

Introduction of published book

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Darwin: An Introduction – Prospects for Modern Evolutionary Studies –

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I published one book on Charles Darwin in 2011 in Japanese (Saitou, 2011; <https://www.chikumashobo.co.jp/product/9784480065971/>). Many books on Charles Darwin were published in 2009, in Japan too, to celebrate his 200th year anniversary. Chikuma Shobo editors approached me sometime in late 2008 and they asked me to write about Darwin. I published one booklet on Japanese three years before (Saitou, 2005) and it was sold well. I also published one textbook on genome evolution one year before (Saitou 2007). Editors probably thought that I was appropriate to write about Darwin. I think they were right. I respect Darwin, and I like history of sciences. However, I was so busy in those days, and could not complete my writing in 2009, and eventually my book on Darwin was published two years later, in 2011. Darwin bicentennial fever was already over, and my book did not sell well. Three years later, in 2014, publisher decided to cease distribution of printed book, though this book is still on sale as electric book.

My book about Darwin consists of eight chapters. In English, they are as follows:

Chapter 1: Darwin and his age

Chapter 2: Biology before Darwin

Chapter 3: Darwin's evolutionary theory

Chapter 4: Other area studied by Darwin

Chapter 5: World view of Darwin

Chapter 6: Up and downs of Darwinism

Chapter 7: From selection theory to neutral theory

Chapter 8: Darwin in modern biology

Appendix: Explanation of basic concepts regarding organismal evolution

I will briefly explain contents of each chapter. Charles Darwin was born on February 12th, 1809, and died on April 19th, 1882. He thus lived most of the 19th century. Therefore Chapter 1 starts with sketch of that century. As mentioned in Saitou (2020), Abraham Lincoln was born on the same day when Charles Darwin was born. Darwin published “On the Origin of species” in 1859 (Darwin, 1859), however, most popular book in British Empire at that year was “Notes on nursing” written by Florence Nightingale, founder of modern nursing. Section 2 of Chapter 1 is about Darwin’s relatives, particularly Erasmus Darwin, paternal grandfather of Charles. Charles Darwin is now much more famous than his grandfather Erasmus, however, Charles was only known to be one grandson of that famous Erasmus Darwin when Charles was young. In fact, this was major reason that Robert FitzRoy, Captain of H.M.S. Beagle, invited Charles for dinner every day on that ship. Josiah Wedgwood, founder of pottery company Wedgwood, was maternal grandfather of Charles. Robert Darwin, father of Charles, was medical doctor. Robert was taller than Charles with 185cm and was pretty heavy, often more than 150kg. Francis Galton, who invented correlation concept and many other statistical analyses, was also grandson of Erasmus Darwin, though his paternal grandmother was different from that of Charles Darwin. Section 3 of this chapter is titled “Dropout of school education”, followed by “Voyage of Beagle” in section 4, and “Returning to England until death” in section 5. Life of Charles Darwin is well known, and I do not go into detail.

Chapter 2, titled “Biology before Darwin” has following seven sections; Until Renaissance, Natural History and Taxonomy, Developments of other areas of biology, Geology, Evolutionary thoughts before Lamarck, Evolutionary thoughts after Lamarck and before Darwin, and Evolutionary thoughts in Japan during Edo Period. Development of biology is also well studied and many books were published in English, so I only introduce three Japanese mentioned in section 7. First one is KAMATA Ryuou (1754-1821), medical doctor and philosopher. In his book published in 1822, after he died, he clearly mentioned both organismal evolution and evolution of universe. Second one is NINOMIYA Takanori (1787-1856), who is famous as social reformist. Third one is MATSUMORI Takeyasu (1825-1892), who worked as high rank samurai in Yamagata Prefecture, but also was naturalist. It is not clear how these three individuals reached evolution concept. But at least it is clear that in Japan, organismal evolution was naturally accepted by some naturalists.

Chapter 3, titled “Darwin’s evolutionary theory”, is explanation of his “Origin of Species”. This book is pretty well known for many people, so I only mention my comment on epigraphs. In first edition, Darwin cited sentences from works of two famous English writers, his contemporary W. Whewell (1794-1866) and Francis Bacon (1561-1626), probably most famous philosopher in 17th Century England.

"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws."

W. WHEWELL: *Bridgewater Treatise*.

"To conclude, therefore, let no man out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain, that a man can search too far or be too well studied in the book of God's word, or in the book of God's works; divinity or philosophy; but rather let men endeavour an endless progress or proficiencie in both."

BACON: *Advancement of Learning*.

Second edition was published in January 1860, less than three months later after publication of first edition. Darwin now added one more epitaph by Joseph Butler (1692-1752).

"The only distinct meaning of the word 'natural' is *stated, fixed, or settled*; since what is natural as much requires and presupposes an intelligent agent to render it so, *i.e.* to effect it continually or at stated times, as what is supernatural or miraculous does to effect it for once."

BUTLER: *Analogy of Revealed Religion*.

All these three sentences are from natural theology thinkings. Thus some people argued that Darwin believed or tried to behave to believe in natural theology. I doubt it. In contrast, he found some logic, even in natural theology, that he can agree with. Addition of sentences by Butler, who were active in 18th century, can be considered to be inserted between 17th century Bacon and 19th century Whewell. I guess Darwin wanted to show gradual deepening or even "evolution" of human's philosophical thoughts during three centuries, and he implicitly suggested that he is following this trend.

Chapter 4, titled "Other area studied by Darwin" first list 19 books he published during his life. I mentioned his books related to Voyage of Beagle, classification of Barnacles, and study of plants. I skip them and would like to briefly mention about his trial for searching principles of heredity. In his "The different forms of flowers on plants of the same species" published in 1877, Darwin used primrose and focused on discrete characters such as length of styles. Unfortunately, Darwin did not have clear hypothesis on principles of heredity unlike Mendel, and he also did not understand law of large numbers. He produced only less than 300 primrose seeds, and did not reach that famous 3:1 ratio discovered by Mendel.

Chapter 5, titled "World view of Darwin", starts from world views before Darwin or Darwinian revolution. In Europe, it was simply based on Christianity. However, there were already some preludes to non-Christian thinking, such as Immanuel Kant (1724-1804), who proposed origin of Solar system from interstellar clouds and Georges-Louis Buffon (1707-1788) who published "Histoire Naturelle". In this sense, Darwin showed up in appropriate timing. Second section of this chapter is "Influence from surrounding people". Charles contended in his autobiography (Darwin, 1958) that he was not influenced from "Zoonomia" written by Erasmus Darwin, paternal grand father of Charles. However, Charles also became atheist as Erasmus was, as well as Elder brother of Charles, Erasmus. In contrast, Emma, wife of Charles, was devout Christian. She did not like Charles not attending Church. Last section of this chapter was "Incomplete Darwinian revolution". Darwin was great for clearly showing evidence of organismal evolution, including human evolution. However, he was stuck in main evolutionary mechanism, for he pushed his favorite "natural selection". Both natural theology and his natural selection assume that organisms are so adapted to this world. This view is now known to be wrong, as we will see in later chapters of this book.

Chapter 6, titled "Up and downs of Darwinism" is now dealing with developments of evolutionary studies mainly after Darwin. Moritz Wagner (1813-1887), contemporary of Darwin, pointed out importance of geographical isolation as cause of speciation. This idea is now well established, but surprisingly, speciation was assumed to be driven by natural selection for many years. August Weismann (1834-1914) was proponent of germ-line

theory that rejects inheritance of acquired characters. He also proposed “Neo-Darwinism” in which only natural selection is mechanism for evolution. Genetics was established after “rediscovery” of Mendel’s laws of heredity in 1900. DNA was discovered as material basis of heredity in 1940s, and double-helix structure of DNA was proposed in 1953. Importance of mutations in evolution was first clearly demonstrated by Hugo de Vries (1848-1935), and Thomas Morgan (1866-1945) also supported this idea with combination of elimination of detrimental mutations through negative selection. Therefore, Darwin’s natural (positive) selection theory was almost rejected in early 20th Century. Unfortunately, natural (positive) selection was resurrected by emergence of population genetics theory established by J. B. S. Haldane (1892-1964), R. A. Fisher (1890-1962), and Sewall Wright (1889-1988) during 1920s and 1930s. But new data emerged from biochemistry; amino acid sequences of proteins. Emile Zuckerkandl (1922-2013) and Linus Pauling (1901-1994) discovered approximate constancy of amino acid changes, and they nicknamed this phenomenon as “molecular clock” (Zuckerkandl and Pauling, 1965). This and other new molecular data brought molecular evolution as mainstream of modern evolutionary studies from 1960s.

Chapter 7, titled “From selection theory to neutral theory”, describes paradigm shift from Darwin’s natural selection theory to Kimura’s neutral theory. Motoo Kimura (1924-1994) was already famous for his theoretical studies on population genetics. He was Neo-Darwinist until he faced amino acid sequence data. He realized that substitution rates of protein amino acids are too high if we assume these changes are solely governed by Darwinian (positive) natural selection (Kimura, 1968). It was Kimura (1983) who coined “positive selection” (Darwinian selection) and “negative selection” (purifying selection). Kimura’s neutral theory was supported by DNA sequence data too. Interested readers may read Saitou (2018) on neutral evolution at DNA and genome levels. Kimura influenced many Japanese researchers who were interested in evolutionary studies. YASUDA Norikazu, OHTA Tomoko, MARUYAMA Takeo (1936-1987), TAKAHATA Naoyuki, YAMAZAKI Tsuneyuki, AOKI Ken-ichi, TAJIMA Fumio, TACHIDA Hidenori, and TAKANO Toshiyuki once belonged to Division of Population Genetics at National Institute of Genetics. This laboratory was renamed as Population Genetics Laboratory in January 2020, and I (SAITOU) is professor there. Masatoshi NEI was also influenced by KIMURA, and became one of most well-known neutralist. NEI produced many Japanese Ph.D.s including TATENO Yoshio, TAJIMA Fumio, OTA Tatsuya, TAKEZAKI Naoko, and myself. Many Japanese researchers also worked at NEI laboratory as postdoctoral fellows. They include GOJOBORI Takashi, TAKAHATA Naoyuki, GOTO Osamu, TAMURA Koichiro, SUZUKI Yoshiyuki, ITO Tsuyoshi, NOZAWA Masafumi, MISAWA Kazuharu, and KATSURA Yukako.

Chapter 8, titled “Darwin in modern biology” is final chapter of this book. There are eight sections in this chapter. Section 1 is “Natural selection under evolution of organisms cultivated by human”. This section discusses artificial selection, in which positive Darwinian selection is expected to occur. This is because humans carefully choose organisms for their own purposes; humans are gods for these organisms, and both positive and negative selection occur under this situation. I mentioned about genetic changes in rice and silkworm. Section 2 is “Darwinian natural selection really observed in nature”. Molecular evidences of positive Darwinian selection was explained for influenza virus spike proteins reported by GOJOBORI Takashi’s group and for one portion of HLA proteins whose function is to grasp foreign antigens such as corona virus spike proteins reported by Masatoshi NEI’s group. However, relationship between host immune system and infectious disease is special case of evolution, and any change is acceptable in extreme case. Therefore, there is no “improvement” in this circular system. In contrast, optimum pH changes of stomach lysozymes in various mammalian species may be considered to be “improvement” or adaptation to new environment for this enzyme, when this enzyme started to be expressed in stomach where HCl, strong acid, is extracted. After publication of this book in 2011, our group found that common ancestral sequences of lineage specific conserved noncoding sequences seem to experience nucleotide substitutions whose rates were higher than

mutation rate (Saber et al. 2016; Saber and Saitou 2017). This suggests that evolutionary conservation started after lineage specific nucleotide sequences emerged through Darwinian positive selection.

Sections 3-7 of Chapter 8 was “Geology and paleontology”, “Sociobiology”, “Molecular phylogeny”, “Origin of Life”, and “Human evolution”. Last section 8 was “Influence of <Darwin>”, and Darwinian medicine was mentioned here. This section ends with comparison of two words in Google; Darwin and Beatles. “Darwin” appeared 60 million and more times, while “Beatles” appeared 90 million and more times. I just checked again these two words. Now, as of September 1, 2020, “Darwin” appeared ~165 million times, while “Beatles” appeared ~214 million times. Darwin is now much closer to Beatles! I am very happy to know this result, for we started new journal iDarwin this year (Saitou 2020).

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