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Alfred Russel Wallace, Geographer

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Abstract

Among the great explorers and thinkers who advanced geography in the nineteenth century and helped it evolve into the subject that exists today is a man who is not always connected with the field, Alfred Russel Wallace (1823–1913). Most commonly recognized as 'the other man' in the history of the discovery of the principle of natural selection, Wallace's commitment to the study of landscape and its physical, biological, and human elements was lifelong, and resulted in a wide range of contributions to biogeography, physical geography, human geography, and ethnography. In this year of the double anniversaries of Charles Darwin's birth and the publication of *On the Origin of Species*, a short review of Wallace's contributions is offered in an effort to characterize Wallace as 'a geographer who happened to be interested in evolution'.

Introduction

On October 1, 1852 a bedraggled young naturalist named Alfred Russel Wallace (1823–1913) bid his farewells and stepped off the merchant vessel *Jordeson* at Deal, setting his feet on English soil for the first time in over 4 years. He had just spent 80 days crossing the Atlantic from Brazil; during the first part of the trip his original carrier, the *Helen*, had caught fire and sunk in the middle of the ocean, leaving him and his shipmates to fend for themselves in a pair of barely seaworthy lifeboats. They decided to make for the nearest land, Bermuda, seven hundred miles away. Ten days into the effort they finally were rescued – but even then their fortunes hardly seemed improved when a series of heavy storms buffeted the decrepit *Jordeson* all the way back to England.

Worst of all, Wallace was carrying nearly 2 years' worth of natural history collections with him on the *Helen*, and they all went to the bottom along with the charred remains of the ship. He was only able to save a few odds and ends, including a large series of fish drawings he'd made. Once back on land, however, Wallace was able to cash in on an insurance policy his trusty agent had engineered, and soon he was thinking of continuing on with his work in a new locality.

The making of a biogeographer

Wallace (Figure 1) had traveled to South America with another young prominent-naturalist-to-be, Henry Walter Bates (1825–1892), who later worked out the theory of protective mimicry. The two had decided to try to earn a living as professional specimen collectors, and Brazil seemed to offer the best prospects. But Wallace and Bates also had a larger goal in mind. A few years earlier the two had digested the anonymously-penned *Vestiges of the Natural History of Creation*, and become converts to its message of biological change through evolution. *Vestiges* had been a bit hazy on details such as mechanisms,

Fig. 1. Woodcut of Wallace (the frontispiece to Cope 1891) at the age of about 60.

however, and the boys decided to take every opportunity to look into the matter while engaged in their field work.

This they did, but after 4 years of trekking around the Amazon basin Wallace's health began to fail. Though he had not figured out the key to evolution yet, in the summer of 1852, he decided he had no choice but to leave, only to face his disaster at sea. Once he finally made land again, however, things went better. Over the next 15 months, he published several articles and a pair of books (one a scientific travel narrative entitled *A Narrative of Travels on the Amazon and Rio Negro*; the other an ethnobotanical work called *Palm Trees of the Amazon and Their Uses*). He then set out again as a collector, sailing to what is now known as Indonesia, and then, the 'Malay Archipelago'.

The time Wallace spent in South America was by no means completely wasted. First and foremost, his efforts had matured him into a highly skilled field naturalist – both as a collector, and as an observer. One important thing he observed was how a lot of species populations could be found along one bank only of many major rivers. In later writing up this observation (Wallace 1852), he set out what is now known as the riverine barriers hypothesis of speciation, a biogeographic model which remains an active area of research today. Wallace also had ample opportunity to see that little relation seemed to exist between nearness-of-relation of biological forms and their respective ecological stations, but the reason for this was yet unclear to him. He needed more field time to resolve the mystery. For a while, after returning to England he rested and wrote on his travels, but before long, he felt the urge to get back in the field. At first he considered returning to South America, or collecting in Africa, but in the end the choice was Australasia. He was able to secure a grant from the Royal Geographical Society to cover the trip to Singapore, but beyond that he was largely on his own.

During his nearly 8 years in the East Wallace accumulated 14,000 miles of travels, mounting some 70 separate expeditions, mostly in native-built crafts. He eventually amassed over 125,000 specimens, along with a wealth of field observations on the ecology and habits of animals, the physical geography of the lands he visited, and the ethnology and ethnography of the native peoples he worked with and among (Figure 2). Four years into the adventure, he came to the revelation for which he is probably best known: his independent fashioning of the theory of natural selection. While ill on or near the island of Ternate in the Moluccas, he connected the ideas of Thomas Malthus on human population controls to the fact of character variation within animal and plant populations, and the ability of natural rates of fecundity to outstrip the replenishment of vital resources. Simply, there had to be a competition for the resources, with the most 'fit' individuals tending to persist longer, and differentially passing along their suites of adaptations to their progeny. When the illness passed he sketched out an essay on the idea and sent it off to Charles Darwin (with whom he had already struck up a professional correspondence) and the famous geologist Charles Lyell, for comment. Darwin was shocked and looked to Lyell and another of his friends, the botanist Joseph Hooker, for help in resolving this possible challenge to his priority on the subject. Lyell and Hooker decided to have the essay read along with two unpublished fragments of Darwin's writings on the subject at the next meeting of the Linnean Society of London; this took place on July 1. 1858. Darwin then shifted into full gear and began to work up his, as he put it, 'abstract' of the subject, *On the Origin of Species*. This was released to great acclaim in November 1859.

Three years before the 1858 'Ternate' essay, Wallace had already published a work that some point to as laying the cornerstone for modern biogeographical studies. This paper (Wallace 1855), written while Wallace was staying in Sarawak, identified a basic relationship between the spatial distribution of living and extinct species: that the most closely related ones appeared to be at once physically most closely situated through time (as part of the fossil record) and in space (in their geographical distribution). The explanation for this clearly seemed to be an evolutionary one, but Wallace merely pointed out the relationship without theorizing a cause. Indeed, it would have been premature for him to suggest an evolutionary explanation just then, as he had yet to fathom a mechanism that could bring it all about. Still, this basic idea of affinity through time and space has ever since stood at the very core of biogeographical studies, especially in the form of its modern incarnation, vicariance biogeography, the study of population separations into so-called 'sister' species.

Wallace was responsible for two other important biogeography-related accomplishments during his term in the East. The first was his recognition of a marked break in the distribution patterns of animal groups between the western and eastern parts of the Archipelago. Between the islands of Bali and Lombok, especially, there is a sharp change in faunal compositions. This discontinuity corresponds with the limits of the Sunda Shelf and the deeper waters beyond to the east; animal populations dispersing from the west (the main diversity source) had been able to move from current island to island during periods of lower ocean levels (as during the Ice Age), but not beyond the edge of the shelf, where the water barriers remained large and deep even during those times of lower water levels. Most groups originating to the east had either not had enough time to reach

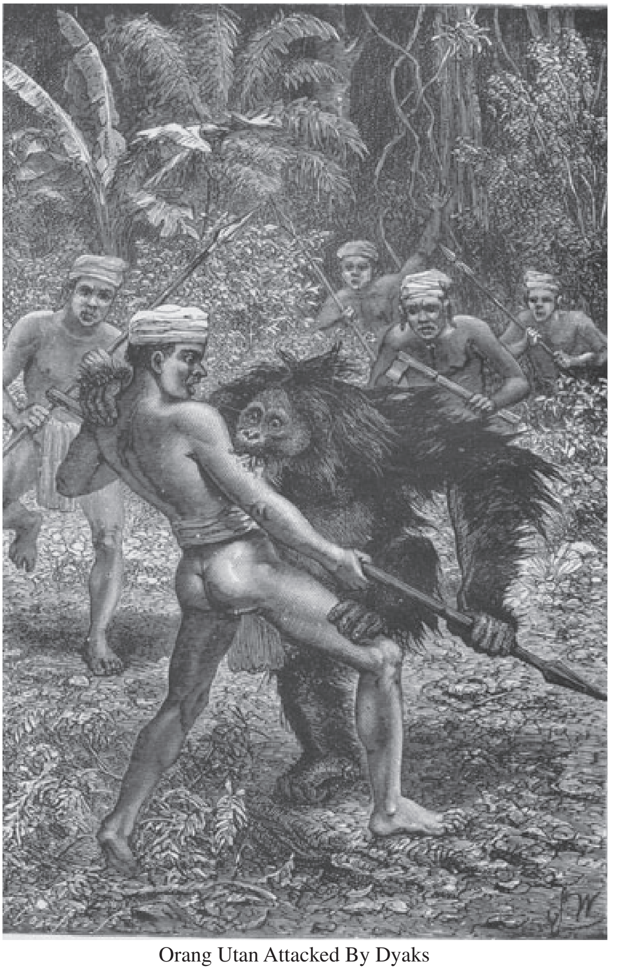
Orang Utan Attacked By Dyaks

Fig. 2. Famous scene ('Orang Utan attacked by Dyaks') from Wallace's great work *The Malay Archipelago* (1869).

this point, or been thwarted by the greater number of deep water barriers. This demarcation between the eastern and western parts of the Archipelago became known as The Wallace Line, and for 150 years it has been an instrumental concept in attempts to sort out the complex geological and geographical history of the eastern part of Indonesia, now often known as Wallacea (Figure 3) (see Beck et al. 2006; Metcalfe et al. 2001; Van Oosterzee 1997; Whitmore 1981).

It was also during this time that Wallace took up his defense of the faunal regions scheme introduced by the English ornithologist Philip L. Sclater. Sclater had published a paper in 1858 identifying six major biotic realms of bird diversity on earth, and the next year Wallace followed this up with a publication of his own (Wallace 1859) that provided additional data in support of the model. This system of faunal classification has remained a fixture in the description of biological diversity to this day.

At least two other biogeography-related themes may be found in the work Wallace carried out before his second return to England in 1862. The first concerns his approach to natural selection. Unlike Darwin, Wallace never coupled the adaptive process with its

Fig. 3. Detail from the world map in *The Geographical Distribution of Animals* showing (in dark red) The Wallace Line, the boundary between the Oriental and Australian regions.

immediate results: adaptive structures. For Darwin, this quasi-circularity has sometimes led to the criticism that the concept of adaptation is a tautology. Wallace instead looked on natural selection as being, more simply, the removal of the unfit. In his Ternate essay, he likens the action of natural selection to the way, the governor on a steam engine works: that is, to keep the pressure constant under otherwise destabilizing influences. The function of natural selection was not so much to 'cause evolution' as it was to ensure that populations remained fit within their ecological context. Ostensibly, were that context itself to change, this would force changes in the selection regime, the bringing out of new adaptations, and thus evolution. This has led many sources to conclude that Wallace had adopted more of an 'environmental selection' model than did Darwin, but the reality is probably both more complicated and more interesting than that, for two reasons.

First, from the point of view of the individual organism, *everything* – including members of both its own species and other species, and various extra-population influences – represents the 'external environment'. Second, and more interestingly, this simple understanding gives no hint as to how or why diversification into ever-more complexly functioning creatures takes place: that is, why do we have so many levels of complexity of organic interaction, as opposed to just some endless supply of beetles or bacteria? The answer might lie in the ecological biogeography of the situation. Individual organisms are brought into the world 'pre-adapted' to cope with the immediate contingencies of their surroundings, but in mass, as dispersing populations, they find it easier to fit in with some existing community structures than others. The Wallacean approach to natural selection suggests that new adaptations emerge on a 'whatever' basis: that is, that the environment, in its most general definition, acts upon natural variation in such a way as to select out *whatever* new traits that, simply stated, work. It follows that those environmental settings that permit the widest range of new opportunities to 'be at the right place at the right time' to make use of available resources will be those that most encourage both the integration of new populations, and the development of new adaptations that resist over-specialization, in turn decreasing the likelihood of extinction in the longer term. All of this follows logically from Wallace's concept of the removal of the unfit: through this one can see that there is no 'process' of adaptation, merely: (1) idiosyncratically emerging adaptive structures that (2) create a *potential* for evolution by sustaining the organism's ever-changing engagement with its environment. This logical structure circumvents the tautology criticism by viewing adaptations as a structural result only: that is, as the immediate conveyor of a negative feedback process that keeps populations healthy enough to sustain the positive feedback generating processes (genetic mutation, dispersal and migration, and community engagement through malleable behavior) that lead ultimately to increasing sophistication of energy capture and utilization, and thus evolution, in the overall system (Smith 2004).

This brings us to the second theme already evident in Wallace's pre-1862 leanings: the idea that in nature there are always 'more recondite' (one of his favorite phrases) forces at work than immediately meet the eye. Before he came to natural selection, he apparently believed that adaptations emerged at random, being in some method correlated with evolutionary change, but not driving it. Later, Wallace would extend his appreciation of the place of more remote causes in evolution to an entirely new arena when he incorporated spiritualism into his world view; but this is another story (see Smith 2008).

Wallace's post-1862 work in biogeography

Wallace's return to England in 1862 by no means signaled for him the beginning of a fade from celebrity – quite the opposite, actually. He would live on another 50 years plus (he died in 1913), and in each of these following decades he published over 150 works. For about a dozen years after 1862, subjects other than biogeography absorbed most of Wallace's attention, but in the early 1870s, he began to work on what would turn out to be three important books on the subject. The first one completed was the massive two-volume tome *The Geographical Distribution of Animals* (Wallace 1876). This commenced with a review of general principles (including evolution) affecting geographical distribution, and continued on with summaries of the fossil record, the faunal histories and characteristics (''zoological geography'') of the Sclaterian realms, and finally the characteristics and causes of the distribution patterns of major individual animal groups (his so-called ''geographical zoology''). The book was met with universal critical applause. Among its influential features was its insistence on the importance of the geological record to interpreting present-day distribution patterns, its statistical summaries of distribution patterns, its innovative use of plates portraying representative animal forms from all the geographical areas dealt with (these plates later helped inspire the development of the faunal diorama displays in natural history museums, and perhaps even the more recent biome habitat exhibits becoming increasingly popular in today's zoological parks), and its use of evolutionary models (Figure 4).

Two years later (1878) Wallace came out with a book of essays (some already published and some not, though in the latter case thoroughly revised) that focused on the ecological biogeography of the part of the world he knew the best: the tropics. *Tropical Nature and Other Essays* also proved a notable success, providing its readers with an up-to-date summary and interpretation of the geographical and biological foundations of the tropics, along with readable treatments of the habits of particular species. Included among its pages was an early discussion of a subject that has been under debate ever

Fig. 4. Map of the Ethiopian Region from *The Geographical Distribution of Animals*.

since: just why it is there are so many more species in tropical regions than in higher latitude ones (see Goldberg et al. 2005; Mittelbach et al. 2007). Wallace favored an explanation grounded in the apparent stability of conditions in the tropics; that is, that the ''equatorial zone... exhibits to us the result of a comparatively continuous and unchecked development of organic forms; while in the temperate regions, there have been a series of periodical checks and extinctions of a more or less disastrous nature, necessitating the commencement of the work of development in certain lines over and over again'' (Wallace 1878, p. 123).

In 1880, Wallace released what some people consider to be his finest extended scientific work: *Island Life*. The book is actually something of a hybrid effort; its first two-fifths opens with another summary of the principles of animal distribution, then moves on to a discussion of the age of the earth (as indicated by his analysis of surface erosion rates). There follows over 100 pages of development of his original theory of Ice Age causation, largely to the end of explaining specifics of distribution not treated under the more general principles laid out in *The Geographical Distribution of Animals*. The last three-fifths of the book provides a review of the biotas of the world's islands, organized around the classification of island types he drew in part from Darwin.

Wallace continued to write on biogeographical subjects for several more years (including in his *Darwinism* in 1889, in which he discussed, for example, ideas on corridor dispersal along mountain chains), but after about 1895 his production dwindled: he just did not have a lot more to say.

Wallace's work in physical geography

It may come as some surprise to those accustomed to thinking of Wallace as a biologist and biogeographer that he was also an accomplished physical geographer. Much of his work in this realm was intended to support his biological explorations, but along the way he also made quite a few significant original contributions. In his early years, Wallace was apprenticed to an older brother as a surveyor, and it was this experience – the outdoor work – that ultimately led him to natural history studies. His attraction to the subject would have been clear enough early on had he been able to complete his planned monographic study of the physical geography of the Amazon basin upon his return from South America, but thoughts of this project ended when he lost most of his notes in the ship's fire. As it was, it was not until 1863 that his mastery of the subject matter became evident when he presented a lengthy paper titled 'On the Physical Geography of the Malay Archipelago' to the members of the Royal Geographical Society. It made such a strong impression at the time of its delivery that the Society's president, Sir Roderick Murchison, was reported to remark:

> ... as a geologist, he must say, in all the years he had had the honour of being connected with the Society, he had never heard a paper read of a more luminous character, and which so bound together in the most perfect forms all the branches of the science of natural history, more particularly as it developed the truths of geography upon what he considered to be its soundest basis, that of geological observation and analogy (Murchison 1863, p. 210).

Wallace was later awarded the RGS's Founder's Medal at their meeting of May 23, 1892; as early as 1870 he had received institutional recognition for his work in geography in the form of the Gold Medal of the Société de Géographie (Paris).

Wallace had also had early experience as a professional mapmaker, having received several commissions to do work in the South Wales area in the 1840s. This background came in handy during his years in the Amazon basin, as one project he *was* able to complete there was a map of the Rio Negro – which became a standard reference on the area for some 50 years. A few words had to perhaps be slipped in this study regarding Wallace as an explorer *per se*: although he kept letters of introduction from various authorities to help him out when possible, most of his 12 years of travels were carried out in areas very remote from European influence. He was probably the first European to see the upper reaches of the Rio Negro, and also the first to set up a residence on New Guinea for an extended period. Most of the time he worked practically alone, with only temporary native hires helping him out.

His surveying experience also came in handy when he (rather inadvisedly, if the truth be told) later accepted a 500 pound wager – a large sum of money at the time, 1870 – to provide a proof of the rotundity of the earth. Although Wallace ultimately won the bet by showing how the curvature could be detected along a long straight stretch of channelized water (this was the celebrated Bedford Canal Experiment), his challenger proved to be a fanatic and not only refused to pay up, but seriously harassed Wallace for the next 15 years (Garwood 2007).

More important than this foray into geodesy, however, were Wallace's geological/geographical studies on the age of the earth, causes of the Ice Age and glacier movement, island classification, and planetary surface environments. In the late 1860s, he became interested in the debate over the earth's age that had been started by the physicist William Thomson (later Lord Kelvin) a few years earlier. Wallace attacked the question by looking into what was known about surface erosion rates, and attempting to calculate how long it would take to produce the observed thicknesses of sedimentary units. He concluded (Wallace 1870) that the processes involved might require a time span of as little as 24 million years since the beginning of the Cambrian Period, a total that was not out of sync with the physicists' calculations (which turned out, of course, to significantly underestimate the actual figure).

Wallace's work on island classification and the permanence of ocean basins and continental masses also led to some incorrect conclusions; nevertheless the inaccuracies involved were more owing to lack of pertinent information than bad reasoning. In those days, land was thought only to have moved up or down and not laterally, as we now know it does through continental drifting. Wallace looked to the characteristics of biotas on islands as a primary argument against competing theories of land-bridging, as with but very few exceptions mid-ocean islands were highly faunally depauperate, and thus must never have been connected with the continents. In most cases he turned out to be correct—but not for the reason he suspected.

Wallace's first writing on glaciation was an 1867 review of glacially-induced geomorphological features. By the later 1870s he was studying the subject closely. His conclusions were stated in a lengthy book review (Wallace 1879a) in which he set out an entire theory of the Ice Ages, based in good part on climatologist James Croll's theory of astronomical causation as related to shifts over time in the eccentricity of the earth's orbit (Croll 1875). But he also integrated his own ideas on how changes in surface geography might have created a synergistic effect when combined with the astronomical ones. Tinkler (2008) has viewed Wallace's interest in Ice Age evolution as devolving from the 'age of the earth' debate; that is, Wallace regarded rates of natural selection as varying according to the degrees of challenge provided by environment at different times over earth history. (Here is one good example of Wallace's tendency to look toward 'more recondite' forces in nature: evolution might proceed more quickly in response to the rapid onset of new climato-environmental conditions as populations were forced to select out new adaptations more quickly than usual.) He also involved himself in discussions on the mechanics of glacial ice movement, and how this was related to the evolution of alpine lake basins, helping to debunk earlier views (Wallace 1893).

In 1898, Wallace authored a book called *The Wonderful Century*, in which, he outlined what he felt to be the nineteenth century's notable successes and failures. In researching, the astronomy section of the book he became interested in data suggesting the Sun might be at the very center of the known Universe, and in turn that Earth might be the only place where intelligent beings could exist. This idea became the theme for a 1903 paper, and several months later an entire book, both entitled *Man's Place in the Universe*. Much of the argument centered on the necessary conditions for life on the surface of a planet, and thus in reasoning based on principles of physical geography. In the following years, the astronomer Percival Lowell raised a related issue, advocating the notion that the so-called 'canals' that had been observed on Mars were engineering projects fashioned by intelligent beings living there. (Actually, the images of the 'canals' were later determined to arise as the by-product of telescope optics.) In 1907, Wallace used principles of physics, physical geography, and climatology to demolish Lowell's theory in a little book entitled *Is Mars Habitable?* In this work, Wallace was able to closely estimate the planet's albedo and surface temperature properties, and correctly predict that at least one of its white polar caps is composed not of frozen water, but instead carbon-di-oxide. For such early applications of the principles of physical geography to planetary surface environments, Wallace can reasonably be credited as one of the founding fathers of astrobiology.

Wallace also worked on human geography subjects. After about 1880, he spent at least as much of his time on social causes as he did natural science problems. In 1880, he was made the first president of the Land Nationalisation Society, an organization dedicated to wresting control of the land from large landholders. He remained the Society's president all the way through to his death in 1913. Wallace was not merely an administrator in this cause: he also invented the basic strategy for executing the changeover. The land would increasingly be turned over to State ownership; this would be accomplished through the establishment of terminable annuities effected slowly, over two or three human generations. As this took place, citizens would begin *renting* the land from the State. According to Wallace's plan, tenants would rent land parcels at various rates; these rates would be determined on the basis of the parcel's nearness to important societal functions and other basic geographical criteria – but, additionally, tenants would be allowed to own absolutely any improvements they made while renting. As he put it, through his early studies of Herbert Spencer's ideas on justice ''a seed was sown in my mind which long afterwards developed into that principle of the separation of the inherent value of land from the improvements effected in or upon it, which was the foundation of [my] proposals'' (Wallace 1900, p. 333).

Wallace also offered a variety of schemes for dealing with other social issues, though many of them had no explicit geographical connection. Another that did, however, was his frequent urgings against human destruction of the environment, especially as regards the effects of industrialization and agriculture on species loss. Although not everyone now considers him a true proto-conservationist – he seemed to be more concerned with the effects of environmental degradation on human aspirations than on the animal and plant world itself (see the arguments of Knapp 2008) – it is nevertheless true that he spoke to related issues on numerous occasions (Figure 5) (see Smith 2000).

We should also take note of Wallace the anthropologist. Again, many of his ideas in this realm pass well beyond the geographical, but in the particular direction of ethnography he made a considerable mark. For example, he was one of the first to opine that the native Australians were not closely related to their Southeast Asian neighbors (Wallace 1879b). In an earlier paper (Wallace 1867b), he argued the now overturned position that Polynesians were most likely more closely related to African peoples than to the nearby Malaysians.

Final remarks

Considering Wallace's lifelong interest in the land and its various physical, biological, and social elements, it is difficult to view him as being other than, in the main, a geographer. Of course, he was a geographer with a somewhat unusual abiding interest in evolution, but perhaps geographers should not hold that against him.

In Wallace's day, humankind was finally coming to grips with the notion that we had a significant, and understandable, history. Biologists were not the only ones entertaining thoughts of long term change in the nineteenth century: geologists had earlier settled on their own theory of laws-driven change – uniformitarianism – and during this period astronomers were not only registering observable phenomena, but also looking for ways to understand them in a changing cosmological context. Anthropologists, meanwhile, were discussing various models for human origins, while early archeologists were beginning to flesh out the history and evolution of societies with their discoveries

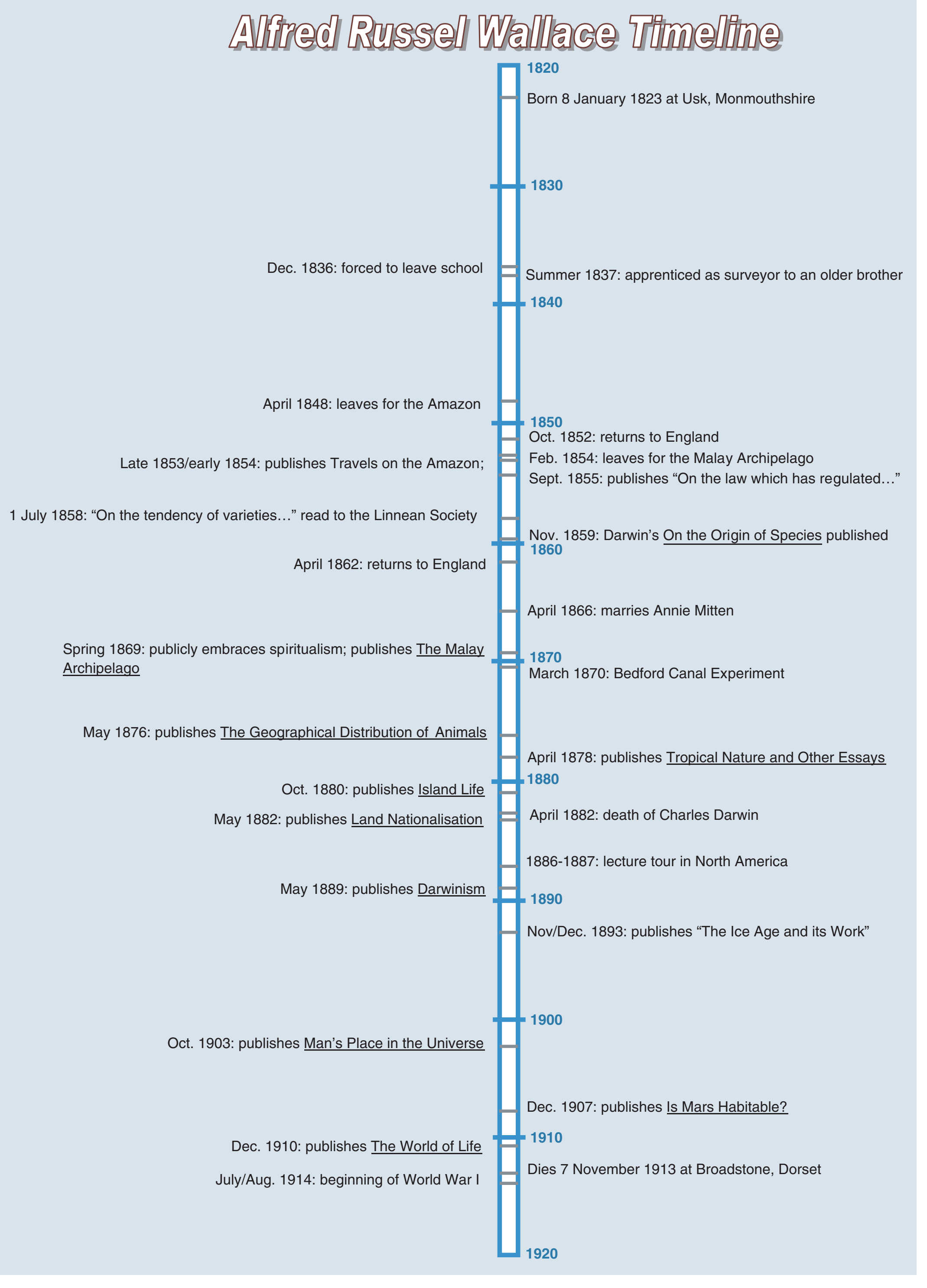

Fig. 5. Wallace Timeline.

of the ruins of past civilizations. Wallace (and, of course, Darwin as well) found himself right in the middle of all this recovery of our origins, and contributed a good deal to its synthesis.

What makes Wallace a bit different from his contemporaries and near contemporaries, however, was that he never lost his sense of the primacy of the here and now. It was not enough for him to theorize about process, about how the past becomes the present. Nor was he ever satisfied merely to identify what *is*; beyond this he sought to expose what was lacking in our knowledge system, and to envision what could be if we only tried to make it so.

In the search for those 'recondite forces' that bind us all together, Alfred Russel Wallace was both a pioneer and a leader. In maintaining a central interest in the condition of humankind, its failures to date, and its possible futures, he is a good role model for thinkers of today in geography. He was ever-mindful of the need for facts-based thinking, both in the physical and human realms, but never allowed mere facts to gain the upper hand over a sound moral and ethical compass. Of equal interest, meanwhile, were his innovative uses of spatial reasoning in methods that directly complemented fundamental models of process. This is most evident in the way he moved beyond his early, geographical determinism-like model of evolutionary change (as in his 1855 Sarawak paper) to one invoking natural selection and a combined dispersalism/vicariance mode of thinking, his linking of astronomical cycles and physiographic change to Ice Age evolution and biogeographic patterns, and his recognition of the possible relevance to societal evolution of the difference between land value due inherently to geographical location, and to secondary enhancements. Wallace's example presents a challenge for societally committed geographers: can we continue to improve our knowledge of the past and present, while striving to identify new and more universal models of process that can help us manufacture a livable future?

Short Biography

Charles H. Smith is Science Librarian and Professor of Library Public Services at Western Kentucky University, Bowling Green. He holds a BA in Geology from Wesleyan University, CT, USA an MA and PhD in Geography from Indiana University and the University of Illinois, respectively, and an MLS from the University of Pittsburgh. Originally graduated-trained as a biogeographer, he has branched out to work both in that field and in history and philosophy of science, systems theory, bibliography, and website development. His publications include about three dozen first- or sole-authored peer-reviewed papers in journals ranging from the *Journal of Biogeography* and *Nature* to the *International Journal of General Systems* and *Choice*, five books (the most recent in 2008 for Oxford University Press: *Natural Selection and Beyond: The Intellectual Legacy of Alfred Russel Wallace*), and ten informational websites (the most popular being the still-growing 'Alfred Russel Wallace Page'). His current projects include editing Wallace's 1886–87 North American lecture tour journal, constructing a new website featuring mammalian distribution maps, and looking into the implications of an empiricism-friendly final causes model based on ideas of the philosopher Spinoza.

Note

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