evidence for mass migration of species, and drastic and repeated climatic changes throughout the earth's history.

The book has two parts. The first is *The Dispersal of Organisms: its Phenomena, Laws, and Causes* (10 chapters), in which the biogeography of plants and animals across the planet is explored in relation to the effects of climate and dispersal. Wallace particularly emphasizes changes of climate involving glacial epochs, which is something that he also covered in several of his research papers, producing the first theory of continental glaciation based on a combination of geographical and astronomical causes. He also covers the estimated age of the earth, and the relative permanence of continents compared with many of the islands. Ultimately, of course, he considers evolution to be "the key to distribution" of all living things; and conversely, geographical distribution was always his strongest evidence in favor of biological evolution.

The second part of the book is *Insular Faunas and Floras* (14 chapters), where case studies are examined for most of the major and/or biogeographically significant islands around the world. These include: (i) oceanic islands, such as the Azores, Bermuda, Galápagos Islands, St Helena, and Sandwich Islands; (ii) continental islands, such the British Isles, Borneo, Java, Japan, Formosa, and Madagascar; and (iii) what he calls "anomalous islands," which include New Zealand (covered in two chapters) and the Celebes.

Unlike Darwin, most of Wallace's theories were based on personal field experience, and this, combined with his ability to synthesise the ideas of his contemporaries in a concise but highly readable manner, makes this book a great read for scientists, historians, and anyone interested in the historical development of the Theory of Evolution.

This reprinting of the first edition of his great work includes a Foreword (by David Quammen), and a long and informative Introduction (by Lawrence R. Heaney). These allow the modern reader to place Wallace's ideas into a modern *post*-continental drift paradigm, where our ideas on evolution have been influenced by genetics, DNA, and other developments not available to Wallace at the time of his writing. Nevertheless, despite the now somewhat dated and, in some cases no longer accepted, ideas on how plants and animals moved around the world, Wallace is still, rightly, seen as the father of Island Biogeography. He has been a major influence on those subsequent workers developing and refining the theories of dispersal and speciation on isolated island chains. Wallace also (unwittingly it seems) pre-empted other theories relating to some of these islands: his map on page 443 showing the 1000 fathom depth line connecting Australia to New Zealand via New Caledonia, anticipates by nearly a century some of the theories about the now largely submerged continent of Zealandia/Tasmantis, and potential early Cenozoic dispersal routes into New Zealand from Australia.

Well written, engaging and educational, this book is definitely one that any serious biologist should read.

John G. Conran, Australian Centre for Evolutionary Biology & Biodiversity (ACEBB) and Sprigg Geobiology Centre, School of Earth and Environmental Sciences, DX 650 312 Benham Building, University of Adelaide, SA 5005, Australia; E-mail: john.conran@adelaide.edu.au

Syst. Biol. 63(2):284–288, 2014

DOI:10.1093/sysbio/syt112
Advance Access publication January 3, 2014

On the Organic Law of Change: A Facsimile Edition and Annotated Transcription of Alfred Russel Wallace's Species Notebook of 1855–1859.—Edited and annotated by James T. Costa. Cambridge, MA: Harvard University Press, 2013. xii+573 pp. ISBN 978-0-674-72488-4 $49.95 £36.95 €44.95 (hardback).

History prefers to remember single individuals, whether it be George Washington or Adolf Hitler, Isaac Newton or Albert Einstein. At the time of his death in 1913, Alfred Russel Wallace was as internationally well-known as any other English language biologist, but history has preferred to remember Charles Darwin instead. James Costa's presentation of Wallace's *Species Notebook* is part of a concerted attempt to redress Wallace's eclipse, as part of the centenary activities commemorating his death.

Wallace (1823–1913) was as important as anyone in turning biology from natural history into a science. Even as late as 1895, when Alfred Nobel created his famous prizes, the only scientific part of biology was still considered to be "physiology and medicine" rather than the much broader field we now recognize. Things have changed so much that, these days, we even divide biological science into many disciplines, including biogeography, evolutionary biology, ecology, genetics, physiology, biochemistry, immunology, and so on. Our debt to Wallace is in helping to establish the first two of these disciplines. Many other people made important contributions, of course, not the least being Alexander von Humboldt in biogeography and Charles Darwin in evolutionary biology, but Wallace was there at the crucial time in the second half of the 1800s, so that he literally saw natural history become biological science in his own lifetime, and actively participated in that transition.

Wallace is tolerably well-known within biology itself, if not outside it (Smith and Beccaloni 2008), and he

is sometimes credited with being the "co-discoverer" of natural selection as the mechanism for evolutionary change in biology. Wallace seems to have become a convert to "species transmutation," as it was then called, in 1844–1845, whereas Darwin had converted in 1837–1838. Indeed, the parallels between Darwin and Wallace are telling. Both of them left Europe as young men, and were thus exposed to a level of biodiversity that is simply not available anywhere in Europe (both men were in South America, and Wallace also in southeast Asia). Both subsequently thought about how to explain the development of that biodiversity, in a way that none of their predecessors had. They both read Thomas Malthus' 1798 *Essay on the Principle of Population*, and thus both focused on the population-level phenomena that are involved in speciation. So, it is no great surprise that they reached the same general conclusions.

But there the similarities end. Wallace did not have Darwin's 'natural advantages' (see Morrison 2014). Although he also was the son of a gentleman (in his case a trained but nonpracticing lawyer, with income from inherited property), and received a fee-paying (grammar school) education, Wallace was born into a family whose financial position was steadily deteriorating (due to bad investments and failed business ventures). So, he left school at 14 years and thereafter had to work for a living, receiving no further formal education. This means that he was entirely self-taught as a biologist, which is not bad for someone who became one of the greatest field biologists in history. Moreover, he had none of the influential connections in British science that were so important for Darwin's career, and he therefore spent much of his time overseas (earning money as a collector of natural-history specimens).

Not unexpectedly, Wallace was a social activist who was critical of the social and economic system of Victorian Britain, which did not endear him to the "powers that be." Moreover, Wallace was no better at investment than was his father, so that his own financial position deteriorated later in his life. He never obtained a salaried position, living instead on income from his natural-history collections, as well as writing, lecturing, editing, and exam correcting. (Apparently, in 1873 Darwin considered paying him to help with the revised edition of *The Descent of Man*, but eventually gave the job to his son George; Browne 2002.) Finally, he was awarded a very modest government pension in 1881.

What is perhaps not so well known is that Wallace deliberately set out in the late 1840s to unravel the "mystery" associated with the "variations, arrangements, distribution, etc., of species," as he explained to Henry Walter Bates (of Batesian mimicry fame) (Wallace Correspondence Project letter #348), who had inspired him to become an entomologist. In some poorly explained manner, both Bates and Wallace managed to get themselves to the Amazon in 1848, as natural-history collectors, where Wallace spent 4 years and Bates 11 years.

Wallace's natural determination and tenacity became clear after he lost 2 years' worth of specimens plus his notebooks when his ship (*Helen*) burned and sank in the Atlantic, leaving everyone drifting in lifeboats for 10 days. Indeed, he was leaving the Amazon due to ill health, and he had already lost his younger brother, Herbert, who had come out to help him. (Unfortunately, he was not the last of Wallace's assistants to die on the job.) Nevertheless, by 1854 Wallace was on his way again, this time to southeast Asia, where he remained until 1862. His success between 1855 and 1858 at unraveling the mystery of species origins was therefore probably no great surprise to himself. Costa's new book is, in many ways, the story of that success.

This book is a reproduction of one of Wallace's notebooks from his time in southeast Asia (manuscript #180 of the Linnean Society of London), which he started in 1855 and continued intermittently until 1859 (with some later entries up to 1862), when he transferred his main attention to the journals that would later comprise Wallace (1869) (some of the *Notebook* ended up there, as well). Each double-page of Costa's handsomely printed book has on the left a photo of one page from Wallace's original notebook, along with a printed transcription of the text, and on the right Costa's annotations and commentary. Costa's copiously informative annotations are usually much longer than Wallace's original writing, so that there is actually more of Costa in this book than of Wallace.

Costa notes that "this notebook is more like a commonplace book ... the arguments for his planned book on transmutation are found side by side with specimen label designs; his discussions of the nature of species and varieties, the meaning of fossils, struggle in nature, or the branching history of life all share space with notes on the cost of rice, lists of books to read, a proposed remedy for the proliferation of taxonomic synonyms, and a practical scheme for a library of natural history." It thus differs from Wallace's other notebooks and journals in that it is only partly chronological, and contains intermixed notes on a wide range of theoretical subjects, which in hindsight show us Wallace arriving at his evolutionary ideas. (If any taxonomists are wondering, Costa 2013a explains Wallace's proposed "remedy.")

Of particular interest is the fact that Wallace clearly intended much of the writing to be the basis for a book. He mentions his notes for an intended book in a letter to Darwin in 1857 (WCP #4080) and to Bates in 1858 (WCP #366), and he makes reference to "my last chapter" in the *Notebook* itself. Costa assumes that the relevant notes start on page 35 of the *Notebook*, which is conspicuously headed "Note for *Organic Law of Change*," the presumed title of the book (McKinney 1966). This book was never published, and it is Costa's stated intent to redress that by publishing the *Notebook* now. To this end, he provides a convenient Appendix specifically highlighting those "Species Notebook Entries Bearing on Transmutation and Related Topics."

To understand the importance of this *Notebook* requires a bit of background. Most biologists have at least heard about the story of Wallace sending to Darwin his essay on natural selection (published as Wallace 1858). However, this story is usually somewhat confused (Costa 2013b), and one of the points that Costa tries to make clear is the role of the geologist Charles Lyell in this event. Lyell was Darwin's mentor when he was a student, and from a simplistic point of view all Darwin did was apply to biology Lyell's geological ideas (small changes accumulating continuously over a very long period of time can lead to big effects). However, although Darwin thought that this idea was applicable to biology, Lyell did not (apparently for religious reasons), and he actively opposed it in his writing. Much of Wallace's *Notebook* is specifically aimed at a detailed refutation of Lyell's arguments (occupying at least 25 of the 56 pages on transmutation). Wallace wrote prolifically on his trips, whenever he was delayed by infirmity or the weather, and in this manner he filled his notebooks and wrote papers for publication.

Wallace's first transmutation paper was Wallace (1855), in which he suggested that "every species has come into existence coincident both in space and time with a pre-existing closely allied species," but he did not suggest a mechanism for their origin. Lyell read this paper, and immediately opened the first of a series of notebooks on "the species question," in which the first entry is a note on Wallace's paper. Coincidentally, it was probably in July–August 1855 (when he was laid up with a damaged foot) that Wallace turned to his own notebook (see Brooks 1984), and started on his dissection and refutation of Lyell, particularly his arguments concerning nonprogression of the fossil record, geographical distributions, domesticated organisms, and the limits of biological variation. Costa details these arguments in his Appendix "On Wallace's Critique of Charles Lyell and *Principles of Geology*."

Lyell drew Darwin's attention to the 1855 paper, but Darwin seemed not to recognize that it presaged all of what we now recognize as the major Darwinian themes (gradualism, utility, adaptation to different environments, allopatric speciation, imperfection of the fossil record, etc.). In 1856, Lyell explicitly recommended to Darwin that he needed to get on with publishing his own views (Darwin Correspondence Project #1862). Darwin wrote to Wallace in December 1857 (DCP #2192) assuring him that "You must not suppose that your paper has not been attended to: two very good men, Sir C. Lyell and Mr. E. Blyth at Calcutta specially called my attention to it." (Apparently, the only response to the paper that Wallace had previously heard was to stop theorizing and stick to collecting.)

This is why Wallace sent Darwin the crucial essay (dated February 1858, mailed in April? received in June; see Wyhe and Rookmaaker 2012, Smith 2013a)—he was replying to Darwin's letter, and asked him (if he thought well of it) to pass the essay on to Lyell, who was at least as much the intended recipient as Darwin. Darwin then wrote to Lyell: "Some year or so ago, you recommended me to read a paper by Wallace in the Annals, which had interested you & as I was writing to him, I knew this would please him much, so I told him. He has to day sent me the enclosed & asked me to forward it to you. It seems to me well worth reading. Your words have come true with a vengeance that I shd. be forestalled" (DCP #2285). The essay provided the missing suggestion of a mechanism for the origin of species, thus producing in "a bedridden and fevered state" what Darwin had labored over for 20 years.

Lyell recommended publication, even though Wallace had not specifically asked for this (as noted by Darwin in #2285), and Wallace later indicated that he did not consider it a finished product (having sketched it out in one evening, and then written it out over the following two nights). However, both Lyell and Joseph Dalton Hooker (one of Darwin's closest friends) urged Darwin to publish a brief abstract of his own long-standing ideas (Darwin 1858), at the same time as Wallace's manuscript. The papers were thus read jointly before a meeting of the Linnean Society of London on 1 July. This is what happens to you when you have powerful friends, and what happens to you when you do not. Wallace was not consulted on this morally questionable "delicate arrangement," and did not find out about it until August, when he received his mail from the monthly steamer after he returned from a collecting trip. Wallace's well-deserved fame within the scientific community dates from his return to Britain in 1862, when he could speak for himself directly.

As an aside, it is worth pointing out two things. First, Darwin and Wallace did not actually originate the idea of natural selection, which had previously been discussed by people such as Edward Blyth, James Hutton, Patrick Matthew, Herbert Spencer, and William Charles Wells (McKinney 1971) [see also http://historiesofecology.blogspot.se/2013/08/predecessors-of-darwin-and-wallace.html]. However, this had been in relation to within-species diversity, whereas Wallace and Darwin applied the idea to the origin of between-species diversity (i.e., the origin of new species). Second, Wallace and Darwin did not actually propose exactly the same idea. For example, Kutschera (2003) lists six important differences between the two original papers, some of which became more apparent when the authors later elaborated on their own versions. Indeed, Wallace became what we would now call a neo-Darwinist (Darwinism without inheritance of acquired characters) (Kutschera and Hossfeld 2013).

What is of more direct interest for this book review, however, is that Wallace's essay actually stopped *both* Darwin and himself from writing their planned books. From 1856 to 1858, Darwin had been working on what he called his "Big Species Book" (otherwise known as *Natural Selection*, finally published by Stauffer 1975), having started after the birth of his last child. But, with Wallace looking over his shoulder, he realized the need to get a book into print fast, and so he edited down

and rewrote what text he already had, and published what he referred to as an "abstract" as *On the Origin of Species*. Wallace also changed his plans when Darwin published this book (which, incidentally, he lavished praise upon, in his correspondence), and he did not publish a book-length discussion of natural selection until 30 years later (Wallace 1889), and 7 years after Darwin's death. So, Darwin stole Wallace's thunder twice in print: once in a journal and once with a book.

Costa's book is thus the first publication of what has been left to us of Wallace's intended book; and we owe a debt to him for making it available at last. Interestingly, we learn nothing about the 1858 essay, which seems to have been produced as a flash of inspiration. As noted by Wyhe (2013): "This makes his essay proposing natural selection all the more mysterious. For Darwin we have a detailed paper trail revealing the development of his conception of natural selection. For Wallace we only have his published essay. What inspired Wallace's famous eureka moment in the midst of a malarial fever?" Presumably, we will never know. (Wallace's own account was written more than 30 years later, in Wallace 1891.)

The Wallace cottage industry exists, but it is nothing compared with the Darwin one (Morrison 2014). The centenary of his death has therefore provided an excuse for an increase in Wallace-related publications. As well as this *Notebook*, you can now read all of his known letters in *Wallace Letters Online* (the online part of the Wallace Correspondence Project), along with a printed selection of them (Wyhe and Rookmaaker 2013). Other previously unpublished books are starting to appear, including the travel diary of his North American lecture tour (Smith and Derr 2013), as well as commentated editions of his major works, such as *Island Life* (Heaney 2013).

Wallace produced no clear counterpart to Darwin's magnum opus, but he did write 22 books on scientific and social issues (the last two of them when he was 90 years old), along with more than 700 papers, essays, commentaries, book reviews, letters to the editor, etc. Much of his writing is part scientific, part travelogue, and part social commentary, and so it is worth seeking out—for example, Wallace (1869) went through 10 editions and has never been out of print. Most of the books are available online, either in the "Celebrating Alfred Russel Wallace" collection of the *Biodiversity Heritage Library* or in *Google Books*; and all of the articles can be accessed at the recently established *Wallace Online* web site (based on the incredible bibliographic work in librarian Charles Smith's *Alfred Russel Wallace Page*).

The corpus of work for which Wallace is best known is his study of biogeography (mainly zoogeography, because he principally collected insects, but also birds), but he also worked on what we now call environmental issues (he argued strongly for conservation), and even what is now known as exobiology or astrobiology (he argued that life on Earth is unique). More controversially, he also involved himself in social criticism (e.g., land reform, the labor movement, women's suffrage), atheistic spiritualism (he believed that humans were not affected by natural selection, and that therefore current evolutionary ideas were incomplete), and antivaccination activities (statistical epidemiological data had convinced him that it was worthless).

Wallace was a polymath, to be sure, and probably among the last to be so, which makes him one of the most interesting figures in the history of English-language ideas. As Smith (2013b) has noted: "Wallace was not a conventional thinker, and those who try to pigeonhole his thoughts are bound for failure." So, you need to read the man for yourself, and Costa's book provides you with one more important way to do this.

References

Brooks J.L. 1984. Just before the origin: Alfred Russel Wallace's theory of evolution. New York: Columbia University Press.

Browne J. 2002. Charles Darwin: a biography, Vol. 2, The power of place. New York: Knopf.

Costa J.T. 2013a. Synonymy and its discontents: Alfred Russel Wallace's nomenclatural proposals from the "Species Notebook" of 1855–1859. Bull. Zool. Nomen. 70:131–148.

Costa J.T. 2013b. Engaging with Lyell: Alfred Russel Wallace's Sarawak Law and Ternate papers as reactions to Charles Lyell's "Principles of Geology". Theory Biosci. 132:225–237.

Darwin R. 1858. On the perpetuation of varieties and species by natural means of selection. J. Proc. Linn. Soc. Zool. 3:46–53.

Heaney L.R., ed. 2013. Alfred Russel Wallace: island life, or the phenomena and causes of insular faunas and floras. Chicago, IL: University of Chicago Press.

Kutschera U. 2003. A comparative analysis of the Darwin-Wallace papers and the development of the concept of natural selection. Theory Biosci. 122:343–359.

Kutschera U., Hossfeld U. 2013. Alfred Russel Wallace (1823–1913): the forgotten co-founder of the Neo-Darwinian theory of biological evolution. Theory Biosci. 132:207–214.

McKinney H.L. 1966. Alfred Russel Wallace and the discovery of natural selection. J. Hist. Med. Allied Sci. 21:333–357.

McKinney H.L., ed. 1971. Lamarck to Darwin: contributions to evolutionary biology 1809-1859. Lawrence (KS): Coronado Press.

Morrison D.A. 2014. [Book review of] Darwin and his children: his other legacy. Syst. Biol. 63: (forthcoming).

Smith C.H. 2013a. A further look at the 1858 Wallace-Darwin mail delivery question. Biol. J. Linn. Soc. 108:715–718.

Smith C.H. 2013b. Alfred Russel Wallace's world of final causes. Theory Biosci. 132:239–249.

Smith C.H., Beccaloni G., eds. 2008. Natural selection and beyond: the intellectual legacy of Alfred Russel Wallace. Oxford: Oxford University Press.

Smith C.H., Derr M., eds. 2013. Alfred Russel Wallace's 1886-1887 travel diary: the North American lecture tour. Manchester, UK: Siri Scientific Press.

Stauffer R.C., ed. 1975. Charles Darwin's "Natural Selection". Cambridge: Cambridge University Press.

Wallace A.R. 1855. On the law which has regulated the introduction of new species. Ann. Mag. Nat. Hist. 16:184–196.

Wallace A.R. 1858. On the tendency of varieties to depart indefinitely from the original type. J. Proc. Linn. Soc. Zool. 3:53–62.

Wallace A.R. 1869. The Malay Archipelago: the land of the orangutan and the bird of paradise; a narrative of travel with studies of man and nature. London, UK: Macmillan & Co.

Wallace A.R. 1889. Darwinism: an exposition of the theory of natural selection, with some of its applications. London, UK: Macmillan & Co.

Wallace A.R. 1891. Natural selection and tropical nature. London, UK: Macmillan & Co.
Wyhe J. van 2013. Dispelling the darkness: voyage in the Malay Archipelago and the discovery of evolution by Wallace and Darwin. Singapore: World Scientific.
Wyhe J. van, Rookmaaker K. 2012. A new theory to explain the receipt of Wallace's Ternate essay by Darwin in 1858. Biol. J. Linn. Soc. 105: 249–252.
Wyhe J. van, Rookmaaker K., eds. 2013. Alfred Russel Wallace: letters from the Malay Archipelago. Oxford, Oxford University Press.

David A. Morrison, Section for Parasitology, Swedish University of Agricultural Sciences, 751 89 Uppsala, Sweden; E-mail: david.morrison@slu.se