THE WALLACE LINE

Wallace described two great faunal regions and the boundary, defined by a deepwater gap, between them. West of the line, groups such as hornbills, carnivores, primates, and insectivores predominated. Marsupials, cockatoos, birds of paradise, and other distinctive groups predominated to the east. Such patterns in biogeography helped advance his thinking about evolution.

MALAY PENINSULA

Argus pheasant

Malacca

Mount Ophir

July to September 1854

WALLACE'S ROUTES
Started at Singapore April 1854
Last returned to Singapore January 1862

Malayan tapir

Malayan colugo

SINGAPORE

April to June 1854
January to May 1856

Sumatran tiger

Siamang gibbon

Sumatran rhinoceros

Rhinoceros hornbill

Orange-backed woodpecker

SUMATRA

SUNDA SHELF

To Bali and Lombok June 1856

SARAWAK

Kuching

Sarawak River

November 1854 to January 1856

Simunjon (Simunjan)

Orangutan

Muntok

BANGKA (BANGKA)

Palembang

November 1861 to January 1862

Lobo Raman

BILITON (BELITUNG)

Land Bridges
During glacial epochs water was tied up in polar ice, exposing land bridges that intermittently connected Sumatra, Java, and Borneo with the mainland and allowed Asian species to arrive.

Geologic Activity
Volcanic eruptions, elevation and subsidence of landmasses, and tectonic movements have added complexity to patterns of animal distribution.

Sunda Strait

JAVA SEA

Batavia (Jakarta)

Buitenzorg (Bogor)

July to November 1861

Samarang (Semarang)

JAVA

Green junglefowl

Javan rhinoceros

(Indonesian subspecies)

INDO-MALAYAN REGION

During glacial epochs of lowered sea level, ancestral species from southeastern Asia arrived by overland dispersal and then, when the sea rose again, found themselves marooned. With time, some lineages gave rise to new subspecies, such as the Javan rhinoceros.

Species found predominantly west of Wallace's line

Birds (177 species)
- Babblers (57)
- Broadbills (9)
- Bulbuls (29)
- Hornbills (10)
- Tits and titmice (3)
- Trogons (8)
- Pheasants (22)
- Woodpeckers, barbets (39)

Mammals (215 species)
- Carnivores (47)
- Insectivores (27)
- Mouse deer, deer (15)
- Odd-toed ungulates (3)
- Pangolins (2)
- Primates (28)
- Rodents (79)
- Tree shrews (14)

VIRGINIA W. MASON, NG STAFF
RELIEF BY JOHN A. BONNER, ART BY HIRAM HENRIQUEZ, NG STAFF. SOURCES: ALFRED RUSSEL WALLACE, *THE MALAY ARCHIPELAGO* (WOODCUTS) AND *GEOGRAPHICAL DISTRIBUTION OF ANIMALS*; BERNARD MICHAUX; PAPUAWEB PROJECT

ORANGUTAN
Pongo pygmaeus

Two species of orangutan are now known, one on Sumatra and one on Borneo, where Wallace studied it. Both are great apes, closely related to African forms such as chimpanzees and gorillas—and to humans.

BORNEO

Tree shrew

Thick-spined porcupine

Otter civet

Green broadbill

Babirusa

Bare-backed fruit bat

Sulawesi dwarf cuscus

CELEBES SEA

WALLACE'S LINE

Makassar Strait (Makasar Strait)

CELEBES (SULAWESI)

Gulf of Tomini

Maros

Macassar (Ujungpandang)

September to December 1856
July to November 1857

The 100-fathom line (600 feet) marks the extent of land bridge.

100 fathoms

Wallacea
This area, including Celebes, the Moluccas, and the Lesser Sunda Islands, is a transitional zone, isolated from both Asia and Australia by deep water. Thirty-six species of mammals and nineteen species of birds are endemic—evolved here and found nowhere else.

FLORES SEA (FLORES SEA)

Yellow-crested cockatoo

Bileling (Singaraja)

BALI

Blue-eared barbet

August 1856

Ampanam (Ampenan)

LOMBOK (LOMBOK)

SUMBAWA

COMODO (KOMODO)

FLORES (FLORES)

LESSER SUNDA ISLANDS

CHANDANA (SUMBA)

Bali and Lombok
Between these islands, so close together, falls a deepwater divide. Wallace noticed that their bird faunas differed dramatically.

Dielli (Dili)

January to April 1861

TIMOR

Timor honeyeater

December 1857
May 1859

Coupang (Kupang)

DEEP SEA (MORE THAN 100 FATHOMS)

Grey cuscus

BANDA SEA

SERWATTY IS.

Babber (Babar)

TIMOR LAUT (TANIMBAR IS.)

0 mi 100
0 km 100

PRESENT-DAY PLACE-NAMES ARE IN PARENTHESES.

The Moluccas
These smaller islands, framed by Gilolo, Bouru, and Ceram, harbor some unique marsupials and birds, including the Moluccan megapode, first identified by Wallace.

MOLUCCA SEA

June to September 1859

Menado (Manado)

Lowland anoa

Many visits to Ternate and adjacent islands between January 1858 and July 1861

Ternate (Ternate)

Makian (Kaieli)

Batchian (Bacan)

GILOLO (HALMAHERA)

Moluccan megapode

Wallace's standard wing

SULA-MANGOLA (SULA ISLANDS)

OBY (Oki)

Mysol (Misool)

Southern cassowary

BOURU (BURU)

CERAM

Wahai

Amboyna (Ambon)

Many visits between December 1857 and June 1860

Warus-warus (Waru)

Goram (Gorong)

April to May 1860

Matabello Is. (Watubela Is.)

Banda Is.
December 1857
June 1859
April to May 1861

KE IS. (KAI IS.)

Dobbo (Dobo)

January to July 1857

ARU ISLANDS

Palm cockatoo

Greater bird of paradise

Wallace's dasyure

AUSTRO-MALAYAN REGION

The major landmasses of Australia and New Guinea, connected as one during low-water epochs, form the region's core area. Marsupials diversified richly on those lands and radiated westward as opportunities arose, with two species of cuscus reaching as far as Celebes, just east of the line.

Species found predominantly east of Wallace's line

Birds (241 species)
- Cassowaries (3)
- Cuckoos (4)
- Kingfishers, bee-eaters (8)
- Megapodes (11)
- Owlet-nightjars (7)
- Parrots, cockatoos (52)
- Perching birds (93)
- Pigeons, doves (13)
- Rails (9)

Birds of paradise (41)

Mammals (79 species)
- Marsupials
  - Bandicoots (10)
  - Cuscus (16)
  - Sugar gliders (5)
- Placentals
  - Anoa (2)
  - Babirusa (1)
  - Flying foxes, fruit bats (20)
  - Squirrels, rats (25)

Morty (Morotai)

Red bird of paradise

WAIGIOLI (WAIGEO)

July to September 1860

Tree kangaroo

Dorey (Manokwari)

April to July 1858

VOGELKOP PENINSULA (JAZIRAH DOBERAI)

Brown dorcopsis

Magnificent bird of paradise

JOBIE (YAPEN)

NEW GUINEA

New Guinea
New Guinea and the nearby islands contain relatively few mammal species but many endemic species of birds, reptiles, and insects.

More than three dozen bird of paradise species are known, all but two native east of the 100-fathom line (left). Wallace himself discovered one of the exceptions, now called Wallace's standard wing, on Batchian.

BLACK SICKLE-BILLED BIRD OF PARADISE
Epimachus fastuosus

AUSTRALIA

The

MAN WHO WASN'T DARWIN

ALFRED RUSSEL WALLACE charted a great dividing line in the living world—and found his own route to the theory of evolution.

By David Quammen · Photographs by Robert Clark

West of the line, in Sumatra, Wallace saw a species of dead-leaf butterfly whose closest relatives are African and Asian.

SOPHIA M. SACHS BUTTERFLY HOUSE, MISSOURI BOTANICAL GARDEN; CLEVELAND METROPARKS ZOO (OPPOSITE)

W

THE ISLAND OF TERNATE is a small, graceful volcanic cone rising leafy green from the sea in northeastern Indonesia, 600 miles east of Borneo. Although it's an out-of-the-way place, tucked between much larger islands, Ternate was once an entrepôt of the Dutch empire, from which spices and other precious tropical commodities traveled westward by ship. Today its busy dock area, its fruit and fish markets, its mosques, its old forts, its sultan's palace, and its tidy concrete houses are strung like carousel lights along a single ring road that traces the coastline. Its upland slopes are mostly forested and unpopulated, and in those woods, if you're lucky, you might still spot a certain resplendent bird, emerald-breasted, with two long white plumes dangling capelike from each shoulder, whose scientific name—*Semioptera wallacii*—honors the man who first brought it to scientific attention. That man was Alfred Russel Wallace, a young English naturalist who did fieldwork throughout the Malay Archipelago in the late 1850s and early '60s. What you won't see on Ternate is any grand plaque or statue commemorating Wallace's place in scientific history or the fact that, from this little island, on March 9, 1858, he sent off a highly consequential letter, aboard a Dutch mail steamer headed westward.

The letter was addressed to Mr. Charles Darwin. Along with it Wallace enclosed a brief paper titled "On the Tendency of Varieties to depart indefinitely from the Original Type." It was the product of two nights' hasty scribbling, which followed a moment's epiphany during a fever, which in turn followed more than ten years of speculation and careful research. What the paper described was a theory of evolution (though not under that name) by natural selection (not using that phrase) remarkably similar to the theory that Darwin himself, then an eminent naturalist of rather conventional reputation, had developed but hadn't yet published.

This is a classic episode in the history of science, a story of a coincidence and its aftermath, told and retold in books about how evolutionary biology came to be: the near simultaneous formulation of what we now think of as Darwin's theory by Darwin himself and a young upstart, Alfred Russel Wallace. Classic or not, many people nowadays are unaware of it. Wallace, famed during his life as Darwin's junior partner and for his other contributions to science and social thought, fell into obscurity after his death, in 1913. In recent decades his renown has been revivified, both by scholars who mine every aspect of Darwin's life—Wallace was a crucial part—and by a few popular writers. His grave marker, in the village of Broadstone, no longer stands crumbling and overgrown by tree limbs. His portrait now hangs, along with an older one of Darwin, in the meeting room of the Linnean Society in London, the same scientific society to which the Darwin-Wallace co-discovery was announced 150 years ago, on the evening of July 1, 1858. His writings, on subjects from evolutionary theory and social justice to life on Mars, are coming back into print or turning up on the Web. He is recognized among science historians as a founder of evolutionary biogeography (the study of which species live where, and why), as a pioneer of island biogeography in particular (from which the science of conservation biology grew), as an early theorist on adaptive mimicry, and as a prescient voice on behalf of what we now call biodiversity. That is, he's a towering figure in the transition from old-fashioned natural history to modern biology. During his years afield Wallace was also a prolific collector, a ruthless harvester of natural wonders; his insect and bird specimens added richly to museum holdings and the discipline of taxonomy. Still, most people who know of Alfred Russel Wallace know him only as Charles Darwin's secret sharer, the man who co-discovered the theory of evolution by natural selection but failed to get an equal share of the credit.

Wallace's story is complicated, heroic, and perplexing. Besides being one of the greatest field biologists of the 19th century, he was a man of crotchety independence and lurching enthusiasms, a restless soul never quite satisfied with the place in which he lived, a believer in spiritualism and séances, a devotee of phrenology, a dabbler in mesmerism, a later apostate from Darwinian theory when it came to the development of the human brain, an opponent of smallpox vaccination, and an advocate of nationalizing large private landholdings, who by these and other eccentricities gave his detractors some grounds for dismissing him as a crank. Which they did. The question that no scholar or biographer has adequately answered is: How to reconcile such brilliant achievements, radical convictions, and incautious zealotries within one human character—the character of a consummate empiricist and field naturalist? If he hadn't existed, this Alfred Wallace, it would have taken a very peculiar Victorian novelist to create him.

THE FIRST CARDINAL point in the biography of Alfred Wallace is that for him, as for Will Shakespeare but not for Charles Darwin, impecuniousness was the mother of invention. He was a curious lad from a family with no money. At age 14, in 1837, having left school, he went to work. Darwin, at that time a young gentleman of 28 with a wealthy father who subsidized his adventures, had just arrived home aboard the *Beagle*.

Wallace was largely self-taught, frequenting town libraries and workingmen's institutes during the decade he labored as a land surveyor, a builder, and a schoolteacher in the city of Leicester. Early on he discovered the life and writings of Robert Owen, the founder of British socialism, who became his "first teacher in the philosophy of human nature," as Wallace later recalled, and an influence toward his own socialist convictions. During his surveying period, spent largely in rural Wales, he got interested in nature by way of botany, taking long walks across the moors and mountains, training himself to identify plant families with help from a cheap paperback guide. His teaching job left him time for an eclectic syllabus of personal reading that included Humboldt's *Personal Narrative of Travels,* and, most consequentially, Malthus's *Essay on the Principle of Population,* which had catalyzed Charles Darwin's thinking about the struggle for survival and would catalyze Wallace's too. Although Wallace found himself unsuited to teaching, the year at Leicester yielded one memorable event: He became friends with a young man named Henry Walter Bates, a former hosier's apprentice, who introduced him to the joys of beetle collecting.

Books were always important to Wallace, and he testified that two others helped set his course. One was Charles Darwin's *Journal* from the voyage of the *Beagle,* a lively travel narrative that gave almost no hint of evolutionary ideas. The other, more daring and incendiary, was an anonymously authored best seller titled *Vestiges of the Natural History of Creation,* published in 1844, which did offer an evolutionary vision of life on Earth, though not in a form that most discerning readers found persuasive. The prevailing orthodoxy in Western culture was that God had shaped all species through special acts of creation, and that every species was essentially fixed, incapable of varying much from an ideal type. Such fixity was not just a religious dogma but a scientific one; the science philosopher William Whewell, for instance, had recently written: *"Species have a real existence in nature,* and a transmutation from one to another does not exist." In opposition to that view *Vestiges* hypothesized a "law of development" in living creatures, whereby one species is transformed into another by external circumstances, in incremental stages, from simple life-forms to complex ones, up to and including man. The result was adaptation. God still played a role, according to *Vestiges,* but more distantly—as ultimate designer of the process.

The book was a potpourri of interesting facts, absurd factoids, savvy insights, tenuous suppositions, and woozy deductive leaps, which variously satisfied or amused readers ranging from Queen Victoria to John Stuart Mill to Florence Nightingale. Darwin thought it shaky at best. Wallace, younger and more impressionable, saw in it "an ingenious hypothesis" yet to be proved, or maybe not, by further research. For him *Vestiges* represented both "an incitement" to gather natural history data and a provisional theory against which new data could be tested. Thus incited, he and his friend Bates cooked up a plan to go to the Amazon rain forest in quest of such data.

Having almost no money, they paid their expenses by shipping back natural history specimens for sale to museums and private fanciers.

Butterflies, beetles, and birds were mostly what was wanted, and if the creatures were both rare and gorgeous, all the better. Their agent was Samuel Stevens, of Bloomsbury Street in London, a faithful man who would play an enduring role in Wallace's life, linking him to the buyers and eventually to the scientists of England.

Wallace's four-year saga in the Amazon—exploring remote headwater regions along the Rio Uaupés and elsewhere (while Bates traveled separately), making observations, gathering specimens, taking notes, drawing sketches—was a triumph of persistence, invaluable as a training exercise but ending in disaster. He sailed home from Pará (Belém), Brazil, in August 1852, aboard the *Helen,* which caught fire and sank. Wallace survived in a lifeboat, but all the collections he'd brought with him, comprising thousands of insects and probably hundreds of bird skins, were gone. Then the ship by which he was rescued, a dubious tub called the *Jordeson,* met a harrowing storm and almost sank too. "Fifty times since I left Pará have I vowed," Wallace wrote to a friend, "if I once reached England, never to trust myself more on the oceans. But good resolutions soon fade." Within days of limping ashore, Wallace had begun planning his next trip. This time he would go east, into a world of islands.

HIS LONG EXPEDITION to the Malay Archipelago was a much different matter, far more fruitful in its yield of specimens and ideas. Wallace arrived at Singapore in April 1854 and spent the next eight

Wallace was a man of crotchety independence and lurching enthusiasms. If he hadn't existed, it would have taken a very peculiar Victorian novelist to create him.

The tiger is an Asian species that reached Sumatra, Java, and Bali. The Sumatran subspecies still survives in the wild, tenuously, and in zoos (above).

FORT WAYNE CHILDREN'S ZOO

years zigzagging among the islands, traveling by every sort of boat, from mail steamer to merchant schooner to dugout canoe. Onshore, he lived as the local people lived, sheltering in thatched houses and eating whatever could be traded for or bought. He made stops on Sumatra, Java, Bali, Lombock, Borneo, Celebes, Gilolo, Ternate, Batchian, Timor, Ceram, a little cluster of islands called Aru at the eastern extremity of the archipelago, and the Vogelkop peninsula of New Guinea. He sailed close past the island of Komodo (but despite his search for notable fauna, remained unaware of the existence of Komodo dragons). In some places, such as Sarawak and Aru, he lingered for months, netting butterflies and grabbing beetles in the nearby forests, shooting birds, or else simply processing his specimens and his impressions, healing his infected feet, recovering from bouts of malaria, waiting for the rains to end or the winds to shift. He learned enough of the Malay language to do business in remote locales. He hired a Bornean boy named Ali to help with bird shooting and other chores. Everywhere he went, he collected, preparing and packaging his insects and bird skins and mammal pelts with great care, keeping them with him until he reached a port, then shipping consignments to Samuel Stevens back in London. From little Aru alone, with its birds of paradise and other special attractions, he brought away more than 9,000 specimens, representing 1,600 different species, more than a few of those new to science. He figured the whole lot might be worth £500. Stevens sold it for twice that—amounting to about $100,000 in today's value.

The numbers from Aru, reflecting a ratio of specimens to species of almost six to one, signal a critical fact about Alfred Wallace and the way he worked. Being a commercial collector as well as a natural historian, he wanted multiple specimens of a given species, not just one or two representatives, especially if the species was visually impressive, such as the birdwing butterflies, the giant longicorn beetles, or the birds of paradise. In the Amazon he had taken 12 specimens of a spectacular flame red bird, the Guianan cock-of-the-rock *(Rupicola rupicola)*, and admitted he would have killed 50 if they hadn't been so rare and elusive. In Aru, likewise, he was greedy for as many specimens of the greater bird of paradise *(Paradisaea apoda)* as possible. Still later, during an excursion along the Maros River in Celebes, he got six good specimens of *Papilio androcles*, one of the largest swallowtail butterflies, with long white tails dangling down like streamers. And from the island of Waigiou, just offshore from New Guinea's Vogelkop, he harvested 24 individuals of the red bird of paradise *(Paradisaea rubra)*. His purpose in collecting multiples was not just to aggrandize supplies of the most decorative species for sale; it was also the desire to represent each species in his personal collection with a "good series" of individuals.

The consequence of such redundant collecting was that Wallace saw and recognized—to a degree that Charles Darwin had been slower to see and recognize—something momentous about creatures in the wild: That each species encompasses considerable variation among individuals. Not every specimen of *Papilio androcles* has tails as long and as white as every other. Not every greater bird of paradise is as great as every other. Individuals vary genetically from their siblings and cousins in ways that may manifest as visible and physiological inequities.

This insight is crucial to the idea of evolution by natural selection. Individual variation provides the differential material upon which selection works. Darwin appreciated such variation in domesticated species but became aware of its prevalence in the wild only during his long project on the classification of barnacles, an eight-year detour along his slow course toward publishing his theory. Wallace got there by a shorter route because, being forced to pay his way as a commercial collector, he constantly saw variation in his inventory.

PATTERNS OF SPECIES distribution in space and in time provided other clues toward an evolutionary theory. Those patterns told Wallace little about how evolution might work, but they reaffirmed his hypothesis (derived from the book *Vestiges*) that species had evolved, one from another, by some sort of natural process of descent and transformation.

Although he didn't use the word "biogeography," as early as 1852 he was practicing that branch of science. After returning from Brazil,

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David Quammen and Robert Clark previously collaborated on the award-winning November 2004 cover story "Was Darwin Wrong?"

he published a paper, "On the Monkeys of the Amazon," in which he described the distribution of monkey species in the upper Amazon Basin and showed that each was localized either on one side or another of the three great converging rivers, the main stem Amazon, the Negro, and the Madeira. This was curious. If God had created all species from scratch and placed them in their appropriate locations, why hadn't he put these monkeys on both sides of a given river?

Three years later in Borneo, as Wallace waited out the wet season in a lonely little house near the mouth of the Sarawak River, with no company but his Malay cook, he cast his mind back to some of the books he had read (such as Swainson's *Treatise on the Geography and Classification of Animals,* Humboldt's *Travels,* Darwin's *Journal*) and the museum catalogs he had inspected. Those sources offered plenty of raw data on the worldwide distribution of animals—which species and groups of species occur here but not there. Hummingbirds are native only to the Americas; sunbirds only to the Old World, from western Africa eastward. Toucans are a tropical American family; hornbills occupy roughly the same niches as toucans, but in tropical Africa, Asia, and the eastern islands. Similar patterns turn up among insects, fishes, reptiles, mammals, plants. Wallace hankered to know why. It occurred to him, he wrote later, "that these facts had never been properly utilized as indications of the way in which species had come into existence."

He also remembered, from reading Charles Lyell's three-volume opus on geology and the fossil record, how similar species seem to have succeeded one another in time. Combining these two forms of evidence, geographical and geological, Wallace formulated what he called a "law" of species origins: *"Every species has come into existence coincident both in space and time with a pre-existing closely allied species."* He composed a paper around that idea and sent it off to London. The paper's subtext, clear but unstated, was evolution—"closely allied" (similar) species appear adjacent to one another in geographical space and in geological time because they have descended from common ancestors. Wallace was now confident of that much. But he couldn't yet propose a mechanism by which such transformation occurred.

His paper was published promptly in a good natural history journal, but most of those who read it, including Darwin, failed to recognize that it represented the second big step by an obscure young naturalist toward a theory of evolutionary origins. Instead of positive feedback and intellectual engagement, for which Wallace had hoped, he got a message from Samuel Stevens about some naturalists who'd muttered that young Wallace should quit theorizing and stick to gathering facts.

He ignored that condescending advice. During stopovers on the islands of Bali and Lombock, which are separated by a deep but narrow strait, he noticed another set of presence-and-absence patterns. "In Bali we have barbets, fruit-thrushes, and woodpeckers," he later wrote. On the Lombock side "these are seen no more, but we have abundance of cockatoos, honeysuckers, and brush-turkeys, which are equally unknown in Bali, or any island further west." He would see similar disparities between the larger islands of Borneo and Celebes, just to the north, which faced each other across another deep strait. Borneo, on the west side, contained monkeys of many kinds, wild cats, *(Continued on page 132)*

Butterflies, beetles, and birds were mostly what was wanted, and if the creatures were both rare and gorgeous, all the better.

Birds of paradise, ornately adorned for mating displays, lured Wallace to the eastern reaches of the Malay Archipelago.

NATURAL HISTORY MUSEUM, TRING

(Continued from page 123) deer, civets, otters, and a high diversity of squirrels. Celebes, on the east side, harbored few native mammals, one being the marsupial cuscus, whose "allied" species (other cuscuses, and marsupials generally) could be found eastward, through the Moluccas, New Guinea, and Australia. All these facts fit an evolutionary vision of biogeography more persuasively than they fit a pious dogma of special creations.

The third step toward his theory was the one he took in 1858, somewhere on or near Ternate, when he suddenly put the clues from biogeography together with the phenomenon of variation within species, the insights of Malthus on excess population growth, the fact that food and habitat are limited even when reproductive rate isn't, and the realization that most offspring born to any species cannot survive. "Vaguely thinking over the enormous and constant destruction which this implied, it occurred to me to ask the question, Why do some die and some live?" His answer was that those variants best fitted to their circumstances survive. "An antelope with shorter or weaker legs must necessarily suffer more from the attacks of the feline carnivora," as he put it. Furthermore, this process must yield adaptive directional change in the species overall. Why does a giraffe have a long neck? Because the short-necked ones have failed to leave offspring.

Excitedly, he sent off his manuscript to Mr. Darwin, whom he knew as a genial but somewhat aloof scientific pen pal. In the cover letter Wallace said that he hoped the idea would be as new to Darwin as it was to him.

Of course it wasn't. To Darwin the idea was 20 years old, and it was his. But after two decades of continuing research, refinement of his arguments, distraction into other projects, and hesitancy, Darwin had nothing in print to prove ownership.

ALFRED WALLACE was stuck on the coast of New Guinea, punished by wet weather and hunger and fever, on the July evening when Wallace's paper, along with unpublished offerings from Darwin, were read as a joint presentation to the Linnean Society. That event, a delicate and somewhat high-handed compromise allowing Darwin the opportunity to co-announce the discovery with Wallace, had been brokered by two of Darwin's powerful scientific friends. Wallace himself had not been consulted about the arrangement, although he was pleased and flattered when he heard of it. In November of the following year, 1859, Wallace was still in the Malay Archipelago, still chasing new butterfly species and enduring physical hardships, when Charles Darwin published *On the Origin of Species,* the book he had composed hastily after being shocked into action by Wallace's paper. Wallace received his copy by mail steamer, as a courtesy from Darwin, and read it five or six times, each time more impressed with how Darwin had brought the whole subject together. "It is the 'Principia' of Natural History," he wrote to an old friend. "Mr. Darwin has given the world a *new science* & his name should in my opinion stand above that of every philosopher of ancient or modern times. The force of admiration can no further go!!!" If Darwin's name stood above that of every philosopher, it would certainly stand above Wallace's as author of this evolutionary theory. And so it did. But Wallace, a generous-spirited man, comfortable with his own strengths and limits, didn't begrudge that.

About the same time, he sent another paper back to London, to be published in the Linnean Society journal as "On the Zoological Geography of the Malay Archipelago." Here he enlarged upon his observations of animal distribution to recognize two distinct biogeographical regions, the Indian and the Australian. Draw a line through the strait between Borneo and Celebes, continue it southward between Bali and Lombock, and to the west of that line you would find primates, carnivores (including the tiger, right into Bali but no farther), insectivores, pheasants, trogons, bulbuls, and other distinctly Asian species; to the east you would see cockatoos, lories, cassowaries, megapodes, cuscuses and other marsupials, and a much higher diversity of parrots than squirrels. The two regions, though their climatic and habitat conditions are similar, harbor two distinct complements of fauna. "Facts such as these can only be explained by a bold acceptance of vast changes in the surface of the earth," Wallace wrote. What he meant was this: The whims of God didn't put species where we find them. History, evolution, ecological dispersal, and geological changes did.

Eight years later the brilliant anatomist and Darwinian partisan Thomas H. Huxley called

this east-west boundary "Wallace's line," and the label endured.

Although Wallace correctly deduced that Bali and Borneo had formerly been part of the Asian mainland, he didn't know that lowered sea levels (during glacial periods) had caused the intermittent connectedness; nor could he imagine that Celebes was an anomalous island patched together by plate tectonics. Still, he anticipated those insights with his pointed presentation of evidence he had gathered during his years of looking and collecting. Wallace's line, dividing the Southeast Asian region from the Australian, became one of the fundamental facts of modern biogeography. In itself it was merely a descriptive delineation; what made it profound and useful were the evolutionary, ecological, and geological questions that it brought into focus. Alfred Wegener, proposing continental-drift theory in the early 20th century, would be another scientist among many indebted to Alfred Russel Wallace.

WALLACE RETURNED to England in 1862, by which time *On the Origin of Species* was in its third edition and Charles Darwin well on his way toward being renowned and excoriated throughout the world. Wallace reached London bearing two live birds of paradise, which he sold to the Zoological Gardens. Darwin welcomed him as a valued colleague and invited him for a home visit almost as soon as Wallace stepped off the boat. During his Malay expedition, Wallace figured, he had traveled 14,000 miles within the archipelago (not counting the distance between London and Singapore), made 60 or 70 separate journeys, and collected 125,660 specimens. Thanks to Samuel Stevens, he had some money awaiting him.

But life afterward wasn't easy for Wallace. He lost a sizable share of his capital by unwise investments, and he helped support other family members, including his mother. He tried for a couple of tempting jobs (museum administration, forest management), didn't get either, and couldn't afford to stop scrambling for money. So he kept himself busy as a freelance author of articles and books, which gave him great mental freedom but zero security. By early 1869 he had a wife and two children. Also that year, he published *The Malay Archipelago,* the great narrative of his travels through the eastern islands. In 1880, when Wallace was struggling financially, Darwin stood up for his old partner in discovery, lobbying hard and successfully to get him a special government pension.

Wallace's later career and the diverse vectors of his thinking are best represented by his publications. Among his books were *Contributions to the Theory of Natural Selection* (1870), *On Miracles and Modern Spiritualism* (1875), *The Geographical Distribution of Animals* (1876), *Tropical Nature, and Other Essays* (1878), *Island Life* (1880), *Land Nationalisation* (1882), *Bad Times: an Essay on the Present Depression of Trade* (1885), *Is Mars Habitable?* (1907), and *The Revolt of Democracy* (1913). When he published a full treatise on natural selection, in 1889, with characteristic humility he titled it *Darwinism.* Eponymy wasn't important to him; ideas were; and he remained extraordinarily free of concern about who got credit for what.

He had lived richly for a man without much education or money. He had traveled far and widely, both in geographical space and in intellectual breadth. He knew his own line. There was none other like it. □

"It occurred to me to ask this question, Why do some die and some live?" Wallace's answer was that those variants best fitted to their circumstances survive.

Wallace found, among all else, the world's largest bee. The inch-and-a-half-long females have huge jaws for collecting resin.

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