The Nature of Science in Biology: A Resource for Educators

Editor: Dr. Thomas J.J. McCloughlin FLS FRSB

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Figure 1
Caption: Six-year old Henry Wicklin with smallpox in Gloucester in 1896. Wellcome Images V0031456.
Source: Downloaded from https://commons.wikimedia.org/wiki/File:Gloucester_smallpox_epidemic,_1896;_Henry_Wicklin,_aged_6_Wellcome_V0031456.jpg.

Figure 2
Caption: The Gillray cow-pock cartoon of 12 June 1802. Library of Congress, Prints & Photographs Division, LC-USZC4-3147.
Source: Downloaded from https://commons.wikimedia.org/wiki/File:The_cow_pock.jpg.

Figure 3
Caption: A banner at the storming of the US Capitol on 6 January 2021. Taken by Tyler Merbler.
Source: DSC09488-2. Downloaded from https://commons.wikimedia.org/wiki/File:2021_storming_of_the_United_States_Capitol_DSC09488-2_(50812780957).jpg.

Darwin's Theory of Evolution by Natural Selection in the Origin of Species and the Research Community in the Voyage of the Beagle

All figures reproduced with permission from John van Wyhe (ed.) (2002). The Complete Work of Charles Darwin Online Downloaded from http://darwin-online.org.uk/

Contents

Alexander von Humboldt on Evolution of Natural Species

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Abstract

The aim of this paper is to analyse Alexander von Humboldt's views on the theory of evolution and tackle the following question: Can Humboldt be considered an evolutionist? I seek to show that Humboldt acknowledges three essential Darwinian elements of the theory of evolution: fossil records, the geographical distribution of species and the struggle for survival. Further, Humboldt recognises a special relation between the natural environment and organic life, and understands it in light of his naturalistic holism. This holism reveals the unity of organic and inorganic nature and highlights the agency of organic life whilst allowing it to create and preserve the adaptive conditions in the natural environment. Accordingly, I argue that Humboldt believes some kind of evolutionary process happens in nature. However, due to the immense influence of Kant's transcendental study and the rigid utilisation of the empirical method, Humboldt concludes that we cannot acquire knowledge of the exact course of the evolutionary process. This, however, does not imply Humboldt discredits the theory of evolution.

***Keywords*:** Theory of evolution, struggle for survival, natural environment, Kant, Darwin

Apstrakt:

Cilj ovog rada predstavlja anliziranje stavova Aleksandra fon Humbolta o teoriji evolucije, kao i razmatranje sledećeg pitanja: da li se Humbolt može smatrati evolucionistom? Pokušaću da pokažem da Humbolt prepoznaje tri suštinska darvinovska elementa teorije evolucije: evidenciju putem fosila, geografsku rasprostranjenost vrsta i borbu za opstanak. Povrh toga, Humbolt uočava specifičnu relaciju između prirodne sredine i organskog života koju tumači u svetlu svog naturalističkog holizma. Ovaj holizam nam otkriva jedinstvo organske i neorganske prirode i naglašava delovanje organskog života, dok mu istovremeno omogućava da kreira i održava adaptivne uslove u prirodnoj sredini. Shodno tome, smatram da Humbolt veruje da se nekakav evolucioni proces dešava u prirodi. Ipak, zahvaljujući snažnom uticaju Kantovog transcendentalnog učenja, kao i stroge upotrebe empirijskog metoda, Humbolt zaključuje da ne možemo imati znanje o tačnom toku evolucionog procesa. Ovakav zaključak, pak, ne podrazumeva i potpuno diskreditovanje teorije evolucije.

Ključne reči: teorija evolucije; borba za opstanak; prirodna sredina; Kant; Darvin;

Introduction

When Darwin introduced his theory of evolution, the history of biological sciences marked one of the greatest scientific revolutions.[15] Darwin shook the foundations of traditional doctrines about the existence of eternal species, substance, etc.; his theory disproved the view which argued fossil shells are entities initially created in stone. Nevertheless, the idea of the evolution of natural organisms circulated long before Darwin finally formulated his theory.[16] And, as expected, opinions were different. Whilst some scientists, e.g., Lyell, have dismissed the possibility of the evolution of natural species, others argue that evolution is the best explanation for the observed similarities between different organisms.[17]

In this paper, I explore the thoughts of an author whose viewpoint on the evolution of natural species appears to be overlooked in literature. Alexander von Humboldt was an investigator and scientist who, due to his results in the field of biogeography, was proclaimed the 'father of modern geography'. It is well known that Darwin expressed admiration for Humboldt, yet it seems that many contemporary authors overlook that Humboldt considered the question of evolution long before Darwin. At first glance, Humboldt's answer to the question about the possibility of evolution of species seems nullifying. However, I believe this impression is fallacious.

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[15] I would like to thank the organisers of the Dublin City University conference for allowing me to share my research with colleagues who are equally enthusiastic about interdisciplinary research. Finally, I am grateful to Slobodan Perovic for his insightful comments and immense support during my research.

[16] In his work, *Protogaea*, Leibniz presents his study of fossil records and reflects on their origin and similarity with living species (Leibnitz, 2008).

[17] Although he spoke of gradual natural changes caused by the action of natural forces, Lyell remained an anti-evolutionist throughout his life. Recognising that the struggle for survival happens in nature, and that organisms must adapt to the changing conditions of various ecosystems, Lyell was close to formulating the basic thesis of Darwin's theory. Nonetheless, without insight into the evolutionary context of the struggle for survival, Lyell turned to God, the great "Author of Nature" and claimed He maintains the "harmony of nature"; with His actions alone, God prevents the complete extinction of the organic world (Lyell, 1832). As an example of the scholar who was an evolutionist in Darwin's time, we can mention Joseph D. Hooker (1817-1911), whom Darwin himself mentions in *On the Origin of Species* (Darwin, 2008).

Thus, I show that Humboldt concluded that *some kind* of evolutionary process happens in nature, yet it appears that we cannot acquire knowledge of the exact course of such a process. Namely, Humboldt acknowledges three essential elements of Darwin's theory of evolution: fossil records, the geographical distribution of natural species and the struggle for survival. Nonetheless, due to the immense influence of Kant's transcendental study and the limits of the empirical method, Humboldt concludes that we cannot obtain the knowledge about the evolution of organisms.

Humboldt on Evolution

When approaching the analysis of Humboldt's stance on evolution of species, one should not overlook that Humboldt's research is not directed towards this problem. Humboldt seeks to represent a *holistic* understanding of the natural system reflected in its "unity in diversity, and of connection, resemblance and order, among created things most dissimilar in their form". (Humboldt, 2010, p. 5). Accordingly, we can say Humboldt's theory represents a natural system whose maintenance depends on the mutual functional connection of its parts. The role of the organic world is recognised in such a system because the living world manifests the same forces we see operating in inorganic nature (Humboldt, 2010, p. 339).

Humboldt is an empiricist; he employs an empirical method which enables us to reach the knowledge about the connection and action of natural forces "in all that presents itself to our observation" (Humboldt, 2010, p. xxii). At the same time, Humboldt acknowledges the limitations of this method and argues that complete knowledge of natural phenomena is (and will remain) unattainable:

> Experimental sciences, founded on observation of the external world, cannot aspire to completeness; the nature of things and the imperfection of our organs are alike opposed to it. We shall never succeed in exhausting the inexhaustible riches of nature, and no generation of men will ever be able to boast of having comprehended all phenomena.
>
> (Humboldt, 2010, p. 59)

Limits of empirical method and our cognitive apparatus seem to be the reason why we cannot discover the origin of natural species:

> In the vegetable as well as in the animal kingdom, the causes of the distribution of the species are among the number of mysteries, which natural philosophy cannot reach. This science is not occupied in the investigation of the origin of beings, but of the laws according to which they are distributed on the globe... But it [natural philosophy] approaches not problems, the solution of

> which is impossible, since they touch the origin, the first existence of a germ of life.
>
> (Humboldt, 1821, pp. 180-181)

Thus, Humboldt believes that although we cannot unveil the causes of distribution of natural species and 'a germ of life', we can discover the laws governing distribution of organisms on a planet. Hence, we can say Humboldt is focused on what is *present*; he seeks to explain how currently existing species are distributed on the planet. As a result, the question of evolution of natural species goes 'beyond' our possible knowledge. As noted, such a conclusion is a corollary of radical utilisation of the empirical method. However, additional reasons can be found in the significant influence of Kant's transcendental philosophy about the limits of our possible knowledge. Recall that Humboldt acknowledges the existence of such limitations: "The objective world, thought by us, reflected in us, is subjected to the unchanging, necessary, and all-conditioning forms of our intellectual being" (Humboldt, 2010, p. 64). Apparently, Kant and Humboldt have a common outlook on the origin of natural species. In *Universal Natural History and Theory of the Heavens* (2008), Kant argues we will not be able to understand the development of "the origin of the entire present arrangement of the planetary system before we completely and clearly understand the development of a single plant or caterpillar on mechanical principles" (Kant, 2008, p. 18). Stressing the contingency of organisation of organic beings, Kant argues that living organisms are *mechanically inexplicable*. Namely, matter (of which organic beings are made) could have been organised in a thousand different ways; the organisation we currently observe is a mere contingency (Kant, 2007, p. 188).

Organisms are contingent with respect to mechanical laws (Ginsborg, 2001, p. 238); mechanical inexplicability is the reason why we cannot know the evolutionary process of natural species (Kant, 2007, p. 228). Given the organisational contingency of organic matter, the question of evolution of organisms is something that transcends the limits of our possible knowledge. We find a similar conclusion in Humboldt:

> Physical science, as the name imports, limits itself to the explanation of the phenomena of the material world by the properties of matter. All beyond this belongs not to the domain of the physics of the universe, but to a higher class of ideas. The discovery of laws, and their progressive generalisation, are the objects of the experimental sciences. Kant, who has never been deemed an irreligious philosopher, has traced with rare sagacity the limits of physical explanations.

(Humboldt, 2010, p. 33)

If the organisational matter of organic beings is contingent, i.e., if it cannot be subsumed under the operative domain of physical laws, the required explanation will not belong to the domain of physical science, but to the realm of ideas. The claim that Kant has traced 'with rare sagacity the limits of physical explanations' suggests that Humboldt endorses Kant's conclusions about the evolution of natural species. Does this indicate Humboldt completely discredits the theory of evolution? In other words, is Humboldt an anti-evolutionist? Next, I explore his considerations of the natural environment and struggle for survival and show this is not the case.

The Natural Environment and its Struggle for Survival

When approaching the analysis of Humboldt's notion of the natural environment, one should keep in mind Humboldt's holistic understanding of the natural system. Recall that his holistic outlook on nature implies the unity of different parts of the natural system; their functioning enables the continuity of the natural system. In this sense, we can speak of a holistic unity of an organic and an inorganic nature. However, the unity of different parts of the natural systems does not imply an absence of tensions that can be embraced by the notion of the struggle for survival. In an essay entitled *Views of Nature* (Humboldt, 1850) we encounter a record of such a struggle. Describing the nocturnal life of the tropical primeval forest, Humboldt cites the example of the jaguar pursuing peccaries and tapirs and notes the ensuing disturbance amongst the apes in the trees that, in turn, unsettles the tribes of birds. Suddenly, "the whole animal world is in a state of commotion" (p. 200). Accordingly, we can argue that Humboldt observed a Darwinian struggle for survival[18] that can be defined in terms of a predator-prey relation. Yet, Humboldt's notion of the struggle for survival has another meaning.

Humboldt observes that the primeval forest is inhabited by distinct natural species inhabiting its most remote parts:

> Such uniformity of association is unknown in tropical forests. The excessive variety of their rich sylvan flora renders in vain to ask, of what do the primaeval forests consist. Numberless families of plants are here crowded together; and even in small places, plants of the same species are rarely associated.
>
> (Humboldt, 1850, pp. 194-195)

[18] Darwin's notion of the struggle for survival is used in a broad sense. This term comprises: 1) the relation of an organism to other organic beings, i.e., their mutual competition for limited resources; 2) an organism's life; and 3) its ability to produce offspring (Darwin, 2008, p. 51).

In other words, Humboldt recognises the tendency of the living world for thorough expansion; organic beings seek to occupy every spot of free space. The climbing plants on the trees compete with one another for food and light (Wulf, 2015, p. 72). In this struggle for survival, we can detect the unity of the natural environment and organic world which becomes *part of the natural environment, whilst the struggle for survival rises from the need to adapt to the given conditions*. However, the organic world is not enclosed within a sphere where certain principles determine its action. *The living world sets its own limits because of its ability to additionally create external conditions, adapt, and survive*. Accordingly, we can say the notion of a natural environment is extended and includes: 1) external factors (i.e., temperature, humidity, etc.) to which organisms must adapt in order to survive; and 2) the organic world of the same ecosystem.

Apparently, Humboldt recognises the adaptation of organisms to changing conditions of the natural environment. Further, he acknowledges that limited natural resources cause mutual competition of natural species, introducing the Darwinian struggle for survival. Thus, we can question whether Humboldt really rejects the evolution of natural species. The importance of this question becomes apparent when we encounter Humboldt's study of the fossil record.

Humboldt's Investigation of the Fossil Record

It is known that Darwin believed fossil records to be the most important evidence for his theory of evolution. However, due to the imperfection of fossil records (e.g., the lack of fossil shells that show gradual transitions between species), Darwin turned to the geographical distribution of natural species (Archibald, 2017, p. 75); The example of finches in the Galapagos Archipelago has become a favoured example of the adaptation and evolution of organisms caused by different conditions of the natural environment (Darwin, 2008, pp. 292-293). Whilst Humboldt's results in the field of geographical distribution of species are mostly recognised today, his study of fossils is recurrently overlooked in the literature.

In his investigation of fossils, Humboldt concludes that fossil shells: 1) evince to various (terrestrial, atmospheric, etc.) changes that have occurred on Earth (such as dry periods in areas now wet); 2) reveal the geographical distribution of extinct species; 3) display the structure of extinct species, i.e., they enable us to assemble the appearance of extinct species; and 4) assert the relation between extinct organisms and living species (Humboldt, 2010, pp. 260-278). The latest assertion seems to suggest that fossil records directed Humboldt towards the assumption of evolution of natural species. In *Cosmos* (2010), Humboldt states:

> As we descend from stratum to stratum to study the relations of superposition, we ascend in the order of time, and new worlds of animal and vegetable existence present themselves to the view. Widely extended changes of the surface of the globe, elevations of the great mountain chains of which we are able to determine the relative age, have been accompanied by the destruction of existing species, and by the appearance of new forms of organic life; a few only of the older remaining for a time amongst the more recent species.
>
> (Humboldt, 2010, p. 260)

Humboldt seemingly acknowledges the relation between extinct and living species. Further, he notices that the rising of the mountains leads to the disappearance of certain organisms, whose places were taken by new species. Hence, we can say the fossil records directed Humboldt towards the observation of: 1) the structural similarity between extinct and living species; and 2) the direct influence of environmental conditions on the emergence of new species. Bearing in mind Humboldt's understanding of the natural environment and the struggle for survival, we seem to reach the conclusion that Humboldt is the evolutionist. However, some assertions seem to challenge this conclusion:

> In our ignorance of the laws under which new organic forms appear from time to time upon the surface of the globe, we employ the expression of "new creations," when we desire to refer to the historical phenomena of the variations which have taken place at intervals, in the animals and plants which have inhabited the basins of the primitive seas and the uplifted continents.
>
> (Humboldt, 2010, p. 260)

Such words create an apparent tension that can be neutralised when we recognise that Humboldt endures his silence because he believes we are *unable to discover the laws* governing the evolution of species. As previously indicated, Humboldt seems to believe that some kind of evolutionary process happens in nature:

> In studying the relative age of fossils by the order of superposition of the strata in which they are found, important relations have been discovered between families and species (the latter always few in number) which have disappeared and those which are still living. All observations concur in shewing, that the fossil faunas and floras differ from the present animal and vegetable forms the more widely, in proportion as the sedimentary beds to which they belong are lower or more ancient.

> Thus great variations have successively taken place in the general types of organic life.
>
> (Humboldt, 2010, pp. 263-264)

Finally, Humboldt directly talks about evolution:

> The doctrine of evolution shows us how, in organic development, all that is formed is sketched out as it were beforehand, and how the tissues of both vegetable and animal matter are uniformly produced by the multiplication and transformation of cells.
>
> (Humboldt, 2010, p. 60)

As aforesaid, Humboldt seems to believe some kind of evolutionary process happens in nature. Yet, following Kant, he concludes we can attain no knowledge of the exact course of such a process. The reasons for this conclusion are found in 1) the limits of our cognitive apparatus; 2) the radical application of the experimental method; and 3) the contingent material organisation of organic beings. In other words, just as matter could be organised in a thousand different ways, so the process of evolution could develop in a different manner. The available fossil records and geographical distribution of species cannot undeniably indicate which of these many possible processes is the actual process.

Conclusion

Following the preceding sections, we can detect the secluded tension between Humboldt's and Darwin's standpoint on the evolution of natural species. Whilst Humboldt retains a certain degree of scepticism when considering the problem of evolution, Darwin commences with the assumption that the history and evolution of organic beings can be discovered. Nonetheless, we find significant similarities between the two scholars: both opt for the empirical method and observe the relations between the natural environment and organisms.

Previous sections also suggest that Humboldt interprets the relation between the natural environment and organisms differently than

Darwin.[19] Humboldt understands this relation according to his naturalistic holism that highlights the unity of the organic and inorganic world. Thus, the natural environment and organic beings causally influence each other and create a natural equilibrium. Yet, the greatest difference between Humboldt and Darwin is the following: Humboldt lacks a mechanism which explains how the transmutation of natural species happens. Recall that Humboldt argues "in our ignorance of the laws under which new organic forms appear from time to time upon the surface of the globe, we employ the expression of 'new creations'" (Humboldt, 2010, p. 260). Darwin recognises the importance of such laws,[20] arguing that "the laws of variation have been the same, and modifications have been accumulated by the same power of natural selection" (Darwin, 2008, pp. 302). Humboldt lacks the precise mechanism of natural selection in order to overcome the epistemological gap in his research on the problem of evolution. Further, Humboldt (like Kant before him) fails to notice the following: just because we are able to imagine a thousand different developments of the process of evolution, it does not imply the process we currently observe is not an actual one.

This paper aims towards the analysis of Alexander von Humboldt's view on the evolution of natural species. At the same time, I addressed the following question: Can Humboldt be regarded as an evolutionist? The presented analysis, if successful, leads to a positive conclusion. As mentioned, some of Humboldt's assertions seemingly challenge this conclusion. Such an impression can be neutralised when we understand that Humboldt believed we cannot obtain the knowledge about the laws and causes governing the evolution of organic beings. This, however, does not imply a rejection of the possibility of the evolution of species.

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[19] Darwin interprets the relation between the natural environment and organisms somewhat differently. His discussion on the adaptation and struggle for survival suggests the following interpretation: the natural environment imposes certain living conditions to which organisms must adapt in order to survive. However, it seems that the agency of the organic world is limited to the processes of adaptation and survival; organisms cannot create and preserve certain conditions of the natural environment. As a result, the relation between the natural environment and the organic world is a causal relation which operates in one direction: from the natural environment to the organic world that needs to adapt.

[20] Darwin cites the so-called Laws of Correlation of Growth, and Unity of Type and Conditions of Existence as laws that govern the changes in organisms (Darwin, 2008).

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