

Philosophy? On Ernst Mayr's "New Philosophy of Biology"

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Abstract: Ernst Mayr is a well-known biologist and philosopher in the twentieth century. Being a biologist, he is an important person in constructing the synthesis theory of evolution; being a philosopher, he has advocated a new philosophy, which, he claims, synthesizes the achievement of different biologies and physics, while at the same time getting rid of the influences of the traditional philosophy of science. In this essay, I will systematically investigate the main principles and the basic scheme of his new philosophy. I find that Mayr's new ideas of philosophy of biology can be summarized as the following five statements: The physical science is not the standard paradigm of the whole science; The historical narratives are more important than the explanation of laws; The explanation and the prediction are asymmetrical in life science; Concepts are more essential than laws in biology; There is no conflict between causality and teleonomy.

Key Words: Ernst Mayr, Pilosophy of Biology, Philosophy of Science

1. Introduction

As we know, philosophy of science must be rooted in the soil of science, including physical science and biological science. It is regretful, however, that the philosophy of science before the middle of twentieth century was almost entirely based on physical science. Early in the middle of nineteenth century, Darwin had already said that the development of biology would bring philosophy into prosperity, but either the positivism of the time or the logical positivism arising in the beginning of twentieth-century borrowed almost no ideas from biology. It seemed that for a long time biological thought had not made any influences on philosophy. From the middle of the twentieth century, because of the revolution of the molecular biology and the new syntheses of the evolutionary theory, things began to change. More and more philosophers began to pay attentions to biological ways of thinking, and developed new ideas based on biology. From then on, philosophy of biology became a hot discussion area in the philosophy of science. Theses and works began to spring up.

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Among these thinkers, American biologist and philosopher Ernst Mayr is a leading figure. His new philosophy of biology and philosophy of science become influential theories. As we already know, being a biologist, he is an important person in constructing the synthesis theory of evolution; being a philosopher, he has advocated a new philosophy, which, he claims, synthesizes the achievement of different biologies and physics, while at the same time getting rid of the influences of the traditional philosophy of science. What kind of influences does biological science bring into philosophy? What does biological science provide for contemporary philosophy? What is the main scheme of Mayr's new philosophy? From his first philosophical paper (1961) to his last book *What Makes Biology Unique?* (2004) Mayr had tried to answer these questions. This paper will explore the core ideas of his new philosophy of biology.

2. Physical science is not the standard paradigm of science

According to Mayr, physical science represented by the classical mechanics first grew after the modern scientific revolution. At that time, however, biology was still in the stage of germination. And it had not developed until the middle of nineteenth century. Consequently, the ideas and methods of physical science naturally became the yardstick of all science. Most philosophers naturally saw physical science as the norm of science. They thought that once we understand physics, we understand any other sciences. This tradition continues to influence philosophy today. Mayr refers to this regretfully: "Since the scientific revolution, the philosophy of science has been characterized by an almost exclusive reliance on logic, mathematics, and the laws of physics (Mayr 1988, v)." He also says that all the works claimed being "philosophy of science" actually deal only with physical science (Mayr 1982, 33). It seems that there is no lively organic world; it seems that the theoretical achievements made by biologists do not have any influence on human philosophical thought. Therefore, Mayr points out, we must establish a new philosophy. The first task of this new philosophy is to get rid of the influences of physicalism.

How do we get rid of this influence? Mayr suggests that we first should change our traditional beliefs about the unity of science, and properly emphasize the plurality of science, namely that we should notice that physical science and biological science are not the same science. People often believe that Newton and physical law are co-extensive with science, but early before seventh century there were several other traditions of science that virtually had nothing to do with Newtonian mechanics (Mayr 1982: 33). For instance, natural history was just a tradition that was quite different from Newtonian tradition. Later, "Physiology lost its position as the exclusive paradigm of biology in 1859 when Darwin established evolutionary biology. When behavioral biology, ecology, population biology, and other branches of modern biology developed, it became even more evident that how unsuitable mechanics was as the paradigm of biological science (Mayr 1988: 12)."

Advocating the autonomy of biology and opposing the unity beliefs of the physicalism, one must refute the theoretical foundation of the physicalism: reductionism. Physicalists believe that the autonomy of the biological science is only superficial. In principle, all biological theories can be reduced to physical theories. But according to Mayr, reduction leads to no result and is nonsensical method. For at different level of the biological hierarchical system, there will emerge new properties. Though both the higher levels and lower level of the hierarchical system are composed of atoms and molecules, the processes on higher level are often independent of the processes of lower levels. Mayr therefore points out, there are different problems at different levels, and we should raise different theories at each level. In this way, each level will lead to independent biological branch,

from macromolecular level to organelle, cell, organ and others: at molecular level is molecular biology, cellular level is cytology and tissue level is organism biology, etc. Thus, in order to interpret life phenomena sufficiently, we must do research on every level.

Of course, when criticizing physicalism, Mayr does not completely abandon the belief of the unity of science. He says: "When confronted by mythology or religion, science offers a unified front. All sciences, in spite of manifold differences, have in common that they are devoted to the endeavor to understand the world. Science wants to explain, it wants to generalize, and it wants to determine the causation of things, events and processes. To that extent, at least, there is a unity of science (Mayr 1982: 32)." But such unity has nothing to do with the reductive unity of physicalism. When criticizing the unity view of physicalism, biologist Simpson raises a completely different view. He says: "Biology, then, is the science that stands at the center of all science ... And it is here, in the field where all the principles of all sciences are embodied, that science can truly become unified (see Mayr 1982: 35)." After citing Simpson's words, Mayr points out, we might not agree with all Simpson's viewpoint, but we could see Simpson clearly showing to us the ongoing direction of the unity of science. He says: "I believe that a unification of science is indeed possible if we are willing to expand the concept of science to include the basic principles and concepts of not only the physical but also the biological science. Such a new philosophy of science will need to adopt a greatly enlarged vocabulary---one that includes such words as biopopulation, teleonomy, and program. It will have to abandon its loyalty to a rigid essentialism and determinism in favor of a broader recognition of stochastic processes, a pluralism of causes and effects, the hierarchical organization of much of nature, the emergence of unanticipated properties at higher hierarchical levels, the internal cohesion of complex system, and many other concepts absent from---or at least neglected by---the classical philosophy of science (Mayr 1988: 21)."

3. The historical narratives are more important than explanations of laws

According to traditional philosophy of science, the basic form of scientific explanation is to cover the needing explanatory events under a law or laws. What is law? From epistemological point of view, law is a kind of statement as follows: (1) it contains a universal determiner, not referring to any specific time, place and individual; (2) it has empirical content and obtained confirmation; (3) it is subordinate to a more general theory, and thus has theoretical assurance. The first requirement is criterion of "universality", the second is "verifiability", and the third is "coherence". Physicalists believe that any branch of science that deserves to be a real science must have a series of such laws.

In term of such requirements, J. J. C. Smart claimed that only physics and chemistry have universal laws; biological science has no laws (see Mayr 1982). Well-known philosopher Karl Popper also believed that there are no laws in biology (see Mayr 1982). Popper thought that because the evolution of life on the Earth and the evolution of human society are unique historical processes, the descriptions of evolution are not laws, but only single historical statements. Popper therefore claimed that finding the "invariable order" and "laws" of evolution is impossible. Some philosophers even began to doubt the scientific status of evolution.

Mayr also believes that there are no laws in biology, but he does not deny the scientific status of evolutionary theory. Instead, he suggests that we should change our traditional ideas about science. Mayr holds that the so-called biological laws people often talk about are not universal, because they all have exceptions. He says there is only one universal law in biology: "all biological laws have exceptions (Mayr 1982, 38)." Mayr thinks that because the events biology tries to describe are

historically unique, the biological generalization is probabilistic. Every life form is related to history, and therefore it has unique features. This means that the explanation of life phenomena is not the same as that in physical science. As a matter of fact, Mayr thinks that the ideas of laws are the inevitable result of the false view of essentialism.

Essentialism was developed by Plato and had dominated the thinking of west philosophical thought from then on. According to essentialists, the variable phenomena world is the reflection of the invariant essences. These essences are what is real and important in this world. The variation of the real world is only the imperfect manifestation of the underlying essences. Invariability and discontinuity are especially emphasized by the essentialists. Mayr suggested that such kinds of ideas must be replaced by the new ideas of population thinking. Opposite to essentialism, population thinking believes that the important thing is not essence, but individual. Many biological phenomena, especially population phenomena are characterized by extremely high variances. Rates of evolution or rates of speciation may differ from each other by three to five orders of magnitude, a degree of variability rarely if ever recorded for physical phenomena. Entities in the physical world have constant characteristics, while biological entities are characterized by their changeability. Such kind of specificity in biological entities tells us that we must use a new kind of thinking for investigating biological phenomena which is completely different from the thinking for investigating entirely homogeneous lifeless things. What does this new thinking looks like? According to Mayr, traditional thinking emphasizes invariance and essence, whereas the new thinking emphasizes uniqueness and history. Therefore Mayr claims, the new philosophy of biology “should not focus most of its attention on laws, considering what small roll laws actually play in much of biological theories (Mayr 1982: 76).”

If laws are not important in the explanation in biology, then how does the biological explanation proceed? Mayr thinks, the more important explanation in biology is the historical narratives. He says: “it might have been evident soon after 1859 that the concept of law is far less helpful in evolutionary biology (and for that matter in any science dealing with time-dominated processes such as cosmology, meteorology, paleontology, or oceanography) than the concept of historical narratives.” (Mayr 1982: 130) T. A. Goudge once said: “narrative explanations enter into evolutionary theory at points where singular events of major importance for the history of life are being discussed ... Narrative explanations are constructed without mentioning any general laws ... Whenever a narrative explanation of an event in evolution is called for, the event is not an instance of a kind [class], but is a singular occurrence, something which has happened just once and which can not recur [in the same way] ... Historical explanations form an essential part of evolutionary theory(from Mayr 1982: 71)”. Mayr agrees with this idea. According to Mayr, historical narratives have explanatory value because earlier events in a historical sequence usually make a causal contribution to later events .Thus one of the objects of historical narrative is to discover causes responsible for ensuing events. However, he states, “philosophers trained in the axioms of essentialistic logic seem to have great difficulty in understanding the peculiar nature of uniqueness and of historical sequences of events. Their attempts to deny the importance of historical narratives or to axiomatize them in terms of covering laws fail to convince(Mayr 1982: 72).” Therefore Mayr concludes: “The so-called laws of biology are not the universal laws of classical physics but are simply high-level generalizations.” He continues, as Kitcher has stated: “there are a number of sciences that proceed extraordinarily well without employing any statements which can uncontroversially be called laws (Mayr 1988: 19).”

4. Explanation and prediction in biology are asymmetrical

According to the physicalists' model of explanation, i.e., the "deductive-nomological theory" (or covering-law model), explanation and prediction are symmetrical. Such a model can be diagrammatically represented as follows:

- | | |
|---|-----------------------|
| (1) $L_1 \cdot L_2 \cdot L_3 \dots L_n$ | Explanatory statement |
| (2) $C_1 \cdot C_2 \cdot C_3 \dots C_k$ | |
| | |
| (3) E | Explanatory object |

Where, $L_1 \cdot L_2 \cdot L_3 \dots L_n$ are law-like universal statements, $C_1 \cdot C_2 \cdot C_3 \dots C_k$ is particular statement concerning about the initial or premise conditions, E is deductive result, and also is the object to be explained. That is to say, if E is known and E can be deduced from (1) and (2), then E is explained. Otherwise, if (1) and (2) is known, and (3) can be deduced from (1) and (2), then (3) is a predictive result. This implies that the explanation and prediction in physical science are symmetrical. Thus, if a scientific theory can make good prediction, its explanatory value is also high; on the other hand, if its explanatory value is high, then it can make good predictions.

Mayr believes, such parlance does not fit biology. He states: "the theory of natural selection can describe and explain phenomena with considerable precision, but it cannot make reliable predictions, except through such trivial and meaningless circular statements as, for instance: 'The fitter individuals will on the average leave more offspring'" He continues for supporting Scriven's idea: "one of the most important contributions to philosophy made by the evolutionary theory is that it has demonstrated the independence of explanation and prediction (Mayr 1988, 31-32)."

Of course, Mayr holds that the asymmetry of explanation and prediction does not exclude that there are also predictions in biology. Biologists will be very happy if their causal explanations simultaneously have high predictive value. There are many kinds of predictions in biology, such as prediction in classification, prediction of physicochemical phenomena on molecular level, prediction of the outcome of complex ecological interactions and prediction of evolutionary events, etc., but nearly all of these predictions are statistical. The reasons for the statistical characteristics of biological predictions are as follows: (1) biological events are always randomness, and many processes are indeterminate; (2) biological entities are unique, and there are no laws for these unique entities; (3) biological entities are extremely complex, and this complexity makes us quite difficult to describe them completely; (4) emergence of new qualities at higher levels of integration makes it impossible to predict just from the properties of the components. Mayr thus points out that though predictive ability in physical science is the touchstone of the goodness of a causal explanation, in biology it is not a prerequisite of a good biological theory (Mayr 1988: 33-35).

5. Concepts in biology are more essential than laws

If laws in biology are not important, as Mayr emphasizes time after time, then how does biology develop its theories? Mayr claims that though biology does not, like physics, raise laws to develop its theory, biologists often organize their generalizations into a framework of concepts. One might say that law versus concept is only a formal difference, since every concept can be translated into one or several laws. But Mayr thinks that even if this were formally true, such a translation would not be helpful in the actual performance of biological research. Why not? Mayr thinks, "laws lack the flexibility and heuristic usefulness of concepts (Mayr 1982: 43)." Since biologists always

generalize their conclusions into conceptual framework, the progress in biological science is largely a matter of the development of these concepts or principles. Though the discovery of new fact is also an important symbol of scientific progress, in evolutionary biology, major progress is made by introducing new concepts or improvement of existing concepts. As he says, “our understanding of the world is achieved more effectively by conceptual improvements than by the discovery of new facts, even though the two are not mutually exclusive (Mayr 1982: 23).” For instance, plant breeders had already discovered the ratios of 3:1 many times before Mendel. Even Darwin had obtained a number of such ratios in his plant-breeding work. Nevertheless, all this was meaningless until Mendel introduced the appropriate concepts and until Weismann introduced additional concept that made Mendelian segregation more meaningful. This is much truer for evolutionary biology and systematics than for functional biology. Mayr points out, one can easily take almost any advance in these areas and show that it did not depend as much on discoveries as on the introduction of improved concepts. Mayr thus says: “the contributions made by new concepts or by the more or less radical transformation of old concepts is equally and often more important than facts and their discovery(Mayr, 1982: 24).” Why do the improvement of concepts and the posing of new concepts advance biology? The reason Mayr gives is that these concepts can help to clarify a previously confusing area of biology and can lead to new theory formation and countless new investigations. For instance, many phenomena now explained by natural selection were widely known long before Darwin, but the explanations to these phenomena at that time were very confused. Until concepts like evolution, common descent, geographic speciation, isolating mechanism, and natural selection were introduced into biology, the primary confusion situation obtained reoriented, and the natural selection theory gained strong explanation power. Meanwhile, a lot of biologists were brought into the area of research of evolutionary theory (Mayr 1982: 24).

How do we improve the biological concepts? According to biological development, Mayr raises several kinds of methods for improving concepts: (1) eliminating invalid theories and concepts; (2) eliminating inconsistencies and contradictions; (3) importing from other fields; (4) eliminating semantic confusions; (5) eclectically fusing competing theories (Mayr 1982: 840-843).

In a word, Mayr thinks, “progress in the biological sciences is characterized not so much by individual discoveries, no matter how important, or by proposal of new theories, but rather by the gradual but decisive development of new concepts and the abandonment of those that had previously been dominant (Mayr 1982: 856).”

I think Mayr does a good work to emphasize the important role of concepts in the development of biology. But this is right for all sciences. Concept change is a feature of the development of any science. It isn't peculiar to biology.

6. There is no conflict between causality and teleonomy

When talking about the relations between biology and other science, Mayr advocates that we should properly emphasize the plurality of sciences. He believes that the physicalists' views of the unity of science are false and that biology is an autonomous science. Likewise, when talking about the characteristics of biological science itself, Mayr thinks that biology itself also is not a homogeneous, unified discipline. Rather, it is a heterogeneous, diverse subject. For biology can be divided into the study of proximate causes, the subject of physiological or functional biology, and into the study of ultimate causes, the subject of natural history or evolutionary biology.

Mayr points out, functional biologists are vitally concerned with operation and interaction of structural elements, from molecules up to organs and whole individuals. His ever-repeated question is “how?” How does something operate? How does it function? On the contrary, evolutionary biologists are vitally concerned with why an organism is the way it is. Their basic question is “Why?”

It is evident that the causations functional biology and evolutionary biology are concerned with are remarkably different. Functional biologists are concerned with “proximate cause”, whereas evolutionary biologists are concerned with “ultimate cause” or “evolutionary cause”. Proximate causes relate to the functions of an organism and its parts as well as its development, from morphology to biochemistry, whereas ultimate causes, evolutionary causes or historical causes attempt to explain why an organism is the way it looks like. We may ask: why do organisms have two different causes? Mayr’s answer is: organisms have a genetic program. Proximate causes are concerned with decoding the genetic program of a given individual, whereas evolutionary causes are concerned with changes in the genetic program through time and the reasons for these changes.

Mayr holds that physical science only investigates proximate causes, for “why” questions in the sense of “for what” are meaningless for lifeless objects. We can ask: “why the Sun is hot?” But this is only in the sense of “how to occur”. In contrast, “why” questions in life sciences have great methodological value. The question “why are there valves in vein?” conducted Harvey finding blood circulation. For these reasons, Mayr holds that we can raise questions about the meaning of biological processes through two ways: First, to ask the functions of the biological structures; second, to ask the origin and developmental reasons of biological processes. Thus evolutionary biologists must often raise “why” questions if they want to know the reasons for biological evolutions.

Since we often ask “why” questions in biology, Mayr thus suggests that we must rethink the teleological problems. As we know, Aristotle was the first person who systematically brought up teleological thought. He thought that the teleological cause is an important reason for the development and changes of things. From the beginning of modern science, Galileo, Bacon and Descartes strongly criticized Aristotle’s teleological thought. However, Harvey established blood circulation theory by asking what the purpose of the activity of the heart is (i.e. “why” question), nearly at the same time Galileo claimed that the major aim of scientific research was to solve “how” questions rather than “why” questions. Thereafter, there had been a debate between extreme mechanism and extreme vitalism in biology. With the development of biology, more and more biologists found that teleological explanation widely existed in biology. It is under this circumstance that Mayr also aggressively justifies the rationality of teleological explanation that exists in biology. To begin with, he analyses traditionally how people misconstrue Aristotle, regarding him as a cosmic teleologist. Mayr thinks that this is completely wrong. He points out, Aristotle actually was first and foremost a biologist, and “it was his preoccupation with biological phenomena which dominated his ideas on causes and induced him to postulate final causes in addition to the material, formal, and efficient causes (Mayr 1988: 29).” What is the essence of teleological causes or final causes? Biologist Delbruck once said that if we employ modern terms like genetic program for *eidos*, then we can relevantly understand Aristotle’s original idea. Mayr thinks that such opinion is quite true. He claims that Aristotle’s *eidos* is totally different from Plato’s *eidos*: “Aristotle saw with extraordinary clarity that it made no more sense to describe a house as a pile of bricks and mortar. Just as the blueprint used by the builder determines the form of a house, so does the *eidos* (in

Aristotelian definition) give the form to the developing organism, and this *eidōs* reflects the terminal *telos* of full-grown individual (Mayr 1988: 56).”

Of course, Mayr knows that Aristotle was unable to know what indeed *eidōs* is, but modern science reveals that it is “genetic program.” Mayr believes that all teleonomical processes in biological world actually are programmed processes. Thus Mayr claims that “the existence of telonomic programs ... is one of the most profound differences between the living and the inanimate world, and it is Aristotle who first postulated such a causation (Mayr 1988: 57).”

In conclusion, Mayr holds that “the use of so-called teleological language by biologists is legitimate (Mayr 1988: 59);” “Teleonomic (that is, programmed) behavior occurs only in organisms (and man-made machines) and constitutes a clear-cut difference between the levels of complexity in living and in inanimate nature (Mayr 1988: 60);” “the heuristic value of teleological *Fragstellung* makes it a powerful tool in biological analysis (Mayr 1988: 60).” Of course, Mayr does not deny that there are false conclusions in Aristotle’s teleology, but he thinks that “Aristotle’s error was not that he used teleological explanations in biology, but that he extended the concept of teleology to the nonliving world (Mayr 1988: 56).”

7. Conclusion: toward a new philosophy

In his tremendous amount of papers and works, Mayr also refers many other philosophical theses, such as, the questions about the ontological status of species, the problem of the unit of natural selection, biology and human value, etc., but his main philosophical principles are as we discussed above.

In his famous book *The Growth of Biological Thought*, Mayr summarizes his main ideas as follows: (Mayr 1982, 75-76)

“(1) That a full understanding of organisms cannot be secured through the theories of physics and chemistry alone.

“(2) that the historical nature of organism must be fully considered, in particular their possession of an historically acquired genetic program;

“(3) that individuals at most hierarchical levels, from the cell up, are unique and form populations, the variance of which is one of their major characteristics;

“(4) that there are two biologies, functional biology, which asks proximate questions, and evolutionary biology, which asks ultimate questions;

“(5) that the history of biology has been dominated by the establishment of concepts and by their maturation, modification, and—occasionally—their rejection;

“(6) that the patterned complexity of living systems is hierarchically organized and that higher levels in the hierarchy are characterized by the emergence of novelties;

“(7) that observation and comparison are methods in biological research that are fully as scientific and heuristic as the experiment;

“(8) that an insistence on the autonomy of biology does not mean an endorsement of vitalism, orthogenesis, or any other theory that is in conflict with the laws of chemistry or physics.”

From these, we can conclude that the main goal of Mayr’s new philosophy is to emphasize the autonomy of biological science. Actually he is one of the founders of the autonomism (versus provincialism) of philosophy of biology. Being a biologist who has done research on the macro-biological problems for decades, Mayr deeply realizes that biology, especially evolutionary biology

has a unique research tradition and conceptual framework. Thus he strongly opposes physicalism, essentialism and reductionism. In the process of summarizing the characteristics and ways of thinking of biology, Mayr raises many new ideas with independent thinking, and there are no lacks of profound insights. He himself already said in his *The Growth of Biological Science*, “biologists like Rensch, Waddington, Simpson, Bertalanffy, Ayala, Mayr, and Ghiselin have made a far greater contribution to a philosophy of biology than the whole older generation of philosophers, including Casirer, Popper, Russell, Bloch, Bunge, Hempel, and Nagel (Mayr 1982: 75).” Indeed, Mayr’s contribution to philosophy of biology is enormous, and he also is creditably one of the greatest thinkers of philosophy and biology. But we should also aware that his thought is only one school of contemporary philosophy of biology. Some of his arguments still need to be developed and some of his conclusions may not correct.

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