



Alfred Russel Wallace & the Origin of Species

by Ami Friedman, with contributions from Douglas Allchin

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Our story starts in autumn of 1847 in Great Britain.



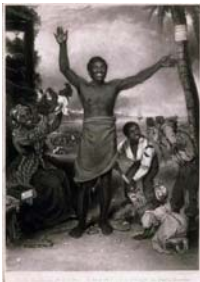
Queen Victoria is in the 10th year of her reign, her 5th child with Prince Albert last year.



A new era is emerging, influenced in part by an earlier Age of Enlightenment, with its celebration of reason, science and optimism.



With the steam engine, industry is expanding and railroads are expanding across Britain. With unionization, new laws limit the work day and create a bit more leisure time.



Slavery is gone, abolished in 1833.



In further reforms, following riots in 1831, the House of Lords agreed to extend voting rights to the middle class, leading to a more democratic government.



Women, too, are now also seeking those rights!



Charles Dickens, building on the successes of his *Oliver Twist*, has recently published his satire on selfishness, *Martin Chuzzlewit* (1844).



As industry grows, so too does the dirty air, blackening the city's facades.



Gas lighting, however, has spread. In pubs, mirrors — etched with the name of their beers — reflect the internal light, making them seem like "little bubbles of light in a dark city."

Finding Work



In Neath, Wales, a young man, 24 years old, writes to a companion, suggesting that they go on an expedition to the Amazon to collect new plants and other animals. The young man is Alfred Russel Wallace.

Wallace is the 8th of 9 children. His family was middle-class but suffered from periodic economic hardships. Now he is looking for work himself.

For quite a while, he had worked as a surveyor, at first apprenticed to his older brother, William. Despite the long hours, he enjoyed working outdoors and hearing about his brother's interest in geology. Later, after William died, and other ventures, he returned to surveying, profiting from the expansion of the railroad until massive speculation ended it in financial panic. Wallace was looking for work again.

What might Alfred do? He has two passions. One is reading — for a while his father had been a librarian. The second is plants and natural history and collecting. He later recalled how it started:

A lady, who was governess in a Quaker family we knew at Hertford, was talking to some friends in the street when I and my father met them, and stayed a

few moments to greet them. I then heard the lady say. "We found quite a rarity the other day—the *Monotropa*; it had not been found before." This I pondered over, and wondered what the *Monotropa* was. All my father could tell me was that it was a rare plant; and I thought how nice it must be to know the names of rare plants when you found them. (Wallace 1905)



In 1841 Alfred "spent one shilling from his meager supply for a paperbound book": a plant field guide (Brooks 1984, p. 1). He spent much of his leisure time trying to identify the local plants. A few years later, Wallace, then age 21 and working as a schoolteacher, was introduced to Henry Walter Bates (shown here many years later). Bates also loved the outdoors. His love was collecting, especially beetles and he invited Wallace to see his collection. Wallace was impressed that so many beetles could be found in such a small area around town:

. . . so I at once determined to begin collecting, as I did not find a great many new plants around Leicester. I therefore obtained a collecting bottle, pins and a store-box; and in order to learn their names and classifications I obtained, at wholesale price through Mr. Hill's bookseller, Stephen's "Manual of British Coleoptera," which henceforth for some years gave me almost as much pleasure as Lindley's Botany (Wallace 1905, I, pp.236-37)

The two had shared several outings and maintained a correspondence after Wallace left the area. Now Wallace was writing to Bates, asking him if he wanted to join him collecting specimens again — this time in South America!



Wallace is probably also inspired by his reading of travelogues of other great collector-naturalists: *Personal Narrative*, by Alexander Humboldt, and *The Voyage of the Beagle*, by Charles Darwin. Wallace sees an opportunity: the Amazon is teeming with lots of organisms that have not been well collected or studied. In addition, living will be cheap. Was Bates interested? "Yes," Bates responded.

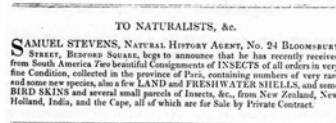
THINK (1): If you were Wallace, how would you fund such an expedition?

Wallace and Bates planned to fund their expedition primarily by selling some of what they collected. That is, in addition to collecting for themselves, they would obtain duplicate specimens that would be valued by museums and other private collectors.



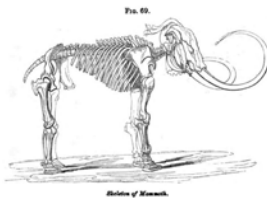
They enlisted the support of Samuel Stevens as their agent, who proved to be (in Wallace's estimation) both "excellent and trustworthy" (Wallace 1905, I:266).

ACTIVITY 1: Imagine you are Stevens. What might you include in an advertisement to sell such specimens caught abroad? Note that print space is costly, so you need to be concise as well as informative as you try to promote sales.



Compare your ideas with Stevens' first advertisement.

There was another opportunity for compensation on Wallace's and Bates' expedition, although more remote. They could write about their travels upon their return. That would depend, of course, on what they saw and did, and how vividly they could write about their adventure.



Wallace had other motives for going to the Amazonian rainforest, as well. He had been inspired by an exciting new book, *The Vestiges of the Natural History of Creation*. Natural historians were by now accustomed to fossils changing type in successive geological layers. The author suggested, however, that just as organisms change as they develop, the species changed historically, organically. The idea was not entirely new. But this book presented considerable evidence and was well written. It also threatened widespread beliefs about the fixity of species, and thus about the stability of the natural order. That raised controversy. Yet the proposed stages of advancement from simple to complex also seemed to fit in with the cultural spirit of progress. Wallace had read the book eagerly and with delight, and corresponded with Bates about it. Bates, he learned, was not impressed. Still, Wallace was struck by the similarities and differences of the organisms he observed in nature, so he wondered how species related to one another and whether, or how, they might change. The Amazon, with its great diversity, would be a great place to explore the new ideas.

THINK (2): What types of data would you advise Wallace to collect if he was interested in species and their varieties and laws of nature that might explain them?

Expedition to the Amazon

In 1848 Wallace and Bates set sail for South America. They remain in the Amazon for 4 years. (Here is another pair of collectors with all their gear several years later [Haeckel and



Maclay, 1866].) The two friends use local natives as guides, as illustrators, as hunters, and as collectors. In addition to collecting specimens, they record the region's geography. After a while, they note that one species of monkey is found on only one side of the main river, while a closely related species inhabits the other side. For other animals, too, big rivers seem to be boundary of the species' range. They even observe the native inhabitants and their languages. Wallace keeps an extensive journal. But after several years Wallace gets yellow fever. After recovering, he heads back to England.



After a month at sea, however, Wallace's boat catches fire and sinks, taking with it most of the major batch of specimens Wallace had brought with him (Turner painting of another shipwreck). Those aboard have food, but little water. Ten days later they are rescued by a passing cargo ship.



London Again

Wallace returns to London in 1852. While he was away, London had experienced a great exhibition, with its remarkable Crystal Palace, reflecting again the technology and wonder of the era.



Dickens is publishing serial chapters of his 9th novel, *Bleak House*, a harsh critique of the British judicial system.

New water companies are continuing to lay pipes to supply running water to the whole of London.



Wallace reunites with his family.

THINK (3): As Wallace, how might you recover from this disaster? What options are available to you to benefit from your investment of time and effort, if most of your specimens are gone?

Fortunately, Stevens (Wallace's agent, remember) had taken out insurance and Wallace receives a small sum (£200) to live on for a while. Wallace establishes residence in London near the Zoological Society offices and begins attending meetings of the zoological and entomological societies. While he had lost most of his specimens (one beetle collection survived) and notes from his travels, Wallace can nonetheless rely on his memory. He also has scattered notes that survived the wreck and letters that he had sent home while away. In the following years, he publishes two books: *Palm Trees of the Amazon and Their Uses* (1853), exhibiting his enduring love of plants, and *A Narrative of Travels*

on the Amazon and Rio Negro (1853). In addition, Wallace discusses his work with other naturalists, examines the museums and formally presents some of his observations and ideas at the societies. For example, Wallace had been particularly struck by the distribution of monkeys on either side of the Rio Negro. This river marked the limits of many organisms: Columbian types to the west, and Guyanan types to the east. Wallace advises his fellow collectors that when travelling along large rivers, one must carefully note on which side a specimen was found.

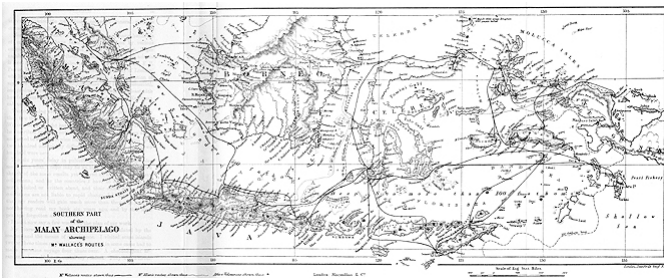


THINK (4): As Wallace, at this point in your life and career (now age 30), what would you do next? Would you risk another collecting expedition? If so, would you return to the Amazon? How would you plan an expedition differently? Or would you try to apply your surveying skills in a related field — say, architectural drafting?

Wallace had reflected on his situation even as he was returning to England following his rescue in 1852:

Fifty times since I left Pará [on the South American coast] have I vowed, if I once reached England, never to trust myself more on the ocean. But good resolutions soon fade, and I am already only doubtful whether the Andes or the Philippines are to be the scene of my wanderings. (1852 letter in Wallace 1905, I:310)

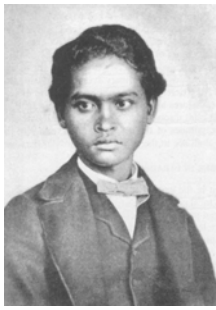
That is, all his time in London, he was considering where to go, not whether he would. Ultimately, Wallace decides to go to the Malay Archipelago in Southeast Asia, another area of great diversity relatively unexplored by European naturalists. Funding is once again a challenge. On this occasion, he had met many gentlemen of standing through presenting his work. Through those contacts, he secures travel on a government ship bound for Singapore, and leaves in March of 1854.



In the Malay Archipelago

Wallace's travels are "hop-scotchy," following no real pattern. He has to use what connections he can when they make themselves available. Still, over many years, he is able to visit every major island at least once. Most he visits

several times.



In many ways, his expedition is similar to his experience with Bates in the Amazon. For example, he again relies on natives for support — including a "house boy," Ali, who helps cook, translate, guide, and trap and skin specimens.



Wallace collects specimens. He describes his daily routine in a letter to his mother:



Singapore is very rich in beetles & before I leave I think I shall have a most beautiful collection - I will tell you how my day is now occupied. Get up at half past 5. Bath & coffee. Sit down to arrange & put away my insects of the day before, & set them safe out to dry. Charles mending nets, filling pincushions & getting ready for the day. Breakfast at 8. Out to the jungle at 9. We have to walk up a steep hill to get to it & always arrive dripping with perspiration. Then we wander about till two or three generally returning with about 50 - 60 beetles, some very rare & beautiful. Bathe, change clothes & sit down to kill & pin insects. Charles d[itt]o. with his bugs & wasps, I do not trust him yet with beetles. Dinner at 4. Then work again till six. Coffee - Read - if very numerous work at insects till 8-9 then to bed - Adieu with love to all. (Letter, May 28, 1854)



He continues to note how species relate to each other, especially geographically. In 1855 he believes that he has finally found a law, or reliable regularity: "Every species has come into existence coincident both in space and time with a pre-existing closely allied species." Species may change, he hints, echoing ideas from *The Vestiges*, but he now rejects its view of progress: "though it may appear to some readers essentially a theory of progression, it is in reality only one of gradual change." Many naturalists believed that new varieties will emerge when organisms are placed under new living conditions, such as domestication. But they did not thereby become new species.



Wallace is now thinking about species and varieties in terms of their locations. For example, he has encountered trogons in Asia. These birds are similar to many species he saw in the Amazon. But whereas all the trogons in South America were green-backed, here they are all black-backed. Why?



Wallace is also impressed with a butterfly given to him by a member of the ruling family on the island of Borneo. It is spectacular: 6½ inches across, with a striking silky green wing pattern. Wallace recognizes the remarkable size and brilliant color, similar to specimens he knows on islands to the east: it is a bird-wing butterfly, of the genus *Ornithoptera*. But it is also new. What a triumphant discovery for Wallace! He names it *Ornithoptera brookiana*, honoring his benefactor. While continuing to admire the new butterfly's magnificence, he ponders on the two similar species and their geographical proximity, not unlike the case of the trogons.

THINK (5): How might Wallace account for two similar types existing in neighboring areas at the same time, rather than in succession to one another?

Wallace has previously concluded that species seemed linked in time and place, but now he considers the additional possibility that one type may spread to two or more different locales, each with conditions that lead to their own variants. The lineages of species, he imagines, may branch. He writes a paper summarizing all his new views and it is soon published in a natural history magazine in London.



Wallace continues to criss-cross the islands, collect specimens, and takes note of the distribution of organisms.

ACTIVITY 2: Mapping the distribution of species in the Malay Archipelago.



As he continues his hop-skotch travels and collecting, he begins to notice another striking pattern in the distribution of organisms in the islands. He describes it in an 1856 letter to his agent, Stevens, who then publishes it in the London periodical, *Zoologist*.

Ampanan, Lombock, August 21, 1856.

—Another month has passed since I wrote to you. . .

The birds have, however, interested me much more than the insects, as they are proportionably much more numerous, and throw great light on the laws of geographical distribution of animals in the East. The Islands of Baly and Lombock, for instance, though of nearly the same size, of the same soil, aspect, elevation and climate, and within sight of each other, yet differ considerably in their productions, and, in

fact, belong to two quite distinct zoological provinces, of which they form the extreme limits. As an instance, I may mention the cockatoos, a group of birds confined to Australia and the Moluccas, but quite unknown in Java, Borneo, Sumatra and Malacca; one species, however (*Plyctolophus sulphureus* [or the lesser sulfur-crested cockatoo]), is abundant in Lombok, but is unknown in Baly, the island of Lombok forming the extreme western limit of its range and that of the whole family. Many other species illustrate the same fact, and I am preparing a short account of them for publication. My collection here consists of sixty-eight species of birds, about twenty of which are probably not found west of the island, being species either found in Timor and Sumbawa or hitherto undescribed.



That is, Wallace finds a sharp discontinuity of forms across the archipelago. This seems to contradict the law he enunciated earlier, that species exhibit geographical continuity. Wallace begins puzzling further: what had caused the abrupt change? It reminded him of the species boundaries along the Rio Negro in South America.



While visiting the island of Aru in the east, he captures a butterfly specimen that puzzles him. It is another *Ornithoptera*, or bird-wing butterfly. It resembles two species known from the nearby islands of Amboina and New Guinea. Yet it seems stable and distinct, not a transient variety: three species, very closely allied. They certainly reflect the geographical gradation and branching of forms he has noticed before. But what about the memorable *Ornithoptera brookiana* he named not long ago? It is nearby, but now, by comparison, seems remarkably different. Perhaps all four forms had been part of a gradation in the past? If so, then the intermediate forms had since disappeared. Why or how?

THINK (6): Address Wallace's puzzle. How might you explain the absence of intermediate forms?



Wallace [shown here with friend Frederick Geach] continued to travel, collect specimens, note their locations, and ponder on their distribution. Early in 1858, as he recalled later:

I was . . . suffering from a sharp attack of intermittent fever, which obliged me to lie down every afternoon during the cold and subsequent hot fits which lasted together two or three hours. It was during one of these fits, while I was thinking over the possible mode of origin of new species, that somehow my thoughts turned to the "positive checks" to increase among savages and others described in much detail in the celebrated *Essay on Population*, by Malthus, a work I had read a dozen years before. These checks--disease, famine, accidents, war, &c.--are what keep down the population, and it suddenly occurred to me that in the case of wild animals these checks would act with much more severity, and as the lower animals all tended to increase more rapidly than man, while their population remained on the average constant, there suddenly flashed upon me the idea of the survival of the fittest--that those individuals which every year are removed by these causes--termed collectively the "struggle for existence"--must on the average and in the long run be inferior in some one or more ways to those which managed to survive.
(Wallace 1903)

In other words, he imagines that the intermediates had died out. New varieties had been created, but by being better able to cope with the "struggle for existence," they had replaced the original species. Wallace now has a clearer vision of how species could change, then change again, ultimately departing indefinitely from the original type. He puts his thoughts to paper and sends the manuscript off to London again, this time to a colleague with whom he shared some earlier correspondence on this issue.

Wallace and Darwin



The letter arrives, as intended, on the desk of one Charles Darwin, whose travelogue Wallace had once read. Darwin reads it with dismay. It parallels his own thoughts, ideas he has long held but failed to publish. Even worse, geologist and friend Charles Lyell had read Wallace's 1855 paper and, noting the similarities in views, had urged him to publish to establish his priority. Darwin had demurred. Now he wrote to his friend and colleague:

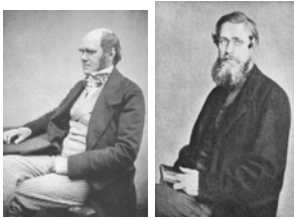
My dear Lyell
Some year or so ago, you recommended me to read a paper by Wallace in the *Annals*, which had

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. You said this when I explained to you here very briefly my views of "Natural Selection" depending on the Struggle for existence.— I never saw a more striking coincidence. if Wallace had my M.S. sketch written out in 1842 he could not have made a better short abstract! Even his terms now stand as Heads of my Chapters.

Please return me the M.S. which he does not say he wishes me to publish; but I shall of course at once write & offer to send to any Journal. So all my originality, whatever it may amount to, will be smashed. Though my Book, if it will ever have any value, will not be deteriorated; as all the labour consists in the application of the theory.

I hope you will approve of Wallace's sketch, that I may tell him what you say.

My dear Lyell | Yours most truly | C. Darwin



Darwin also writes to his friend and colleague, Joseph Hooker. In the event, Lyell and Hooker decide to present Wallace's paper to the Linnean Society, but coupled with a few excerpts from Darwin's own work, which they each know well by now. Wallace, still in the Malay archipelago, is wholly unaware of the unfolding events. The papers are read as planned on July 1, 1858.

Within three weeks Darwin begins writing a book, published the following year as *On the Origin of Species*. Wallace returns home in 1862; 2½ years after the publication Darwin's volume.

THINK (7): Given this information, who would you credit with the discovery of this theory, evolution by natural selection?

TABLE

The independent discoveries of natural selection and its role in the origin of new species offers a rare opportunity to consider the nature of discovery in science. Note some of the striking similarities in Wallace's and Darwin's life experiences.

Similarity	Wallace	Darwin
natural history collecting in childhood	plants & beetles	beetles

different species separated by rivers	monkeys, insects & birds in Amazon (Rio Negro)	rheas in Patagonia (Rio Negro)
similar species across oceans	trogons (S. America & Malay)	mockingbirds, finches (American mainland & Galapagos)
species similarities & differences in archipelago	cockatoos, bird-wing butterflies & others (Malay)	tortoises, finches (Galapagos)
Malthus, <i>On Population</i>	1846 reading	1838 leisure reading

THINK (8): Describe how each shared experience noted was important in reasoning about new species and natural selection. What fundamental concept can be associated with each? If you know of other similarities between Wallace and Darwin, describe them and their potential significance.

TABLE

In other respects, the lives of Wallace and Darwin differed, in some cases quite markedly:

Difference	Wallace	Darwin
family background & class	middle class, working	wealthy elite, income from estate farm
collections	10,000 specimens from Amazon; 125,000 from Malay; over 1,000 new species	5,430 specimens
species in focus	collected widely in nature	studied especially domesticated animal breeds
field observations	focused on groups	focused on individuals
relationship with native cultures	peers who helped him hunt, collect, travel	mostly hired as assistants, or as "curiosities"

As a result, Wallace's and Darwin's theories also differ in detail. For example, Darwin placed great emphasis on the analogy

between artificial selection and natural selection, whereas Wallace did not. Wallace maintained that variation was strictly blind, whereas Darwin sometimes said that an organism's conditions might influence its make-up and inherited qualities. Darwin emphasized competition between individual organisms, Wallace between established groups. Wallace also emphasized the environment as the main factor promoting selection, whereas Darwin stressed competition. Darwin viewed mental faculties and morality as arranged in a series from primates to "primitive" cultures to "advanced" cultures like his own. For him, these gradations helped indicate the evolutionary origin of humans. By contrast, Wallace saw all humans as equally moral, reflecting a sharp distinction from animals. He never accepted the human mind as subject to evolution, only their physical form.

THINK (9): Discuss how a comparison of the similarities and differences between Wallace and Darwin informs (and possibly changes) your view of the credit each should receive, and why.



Wallace and Darwin were both celebrated by the Linnean Society on the 50th anniversary of the announcement of their discoveries (with a cast medal) and again on the 100th anniversary (with a plaque on the historic site.)

NOS Reflection Questions

[These are not merely review, but function to help complete and consolidate the lessons of the case study.]

How does the case of Alfred Russel Wallace & the Origin of Species illustrate the following dimensions of the nature of science, or how science works?

1. the influence of early encounters and life experiences?
2. personal motivation?
3. funding?
4. scientific communication ?
5. diversity in scientific thinking (by different persons)?
6. priority and credit?

revised Sept. 2012