

# Alfred Russel Wallace (1823–1913): the forgotten co-founder of the Neo-Darwinian theory of biological evolution

Ulrich Kutschera · Uwe Hossfeld

Received: 5 June 2013 / Accepted: 1 July 2013 / Published online: 27 August 2013  
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**Abstract** The British naturalist Alfred Russel Wallace (1823–1913), who had to leave school aged 14 and never attended university, did extensive fieldwork, first in the Amazon River basin (1848–1852) and then in Southeast Asia (1854–1862). Based on this experience, and after reading the corresponding scientific literature, Wallace postulated that species were not created, but are modified descendants of pre-existing varieties (Sarawak Law paper, 1855). Evolution is brought about by a struggle for existence via natural selection, which results in the adaptation of those individuals in variable populations who survive and reproduce (Ternate essay, 1858). In his monograph *Darwinism* (1889), and in subsequent publications, Wallace extended the contents of Darwin's *Origin of Species* (1859) into the Neo-Darwinian theory of biological evolution, with reference to the work of August Weismann (1834–1914). Wallace also became the (co)-founder of biogeography, biodiversity research, astrobiology and evolutionary anthropology. Moreover, he envisioned what was later called the anthropocene (i.e., the age of human environmental destructiveness). However, since Wallace believed in atheistic spiritualism and mixed up scientific facts and supernatural speculations in some of his writings, he remains a controversial figure in the history of biology.

## Introduction

Due to his excellent scientific work in geology and different branches of the life sciences, Charles Robert Darwin (1809–1882) is revered as one of the most influential scientists of the nineteenth century. Despite the fact that the co-discoverer of the “Darwinian” principle of natural selection, Alfred Russel Wallace (1823–1913) (Fig. 1) published many more books and papers than his senior colleague, he soon became one of the “forgotten” scientists in evolutionary biology (Smith and Beccaloni 2008).

In an obituary published 2 weeks after Wallace's death in the journal *Nature*, his friend and colleague Edward Bagnall Poulton (1856–1943) wrote that “The last link with the great evolutionary writers of the mid-nineteenth century—the men who transformed the thought of the world—is broken” (Poulton 1913, p. 347). Then, he described the “biologist in the shadow of Darwin” as one of the most important naturalists of his age. With respect to the “man himself”, the author mentioned Wallace's “charming personality” and described his character: “he was tall, with a magnificent head, a strong, clear, and pleasant voice, a hearty laugh, a keen sense of humour, an intense and vivid interest in the most varied subjects. But the central secret of his personal magnetism lay in his wide and unselfish sympathy” (Poulton 1913, p. 348). Finally, Wallace's broad interests in “the field of biological and especially of evolutionary inquiry” is highlighted (Poulton 1913, p. 349). Similarly, in the journal *Auk*, an anonymous author wrote that “Wallace, while standing in the highest rank among ornithologists, entomologists and botanists is best known in the broader field of philosophy and evolutionary thought, where his name is closely linked with those of Lyell and Darwin” (Anonymous 1914, p. 138).

One century later, Alfred R. Wallace is not only acknowledged as the “second discoverer of natural

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This article is a contribution to the Special issue Alfred Russel Wallace (1823–1913): The man in the shadow of Charles Darwin—Guest Editors U. Kutschera, U. Hossfeld.

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U. Kutschera (✉)  
Institute of Biology, University of Kassel,  
Heinrich-Plett-Str. 40, 34132 Kassel, Germany  
e-mail: kut@uni-kassel.de

U. Hossfeld  
Arbeitsgruppe Biologiedidaktik, Universität Jena,  
Am Steiger 3, Bienenhaus, 07743 Jena, Germany



**Fig. 1** The British naturalist Alfred Russel Wallace (1823–1913) was a self-educated botanist, zoologist and philosopher of science. He was the pre-eminent tropical biologist-traveller of his day, founder of zoological geography and co-founder of the Neo-Darwinian theory of biological evolution via directional natural selection (adapted from a photograph, 1853)

selection in the wild”, but also as (co)-founder of biogeography, systematic biodiversity research and astrobiology (Berry 2013; Costa 2013; Hossfeld and Olsson 2009; Kutschera 2003, 2008, 2009a, b, 2012). Moreover, Wallace was the evolutionary anthropologist who envisioned the anthropocene, i.e., the “age of Man” (Kutschera 2013).

In this Editorial, we briefly summarize the life, work and major achievements of Wallace and outline his legacy with special reference to the principle of natural selection from a Neo-Darwinian perspective. A biographical sketch (Table 1) and the list of his 22 books (Table 2) provide background information for the sections that follow.

### Sarawak Law and the transformation of species

In his famous monograph *Principles of Geology*, which was published as a series of three books in 1830, 1832 and 1833, the geologist Charles Lyell (1797–1875) discussed in detail the forgotten work of the French naturalist Jean Lamarck (1744–1829). In vol. 2 of his *Principles*, Lyell argued, with reference to Lamarck’s *Philosophie Zoologique* (1809), that “at the end of many successive generations, these individuals, which originally belonged to another species, are transformed into a new and distinct species” (Lyell 1832, p. 5). This concept was labelled by him as Lamarck’s “Theory of the transmutation of

species”. In the next sections, Lyell (1832) summarized his “Reasons for rejecting Lamarck’s hypothesis”. The geologist wrote that “We must suppose that when the author of nature creates an animal or plant, all the possible circumstances in which its descendants are destined to live are foreseen ...” (Lyell 1832, p. 7). Moreover, he complained that, according to Lamarck (1809), “Nature, we are told, is not an intelligence, nor the Deity, but a delegated power—a mere instrument—a piece of mechanism acting by necessity—an order of things constituted by the supreme being, and subject to laws which are the expression of its will. ... such is the machinery of the Lamarckian system.” In addition, the geologist argued that there are “No facts of transmutation authenticated” (Lyell 1832, p. 13).

Alfred R. Wallace was deeply impressed when he read these sentences. His first major theoretical article, the “Sarawak Law paper” of 1855, was written in response to Lyell’s rejection of Lamarck’s concept of evolutionary change. Wallace was living in the province of Sarawak on the island of Borneo, when he summarized the biogeographical and paleobiological evidence for species transformations available at that time. Accordingly, Wallace argued that species are not constant, but may represent modified descendants of earlier variants (Wallace 1855). He deduced a “Law” that the author summarized in the following sentence: “Every species has come into existence coincident both in space and time with a pre-existing closely allied species” (Wallace 1855, p. 186). However, the 32-year-old biologist was unable to provide a mechanism that would account for the gradual transformation of species in nature, and therefore his article did not have much impact (Costa 2013).

### Ternate paper: evolution by natural selection

Only 3 years later, Wallace wrote his famous “Ternate essay” (Fig. 2), wherein he pointed out that “The life of wild animals is a struggle for existence” (Wallace 1858, p. 54). He illustrated this principle with reference to birds, mammals, and insects (his remarks on concealment and adaptation of these organisms are noteworthy in this context, Fig. 3). Basically, Wallace (1858) described the principle of natural selection in populations of organisms, but he did not use this “Darwinian” key term (Kutschera 2003, 2008). Wallace sent his manuscript to Charles Darwin and asked him to pass it on to Charles Lyell. Darwin managed to publish Wallace’s essay, together with some of his earlier writings on natural selection, in the *Proceedings of the Linnean Society, London* (August 1858). In response to the “Wallace-essay”, which contained a similar theory as that Darwin had developed over the past two decades, he published an “Abstract”, taken from his unfinished

**Table 1** Summary of the life and work of Alfred Russel Wallace

1. Youth and early adulthood (1823–1847)	Alfred Russel Wallace born at Usk, Monmouthshire (Wales, UK) on the 8th of January 1823; attends grammar school at Hertford, 1828–1837; leaves school at 14 due to financial problems of his father; learns the profession of land surveying, 1837–1843; teaching job in Leicester, 1844; meets entomologist Henry W. Bates (1825–1892); interest in botany, zoology, and species transmutation (evolution)
2. Expedition to Amazonian South America (1848–1852)	A. R. Wallace and H. W. Bates travel to Brazil to collect, for private and commercial purposes, natural history specimens (insects, birds etc.). In addition, Wallace wanted to seek convincing evidence for species transmutations and the mechanism of evolutionary change. On his return to England Wallace's ship caught fire and sank, along with almost all specimens and notes. Back in England, Wallace published his first two books (nos. 1 and 2)
3. Expedition to Southeast Asia (1854–1862)	A. R. Wallace arrived in Singapore in April 1854 and spend the next 8 years travelling 20,000 km around the Malay Archipelago (today Singapore, Malaysia and Indonesia); "Sarawak Law paper" (1855), "Ternate essay" (1858); description of 'Wallace line' separating the 'Australian and Indian regions of zoology' (1859); during his one-man excursions, Wallace had collected, with assistants, ca. 125,000 specimens of insects, birds, mammals etc.; more than 1,000 of them were un-described species
4. Free-lance writer, biologist and spiritualist (1863–1913)	After his return to England in 1862, Wallace lost most of his savings through bad investments; he could not find an appropriate position and, after his marriage, earned money by writing books, occasional lectures (North America, 1886/87), and later received a small pension. Wallace published his bestseller <i>The Malay Archipelago</i> (1869) (no. 3), a monograph on the <i>Geographical Distribution of Animals</i> (1876) (no. 6), Darwinism (1889) (no. 12) and many other books on scientific and social issues. Wallace became a spiritualist and defended this atheistic belief system (books no. 5, 12, 20). In one of his last monographs he discussed natural selection with reference to Darwin as the original discoverer of this law of nature. A. R. Wallace died at Broadstone, Dorset on 7 November 1913

The books no. 1–22 referred to in the text are listed in Table 2

"Species book", under the title *On the Origin of Species* (Darwin 1859).

Four decades after he wrote his "1858-paper", Wallace published his popular book *The Wonderful Century*, wherein he provided "personal details" concerning the origin of his "theory of how the change of species actually occurred" (Wallace 1898, p. 139). In February 1858, Wallace was "living at Ternate in the Moluccas" ... and recounted his discovery in the following words: "I was suffering from a rather severe attack of intermittent fever, which prostrated me for several hours every day during the cold and succeeding hot fits. During one of these fits, while again considering the problem of the origin of species, something led me to think of Malthus' essay on population (which I had read about 10 years before), and the 'positive checks'—war, disease, famine, accidents, etc.—which he adduced as keeping all savage populations nearly stationary. It then occurred to me that these checks must also act upon animals, and keep down their numbers; and as they increase so much faster than man does, ... it was clear that these checks in their case must be far more powerful. ... There suddenly flashed upon me the idea of *the survival of the fittest*—that the individuals removed by these checks must be, on the whole, inferior to those that survived. ... That same evening I sketched out the draft of a paper; in the two succeeding evenings I wrote it out, and sent it by the next post to Mr. Darwin" (Wallace 1898, pp. 140–141).

Concerning religious opposition to this revolutionary idea, Wallace argued as follows: "It had been so long the custom to treat species as special creations, and the mode of their creation as 'the mystery of mysteries', that it had

come to be considered not only presumptuous, but almost impious, for any individual to profess to have lifted the veil from what was held to be the greatest and most mysterious of nature's secrets ... Evolution is now universally accepted as a demonstrated principle" (Wallace 1898, pp. 141–142). Finally, the author distinguishes between the process of evolutionary change and the mechanisms that bring about these continuous modifications: "The only thing discussed now is, not the fact of evolution—that is admitted—but merely whether or not the causes alleged by Darwin are themselves sufficient to explain the evolution of species, ...". Thereafter, the unselfish biologist praised the work of his senior colleague in the following words: "It not only places the name of Darwin on a level with that of Newton, but his work will always be considered as one of the greatest, ... of the scientific achievements of the nineteenth century" (Wallace 1898, p. 143).

### The six laws of nature

Nine years after the publication of his "1858-Ternate essay" (Fig. 2), Wallace (1867) characterized the principle of natural selection, with reference to Darwin's book *On the Origin of Species* (1859), in more detail. He summarized his idea in "six laws" that can be outlined as follows: "(1) multiplication in geometrical progression; (2) limited populations; (3) heredity, or likeness of offspring to their parents; (4) variation; (5) unceasing change of physical conditions upon the surface of the earth", supplemented by (6) "the equilibrium of nature" (Wallace 1867, pp. 470–471).

**Table 2** Complete list of the 22 books authored or edited by Alfred Russel Wallace over a period of 60 years as a public intellectual and naturalist

1. Wallace AR (1853) *Palm trees of the amazon and their uses*. John Van Voorst, London
2. Wallace AR (1853) *A narrative of travels on the amazon and rio negro, with an account of the native tribes, and observations on the climate, geology, and natural history of the amazon valley*, 2nd edn. (1889) Reeve & Co., London
3. Wallace AR (1869) *The Malay Archipelago; the land of the orang-utan and the bird of paradise; a narrative of travel with studies of man and nature*. Vols. 1 and 2, 10th edn. (1891) Macmillan & Co., London
4. Wallace AR (1870) *Contributions to the theory of natural selection. A series of essays*, 2nd edn. (1871) Macmillan & Co., London and New York
5. Wallace AR (1875) *On miracles and modern spiritualism. Three essays*, 3rd edn. (1896) James Burns, London
6. Wallace AR (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*, vols. 1 and 2. Macmillan & Co., London
7. Wallace AR (1878) *Tropical nature, and other essays*. Macmillan & Co., London
8. Wallace AR (ed) (1879) *Australasia*, 4th edn. (1884) Edward Stanford, London
9. Wallace AR (1880) *Island life: or, the phenomena and causes of insular faunas and floras, including a revision and attempted solution of the problem of geological climates*, 3rd edn. (1902) Macmillan & Co., London
10. Wallace AR (1882) *Land nationalisation; its necessity and its aims; being a comparison of the system of landlord and tenant with that of occupying ownership in their influence of the well-being of the people*, 3rd edn. (1883) Trübner & Co, London
11. Wallace AR (1885) *Bad times: an essay on the present depression of trade, tracing it to its sources in enormous foreign loans, excessive war expenditure, the increase of speculation and of millionaires, and the depopulation of the rural districts; with suggested remedies*. Macmillan & Co., London
12. Wallace AR (1889) *Darwinism; an exposition of the theory of natural selection with some of its applications*, 3rd edn. (1905) Macmillan & Co., London
13. Wallace AR (1891) *Natural selection and tropical nature; essays on descriptive and theoretical biology*. Macmillan & Co., London
14. Wallace AR (1898) *The wonderful century; its successes and its failures*, 7th edn. (1908) Swan Sonnenschein & Co., London
15. Wallace AR (1900) *Studies: scientific and social—a collection of essays*, vols. 1 and 2. Macmillan & Co., London
16. Wallace AR (1903) *Man's place in the universe; a study of the results of scientific research in relation to the unity or plurality of worlds*, 4th edn. (1904) Chapman & Hall, London
17. Wallace AR (1905) *My life; a record of events and opinions*, vols. 1 and 2. Chapman & Hall, London
18. Wallace AR (1907) *Is mars habitable? A critical examination of professor Percival Lowell's book "mars and its canals," with an alternative explanation*. Macmillan & Co., London
19. Wallace AR (ed) (1908) *Notes of a botanist on the amazon and andes (original material by Richard Spruce, "edited and condensed by Alfred Russel Wallace")*, vols. 1 and 2. Macmillan & Co., London
20. Wallace AR (1910) *The world of life; a manifestation of creative power, directive mind and ultimate purpose*, 5th edn. (1911) Chapman & Hall, London
21. Wallace AR (1913) *Social environment and moral progress*. Cassell & Co., London
22. Wallace AR (1913) *The revolt of democracy*. Cassell & Co., London

The biologist regarded these six laws as the “condition of nature” and concluded that “It is from these universally admitted facts that the origin of all the varied forms of nature may be deduced by a logical chain of reasoning” (Wallace 1867, p. 473).

On the following pages, Wallace (1867) argues against “design by the Creator” and defends “Mr. Darwin's view” of a common ancestor of all forms of life on Earth. He asks “Are not improved steam engines or clocks the lineal descendants of some existing steam engine or clock? Is there ever a new creation in art or science any more than in nature? Did ever patentee absolutely originate any complete and entire invention, no portion of which was derived from anything that had been made or described before?” (Wallace 1867, p. 487). The answers to these questions are, according to Wallace (1867), “No!”.

At that time, the 44-year-old Wallace was still an adherent of philosophical naturalism, but spiritualistic ideas, which were, however, not related to religious dogma, had already occupied his mind (Fichman 2001). In later writings, notably in his monograph “Darwinism” (Wallace 1889), he refined his version of the principle of natural selection, especially by the incorporation of the concepts of the zoologist/cytologist August Weismann (1834–1914). These elaborations of the classical idea of 1858 are detailed in the next sections.

### Darwinism and the conspiracy theory

Between October 1886 and April 1887, the naturalist and free-lance science writer Alfred R. Wallace was travelling on a lecture tour across the United States. In his public



**Fig. 2** In February 1858, the 35-year-old Alfred R. Wallace was suffering from an attack of fever on the Indonesian island of Ternate (or Halmahera, the exact location is unknown). Suddenly, the concept of the struggle for existence (and, as a consequence, natural selection) came into his mind. He wrote his famous “Ternate essay” and sent it to Charles Darwin (adapted from a historical drawing)



**Fig. 3** The entomologist Alfred R. Wallace studied the taxonomy, distribution and colour variance of butterflies in nature (Malaysian Papilionidae), and published a biospecies-definition. These insects (depicted are various forms of *Papilio memnon*) are examples for disguise, which serves to protect the insects from their enemies in the ‘struggle for existence’ in their natural habitat (adapted from Wallace 1865)

lectures on evolution, he outlined the “evolved” system of theories on ‘descent with modification by means of natural selection’, as described in Darwin’s *Origin of Species* (1859) (it should be noted that, for another, broader audience, Wallace lectured on spiritualism). Based on his public science lectures, and the most recent literature available, Wallace (1889) published one of his most important books, entitled *Darwinism* (Smith and Derr 2013). In this illustrated monograph, the author summarized the evidence for evolution (a process he regarded as a fact), and again considerably up-dated the “Darwin–Wallace-principle of natural selection” written at Ternate, and, 9 years later, in a more precise version (Wallace 1858, 1867). Why did Wallace use the term “Darwinism”, without mentioning his contributions on this topic in the first place? In other words, why did the “man in the shadow of Darwin” always downplay his contributions to the development of the theory of natural selection?

An answer to this question can be found in the obituary that was published shortly after his death (Nov 7) by Poulton (1913). The author of this commentary, a biologist and friend of Wallace, described his “unselfish sympathy”, associated with his believe in “inspiration”. In a letter, Wallace had told Poulton that “all my best ideas have come to me suddenly”. Accordingly, the famous “Ternate essay” of 1858 was thought out by Wallace within 2 h, and the text was written down in three evenings (Poulton 1913, p. 349).

Since Wallace, an honest, curiosity-driven scientist, knew that Darwin had collected numerous observations over the past two decades that were finally summarized in his *Origin of Species* (Darwin 1859), he was happy to be recognized as the co-discoverer of the “Darwinian” principle of natural selection, but never claimed an equal status (see the “Darwin–Newton”-comparison quoted above, Wallace 1898, p. 143). Accordingly, the dedication in his most successful book *The Malay Archipelago* reads as follows: “To Charles Darwin. Author of ‘*The Origin of Species*’. I dedicate this book not only as a token of personal esteem and friendship but also to express my deep admiration for his genius and his work” (Wallace 1869).

Finally, it should be stressed that the still popular “conspiracy theory”, stating that Charles Darwin stole concepts concerning species divergence from Wallace’s “Ternate essay” of 1858 was thoroughly refuted by historians of science (see, for instance, Beddall 1988). Darwin was an honest man. He secured his priority concerning the species question with reference to natural selection, because he had written extensive manuscripts on the “struggle for life” two decades before Wallace discussed this topic when he was in the Malay Archipelago (Hossfeld and Olsson 2009; Kutschera 2009a, b; Costa 2013).

## Wallace co-founded the Neo-Darwinian theory

In contrast to Darwin (1859), the co-discoverer of natural selection always rejected the Lamarckian idea of an inheritance of acquired characteristics (see Wallace 1858, 1889, 1910). Moreover, Wallace developed, based on his extensive work as an entomologist and ornithologist (Figs. 3, 4), a biological species concept. For instance, in a paper on the Papilionidae, a family of diurnal Lepidoptera, he provided the following definition “Species are merely those strongly marked races or local forms which, when in contact, do not intermix, and when inhabiting distinct areas are generally believed to have had a separate origin, and to be incapable of producing a fertile hybrid offspring” (Wallace 1865, p. 12). Darwin (1859), however, did not unequivocally tell his readers what species are and how one can distinguish them from varieties (Kutschera 2003). Wallace’s definition is very similar to Mayr’s “biospecies concept” of 1942 (see Mayr 1982 and, for a detailed discussion of this topic, Mallet 2009). In addition, Wallace accepted August Weismann’s doctrine of the continuity of the germ-plasm, as well as his conclusion that sexual reproduction creates variability within animal populations (Wallace 1889, 1910).

In his monograph entitled *Darwinism* (Wallace 1889) and in subsequent writings, the author distinguished between what was later called “stabilizing vs. directional selection” (Kutschera 2009a, b). For instance, in one of his



**Fig. 4** The ornithologist Alfred R. Wallace discovered and described many species of birds. Depicted is the Malaysian taxon *Spizaetus nanus* (Wallace 1868). This widespread bird of prey is known under the common name ‘Wallace’s Hawk eagle’ and today belongs to the threatened birds of Asia (adapted from Wallace 1868)

journal articles on this topic, Wallace (1901) described the process of natural selection as “the continuous weeding out of the less fit”, which will “produce two distinct effects, which require to be clearly distinguished” (Wallace 1901, p. 26). Thereafter he explains these processes in the following words: “The first is the preservation of each species in the highest state of adaptation to the conditions of its existence; and, therefore, so long as these conditions remained unchanged, the effect of natural selection is to keep each well-adapted species also unchanged. The second effect is produced whenever the conditions vary, when, taking advantage of the variations continually occurring in all well-adapted and therefore populous species, the same process will slowly but surely bring about complete adaptation to the new conditions” (Wallace 1901, p. 26).

Thereafter, he discusses the common objections against the “second (creative) effect” of natural selection in the wild, which had been summarized in the popular argument that “the right variations will not always occur at the right time”. Wallace (1901) described the “large variability” within populations, and refers to “a variation of from 10 to 25 % on each side of the mean size”. Based on this large variation in populations of animals, he explains the process of “directional selection” in the following words: “Now, as the weeding-out process is so severe, only from 1 in 10 to 1 in a 100 of those born surviving to produce young, the above proportion of variations affords ample scope for the selection of any variation needed in order to modify the species so as to bring it into harmony with new or changing conditions” (Wallace 1901, pp. 27–28). He concluded that “Natural selection has thus supplied that motive power of change and adaptation that was wanting in all earlier attempts at explanation” (Wallace 1901, p. 28). Finally, the biologist refers to the “fact and mode of evolution” and points out that “after 20 years of observation and research, Charles Darwin produced a work which at once satisfied many thinkers” (Wallace 1901, p. 29).

In his last books, Wallace (1910, 1913) repeated these statements in modified form. In the year of his death, he summarized the “creative power” of natural selection as follows: “... every form of organic life during all the vast extent of geological time has been subject to the law of natural selection, which has incessantly moulded their bodily form and structure ... in strict adaptation to the successive changes of the world around them” (Wallace 1913, p. 95).

Therefore, (1) Wallace rejected the Lamarck–Darwin-concept of an inheritance of acquired characteristics and, instead, adopted Weismann’s concepts, (2) defined what species are, and (3) distinguished between stabilizing vs. directional selection. These facts document that he was, together with Weismann, the co-founder of the Neo-Darwinian theory of biological evolution (Reif et al. 2000; Kutschera and Niklas 2004).

## The spiritualistic naturalist

It is well known that Wallace (1870) disagreed with Darwin (1859, 1871) with respect to the evolutionary development of human intelligence (Fichman 2001; Pinker 2010). In his last popular books, *Man's Place in the Universe*, *The World of Life* and *Social Environment and Moral Progress*, Wallace (1903, 1910, 1913) systematically mixed up (non-religious) spiritualistic ideas with scientific facts and finally became a teleologist. He concluded that “the exact conditions on our earth ... should allow ... the origin and evolution of the organic world culminating in man” (Wallace 1913, p. 119). The ‘spiritualistic naturalist’ did not accept Darwin’s conclusion that natural selection can explain the evolutionary development of our species without reference to supernatural causes. Accordingly, in his last book, Wallace (1913) argued that “with the advent of man there had come into existence a being in whom that subtle force we term mind became of far more importance than mere bodily structure ... this wonderful faculty taught him to govern and direct nature to his own benefit ...” (Wallace 1913, p. 98). In addition, the author argued that “... the higher intellectual and moral nature of man has been approximately stationary during the whole period of human history, and that the cause of the phenomenon has been the absence of any selective agency adequate to increase it, renders it necessary to give some further explanation as to the probable or possible origin of his higher nature ...” (Wallace 1913, pp. 101–102). This ‘alternative explanation’ was an unscientific mixture of spiritualistic ideas and natural phenomena (Wallace 1889, 1903, 1910, 1913).

These philosophical speculations were not accepted by his fellows so that the “spiritualistic naturalism” of Wallace is still regarded today as a set of ideas that are outside the world of science (Fichman 2001; Raby 2001; Slotten 2004).

## Conclusions

Alfred Russel Wallace (Fig. 1; Table 1) was one of the most distinguished naturalists and evolutionary biologists of the nineteenth century (Poulton 1913). A proficient writer of 22 books on a variety of topics (Table 2), and single author of more than 700 articles (Smith and Becaloni 2008), he was not only a specialist in several branches of biology (Figs. 3, 4), but also one of the greatest “generalists” of the life sciences. One year after his death, this conclusion was summarized in the following words: “In the present days of specialization it seems impossible for men of this type to develop and it is doubtful if the world will ever again see men of such broad learning as

those who contributed to the fame of what Wallace himself has termed *The Wonderful Century*” (Anonymous 1914, p. 138). However, in most obituaries and later writings on the scientific achievements of Wallace, the fact that he was an adherent of spiritualism was not mentioned.

In numerous of his later publications, Wallace (1889, 1903, 1910, 1913) mixed up his spiritualistic philosophy with scientific data and considered the evolutionary development of the intelligence of our species (*Homo sapiens*) as a “spiritualistic phenomenon” (Pinker 2010). These speculations were not accepted by his colleagues and damaged the reputation of the gifted naturalist considerably (Raby 2001; Slotten 2004). Despite these non-scientific arguments in some of his later books, Wallace must be acknowledged as the co-founder of the Neo-Darwinian theory of biological evolution (‘Weismannism’, or ‘Wallaceism’). We conclude that this may be one of his most significant “philosophical” contributions to the natural sciences of the early twentieth century (Kutschera and Niklas 2004).

**Acknowledgments** This project was supported by the Alexander von Humboldt-Stiftung, Bonn, Germany (AvH-fellowship 2011/12 to U.K., Stanford, CA, USA).

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