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Including Karl Popper's Medawar Lecture 1986 and Three Related Texts

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Introduction

Karl Popper, as a philosopher of science and sociology[1], is well known for his books *The Logic of Scientific Discovery* and *The Open Society and Its Enemies*. He is less well known for his many contributions to biology and more specifically to theories of evolution. His two books *The Self and Its Brain* and *Knowledge and the Body-Mind Problem*[2] were about mind, consciousness, and how individuals influence their own evolution. These books contain Popper's criticism of what he describes as modern materialism where all actions of the mind are reduced to neuronal processes. Popper discusses the emergence of language and the interaction and inter-connection between the human mind and the huge realm of objective knowledge that is fixed in our memories, in books, and in other media. This interaction of mind and knowledge is an essential part of how our brains work. It saves the human brain from being neuronally determined; it makes us unpredictable but not irrational. It gave us humans greatness, with the potential in each person to surpass him or herself by interacting with the world of knowledge. Thus, Popper's interaction theory is an important contribution to the biology of humans, even though no electrophoresis or centrifuge was deployed.

Popper's study of biology and evolution began when he was young and continued throughout his long life (1902–1994). His last interview, entitled 'Mind as a Force Field', was recorded just one month before his death.[3] Popper's biological contributions culminated in his Medawar Lecture, held on 12 June 1986, at the Royal Society in London. For nearly two decades this lecture was locked away as 'closed material' and is published here for the first time in English.

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[1] Popper (1934/1959); Popper (1945). Abbreviations used in this book: fn.: footnote; i. o.: in original; loc.: e-book location; KPS: the *Karl-Popper-Sammlung* archive, University of Klagenfurt, Austria. The first number after 'KPS' denotes the box, the second number the folder, followed by slash and page number. Square brackets in quotations contain insertions made by the author (H.J.N.)

[2] Popper (1977) and Popper (1994b).

[3] Popper (1994c).

The Medawar Lecture was about 'A New Interpretation of Darwinism'. It laid the groundwork for a new world view, based on new results of evolutionary and molecular biology: the main sources of nature's creativity are not Darwin's blind chance and natural selection but the problem-solving activity of all organisms and, in a later evolutionary stage, the curiosity, preferences, and anxieties of individuals. This lecture, its origin in Popper's troubled year 1986, and its impact are discussed in Chapter *II*: 'All Organisms Influence Their Own Evolution'.

In Chapter *I*, before this discussion, we look back on an episode in Popper's life, when in 1936, fifty years previous to this ground-breaking lecture, his biological interests were inspired by a group of young scientists who were on their way to becoming part of Britain's molecular biology avant-garde. Popper often remembered these biological meetings in the 'old windmill at Hunstanton'. Among the participants were future world-renowned intellectual leaders such as Desmond Bernal, a pioneer of X-ray crystallography and mentor of two Nobel Prize winners; John Haldane, known for his contributions to population genetics and theories about the origin of life; Conrad Waddington, the founding father of epigenetics; and the later Nobel Prize winner Dorothy Crowfoot Hodgkin.

In Chapter *III*, three of Popper's biological papers, which are printed in the Appendix for the first time, are discussed. This last chapter is an essay about the impact and the consequences of Popper's thoughts on molecular biology and evolution. It explains the distinction between information that can approach the DNA directly and new knowledge that cannot. It pursues Popper's thoughts about DNA as an inanimate molecule, and the cell as the factory of life. Both DNA and the cell are centres of knowledge, however, only the cell is the source of activity. The two new secrets of life are (*i*) the origin of matter's knowledge about itself, and (*ii*) the life-defining importance of pursuing goals. The essay goes back to the first molecular beginnings of acquiring new knowledge, as well as to the assumed first realisation of real activity or 'will' as a network of propensities. The two characteristics of primitive life are just the same as those which make our human way of life so rich and valuable: knowledge and activity.

Chapter *I.*

Karl Popper, Hunstanton Windmill, and the Beginnings of Molecular Biology

1. *The Old and the New Secrets of Life*

In the beginning of creation God made heaven and earth. “God said, ‘let there be light’, and there was light… God created man in his own image… male and female he created them, [he] blessed them and said to them, ‘Be fruitful and increase, fill the earth and subdue it, rule over the fish in the sea, the birds of heaven, and every living things that moves upon earth’”.[1] There is hardly a child in the world who has not heard this fascinating story about the origin of nature and man as described in the Book of Genesis. For nearly three thousand years this book remained by and large unchallenged. Then, on 24 November 1859, Charles Darwin’s book *The Origin of Species by Means of Natural Selection* was published. First some scientists and thereafter increasingly more people became convinced that Darwin’s ‘natural selection’ was the real cause of the variety of species and of their descent from one common root. Currently, there can hardly be a Christian, Muslim, Jew, or anyone else in the world who has not heard of this interpretation of the origin of life.

As the new believers understood Darwin, his theory of ‘natural selection’ had nothing to do with God or spirituality but only with pure coincidental mutations and a selection process resulting in the survival of the fittest.

The new world view spread rapidly, and where it superseded religion a ‘spirit-free’, or shall we say, ‘spirit-less’ mechanism of natural selection became a new ideology, no less ardently defended by its acolytes than religion had been. As a political ideology the idea of the *extermination of the less adapted* gathered momentum and became the guideline not just for biologists, but also for those who wanted to establish a kind of scientific foundation for nationalism, racialism, economics, and for the theory of social Darwinism.

[1] The New English Bible, Oxford (OUP) 1970, Genesis 1.

Beyond any ideology, scientists too defended Darwinism with their own objective thinking. A large body of evidence emerged to support the idea of natural selection. This included the Mendelian laws of inheritance, population genetics and the clarification of the genetic code written in the DNA. A hundred years after Darwin's famous book, his theory of natural selection was one of the best proved scientific theories ever developed.

However, even best-proved theories are not protected against either scientific objections or revolutionary new interpretations. The former came, of course, from science itself. The latter, with a completely new interpretation of the ideas of natural selection, came from the philosopher Karl Popper.

As the body of research on natural selection grew, biologists asked many new questions such as: how can all the admirable creations of evolution result from random mutations and DNA-copying errors which are mostly known as being detrimental? Would it not be the case that well-directed variations result in better adaptations at a faster pace? Why ever would nature have developed the beautiful, but badly-adapted and most unfavourable tail feathers of the peacock? How did it happen that some cloven-hooved animals finally got long necks after having indulged their appetite for high growing leaves over millions of years? How was the white speckled 'peppered moth' able to darken its colour corresponding to the new industrial blackening of their environment in a time span of only a few generations?

Two ideas emerged to save Darwin's theory. Firstly, the 'Baldwin effect' (1896) explained how the self-chosen environment could impose a selection pressure which favours adaptation to the self-chosen niche.[2] This explanation also applies to self-chosen behaviour, thus explaining the adaptation of the peppered moth, as well as the conspicuous decoration of the peacock's tail feathers. Secondly, 'population genetics' (developed 1918–1930) explained how some million years of slow evolution could be skipped by nature's invention of a gene pool that can be seen as a stock of thousand or more problem-solving solutions, available to resolve threats that may emerge due to illnesses or environmental catastrophe.

These new explanations supported Darwin's theory of evolution, based simply on the variation of inheritable material (later called the genome) and selection. Furthermore they seemed to provide strong evidence against Lamarckism, the theory of the inheritance of acquired properties. This theory was published by the French biologist Jean-Baptiste Lamarck (1744–1829) fifty years before Darwin's Origin of Species. It was defended by

[2] James Mark Baldwin (1861–1934), American philosopher and psychologist. The 'Baldwin effect' is named after him, meaning alterations of the genome occurring as a result of long-term living in a new ecological niche.

many biologists even up to fifty years after Darwin's great work. Labelled 'Lamarckism' this theory stands for the inheritance of newly acquired properties from one generation to the next. Lamarckism was strongly rejected by August Weismann, who in 1883 re-formulated Darwinism in a version which was more up-to-date and scientifically provable: 'there is no retroactive effect from an individual on its germ plasma'. This dogma, later called 'Weismann dogma' or the 'Weismann barrier'[3], was defended as a mainstream theory until well into the second half of the 20th century.

The famous philosopher Sir Karl Popper became fascinated by the idea that the Baldwin effect, while still based on Darwin's theory of variation and selection, can easily be interpreted as a process that indirectly conveys traits of the individual into its genome. This Baldwin effect is essential to Popper's philosophy of biology and deserves further explanation before I continue. It is based on the fact that individuals of the same species of plants or animals have slightly different genes. Some gazelles of a herd may have an altered gene which provides them with a slightly longer neck. Their lengthened necks enable them to eat leaves from trees while their relatives, without this handy gene, are bound to eat grass and leaves from bushes nearer to the ground. However, this altered gene would have been useless or even inconvenient had gazelles not also been led by their curiosity and their desire to search for a better world. Assume that the leaders of the herd preferred leaves growing on trees and often lead the entire herd away from grass land to the enticing trees. The poor grass eaters now had some trouble staying healthy and strong; while the long neck gazelles had more time and inclination for propagation. They produced more offspring, and after some generations only the long necked gazelles remained. This example is, of course, simplified for the sake of the illustration.

The Baldwin effect can influence evolution as long as there is a colourful mixture of genes available to support the preferences of the individuals. Such mixture comes from coincidental gene mutation and from copying mistakes when cells divide to change themselves into more cells. However, the main 'trick' of nature to establish a broad spectrum of slightly altered genes is sexual reproduction. As we all know, children inherit the genetic mix of both their parents. This results in the enormous gene pool where, among the seven billion humans on this earth, no two are the same.

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[3] August Weismann (1834–1914), German evolutionary biologist. Weismann's dogma was firstly formulated in an offprint of the series *Aufsätze über Vererbung und verwandte biologische Fragen. II. Ueber die Vererbung*, Jena (Fischer) 1883. See also below: chap. *III*, sect. *2*, *3*, and *5*.

Our simplified story tells us that the creativity of evolution does not come from blind chance and natural selection even though it is based on the mechanism of blind chance and natural selection. The initiative always comes from the preferences of the individuals. The Baldwin effect was not Popper's invention; but it was Popper who first saw clearly that the creativity of evolution comes from the activity, creativity, and knowledge of the individuals.

For a long time Karl Popper was not known as a philosopher of biology, and even today only few people would call him so. Wikipedia's table of 24 'notable philosophers of biology' does not list his name. This astounding lack of awareness can be explained from the fact that Popper was generally considered either as a philosopher of science or as a philosopher of sociology due to his two famous books 'Logik der Forschung' (1934), first published in English as 'The Logic of Scientific Discovery' in 1959, and 'The Open Society and Its Enemies' (1945). Nevertheless, since the early sixties and throughout his lifetime, Popper developed a series of important and progressive ideas about evolution and Darwinism, and even made some significant contributions concerning the origin of life. In a postscript to one of Popper's works in German language, I reviewed forty of his, published or archived, biologically relevant works and referred to a further sixty smaller contributions. In this book, I will continue my endeavour to establish him as an eminent philosopher of biology.

In Popper's view, the direction of an organism's evolution can be attributed much more to the Baldwin effect and the preferences of organisms than to the Darwinian process of variation and natural selection. At the same time, Popper does not deny that the Baldwin effect is consistent with Darwin's theory. Thus, rather unnoticed, a new kind of spirituality is mingled with the well-known Darwinian mechanism of evolution, namely the individual's curiosity: its wishes, problem-solving capacity and unceasing search for a better environment. Alluding to one of Popper's book titles, all organisms influence their own evolution by being endlessly 'In Search of a Better World'.

However, after the overwhelming success in explaining evolutionary processes by Darwin's 'variation and selection', and after Darwinism had triumphed over so many religious and Lamarckian opponents, anyone who tried to rehabilitate any kind of Lamarckism had a hard time. To think of acquired properties or of acquired behaviour as inheritable was considered a sin against the new biology. This theory of evolution, with a molecular foundation established since the 1930s, was on its way to being on a par with the exact science of physics.[4] In contrast, Lamarckism was increasingly rejected as sheer superstition.

Small wonder that even among scientists of the new molecular biology, the beginning of a fundamental turning away from pure Darwinism to new theories about cases of inheritance of acquired properties was either virtually ignored or strongly opposed. Thus, not only philosophers, but even pioneers of molecular biology (the discipline concerned with the biochemistry within the cell) had a long wait for general recognition: Conrad Waddington's 'epigenetics' (1942); Barbara McClintock's genetic control mechanisms (1944); Lynn Margulis' co-operating genes (1967); or the many others who discovered the role of histones in the gene regulatory network in the 1980s.

Only gradually was the inheritance of some acquired properties accepted among scientists. The role of chance in selection ceased to be the only mechanism fundamental to shaping living creatures or determining the course of evolution. As is inevitably the problem with best-sellers and the popular press, there was an untimely delay of several decades before the flashes of genius were followed by claps of thunder. In fact, it took until after 2000 before the wave of public recognition led to popular science books eventually coming up with titles like 'How experiences are passed on', 'How our way of life controls our genes', or 'How environment shapes our genes'.[5]

Even this new biology leaves some questions of life unanswered. The more we know about the way the cell manages the genome, the more new questions arise. The more we discover about the genome being like a big notebook where the *when*, *where* and *how* of protein synthesis are listed, the more we ask: what is the innermost core of the cell's activity? How is it that the cell reads some text and yet makes other text illegible? How became the cell able to mark important passages or even to double these texts; or to reproduce damaged texts by using a copy, while protecting long passages from any changes in order to use them unaltered for hundreds of millions of years? Where does the cell get all its knowledge from? Knowledge and activity: is it all explicable as pure chemistry? These questions seem to be philosophical ones, and some argue they are of no great interest to biologists. However, some scientists are interested in entering into this debate in an attempt to give answers.

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[4] Kegel (2009), Introduction.

[5] A selection: Bauer (2008) and (2013), Carey (2012), Francis (2012), Kegel (2009), Lane (2010), Jablonka (1999) and (2005), Ridley (2004), Shapiro (2011), Spork (2009).

2. *Karl Popper's Medawar Lecture 1986*

This is where Karl Popper and his philosophy of biology come into play. In 1986, Popper delivered his Medawar Lecture to the Royal Society, London. This lecture was a significant event in the 1986 calendar of the Royal Society, and a highlight in Popper's philosophy of biology. It is published for the first time in English in this book (Appendix *A*) after a German version preceded it last year. It was held some fifty years after Popper first began to ponder over the problems of biology that had preoccupied him since childhood. His theories started to take shape in 1935 and 1936 when he met a bunch of young scientists highly involved in what is known today as modern molecular biology. In the following sections of this chapter, I will give more details of Popper's encounter with these avant-garde biologists of Cambridge and London who later became quite famous. Thereafter I will say something about Popper's Medawar Lecture, about its origin, its argument, and its relevance to today's philosophy of biology and even to the whole discipline of biology.

Even today, indeed nearly three decades after Popper's lecture, the bio-philosophical questions posed at the end of Section *1* are not fully answered and the new secrets of life are not yet revealed: What is the origin of the activity that forms the basis of all life, of its aims, purposes and problem-solving capacities? What is the origin of the growth of knowledge in the cells, knowledge in each cell that equals the contents of a big library?

In looking to answer these questions, I refer to Popper's theory of knowledge. From this well-known and widely-accepted theory we can appreciate that it is impossible to get new knowledge by simply collecting facts. It is impossible because, as Popper explains, knowledge can only be achieved through the exploration of theories and expectations. Knowledge is gained by establishing a theory or expectation, and then checking it for veracity. When an assumption remains unrefuted, it contributes to the growth of knowledge. This method of trial and error elimination, based on logical reasoning, is the only possible method to gain new knowledge about the world or the environment, for both brains and living systems like cells, plants, or animals: "There [is] no other way into the unknown, for logical reasons"[6], said Popper.

I will explain shortly why the only way to get new knowledge about the world is by this method of trial and error. Let us consider *Homo erectus* when he, for the first time ever, ate one mushroom and then a second one

[6] Popper (1974a), last paragraph of chap. 12, in original: 'was' instead of 'is'.