Alfred Russel Wallace deserves better

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During 2009, while we were celebrating Charles Darwin and his *The origin of species*, sadly, little was said about the critical contribution of Alfred Russel Wallace (1823–1913) to the development of the theory of evolution. Like Darwin, he was a truly remarkable nineteenth century intellect and polymath and, according to a recent book by Roy Davies (*The Darwin conspiracy: origins of a scientific crime*), he has a stronger claim to the Theory of Evolution by Natural Selection than has Darwin. Here we present a critical comparison between the contributions of the two scientists. Sometimes referred to as 'The other beetle-hunter' and largely neglected for many decades, Wallace had a far greater experience of collecting and investigating animals and plants from their native habitats than had Darwin. He was furthermore much more than a pioneer biogeographer and evolutionary theorist, and also made contributions to anthropology, ethnography, geology, land reform and social issues. However, being a more modest, self-deprecating man than Darwin, and lacking the latter's establishment connections, Wallace's contribution to the theory of evolution was not given the recognition it deserved and he was undoubtedly shabbily treated at the time. It is time that Wallace's relationship with Darwin is reconsidered in preparation for 2013, the centenary of Wallace's death, and he should be recognized as at least an equal in the Wallace–Darwin theory of evolution.

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Charles Darwin's birth (1809) and the publication of *The origin of species* (1859) have recently been amply celebrated throughout the world. In the UK, there have been radio and television programmes, a film, a number of books, a new wing dedicated to his memory in London's Natural History Museum plus a statue given pride of place in the same building. However, as the achievement of *The origin of species* was to lay out the theory of evolution by natural selection, it is a pity that the crucially important contributions of Alfred Russel Wallace to the development of this theory have been largely ignored. To redress the balance, we consider it timely to reiterate the views of American commentators between 1958 and 1988 who claim that Wallace was shabbily treated following the production of his theory of evolution in 1858. These include Eiseley (1979, 2009), McKinney (1966), Brooks (1984), Brackman (1980), and Beddall (1968).

Recently, Roy Davies has assembled a convincing case that Darwin was much more cavalier with attribution, particularly with regard to Wallace, than commonly thought and in several instances failed to cite or give adequate credit to his antecedents (Davies 2008). He concludes that Wallace has a stronger claim to the theory of evolution than commonly realized. In this article, we compare the routes taken by both Darwin and Wallace in the development of evolutionary theory with a view to a fairer acknowledgement of their relative contributions.

The contrasts between Darwin and Wallace, the two leading proponents of nineteenth century evolutionary ideas, could not have been more marked. It is interesting to compare the education of these men in their formative years. They were both intelligent, inquisitive people with strong interests in natural history. However, their educational paths were quite different. Darwin, born in 1809, was the son of a wealthy doctor and grandson of Erasmus Darwin. The latter, a physician, was also one of the key thinkers of the Midlands Enlightenment, a natural philosopher, physiologist, abolitionist, inventor and poet. Charles' mother died when he was 8 years old and he was sent as a boarder to Shrewsbury School.

Wallace was born 14 years later in 1823, in Llanbadoc close to the small town of Usk in Monmouthshire, South

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Wales. He was one of a family of eight children, five of whom died prematurely. Their father, Thomas Wallace, was a failed lawyer who had fallen on hard times. His birthplace (figure 1a) was chosen by his father as a place where a meagre income would be sufficient for a growing family (Hughes1989, 1991; Claridge 2008).

The family was never well off, a trait to which Wallace conformed throughout his long life. When he was five years old, the family moved back to England in Hertford and Alfred went to Hertford Grammar School from which he was withdrawn at the age of 14 in 1836 due to family financial problems.

After his school years Darwin first acted as apprentice doctor to his father before attending Edinburgh University to read medicine, an activity in which the brutality of surgery sickened him, meaning that he neglected his medical studies. He turned instead to natural history and was active in student natural history societies. He learned taxidermy from a freed black slave who fascinated him with tales of the South American rainforest. From his grandfather and from the works of Lamarck, he became interested in evolution, in particular, on the inheritance of acquired characteristics. From Robert Jameson he gained a knowledge of stratigraphic ecology and of plant classification by assisting him in his work on the extensive collections of the Museum in Edinburgh University.

Wallace's life was never going to be as straightforward as this. After school, he moved to London to work first with his 19-year-old brother John, an apprentice carpenter in a builder's yard. There, at John's suggestion, Alfred attended the London Mechanics' Institute and became acquainted with the ideas of the radical reformer, Robert Owen. In 1837, Alfred began work with his eldest brother William as an apprentice land surveyor, and in 1839 these two moved to Kington in Herefordshire and later to Neath in Wales. During these times, Wallace learned many trades: carpentry and related builder skills from brother John while with William he gained an amazing grasp of surveying, map making, civil engineering and architecture. With the help of the librarian in Neath public library, his interest in botany was stimulated and dramatically enhanced when he purchased a major treatise on systematic botany. This he read and digested avidly and indeed annotated it thoroughly to enhance its use in his botanical studies (Raby 2001). Wallace also became a skilled self-taught zoologist, an anthropologist and a school teacher, having taught himself Latin and algebra. William's job as land surveyor exposed Wallace to the countryside which further stimulated an already well-developed love of nature. During this time he read avidly and indeed gave lectures in basic science at the Neath Mechanics' Institute (figure 1b). By 1843, William's business had declined and Wallace became unemployed before being hired as a teacher in the Collegiate School in Leicester. While reading in the Leicester public library, he discovered Thomas Malthus's *Essay on the principle of population* and encountered Henry Bates. Both events became important parts of his life. Bates, a little younger than Wallace, was a keen collector, especially of beetles, and had already published a paper in the *Zoologist* on this subject. Clearly they shared a common interest and Wallace learned a great deal from Bates. They became firm friends and later were to spend time together collecting in the tropics.

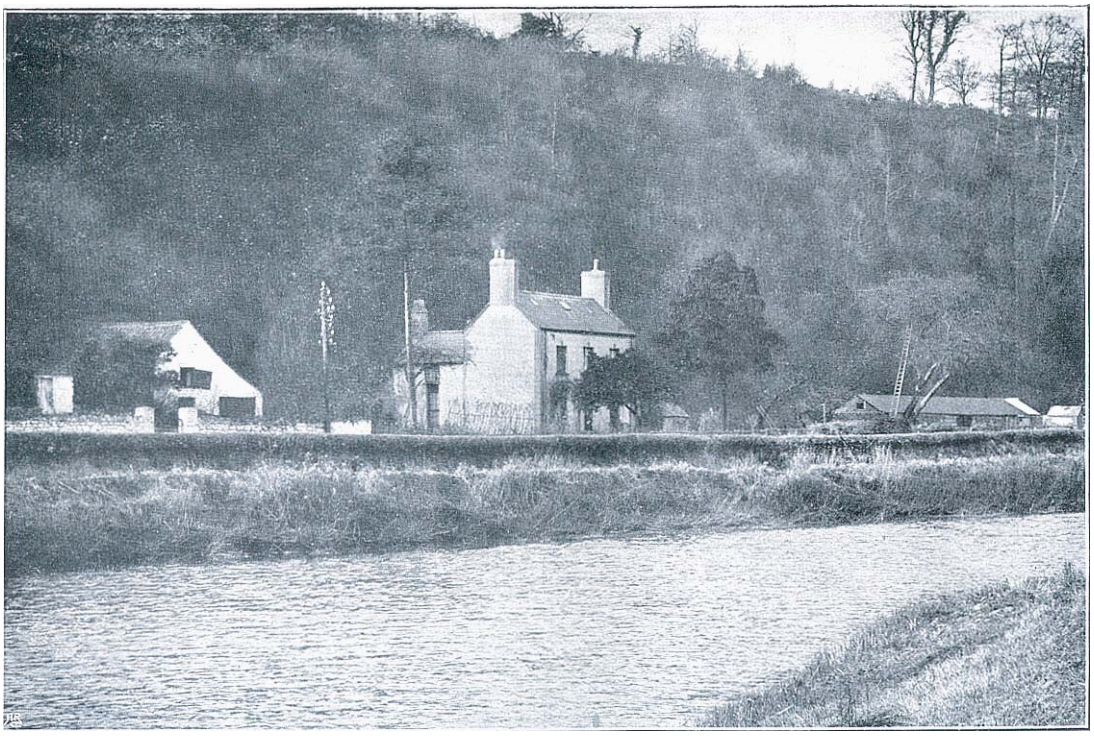
Darwin had also had an interest in beetles at about the same stage in his career. In 1827 he withdrew from Edinburgh and entered Christ's College, Cambridge University to study theology, although his preferences then were riding and shooting. A craze at the time, encouraged by his cousin William Darwin Fox, was collecting beetles. Fox introduced him to the eclectic Reverend John Steven Henslow, a professor of botany, a beetle expert and teacher in mathematics and theology. Darwin joined Henslow's natural history course and became his favourite pupil. He did well in his final examinations in theology but scraped through in Mathematics, classics and physics. He had to stay in Cambridge until June 1831 so he planned to study natural history in Madeira with a friend after graduating and, in the meantime, joined a geology course with Adam Sedgwick and later went with him to map strata in Wales (Desmond and Moore 1991; Browne 2002).

This, then, was Darwin's intellectual background, which clearly gave him a pretty broad education in the topics most suited to his life as collector and explorer during his five-year voyage charting the coastline of South America with Captain Robert FitzRoy on *HMS Beagle*. He differs from Wallace in some important aspects. First, as has been widely noted, there were significant class differences in their backgrounds. Darwin was scion of wealthy upper-class parents, but second, at this time, religion was a dominant part of life. A creationist approach to living things was *literally* gospel. Darwin studied theology as an entrée to a probably successful career. He married Emma, a profoundly religious woman who became extremely uneasy at the intellectual directions her husband was taking.

On the other hand, Wallace was a free-thinker, quite open-minded and free from any religious baggage. His perambulations during the most formative years had exposed him to a wide range of skills, fitting him ideally for the challenges and hardships to come in exploring and collecting samples. His addiction to reading widely in scientific and philosophical works fed a voracious appetite for knowledge so that, both physically and mentally, he was ready for future dangerous adventures.

It is hard to summarize the characters of these two giants of natural history. To some extent, Darwin had the less challenging life and was less prepared for the rigours of five years on the *Beagl*e. He was a slim athletic figure, prone

(a)



(b)

Figure 1. **(a)** Wallace's birthplace, Kensington Cottage (now extended and renamed Kensington House) on the banks of the River Usk at Llanbadoc near the small Welsh town of Usk, Monmouthshire (Wallace 1908). **(b)** Wallace had lectured on physics during two winters at the Mechanics' Institute at Neath. Alfred helped John, his elder brother, to design and construct this newer building, which was not opened until 1848 (by which time Alfred had left for the Amazon) (Wallace 1908).

to regular bouts of sea sickness, a fact that probably helped his scientific endeavours since he was always eager, on the slightest pretext, to leave the ship wherever it made shore, to explore and to collect specimens. Neither, at least at first, was he as prepared through reading and research as was Wallace. Finally, in the long run, Darwin's career as an explorer was quite brief. On return from the *Beagle* expedition he became sick, possibly from Chagas's disease though there is some doubt about this, which left him debilitated for the rest of his life. Darwin left for South America on the *Beagle* in December 1831, returning to Falmouth in October 1836.

Wallace, together with Henry Bates, started in 1847 to plan an expedition to Brazil, having secured financial backing and agreements to buy any samples returned to the UK. They set sail a year later in April 1848. The first of his expeditions associated with Bates involved a four-year exploration (1848–1852) along the Amazon and Negro rivers, and led to a regular despatch of items to London dealers as well as his first exposure to the tropical world. Unfortunately, when Wallace was on his way home, fire on the ship in mid-ocean destroyed most of his most treasured samples, and very nearly cost him his life.

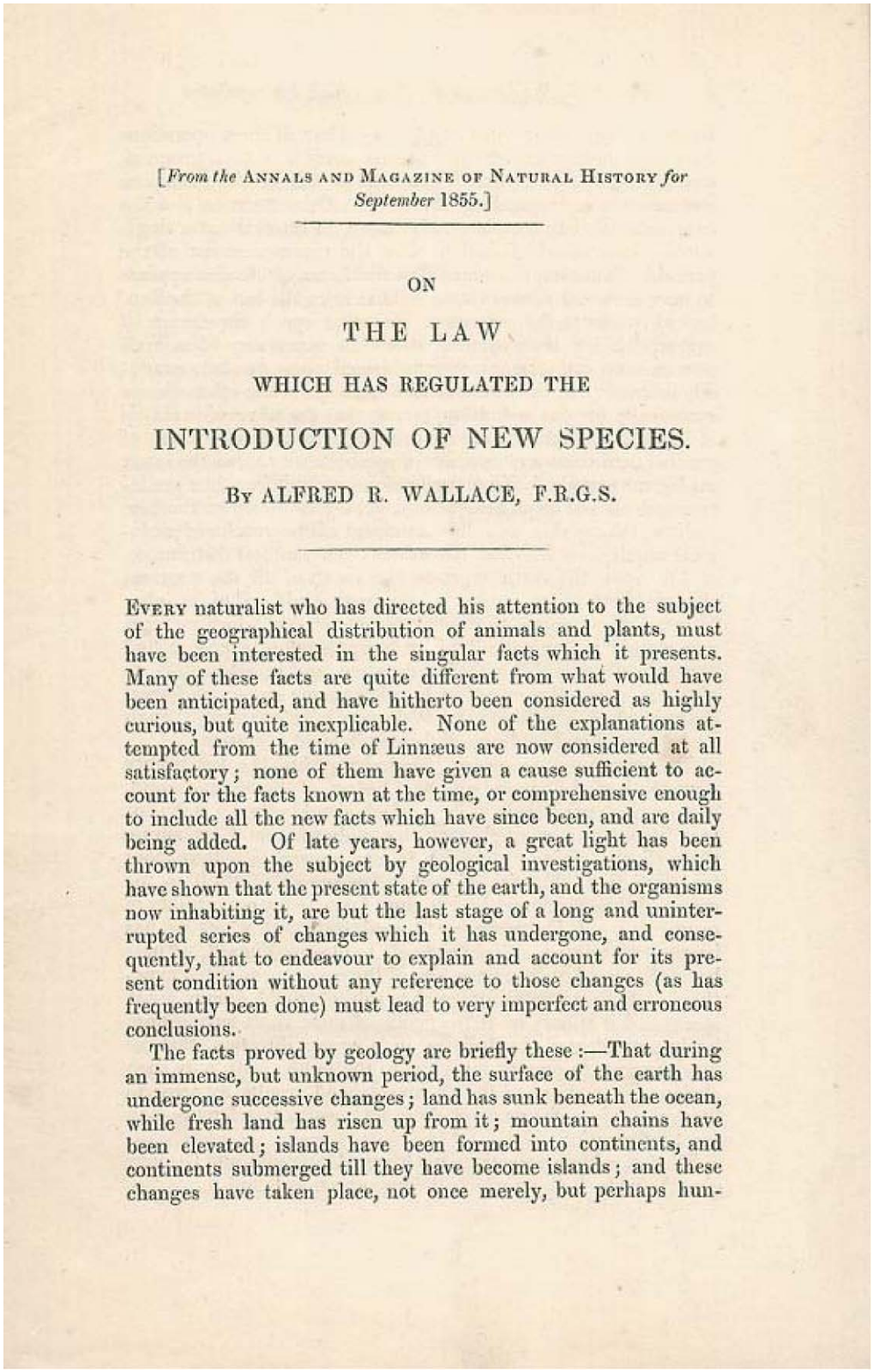
From 1854 to 1862, Wallace embarked on a longer voyage of exploration. From Java, Borneo, Celebes, the Aru Islands, New Guinea to Bali he covered 14 000 miles (web citation). During this time, with the help of Ali, his local expert, he collected a vast array of items of which over 125 000 were brought back to Britain. These included 83 200 beetles, 8050 birds, 13 100 butterflies and moths, and 310 mammals; among these, 7 complete hides of orang-utans (Fichman 2004). Wallace's expeditions to Brazil and later to the Malaysian archipelago lasted, from start to finish, a total of 20 years. It is hard not to conclude that Wallace had, in all, much more experience in exploring and collecting and throughout, more opportunity to compare small differences in species composition from widely different environments than had Darwin. This was to have a profound influence on his own theories of evolution and the origin of species.

He relished the opportunity to live among the diverse inhabitants of the islands he explored, all of whom he treated with courtesy and respect. Throughout this period he overcame many trials including tropical storms, leeches, insect bites '*covered from head to foot in inflamed lumps*', infections with boils and malaria. It was also a time of great inspiration leading to the production of ideas that would shake the foundations of the nineteenth century scientific world. As well as monumental taxonomic achievements, he became father of the blossoming science of biogeography, and discovered the geographical demarcation between the Asian and Australian fauna, known ever since as 'The Wallace Line', and that we now realize is a consequence of tectonic movement and continental drift. It took more than a century before geological discoveries made clear the deep underlying mechanisms involved (Wallace 1880; Raby 2001; Slotten 2004; Michaux 2008).

It is apparent that right from the start of his career as an explorer–collector, Wallace was engaged in thinking about the origins of living things. He was greatly influenced by the Victorian work on evolution, *Vestiges of the natural history of creation* (Chambers 1844) and in the autumn of 1847 he wrote to his friend Henry Bates, proposing that they undertake a collecting expedition to the River Amazon on which they could gather facts '*towards solving the problem of the origin of species*'. The resulting expedition to the Amazon and Negro Rivers, and subsequently to the Malaysian archipelago, enabled him to collect and describe a vast number of different biological specimens, and to analyse their geographical distributions. Integration of this information revealed simple and obvious answers about the evolution of species and led, in 1855, to the publication of a paper (figure 2) containing the so-called 'Sarawak Law', which states that 'every species has come into existence coincident both in space and time with a pre-existing closely allied species' (Wallace 1855).

The paper drew on examples from the fossil record, the geographical distributions of related organisms and the existence of 'rudimentary organs' to demonstrate that species have arisen by modification and divergence from previously existing species: '*two or three distinct species may have had a common antitype, and each of these may again have become the antitypes from which other closely allied species were created*'. Somewhat ironically (in view of Darwin's association), the paper refers to the case of the Galapagos Islands where the existence of a flora and fauna, distinct from but related to allied forms on the South American continent has '*not hitherto received any, even conjectural explanation*'. Wallace went on to suggest that that the islands had been first colonized by mainland species through the agency of wind and currents, and that a sufficient period had elapsed for the original species to die out and be replaced by '*modified prototypes*'. The separate islands would have acquired their distinctive biota in a similar manner, '*either on the supposition that the same original migration peopled the whole of the islands with the same species from which differently modified prototypes were created, or that the islands were successively peopled from each other, but new species* [having] *been created in each* [island] *on the plan of the pre-existing ones*'. As a broad-brush explanation for the Galapagos biota, this would not be contradicted by modern-day biologists.

It has been noted by Michaux (2000) that this paper can now be seen as a statement of Wallace's theory of evolution, but as he lacked a mechanism by which the transformations could occur, he presents it very cautiously, not using the term 'evolution' and using the term common 'antitype' instead of common 'ancestor'. Quoting Michaux: '*However, all the*



[*From the* ANNALS AND MAGAZINE OF NATURAL HISTORY *for September* 1855.]

ON

THE LAW

WHICH HAS REGULATED THE

INTRODUCTION OF NEW SPECIES.

BY ALFRED R. WALLACE, F.R.G.S.

EVERY naturalist who has directed his attention to the subject of the geographical distribution of animals and plants, must have been interested in the singular facts which it presents. Many of these facts are quite different from what would have been anticipated, and have hitherto been considered as highly curious, but quite inexplicable. None of the explanations attempted from the time of Linnæus are now considered at all satisfactory; none of them have given a cause sufficient to account for the facts known at the time, or comprehensive enough to include all the new facts which have since been, and are daily being added. Of late years, however, a great light has been thrown upon the subject by geological investigations, which have shown that the present state of the earth, and the organisms now inhabiting it, are but the last stage of a long and uninterrupted series of changes which it has undergone, and consequently, that to endeavour to explain and account for its present condition without any reference to those changes (as has frequently been done) must lead to very imperfect and erroneous conclusions.

The facts proved by geology are briefly these:—That during an immense, but unknown period, the surface of the earth has undergone successive changes; land has sunk beneath the ocean, while fresh land has risen up from it; mountain chains have been elevated; islands have been formed into continents, and continents submerged till they have become islands; and these changes have taken place, not once merely, but perhaps hun-

Figure 2. Wallace's Sarawak Law: that species have diverged from a common ancestor. ' *Every species has come into existence coincident both in space and time with a pre-existing closely-allied species'* (Wallace 1855).

Darwinian themes are clearly portended – gradualism, utility, adaptation to different environments, allopatric speciation, imperfection of the fossil record and so forth.' However, for whatever reason, the paper was almost totally ignored by the scientific community (Raby 2001; Slotten 2004; Davies 2008).

In a further paper, appearing early in 1858, Wallace came much closer to a direct advocation of evolution, showing by cogent argument the absurdity of the view that permanent varieties could arise naturally, yet the species from which they were derived had to have been specially created. He called upon naturalists to agree that varieties and species differed only by degree, as a result of common descent. The inference was that the formation of varieties and their indefinite divergence was the raw material for evolution (Wallace 1858). But, as mentioned above, Wallace's evolutionary theory had a very serious gap – there was no mechanism by which new varieties could replace the parental forms.

Unknown to Wallace, Charles Darwin had understood the required mechanism for some years. Following his return from the *Beagle* voyage, he had given much thought to the evolution of species and in 1844 he had drafted an abstract of his views, which he showed to Joseph Hooker but made no attempt to publish. In this, he described the tendency for organisms to produce variants, and reasoned that advantageous variations would be more likely to survive in the struggle for existence. However, he seemed to think that this process would be confined to small isolated populations, as on islands, and would result merely in a species adapting to changing conditions. The continued modification and divergence to produce a range of species that exploited different habitats was not proposed. Indeed, Brackman (1980) gives an autobiographical quote from Darwin in which, referring to his 1844 abstract, he says '*at the time, I overlooked one problem of great importance: ... the tendency of organic beings descended from the same stock to diverge in character as they become modified* '.

Following 1844, Darwin laboured long on the advancement of his evolutionary theory, for example, making very detailed studies of variation in domesticated animals, but there is no record of his having shown his progress to anyone. As we shall see, this changed following the publication of Wallace's Sarawak Law in 1855.

Had a newcomer to evolutionary biology examined the literature during 1855–58, he or she might have concluded that the leading evolutionary theorist of the time was Wallace and not Darwin. The reaction of Charles Lyell to the Sarawak Law paper emphasizes this point – following its publication he visited Darwin to warn him that Wallace was getting very close to solving the '*species problem*', and to urge him to move quickly to establish his priority. Though Darwin never acknowledged the Sarawak Law paper, a graduate student, Lewis McKinney (1966) found a copy of it in his collected papers. It had been heavily annotated by Darwin who had obviously recognized its importance. In response, Darwin began to write his *Origin of species*, but made no move to publish anything quickly.

Wallace wrote to Darwin in late 1856 – the first of several letters over a short period extending to June 1858. None of these survive, but we know from Darwin's reply that in the first letter (which Darwin would have received in the spring of 1857) Wallace had asked him what he thought of the '*Sarawak Paper'*. A little later, in September of that year, Darwin wrote a synopsis of his theory of evolution by natural selection and sent it to an American, Dr Asa Gray, who appears to have been more an acquaintance rather than a friend, with the request not to reveal its content to any other person. This synopsis included the principle of modification and divergence to fill available niches and was, in essence, the theory of evolution as subsequently published in the *Origin of species*.

Darwin later credited the writings of Malthus as the clue he needed to discover natural selection, and early in 1858, while suffering from malaria, Wallace had leisure to think deeply and went through the same mental process. Thus, he arrived at the mechanism of natural selection, though he did not give it that name. This completed Wallace's theory of evolution; he wrote it out and posted it to Darwin from the island of Ternate on 9 March when the first available ship arrived. McKinney (1966) has drawn attention to another letter, which still exists, and was sent by Wallace on the same boat, on the same day, to Frederick Bates (figure 3). The letter corroborates the dates of posting; it carries the cancellation marks for the various stages of its journey from Ternate and arrived in the Leicester post office for delivery on 3 June. The letter to Darwin should therefore have been delivered on the same day or very soon after, but he claimed not to have received it until 18 June. The fact that he had, in the meantime, written to Hooker on 8 June to say that he had finally solved the frustrating problem of how species diverged in nature, looks a little suspicious in these circumstances.

Wallace had requested that his paper should be forwarded to Charles Lyell, and Darwin duly complied on 18 June, including a letter that expressed some anguish at his having been scooped. Faced with a delicate situation, Lyell and Hooker decided to arrange a joint presentation of Wallace's and Darwin's theories at the next (and imminent) meeting of the Linnaean Society. The fact that Darwin had no prepared manuscript was an obvious difficulty with this course, but was circumvented by his submission of his 1844 sketch together with extracts from his 1857 letter to Asa Gray. Protocol should have dictated that Wallace's paper be read first but Lyell and Hooker arranged to have it presented after that of Darwin. It is often stated, or implied, that Wallace

Figure 3. The envelope–letter from Ternate posted by Wallace to Bates, arrived via Singapore and London to Leicester on 3 June 1858: another on the same ship went to Darwin.

consented to this arrangement; for example, Nanjundiah (2009) states that the 'large-heartedness' of Wallace ensured that an agreeable compromise was reached. However, although Wallace undoubtedly was large-hearted about the affair, he was still in the Malayan archipelago at the time, so any such reactions to it were necessarily retrospective.

The question arises of who really did have priority in the development of the theory of evolution by natural selection. There seems little doubt, based on his 1844 sketch and the letter to Asa Gray, that Darwin had a complete theory before Wallace. Darwin's apparent falsification of the date on which he received the Ternate paper cannot, therefore, be interpreted as a cover for the stealing of Wallace's ideas as presented in that paper. The more likely explanation for Darwin's behaviour is that it gave him the opportunity to write to Hooker saying that he had now solved all problems and at last had a complete theory, thus strengthening his claims to priority, apparently prior to receiving the Ternate paper.

Nevertheless, there is a significant probability that without Wallace, Darwin would not have completed his theory when he did. His letter to Asa Gray in which he first propounded the principle of divergence with modification was subsequent to his reading of Wallace's '*Sarawak Paper*' in which, as we have already seen, the principle was implicit, if not spelled out. Furthermore, although his letter to Asa Gray preceded Wallace's 1858 short paper on varieties in which the principle of divergence was more explicit, advocating that varieties and species both arise by common descent, Darwin had by this time received further letters from Wallace. It is reasonable to assume that in this correspondence Wallace was bouncing his ideas off Darwin (why else would he write to him?) and these would surely have included ideas for his forthcoming paper on varieties. The fact that these letters are missing from Darwin's otherwise well-organized correspondence adds to the suspicion that they may have contained ideas that Darwin subsequently claimed as his own. Darwin's admission in later years that '*I was forestalled in only one important point, which my vanity has always made me regret*' (Brackman 1980) adds weight to this suspicion.

It is also telling that in later years, when the two men had much friendly correspondence, that Darwin, commenting on a recent paper by Wallace, wrote '*you ought not [……] to speak of the theory as mine; it is just as much yours as mine'* (Brackman 1980). It is a pity though, that such magnanimity was not shown at an earlier stage – Wallace got not so much as a mention in the first two editions of the *Origin of species*.

That Wallace almost certainly solved the problem of divergence before Darwin did is, perhaps, not surprising. Wallace had much the greater experience in the field of biogeography, which was so fundamental to unravelling the relationships between species. But, even more importantly, he had the advantage that, unlike Darwin, he was looking actively for evidence of evolution while in the field, and

could therefore tailor his data collection appropriately. By contrast, Sulloway (2009) has recently argued most persuasively that during the voyage on *The Beagle* Darwin was still a creationist in attitude; this blunted his appreciation of the evolutionary significance of the Galapagos fauna to the extent that he failed to collect a single tortoise specimen and neglected to label his finch specimens with their exact islands of origin.

One absorbing aspect of the Darwin–Wallace discussion is the differences in personality and circumstances between these giants of biology at that time. As was discussed earlier, the difference in lifestyles between Darwin and Wallace was marked. The former, a product of wealth and privilege, lived with his family in Down House in an English countryside which was easily accessible to the intellectual heart of the British Empire. Wallace, on the other hand, was to all intents and purposes a maverick and an outsider. Darwin was, for much of his life, driven by the desire to become known as the person who solved the mystery of the evolution of new species. No one doubts his massive contributions to this field, but whereas he shared and published his findings in other areas of biology, he kept his data and conclusions on evolution to himself – this was his province, to be shared with no others. Wallace was also consumed by a passion to unravel the secrets of evolution, but not in such a possessive way. When the data led him to conclusions, he published them for others to share and use. He wrote to Darwin to ask what the great man thought of his ideas, little suspecting that Darwin was not so much a collector of ideas on evolution but a hoarder who was unlikely to give anything back.

Darwin's obsession with his priority in the field of evolution was also manifested in the early editions of his *Origin of species* where there was no acknowledgement of his debt to other enormously influential antecedent biologists, most notably Erasmus Darwin, Edward Blyth, Robert Chambers and Patrick Matthew (the first to write about '*natural means of selection*'). Darlington (1959) has commented on these matters in a detailed survey.

On the other hand, Wallace appears to have been driven by curiosity rather than a desire for fame and reputation. In keeping with this, he was an incredibly generous, modest man, only too ready to cede reputation to a person such as Darwin whom he regarded with great respect. Wallace's polite deference towards Darwin during his long sojourn in the East Indies has been emphasized in an extensive primary (Wallace 1876, 1880, 1908) and secondary literature (Smith 1991; Slotten 2004; Smith and Beccaloni 2008). His relationship with the famous son of a famous dynasty at the centre of power and influence and close to the intellectual triangle of London, Oxford and Cambridge, seemed to have been regarded as a huge honour by the young man from Usk.

During his years in the field, Wallace was living a hand-to-mouth existence, not only when travelling from island to island in the Far East, but for several years after his return to London in 1862; a letter from Darwin without doubt helped his plea to be granted a small pension. His vivid and infectious enthusiasm for the beauty of the living world is typified by his Herculean efforts that brought two live birds of paradise back to England. Keeping them fed with a supply of ship's cockroaches was in itself a full-time task, and the extraordinary lengths to which Wallace went to secure their safe voyage is splendidly recounted by Raby (2001). Finding a new home in the Zoological Society of London, these prized symbols of his fantastic and exotic voyages served as a vivid image in the public imagination of the vast uncharted world of nature (figure 4).

Darwin died in April 1882 at the age of seventy-three, and was buried in Westminster Abbey. Wallace *'That perennial afterthought in the Darwinian story'* was a pall-bearer (Desmond and Moore 1991). The son, George Darwin, had considered it 'gracious' to ask Wallace to bring up the rear behind Spottiswoode, the President of the Royal Society, and Lubbock, President of the Linnean, Hooker and Huxley. During and after the 1880s, Wallace wrote very little on science or natural history, with the exception of reviews. In these later works the breadth and depth of his original thinking became evident. He questioned the assumptions upon which Victorian values were based, and never accepted the principles of free-enterprise capitalism. His main preoccupation became land reform, as existing laws of land allocation benefited only the rich landowners. He also became increasingly interested in the social implications of evolutionary theories. Raby (2001) points out that Wallace's radical socialist ideals were inculcated during his teenage experiences of the working conditions and deprivation in industrial South Wales and later in London. Fichman (2004) further asserts that Wallace's deep humanist values and sense of obligation to the exploited masses had long become fundamental to his personality and way of life.

He lectured widely, toured America, and enjoyed his family circle. Continuing to publish right up to his ninetieth year, Wallace daringly enquired into a broad range of controversial topics including phrenology, mesmerism and spiritualism, and entertained the possibility of the existence of extraterrestrial life. He was also vociferously against the smallpox vaccination campaign.

Many have maintained that these wider interests detract from his earlier mainstream biological reputation, but it must be realized that the climate of Victorian times was so very different from today. In that era of polymath accomplishment, possibilities for making significant contributions across an eclectic range of interests contrasts with the focused demands of specialist expertise now. Much of medical practice was hardly scientific, and certainly not evidence-based. Thus, a century ago, a degree of scepticism about the safety of newly implemented procedures was fully justifiable.

Figure 4. A male red bird of paradise (*Paradisaea raggiana*) similar to the two live birds brought back to England in 1862.

Today, when hypnotherapy and cognitive psychotherapy are accepted as highly valuable treatments for a variety of common psychological dysfunctions, the earlier interest in mesmerism, the precursor of hypnotism and ideas about autosuggestion, cannot be dismissed as an irrelevance. Astrobiology, a discipline supported even now by only sparse data, is currently fashionable in terms of the possible primary origins and sources of the molecular building blocks of life on earth. Understanding of the mechanisms of survival of microorganisms in harsh environments on earth has been extended by questions posed by those investigating the possibility of life on other planets. Thus many, if not all, of Wallace's enthusiasms can no longer be regarded as misplaced, but rather be seen as prescient and significant indicators of his powers of lateral thought, especially in an optimistic culture where newly observed phenomena, however seemingly implausible, could possibly lead to new vistas.

Interest in spiritualism, the most contentious of Wallace's enthusiasms, relates to his growing belief, even from his early days, that more 'recondite forces' than those involved in natural selection are influential in shaping the human mind with its unique characteristics of consciousness, cognition and higher facilities (Moore 2006). This led to Darwin's despairing letter of 1868 in which he wrote '*I grieve to differ from you, and it actually terrifies me and makes me critically distrust myself*', and in 1869: '*I hope you have not murdered too completely your and my brainchild'* (Marchant 1916). In 1901, Wallace was to firmly assert that: *'natural selection is not the all-powerful, all-sufficient and only cause of the development of organic forms'*.

Indeed, the detailed examination of whole sections of Wallace's publications on evolutionary theory (as yet perused by few) reveals aspects of his ideas that have not been developed and elaborated in the light of newly available biological evidence (Smith and Beccaloni 2008). Thus, Smith (2008) points out how Wallace's appreciation of the continuous restoration of order wrought by the stabilizing influence of natural selection on the disordered progress of speciation has been largely overlooked. That he should make the extraordinary analogy to the action of the centrifugal governor in a steam engine presages ideas on metabolic control by negative feedback, and the self-controlling complexities of systems theory, cybernetics and, most recently, systems biology. Wallace's ideas on the importance of environmentally directed evolution extended far beyond Darwin's. For instance, adaptive mechanisms ensure that populations tend to extend more easily in some directions by newly developing associations and interactions. The progress of several aspects of evolutionary theory has been delayed as a consequence of the slow appreciation of the details of Wallaceism.

His own humble beginnings were never forgotten and his broad concerns for the social conditions of the poor

Figure 5. Memorial to Wallace in Llanbadoc church

and underprivileged were still at the centre of his thoughts. When proposed for a Fellowship of the Royal Society in 1893, at the age of seventy, he professed not to see why he had been so honoured, '*I really have done so little of what is usually considered scientific work,'* although in 1868 he had already received its Royal Medal, and in 1890 its Darwin Medal. In 1908, he was awarded the Copley Medal of the Royal Society. The same year, he was first recipient of the Darwin–Wallace Medal of the Linnean Society, and the Order of Merit of the British Empire.

Although one of the world's most distinguished scientists at the time of his death in 1913 (figure 5), Wallace's achievements were soon almost forgotten, partly as a consequence of his retiring personality and naturally modest disposition (Wilson 2000).

Perhaps the most astonishing aspect of this fascinating story is Wallace's continuing subservience and acquiescence to being consistently regarded as the second of equals: he even went so far as to affirm publicly his admiration for *Origin of species* by assessing his own contributions to insights into '*the mystery of mysteries'* with great humility '*that is to say, as 20 years work is to one week*' (Anon 2008).

In 1889, seven years after Darwin's death, Wallace (1889) was to publish a volume on evolution, the title of which in itself was a paean of praise for Darwin. After a long period of eclipse since the 1920s, there has been a renewal of interest in Wallace's achievements (Fichman 2004). A notable example of this has been the staunch advocacy of Wallace through public lectures by the naturalist and broadcaster David Attenborough. A full reinstatement of Wallace's claim to originality is long overdue: the Wallace–Darwin Theory is a more legitimate title for the central principle that has underpinned biology for the past 150 years.

References

Anonymous 2008 Wallace defends Darwin's priority – 50 years on; in *Survival of the fittest: celebrating 150th anniversary of the Darwin–Wallace Theory of Evolution* (eds) B Gardiner, R Milner and M Morris (London: The Linnean Society)

Beddall B G 1968 Wallace, Darwin and the theory of natural selection: a study in the development of ideas and attitudes; *J. Hist. Biol.* **1** 261–324

Brackman A C 1980 *A delicate arrangement: the strange case of Charles Darwin and Alfred Russel Wallace* (New York: Times Books)

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

Browne E J 2002 *The power of place*. Vol. 2 of *Charles Darwin* (Princeton, NJ: Princeton University Press)

Chambers R 1844 *Vestiges of the natural history of creation* (London: John Churchill)

Claridge M 2008 Alfred Russel Wallace – a Welsh entomologist!; in *The Linnean Society. Special issue No 9: Survival of the fittest* (eds) B Gardiner, R Milner and M Morris (London: the Linnean Society) pp 17–24

Davies R 2008 *The Darwin conspiracy: origins of a scientific crime* (London: Golden Square Books)

Darlington C D 1959 *Darwin's place in history* (Oxford: Blackwell)

Desmond A and Moore J 1991 *Darwin* (London: Michael Joseph)

Eisley L C 1979 *Darwin and the mysterious Mr. X: new light on the evolutionists* (London: J M Dent)

Eiseley L C 2009 *Darwin's century: evolution and the men who discovered it* (New York: Barnes and Noble, reprint of the first edition of 1958)

Fichman M 2004 *An elusive Victorian: the evolution of Alfred Russel Wallace* (Chicago: Chicago University Press)

Hughes R E 1989 Alfred Russel Wallace; some notes on the Welsh connection; *Br. J. Hist. Sci.* **22** 401–418

Hughes R E 1991 Alfred Russel Wallace (1823–1913): the making of a scientific non-conformist; *Proc. R. Inst.* **63** 175–183

Marchant J 1916 Alfred Russel Wallace: letters and reminiscences, 2 volumes (London: Cassell)

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

Michaux B 2000 *http://people.wku.edu/charles.smith/wallace/S020.htm*

Michaux B 2008 Alfred Russel Wallace, biogeographer; in *Natural selection and beyond: the intellectual legacy of Alfred Russel Wallace* (eds) C H Smith and G Beccaloni (Oxford: Oxford University Press)

Moore J 2006 Wallace in wonderland; *Ann. Hist. Philos. Biol*. **11** 139–154

Nanjundiah V 2009 The origin of species after 150 years: one hundred and fifty years without Darwin are enough; *Resonance* **14** 124–153

Raby R 2001 *Alfred Russel Wallace: a life* (London: Chatto and Windus)

Slotten R A 2004 *The heretic in Darwin's court: the life of Alfred Russel Wallace* (New York: Columbia University Press)

Smith C H (ed.) 1991 *Alfred Russel Wallace: an anthology of his shorter writings* (Oxford: Oxford University Press)

Smith C H 2008 Wallace's unfinished business; in *Natural selection and beyond: the intellectual legacy of Alfred Russel*

Wallace (eds) C H Smith and G Beccaloni (Oxford: Oxford University Press)

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

Sulloway F J 2009 Why Darwin rejected intelligent design; *J. Biosci*. **34** 173–183

Wallace A R 1855 On the law that has regulated the introduction of a new species; *Ann. Mag. Nat. Hist.* **16** 184–196

Wallace A R 1858 Note on the theory of permanent and geographical varieties; *Zoologist* **16** 5887–5888

Wallace A R 1876 *The geographical distribution of animals, with a study of the relations of living and extinct faunas as elucidating the past changes of the earth's surface*, 2 vols (London: Macmillan)

Wallace A R 1880 *Island life* (London: Macmillan)

Wallace A R 1889 *Darwinism: an exposition of the theory of natural selection with some of its applications* (London: Macmillan)

Wallace A R 1901 *Miracles and modern spiritualism*; Reprint of 1896 rev. 3rd edition (London: Nichols)

Wallace A R 1908 *My life* (London: Chapman and Hall, reprinted Elibron Classics series 2005) Web citation: *http://www.papuaweb.org*

Wilson J G 2000 *The forgotten naturalist: in search of Alfred Russel Wallace* (Kew, Victoria: Australian Scholarly Publishing)

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