The Other Man

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Alfred Russel Wallace
A Life
Peter Raby
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Coincidences are not unknown in science. Newton and Leibniz each invented the calculus; Correns, Tschermak and de Vries rediscovered the laws of Mendel at about the same time; and Sudarshan and Marshak on the one hand, and Gell-Mann and Feynman on the other, may have independently discovered the basic form of the interaction that governs nuclear beta decay. But for sheer implausibility, there is one coincidence that beats all others. That is the apparently simultaneous discovery of the central principle in biology, the theory of evolution by natural selection. One person, Charles Darwin, came to the discovery after long and patient thought and analysis. He sat over it for years, refining his arguments all the while and preparing to write a massive book in which to announce it to the world. Another person, Alfred Russel Wallace, much the younger of the two and nowhere as well-known as Darwin at the time, made the same discovery, more or less in one bout of inspired creativity, when he was laid low by fever in a tropical forest. This biography by Peter Raby shows how the paths that lead to a great idea can be similar in some respects and dissimilar in others.

In the minds of most people, Charles Darwin's is *the* name that occurs when thinking about evolution. The fate of Alfred Russel Wallace for the past 100 years and more has been to be thought of as the Other Man. That will very likely continue as his destiny. Considering that Wallace discovered the one unifying concept encompassing all of biology independently of Darwin, this is grossly unfair. Raby's book goes some way in restoring to Wallace the credit that is rightly his. In the process of doing so, he draws our attention to an interesting feature of Victorian England. In spite of the various inequities that it suffered from, it allowed a bright boy from a poor family to follow his interests and become a man of science. Wallace lacked the right family background, lacked wealth and lacked connections – lacked influence, we might say. He was largely self-taught and had to live by the money he earned by his own work (never a consideration with Darwin). The English class system may have been part of the reason why Wallace's reputation was at no time ranked as highly as it deserved to be. But much of the responsibility, it seems, can be laid at the door of Wallace himself. He was modest, self-effacing and – in particular when it came to comparing himself with Darwin – diffident to a fault. He invariably tended to downgrade his achievements. This sort of behaviour appears not just unusual to us, it appears positively bizarre, hardly the way to go about improving one's prospects in the world of science. But in the case of Wallace, it happens to be true.

Born in England near the Welsh border in 1823, Wallace was 14 years younger than Darwin. His father was a poor manager of money and quickly went through what had been a regular income. From then on the family suffered from financial problems almost continuously. Forced to earn a living early, young Wallace was apprenticed to a surveyor at the age of fourteen. In those days the first railway lines were being laid; thanks to his work as a surveyor, he developed a taste for adventure and the outdoors that lasted all his life. Another trait that showed up at a very young age was a passion for reading. Wallace claimed to have read, when young, almost every book that was 'celebrated or interesting'. Along with reading, Wallace enjoyed collecting insects, especially beetles – a trait in which he resembled the young Darwin. There were some hints of what would come later in his life. Darwin's journal *Voyage of the Beagle* came out when he was nineteen (*Box* 1). Wallace went through the book carefully and made notes from it. A sensational and anonymously published book called *Vestiges of the Natural History of Creation* appeared in 1845, nine years after Darwin returned from the Beagle voyage. It was actually written by one Robert Chambers. The book made a strong impression on Wallace. Chambers made two bold assertions. One, the living world was as much subject to natural laws as the non-living world. And two, living species were not permanent entities but could change. Both assertions appeared attractive to Wallace. Unfortunately, *Vestiges* remained silent about the possible mechanisms that might cause a species to change. For this reason, what Chambers said remained vaguely unsatisfactory. Here is an interesting example of an important

Box 1.

The Beagle was a naval ship fitted out for surveying the South American coast, the coast of some Pacific islands, and to chart oceanic pathways. These tasks were important for the British empire. It set out on December 27, 1831 and returned on October 2, 1836. Against initial paternal opposition, Darwin managed to get on board as Ship's Naturalist. For him the journey turned out to be a voyage of discovery in more senses than one. In his autobiography Darwin says "The Voyage of the 'Beagle' has been by far the most important event in my life, and has determined my whole career ..". He made a book, *Voyage of the Beagle*, out of the journal that he maintained. It was an instant success and continues to charm even today. Unlike the more famous *The Origin of Species*, this book shows Darwin in the process of discovery. Here he is more relaxed and less circumspect, more speculative and less constrained, than in the *Origin*. For example, consider the finches of the Galapagos islands, known to this day as Darwin's Finches. With their extraordinary beak shapes and feeding habits, they have acquired legendary status as living examples of how natural selection works. They are mentioned here (with some hesitancy), though not in the *Origin*. Here is how he first expresses his suspicions of what might have been going on: "Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends".

fact. Namely, even when one is correct in stating what happens, people tend to accept it only if one can also explain *how* it happens. Most important of all his reading, Wallace went through a small book, *Essay on the Principle of Population*, written by the Reverend Thomas Malthus. The message of this pamphlet remained locked up in his mind for a further twelve years. Then, in a burst of feverish activity, it emerged transformed as the principle of natural selection.

The turning point in Wallace's life came when he set off by boat on a collecting trip to the Amazon jungle in 1848. There were two attractions. He was drawn by the prospect of seeing an exotic world. Also, he wanted to see if he could make a living by doing what he enjoyed. Henry Bates, an old friend, was his companion on the voyage. As with Wallace, Bates too belonged to the lower middle-class and was a self-taught naturalist. He was to become famous later for his explanation of how some butterflies (that can be eaten, and so are at risk) improve their chances of survival by successfully mimicking, or copying, the appearance of others (that are inedible). The Amazon trip lasted three years and ended in a tragedy. The specimens that Wallace shipped back to England did not raise much money when sold. Worse, a fire on board destroyed all his sketches, notes, drawings and precious insect collections just before he returned to England. But in a larger sense the voyage was a success. The tropical rain forest worked on Wallace in a way that it had much earlier worked on Darwin. It opened his eyes to the sheer variety of living forms, their abundance and their extraordinary adaptations. By the time he came back, his name was well-known in naturalist circles.

Wallace started planning for his next journey soon after returning from America. This time it was to be to the Malay Archipelago and for eight years. In his own words, the trip turned out to be 'the central and controlling incident' of his life. In February 1854, just before setting off, Wallace had got to know of a theory of evolution based on a 'Divine scheme of organized nature'. It had been put forward by the President of the Geological Society in London. He thought the theory was an 'ideal absurdity' and felt challenged to come up with a better alternative. Much thought resulted in an essay titled *On the Law Which Has Regulated the Introduction of New Species*, written in a house at the mouth of the Sarawak river. He put forward the central idea as a law: whenever a new species first appeared on Earth, it did so close to where there was an already-present species. One species could change 'either slowly or rapidly into another'; he remained unsure how. Though some way from formulating the idea of natural selection, he was getting close. It was well-known, of course, that species which occurred close to each other often resembled each other. Wallace claimed that his 'law' provided a better explanation for the resemblance between neighbouring species than any other hypothesis. His confidence was so much that he went on to add something else. If his law was true, said Wallace, deductions made from

it would be as valid as the deduction of elliptical planetary orbits from the law of universal gravitation (*Box* 2). Darwin had been slowly chewing through the implications of natural selection for some twenty years when the Sarawak paper (published in 1855) came to his attention. It did not make much of an impression. 'Nothing very new' was the remark he made in the margin of his copy. Raby's guess is that Darwin did not see that Wallace was thinking along the same lines as himself because of misleading wording. For example, Wallace used the word 'created' where he meant 'evolved'. This seemed to suggest that in his mind a species appeared 'out of nowhere' instead of being modified from a pre-exisiting species. Also, Wallace used the strange-sounding word 'antitype' when he really meant (in referring to a species) 'prototype'. All this made Darwin feel that there was no cause to be worried by the possibility that Wallace might snatch the credit for discovering natural selection from him. But his good friend Charles Lyell, whose geological researches provided crucial support to the thinking of both Darwin and Wallace, immediately grasped what Wallace was getting at. Lyell warned Darwin that he stood the risk of being scooped. Darwin re-read Wallace's paper and this time he was slightly shaken. Nevertheless, he carried on with his enterprise – producing a major book on evolution at his own measured pace – much as before.

The blow fell in 1858. Wallace had been laid low by malaria on the island of Ternate. The forced leisure made his thoughts return to the problem of how species might change. Malthus's essay, read long ago, came back to his mind and provided him with the key to understanding natural selection – in a flash,

Box 2

The evocation of Newtonian law was symbolic of what was a goal for Wallace as it was for many others working on biological problems: physical science had set the benchmark by which other areas of human endeavour had to be judged if they were to be accorded scientific status. One might note here that later, in the famous last paragraph of *The Origin*, Darwin explicitly drew attention to the analogy between natural selection and gravitation as laws of nature. The desire to validate all of science by applying the standards of mathematical physics has been a mixed blessing. Some, for example the distinguished evolutionary biologist Ernst Mayr, have considered it a positive hindrance; in his trenchant phrase, 'Physics envy is the curse of biology'.

The last sentence of the *Origin* reads as follows: "There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved". Interestingly, the phrase "by the Creator" was missing in the first edition. It was added later when Darwin found that the omission attracted criticism that was annoying because it was directed at something that was irrelevant to the main message of the book.

as it were. Malthus's reasoning was simple: there was an innate tendency on the part of human populations to grow unchecked. The supply of food could never keep up with the increase in numbers. The reason, he said, was that the land available for agriculture would increase only slowly, by something like an arithmetical progression. On the other hand, populations grew in geometrical progression – much faster. Because of this, there would be a struggle for existence in which those least able to compete were weeded out. Further, there would be other direct or indirect consequences of unchecked human population growth, namely war, hunger and disease. Again, those best capable of surviving would do so whereas others, those 'less fit', would be eliminated (*Box* 3).To Wallace this immediately suggested how a similar mechanism, what came to be known as natural selection, might act on all living forms (*Box* 4).

In an amazing coincidence, Darwin had hit upon the very same mechanism after being inspired by the same book. Wallace was overjoyed at having discovered what – in his mind – was a fundamental law of nature. Ironically, he could think of no better person to judge how good the theory was than Darwin, who by then had already become famous as a naturalist. He wrote him a letter and enclosed a short manuscript in which the essential idea was elaborated; Darwin was requested to forward the manuscript for publication if he approved of it. The rest of the story is well-known. At first Darwin was dismayed because he feared that if he followed this advice, his behaviour might be considered unethical. But Lyell and Hooker convinced him that the correct thing would be to present his ideas *and* Wallace's simultaneously. Equally importantly, Wallace showed an extraordinary sense of fairness and decency throughout

Box 3.

A journalist, philosopher and sociologist, Herbert Spencer popularised both the word 'evolution' and first used the catchy phrase 'survival of the fittest' to describe the working of natural selection. Oddly, Spencer himself was somewhat of a Lamarckian – he believed in the inheritance of acquired traits. Darwin adopted the phrase enthusiastically. Unfortunately at times it has caused more trouble than it is worth. Some people have used it as a handy tool to attack the entire notion of natural selection. Their reasoning goes something like this. If 'survival of the fittest' describes what happens in evolution, you must first define 'fittest'. The only way to do so is to say that the 'fittest' are those that survive. In other words, Spencer was making the entirely correct but completely empty statement that according to natural selection, the survivors survive. Philosophers have tended to jump into the picture at this stage and conclude that natural selection must be an empty notion. In logic the chain of reasoning sketched above is known as a tautology. In a tautology, the conclusion is hidden in the assumptions made at the beginning. Such a conclusion does not tell us anything new about the world. At the end, a tautology has not generated any information that was not already implicit in the beginning. A tautology nevertheless may be *interesting*, even useful – quite a different matter. For example, given the assumptions of Euclidean geometry, the theorem of Pythagoras is a tautology (as is perhaps all of mathematics). See *Box* 4.

Box 4.

The essentials of natural selection can be summarized by saying that *if* certain assumptions made about living creatures are correct, *then* a particular outcome must follow – this statement, and only this, is the tautology.

(a) The assumptions are that (i) the individuals who make up a species can reproduce; (ii) they differ from one another in various traits; (iii) the differences are heritable – they can be passed on to their children, at least to some extent; and (iv) the same differences can influence how successful they are at surviving, reproducing or caring for their young.

(b) Because of the assumptions just made, some types of individuals must leave behind more offspring then others. Therefore, in the long run, the population will increasingly be made up of the former types rather than the latter. Given the constraints imposed by the nature of genes, by anatomy, by physiology, more generally by the laws of physics, and finally by the environment, these long-term representatives would appear as if they were 'just right' for whatever their form of life is. This outcome is known as *adaptation*.

To undertake a scientific test of natural selection means to examine, in a particular situation, whether the assumptions listed in (a) are correct. The exercise can be carried out by observing, and experimenting on, plants, animals and microbial organisms both under natural conditions and in the laboratory. Unfortunately this is not always possible because the course of evolution can be exceedingly slow. A major change in human beings, for example, may take a couple of hundred generations to be perceived. This is where the conclusion, which was drawn in (b) on the basis of the assumptions made in (a), becomes useful. It forms an important diagnostic test for whether natural selection could be a valid explanation for the evolutionary history of a trait that is observed in a plant or animal in the wild. As with any scientific hypothesis, there may be situations in which natural selection is an unsatisfactory explanation for something that is observed in nature or in the laboratory. When that happens, one needs to think of other explanations.

what followed. The actual presentation took place at a special meeting of the Linnean Society. It was arranged because the one scheduled prev-iously had to be cancelled on account of the death of its President, the famous botanist Robert Brown (the discoverer of 'Brownian' motion). There was no response from the audience. Later, Darwin, for once bestirred to act in what was for him a hurry, published his theory in 1859 as *The Origin of Species*. He maintained all along that the book had been written in a hurry and that it was merely an abstract of a fuller version to come. That fuller version never appeared.

Wallace's reaction to *The Origin* was handsome beyond belief and appears implausible to us today. "Mr. Darwin has given the world a *new science*, and his name should, in my opinion, stand above that of every philosopher of ancient or modern times". To Bates he said "I do not know how, or to whom, to express fully my admiration of Darwin's book. To *him* it would seem flattery, to others self-

praise; .. with however much patience I had worked and experimented on the subject, I could *never have approached* the completeness of his book ...". Darwin reciprocated just as warmly, and with keen understanding: "You must let me say how I admire the generous manner in which you speak of my Book: most persons would in your position have felt some envy or jealousy". When Bates passed on to Darwin one of Wallace's letters to him, Darwin replied "He rates me much too highly & himself much too lowly... But what strikes me most about Mr. Wallace is the absence of jealousy towards me: he must have a really good honest & noble disposition. A far higher merit than mere intellect".

I have tried to give some idea of the main scientific thread that runs through this admirable book. There are other threads as well. The list begins with Wallace's ever-growing reputation as a superb naturalist. He can be called the founder of biogeography, the study of the distribution of animals and plants in space and how that distribution relates to their evolutionary history. Raby also touches on his perennial problems with money, partly solved thanks to Huxley and Darwin's mediation which resulted in a government pension. There were many other parts to Wallace. He had enthusiasms that at times verged on impetuousness. He was opposed to vaccination (he thought the claims for success were not backed by solid data); believed in spirits in spite of plausible evidence of fakery; had strong feelings on the subject of women's rights; advocated land reforms; was a socialist; was convinced that what people needed most was a sense of self-respect; and finally, felt that if humans were to have a future at all, it lay in cooperation, not competition.

In all these respects, Darwin was a recluse. He did what he could to disengage himself from the outside world. He wanted to have only so much to do with human affairs as he was compelled to. Wallace was just the opposite. He had a broad social philosophy; he was convinced it was correct and wanted to convert others to it. Once Wallace tried without success to persuade Darwin to read a 'startling novel and original' book on economics that he had come across. Darwin's response might gladden the hearts of those who feel that the claims of economics to scientific status are dubious even today: "I read many years ago some books on political economy, and they produced a disastrous effect on my mind, *viz.* utterly to distrust my own judgement on the subject and to doubt much everyone else's judgement". Wallace called himself lazy, but was punishingly hard-working (as was Darwin of course); his publications include 22 books and 700 articles. He abhorred pomp and always retained a sense of his own absurdity. He lived till he was 90 and remained intellectually agile and vigorous to the end. He was invited to contribute to a volume being brought out to mark the centenary of Darwin's birth in 1909 but declined, apparently because he was not happy about the company he would have been forced to keep – William Bateson and Hugo de Vries in

particular, both of them well-known as founders of the then-new science of genetics. One would love to know exactly why he felt that way, just as one would love to know how he reacted to the rediscovery of Mendel's laws in 1900. Raby does not enlighten us.

One thing about Wallace bothered all other Darwinians (he counted himself as one, going so far as to write a book titled *Darwinism*). This was his refusal to agree that humans too were products of natural selection. He would not accept that the human mind could be explained in the same manner as other aspects of the living world; he claimed that there had to be something else to it. According to him the existence of the human mind was "itself the living proof of a supreme mind". He thought that consciousness and the powers of the mind were so astonishing that they must have resulted from *artificial* selection, meaning from a scheme of selection carried out with a purpose in view. A Higher Intelligence must have been involved in the development of the human race in the same way that humans had developed races of cows or horses in order to serve special ends. Darwin, Huxley and many others differed from Wallace on this; indeed, differed "grievously", as Darwin told him apologetically.

In ending, let me make a few general remarks. This biography forms an interesting counterpoint to several recent and highly readable biographies of Darwin, especially the one by Desmond and Moore. That book succeeded brilliantly in portraying Darwin as a product of his times. It showed that he was a rich, upper-class British gentleman of leisure whose intellectual development took place in, indeed was shaped by, a Victorian world in which social inequalities were common and some people were more successful than others because of the advantages of birth and circumstance. This way of analyzing Darwin was acclaimed by many but criticised by others, who objected that it made Darwin appear to be almost an inevitable consequence of social forces. With Wallace, though, at least as Raby presents him (which is not all that different from what one had known or guessed), the assessment must be rather different. Here was a man, with neither wealth nor connections, only boundless curiosity. In certain aspects he too was a product of his times. He went on to indulge his curiosity to the fullest, even though prudence and common sense, not to say convention, might suggest a more regular, more stable, more 'normal' career. Going by what we know, it appears that the best way to understand the course of Wallace's life is to see it as following from a highly individualistic set of choices. The point is that these were choices that would have been opposed, not fostered, by societal expectations. No doubt the choices that he made had to mesh with, even exploit, the conditions imposed by an external world, but they were his choices. Raby puts it nicely: Wallace's was an astonishing intellectual odyssey which was at the same time "fed by the Victorian institutions of self-help, the mechanics' institutes and local lending libraries, popular journals and magazines".

We are often tempted to force explanations of human behaviour within a simplistic Nature-versus-Nurture framework. Wallace's life could be said to be dominated by the Nature end of the range of inputs. Luckily there is an interesting 'control experiment' available for us to compare with Wallace. He and Bates were friends and contemporaries, had similar backgrounds, aspired to similar careers, made similar choices and, most importantly, were intrigued by similar questions (as early as 1847, Wallace is writing to Bates about a possible "theory of the origin of species"). Yet Wallace discovered natural selection whereas Bates did not.

Finally, a striking fact that comes through this biography is that Darwin and Wallace saw themselves pre-eminently as theorists. Both were convinced of the central importance of theory even in a field as rooted in observation as natural history. Wallace has been quoted above. Here is Darwin to Wallace, in a letter that went to Ternate and just predated Wallace's momentous announcement to him: "I am extremely glad to hear that you are attending to distribution in accordance with theoretical ideas. I am a firm believer, that without speculation there is no good & original observation". That was in 1857, approximately fifty years before genetics and developmental biology began to provide two more theoretical underpinnings to biology and about a hundred years before neuro-biology ushered in a third. We would do well to ponder the irony here. Namely, modern biology, whose practitioners tend to look down on old-fashioned descriptive botany and zoology, often seems to involve little more than accumulating facts for their own sake; a theoretical underpinning is largely absent. It runs the risk of becoming what Ernest Rutherford once described as 'stamp collecting' – in his mind, everything except physics was just that. The only difference, one might say, is that in this case the stamps are molecule-sized.

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Science can only ascertain what is, but not what should be, and outside of its domain value judgments of all kinds remain necessary.

Albert Einstein
(1879-1955)