionary disputes over taxonomic classification, Woodger appealed to set theory to reconcile the gradualness of evolutionary change with the demand that passage from one taxonomic category to another takes place in a single generation. In other work, Woodger applied formal methods to morphology and proposed a new theoretical understanding of homology based on the concept of 'Bauplan' (Woodger, 1945). Bauplans designate isomorphic systems of anatomical relations that reflect uniformity of organisation among different taxonomic groups, and they can be used to infer relations of descent. Woodger's Bauplan concept has since become widely adopted in evolutionary developmental biology.

At the end of his career, Woodger published a short book in which he reflected on a lifetime of teaching biology to medical students and where he emphasised the need to reform the medical curriculum (Woodger, 1956). Following his retirement, *Nature* published a brief announcement stating that 'Woodger's writing and thinking have had a quiet but deep and pervasive influence over a great deal of modern biological thought' (Anon, 1960, p. 75). Unsurprisingly, a most impressive *Festschrift* was presented to Woodger on the occasion of his 70th birthday (Gregg and Harris, 1964). The volume featured essays on topics as diverse as hierarchical organisation, taxonomic classification, animal growth models, probability theory, formal semantics, and metaphysics. Contributors included eminent biologists such as John Tyler Bonner, Nicolas Rashevsky, Leigh van Valen, Aristid Lindenmaryer, and Richard Lewontin, as well as distinguished philosophers such as Willard Van Orman Quine, Morton Beckner, Czesław Lejewski, and Karl Popper. The latter ultimately wrote Woodger's obituary, in which he dcelared that Woodger 'stimulated the evolution of the philosophy of science in Britain and in the United States as hardly anybody else' (Popper, 1981, p. 328).

Looking back, Woodger emerges as a leading exponent of the organicist school of philosophy of biology that flourished in the 1920s and 1930s, and as one of the primary advocates of theoretical biology long before the field existed as an independent discipline. Woodger's critical work had a decisive influence on Ludwig von Bertalanffy (another pioneer of theoretical biology), as well as on the members of his Theoretical Biology Club, which included prominent biological thinkers like Joseph Needham, Conrad Hal Waddington, John Desmond Bernal, Dorothy Maud Wrinch and Peter Medawar. Woodger's formal work was also influential, shaping the psychological investigations of Clark Hull and the taxonomical ventures of John Gregg, as well as providing the theoretical foundation for the cladistic classification system developed by Willi Hennig.

References

Anon (1960) Biology at Middlesex Hospital Medical School: Prof. J. H. Woodger. *Nature* **185** (4706): 75.

Gregg JR and Harris FTC (1964) *Form and Strategy in Science: Studies Dedicated to Joseph Henry Woodger on the Occasion of his Seventieth Birthday*. Dordrecht: D. Reidel Publishing Company.

Popper KR (1981) Obituary: Joseph Henry Woodger. *British Journal for the Philosophy of Science* **32** (3): 328–330.

Woodger JH (1924) *Elementary Morphology and Physiology for Medical Students: A Guide for the First Year and Stepping-stone to the Second*. Oxford: Oxford University Press.

Woodger JH (1929) *Biological Principles: A Critical Study*. London: Routledge & Kegan Paul Ltd.

Woodger JH (1930a) The 'Concept of Organism' and the relation between embryology and genetics, Part I. *The Quarterly Review of Biology* **5** (1): 1–22.

Woodger JH (1930b) The 'Concept of Organism' and the relation between embryology and genetics, Part II. *The Quarterly Review of Biology* **5** (4): 438–465.

Woodger JH (1937) *The Axiomatic Method in Biology*. Cambridge: Cambridge University Press.

Woodger JH (1931) The 'Concept of Organism' and the relation between embryology and genetics, Part III. *The Quarterly Review of Biology* **6** (2): 178–207.

Woodger JH (1939) *The Technique of Theory Construction*. Chicago: University of Chicago Press.

Woodger JH (1945) On biological transformations. In: Le Gros Clark WE and Medawar PB, (eds). *Essays on Growth and Form, Presented to D' Arcy Wentworth Thompson*, pp. 95–120. Oxford: Oxford University Press.

Woodger JH (1952) *Biology and Language: An Introduction to the Methodology of the Biological Sciences Including Medicine*. Cambridge: Cambridge University Press.

Woodger JH (1956) *Physics, Psychology and Medicine: A Methodological Essay*. Cambridge: Cambridge University Press.

Further Reading

Nicholson DJ and Gawne R (2014) Rethinking Woodger's legacy in the philosophy of biology. *Journal of the History of Biology* **47** (2): 243–292.