Bulletin of the Royal Entomological Society Autumn 2013 Volume 37 (4)

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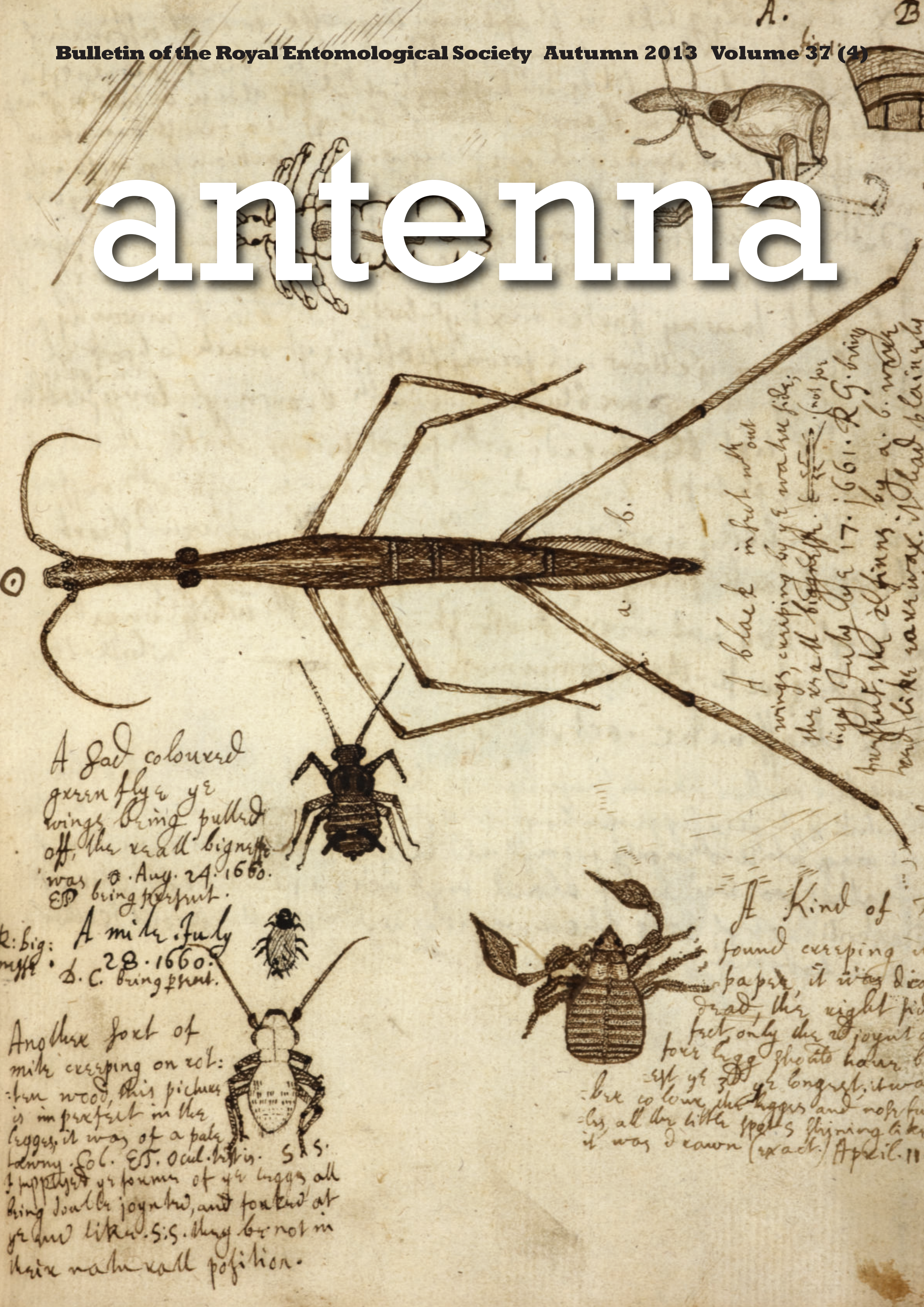

meetings of the society

for more information on meetings and contact details see meetings page on www.royensoc.co.uk

2013

Oct 10 **RES sponsored Wallace 100 lecture**
Venue: Natural History Museum
Dr Tom Fayle on *"Wallace's legacy to biogeography and conservation biology"*

Oct 16 **Climate Change Special Interest Group**
Venue: Rothamsted Research, Harpenden
Convenors: Richard Harrington, Howard Bell

Oct 23 **Joint Aquatic Insect / Insects and Sustainable Agriculture Special Interest Groups**
Venue: Newcastle University
Convenors: Jenni Stockan, Craig McAdam, John Holland

Oct 24-25 **Irish Regional Meeting**
Venue: Dublin Botanic Gardens, Glasnevin
Convenors: Eugenie Regan, Brian Nelson, Archie Murchie

Nov 6 **Orthoptera Special Interest Group**
Venue: Natural History Museum
Convenor: Bjorn Beckmann

Nov 14 **South-East Regional and East Malling Centenary Meeting**
Venue: East Malling Research, Kent
Convenors: John Badmin, Jerry Cross

Dec 5 **Northern Regional Meeting joint with Medical Veterinary Entomology Special Interest Group**
Venue: Northumbria University, Newcastle upon Tyne
Convenors: David George, Prof. Steve Torr

2014

Jun 23-29 **National Insect Week**

Aug 2-8 **European Congress of Entomology**
Venue: University of York, Heslington, York

2015

Sept 2-4 **Ento' 15 Annual Science Meeting and International Symposium**
Insect Ecosystem Services
Venue: Trinity College Dublin
Convenors: Drs Jane Stout, Olaf Schmidt, Archie Murchie, Eugenie Regan, Stephen Jess, Brian Nelson

Special Interest Group meetings occupy either a whole day or an afternoon (check www.royensoc.co.uk for details).

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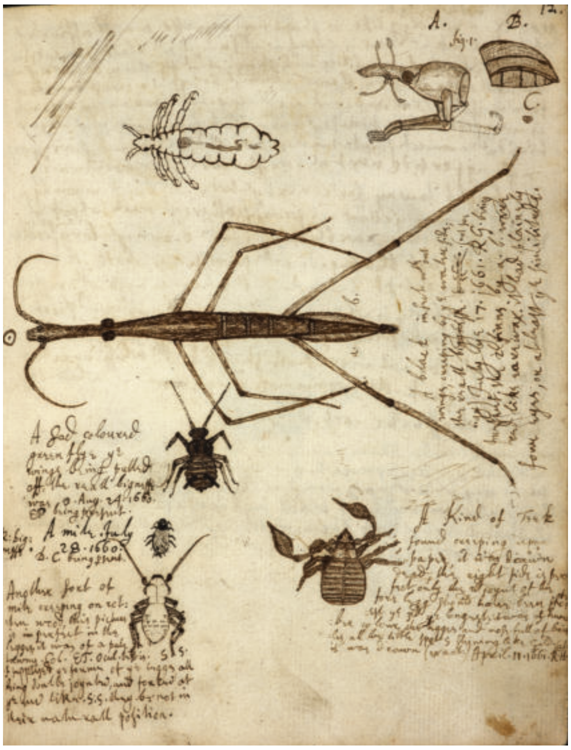

COVER PICTURE

Insect sketches made in the early 1660s, very likely by Robert Hooke.

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Bulletin of the Royal Entomological Society

The Royal Entomological Society
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Assistant Editors:
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Business Manager: Registrar

COPY DATES
For *Antenna* **38** (1) – 1st January 2014 (PS)
For *Antenna* **38** (2) – 1st April 2014 (DG)
Diary Copy date:
five days before *Antenna* copy date above.

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Subscription Rates 2013
The following are the subscription rates due on 1st March 2013: Fellows £54; Members £48; Students £25; Fellows and Members over 65 £32. The journals of the Society are available to individual Fellows and Members at preferential rates via the Subscriptions Department at The Mansion House. *Antenna* is supplied free of charge to Fellows and Members not in subscription arrears. **Cancellation of Journal subscriptions must be notified to Subscriptions Department before the 31st October in the year preceding cancellation.**

Printed by Cravitz Printing Company Limited
1 Tower Hill, Brentwood, Essex CM14 4TA
email: cravitzprinting@btconnect.com

EDITORIAL

As the recent RES questionnaire highlighted, *Antenna* is held in high regard by the Society's members and fellows, being one of the most valued benefits gained through joining the Society. It should come as little surprise, therefore, that I jumped at the opportunity when invited to join the editorial team of this much admired quarterly.

Having first joined the Society as a PhD student in 2003 I have always known *Antenna* in its current A4 format, produced with full colour images to support the interesting and varied articles submitted on all aspects of entomology. My predecessor, Dr Greg Masters, was pivotal in driving the transformation to the present-day publication that we all value so highly, for which we all owe a debt of thanks.

With several changes being made to the editorial team of *Antenna* in the last six months, this year represents an ideal opportunity to look to the future. Though we have a few ideas on the table already, we'd warmly welcome any suggestions that you may have. These can be sent to us directly at 'antenna@royensoc.co.uk'.

Perhaps fittingly, several of the articles in this issue look back at the achievements of others, whilst we look forward to the future. On the centenary of Wallace's death, Prof Stuart Reynolds provides some very interesting insights into Wallace's contribution to science, as well as the man himself. Drs Tom Fayle and Andrew Polaszek also focus upon Wallace in their article, reviewing the often overlooked contributions he made to the fields of conservation biology and biogeography. The contribution of Robert Hooke to the field of entomology is the subject of Dr Mark Jervis's article on Hooke's 'Micrographia'. With the European Congress of Entomology being held in York next year, Prof Helmut van Emden provides a timely (first hand) account of the history of this meeting, dating back to the first ECE in 1978 (held several months before I was born!). Dr John Simaika provides an extended report of a more targeted entomological gathering in Bavaria, with these two articles demonstrating the importance of entomological gatherings at all scales. Lastly, John Firth takes us on a trip to Central Italy to share some stunning photography and interesting observations on the local Lepidoptera.

This issue also features reports on the Westwood Medal and several recent meetings and events, including National Insect Week 2012. Dr Luke Tilley (Director of Outreach for the RES) concludes that 2012 was the most successful NIW yet, with this being the first year that social networking had been used to promote the event. These are undoubtedly exciting times for public communication of science, including for the RES, and we look forward to a similarly successful NIW in 2014.

Finally, I'd like to convey our Season's Greetings from all at *Antenna*, as well our best wishes to you all for the New Year.

Dave George

Guidelines for submitting photographs

To maintain a high quality we suggest that submissions for *Antenna* be presented via e-mail or on CD. Files must be in a PC-compatible format preferably in MS Word.

Electronic images can be embedded in the Word document but we will also require separate electronic images. These images should be at least 300dpi at an image size that is either equal to, or greater than the expected final published size.

Please do not submit images that have been printed from a computer on a domestic inkjet or laser printer. Even if the camera is a good one and photo quality paper is used, the graininess is very hard to deal with. If plain paper is used, the prints are virtually unusable.

Photos taken on film should ideally be submitted as slides or as reasonable sized prints for us to scan or alternatively they can be scanned in by authors provided the scanner is capable of scanning at up to 1200dpi.

If an image is intended for the front cover then the photograph should be in portrait format (i.e. the shape of the final image) and will need to be quite a large file size (at least 5,000kb) or a good quality slide or print.

To give an idea as to what happens when the image is not of sufficient size, take a look at these two photographs. One is 300dpi and the other is 72dpi.

300dpi

72dpi

CORRESPONDENCE

'True Weevils (Part III)': errors, corrections and amplifications

My attention has been drawn to a number of errors, particularly in the 'Curculionoidea: Key to groups' in the recent publication on 'true' weevils (Morris, 2012). Some of the problems relate to the changes in higher classification that have been made during the rather prolonged period of production of the weevil handbooks (1990-2012).

It was perhaps misguided to attempt a key to the weevils, even of the relatively small fauna of the British Isles, without drawing attention to the many exceptions, or anomalous species, in groups which otherwise illustrate clear characters.

The key to what were then known as Curculionidae-Phanerognatha (Morris, 2002) contains fewer flaws than the key under discussion, though Hyperinae were inadvertently omitted (Morris, 2003).

The following is an attempt to rectify, or at least explain, some of the errors. It is unlikely, however, that a completely foolproof scheme can be constructed to cope with every group and species, without considerable detail and discussion.

In the 'Key to groups' at couplet 4' and 4" (p. 2) two 'anomalous' species should have been included with the Entiminae at 4': *Stenopelmus rufinasus* (Erirhinidae) and *Rhinocyllus conicus* (Lixinae-Rhinocyllini) have uncharacteristically short rostra; they are keyed at couplet 16. They were correctly keyed in Morris (2002).

At couplet 26' and 26" (p. 6) the difference between 'mucro' and 'uncus' is not satisfactory as a distinguishing feature. It is not clear how the remaining part of the key to groups is best tackled. One approach would be to split off individual characteristic species, but this would perhaps be tedious for workers who would wish for a quicker route to identification. To some extent this approach is already apparent, with *Acalyptus carpini*, *Ellescus bipunctatus*, *Brachonyx pineti* and some other species split off separately from their appropriate subfamilies. It may be that despite the flaws in the key, it can be used with caution (and indulgence), in conjunction with the colour habitus figures (plates 12-43), to effect identification.

It has been suggested that couplet 31' (p. 7) is misleading as not all the exceptions to the characteristics of Ceutorhynchinae have been included. Qualifiers such as 'most', 'some' and 'general' do perhaps indicate the uncertainty in providing a comprehensive account of the species in this large subfamily. Morris (2008) should assist in indicating the range of variation within the group, particularly by reference to the colour illustrations. A serious error (in Morris 2012) is that Ceutorhynchinae are included in a section stated to have toothed tarsal claws (couplet 29'). The exceptions are *Amalorhynchus melanarius*, *Ceutorhynchus contractus*, *C. erysimi*, *Hadroplontus litura*, *H. trimaculatus*, *Phytobius leucogaster* and all *Pelenomus* except *P. quadricorniger*.

On page 47 the figure illustrating the untoothed femora of *Brachonyx pineti* is number 71, not 82.

In pages 65-66 it is perhaps confusing that the figures quoted, though correct, include those shown on pages 1-2, i.e. in the 'key to groups', rather than with the text. Thus geniculate antennae are illustrated by Figs 147 and 148 as well as Fig. 3 (and Fig. 4). Figure 149 illustrates the usual, more or less porrect, rostrum as well as Fig. 6, but the 'hidden' rostrum characteristic of *Rhamphus* is illustrated only by Fig. 5.

On page 82, couplet 2', Fig. 186 should read Fig. 184 and couplet 2" Fig. 187 should read Fig. 185 (this error is not too serious as the figures quoted (erroneously) illustrate the stated characters as well as the correct figures).

Although not an error, it is worth pointing out a difference of treatment of figures between earlier handbooks (Morris, 1990, 1997) and later ones (Morris, 2002, 2008, 2012). In the earlier accounts each figure was attributed to a named species; in the latter ones this was not done. In some cases the actual species illustrated could be identified, but in others it could not, the illustrations being 'general'. The author's opinion is that this change (an editorial one) was retrograde.

Acknowledgements

I am grateful to the following for pointing out errors or other assistance: Bill Blakemore, Pete Cranston, Andrew Duff, Clive Washington and an anonymous reviewer of Morris (2012).

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Renaissance of the website "Ants of (sub-Saharan) Africa", at http://antsofafrica.org

The ants of Africa are an under-appreciated resource for anyone wishing to know more of how invertebrate populations are structured and determined. This profusely illustrated "electronic encyclopaedia" brings together a very wide range of information from the research efforts of many individuals and teams. A special effort has been made to include material from non-English sources, with over 500 taxonomic papers reviewed. From its initiation in 1998, the web format has allowed the site to be updated as fresh information becomes available.

Text Chapters cover Geography & History; Ant Mosaics; Economic Importance of Ants; Biodiversity and Niches; and, Taxonomy, with a glossary of terms in English, Italian, German and French.

The site has an almost complete Catalogue of all named species. As at September 2013, the total comes to almost 2,100. Each species has its own webpage and for all there are text entries giving subspecies, junior synonyms and other names, with authorities. Also given are type locations, other geographical information and notes on bionomics. There are reports of 238 unnamed "forms" (from 90 genera and 13 subfamilies). In addition there is information, including photographs, on almost 100 species from non-African countries.

Clickable illustrated Keys, many newly developed, are given to aid identification from subfamily level and for all the genera with more than two species. As far as possible, the emphasis is on characters that are readily visible using a stereomicroscope at no more than x 40 magnification.

For all but two species, one known only from the male, the original or translated descriptions are given either in the main text or on linked "TAXONOMY" cards; of which there are around 5,000, covering the subspecies and synonyms as well as the type species. In constructing the keys, many of the original descriptions have had to be translated from non-English sources, most commonly French but also German and Italian, with a few from Latin. There are drawings or photographs of all but about 150 of the species. Of the photographs, almost 800 are original to this site with 171 of the drawings being my own as site author. For six species known images were initially inaccessible but, of those, four now have photographs. For each species the known distribution from published records is summarised on a "DISTRIBUTION" card. For all species where fresh specimens have been received and identified, a table giving the collection details is included and, in many cases, linked "ALBUMS" of photographs are also provided.

Over 4,000 illustrations are incorporated. A conspectus, or summary catalogue in spreadsheet format (Excel 2003), lists all the species, type locations, first publication dates and authors. Availability of descriptions, drawings and photographs also are given. Each entry is linked to the appropriate page in the main catalogue. A separate worksheet covers the forms listed in the literature but not identifiable. A second catalogue gives the known distribution for all 42 countries, with over 8,600 records.

The whole text is extensively linked, with indexing of over 3,700 specific names (subspecies, junior synonyms, varieties, etc.), and comprehensive references to both modern and historic literature. Every species is linked to the appropriate page in the Hymenoptera Name Server at Ohio State University, in conjunction with www.Antbase.org.

In August 2013, after much effort and hope for an alternative institutional host, I decided to personally meet the costs of hosting, initially on a two-year contract. In due course, the British Library Web Archive will update their holding.

Note on use of the website. The electronic format has the advantage of permitting cross-access through "clickable links", thus, the user can move from the "Contents" page to individual sections, from sections to illustrations and so-on. When using the "Keys to Species" the "clickable links" enable rapid movement from couplet to couplet or on to the individual taxon and, from either, a button gives easy return to the source couplet. The "Taxonomic Name Indices", which can be accessed from the "Contents" page and from all sections of the narrative Chapters, represent my attempt to alphabetically list all the published names which relate to the presently definitive species. Each name has a "clickable links" to the definitive species - and thus provides quick access from published names - be they subspecies, junior synonyms, outdated names, or otherwise. The supreme example of a multiplicity of names under a single species can be found with *Camponotus maculatus* which, bearing in mind the poor state of all Camponotine taxonomy, has some 10 subspecies,

Figure 1. Screen capture of the website cover page.

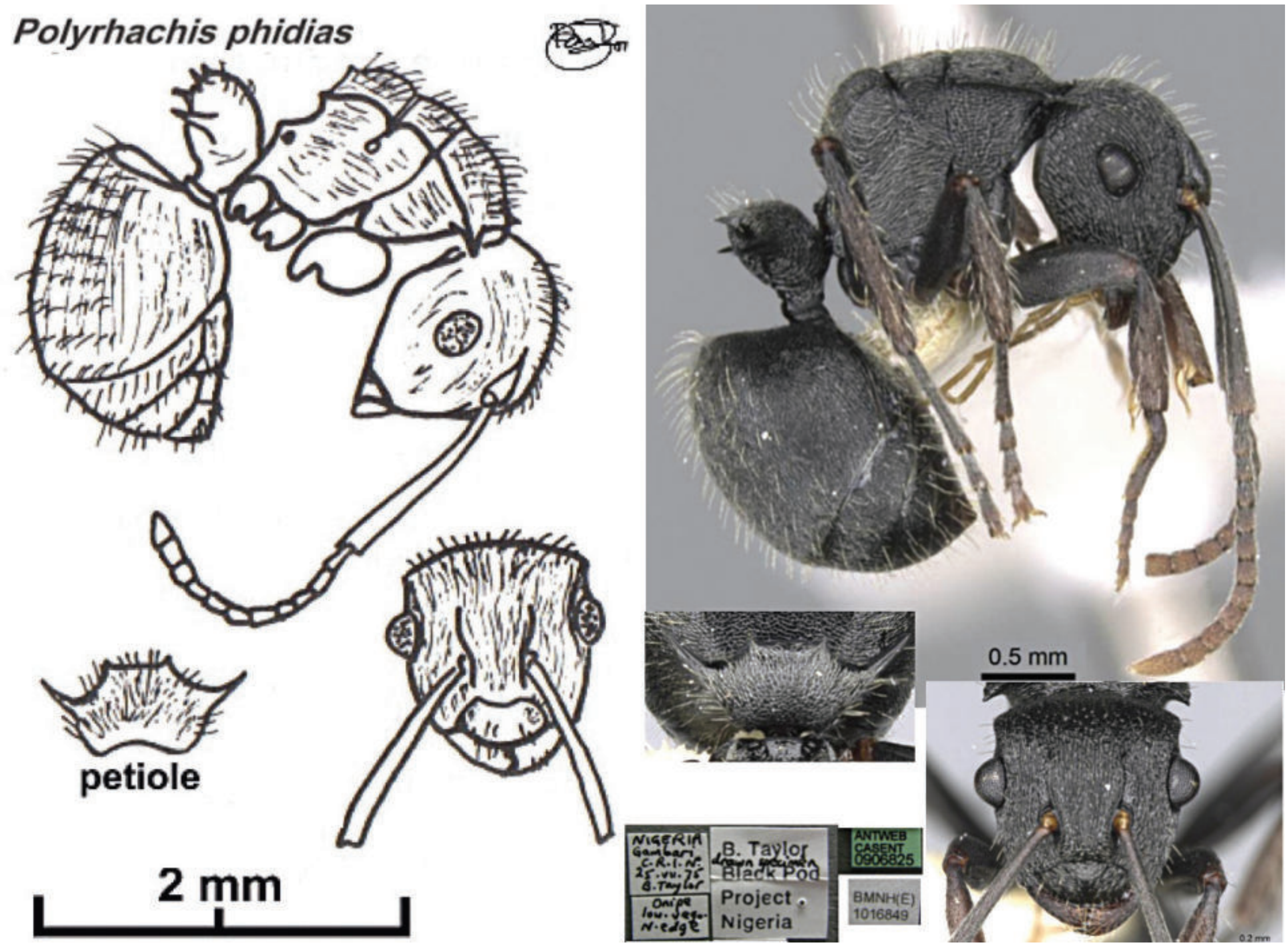

Figure 2. Compilation of images of *Polyrhachis phidias*, that on the left being my drawing as published in 1978 (slightly edited) and on the right photographs of the same specimen released on 18.ix.2013, by Antweb, photographer Michele Esposito. http://www.antweb.org/specimenImages.do?name=casent0906825

31 junior synonyms and 11 other "unavailable names". In that catchall status, it has been found throughout Africa, right across Asia and into Australasia.

Some may feel the quality of my "photomontages" is low compared to the general Automontage standard of today (see www.antweb.org). Regrettably, I do not have outside financial support nor even ready access the very expensive equipment needed to achieve that standard. My photographs are taken using a 10 MP basic digital camera, which has a lens almost the same width as a microscope eyepiece. By simply holding the camera on the eyepiece I take about 20 different shots of an ant mounted on a card point. I then collate those images into what I call a "photomontage", adding a scale and label. Importantly, these photomontages do show diagnostic characters sufficiently well, a point on which the Antweb images quite frequently fail, and I have managed to separate over 1,000 species using these photographs.

Contributors. Many people have contributed specimens and information to this website, with many more, including the RES, providing fundamental support and access to facilities. Without them it would not exist in its current form. I cannot express my thanks adequately for their support, interest and encouragement. A full list of contributors is available on request, either to myself or the Editors of *Antenna*. Comprehensive notes on other support and deposit of specimens can be found in the "Preface" section of the website.

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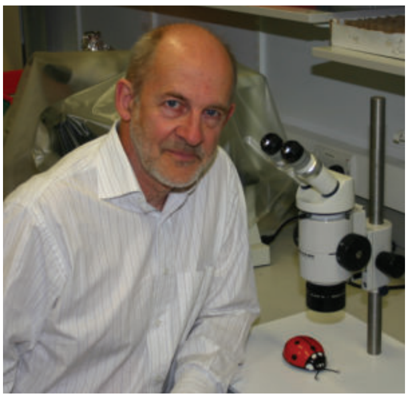
Alfred Russel Wallace: circa 1895. (First published in Borderland Magazine, *April 1896.)*

Alfred Russel Wallace:

Ardent beetle-hunter and co-discoverer of natural selection

Stuart Reynolds
Department of Biology and Biochemistry, University of Bath



Alfred R. Wallace died just 100 years ago (7th November, 1913), and together with Charles Darwin is by far the Royal Entomological Society's most famous alumnus. Wallace and Darwin were co-discoverers of natural selection and its role in evolution, and can justifiably be called the originators of the principle that today orders essentially all thinking about biological science. We now know that natural selection isn't just about the structure and behaviour of organisms, but touches the most intimate details of how cells work and the nature of the molecules of which they are made. It would be easy to say here that Wallace and Darwin, knowing nothing of modern molecular genetics, would have been astonished by the reach of natural selection. But actually, I think that they would not! Wallace and Darwin were both remarkably far-seeing theorists who did much more than simply discover the principle of natural selection; they were also the first to realize that absolutely every characteristic of an organism is subject to its sway.

Although Wallace was widely interested in natural history, he was primarily an entomologist. Although in his writings about evolution he drew examples from many animal groups, those about insects were always the most fully developed. Wallace was particularly interested in Lepidoptera and Coleoptera, and during his years as a professional natural history collector he sent home literally tens of thousands of entomological specimens.

Wallace's association with what was then the Entomological Society of London (the Royal epithet wasn't added until after Wallace's death) was a strong one, and the Society is proud of the connection. Between 1854 and 1871 Wallace published 15 substantial papers in the Society's *Transactions*. Wallace was the Society's President in 1870-71, and today his writing slope (portable writing desk) is used by the President at Council meetings, although it is currently on loan to the Hertford Museum for a centenary Wallace exhibition http://www.hertfordmuseum.org/wallace-exhibition.asp.

Wallace's reputation slid in the years after his death, and it is only recently that interest in his achievements and legacy has regrown. If you're interested to read more about him, then the splendid Wallace website http://wallacefund.info/ is the first place to look. Here I will largely summarise widely held present-day opinion, adding one or two novel points drawn from Wallace's papers in RES journals.

The story of Wallace's discovery of natural selection bears a brief retelling here. Like Darwin, Wallace had become convinced that species were not immutable, that the present diversity of species must be the consequence of past evolutionary change, and that taxonomic groupings were indeed what we now routinely call "related" by descent from a common ancestor. The morphological and anatomical evidence for this was already abundant (several authors including Darwin's own grandfather had pointed it out); the problem was that there seemed to be no convincing mechanism that could drive the divergence of species, so that few naturalists were prepared to abandon the prevailing paradigm in which species were presumed to have been separately created. The Victorian age was one in which religion played an important part in every aspect of life; the fact that many clergy held that the biblical account of separate creation was literally true, was of course a strong disincentive to question it.

Against this background, Darwin and Wallace separately strove to understand how new species could arise. Darwin, by 14 years the older man, seems to have happened upon the idea of natural selection in 1839. Wallace came upon it completely independently in 1858. Already one of the most eminent naturalists of his day, but naturally cautious, Darwin knew that he would have to work hard to persuade others of the reality of evolution. He feared that even speculating about the mutability of species would expose him to public attack. He worked alone for some years, only gradually revealing his evolutionary ideas to his most intimate friends. Importantly, it would turn out, he did write a fairly full sketch of his theory of natural selection in 1842, but decided not to publish until he had more evidence. Meanwhile Wallace, more confident in his pro-evolutionary beliefs, was thinking about the same problems. Like Darwin, Wallace drew on his own experience of tropical speciosity, the extent of variation within and between species, and of the extent to which environmental conditions limited the geographic extent of species. Where Darwin was impressed most with his experiences of the Galapagos and the West coast of South America, Wallace was thinking about Amazonia, and especially Indonesia and Malaysia.

Darwin had probably previously heard of Wallace, an intrepid explorer and natural history specimen collector, who published occasional journal articles about his travels and collections from 1849 onward, but only in 1855 did he realize that the younger man might be a serious contender in the race to explain the mechanism of evolution, when he read Wallace's (1855) paper on "the law" of species origin (which stated that new species arise from existing ones but did not mention natural selection). Only in 1856 did Darwin begin to write a full account of natural selection, arguably because he had now realised the risk of his idea being "scooped".

Sure enough, early in 1858, when Darwin's new manuscript on natural selection was only partially completed, and before anyone outside of Darwin's circle knew about it, Wallace hit upon exactly the same idea. Being temporarily confined to bed by a bout of fever, probably on the Indonesian island of Gilolo (now called Halmahera), Wallace mused on the obsession that he shared with Darwin. How could one species arise from another? Like Darwin, Wallace later stated that the idea of natural selection was directly stimulated by reading Malthus's essay "*On Population*" (originally published in 1798, but much altered in later editions; Wallace later specified influential passages from the 6th edition of 1826), which proposed that human populations have a natural tendency to increase geometrically, but are limited by "checks" due in part to the lack of resources. Both men put the idea of Malthusian checks on natural populations of animals and plants together with their own observations of species variation and spatio-temporal environmental variability to explain the transmutation of species. Where there was variation in the ability to exploit resources and evade checks, they argued, then selection of the fittest varieties would occur. Both men named the new principle "natural selection". The only substantial difference between them was that whereas Darwin gave considerable importance to evidence from artificial selection as practised by farmers, dog breeders, etc., Wallace did not (indeed he never considered that the analogy between natural and artificial selection was a good one) but instead emphasised the extent of variation in natural populations. Wallace later (1889) said, "*The foundation of the Darwinian theory is the variability of species, and it is quite useless to attempt even to understand that theory… unless we first obtain a clear conception of the nature and extent of this variability.*"

Having written a short account of his idea, Wallace sent it directly to Darwin with a request for comment. The letter was sent from Ternate, Indonesia on 9th March 1858 and (probably) arrived at Darwin's home on 18th June. Of course, Darwin was shocked to realise that he would now have to share the credit for discovering the principle of natural selection. He immediately wrote to his close friend Charles Lyell, "*I never saw a more striking coincidence; if Wallace had my MS sketch written out in 1842 he could not have made a better short abstract!*"

Because almost every atom of Darwin's correspondence has been preserved, we know the extent to which he agonized about how to respond to Wallace's letter. But his inner circle of friends was in no doubt; Lyell and Hooker immediately arranged to have Wallace's paper read at a regular meeting of the Linnean Society on 1st July 1858, alongside a paper modified from a long letter that Darwin had previously written in 1857 to the American biologist Asa Gray. The two papers (Darwin and Wallace, 1858) were published back-to-back in the Linnean Society's *Zoological Journal* in October 1858, with an introduction that asserted Darwin's priority. But Wallace had not asked Darwin to forward the paper for publication, and Darwin was uneasy about this. Darwin wrote to Wallace about what had been done, and was immensely relieved when Wallace endorsed his actions. Darwin immediately set to work writing a cut-down "abstract" of the much longer work on natural selection that he had originally planned. This became the classic "*Origin of Species*", published on 24th November 1859. By contrast, Wallace waited more than thirty years to produce his own "big" account of natural selection, which he called "Darwinism" (Wallace, 1889).

While some have questioned the ethical integrity of Darwin and his friends in publishing Wallace's letter in the way they did, the general opinion today is that their actions were fair according to the standards of the time, especially considering that Wallace's remote location made communication very slow. Certainly Wallace himself never questioned Darwin's good intentions, always giving his older colleague the credit of priority for the idea itself and also for the fullness of its development. Again and again, Wallace would receive public praise for his amiability and modesty. Wallace (1889) was unstinting in Darwin's praise: "*… we claim for Darwin that he is the Newton of natural history, and that, just so surely as that the discovery and demonstration by Newton of the law of gravitation established order in place of chaos and laid a sure foundation for all future study of the starry heavens, so surely has Darwin, by his discovery of the law of natural selection and his demonstration of the great principle of the preservation of useful varieties in the struggle for life, not only thrown a flood of light on the process of development of the whole organic world, but also established a firm foundation for all future study of nature.*"

It is remarkable that the two men should have lighted upon the same idea. What characteristics singled them out for this achievement? In some ways, the two had much in common. Wallace was, like Darwin, a highly accomplished naturalist with wide interests. Both had extensive tropical experience and an interest in biogeography. Both were remarkably able analysts and synthesizers of the findings of others, explaining complex arguments in ordinary language (anyone who doubts this of Wallace should read Chapter 1 of "Darwinism" [1889], which sets out the basic theory of natural selection with admirable brevity and clarity).

It is often now said that Wallace has received less than his proper share of credit for the discovery of natural selection. Is this true? Darwin himself went to considerable lengths (e.g. in his autobiography [F. Darwin, 1887]) to emphasise that Wallace had indeed worked out the theory of natural selection entirely independently. In the public eye also, Wallace was not at all a minor figure during his lifetime. He was a prolific author and for the last four decades of the nineteenth century was himself almost as well known a scientific public figure as Darwin, being universally acknowledged as co-originator of the theory of natural selection. Although he didn't become wealthy, that's hardly a novel position for a scientist, and his books (especially "*The Malay Archipelago*" [1869]) sold well. He was able to retire from his collecting work and make his way as an independent researcher and author. On the other hand, his ambitions to secure an institutional position were unsuccessful. Eventually, he received (from 1881) a public pension and recognition from the great and good. In 1908, the anniversary of the joint Darwin-Wallace paper, Wallace was awarded the Royal Society of London's Copley Medal (its oldest and most distinguished medal) and was also appointed to the Order of Merit (arguably the British Commonwealth's greatest Honour) by King Edward VII.

When, also in 1908, the Linnean Society instituted a medal for "major advances in evolutionary biology" it was called the Darwin–Wallace Medal, and Wallace became the first (and so far the only) recipient of a gold medal. The award recognised that Wallace had made important contributions to evolutionary theory in addition to his co-discovery of natural selection. Most notably, he wrote extensively (there are three chapters in "Darwinism") about the importance of animal colouration (crypsis, warning coloration, mimicry).

Wallace's evolutionary contributions were certainly not all simply elaborations of Darwin's insights. For example, the two disagreed strongly over sexual selection, which Wallace never accepted as an important driving force of evolution. In this Wallace was clearly wrong. On the other hand, Wallace was in fact more Darwinian than Darwin himself in his insistence that the inheritance of acquired characteristics can play no part in evolutionary change. In later editions of the "*Origin of species*", somewhat in despair over the absence of a decent explanation of the mechanism of inheritance, Darwin conceded that Lamarckian inheritance might also contribute to evolution alongside natural selection. Wallace regarded this as backsliding, and in this he was quite right.

In general, both Wallace and Darwin were considerably handicapped by their ignorance of the mechanism and rules of genetic inheritance, and to me it is impressive evidence of the clarity of their thinking that they nevertheless were able to identify between them most of the substantive issues of evolutionary genetics that are still central to the field. Wallace, for example, devoted much thought to the role of hybrid sterility in the origin of new species, recognising that adaption to a changed environment is not enough for speciation, since reproductive barriers are needed to prevent newly evolved forms from interbreeding with the original population. This kind of thinking is now the norm when writing about speciation. Wallace insisted, against Darwin's opinion, that because sterile but otherwise viable hybrid offspring would compete with purebred forms, natural selection in favour of hybrid incompatibility would contribute to the fitness of the evolving separate form. Darwin objected that it was very difficult for a character that involved reduced fitness to evolve; instead he proposed that new species normally evolved under conditions of geographic isolation, and that sterility was an incidental consequence of adaptive change affecting other characters. Wallace didn't give up, however, and devised a scenario (it is set out in detail in a long footnote in Ch VII of "Darwinism") whereby Darwin's objection could be overcome. Wallace was undoubtedly keen on this because he wanted to believe that a new species could evolve in the presence of the original (this is what we now call sympatric speciation). Today, even after more than a century, the questions of whether hybrid sterility can be naturally selected (a phenomenon usually referred to as reinforcement, but sometimes now called the Wallace Effect), and indeed whether sympatric speciation can occur at all, are still controversial (see Johnson, 2008).

Wallace didn't stop, however, with evolution. Given his own scientific background, it was inevitable that he would devote much time to biogeography, and this culminated in the monumental books "*Geographical distribution of animals*" (1876) and "*Island Life*" (1880). Wallace's immense contribution to this discipline is remembered by the appellation of the names Wallacea to the faunal transition zone between Australia and SE Asia, and of Wallace's Line to the boundary between the Asian and Wallacean zones. Wallace also contributed with brilliant synthesis and intelligent commentary to several scientific fields outside his own. Most notably, he wrote a number of important papers on glaciology, a topic not completely outside of his evolutionary line of thought, since it contributed to the nineteenth century debate about the age of the earth and the time that was available in which organic evolution had taken place.

It's true, however, that after Wallace's death in 1913 his reputation slipped considerably. Why? Some have commented that it was because Wallace's social status was inferior to that of Darwin. This seems to me irrelevant. Scientific reputation has never depended on social cachet. The anonymous middle classes produced many of the superstars of High Victorian science such as Humphry Davy, Michael Faraday, and William Thompson (Lord Kelvin). T.H. Huxley was one of the most successful Victorian biologists, famously acting as Darwin's "bulldog" in public debates on evolution, yet Huxley's modest-genteel and penurious background was very similar to that of Wallace. Others have commented on the fact that Wallace did not "get on well" with his peers, perhaps having some of the socially awkward characteristics of Autism Spectrum Disorders (Berry, 2008). It seems to me, however, a bit much to imply that an interest in collecting beetles should be associated with Asperger's Syndrome.

I think that we'd have to say that it was sometimes a problem for other scientists that Wallace was undoubtedly fond of controversy and did not hesitate to pull down the pillars of orthodox opinion. A friend, J.W. Sharpe, later wrote: *"His intellectual interests were very widely extended, and he once* *confessed to me that they were agreeably stimulated by novelty and opposition. An uphill fight in an unpopular cause, for preference a thoroughly unpopular one, or any argument in favour of a generally despised thesis, had charms for him that he could not resist"* (Marchant, 1916).

Two examples from the Society's *Transactions* illustrate Wallace's propensity to enrage his colleagues by going where angels fear to tread. In 1867, Wallace published a substantial paper (more than 100 pages) in which he considered the geographic distributions of pierid butterflies, especially in relation to the colonization of islands. This led him to propose a radical reorganization of the Family's taxonomy. This paper prompted an almost apoplectic response from the eminent lepidopterist W.C. Hewitson (1868), who clearly objected to Wallace's unorthodox approach (but then taxonomic debate has frequently been accompanied by invective!). Hewitson wrote: *"Out of 172 names (I speak only of* Pieris *as it was) there are fifty which I would place as synonyms. It seems incomprehensible to me that I, certainly not tainted with Darwinianism, should have to contest this point with a gentleman who, according to theory, ought not to recognize species at all."* It's clear from this remark that Hewitson's opinions on Wallace's revisionary proposals were strongly coloured by the fact that it was the damnable evolutionist Wallace who had proposed them. Of course, Wallace didn't have the last word on the genera of this Family, but he had established the point that evolutionary relationships were likely to coincide with biogeographic ones. Incidentally, the systematics of the Pieridae have remained controversial ever since. For those interested, a recent (molecular) attempt to impose some order on this Family is that of Braby and Pierce (2006).

My other entomological example of controversy again shows Wallace in the role of unwitting champion of what has been later realised to be an improved paradigm. In his RES Presidential address of 1871, Wallace endorsed the theory of Herbert Spencer (very much an amateur biologist) of the evolutionary origin of the Annulosa (a subkingdom then recognised as comprising the arthropods, annelids and other segmented invertebrates), which supposed that these organisms had arisen during evolution as fusions of multiple individuals, one to each segment, perhaps through a process such as budding. Wallace's interest in this theory was transient, and he unwisely implied that Spencer's theory had been unjustly ignored by comparative embryologists. Of course, this bull-in-a-china-shop entry into what was for him a new field infuriated those who already spent long, sleepless nights thinking about exactly those problems identified by Wallace. He was promptly challenged by a rejoinder in *Nature* by E Ray Lankester (1872) who accused him of not doing his homework properly, and said, "*As a matter of fact, insects are not a number of individualities fused into one, but rather one partially … broken up into many*". In fact, the modern view of embryology is that Wallace's ideas on this subject were not totally wrong, and that in most arthropods (but as it happens not in *Drosophila*!) segments are added during embryogenesis sequentially from a cellularized growth zone (see Peel *et al*, 2005).

It's hard to avoid the conclusion that Wallace was incautious in espousing contrary positions on matters of public interest. He was what we now call a "public intellectual" who espoused conspicuously unconventional political views. Wallace was throughout his adult life unapologetically interested in Owenite and later more frankly socialist politics, and was a prominent advocate of land nationalization. He was against eugenics and militarism. He objected to vaccination, ostensibly on the grounds that it was of unproven merit, but largely on the grounds that it was unfairly imposed on the poor. As evidence of the great benefits of vaccination became available, this looked like a scientific mistake. It is possible that Wallace's radical opinions held back public recognition of his scientific achievements. He himself in 1908 expressed surprise that someone with his political views should receive the grand plaudits that were offered to him on the 50th anniversary of the Darwin-Wallace papers. But he left unsaid that they had been a long time in coming, and perhaps this reflected a general opinion that he was politically unreliable. Wallace was not elected a Fellow of the Royal Society, for example, until 1893.

Perhaps most importantly, Wallace's public support of spiritualism led to doubts about his legacy as a scientist (Moore, 2008). It is impossible to deny that Wallace has been retrospectively judged harshly for his too obviously credulous interest in communication beyond the grave; even though he was not alone among Victorian scientists in holding such beliefs, he was prominent in proclaiming them so loudly while failing to deploy a proper degree of scepticism. In particular, Wallace was badly damaged by a court case in 1876 in which he appeared as witness for the defence in the London trial of Henry Slade, an American spiritualist medium who was duly convicted of fraud. By this time many mainstream scientists had come to see Wallace as a scientific liability.

But on the occasion of this anniversary, we should concentrate on Wallace's undoubted stature as one of the most important of all biologists. Not many could claim to have discovered a biological organising principle of such importance. And he did it mostly by studying insects. Years after the event of the famous 1858 correspondence between them, Wallace (1905) reflected on the factors that had prepared him and Darwin to be co-discoverers of natural selection. He commented: *"First (and most important, as I believe), in early life both Darwin and myself became ardent beetle-hunters. Now there is certainly no group of organisms that so impresses the collector by the almost infinite number of its specific forms, the endless modifications of structure, shape, colour, and surface-markings that distinguish them from each other, and their innumerable adaptations to diverse environments... Again, both Darwin and myself had, what he terms "the mere passion of collecting," - not that of studying the minutiæ of structure, either internal or external. I should describe it rather as an intense interest in the mere* variety *of living things - the variety that catches the eye of the observer even among those which are very much alike, but which are soon found to differ in several distinct characters..."*

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Wallace's legacy: from biogeography to conservation biology

Figure 1. Alfred Russel Wallace as a young man in Singapore in 1862, at the start of his expedition around the Malay Archipelago.

ARTICLE

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Alfred Russel Wallace (Figure 1) is best known as the co-discoverer of evolution by natural selection. While suffering from a malarial fever somewhere near the remote island of Ternate, he realised that if heritable variation between individuals in a species existed, and furthermore that if this variation had some impact on survival, then species should gradually evolve to become adapted to their environments. These ideas, hastily assembled into a paper that he sent to Charles Darwin, whom he knew had some interest in evolution, were subsequently published with Darwin as a co-author in the Journal of the Proceedings of the Linnean Society of London (Darwin and Wallace 1858), and the world of biological sciences was changed forever.

However, Wallace wrote on an extraordinarily wide range of subjects, and it is unfortunate that these contributions have been somewhat overshadowed by his co-discovery of natural selection. He was instrumental in founding the field of biogeography, the study of the factors driving the geographical distributions of plants and animals, and his ideas relating to conservation biology were surprisingly wide-ranging. He also wrote extensively on such diverse topics as politics, spiritualism, astrobiology and anthro-pology. Here we will focus on his contributions to the two linked fields of conservation biology and biogeography.

Even in his famous paper on natural selection, there is a hint that he is aware that man's impact on the natural world is not a positive one: "*Even the least prolific of animals would increase rapidly if left unchecked, whereas it is evident that the animal population of the globe must be stationary, or perhaps, through the influence of man, decreasing.*" (Darwin and Wallace 1858). Indeed, he documented the negative impacts of the "*fast diminishing forests*" on St Helena (Wallace 1880). He also worried that although the King Bird-of-paradise (*Cicinnurus regius*) was a stunningly beautiful creature, which Europeans would flock to the Aru Islands (part of present-day Indonesia) to see, that this would result in the destruction of this species' habitat, and its eventual loss: "*… should civilized man ever reach these distant lands … we may be sure that he will so disturb the nicely-balanced relations of organic and inorganic nature as to cause the disappearance, and finally the extinction, of these very beings whose wonderful structure and beauty he alone is fitted to appreciate and enjoy*." (Wallace 1869). Presumably, however, Wallace would be pleased to have known that this species would go on to survive for at least another 150 years, with it currently being listed by the IUCN as a species of "least concern" (BirdLife International 2012).

Perhaps as a result of his concerns over habitat loss, Wallace was an early advocate of environmental vegetarianism. In a letter he states, "*I believe in it* [vegetarianism] *as certain to be adopted in the future … far less land is needed to supply vegetable than to supply animal food.*" (Wallace 1900). Subsequent assessments quantifying the impacts of dietary choices on the environment have proved him to have been correct, although interestingly it seems that to be most efficient one should consume a small amount of meat or dairy products, since marginal areas of land are often only suitable for grazing (Peters et al. 2007).

Wallace also noticed that disturbance by humans often led to increased vulnerability of habitats to invasion by species from elsewhere, and that this could make it difficult for native species to recolonize these areas. Specifically, he observed that clearance of forests in North America had led to the spread of imported weeds (Wallace 1891), and that the introduction of goats onto St Helena had been catastrophic, with the destruction of many native tree species and "*…with them all the insects, mollusca, and perhaps birds directly or indirectly dependent on them.*" (Wallace 1876). This shows an advanced degree of understanding of the way that the interconnected nature of ecosystems can affect their resilience to perturbation.

We think of human-induced climate change as something of which we, as a species, have only recently become aware, but Wallace was worrying about this in the 19th century. He noticed an article in a gardening periodical in which some subscribers had collated records indicating that certain types of fruits and vegetables could no longer be grown, and ascribed this to human

Figure 2. A map of South East Asia from Wallace's book *On the Physical Geography of the Malay Archipelago* (Wallace 1863) showing what would become known as the Wallace line, separating faunas with oriental affinities from those with Australian affinities.

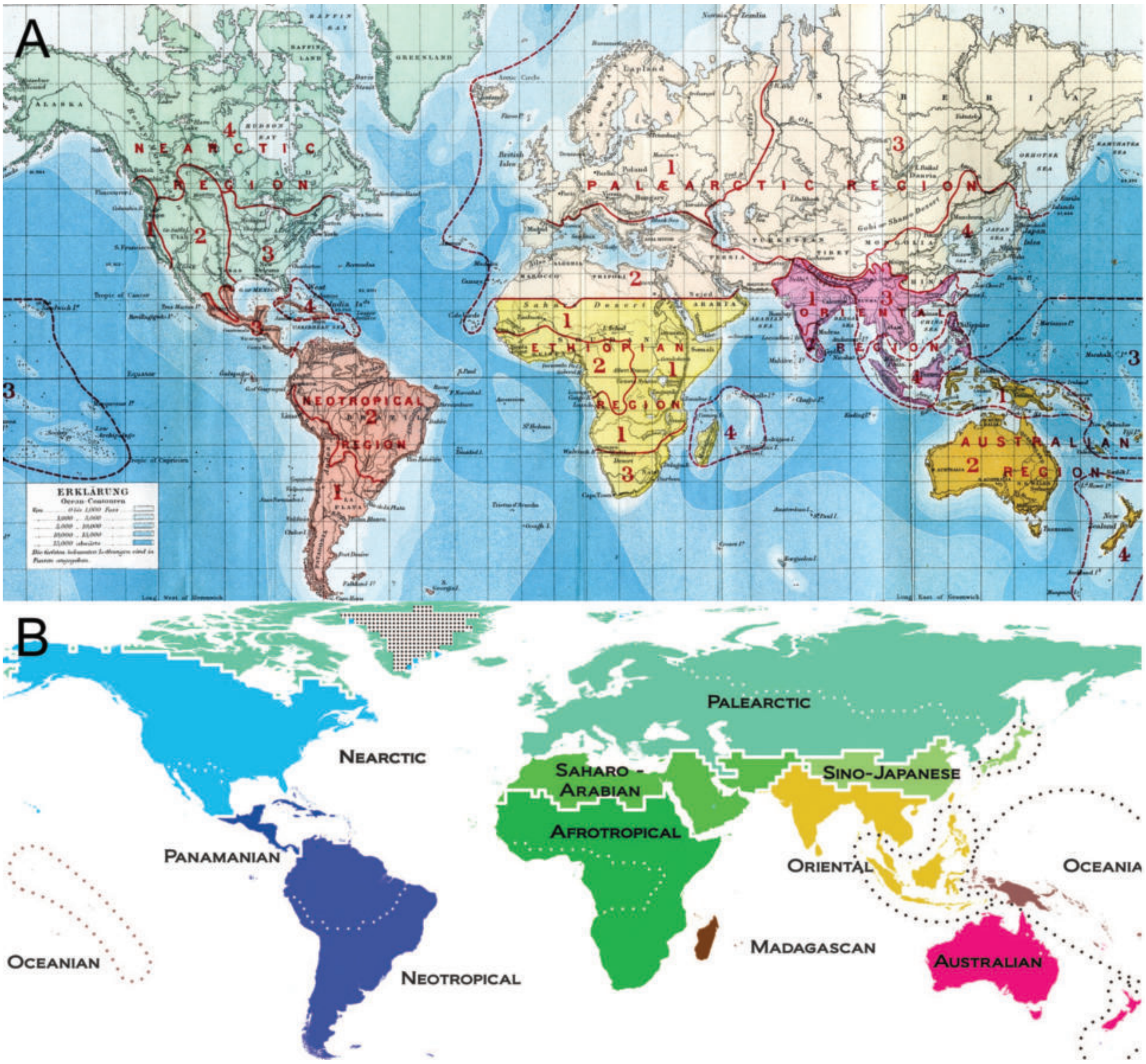

Figure 3. A) Wallace's map of biogeographic regions, based on records of vertebrates available to him in 1876, and his own observation (Wallace 1876). B) Biogeographic regions based on genetic data from Holt et al. (2013) An Update of Wallace's Zoogeographic Regions of the World. Science 339:74-78. Figure reprinted with permission from AAAS. The analytical method that generated this map did not use any prior information of the boundaries of Wallace's biogeographic regions. Note the differing projections of the two maps.

indicating a comparatively recent change of climate … increase in cloud and consequent diminution of sunshine … owing to the enormously increased amount of dust thrown into the atmosphere as our country has become more densely populated, and especially owing to the vast increase in our smoke producing manufactories." (Wallace 1898). More recent work has found that these worries were well-founded, and "global dimming", as it is now called, was a real phenomenon over the latter half of the 20th century, with particulate pollution both blocking sunlight directly and increasing the density of nuclei for condensation of water, and therefore increasing cloud cover (Mishchenko et al. 2007). However, the magnitude of global dimming is now much decreased, following the introduction of laws on emissions.

Although his awareness of conservation issues was impressively broad for the period, the main focus of much of Wallace's work was the study of the distributions of animals and plants. The initial indications that he was aware of the importance of geography in driving the distributions of species came on his first trip to the tropics, to the Amazon. Here he noticed that some species of monkey were present on one side of the larger rivers, but not on the other: "*…the Amazon, the Rio Negro and the Madeira formed the limit beyond which certain species never passed. The native hunters are perfectly acquainted with this fact, and always cross over the river when they want to procure particular animals, which are found even on the river's bank on one side, but never by any chance on the other.*" (Wallace 1852). These observations inspired a quantitative study 140 years later, which showed that this was indeed the case, and furthermore that the wider, and faster-flowing the river, the more different the sets of species of monkeys from opposite banks (Ayres and Clutton-Brock 1992).

While Wallace's Amazon expedition was ill-fated, with the loss of the majority of his specimens due to the sinking of his ship, he would go on to develop extensively the biogeographical ideas initiated during that period, in particular during his second tropical expedition, to SE Asia (Figure 1). In Sarawak, then the domain of the Rajah Brooke, now a state in Malaysian North Borneo, he formulated what would become known as his Sarawak Law. He stated, *"Every species has come into existence coincident both in time and space with a pre-existing closely allied species."* (Wallace 1855). This deduction, which preceded his revelation regarding natural selection, came about as a result of his extensive observations of the distributions of species, and his painstaking work studying the minute differences between them. Here was a first indication that the evolutionary history of species (and groups of species) could have some bearing on their present day distributions.

As he travelled further around the Malay Archipelago, mainly through what is now Indonesia, Wallace noticed that there was a sharp demarcation in the flora and fauna present on either side of a line running between the islands of Bali and Lombok, north between Borneo and Sulawesi, and then to the south of the Philippines. The areas on either side of this line did not differ consistently in terms of volcanic activity, climate, or any other factor that might directly influence the distributions of species. However, many of the islands on the west side of the line sat on a shallow shelf in the ocean connected to the Asian mainland, while many of those to the east were connected by a similar shelf to the islands of Australia and New Guinea. Combining his ideas regarding the influence of geographical barriers, and the potential for species' evolutionary histories to affect their present-day distributions, Wallace concluded that changes in the level of the land relative to that of the sea had given rise to these two nearby, but very different, floras and faunas (Wallace 1863). The boundary between these two regions subsequently became known as the Wallace Line (Figure 2).

When Wallace returned from his travels he continued to collate information on the global distributions of animals and plants, and eventually constructed a map, based on the distribution of vertebrates, delineating regions within which the sets of species present were similar, and between which they were not (Wallace 1876). These biogeographic regions, as they became known, have been in use ever since. Over the last twenty years an enormous amount of information on the evolutionary histories of species has become available through the assessment of genetic similarities between them. A recent study in the journal Science used these data to reassess the validity of Wallace's regions, and found a remarkable agreement between the two maps (Holt et al. 2013; Figure 3). It is quite extraordinary that Wallace, having access to relatively limited records of animal distributions, and using morphological information to determine species' evolutionary relationships, constructed a map so similar to that generated from molecular data today.

The man known to many solely for hurrying a procrastinating Darwin into the publication of the theory of evolution by natural selection was in fact a polymath, with interests in many areas. His ideas relating to the conservation of animals and plants were many decades ahead of their time, and his theories on the factors driving the distributions of these groups founded the discipline of biogeography.

Acknowledgements

This article summarises a presentation made by TMF as part of the Wallace100 lecture series at the Natural History Museum, London, which drew inspiration from an Alfred Russel Wallace anthology by Andrew Berry (Berry 2003). TMF would like to thank the Royal Entomological Society for funding his participation, Kalsum M. Yusah and Maureen Fayle for comments on the article, and the project "Biodiversity of Forest Ecosystems" CZ.1.07/2.3.00/20.0064 co-financed by the European Social Fund and the state budget of the Czech Republic, and Yayasan Sime Darby for additional support.

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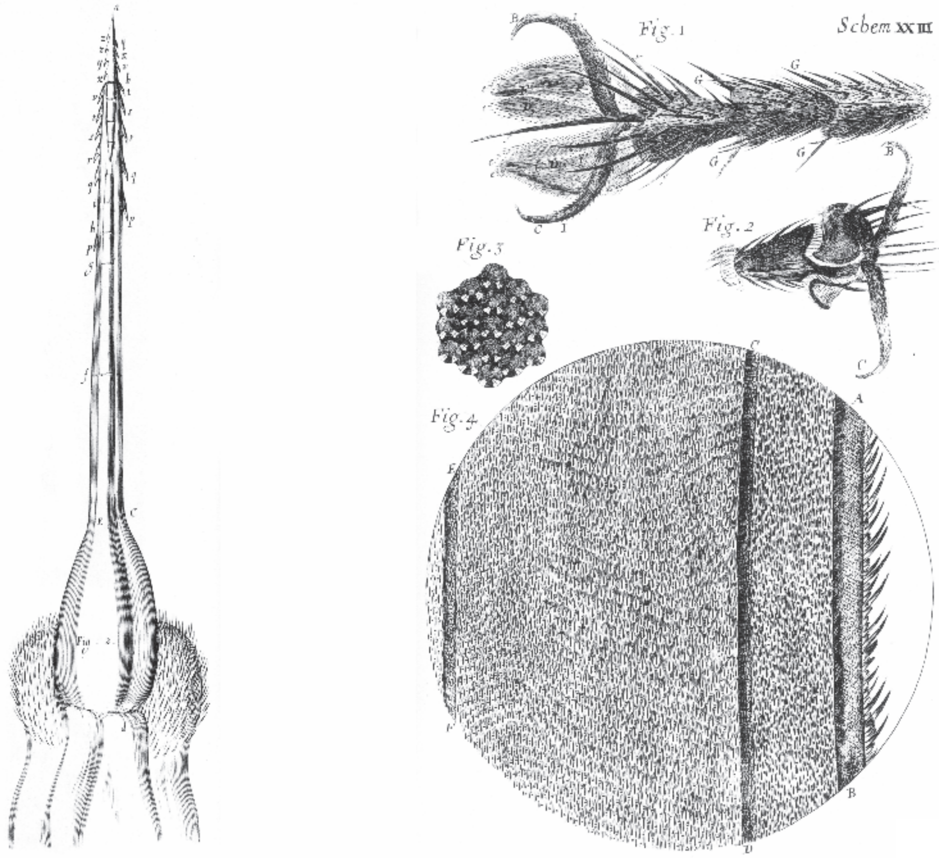

Figure 1. *Left*: the sting of a honeybee, *Apis mellifera* L.. *Right, top*: the feet of a muscoid fly; *Right, centre*: a group of compound eye facets of a horse-fly (very likely *Tabanus autumnalis* L.); *Right, bottom*: part of the forewing of an unidentified fly. Despite its obvious flaws, Hooke's drawing of the sting was a considerable improvement on Stelluti's earlier efforts.

Robert Hooke's *Micrographia* – an entomological cornucopia

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Robert Hooke's *magnum opus*, the book *Micrographia* (1665) – described by Michael Hunter as *"a dazzling display of intellectual virtuosity"* (Hunter 2009) - was indisputably an important milestone in the history of science. Allan Chapman (2005) considers it to be second only to Isaac Newton's *Principia* as a formative book of the modern era; it is regarded as a seminal work of astronomy, of physics, of palaeontology, as well as of microscopy. It was in the *Micrographia* description of the 'Schematism or Texture of Cork' that Hooke famously used the term 'cells' (possibly appropriated from apiology: Hooke drew an analogy between the numerous cell wall-enclosed spaces he saw in a thin section of cork tissue, and the wax cells of a honeycomb).

According to Hooke's biographer, Stephen Inwood, "Micrographia *is regarded as one of the founding works of modern entomology*" (Inwood 2002). When I first read that statement, I was somewhat surprised - *Micrographia* has been included in 'timelines' and other histories of entomology, but generally for no other reasons than it: (i) contained impressively detailed, magnified views of insects, and (ii) opened new avenues for studies of insect structure by demonstrating the potential of the microscope. The consensus has been that the book played only an indirect part in our discipline's historical development. However, upon closely examining *Micrographia*'s text, I realised that a belated case for elevating the book to 'founding work' or 'seminal' status could – indeed *should*, be made. In addition to the fourteen engravings which feature either entire insects or their body parts (three of those illustrations occupy fold-out pages), there are more than twenty chapter-like sections ('Observations'), out of the book's total of sixty, in which insects either are the principal topic or are mentioned in passing. Moreover, those particular sections contain several novel and significant contributions to entomological science for which Hooke has not been given due recognition – at least not until very recently (Vasconcelos de Almeida & de Oliveira Magalhães, 2010; Jervis 2013). For example, he invented the method of tethering an insect to examine its flight mechanism, and he provided valuable pointers as to the function of insect elytra, halteres, mouthparts and antennae. Hooke's speculations on arthropod (insect and mite) reproduction challenged the long-standing assumption that invertebrates such as insects are produced spontaneously from non-living matter.

Micrographia also happens to be highly interesting from an entomologist's perspective because insects were central to its conception, as I shall now elaborate.

Early microscopy, Christopher Wren and the Royal Society

In the early seventeenth century, insects were among the most obvious of natural objects to examine with the recently invented microscope - they were some of the smallest known living organisms, and they were easily obtainable. Members of the Academy of Lynxes in Rome (Giovanni Faber, Galileo Galilei and Francesco Stelluti) studied fleas, lice, honeybees and various kinds of 'flies' using a two-lens version of the compound microscope (known vernacularly as an 'occhialino', and called a 'microscopio' by Faber). Galileo used his to see how insects walked on the underside of a sheet of glass. It seems that occhialinos were typically tripod-mounted, so that they could be conveniently placed over the object to be examined.

The first-ever *printed* microscope-assisted illustration of objects was a Mathias Greuter engraving, dated 1625 - *Melissographia*. Featuring three entire honeybees together with various body parts, all drawn by Francesco Stelluti, it formed part of a tripartite bee-themed gift to Pope Urban VIII whose family (Barberini) coat-of-arms featured a trigon of honeybees. Stelluti's pictures of honeybees (mostly adapted from his earlier work) and one of a weevil in his book *Persio* (1630) (a translation of the *Satires* of the Roman poet Persius) were probably the first ever *published* illustrations of objects made with a microscope (as far as I can ascertain, *Melissographia* was not made generally available).

L'occhio della Mosca (*The Eye of the Fly*) by Giovanni Battista Hodierna appeared in print in 1644. Hodierna, a priest and an astronomer at the court of the Barons of Lampedusa, used an occhialino to study a wide diversity of insects, and he included in his book a single woodcut print that illustrated a fly's head and its compound eyes (Hodierna 1644). That book was a landmark in science because one of the aforementioned illustrations was first ever published microscope-assisted depiction of a *dissected organ*: a section through one of the eyes. The French physician and botanist Pierre Borel also studied insects using a microscope, and his book *Observationum Microscopicarum Centuria* (Borel 1656) features crudely drawn pictures of an entire male moth and one of its antennae (see Fig. 39 in Ford [2009]).

In England during the late 1640s, Christopher Wren examined insects through a microscope which was perhaps optically superior to the occhialino (the latter was more a plaything than a scientific instrument - it revealed only slightly more detail than could be seen with the naked eye; Ford 2009). In 1649 (the year of King Charles I's execution and the subsequent declaration of the Commonwealth of England), the teenage Wren – presumably eager to achieve stability in his life (he was a High Anglican and a Royalist – his father was Dean of Windsor), drafted a patronage-seeking letter intended for Karl Ludvig I, the Elector Palatine, the catholic ruler of part of southern Germany (Jardine 2003). The letter referred to illustrations of small organisms, which were probably insects. In early 1661 – by which time the monarchy in England had been restored, Wren – audaciously, without the approval of the Royal Society (of which he was a founding Fellow), presented three microscope-assisted drawings as part of a gift to the new monarch, King Charles II, who was known to be interested in science (Uglow 2009). A French diplomat who subsequently visited the King's 'cabinet' reported in his diary that he had observed three pen-and-ink drawings of a louse, a flea and the wing of a fly (Neri 2011). The first two drawings were possibly the "*two Mites* [tiny animals], *two living Nothings*" that Wren referred to in his draft letter to the Elector Palatine. [Wren may, however, have improved on the originals, because in 1652 the London instrument-maker Richard Reeve developed a new design of microscope which was made commercially available (Simpson 2008); Wren is known to have remarked flatteringly about Reeve's devices, in 1655 (Jardine 2003).] King Charles II was impressed by Wren's drawings, and requested – via the Royal Society, further examples of such pictures (powerful and wealthy individuals in those days kept 'cabinets of curiosities' – rooms devoted to encyclopaedic collections of objects that included drawings, coins, gems, medals, paintings, minerals and biological specimens, often with the intention of impressing visitors; see Jardine 1999). Wren was thus 'charged' "*in the King's name… to continue the description of several insects, as he had begun*". However, he seems to have quickly lost interest in the project, and after the Royal Society had made repeated requests to him, he informed it that he was unable to deliver what the King had asked for. He was probably too busy, because in February of that year (1661) he had been elected to the post of Savilian Professor of Astronomy at Oxford University (Jardine 2003).

Enter Robert Hooke

Sir Robert Moray (another of the Royal Society's founders) replied to Wren, informing him that he had been 'eased' of the task, and that Robert Hooke had been 'persuaded' to take over. Hooke was at that time working (and had been proving himself to be extremely able) in Boyle's private laboratory in Oxford, so Boyle would have had first-hand knowledge of Hooke's considerable prowess in drawing. Boyle and other Fellows such as John Wilkins may also have been aware of the microscope-assisted sketches of insects which Hooke had produced during his time with Boyle. Those drawings, some of which are shown here (Figure 9), came to light only recently (Neri 2005, 2011).

Robert Hooke was born in 1635, at Freshwater in the Isle of Wight, the last of four children whose father was a Church of England curate. Robert was, from birth, a sickly child, and he was taught at home until he was seven years of age. Following the death of his father, he moved to London; after a brief spell as an apprentice to the portraitist Peter Lely, he ended up at Westminster School in the care of its strict disciplinarian headmaster Dr Richard Busby. Upon completing his

Hooke took up a choral scholarship at Christ Church College, Oxford. He subsequently became a paid laboratory assistant to the anatomist Thomas Willis, and then worked for the 'Father of Chemistry', Robert Boyle. Whilst in Oxford, he joined the informal club of 'natural philosophers' (the original descriptor for scientists) led by John Wilkins, the warden of Wadham College and a key figure in the founding of the Royal Society. Frustratingly, there are no extant portraits of Robert Hooke made during these or later stages in his life.

Robert Hooke has often been unfairly portrayed as a reclusive and highly abrasive individual – a social misfit even. He had foibles, but he was also gregarious and capable of forming long-lasting friendships (Inwood 2002; Jardine 2003). He was involved in London's recently developed coffee-house culture, using those venues to meet friends and Royal Society colleagues, and also to conduct business and even perform experiments (Inwood 2002).

At the Royal Society's meeting of November 5th 1662, Moray proposed that Robert Hooke be appointed 'Curator of Experiments', and at the following meeting the assembled Fellows supported the motion. Note, however, that Hooke was not on that occasion *formally* appointed to the post of Curator of Experiments; furthermore, he did not receive a salary from the Royal Society until long afterwards. The Royal Society was a subscription-based organisation, and lacked the funds to pay him; therefore Hooke continued to be paid by Boyle at least until the summer of 1664 when he became the Royal Society's official employee (Chapman 2004) and at which point in time he would have been adding the finishing touches to *Micrographia* in readiness for its printing. [He had been elected FRS the year before.]

Hooke's official workplace had thus become Gresham College (roughly the present-day site of Tower 42, the old NatWest Tower, in the City of London) where the Royal Society held its weekly meetings.

On March 25th 1663 the Royal Society ordered Hooke to "*prosecute his microscopical observations, in order to publish them*". Subsequently, in anticipation of a visit by the King, Hooke was instructed to compile those 'observations' (very likely just pictures)

FACT BOX 1

Hooke's microscopes

Hooke's three-lens compound microscope (Figure 8) was manufactured by a London instrument-maker, and was the general type also used by Christopher Wren and Henry Power. It is not widely appreciated that Hooke himself invented two additional microscopes for his *Micrographia* work: a two-lens compound microscope (water-filled, with a hemispherical eyepiece lens and a glass bead objective lens), and a single glass bead lens (and thus 'simple') microscope. In the book, he provides a picture of the former and detailed instructions on how to construct the latter. Hooke wrote that he "*made little use of*" the water-filled two-lens device, whereas Brian J. Ford, an expert on microscopy, has established convincingly that, due to the optical limitations of Hooke's compound microscope, he *must* have used his single-lens device in order to see the fine structural detail that is portrayed in several of the *Micrographia* drawings (Ford 1992, 2009). Why then did Hooke, later on in his career (in the late 1670s), state that he "*omitted to make use of*" simple microscopes? [He complained that they caused him eye strain – they had to be held extremely close to the eye.] Ford (2009) thinks that Hooke was 'enamoured' of his compound microscope and was therefore reluctant to admit that he had used what amounted to little more than a tiny hand-held lens.

Antoni van Leeuwenhoek very likely based the design of his own, single-lens microscope on the instructions that Hooke provided in his preface to *Micrographia* (Ford 2009); this did not go unnoticed by the Englishman, as the minutes of the Royal Society's meeting of November 23rd 1681 can testify. What is known as the 'Leeuwenhoek microscope' should, arguably, be called the 'Hooke-Leeuwenhoek microscope' (or, as a Cardiff colleague suggested to me – jestingly, the 'LeeuwenHooke microscope'!). Interestingly, Hooke is renowned for having been highly protective of his own inventions and ideas (*vide* his disputes with Oldenberg, Huygens and Newton over priority) – yet it seems he made an exception regarding the invention of the simple microscope.

Hooke required an invariable source of light that he could use when performing microscopy at night, so he invented an illumination device comprising an oil lamp, a brine-filled globe and a condensing lens (Hooke's "Fig. 5" in my Figure 8). He also devised various means of improving the illumination of objects by sunlight.

For his microscopical studies Hooke used not only insects but also other organisms, and he even examined commonplace objects such as textiles, the edge of a razor and the point of a needle. The insects he illustrated (Figures 1-7) were collected both from outdoors (e.g. the grounds of Gresham College) and indoors. Only a short walk away from Gresham College was the open area known as Moorfields which he is known to have frequented.

Hooke was undoubtedly someone who placed a premium on accuracy, yet some of his insect (and other animal) pictures contain major inaccuracies – why? We can attribute some errors such as the inclusion of non-existent, articulated barbs on the stylet of the bee's sting (Figure 1) to the inherent limitations of his microscopes. We also need to bear in mind that Hooke, in his role as the Royal Society's Curator of Experiments, was at the beck-and-call of the Fellows, having to carry out not only his *Micrographia*-related work but also other duties; he was therefore pressed for time. Furthermore, in the early 1660s microscopy was, for Hooke, just one of his many scientific interests, as the other contents of *Micrographia* (relating to astronomy, chemistry, mineralogy, palaeontology, physics) can testify. Thus, the artist's licence evident in his depiction of the wings of the chironomid flies (Figure 4) is quite understandable, as is the absence of legs from his silverfish drawing (Figure 6) (the specimen's legs became entangled in glue, and despite silverfish probably being abundant among his papers, he did not use another individual).

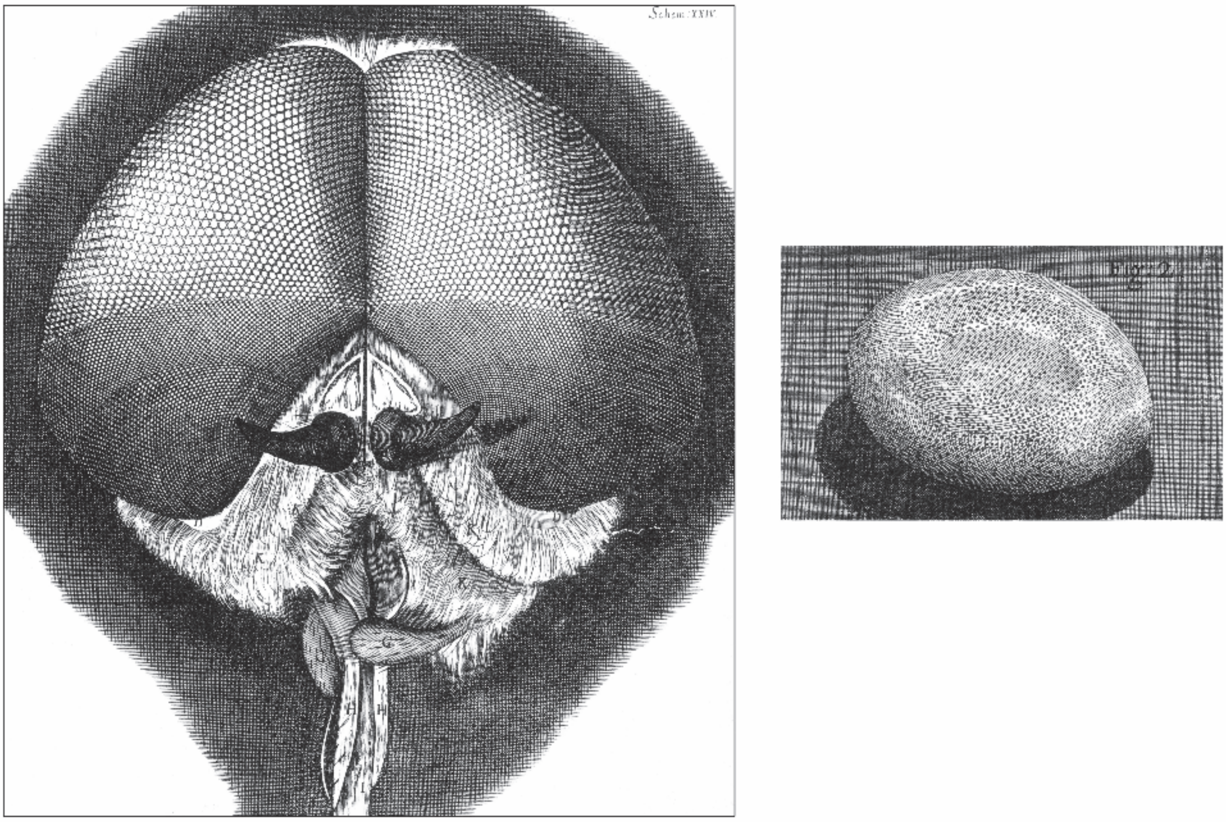


Figure 2. *Left*: the head of a male horse-fly (very likely *Tabanus autumnalis*) *Right*: the egg of a silkworm moth, *Bombyx mori* L.

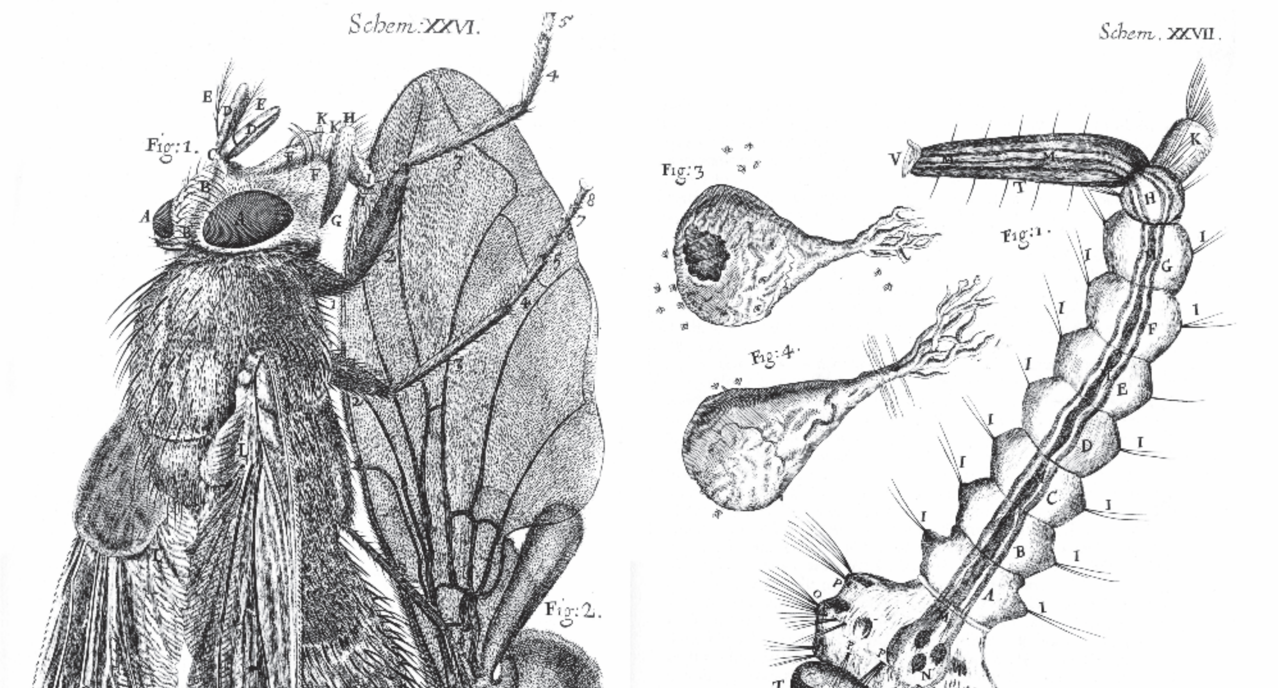


Figure 3. *Left*: a blow-fly identified as either *Calliphora vomitoria* (L.) or *C. vicina* Robineau-Desvoidy, and an entire wing of a *Calliphora* species. *Right*: the larva and pupa of a mosquito, identified as either *Culex pipiens* L. or (less likely) *C. torrentium* Martini. Also shown are Hooke's versions of the 'marine apiaries' illustrated in Willem Piso's *Historia Naturalis Brasiliae* (Piso and Marcgraf 1648).

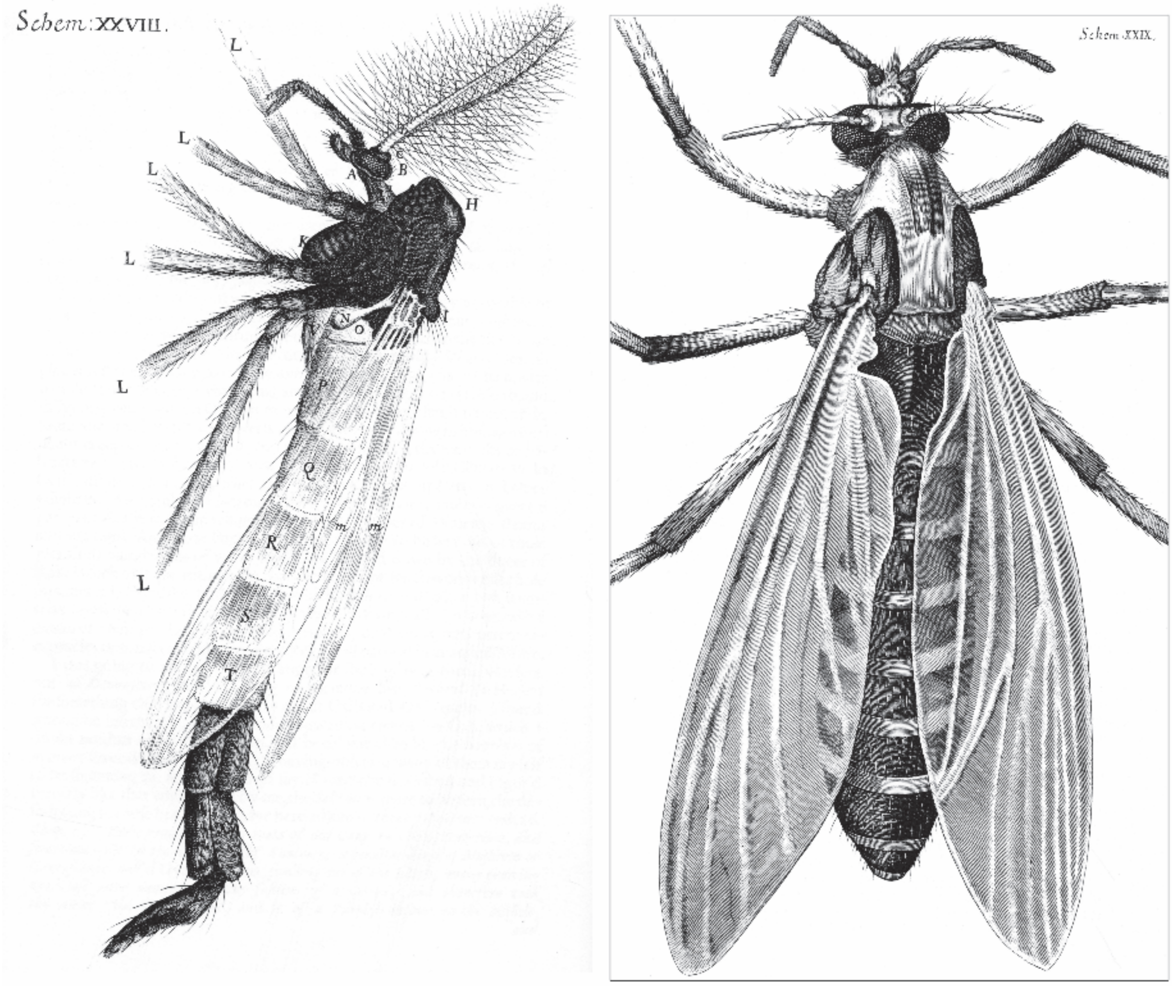


Figure 4. *Left*: a male chironomid fly, identified as either *Microtendipes pedellus* De Geer or (less likely) *Synendotendipes lepidus* Meigen. *Right*: a female of an unidentified species of chironomid fly.

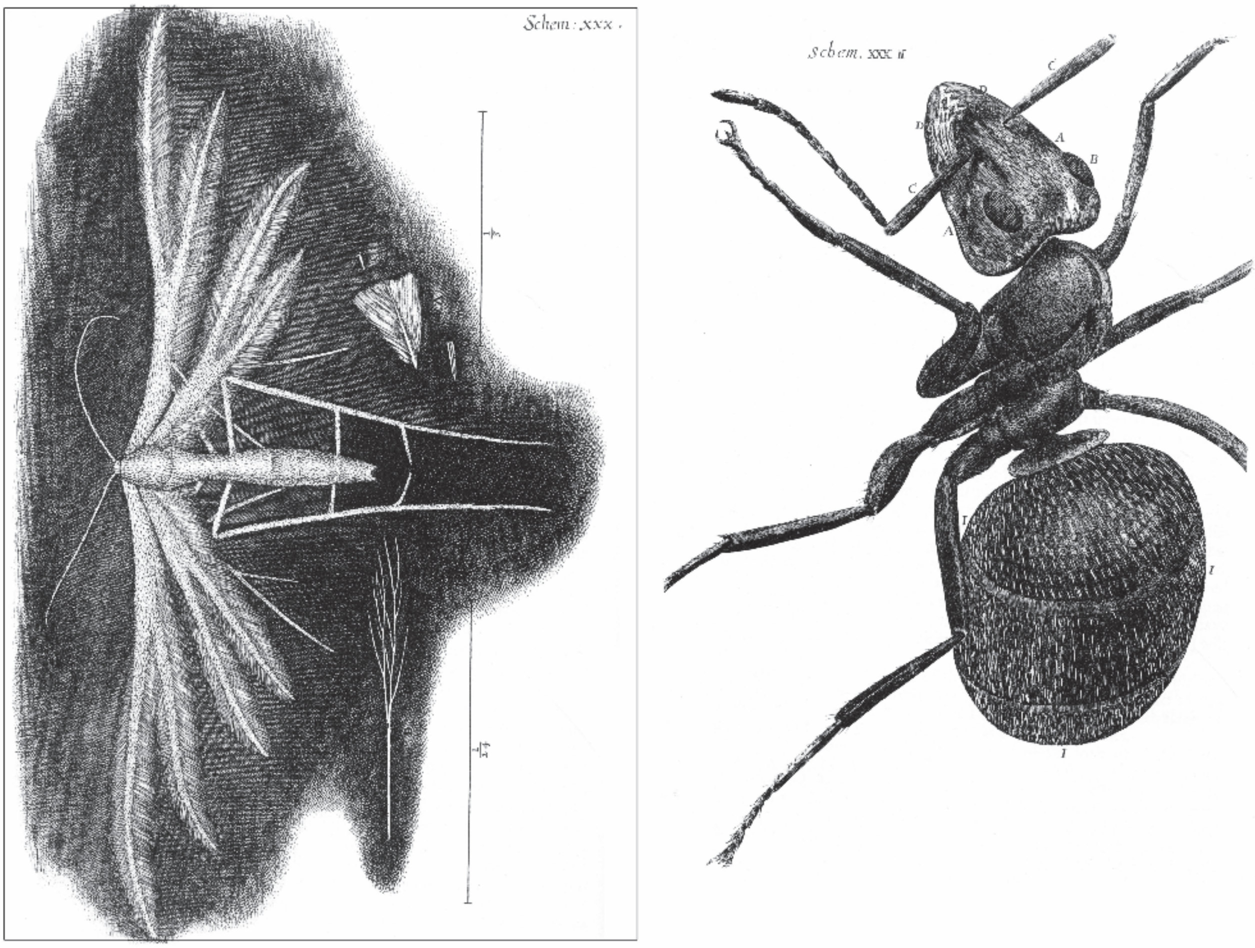


Figure 5. *Left*: a moth, possibly female, identified as *Pterophorus pentadactyla* (L.), the White Plume Moth (the two scale lines denote fractions of an inch). *Right*: a worker of a wood ant, identified as *Formica rufa* L.

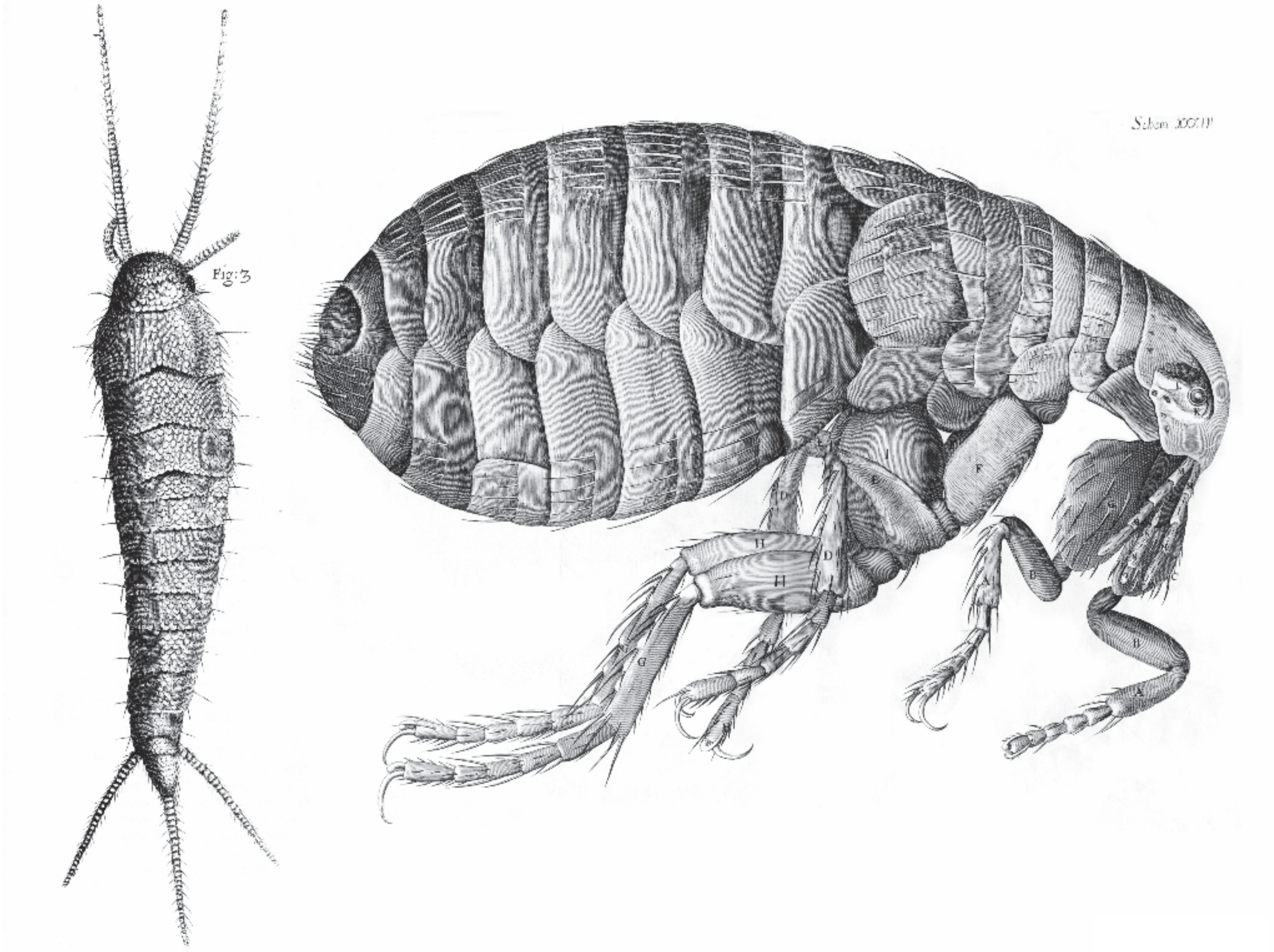


Figure 6. *Left*: a silverfish identified as *Lepisma saccharina* L.. *Right*: a female flea, identified as (most likely) the Human Flea, *Pulex irritans* L.

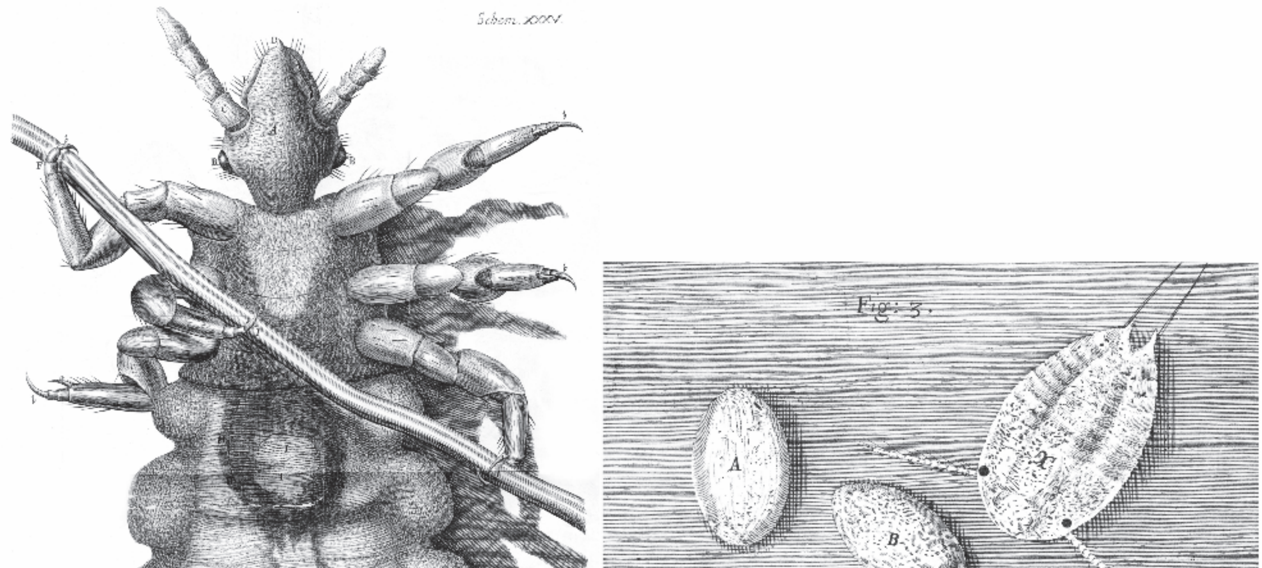


Figure 7. *Left*: a Human Louse, *Pediculus humanus* L. *Right*: two eggs and a first instar nymph of a coccoid hemipteran bug found on a vine – it is possibly a species belonging to the mealybug family (Pseudococcidae).

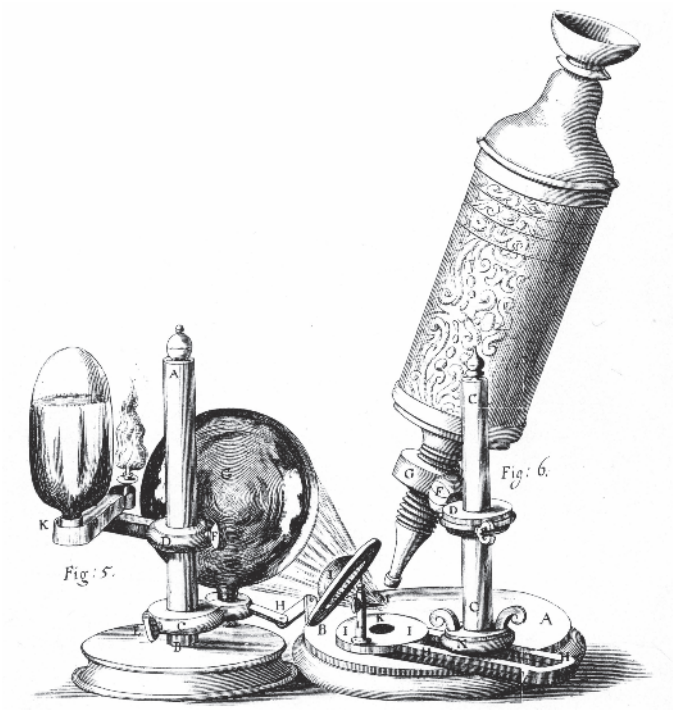
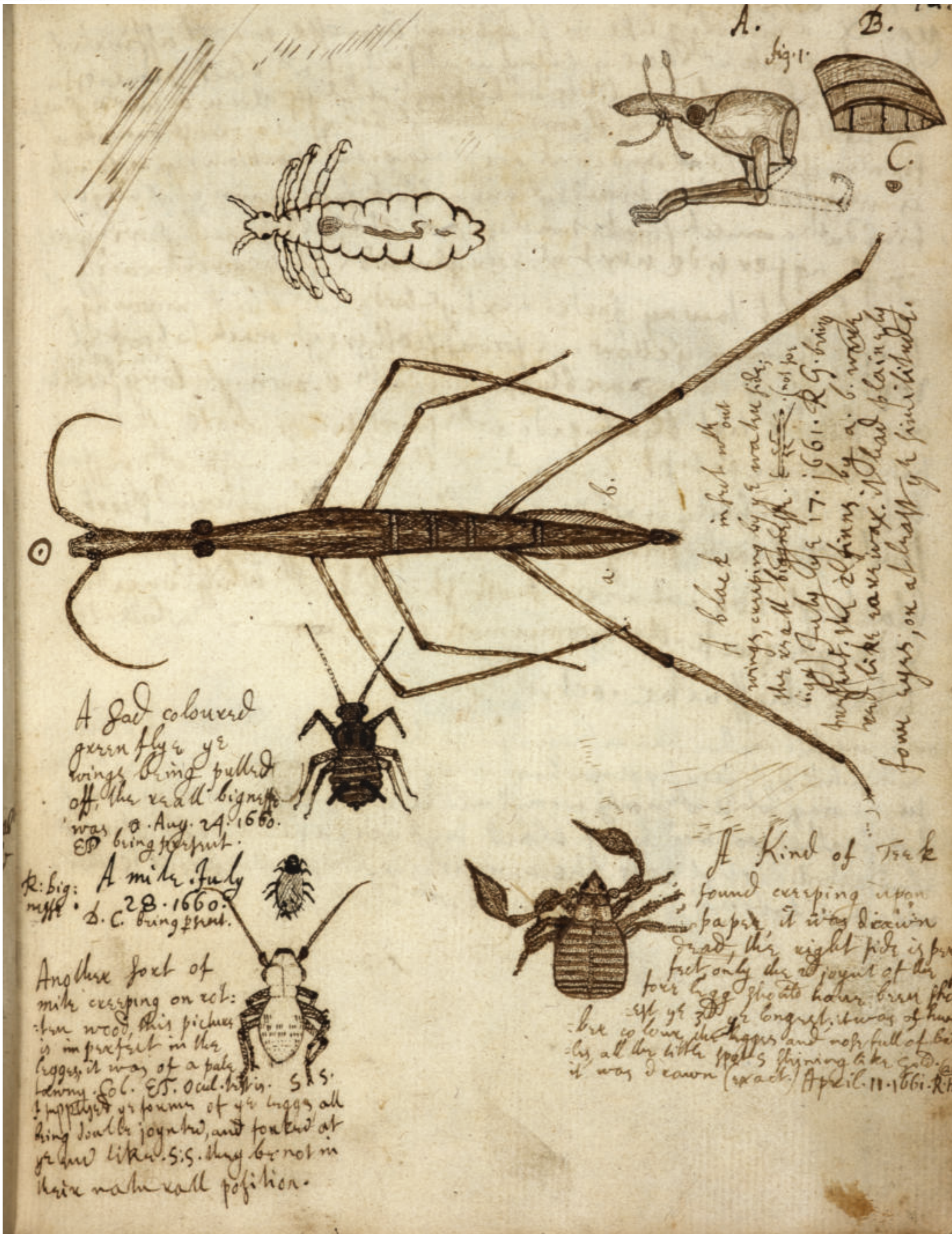


Figure 8 (left). Hooke's London-manufactured compound microscope, and the illumination device he invented. The microscope contained three lenses: a small double-convex eyepiece, a large plano-convex field lens, and a double-convex, short focal length lens objective; it magnified between twenty and fifty times (Henderson 2010). Hooke's hand-held simple microscope (not shown) – which was also the type used by Leeuwenhoek, may have been five times as powerful.

Figure 9 (below). Some insect sketches, made in the early 1660s – very likely by Hooke, included in John Covel's notebook. The sketches were produced before Hooke was asked by the Royal Society to provide King Charles II with drawings of insects. They are of a louse, an aphid, a psocid, a *Hydrometra* species and a weevil (in addition to a mite and a pseudoscorpion). The handwriting is consistent with known examples of Hooke's own script. Note that the caption to the pseudoscorpion ends with the initials 'R.H.'. Other aspects of the labelling are consistent with what is found in *Micrographia*. See Neri (2005, 2011). © The British Library Board, Add. MS 57495. Another of his sketches (not shown here) shows the head (with antennae) of a male chironomid fly.



in a 'handsome' book (not *Micrographia*, although some, if not all, of the material would have been used in its production).

Micrographia's rocky road to publication

Things did not run smoothly for Hooke. First of all, he must have been surprised - to say the least, to discover (possibly in the summer of 1663) that a Halifax physician and natural philosopher, Henry Power, was to report on independently conducted microscopical studies in his forthcoming book *Experimental Philosophy* (Power 1664). Using a three-lens compound microscope, Power had been examining insects, arachnids, nematodes, seeds, pollen and other objects, and he had also written up his findings in the form of 'Observations' – just like Hooke was in the process of doing. Hooke was relieved to discover that Power's manuscript contained only a few crude woodcut prints (as opposed to elegant engravings) and that there were to be no pictures of 'insects'. Nevertheless, like Charles Darwin would do centuries later when faced with a somewhat similar dilemma, he sought the views of his close associates. Fortunately for Science, Hooke was encouraged by his "*Friends*" to go ahead as planned.

The next obstacle that Hooke faced was the Royal Society itself – it was to be the book's publisher. Very likely he had, in their eyes, over-egged the pudding by including in the 'Observations' a great deal of speculative discussion – what he called his 'conjectures and queries'. Moreover, much of the book's frequent hypothesising was not supported by experimental evidence (this is especially true of the book's biological 'Observations'). In his dedication to the Royal Society (which is preceded by a dedication to the King, who was by then not only the Society's patron but also one of its elected Fellows), Hooke begs the Royal Society's pardon for this omission. Experimentation was central to the Royal Society's philosophy – its guiding spirit was Francis Bacon. It is perhaps no coincidence that the Royal Society did not issue its imprimatur for several weeks during which time the book's contents were being scrutinised by the President, Lord Brouncker (Hooke wrote to Boyle, complaining about the delay). Hooke, possibly on the Royal Society's instructions, included a caveat in the second dedication, stating that if he had exceeded the Society's remit, he had not done so on its orders.

FACT BOX 2

The 'Wren authorship' question

Statements by Hooke and Henry Power in the prefaces to their books can be taken to imply that some of *Micrographia*'s insect pictures were drawn by Christopher Wren. Also, the knowledge both that the sketches made by Wren as a young man were reportedly of insects, and that he was the person the Royal Society originally asked to supply it with insect drawings, further muddies the waters. Thus, several writers have assumed that not all of Hooke's pictures were actually his own. For example, the American entomologist Maxwell Power concluded from a highly subjective assessment of the drawings together with an analysis of the Royal Society's minutes for the period leading up to the book's publication, that the 'big three' were the ones mostly likely to have been drawn by Hooke's contemporary: these are the fold-out pictures of the flea, the louse and the horse-fly's head (Power 1945). I have presented elsewhere an argument for Hooke having been the sole author of the book's drawings (Jervis 2013), and space does not permit me to repeat all of it here.

Interestingly, *Hooke himself* provided the evidence that he had drawn at least one of the purported Wren-authored pictures: that of the tabanid fly's head. If you examine his drawing of a sample of the latter's compound eye facets (Hooke's "Fig. 3" in my Figure 1), you will see that each of the facets reflects two windows. Hooke describes in *Micrographia* how *he* (not some other person) manipulated the insect's head to cause the facets initially to reflect the image of a tree outside *his* (not some other person's) 'chamber', and then to reflect the images of *that room's* windows.

As Wren's early sketches have not been found (and are unlikely ever to be), the 'Wren question' will probably never be resolved to everyone's satisfaction. Nevertheless, those inclined to support the Wren authorship hypothesis ought to bear in mind the following: Firstly, when Wren did his 'King's cabinet' sketches (flea, louse and fly's wing), the high-resolving power glass-bead microscope had yet to be invented – by *Robert Hooke*. Assuming Brian Ford to be correct (see Box 1), those pictures would have lacked a considerable amount of detail which only one person – *Robert Hooke*, could have provided. [There is of course the possibility that Hooke added the missing detail to Wren's sketches, rather than produce his own drawings *de novo*, but that would be stretching the bounds of credibility.] Secondly, Hooke was, in the 1660s, better placed than Wren to produce the finest quality publishable pictures of tiny organisms because, as the art historian Meghan Doherty has cogently argued (Doherty 2012), he understood the 'visual vocabulary' used by engravers of that time in translating a three-dimensional object into a two-dimensional image.

Micrographia published at last

Micrographia appeared in January 1665. It was the Royal Society's second publication, after John Evelyn's seminal monograph on trees and forestry, *Sylva* (1664). Most likely it was *Micrographia*'s abundance of pictures, particularly the habitus portrayals of some insects (Figures 1-7, probably all drawn by Hooke himself, see Box 2) - rather than the text, that made the greatest impact among contemporary natural philosophers, other members of the intelligentsia, and the literate public. Samuel Pepys, after reading the book until the early hours of the next day, wrote in his diary that he was "*proud*" to own a copy. According to the Astronomer Christiaan Huygens, the book's large format, fold-out plates showing a louse and a flea were each "*as big as a cat*" (Cobb 2006). Ladies are said to have fainted at the sight of them. *Micrographia* was the first ever science best-seller.

Following the publication of *Micrographia*, Hooke paid much less attention to insects. Firstly, there was a much more urgent matter to occupy him – he was helping to rebuild the City of London after the Great Fire (which occurred in September 1666). Hooke seems to have performed over fifty per cent of the post-fire surveys, and was the architect of a number of buildings (he co-designed, with Wren, the Monument to the Great Fire situated near Pudding Lane, at the junction of Monument Street and Fish Street Hill). Secondly, Hooke's scientific interests were very broad (see Box 3), and insects had, for him, served their purpose: he had succeeded in providing the Royal Society with the requisite drawings, he had successfully demonstrated the potential of the microscope, and he had proved his own skills in microscopy and drawing. Thirdly, the Royal Society's scientific interests, and thus Hooke's designated tasks, were ever-expanding. Notwithstanding the rapid waning of his entomological activities, Hooke made, during his post-*Micrographia* phase, the occasional entomological observation; he reported for example, on the 'flies' (parasitoids, probably Tachinidae or Braconidae) that had appeared in a jar containing some beetles, and on the Cheese Skipper fly (*Piophila casei*) maggots which he observed (by means of the microscope) to jump by placing "*their tail into their mouth*".

Hooke's scientific interests, both in microscopy and in the 'generation' of insects and other organisms, caused him upset several years after *Micrographia*, insofar as the principal character in Thomas Shadwell's Restoration comedy, *The Virtuoso*, spent a considerable amount of money on microscopes in order to study, among other things, "*the nature of eels in vinegar, mites in cheese*", and was described as "*having broken his brains about the nature of maggots*". After witnessing a performance of the play, Hooke wrote in his diary: "*Dammd Doggs. Vindica me Deus* [God grant me revenge], *people almost pointed*".

FACT BOX 3

Hooke resurgent

Robert Hooke is currently being rapidly 'rehabilitated', having long been neglected by scholars in comparison with the most notable of his English and European contemporaries (Cooper & Hunter 2006). To quote Allan Chapman, he had "*fallen through the net of wider historical memory*" (Chapman 2004). [That a process of rehabilitation is necessary is evident from the absence of an entry for Robert Hooke in a recently published encyclopaedia of the history of science.] The current 'Hooke industry' is concerned with bringing to the fore not only Robert's many professional achievements in a diverse array of disciplines, but also his fascinating life (e.g. Inwood 2002; Jardine 2003; Chapman 2004). Its output of papers, books and conferences should not, however, be mistaken for hagiography - Hooke was one of history's most notable polymaths (Allan Chapman calls him 'England's Leonardo'). He can be neatly encapsulated as a 'Renaissance Man' who was the consummate 'Restoration Man'.

Robert Hooke died in 1703, intestate; his funeral and burial took place at St Helen's church, Bishopsgate. There is no headstone or even a grave *per se* (his remains have been lost), but recently several memorials have been installed in London and the Isle of Wight. The attractive rectangular carved stone plaque in the crypt of St Paul's Cathedral is mounted on a wall next to Wren's tomb: it features an extract from the text of his *Micrographia* Observation on the silverfish – an insect which Hooke referred to as a 'bookworm'. Although the engraved metal 'bookworm' at the bottom of the plaque does not portray a silverfish (it resembles a chafer grub), the memorial is a fitting tribute to "*one of the most ingenious men who ever lived*".

Micrographia's entomological illustrations and discussions

Until very recently (Jervis 2013), analyses of *Micrographia*'s insect-related content had mainly been carried out by non-entomologists (historians of science and art) who either accepted Hooke's seventeenth century (and thus pre-Linnean) nomenclature or themselves proffered names, for example 'dragonfly' and 'house-fly' for Hooke's 'Drone-fly' (which is in fact a horse-fly). By attempting to identify and thus provide up-to-date names for all of Hooke's insects, I hoped to establish, with the help of taxonomic experts, a degree of nomenclatural accuracy that would enable deeper understanding of the book's entomological content (Jervis 2013).

The insects in the book's engravings belong to the orders Thysanura, Hemiptera, Phthiraptera, Lepidoptera, Hymenoptera, Siphonaptera and Diptera. In the text, Hooke also mentions two sorts of Coleoptera – 'scarabees' and 'gloworms'. It is testament to Hooke's considerable ability - both as an artist and as a scientist, that many of the specimens in those engravings are identifiable to genus and in some cases even to species. I have also been able to establish the identities of some of the other insects that Hooke mentions in the 'Observations'.

Micrographia's legacy to entomology

Hooke's entomological legacy comprises not only the pictures - which are greatly admired to this day, but also the information and insights he provided regarding various aspects of insect biology, and his technical innovations. I present here a selection of his contributions:

The use of a scale line

As argued by the art historian Janice Neri, one of the fundamental problems faced by Hooke in representing, through drawing, what was seen through the microscope was finding a means of conveying scale, because "*there were no stationary markers or recognizable landmarks in the microworld*" (Neri 2011). In some of his pre-*Micrographia* sketches Hooke included either a suitably-sized dot or a life-sized outline in the caption to the drawing (Figure 9: the mite). In *Micrographia* he dispensed with those devices and used a scale line - but only in a few of his pictures (e.g. the moth in Figure 5).

Narcotisation and mounting

Hooke experienced difficulty in drawing an ant because it struggled, so he placed it in a drop of brandy, and then used a pin to obtain a natural posture. He also performed an 'experiment' in which he twice 'gave' an ant brandy, and observed how it subsequently recovered after becoming "*dead drunk*".

He glued a silverfish (to an unspecified object) - perhaps to restrain it, and he "*fix'd*" the head of a horse-fly to his 'object plate' in order to view it from the desired angle.

Dissection

Hooke went further than Hodierna: he not only dissected the compound eyes of dragonflies, calliphorid flies and a horse-fly, but also cut open a blow-fly's body, revealing numerous "*milk-white*" branching tubes – i.e. what Jan Swammerdam and Marcello Malpighi would later establish to be the tracheal system (Hooke also observed the same branching tubes in a louse, without dissecting it).

We know that Hooke had dissected insects before he was invited to work for the Royal Society, because among his early insect drawings are pictures of the body parts of a weevil (Figure 9), a picture of an aphid whose wings had been removed (Figure 9), and a picture of a dissection performed on what seems to be a wasp.

Insect mouthpart structure and function

Hooke noted how both a blow-fly and a flea protracted and retracted their proboscides, and how the fly spread its labella in order to feed. He understood that fleas and lice suck when ingesting blood from the host, although he mistakenly thought that lice feed via a small hole at the apex of the head (quite understandable, given that in Anoplura the proboscis is retracted into a pouch within the insect's head when it is not in use).

Insect sensory biology

Hooke's writings on this topic were particularly insightful. He inferred that each 'pearl' (ommatidial lens) of a horse-fly's compound eye is, by itself, capable of refracting light rays and captures only a fraction of the available field of view. He also assumed that the images are formed on what he called a 'retina', the specified location of which corresponds to what we now know to be the array of photoreceptor cell tips.

Hooke noted how a calliphorid fly's proboscis bears two 'horns' (the maxillary palps), which he inferred to be involved in olfaction. He also suggested that the fly's antennae are used in smelling or hearing (we know he was correct as to the former function, and future electro-antennography might well show him to be similarly correct about the latter). He remarked that, "*This kind of fly seems by the steams or taste of fermenting and putrifying meat (which it often kisses, as 'twere, with its proboscis as it trips over it) to be stimulated or excited to eject its eggs or seed on it…*" – i.e. he was making the Cartesian connection between stimulus and response.

Hooke inferred that ants use their antennae "*for a kind of smelling*", and he noted the sexual dimorphism in 'gnats' (chironomid midges) with respect to antennal structure – he described the male as "*brush-horn'd*".

Insect flight mechanics

It was said of Robert that, whilst he was a pupil at Westminster School, he "*invented thirty severall wayes of flying*". Not surprisingly, he became deeply interested in how insects fly. He realised that beetle elytra might serve not only to protect the folded hind wings, but also to provide lift (that they really do so, albeit at the expense of aerodynamic efficiency, has been shown by Johansson *et al.* 2012). He also seemed to understand that wing area is an important factor in flight performance. When pondering the function of dipteran halteres, he noticed that those 'pendulums' vibrate, and he insightfully speculated that they might be involved in regulating the movements of the fore wings (however, he also thought they might be involved in breathing – a not unreasonable speculation to have made for the time).

Hooke glued a fly (possibly a syrphid) by its legs to a quill and attempted to establish how its wings moved, noting the wings' stroke plane axis, angle and amplitude. Although he did not manage to precisely elucidate the insects' wing movements, the information he recorded was a remarkable achievement for a scientist working three and a half centuries ago – unaided by a high speed camera.

Insect feet

Hooke noted how the legs of the human louse terminated in two claws, one larger than the other, and how the claws were used by the insect to grasp an individual hair (Figure 7). Regarding the blow-fly's feet (Figure 1), Hooke inferred that, to grip surfaces, the insect used the tips of the claws together with the hairs on the undersides of the pulvilli. However, he thought that, on glass, the claw and hairs achieved their grip by entering tiny pores, and he implicitly criticised Henry Power for having suggested that the pulvilli secreted a glue. We now know that flies attach themselves to very smooth surfaces not by using their claws but by applying just their pulvilli, and that the latter adhere to the surface partly because of the surface tension of an oily cuticular secretion delivered by the distal tenent setae – i.e. a glue of sorts (Gorb 1998). Henry Power was therefore closer than Hooke to correctly understanding how flies are able to walk upside-down on glass.

Insect digestive physiology

Hooke noted how in some biting flies (which seem to have been either mosquitoes or ceratopogonids) the abdomen became swollen when the insects fed. He observed the peristaltic motion of the gut in a human louse, a larval mosquito and the adults of other flies. He also identified in the louse the 'stomach' which we now term the anterior midgut, and he noted the passage of the blood meal through the insect's gut (and also the speed of the digestive process). Using lice, he carried out one of his few *Micrographia* biological experiments, starving a few individuals by keeping them in a box for a few days, and then letting one walk on his hand, whereupon it sucked his blood.

Insect structural colours

Hooke is rightly credited by physicists as having made seminal contributions in *Micrographia* to various aspects of optics. These include insights into the light interference mechanism responsible for iridescence, which he gained by studying bubbles, the mineral Muscovite, stacked layers of blown glass, the feathers of the peacock, the wings of flies and the scales of a silverfish. Remarking on the iridescence of dipteran wings, he wrote: "*These films, in many Flies, were so thin, that, like several other plated bodies……. they* *afforded all varieties of fantastical or transient colours*". We now call this effect 'thin-film interference'. Commenting on the iridescence of the silverfish (*Lepisma saccharina*), he attributed it to the "*multitude of thin transparent scales, which, from the multiplicity of their reflecting surfaces, make the whole Animal appear of a perfect Pearl-colour*". This effect is nowadays termed multi-film or multi-layer interference.

Hooke's drawing of the horse-fly's head (Figure 2) shows, for each of the compound eyes, an area of structural colouration (represented by shading) within the zone of smaller-diameter facets. Hooke did not remark on the colouration, which is caused by multi-film interference (each corneal lens comprises alternating layers of high and low density chitin – i.e. of differing refractive index; for a review of the effect in Diptera, see Bernard and Miller [1968])

Contrary to what has been assumed in the literature, Hooke did not provide an explanation for *Lepisma*'s metallic ("*glistering*") colouration. Large *et al*. (2001) studied another silverfish, *Ctenolepisma*, and found that most of the visible reflectance is accounted for not by the overlapping scales (which are transparent, as in *Lepisma*) but by a multi-layer in the outer region of the insects' cuticle. This 'stack' acts as a broadband reflector – that is, a mirror.

The honeybee's sting

Both Federico Cesi (in *Apiarium* - an essay on comparative aspects of bee biology that had accompanied *Melissographia*) and Henry Power (1644) had written briefly about the sting but Hooke provided deeper insights into its functional anatomy and the effects the venom has on the victim. He realised that the venom was pumped into the victim (he referred to the sting as a 'syringe-pipe', therefore implying that the venom was contained in a reservoir), and that the symptoms of stinging are greater the longer that the sting remains attached to the skin. Hooke also showed some appreciation of the penetration mechanism.

Insect population ecology

Based on his knowledge that a large fly will lay "*neer four or five hundred*" eggs, Hooke speculated that flies would be highly abundant if it were not for the mortality inflicted by bird predation and weather (specifically rain and frosts). Hooke's brief conjecture may have prompted Antoni van Leeuwenhoek to make his seminal calculation of how biotic potential is restricted by environmental resistance.

Insect reproduction

When Hooke wrote *Micrographia*, the prevailing belief among natural philosophers concerning how invertebrates came into existence from non-living matter such as decaying flesh, rotting vegetation and even May dew was that they were generated 'spontaneously' – i.e. without the intervention of an egg laid by a parent animal. Fly maggots featured prominently in such thinking, which can be traced back to Ancient Greece. To seventeenth century natural philosophers, the term 'spontaneous generation' had more than one meaning: either organisms arose from the non-living matter purely by chance, or there existed a 'seminal principle' that structured the matter to form the relevant kind of organism. [Viewed from a present-day perspective, this could be taken to imply a clear 'stochastic versus deterministic' dichotomy; however, in those days it was also thought that a specific kind of non-living matter (e.g. decaying flesh) could generate a particular kind of organism (e.g. a fly maggot).]

The minutes of the Royal Society's meetings that took place during the early 1660s show that the 'history' of insects - particularly the process of 'generation', was something the Fellows felt to be especially interesting. For example, on May 8th 1661, during the meeting at which Wren was requested to continue with his drawing of insects, it was decided that Robert Boyle and John Evelyn should be "*curators for the observing of insects*". The next week, the Society appointed a ten-man committee (which included both Boyle and Evelyn), part of whose brief was to examine "*the generation of insects*"; it was to meet at Boyle's London lodgings. In a Society meeting held on 22nd October 1662 the Fellows debated whether seminal principles were either: (i) derived from the organisms themselves - during that era some natural philosophers assumed that the principles became operative upon a previously existing animal's decay (Anstey 2002) or (ii) transported by air to the site of generation (Boyle is known also to have considered rainwater as the carrier [Anstey 2002]). At the same meeting it was decided that "*several experiments should be tried, of putting blood, flesh, brains, &c., together in a glass or other proper vessel; as also bran and meal; and likewise cheese moistened with sack* [wine], *&c*". At another meeting, held in the summer of 1663, the subject of generation was raised three times; one Fellow was instructed to test, by means of experiment, whether bees are generated from the carcass of a bullock (an idea dating back to Virgil, Ovid and Democritus).

The experiments we know to have been carried out by the Fellows were, by present-day scientific standards, inappropriately designed; not surprisingly they failed to shed light on spontaneous generation. The Tuscan natural philosopher Francesco Redi was the first person to succeed in debunking the supposed phenomenon, at least as regards the 'spontaneous' appearance of fly maggots in rotting flesh, publishing the results of his elegant series of experiments just a few years after *Micrographia* (Redi 1668).

Until the late 1660s Robert Boyle, whose own scientific interests included how organisms are 'generated', believed in the existence of seminal principles, and he often referred to them as 'seeds', even when he was writing about the generation of animals (Anstey 2002). In *Micrographia* Hooke used the word 'seeds' with reference to insect and mite reproduction, but it is evident, when we view his *Micrographia* writings on arthropod reproductive biology in their entirety, that in contrast to Boyle he usually meant actual eggs which are produced by the *parent* animal and which hatch to produce offspring in the form of maggots or caterpillars or somesuch. [Nowhere in *Micrographia* does Hooke define precisely what he thinks an insect or mite egg is, but his understanding seems to have been an advance on William Harvey's (1651) insofar as he never expressed the view that eggs *themselves* could be generated from non-living matter (see Cobb [2006] for Harvey's Aristotelian views on insect generation).Yet, Hooke seems to have held the Harveyan view that the larva was spontaneously produced from decayed matter contained within the egg – at least as regards the blow-fly.]

Hooke also refers to the adults of mites and insects seeking out particular sites to lay their eggs (that is, neither m arriving at the oviposition sites randomly nor broadcasting their eggs) on the basis of their suitability for the progeny both to feed and to survive. It is therefore not surprising that Hooke expressed doubts over spontaneous generation (he did so in more than one place in his book). For example, when reflecting on how mosquito larvae and pupae came to be in a sample of rainwater, he asked whether "*all those things that we suppose to be bred from corruption and putrifaction* [decay, and possibly also fermentation], *may not be rationally suppos'd to have their origination as natural as these Gnats, who, 'tis very probable, were first dropt into this Water, in the form of eggs*". Yet, despite this and other evidence of Hooke's scepticism in his *Micrographia* writings, he was for centuries overlooked as having contributed (or at least *offered*) something meaningful to the seventeenth century debate over 'spontaneous generation' (Inwood 2002; Vasconcelos de Almeida & de Oliveira Magalhães, 2010; Jervis 2013). Hooke's name has, until very recently, been missing from the list of contemporary sceptics (who included Antoni van Leeuwenhoek, Jan Swammerdam and Francesco Redi).

Hooke's scepticism over spontaneous generation possibly informed his thinking regarding the nature of metamorphosis in holometabolous insects, as I shall now explain (see next section).

Insect metamorphosis

Until Jan Swammerdam revealed, post-*Micrographia*, the 'remodelling' aspect of metamorphosis through his dissection of the last instar larva of the silkworm *Bombyx mori* L., the accepted positions on spontaneous generation and insect metamorphosis were closely intertwined (Dinsmore 1998; Cobb 2000, 2006). William Harvey thought not only that insect eggs could be spontaneously generated, but also that the holometabolous insect life-cycle comprised more than one egg stage: the 'imperfect' egg from which a 'worm' is thrust out (the worm itself being regarded as "*no more than a crawling egg*"), and a 'perfect' egg (the pupa) (Cobb 2006; Erezyilmaz 2006). With Lepidoptera in mind, Harvey thought that the 'perfect' egg acts as a seal that imprints the adult form upon the amorphous matter contained within. Furthermore, Harvey thought that because the adult was spontaneously formed from the decayed remains of the larva, the imago was an entirely different individual. That metamorphosis involves a 'jelly mould' mechanism was not an unreasonable assumption for Harvey to have made, given that when you examine a butterfly pupa you can often easily discern some adult features such as the eyes, proboscis, antennae and wings. Robert Hooke, however, was able, with the microscope (as he himself reported) to see at least some of the *internal* anatomy of the *Culex* individuals he examined during the course of their development from young larvae to adults, and he reported that the eyes of some individuals of the type illustrated in his "Fig. 2" (in my Figure 3) altered in appearance, eventually resembling those of the adult mosquito (he was very likely observing changes in the pharate adult). In summarising the various observations he had made on *Culex*, Hooke wrote that he had witnessed a hitherto unrecorded phenomenon in natural history. Given that the emergence of an imago from its pupal casing was, at that particular time, neither a novel nor a particularly remarkable discovery (thanks to the observations made on Lepidoptera by Jan Goedart: see Goedart [1662-1667] and Ogilvie [2008]), we might wonder what Hooke was alluding to. Perhaps he had realised that in *Culex* metamorphosis is a process that does not, in reality, entail the decay of an organism and its replacement by another, and that a fully-formed imago does not come into being instantaneously. However, even if Hooke *had* understood mosquito metamorphosis in its modern sense, he thought differently about metamorphosis in the blow-fly: the four lines of text he devoted to the process undergone by that insect (on page 124 of *Micrographia*) can be taken to imply that the imago is produced by the action of heat upon a seminal principle within the 'aurelia' (thus conforming to an idea expressed by Boyle, see Anstey [2002]).

Insect natural history

Hooke seems to have made few, if any, excursions into the countryside, being very much an urbanite. Nevertheless, close scrutiny of *Micrographia* shows him to have been interested in how insects live:

It might come as a surprise to entomologists, even to experts on plant galls, that several pages of *Micrographia* are concerned with gall insects. Hooke mentions galls on gooseberry (presumably *Aphis grossulariae*), willow (presumably *Pontania* sp.), roses (presumably *Diplolepis* spp.) and oaks (the twig and root galls of *Biorhiza pallida*, and the galls produced by other cynipids). It seems he had actually observed each of those structures, as opposed to having only read about galls in works such as John Ray's *Catalogus Plantarum* (Ray 1660). He dissected oak root galls sent to him by another Fellow and found a larva inside. However, he mistakenly thought that it was the 'worms' (larvae), not the adult insects that emerged from galls and thus produced the exit-holes he had noticed. Nevertheless, he correctly hypothesised that the causal agent of gall formation is the *insect* – not the plant. Furthermore, he wrote that the progeny obtained nourishment from the enclosing tissue.

Hooke made some of his observations on insects outdoors: he mentions the hovering flight of syrphid flies, adult blow-flies occurring in the winter (in snow), flies 'swarming' around decaying flesh (see *Insect sensory biology*, above), butterflies flying about brassicas, and the (true) swarming behaviour of tiny flies (probably ceratopogonids). He noted how ants would "*sally out in great parties*" from the place they inhabited (i.e. their nest) to make "*most grievous havock of the Flowers and Fruits*", and then return by the same route. He also mentioned that winged ants "*fly up and down in the air*". In discussing bioluminescence in an Observation ostensibly concerned with physics, Hooke mentioned glow-worms as an example of the production of light without "*tangible heat*", and how those insects "*can at pleasure either increase or extinguish that Radiation*".

Micrographia's influence on early entomology

For the seventeenth century and later scientists who read *Micrographia*, Hooke had opened new avenues to them – and not just at the microscopic scale. William Derham, Antoni van Leeuwenhoek and Jan Swammerdam were likely stimulated to undertake some of their own investigations as a result of delving into the entomological cornucopia that is *Micrographia*:

By removing the halteres from a fly, Derham confirmed Hooke's hypothesis that those organs are involved in the control of flight (Derham 1713);

Hooke's *Micrographia* account of the structure and motion of dipteran forewings and halteres very likely inspired Derham to perform that experiment. Antoni van Leeuwenhoek based not only his design of microscope, but also his initial choice of insects (and other specimens) on *Micrographia* (in the Dutchman's early works, "*the line of influence is unmistakable*" states Ford [2009]). According to Cobb (2000) Jan Swammerdam may have been inspired to undertake microscopic examinations of insect structure as a result of reading Hooke's book, while Meli (2010) suggests that the flaws in Hooke's drawings of the mosquito motivated Swammerdam to produce his own versions. Perhaps Hooke's writings on *Culex* provided part of the inspiration for Swammerdam to take a close look at insect reproduction and metamorphosis – with paradigm-shifting consequences (see Cobb [2006] for an engrossing narrative). [I should also mention John Ray: we know that, by 1668, he had examined *Micrographia* (Lankester 1848).]

Entomology as a scientific discipline is considered by some historians to have begun with the publications of Redi (*Esperienze Intorno alla Generazione degl'Insetti*, 1668), Swammerdam (*Historia Insectorum Generalis*, 1669), Malpighi (*Dissertatio Epistolica de Bombyce*, 1669) and Ray (*Historia Insectorum* 1710). Although it would be hard to justify applying the label of 'entomologist' to Hooke, he can be argued to have at least helped to lay the foundations of entomological science by virtue of his pioneering empirical investigations into, and his speculations on, insect life-cycles, structure, physiology, behaviour and even population ecology. The full title of Hooke's book is: *Micrographia or some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries thereupon*. Perhaps if it had made explicit reference – like the titles of Redi's, Swammerdam's, Malpighi's and Ray's books – to *insects*, entomologists of the late modern era might have appreciated Hooke's writings for their significant entomological content much sooner. This *Antenna* article will, I hope, help to secure a well-deserved, prominent place for Robert Hooke in the minds of present-day and future entomologists.

Acknowledgements

Figures 1-8 are reproduced by permission of the Rare Book and Manuscript Library of the University of Pennsylvania. Figure 9 is reproduced by permission of The British Library Board. I thank Mike Claridge, Matt Dray, George Jervis and Peter Smithers for commenting very usefully on drafts of this article. I am also grateful to the taxonomic experts who helped me to identify the insects illustrated and discussed in *Micrographia* - see Jervis (2013) for full acknowledgements. Charles Godfray kindly advised me that the 'flies' which emerged from Hooke's beetles might have been wasps. I also thank the various biographers of Robert Hooke whose writings inspired me to look more closely at *Micrographia*. Lastly, I thank my wife, Julia, for her immense tolerance of my frequent Hooke-induced trances and Hooke-inspired monologues.

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European Congresses of Entomology – a brief history

Helmut van Emden

From 3-8 August 2014, the Society will be hosting the tenth European Congress of Entomology at the University of York. The Society has already hosted congresses in this series twice before, again at York in 1990 and the first such congress in 1978 at my own university, Reading. It occurs to me that I am probably the only person who knows the full story of the European Congresses of Entomology over the 36 years of their existence, and the forthcoming tenth congress seems a good opportunity to put the origins of the series on record.

In 1976, the 15th International Congress of Entomology was held in Washington, D.C. Most of the programme was devoted to symposia of invited speakers, mainly American, who literally read the papers of their students that we were told had been "unable to secure travel funds". Younger hands-on researchers from other continents were shoe-horned into three minute slots from 8pm onwards – a time when those not speaking that evening were networking in local restaurants. You will have gathered that the scientific programme thus left a lot to be desired, and dissatisfaction with it motivated two forest entomologists, Siegfried Bombosch (Göttingen, Germany) and Alf Bakke (Åls, Norway) to conceive European congresses as easier for younger European entomologists to attend; they would be held half-way between the international ones. This made 1978 the target date for a first European Congress of Entomology, intended to be held in Germany.

Our two enthusiastic forest entomologists soon discovered that reaching agreement on where in Germany the congress might be held was going to prove impossible; as time was passing they switched their attention to the UK, which at that time had the attraction of cheapness with a fairly devalued pound. A letter (in German; in 1976 English was not yet the universal form of communication) was therefore written to our Society, urging it to run the first European Congress of Entomology. I was known to be pretty fluent in German, and so I was called to London to translate the letter for Council. The letter required a reply in German: there was then further correspondence and, once I had booked lecture rooms and accommodation at Reading on behalf of the Society, it became inevitable that I would finish up recruiting an organising committee. The dates of the congress would be 19-22 September 1978, and time was now getting really short. The box below lists my committee. There were two non-entomologists to enable logistics to be managed and problems to be solved if the rest of us wanted to be in the lecture sessions. Don Broom was a vertebrate behaviour colleague in Zoology, and Bill Watts was in the Registrar's Department. Bill had an

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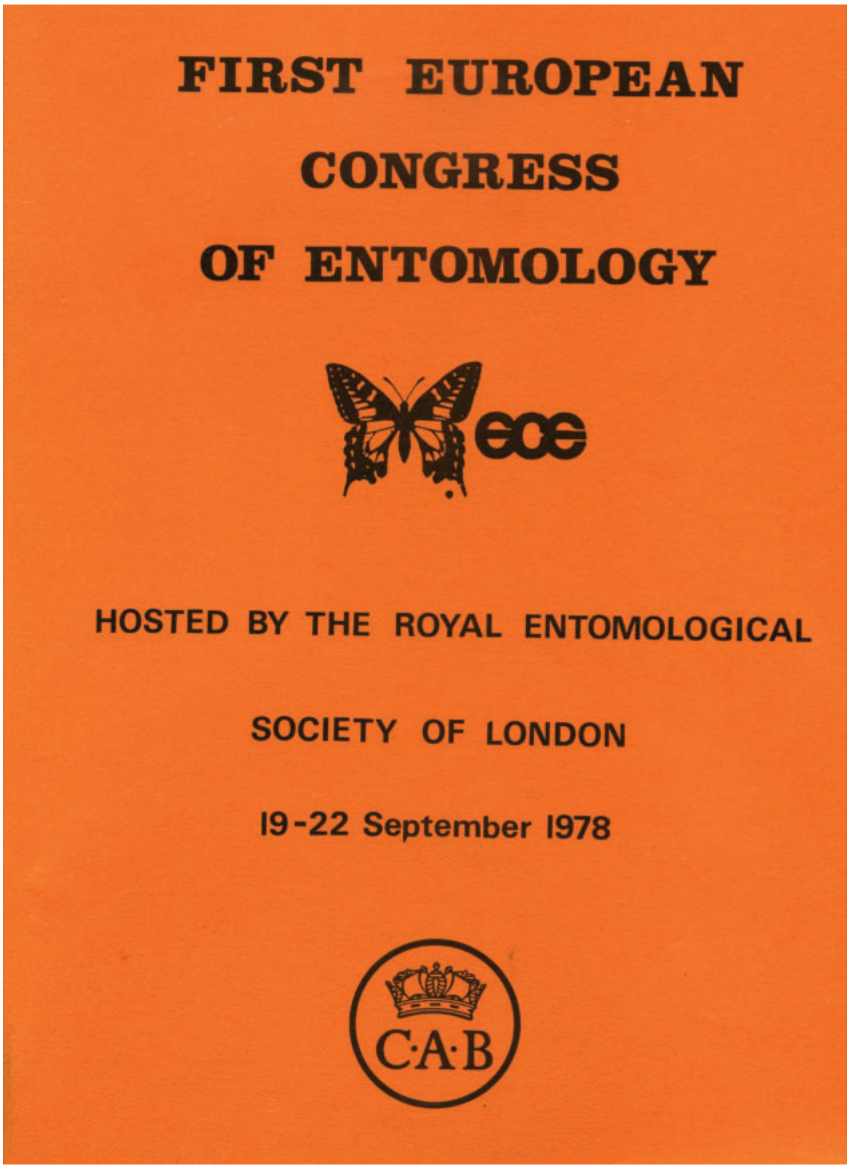

Figure 1. The cover of the Conference Handbook and Programme for the first congress.

amateur interest in dragonflies but, more importantly in 1976, he had access to expensive and wonderful machines that could copy documents, print labels, etc. Such things were still unheard of in academic departments! Don and Bill proved an inspired choice; the congress office became a social focus and Bill stocked everything he thought might be needed – like safety pins, pens, postcards and stamps.

Early registrations were alarmingly low. Our sole publicity had been a 'round robin' to the secretaries on an out-dated list we had of entomological societies in Europe. Many had no headquarters and our letters went to private addresses; in many cases the information probably went no further. At the official deadline for registrations we had only nine participants offering two papers between them. Fortunately things eventually picked up, and we finished up with 150 entomologists from 16 countries presenting 70 oral and 14 poster presentations. In exchange for receiving the presentation abstracts, CABI printed the conference booklet for us free of charge. Figure 1. shows the cover of the booklet, and the other pages remind me that the organising committee was quite ambitious. We mounted an "accompanying persons" programme with trips to London, Windsor and Mapledurham House, and on Wednesday afternoon there was a choice of scientific visits to Rothamsted, Silwood Park or the Pest Infestation Lab. in Slough. On that afternoon everyone finished up in South Kensington for the President's reception at the Society's then HQ in Queen's Gate. I see we usually had three lecture rooms going at the same time, as well as a film programme and a trade exhibition. We had a congress tie for sale, produced a daily bulletin and had a message board which moved daily between the lecture venue (Fig. 2) and the Hall of Residence. We also provided facilities for photocopying, interpreting, currency exchange and travel arrangements; there was also information on local travel and recommended restaurants.

The atmosphere at the closing ceremony can only be described as "euphoric". Everyone seemed to have had a thoroughly good time and many bizarre proposals were made from the floor, including one that the organising committee should blow what was left in the funds on a dinner for themselves at an expensive London restaurant. Although passed with acclamation, the proposal was never acted upon! Everyone wanted a second congress in four years time, and the Swiss delegates thought their national entomological society would probably agree to be the hosts; the first European Congress ended on that optimistic note.

In the event, the Swiss offer never materialised, and so I went back to the Germans since they had been involved in the original idea. I struck lucky. The Germans had undertaken to run the 17th International Congress in Hamburg in 1984 and the lead organiser, Professor Berndt Hydemann thought a smaller dummy run at his university in Kiel would be helpful. A second European Congress of Entomology in 1982 would be eminently suitable for this. Problem solved. At Kiel, an offer to host the third congress came from The Netherlands, and so the third congress was held in Amsterdam in 1986. To me, this was a critical landmark. I had always expected the enthusiasm generated at the Reading event to lead to a second congress, but had felt that only a third would confirm that the series was likely to continue.

However, there was now a hiccup, and no offer to host the fourth congress was made in Amsterdam. Thus, when the Hungarians eventually stepped forward with an offer, it was too late to make 1990, and the fourth congress (in Godollo) was not held till 1991. Because of the hiccup, the Godollo congress agreed that the hand-to-mouth organisation of congresses should be replaced with the formation of a Standing Committee of

The growth of ambition: The first congress venue (Fig.2, left) compared with that of the seventh in Thessaloniki (Fig.3, right).

representatives of national entomological societies.

Our Society had offered to put the congress schedule back on track with the fifth congress held at York in 1994, a highlight of which was the Congress dinner held on a platform of the York railway museum!. The RES had also been charged with forming and chairing the new Standing Committee; I wonder if you can guess who got the job? So yours truly contacted all the known national entomological societies in Europe, and enough responded with nominations to enable a representative Standing Committee to hold its first meeting at the York congress. In order to avoid a life sentence, I obtained agreement that, at the end of each congress, the Chair should pass to the national Society that had been the host. Each European congress would also provide an opportunity for representation on the Standing Committee to change.

At York, some confusion was created by the convenors of the Godollo and York congresses (Laslo Papp and Duncan Reavey) proposing that a European Entomological Society should be formed. This would cater for individuals in those countries with no national society, but it was unclear what it might mean for entomologists in other countries or whether it would take responsibility for the European Congresses of Entomology. Before the RES could discuss the issue, a meeting at the York Congress had already approved the formation of the European Society, and many entomologists had paid their first subscription. However, the whole thing came to nothing and, with Duncan Reavey re-locating to South Africa, the new "members" heard no more.

The formation at York of a Standing Committee made it possible to announce at the closing ceremony that the sixth congress would be hosted by the Czechs in Ceske Budejovice in 1998. Here it was agreed that the next congress in 2002 would be in Thessaloniki in Greece, and – job done – I happily handed over the Chair of the Standing Committee to Tomas Soldan, the organiser of the Czech congress.

Now came the next "hiccup". Unknown to me, illness prevented Dr Soldan continuing in his employment, and so the Standing Committee was never involved in advising and supporting the Greeks in the organisation of their congress. Only at the Thessaloniki congress did I discover that Soldan's boss at the Academy of Sciences, Frantisek Sehnal, had single-handedly worked with the Greeks and ensured the continuation of the series.

My brother fell terminally ill in 2002 and, having decided there was no way I could leave the UK, I reluctantly did not register for Thessaloniki. However, my brother passed away not many weeks before the congress, and my wife and I agreed it would probably do me good to escape abroad. I therefore registered at very short notice, and – it being a hot day – turned up at the impressive venue (Fig. 3) for the opening ceremony with no jacket and a short-sleeved pink shirt. As soon as I entered the hall, I was grabbed by the chief organiser (who happened to be a past student of mine) and dragged to the platform to join the VIPs, all in serious dark suits! I was then introduced to the audience as the "founder" of the European congresses, and asked to give an off-the-cuff speech. So I said a few words about how the congresses started. Fortunately I was wearing the tie from the Reading congress, which enabled me to point out that I had omitted wearing a jacket in order not to hide the tie!

At the closing ceremony in Thessaloniki, it was proposed that a new Standing Committee with a less transient constitution be formed, and names were proposed and duly elected. The members of this Committee would serve for a fixed period, and be replaced by invitation. This Standing Committee has operated successfully for over ten years, and is now called the "Council". It has a formal constitution, which can be found at www.europeanentomology.eu. Also at the closing ceremony, I was honoured to be elected as "Honorary Life President of the Standing Committee (now Council) for European Congresses of Entomology"; with this title came the promise of a case of quality Greek red wine. My good friend Frantisek Sehnal was thanked for his great help to the organisers of the congress, and presented with a beautiful illustrated book of the region. He walked off with his prize, I've never seen mine!

The 2006 congress (number 8) was held in Izmir (Turkey) and the ninth in 2010 returned to Hungary; it was held in Budapest. And so now we reach the milestone of number 10, to be hosted by the Society at the University of York. I am thrilled that the series took off in the way it has over the last thirty-six years; its future seems assured. Not only have the congresses grown in size, but also in the professional logistics of their organisation (compare Figs. 2 and 3). The first congress in Reading was very simple in many ways, such as in the lack of banners, signs and printed material – nowadays European Congresses of Entomology are not that less impressive than the international ones!

Watch the dragon, see the change: A brief report of a session on biomonitoring at the International Congress of Odonatology in Freising, Bavaria

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Recently, the largest international biannual get-together of dragonfly specialists and enthusiasts worldwide, the International Congress of Odonatology, was held in Freising, Bavaria from June 17th-21st. There I organized a session with my colleague, Jürgen Ott (L.U.P.O. Gmbh), titled "Watch the dragon, see the change", and gave a talk by the same name. As the title suggests, this session was on the use of adult dragonflies as indicators of ecological change. The slogan was catchy enough for the conference organizers to print "watch the dragon" on the conference bags, and to print "follow the dragon" on the bright orange T-shirts of the conference personnel.

The freshwater habitats of dragonflies are rapidly changing, in what has been dubbed the anthropocene, or the age of humanity. Unfortunately for dragonflies, and all other animals and plants that share their aquatic and semi-aquatic life style, many of these changes have negative impacts on their regional distribution and result in changes in both species numbers and numbers of individuals. These impacts can be the result of environmental stressors such as pollution and water abstraction, or ecological changes including habitat degradation and anthropogenic climate change. Dragonfly assemblages are extremely sensitive to these changes, as these are often composed of both a good number of sensitive specialist species and tolerant habitat generalists. For example, in South African rivers, invasive trees such as Black Wattle (*Acacia mearnsii*) shade out dragonfly habitat and reduce water flow. This causes the sensitive, sun-loving stream species to disappear, and impoverished assemblages of generalists to remain.

Using adult dragonflies (the term 'dragonflies' being used here as the collective term for Odonata, which includes both dragonflies and damselflies) for bioindication of stream or wetland habitats makes sense, as despite their great dispersal ability, most remain close to their natal habitat, near the water's edge, to mature, mate and lay eggs. The adults are also easily observed and identified, as they have conspicuously coloured body parts, whether they be red and white legs, a metallic green head, grey-blue eyes, orange wing bands or blue-and-white wing spots. Indeed, second only to butterflies, dragonflies are now a favorite past time for "twitchers".

The drab dragonfly larvae are far more difficult to sample, as they have clumped distributions in their aquatic habitats. Thus qualitative sampling is more effective for getting larvae than standardized sampling, but this is more time consuming. In addition, in many countries, particularly the tropics and subtropics, larvae are not well known and remain undescribed. Thus they are often only identified to family or genus level. Even then, the rarer sensitive genera are often mistaken by freshwater practitioners for the more common tolerant genera. Fortunately, the structure of adult dragonfly assemblages reflects that of the benthic macroinvertebrates. In addition, a major advantage is that adult dragonflies are identified at the species level, instead of the family level, as macroinvertebrates often are, at least in the majority of countries outside of Europe and North America. Thus their taxonomic resolution is much higher, and an index based on their diversity much more sensitive.

Against this background, I introduced and compared all three dragonfly indices currently used. These are the Dragonfly Biotic Index (DBI), the Odonata Habitat Index (OHI), and the Odonata Index of Wetland Integrity

Figure 1a. Mahogany Presba, female (*Syncordulia venator*). This is a rare, stream-dependent species, endemic to the Cape Floristic Region, South Africa. Larvae of any of the four *Syncordulia* species recorded in South Africa are extremely difficult to find with some larvae, but mainly exuviae, from only two species having ever been discovered. Total Dragonfly Biotic Index score = 7.

Figure 1b. View over the stream habitat the Mahogany Presba might be found to frequent: the Palmiet River, Kogelberg Biosphere Reserve, South Africa.

(OIWI). These are to-date the only biotic indices that use adult dragonflies as bioindicators. Indeed, this is a surprisingly recent method, with its first origin 12 years ago in Austria. There Chovanec & Waringer (2001) developed the OHI for indication of the ecological integrity of lowland streams. The Dragonfly Biotic Index has its origin in South Africa (Simaika & Samways, 2009), and although mainly used all along the stream continuum, it has also found application for measuring the ecological integrity of natural and artificial ponds (Rosset *et al.*, 2013), in South Africa, France and Switzerland. A very recent addition, the OIWI (Kutcher, 2011), actually is an index derived from an indicator developed in North America using wetland plants as indicators of habitat integrity. At the session, I presented a comparison of all three indices on a dataset collected at 10 streams, representing 20 sampling sites in the south-eastern Cape of South Africa. The OHI and OIWI had to be modified so that they could be used to indicate the changes along streams. The OIWI performed similarly well to the DBI on the same test dataset, which used a macroinvertebrate index as the basis for comparison (for DBI analyses see Simaika & Samways, 2011, 2012). Interestingly, the DBI and OIWI did not correlate well, indicating that the OIWI may provide additional habitat information. This is an important point to consider, since the basic building blocks that make up an indicator determine what is measured. Different building blocks will lead to different measures. As an analogy, consider the view of a tree in a courtyard from different windows of the building surrounding the tree. Each window will provide a different perspective of the tree. It makes sense therefore that different indicators should respond similarly to the changes in the same habitat, in terms of magnitude and direction of the change, but may be quite dissimilar in comparison to one another.

Several other presentations on the DBI followed. Michael Samways (Stellenbosch University) and John Simaika in “Getting the measure of freshwaters using dragonflies in a changing world,” presented the inner workings of the DBI. The index is a species scoring-based method (Simaika & Samways, 2009), composed of three sub-indices: its geographic distribution (score 0 to 3), threat status (based on IUCN Red List criteria) (score 0 to 3), and sensitivity to disturbance (score 0 to 3). A particularly range-restricted, Red Listed and sensitive species may have a maximum score of 9, while a geographically widespread, tolerant generalist, which may even thrive in disturbed habitats, would score 0. The DBI scores of all species in a habitat are totalled together to give the total DBI score. However, these scores should not be simply compared across regions. For example, in South Africa, the geographic variation in the centers of endemism and richness leads to situations where the naturally species poor habitats that are home to endemics loose out to the species rich areas full of widespread and tolerant Afrotropical species. A simple way of standardizing the DBI is to simply divide the measure by the number of species, giving the DBI/Site. This is not the end, however, since the score still needs to be interpreted, which for rivers, should be done separately for upland and lowland stream sections, as is also done in surveys of other aquatic macroinvertebrates. The Dragonfly Biotic Index, its workings and the exciting species the index is based on, will be presented by Samways & Simaika in a new handbook, titled “Manual of Freshwater Assessment: The Dragonfly Biotic Index”. The DBI also has an international face, with colleagues from Argentina, Federico Lozano and Javier Muzón (Instituto de Limnología, Argenina) presenting in “Use of the DBI in southern South America: first steps in Argentina” the development of new scoring criteria for the DBI. Adapting the use of the index to new geographic regions provides new challenges, as, for example in Argentina, dragonfly and damselfly species are not yet officially Red Listed in all regions. Nevertheless, colleagues have assessed 171 of the 256 known species using IUCN Red Listing criteria. The last presented work which made use of the DBI came from Upper Silesia in Central Europe, and was titled ‘Can post-mining areas be considered secondary biodiversity hotspots? Dragonflies already know the answer’.

Figure 2. Ceres Streamjack, male (*Metacnemis angusta*). Only known from two localities in the Cape, in the Cape Floristic Region. The larvae of the Ceres Streamjack live in small pools created by river braids. These pools have completely cut off from the main stem river, preventing water flow. Total Dragonfly Biotic Index score = 9.

Figure 3. Darting Cruiser, female (*Phyllomacromia picta*). A wonderfully colourful representative of the Corduliidae. Its records are scattered throughout South Africa. The species has been recorded up to Central Africa. It frequents dams and rivers, preferring to perch in trees. Total Dragonfly Biotic Index score = 2.

Sciences, Prague) and Aleš Dolný (University of Ostrava) used the DBI to measure the value of mine subsidence pools. They found that older mine subsidence pools (i.e. those which plants have recolonized by succession) have greater conservation value than farm pond or other pond habitats. These are valuable habitats to dragonflies, including some habitat specialists.

Jürgen Ott, in "How to monitor the unknown", presented on a selection of the rare and difficult to detect dragonfly species of Europe. Despite monitoring using adult dragonflies, larvae or even exuviae (the outer skins cast by dragonflies at emergence), many species still fall through the cracks in standardized sampling protocols. Such species may include *Ischnura pumilio* (Small Bluetail), *Coenagrion scitulum* (Dainty Damselfly), and *Gomphus flavipes* (River Clubtail), among others. Yet data collection must be according to rigorous scientific standards: the quantity and intensity of data collection must be sufficient, the methods appropriate and the data must be comparable with other investigations. Ecologists working in landscape ecology and planning in Germany have shown that, according to the investigated type of water, a minimum 5 to 9 trips to the field with about one hour of time in good weather conditions must be carried out to achieve a representative species list for the site. In general, however, these requirements are normally not reached, as agencies contracting field investigations funded fewer field trips of a lower intensity. In addition, the governmental agencies, which are responsible for checking on the scientific standard of the field investigations, accepted these procedures. Consequently, these studies were not according to scientific standards and the results should be regarded with caution. This is even true for the official monitoring programmes of species according to the Habitats Directive as the time lags between the investigations are too long and the general effort of the studies is too low. In the second part of the presentation it was pointed out that some dragonfly species have a very particular ecology, and these species cannot be monitored with the standard programmes. For example, the Eurasian Baskettail (*Epithaca bimaculata*) is best monitored by exuviae collections or adult sightings by boat. Another example was the Sombre Goldenring (*Cordulegaster bidentata*), which is thought to be rare, but when searched at the right places – isolated springs in the forest – is surprisingly abundant. Thus standardized sampling programmes often do not reflect the real needs and the present knowledge of species. Citizen science projects, which are becoming more and more popular, while valuable, also do not universally include these species.

Christopher Hassall's (University of Leeds) talk was titled "Placing the Odonata in the context of the biological response to environmental change: a case study using UK records." This presentation was particularly excellent, for which Chris later won a prize. In his talk, Chris investigated the potential of dragonflies as barometers of climate change, particularly as effective surrogates for other taxa. Their success as barometers, depends, however, (a) on the consistent response of dragonflies to climate change (e.g. range shift in response to a change in temperature), and (b) the agreement or congruence of the response of dragonflies (the surrogate) and the responses of other taxa (e.g. change in phenology). With great attention to detail it was shown that in congruence with other insect taxa, the ranges of dragonflies are changing, but that these range shifts are highly variable, as are patterns seen in other insect taxa. Changes in phenology are more conservative, but congruent with other insect taxa.

In the next talk, Tim Termaat (Dutch Butterfly Conservation) told us about the Dutch Dragonfly Monitoring Scheme. This scheme has been in existence since 1998, aiming to generate data on population trends, both in terms of distribution patterns and abundances. However, over the 15-year monitoring period, the programme has been able to obtain abundance trends for only 71% of the species, while in contrast distribution trends have been recorded for 81% species in the Netherlands. A pilot study in five different countries of northwestern Europe has shown that occupancy modelling can be used to generate supranational distribution trends for dragonflies. Thus, a future project aims at assessing pan-European distributional trends in dragonflies.

The last presentation by Klaus-Jürgen Conze (AK Libellen) also focused on the work of a stratified monitoring scheme, situated in North-Rhine Westphalia, Germany. In existence since 1997, the 'Ecological Area Sample' is comprised of a network of 200 sample areas, each being 1 km^2. However, until 2010 sampling has mainly focused on birds and their biotopes. In 2011-12 dragonflies were monitored, five times a year. Although difficulties in maintaining the standard used for collecting species have been noted, it is hoped that the data will be able to reveal future trends.

Acknowledgements

Many thanks to the colleagues who offered their time to present their research, making the symposium a great success. I am also grateful to the Royal Entomological Society and the Senckenberg Research Foundation and Natural History Museum Frankfurt, for providing funding to attend the ICO 2013.

Further reading

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Figure 1. *Maculinea arion* on flowers of the Sainfoin (*Onobrychis*) in their favourite 'upside-down' position.

Figure 2. *Maculinea arion* laying eggs into the flowers of Thyme.

Some observations on the Genera *Maculinea* and *Everes* in Central Italy and a problem of identification in the Satyridae

J. Firth

www.FirthFoto.co.uk

In Central Italy, and in particular in Southern Tuscany, where I spend the Summer months with a daily routine of photographing and observing the wildlife in general and the insects in particular, *Maculinea arion* is widespread and, in many years, extremely common. They particularly like the flowers of the Sainfoin (*Onobrychis*) and in neglected fields where this one-time fodder crop was formerly cultivated they can be found taking nectar from the flowers in their favourite 'upside-down' position (see Fig. 1).

Meanwhile, early in May the females can be found laying eggs into the flowers of Thyme plants, which form huge carpets along the margins of the fields (see Fig. 2). This photograph was taken near Arezzo on May 14th 2011, a year when they were particularly common. The individual shown is already slightly battered and has probably emerged from the Ant nest in the very earliest days of May.

Much later in the year however, often at the very end of June, there is evidence that some adults are still emerging, and these females have a problem, because in Tuscany, by this date, the Thyme has finished flowering. Late emerging females appear to solve this problem by choosing to lay their eggs on the closely related and much later flowering Marjoram as shown in Fig. 3.

This photograph was taken near Siena on June 24th 2009 and shows a pristine female which cannot have emerged more than two or three days

Figure 3. Late emerging females of *Maculinea arion* lay their eggs on the much later flowering Marjoram.

Figure 4. In Southern Tuscany *Everes alcetas* emerges early in the year and can frequently be found in late May.

Figure 5. Second brood *Everes alcetas* laying eggs on flowers of *Medicago lupulina*.

Figure 6. Newly emerged *Everes argiades* are frequently mated by what appear to be males of *E. alcetas*.

Figures 7 and 8. This unknown species appears to be resident near Arezzo.

before. I am not in a position to say whether eggs laid by this individual were able to develop successfully, or even to say with complete certainty that eggs were actually laid, but the observation raises intriguing questions as to whether all individuals are genetically programmed to respond to a lack of flowering Thyme in this way, or whether there is a separate race of late emerging *Maculinea arion* which habitually chooses the later flowering Marjoram as the preferred larval host plant (LHP). Unfortunately, since these observations were made the location near Siena has been partially destroyed by agricultural activity and I have not been able to repeat them elsewhere. Reports of this behaviour by other people would be extremely interesting.

This brings us to *Everes*, one of my favourite genera. Not a strong flyer like *M. arion*, the adults spend most of their time hopping about amongst the low-growing vegetation. In Southern Tuscany *Everes alcetas* emerges early in the year and can frequently be found in late May. Figure 4 was taken on May 23 2009, near Arezzo.

It is said that *Everes argiades* emerges earlier than this, but in the locations I have studied I have never found examples of this first brood of *E. argiades*.

Towards the end of June a second brood of *E. alcetas* begins to appear and Fig. 5 shows a female *E. alcetas* laying eggs on flowers of *Medicago lupulina* and not *Galega or Coronilla* sp., the LHPs stated by some authors. This picture was taken on June 26th near Arezzo.

About the same time adult *E. argiades* are emerging, and although the males are about, the newly emerged females are frequently mated by what appear to be males of *E. alcetas* as shown in Fig. 6.

Whether eggs produced by these females produce fertile offspring I cannot say, but it is at least intriguing to speculate on the precise relationship between these two species in Central Italy.

Finally, on several occasions during June 2013 I saw the butterfly shown in Figs 7 and 8 in a location near Arezzo. There appeared to be a small resident population although I never saw more than one individual at any one time. I am suggesting that the family is Satyridae and that the genus is *Erebia*, but more than that I am unable to say. I have sent pictures to several authorities but have received only a deafening silence! I would love to receive comments and suggestions as to its identity. Is it a form of another species such as *Erebia manto* (which is not thought to occur in peninsular Italy) or is it a new species? It was just slightly larger than *E. manto* and the habitat was hilly scrub but not high altitude or exposed.

Society News

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 5th September 2013

New Honorary Fellows
Professor S J Simpson
Dr J P Dempster

New Fellows (1st Announcement)
Dr Jennifer Perry
Professor Richard Michael Elliott

Upgrade to Fellowship (1st Announcement)
Dr Christopher Hassall

New Fellows (2nd Announcement and Election)
Dr Philip Iain Buckland
Professor Philip Charles Stevenson
Dr Muhammad Saeed
Professor Joon-Ho Lee

Upgrade to Fellowship (2nd Announcement and Election)
Dr Zain Ul Abdin

New Members Admitted
Mr Steven Paul Chambers
Dr Charles William Hornabrook
Dr Brian Harding

New Student Members Admitted
Mr Scott Tytheridge
Mr David Preston
Mr Aidan Thomas
Mr Aliyu Aminu

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

Deaths
Dr R W Hornabrook, 1956, New Zealand
Dr P F Prevett, 1654, Kent

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 9th October 2013

New Honorary Fellows
None

New Fellows (1st Announcement)
Dr Fernando E. Vega
Dr Floyd Wayne Shockley
Dr Jan Christoph Axmacher
Professor Rituparna Bose

Upgrade to Fellowship (1st Announcement)
Dr Thomas William Pope

New Fellows (2nd Announcement and Election)
Dr Jennifer Perry
Professor Richard Michael Elliott

Upgrade to Fellowship (2nd Announcement and Election)
Dr Christopher Hassall

New Members Admitted
Mr Robert Edward Sanderson
Mr Miles Hendley
Ms Lucy Catherine Finnegan
Mr David R. Blanchard
Ms Lauren Fuller

New Student Members Admitted
Mr David Robert William Stevenson

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

Deaths
None

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 4th December 2013

New Honorary Fellows
None

New Fellows (1st Announcement)
Dr Richard Michael Smith

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Dr Fernando E. Vega
Dr Floyd Wayne Shockley
Dr Jan Christoph Axmacher
Professor Rituparna Bose

Upgrade to Fellowship (2nd Announcement and Election)
Dr Thomas William Pope

New Members Admitted
Dr Neil Audsley (as at 9.10.13)
Dr Anca-Dafina Covaci
Mr Trevor Grigg
Dr Jonathan P L Cox

New Student Members Admitted
Miss Ellen Dorothea Moss
Mr Joseph Mark Roberts
Miss Gemma Louise Baron
Miss Charlotte Rowley
Miss Eloho Emakpore
Dr Danyal Conn

Re-Instatements to Fellowship
Professor Peter William Verdon

Re-Instatements to Membership
Dr Elizabeth Lois Franklin

Re-Instatements to Student Membership
None

Deaths
Mr G H Allison, 1968, South Africa
Dr J P Dempster Hon.Fres & Past President, 1952, Wiltshire
Professor J L Cloudsley-Thompson, 1950, London
Professor M Locke Hon.Fres, 2001, Canada
Mr E Friedrich, 1987, Germany

NATIONAL insect WEEK

25 JUNE to 1 JULY 2012

Celebrating Great British Insects

National Insect Week

Millions of insects, thousands of people, hundreds of events, one week

Dr Luke Tilley

RES Director of Outreach and NIW Coordinator

www.nationalinsectweek.co.uk

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Twitter: @insectweek

Every two years, the Royal Entomological Society coordinates a week of events and activities to draw the public's attention to the fascinating world of insects and the importance of entomology. National Insect Week has built a substantial audience amongst the general public, education sector, wildlife, environmental and natural history groups since it first took place in 2004. Through a nationwide programme of fun events for all ages, the week helps thousands of people to discover invertebrate diversity and learn more about the entomological research that increases our understanding of the natural world.

Of course, National Insect Week (NIW) is only possible with the support of the official partner organisations and the scores of enthusiastic entomologists, amateurs and professionals, which donate their time and expertise to this biennial initiative. Some organisations and individuals have contributed to NIW since its beginnings almost ten years ago; many others have joined during subsequent years and yet more have become partners in preparation for the next campaign in 2014. There is now a growing list of 67 partner organisations affiliated to National Insect Week and, together with many individual entomologists that lead events and organise activities, NIW has become a strong platform from which the entomological community can inform the public about the importance of insects, and the excellent work of the entomologists that study them of course.

It is clear from the levels of public participation and media interest that NIW now attracts that all those involved have become greater than the sum of their parts. It is very difficult for the public and media to ignore the enthusiastic voices of so many, all giving their time to communicate their work and passion during an intensive week of entomological interest. We are, therefore, keen to hear from any members and Fellows that would like to be involved in NIW 2014 (23rd June – 29th July). If you would like to organise an event, contribute to the teaching resources, bring to attention some research that deserves a wider audience, or you have an idea for something new, then please email the NIW team: info@nationalinsectweek.co.uk.

During 2012 (25th June – 1st July) the NIW campaign particularly, but not exclusively, focused on "Celebrating Great British Insects", drawing on the Diamond Jubilee of the RES patron, Her Majesty the Queen, and the 2012 London Olympics. The aim was to encourage the public to discover the thousands of insect species that can be found in the British Isles.

As a preview to the week, Andrew Halstead (Royal Horticultural Society Principal Entomologist) led a small team of entomologists who spent the Friday before NIW itself in the gardens of Clarence House (the official residence of HRH the Prince of Wales)

Budding entomologists with HRH the Prince of Wales.

invertebrates. The weather was not ideal being cloudy, windy and cool. Despite this, 237 insect species and eleven other invertebrate species were recorded. Thirty children from Wolsey Junior School Croydon spent four hours, with Dr Roger Key, assisting the entomologists and learning about the insects they can find using simple equipment, such as sweep nets, pooters and beating trays. Andrew Halstead and Prof Jeremy Thomas accompanied HRH the Prince of Wales around the garden to demonstrate some of the techniques being used by the entomologists and children to collect insects.

Having enjoyed the lively atmosphere in his gardens, HRH the Prince of Wales invited the NIW team to organise an invertebrate bioblitz at Highgrove House and Gardens for NIW 2014. As expected, press coverage of the event was widespread and the day provided an excellent preview for NIW. The endorsement by HRH the Prince of Wales of NIW, as an initiative, was a welcome addition to the 2012 campaign.

After the royal event, the official launch was held in glorious sunshine at the Mansion House and Garden of the Rose on 25th June, attended by partners and NIW 2012 sponsors (Lafarge Aggregates Ltd and Olympus). The RES Vice Patron, Lord Selborne, was also in attendance. The eminent composer Carl Davis and Three Fold Music performed two songs from The Creepy Crawly Songbook with the children of Killigrew School. The children's author Sonia Copeland Bloom read extracts from her Tales and Truths about Garden Minibeasts series of books. The event marked the official start of NIW 2012 and an opportunity to highlight and thank everybody that contributed to, or would be participating in, the 2012 initiative. Prof Jeremy Thomas and Lord Selborne

Sonia Copeland Bloom reading to children at the NIW 2012 launch.

Chef Lionel Strub with young entomophages.

gave speeches and the photography competition was launched by Prof Chris Haines. The day provided photographic opportunities and a chance for the partners to discuss their events and contributions.

A total of 306 events took place during the week, with details about each uploaded onto the NIW website (www.nationalinsectweek.co.uk), representing more than a 10% increase on 2010. Event organisers were provided with supporting information, a press release and merchandise. Insect hunts, talks, exhibitions, bioblitzes, craft activities, identification workshops and competitions took place up and down the country. A conservative estimate of 40,000 people participated in NIW 2012 activities and events at museums, zoos, nature reserves, schools, universities and parks. Some attendees were learning about insects for the first time and others were expanding their pre-existing interests.

Some highlights of the week were:

'*Insects as flying machines*' at RAF Museum London, a week-long programme of events about insects and flight. There was an afternoon of talks on one of the days, attended by 200 secondary school children. Prof Robin Wootton introduced the audience to the wonders of insect flight. Dr Jason Chapman also showed the audience how radar is used by entomologists to track flying insects. On the same day, more than 150 primary school children went on a bug hunt in the grounds of the RAF Museum, after making their own sweep nets.

'*Edible insects and minibeast hunts*' at National Trust Fountains Abbey. Yorkshire primary schools attended an event about insects as a sustainable food source, led by Mr Peter Smithers and chef Lionel Strub. The children were treated to a number of insect-based dishes and were shown the various ways that people around the world prepare and serve insects. This was followed by a minibeast hunt, led by Dr Roger Key, to explore the insect fauna in the grounds of the Abbey.

'*Inventomology*', a competition that invited primary school children to use the principles of entomology to design their own insect. Over 300 creative entries were received and feedback from children, parents and teachers was very positive. The winners were as follows:

Ages 5-7

1st Aishling Lynch with 'The Bunting Beetle' (see next page)

2nd Thea Wilkins with the 'Wicked Walking Fly'

3rd Idris Kroessin with 'The Long-Necked Rhinoceros Tiger Beetle'

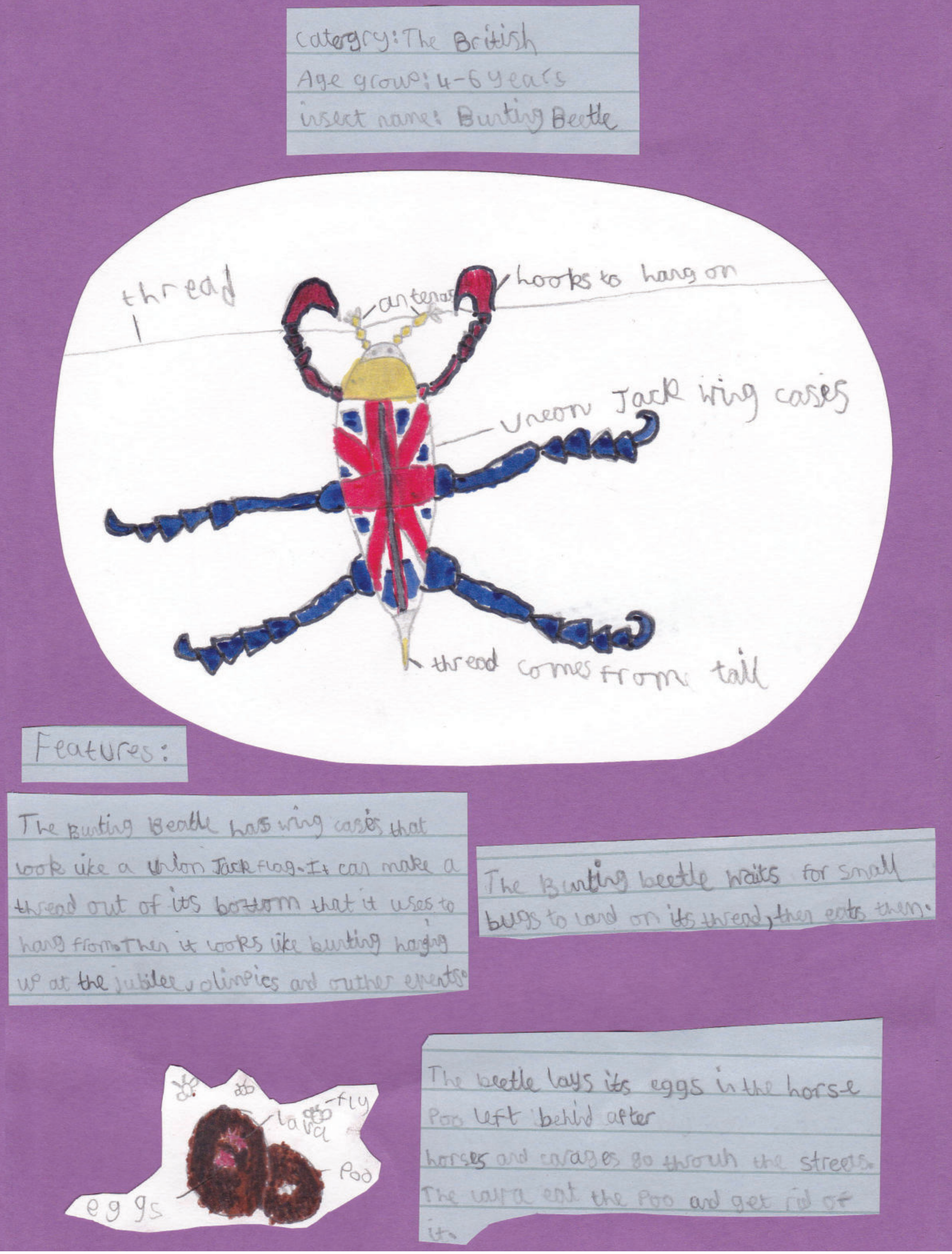
Ages 8-11

1st Joseph with 'Vampire Dragonfly'

2nd Max Chu with 'Cron Beetle'

3rd Joshua Beesley with the 'Bee Scorpy-Hopper Bug'

'*The Great Bug Hunt*', a classroom project requiring children to submit workbooks on British invertebrates, run in conjunction with the Association for Science Education to encourage and



The Bunting Beetle -inventomology winner, ages 5-7.

support learning about invertebrates in the classroom. More than 400 entries were received. The winning schools were:

1st Gwenfo Church in Wales Primary School, Wenvoe

2nd Bentley West Primary School, Walsall

3rd Kinson Primary School, Bournemouth

As in previous years, the NIW website (www.nationalinsectweek. co.uk) served as a focus for the public to find out more about NIW, and insects in general. The website was used to list the events taking place, provide information and resources, and allowed people to navigate to all of the partner organisation websites. The website also featured over 20 blogs by entomologists. Prof Stuart Reynolds' blog (60 years of insects) was the most popular and linked nicely with the Diamond Jubilee. Prof Jim Hardie's blog was also of particular interest with anecdotes about the identification of insects from his role as RES Director of Science.

For the first time, NIW also had a notable presence on social media (Twitter and Facebook). The NIW Facebook page (/nationalinsectweek) and Twitter account (@insectweek) were used to highlight events, interesting entomological news and to link with the official partners.

The teaching resources on the website continued to grow during 2012. The Times Educational Supplement Online (TES) and the Guardian Online Teachers Resources included activities, events and information sourced directly from the NIW website.

National Insect Week 2012 achieved its aim to promote awareness of the importance of insects, entomology and entomologists. It also contributed hugely to the Society's role of disseminating information about insects and insect science. The activities organised during 2012 reached more people than any other NIW campaign, with more events, more official partners, more online activity, more competitions and more media coverage than ever before. The NIW team would like to express sincere thanks to everybody that was involved in the 2012 campaign.

Now, we look ahead to 2014 and showing the public "*the little things that run the world*". If you would like to contribute to NIW 2014 please email info@nationalinsectweek.co.uk. As entomologists and scientists we have a responsibility to communicate our work to those that want to learn more. Younger people particularly enjoy the exposure to enthusiastic experts, teachers and parents appreciate the support and often learn a good deal themselves, and people of all ages love to see others talking about their interests and passions, especially when they are as fascinating as insects. Increased public understanding of entomology helps to secure a future for the field and better informs people's opinions about insects, whether they are pests, pollinators, food for other organisms or in need of conservation.

The Westwood Medal, Revisionary Taxonomy, and the RES

Quentin Wheeler

One of my accomplishments as Keeper of Entomology at the Natural History Museum was working with the leadership of the Royal Entomological Society to conceive the Westwood Medal as a means to bring deserved and much needed attention to the continuing importance of comparative morphology, revisionary taxonomy, and monography in entomology. The impressive research and scholarship embodied in such studies is only rarely publicly acknowledged. The idea was to both celebrate such scientific contributions and inspire the next generation of taxon specialists.

Just as embryological studies added ontogeny to paleontology and morphology to create the triumvirate of evidence of relationship that Louis Agassiz called the three-part parallelism, advances in technology have opened DNA as the latest evidentiary arrow in taxonomy's quiver. To some, the fact that we have studied morphology for five hundred years makes it an old and tired subject, but nothing could be farther from the truth.

My fervent hope is that the Westwood medal will play a part in reversing the perception and fortunes of morphology and revisionary taxonomy. The importance and usefulness of DNA data is established beyond question. With DNA we can identify species from a mere fragment or bit of tissue; we can unravel phylogeny where morphology is too variable or lacking to do so; and we have begun to pry open the black box holding the secrets to the connections between genome and phenome. Given these newfound data, why are morphology-based "descriptive" taxonomic studies important? Several answers are obvious.

Evolution. Morphology is often where variability and natural selection meet. To ignore detailed descriptions of morphology is to remain ignorant of many of the most fascinating and improbable stories in evolutionary history.

Owen effect. Just as Sir Richard Owen wowed his contemporaries by reading so much of the behavior and natural history of the *Moa* from a fragment of a femur bone, knowledgeable morphologists can infer much about the habits of an animal from its anatomical structure. A useful thing for all field biologists.

Biomimetics (nature-inspired design). Countless problems have been solved by turning to the adaptations of species for clues and inspiration. In spite of centuries of such success stories, an organised approach to biomimicry is in its infancy (Benyus 1997). It will be through descriptions of the three-quarters of insect species we do not yet know that we will open a vast library of possibilities to the engineers, inventors, and entrepreneurs who will identify more sustainable ways of meeting human needs.

Eyeball entomology. While leaving a legion of five-legged insects behind a wave of DNA-based field identifications is an option, and perhaps a necessary one for a few taxa, there will always be benefit and personally rewarding joy in having the ability to recognize species on sight. This is particularly true for ecologists, conservation biologists, agriculturalists, and others primarily working in the field.

Origins. For me, the primary reason to continue to explore and describe morphology in detail has to do with pure unadulterated curiosity. The reason I am a taxonomist is that I want to understand the origin and history of transformations that explain the evolution of the astounding structural diversity among insects. Like all the generations of taxonomists before me, this involves pursuit of twin interests in the histories of characters and species.

The challenge of reinvigorating morphology-based taxonomy is neither a scientific nor technological one. Since Hennig, our theories and ability to make descriptions of species rigorously testable hypotheses have never been better. Advances in cyber-enabled taxonomy, or cybertaxonomy, are in the process of removing every barrier to rapid progress in discovering and describing species primarily by opening access to data, images, literature, specimens, and colleagues. Within a few years, if we make the right priorities, all collections can be networked in cyberspace to create a highly efficient taxonomy research environment and a virtual global "species observatory" with which any of the billions of museum specimens may be compared side by side. This will make the completion of a first pass inventory of species possible in a matter of decades (Wheeler et al. 2012).

The challenge of sparking a taxonomic Renaissance is a sociological and political one, finding ways in which to debunk the myth that "descriptive" taxonomy is any less scientific than experimental biology, explain the philosophical fundamentals of hypothesis testing in comparative studies, and begin to restore taxonomy to curricula and taxonomists to faculties. In the middle of a biodiversity crisis the only thing that rivals the urgency of rebuilding taxonomy is expanding our museum collections so that future generations may continue to study and understand the origin and organization of the biosphere.

Cybertaxonomy has quietly begun a revolution to democratize taxonomy. Scientists in developing nations will have access to all that is known of their fauna; students at smaller institutions will have access to all the rare literature and specimens needed to do excellent work; and serious amateurs will have all that they need to become experts in their own right. By all indications, the 21st century is positioned to be remembered as *the* century of species discovery. No generation before appreciated the urgency of completing an inventory of species or had access to efficient tools for travel, communication, and doing revisions. No generation after will have access to so many species and so much evidence of the morphological diversity of life.

While I do taxonomy out of curiosity about the origins of the living "cosmos," it is also a supreme act of altruism. Future biologists will live on a species impoverished planet, yet their curiosity about details of the history of unbelievably improbable adaptations of species and the multi-billion-year history of the origin and diversification of life will remain undiminished. It is only through creating a permanent record of biodiversity in the form of collections, species descriptions, and phylogenetic classifications, augmented by as many sources of data as we can gather, that we assure science will continue to refine our knowledge of the history of life. It is only by recognizing the taxonomists engaged in this fundamental exploration that the sociological and political forces currently suppressing taxonomy can be overcome. I could not be more proud as a Fellow of the RES that our Society is leading the way. There is no doubt that this is an uphill battle, but all those worth fighting are.

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Meeting Reports

Postgraduate Forum 2013

Claire Dooley

The University of Oxford was privileged to host this year's RES Postgraduate Forum. The two-day event took place at Linacre College, one of the few postgraduate-only colleges in Oxford. To kick off proceedings the RES President, Jeremy Thomas, presented his account of "Life as an Entomologist". With tales of his ground breaking research in butterfly conservation and appearances in TV and radio Nature programmes, delegates really got a taste for the exciting elements of entomology. Other invited speakers included Jenny Molloy (University of Oxford) who talked about Open Access in Science, an exceptionally important topic in light of the current concerns in publishing and data sharing, and Nina Alphey (University of Oxford) who provided a myriad of thesis writing tips. Ian Kitching, the fourth invited speaker, offered a peek into the world of entomology at the Natural History Museum, London. Ian showed the audience how a single taxon has not only been used to address questions in climate change and invasive species research but also in the development of e-Taxonomy, online provisioning of high quality taxonomic information. This taxon, which he described as 'charismatic, clever and cute', was

Sphingidae, the Hawkmoths. Ian described how the combination of vast museum collections and expert knowledge of this family has resulted in it being a huge asset to scientific research.

Over the two days, thirteen postgraduate students delivered interesting and exciting talks covering a wide range of ecological topics. We heard about research in insect conservation from Claudia Gray and Rory O'Connor, infectious diseases from Pete Winskill and dispersal measuring techniques from Hayley Jones. We learned about work being done in the field of climate change by Will Hentley and Louise Mair, biocontrol by Romisa Asadi and invasive species by Dominic Henri. Field entomologists Daria Pastok and Hannah Wickenden gave great presentations on their research in spatial variation of insect ecologies, while Scott McKenzie took us into his lab with a pre-recorded video clip incorporated into his talk. This unique presentation allowed the audience to see the experimental set up Scott is using to explore feeding facilitation of above- and below-ground herbivores. The prize winning talks came from Richard Comont in second place and Chris Jeffs in first. Richard gave an outstanding talk on "Ecological correlates of extinction and colonisation in the British ladybird beetles" to compliment the excellent work he is doing in Coleoptera research. Chris, still in the first year of his DPhil at Oxford, gave an enthusiastic and concise account of his pilot study on Barro Colorado Island, Panama, with his talk entitled "Insect pre-dispersal seed predators cause negative density-dependent mortality in tropical tree species".

The poster session brought exhibits of studies spanning from Cornwall to Brazil, and created a wealth of discussion on topics from policy to bumblebee foraging behaviour. The awards for the best posters went to Charlotte Elston in second place and Marcus Blagrove in first place. Charlotte presented her work on "Sublethal effects of thiamethoxam, a neonicotinoid pesticide, and propiconazole, a DMI-fungicide, on colony initiation in bumblebee micro-colonies (*Bombus terrestris*, Hymenoptera: Apidae)", while Marcus demonstrated the research he has been doing on "The *Wolbachia* strain wMel completely blocks both Dengue and Chikungunya transmission in the mosquito *Aedes albopictus*". A special mention must also go out to Rudi Vespoor and Laura Riggi for accompanying their poster with pre-dinner insect snacks, an excellent appetiser before our Lebanese meal!

With such a vast diversity of entomological research being covered, this year's forum really proved to be a stimulating and fun couple of days. Thanks to all those who attended the forum, and to Jeremy Thomas, Ian Kitching and Gordon Port for taking on the difficult task of judging the student talks and posters. I'd also like to thank Kirsty Whiteford for the huge support she provided throughout the planning of the forum.

Using a Bioblitz to enthuse the public

Pippa Gillingham

Bournemouth University

I was recently kindly granted a RES outreach award of £350 to buy kit and identification guides to use at a Bioblitz run by members of the School of Applied Sciences at Bournemouth University on the 8th June 2013. A Bioblitz is a high intensity recording event, where members of the public help to find and identify species over a 24 hour period in a specified location. Several of these events occur every year nationwide. We chose to carry ours out in Poole Park since it is close to a main population centre, popular with families and the main aim of the day was outreach to the local community. I spent the grant money on fold-out charts from the FSC for all available insect groups, particularly for the most charismatic groups (i.e. bees, ladybirds, dragonflies) and the most child/family-friendly cards (Bugs on bushes, Insects). I also bought new family friendly kit (pooters, butterfly nets and hand lenses) to use on the day. Bournemouth University's Festival of Learning provided a marquee for the day to shelter us from any bad weather and provide an obvious meeting point.

The morning of the Bioblitz dawned sunny but with quite high winds, which was a theme for the rest of the day. I started early by putting out some pitfall traps before the park opened. We were soon up and running with the help of several undergraduate and postgraduate students as well as other members of staff from the department who had produced a printed colour guide to give out to families in the park with some charismatic species that they were likely to find pictured on it. In addition, Friends of The Earth had a stall in our marquee, with many members dressed as bees to promote their 'save the bees' campaign. As part of this they gave out Bee Saver kits that included wildflower seeds for people to plant at home.

A group of staff and students set out with binoculars and nets to scope out the park and look for potential habitats for different species. Part way round this walk I was joined by 5 year old Rosie Evans, who attends the local primary school, and her dad Dan. Rosie's homework for that particular week was to find as many minibeasts as possible, so naturally she had come to investigate the Bioblitz event. We set off to an area of long grass to hunt for butterflies, which Dan was very adept at catching for us to identify. We also used sweep nets to look for bugs and spiders, and Rosie did particularly well to notice some plant galls. She was also very pleased to spot several different bee species, earning her a badge from Friends of the Earth as well as a poster to show her school friends.

On getting back to the marquee, I emptied the pitfall traps with the help of a couple of families, and set some children to work using pooters to suck up the insects that had fallen in. Although there were not many present due to the short time the pitfalls were out, they seemed to enjoy this activity anyway. Later on some more children from the local school came to visit the marquee and spent some time looking at the pitfall contents and asking questions about the insects we had trapped. This was a particularly good activity as it is simple and easy to do at home in the garden, and several parents told me they will now be sinking empty jam jars into the soil in their gardens at home to see what they can find.

Overall I would deem the event a success, although I think it can be improved upon in the future. We found around 230 species in Poole Park and involved over 250 members of the public in recording them. The most successful activities at picking up passers-by seemed to be those where we collected specimens close to the marquee and involved members of the public in collecting them from samples (using nets and pooters for example). The DIY spotter guides were also popular, with some families returning after several hours to let us know what they had seen. We intend to run something similar in subsequent years and I think we can do much more to liaise with the local schools, particularly as they teach their pupils about minibeasts. I also think we could have more activities in the marquee itself, such as a design your own insect competition, colouring in sheets and perhaps face painting (which is used to great success during the bi-annual Insect Festivals held in York). All in all, it was a great experience, all the members of staff and students involved really enjoyed themselves and I would encourage anyone that hasn't already taken part to get involved in their local Bioblitz. We will certainly be looking for more experts and amateur enthusiasts alike to help out next year and anyone with artistic talents to help out with face painting would be most welcome!

To find out more about Bioblitzes going on across the nation, see http://www.bnhc.org.uk/home/bioblitz/

To find out about Friends of the Earth's Bee Cause see http://www.foe.co.uk/what_we_do/thebee_cause_home_map_39371.html

For more information on the Poole Park Bioblitz and to download the records generated, see http://www.pooleandpurbeckportal.co.uk/news/140/poole_park_bioblitz_records_now_available/

MEETING REPORT

Virtual scale issues XIII International Symposium on Scale Insect Studies, ISSIS, Sofia, Bulgaria

2nd to 5th September, 2013.

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Scale insects – the Coccoidea, a superfamily in Hemiptera – in many respects are most unusual insects. Sexual dimorphism is extreme (see Figure 1). Males are relatively conventional, being winged and flying, albeit erratically, with a single pair of wings and haltere-like structures that have them misplaced in Diptera accessions even by trained entomologists. Female adults are reduced in external morphology, flightless, more or less globular to ovoid, without an evidently delimited head, thorax or abdomen, and are sessile and sedentary. Weirdness includes life-cycles that lead to the dimorphic adults: 'prepupal' and 'pupal' stages occur in the (non-'holometabolous') male development, but no such stages exist in the female which undergoes one or two fewer moults than the male (depending on taxon), directly from nymph to the 'nymph-like' female adult. Not all coccoids follow this path, however, with males eliminated or present only sporadically in many species. The curious genetics (including extraordinary karyotype diversity and genomic conflicts) exhibited by these insects are subject to much contemporary study. Most curious is the system in *Icerya purchasi* (the cottony cushion scale, Figure 2) which Laura Ross (University of Edinburgh) and colleagues term androdioecy (the coexistence of males and hermaphrodites) – the only such case known in insects. Parthenogenesis in scale insects seems to encourage dispersivity. With nymphs and adult females feeding on phloem, many mealybugs, soft scales and armoured scales have become globalised plant and crop pests, whose control by chemicals, pheromones and natural enemies is a major research area.

Figure 1. Female and male (winged) *Coelostomidia pilosa* (Maskell), Coelostomidiidae, New Zealand.
Photograph: P. J. Gullan

Figure 2. Hermaphroditic adult of *Icerya purchasi* Maskell, Monophlebidae, Australia.
Photograph: P.J. Gullan

Ecologically, coccoids are known for both narrow host-specificity and for

Figure 3. Best young researcher awardees, left to right: Bora Kaydan (2010), Nate Hardy (2013) and Demian Kondo (2007). Far right. Peter Cranston. Photograph: P.J. Gullan.

extreme polyphagy. Being mostly phloem feeders (the major exception is Diaspididae), their plant-sourced diet is low in protein but rich in sugars with the excess usually eliminated as honeydew. This important natural resource provides carbohydrate provisioning, notably for the many ants which tend (perhaps even 'farm') scale insects. Scale insects are veritable chemical factories, producing crimson pigments either derived from *Kermes*, favoured by Mediterranean peoples as one of the oldest organic dyes, or in the form of carmine dye (cochineal), used by Aztecs and Mayans in Central and South America. These 'natural' red colours continue to be used in the food industry, but sadly no longer in the aperitif Campari. Other coccoid-produced chemicals include an extraordinary range of waxes from diverse cuticular glands, and some used by humans include lac and shellac.

Given such a range of biological important phenomena exemplified within the superfamily, it may come as a surprise that researchers on these insects can find enough coherence to meet every three years to discuss their studies. Actually, thirteen International Symposia on Scale Insect Studies (ISSIS) have now taken place, with the most recent held in Sofia, Bulgaria, in September, 2013. This was organised by Katia and Georgi Trencheva of the nearby Bulgarian University of Forestry, with Vladimir Alexziev skillfully managing the audiovisuals. Papers and posters presented by over seventy participants covered all the areas of coccoid studies mentioned above, and more.

The Royal Entomological Society has had a long association with scale insect studies, most notably in publishing papers on the taxonomy and systematics of the group. Therefore, to coincide with the Sofia meeting, *Systematic Entomology* editor Peter Cranston, our society and Wiley publishers assembled a virtual issue on Scale Insect studies. For those who have missed out on the phenomenon, virtual issues bring together a dozen or so previously published papers covering a particular topic, making them available electronically with free unrestricted access. Eight thematic virtual issues have been compiled for *Systematic Entomology* over the past five years, associated often with gatherings such as the Entomological Society of America and International Congress of Entomology. Nate Hardy, now of

Auburn University, Alabama, introduced the issue with a review on the status and future of scale insect (Coccoidea) systematics. With Chris Hodgson, he also authored one of two newly published articles, concerning the value of the rather neglected male scale insects in phylogeny. The twelve other articles range from excellent alpha-taxonomic work to state-of-the-science molecular studies. Some studies highlight the difficulties in reconstructing evolutionary relationships for insects with seriously limited morphology, and illuminate the insights that can come from molecular phylogenetics. Nate's published review, also presented orally to the meeting, provided guidance to maintaining the balance between classical morphological and molecular work and the developing field of transcriptomics, with its potential to provide massive amounts of data and resolve some of the most difficult (deep) relationships in the Coccoidea.

Evidence for the value of a robust estimate of the evolution of the scale insects came in many talks in Sofia, including those concerning relationships with ants, understanding the role of karytopic evolution in cryptic species formation, in the distribution of paternal genome elimination and hermaphrodism, in interpreting host plant and endosymbiont evolution, and in recognising ancient radiations associated with host plants. These evolutionary studies came from several labs, notably those of Lyn Cook (University of Queensland, Brisbane, Australia), Ben Normark (University of Massachusetts, Amherst, USA) and geographically dispersed ex-members of Penny Gullan's lab (formerly University of California, Davis, now retired to Canberra). Molecular approaches were evident also in many studies seeking to understand the species limits of certain pest taxa, and their dispersal pathways to becoming nuisances outside of inferred native ranges.

I am surely not the only entomologist wondering which currently obscure species (or complex of species) will evade quarantine and become the next invader of our crops, horticulture or ornamental plant nurseries. But will there remain enough taxonomic expertise to recognise the species when the inevitable happens? As the meeting drew to a close, Maurice Jansen, whose position with the Netherlands Government is at the 'coal face' of quarantine intercepts and identification, drew our attention to the precarious position of the taxonomic workforce, challenging our abilities to recognise and act on incursions, and to do the necessary systematic research to support biosecurity. Nate Hardy addressed this issue in his review – everyone is having to do more (globalisation), with less resources (funding cuts). It seems extraordinary that the two institutions with the longest traditions, largest collections and greatest responsibilities, lack expertise dedicated to the group; thus Dug Miller has not been replaced at USDA in Beltsville, and the Natural History Museum, London, erstwhile home of Douglas Williams and Jon Martin, similarly lacks a specialist since their retirements. How can biocontrol succeed without professional expertise in the host insects? We know the answer of course, with past costly programmes threatened or invalidated by inadequate taxonomy. Must it take another cassava mealybug to expose that our reliance on an ageing cadre of retirees and naive biocontrol amateurs is not the way to go?

A likeable aspect of the ISSIS are the awards and recognition given to young researchers and more senior practitioners, plus obituaries prepared for those deceased since the previous meeting. The latter were the prolific and internationally respected Hungarian coccidologist Ferenc Kozár and the highly productive Rosa Henderson from the New Zealand Arthropod Collection. Tributes were given to senior colleagues Jan Giliomee (South Africa), Danièle Matile-Ferrero (France) and Imre Foldi (Hungary-France). The best young researcher award went to Nate Hardy, following previous winners Bora Kaydan (from Turkey) and Demian (Takumasa) Kondo (from Colombia). The three are pictured (Figure 3) along with your reporter at a traditional Bulgarian social dinner, with rakija.

As a non-specialist attending as an 'accompanying person' I was most impressed by the collegiality of the group and ongoing interchange and collaborations of researchers. This cannot be said for all such meetings, whether taxon- or topic-based. The location in Bulgaria gave two attendees in particular (myself and Chris Hodgson), along with some colleagues, the chance to see a pair of wallcreepers (*Tichodroma muraria*) in Trigrad Gorge in the scenic Rhodopi Mountains. Previously and elsewhere, this beautiful bird had eluded Chris and I for a combined total of over a century.

The next ISISS meeting will be hosted by Agatino Russo and colleagues in Catania, Sicily, in 2016. I eagerly await further insights into the evolution of this extraordinary group, and hope to hear of an expansion of professional expertise to cover the inevitable new incursions.

OBITUARY

John Patrick Dempster

BSc, DIC, PhD, DSc

24th June 1930 – 4th September 2013

Jack Dempster was elected a Fellow in 1952; serving on Council 1986 – 1989; elected Vice President 1987 – 1989; President 1989 – 1990; and made an Honorary Fellow of the Society, somewhat belatedly, in June 2013, only three months prior to his death.

Jack was born in London on Midsummer's Day 1930. His father, an electrician, was unemployed during the 1930's slump but, via house re-wiring, became a chandelier expert and worked in many famous properties in the city. During World War 2 Jack and his two sisters were evacuated to Totternhoe, Bedfordshire, where he was the only boy in a girls' class. At the age of ten, success in the eleven-plus examination took him to William Ellis School, then in Leighton Buzzard. In 1945 the school returned to its pre-war London premises in Highbury where Jack completed his studies in chemistry, physics, botany and zoology with a side-line in mathematics. Although originally planning to go into medicine his interests had switched to zoology, possibly as a result of childhood exploration of the rich local flora and fauna on what later became a National Nature Reserve. There is little doubt that his paternal grandfather, who was a keen naturalist, and Fellow of the Zoological Society, and retired at the age of fifty to curate his own collections and museum, also had a strong influence on young Jack.

The desire for a London degree, but with the wish to get away from home, took Jack to Hull University in 1948 where he discovered that they specialized in marine ecology. Determined as ever to pursue his chosen subject, arrangements were in hand for him to study entomology at Sheffield University when Hull, possibly impressed by his top place in their first year exam, imported a special tutor, J.R.T. Short, and entomology was added to the University's curriculum. When D.L. Gunn came to give a talk to the Biological Society on the work of the Anti-Locust Centre, as the Society's President, and only entomologist, Jack was called upon to host the guest speaker. Later, when socialising in Hull's Station Hotel, Jack must have made a good impression as he was told, "if you ever want a job – contact me". He did, on graduating in 1950, and spent a year in postgraduate research at Imperial College, Silwood Park before being assigned a post in East Africa. At the last minute the Centre's entomologist in Cyprus was taken ill and Jack was sent there for a year instead, studying the control of *Deciostauus maroccanus* (Moroccan Locust). On his return he studied grasshopper dispersal at Silwood Park during 1951/52, married Gill in August 1953, whom he had met in Hull, and wrote up and was awarded his PhD in January 1954. He was then sent back to Cyprus for another year, this time with Gill, to investigate habitat management as a means of locust control. On their return their daughter was born and, whilst writing up his research in the Natural History Museum, Jack got into a lift with Prof. O.W. Richards who asked, "what are you doing now?" and then surprisingly added, "would you like a job at Imperial College?" This had advantages over a possible posting to South Africa and he agreed to accept a post as Assistant Lecturer at half the salary he had been getting as an SSO with Anti-Locust. He was required to lecture second year undergraduates on Cytology and Genetics and spent several years working with Prof. Richards and Nadia Waloff on the infamous "Broom Patch" at Silwood Park where he studied the population dynamics of Miridae; work which led to him receiving Imperial College's Huxley Medal and Prize.

In 1964, seeking pastures new, or at least as a means of getting out of the Broom Patch, Jack filled in his first job application form and was duly appointed to a PSO post with The Nature Conservancy at Monks Wood Experimental Station, in the County of Huntingdonshire. He joined a growing group of scientists in the Toxic Chemical and Wildlife Section under Dr. N.W. Moore who had been investigating the effects of herbicides and pesticides since 1960, before the publication of Rachel Carson's "Silent Spring". At that time *Brassica* crops were routinely sprayed with DDT to control lepidopterous pests. Jack investigated the population dynamics of *Pieris rapae* (small white butterfly) and *Mamestra brassicae* (cabbage moth) on Brussels sprouts. He found that DDT killed the eggs and first generation caterpillars, but more eggs were being laid, and larvae surviving, on the fresh new growth resulting in better pest survival on the DDT-treated plants. He showed that not only were predators and parasites on the plants being killed, but also that ground living predators, such as carabid beetles, which moved onto the plants at night, were suffering sub-lethal effects. Parallel studies on *Hypocrita jacobaeae* (cinnabar moth) on Ragwort, which were to continue for at least ten years, were started at Monks Wood and on Weeting Heath, Norfolk. With these Jack showed that although eggs and young larvae suffered from arthropod predation, larger caterpillars were immune from predators, but mortality was density-dependent due to starvation from defoliation of the host plant. By 1971 this Section had become more Toxic Chemicals than Wildlife so Jack set up an Invertebrate Population Ecology Section to study special conservation problems involving mainly rare and declining species of butterfly, providing a springboard for several post-graduates to establish their future careers in entomology (including the Society's current President). It was around this time that Jack was awarded his DSc, and over the next three years he concentrated on a study of *Papilio machaon* (swallowtail butterfly) at Wicken Fen, Cambridgeshire. By comparing populations at Bure Marshes, Norfolk Broads, and Hickling Broad, he tried to establish why it died out at Wicken and re-introduction attempts had failed. Apart from paucity of its larval host plant and a drier fenland he showed that museum specimens of Wicken swallowtails were smaller and had shorter wings than re-introduced specimens and tended to be lost to emigration. From 1969 to 1972 he was editor for the British Ecological Society's *Journal of Animal Ecology* and was serving on the Society's Council in 1973 when The Nature Conservancy was dismembered, being replaced by the Institute of Terrestrial Ecology and the Nature Conservancy Council. During the ensuing restructuring Jack was promoted to DCSO, skipping a grade, becoming Head of the Division of Animal Ecology and Senior Officer at Monks Wood, remaining within ITE. Until this time all his research projects had involved relatively small groups of like-minded, dedicated, entomologists/ecologists. He was now the youngest member of the new ITE Management Group responsible for staff in many different disciplines and it came as a bit of a shock to find he was expected to be arbiter for a wide range of staff's personal and work-related problems. He tried to allocate at least one day per week to continue his own studies although one member of staff did suggest to him that NERC was not paying him twice as much to do the same job. He managed some collaborative work on *Gonepteryx rhamni* (brimstone butterfly), but in 1982 after further management restructuring he became Assistant Director (South) for ITE. Fortunately he was able to remain based at Monks Wood where he was able to carry out a three year study comparing populations of *Anthocharis cardmines* (orange tip butterfly) both within and outside Monks Wood. This study came to an abrupt end when he distributed pot-grown cuckoo flowers (the host plant) throughout the wood, only to return the next day to find that the muntjac had selectively eaten them all. It is doubtful if such a set-back was a contributory factor, but Jack decided to retire at the end of 1988. Even this event didn't stop his research as he obtained a Leverhulme Trust grant to continue his work at Cambridge University, and was co-editor with Dr I.F.E. McLean of the 19th R.E.S. Symposium volume published in 1998.

Early retirement freed up more time to rekindle his skills in watercolour painting and to devote more time to his large garden at Hilton, now in Cambridgeshire. Unfortunately failing health meant that he could no longer manage the garden to his own high standards. After a lengthy, unsuccessful, search for an alternative local property, in April 2013 he and Gill moved to Mere, in Wiltshire, where he was able to spend all too little time close their daughter Jane. I am indebted to my late wife who interviewed Jack in 1983 and 1988 and published these interviews in an ITE House magazine. It is a pleasure to thank Gill for providing extra anecdotes for the time before I first met Jack as an undergraduate at Imperial College in 1960.

Jack is also survived by his two sons Tim and Richard, and six grandchildren.

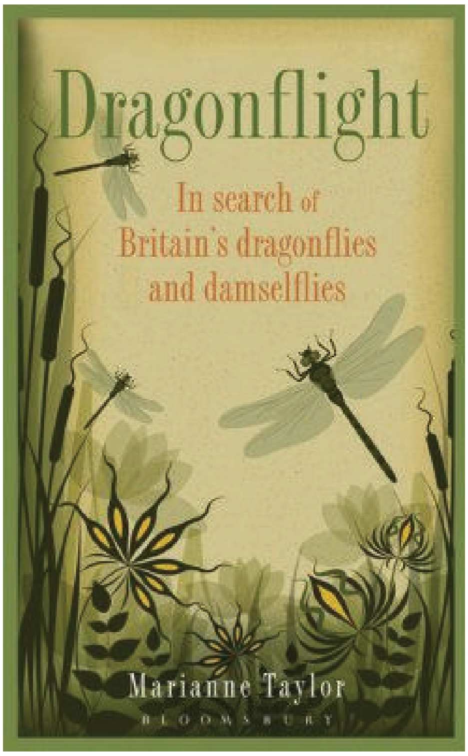
Dr. R. Colin Welch

Book Reviews

Dragonflight: In search of Britain's dragonflies and damselflies

Marianne Taylor

Bloomsbury



The book is the author's story of two years spent in search of 56 British species of Odonata, and a charming natural history diary of time spent during 2011 and 2012 around some wonderful and important freshwater habitats around Britain. Marianne, already a keen birder it seems, first embarked on a trip with an entomological focus in 1995. She sought butterflies on that journey, however, and did not turn her attention and camera lens to British dragonflies until one of her cats started to try and catch a specimen for itself, and eventually succeeded. From then, it did not take long for her to build an appreciation for dragonflies and damselflies leading to this account of trying to find, photograph, and learn about British dragons and damsels. The author is very good at describing her close encounters with the insects and other wildlife. The first chapters explain how she arrived at her quest and give a brief outline about the natural history and ecology of the insects for which she has developed a fascination. The majority of the chapters are named in honour of the main species she prepares to find and observe. Dainty line drawings are introduced throughout the text and there is a small collection of colour photographs in the middle of the book. The appendices offer some technical tips on Odonata photography. The unpredictable British weather features quite heavily alongside the other common frustrations of the natural historian on a quest for a particular group of species.

The author has a genuine obsession with the beauty and natural history of dragonflies and damselflies. The book often returns to her appreciation of what magnificent hunting and flying machines they are, and her poetic anatomical descriptions manage to capture the traits that have allowed this charismatic order of insects to remain relatively unchanged, in terms of body plan, for millions of years. This book will perhaps not offer much to the experienced entomologist based in the UK. It is, however, an almost romantic tale about how and why a person becomes infatuated with a particular group of insects. Something every passionate entomologist can relate to.

Dr Luke Tilley

Dragonflight – In search of Britain's dragonflies and damselflies

Marianne Taylor

This is not a traditional entomology book. It is about the Odonata, and there are some details about their life cycle and their identification. What this book is really about, however, is a passion for insects and natural history in general. The reader is taken on a quest to see all of the UK Odonata species over two summers, with the author learning about this group and their identification as she went along. Each chapter describes the search for a particular species and the circumstances and adventures that accompanied each trip. The writing style is beautifully simple and engaging. As a natural historian I felt transported to each spot and lived through each experience, with its successes, failures and difficulties, to the point where it is hard to believe that I wasn't there myself! Poor views, uncooperative photographic subjects, the tribulations of the weather, beautiful habitats and the accompanying people and species all make for rich and familiar stories. Another nice touch is that the author describes the etymology of the species binomials and how they relate to each species.

The book is not without scientific content and there are descriptions of taxonomy and life cycle stages in their own chapters, while behavioural observations are mostly woven into the chapters. There are also some useful tips on photographing Odonata and a short chapter on folklore.

While this book may not appeal to all entomologists, it is a wonderful way to escape the long dark days of winter for anyone who loves being out in the field looking at insects, particularly Odonata. If you have ever been in a beautiful habitat, surrounded by nature and content at simply observing a particular species, then this book is for you.

Richard Billington

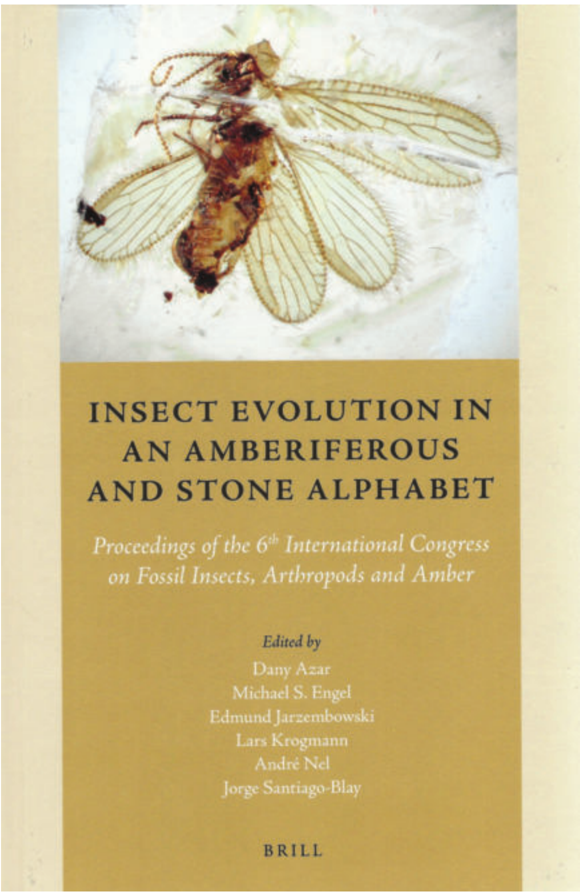
School of Biological Sciences, Plymouth University

Insect Evolution in an Amberiferous and Stone Alphabet

Proceedings of the 6th International Congress on Fossil Insects, Arthropods and Amber

by Dany Azar, Michael S. Engel, Edmund Jarzembowski, Lars Krogmann, André Nel & Jorge Santiago-Blay (editors)

Print ISBN: 9789004210707,
Hardcover viii + 201 pages, August 2013, Brill
Price £ none given by publisher / €130.00 / US$178.00



It is now 15 years since the first international palaeoentomological conference and the volume reviewed here represents the proceedings of the sixth and most recent meeting, held in Lebanon in 2013. The publisher's website gives no indication of the contents of the volume, and so the subtitle may mislead prospective readers into thinking it represents a full account of the meeting. Unfortunately, this is not the case. The volume includes only 12 of the 32 papers submitted, the remainder being published in two other journals by the same publisher (see later).

Following a short preface explaining the rather flowery title, there is a seven page introduction by the editors, including a photograph and list of the participants, followed by a full list of all 32 submitted papers. The main part of the volume consists of the academic papers separated into six sections as follows [with number of papers]: 1) Insects from Caenozoic Amber [4], 2) Insects from Upper Cretaceous Amber [1], 3) Insects from Lower Cretaceous Lebanese Amber [4], 4) Fossil Insect Compression [1], 5) New Amber Outcrop [1], New Techniques for Amber Preparation [1]. The last paper in the first section is misplaced there as it concerns Burmese amber, which is of Cretaceous age. The papers are mainly taxonomic in nature, most describing just a single new taxon, briefly summarized as follows: Mexican amber (Diptera: Psychodidae, new species), Rovno amber (Diptera: Sycoracinae, new species; Hemiptera: Miridae, new species), Burmese amber (Coleoptera: Lepiceridae, new genus and species), Cretaceous French amber (Diptera: Ceratopogonidae, new genus and species, new species), Lebanese amber (Hemiptera: Aleyrodidae and Perforissidae, new genus and species; Neuroptera: Berothidae, new genus and species; Diptera: Tanyderidae, new species plus first description of the male of a previously described species), rock from Lebanon (Blattida: Mesoblattinidae, new genus and species). The two final papers describe a new Lebanese amber outcrop that is no longer accessible as it has a building on top of it, and a very useful technique for preparing very tiny amber samples for scientific study. The descriptions are supported by clear diagrams and colour photographs (most of which are of reasonably good quality).

Despite having a team of six editors, very little attention has been paid to correcting typographical, grammatical or style inconsistency errors and these abound on almost every page. In terms of the physical quality, the cover and binding are good, but the paper used for the inner pages is too thin, resulting in a considerable degree of show-through. In short, for what you get (content and quality of production), this is a very expensive book and it is difficult to see how the high price can be justified (especially for what I expect is a print-on-demand volume). Given there is no indication of the contents on the Brill's website, the subtitle "proceedings of …" is rather misleading as it is only a partial proceedings, representing only around one-third of the papers published from the Congress. The other papers are available online from the journals *Insect Systematics and Evolution* and *Terrestrial Arthropod Reviews* (both also published by Brill), where you will be expected to pay an extra $30 plus tax per paper, unless you subscribe to the journals for €172.00/154.00 ($230.00/206.00) respectively.

The introduction by the editors ends with "a plea for integration" of palaeoentomological data in studies by neoentomologists. This is very important and I support this initiative. I feel the potential for engaging neoentomologists with palaeoentomology would, however, have been significantly increased through production of a more complete, professionally edited and more reasonably priced volume.

David Penney

PRESS RELEASE

from the COLOSS Network

COLOSS,
Institute of Bee Health,
Vetsuisse Faculty,
University of Bern,
Schwarzenburgstrasse 161
3003 Bern, Switzerland.
www.coloss.org

[Immediate: 30/9/13]

Honey bee scientists affirm their need for colony loss network.

Over 80 of the world's leading honey bee scientists met in Kiev, Ukraine, and took the colony loss network COLOSS, originally an EU COST action that ended last year, and turned it into a new non-profit association.

The aims of the new association are to: "improve the well-being of bees at a global level, with a primary focus on the western honey bee *Apis mellifera*. The ultimate goal of the Association is to sustainably mitigate bee population declines and sudden losses by pursuing a number of objectives: a. advocating for bees and their well-being, especially to government legislators and administrators; b. coordinating international research, including the development of standard research methods; c. disseminating knowledge and training related to improving the well-being of bees; and d. promoting youth development and gender balance among those studying, or those actively involved in promoting, the well-being of bees".

Since its original foundation in 2008, COLOSS has significantly improved our understanding of the causes of honey bee colony losses, through the organisation of conferences, workshops, and short term scientific missions, and the coordination of research efforts. The collection of standardised data on the losses experienced by beekeepers, and a coordinated experiment studying the influence of genotype and environment on the survival of honey bee populations have been particular highlights. Most recently, COLOSS has published the first two volumes of the *BEEBOOK* which for the first time gives bee scientists and beekeepers some 1700 standardised research protocols written by 234 authors, enabling the results of research to be comparable across the world.

The new COLOSS Executive Committee has 15 members who are all leading bee scientists, actively involved in research, representing Austria, Germany, Greece, Israel, Italy, Netherlands, Slovenia, Switzerland, Thailand, Turkey, UK, and the USA.

Speaking today at the 43rd International Apicultural Congress "Apimondia", also held in Kiev, newly elected COLOSS President Prof. Peter Neumann said: *"The COLOSS Network engendered an unprecedented degree of collaboration between more than 300 bee scientists from 63 countries worldwide, and was simply too valuable to lose. The new association means that we can continue to collect standardised data on colony losses, to share ideas and the latest thinking, in order to drive forward our understanding of the causes of bee losses and how best to help bees".*

[Ends]

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

Ricola Foundation
Nature & Culture

Diary

Assistant Editor: Duncan Allen (e-mail: antennadiary@gmail.com)
Contributions please! Your support is needed to make this diary effective so please send any relevant items to the diary's compiler, Duncan Allen, E-mail: antennadiary@gmail.com. No charge is made for entries. To ensure that adequate notice of meetings, etc. is given, please allow at least 6 months' advance notice.

Details of the Meetings programme can be viewed on the RES website (www.royensoc.co.uk/meetings) and include a registration form, which usually must be completed in advance so that refreshments can be organised. Day meetings usually begin with registration and refreshments at 10 am for a 10.30 am start and finish by 5 pm. Every meeting can differ though, so please refer to the details below and also check the website, which is updated regularly.

Offers to convene meetings on an entomological topic are very welcome and can be discussed with the Honorary Secretary.

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

2014

Feb 20-21 — **2014 PG Forum**
Venue: University of York
Convenor: Ms Louise Mair (lm609@york.ac.uk)

Mar 5 — **Verrall Lecture by Professor Greg Hurst**
Venue: Natural History Museum

Mar 26 — **Scottish Regional meeting** (forensic entomology, tour and supper)
Venue: Perth Museum, 4-7 pm
Convenor: Jenni Stockan
The speaker will be Ms Amoret Whitaker (NHM) talking about Forensic Entomology. The talk will take place 5-6pm with tours of the collections and light refreshments available before and after the talk.

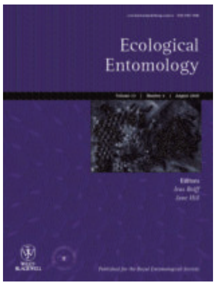
Apr 29 — **Post-harvest Entomology Special Interest Group**
Venue: Food & Environment Research Agency, Sand-Hutton, York
Convenor: Prof. Rick Hodges

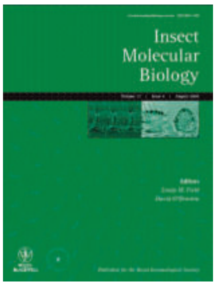
June — **4 RES AGM**
Venue: The Mansion House, St Albans

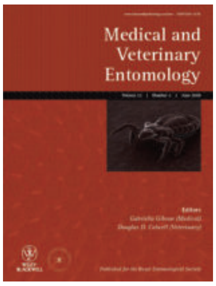
Jun 23-29 — **National Insect Week**

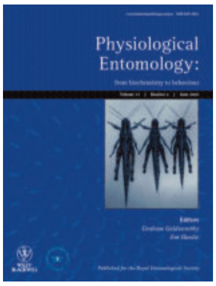
Aug 2-8 — **European Congress of Entomology**
Venue: University of York, Heslington, York
Confirmed plenary speakers:
Janet Hemingway, Liverpool School of Tropical Medicine, UK
Bruno Lemaitre, Ecole Polytechnique Federale, Switzerland
Nancy Moran, Yale University, USA
Vojtech Novotny, Czech Academy of Sciences, Czech Republic
John Pickett, Rothamsted Research, UK
Chris Thomas, University of York, UK
Each session will comprise one keynote presentation (30 mins) followed by eight invited or contributed talks (15 mins each). The keynote speaker will receive a 50% reduction in registration fees only. To encourage international participation the committee encourages applications where joint organisers are based in different countries from one another.

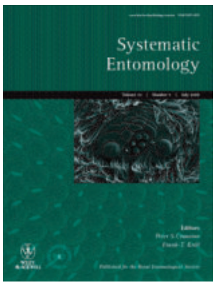
Sep 3 — **Aphid Special Interest Group**
Venue: Harper Adams University
Convenor: Prof. Simon Leather (simonleather@harper-adams.ac.uk)











Publications of the Royal Entomological Society

Agricultural and Forest Entomology provides a multi-disciplinary and international forum in which researchers can present their work on all aspects of agricultural and forest entomology to other researchers, policy makers and professionals.
2014 print or online prices: UK £707, Euroland €900, USA $1,307, Rest of World $1,523
2014 print and online prices: UK £813, Euroland € 1,035, USA $1,503, Rest of World $1,752

Ecological Entomology publishes top-quality original research on the ecology of terrestrial and aquatic insects and related invertebrate taxa. Our aim is to publish papers that will be of considerable interest to the wide community of ecologists.
2014 print or online prices: (with Insect Conservation and Diversity) UK £1,157, Euroland €900, USA $2,145, Rest of World $2,501
2014 print and online prices: UK £1,340, Euroland € 1,035, USA $2,467, Rest of World $2,873

Insect Conservation and Diversity explicitly associates the two concepts of insect diversity and insect conservation for the benefit of invertebrate conservation. The journal places an emphasis on wild arthropods and specific relations between arthropod conservation and diversity.
2014 print or online prices: UK £707, Euroland €900, USA $1,307, Rest of World $1,523
2014 print and online prices: UK £813, Euroland € 1,035, USA $1,503, Rest of World $1,752

Insect Molecular Biology has been dedicated to providing researchers with the opportunity to publish high quality original research on topics broadly related to insect molecular biology since 1992. *IMB* is particularly interested in publishing research in insect genomics/genes and proteomics/proteins.
2014 print or online prices: UK £1,178, Euroland €1,496, USA $2,177, Rest of World $2,538
2014 print and online prices: UK £1,354, Euroland € 1,722, USA $2,504, Rest of World $2,920

Medical and Veterinary Entomology is the leading periodical in its field. The Journal covers all aspects of the biology and control of insects, ticks, mites and other artropods of medical and veterinary importance.
2014 print or online prices: UK £678, Euroland €864, USA $1,255, Rest of World $1,465
2014 print and online prices: UK £780, Euroland € 994, USA $1,445, Rest of World $1,685

Physiological Entomology is designed primarily to serve the interests of experimentalists who work on the behaviour of insects and other arthropods. It thus has a bias towards physiological and experimental approaches, but retains the Royal Entomological Society's traditional interest in the general physiology of arthropods.
2014 print or online prices: UK £646, Euroland €796, USA $1,156, Rest of World $1,349
2014 print and online prices: UK £717, Euroland € 915, USA $1,330, Rest of World $1,551

Systematic Entomology encourages the submission of taxonomic papers that contain information of interest to a wider audience, e.g. papers bearing on the theoretical, genetic, agricultural, medical and biodiversity issues. Emphasis is also placed on the selection of comprehensive, revisionary or integrated systematics studies of broader biological or zoogeographical relevance.
2014 print or online prices: UK £1,113, Euroland €1,416, USA $2,059, Rest of World $2,403
2014 print and online prices: UK £1,279, Euroland €1,629, USA $2,368, Rest of World $2,764

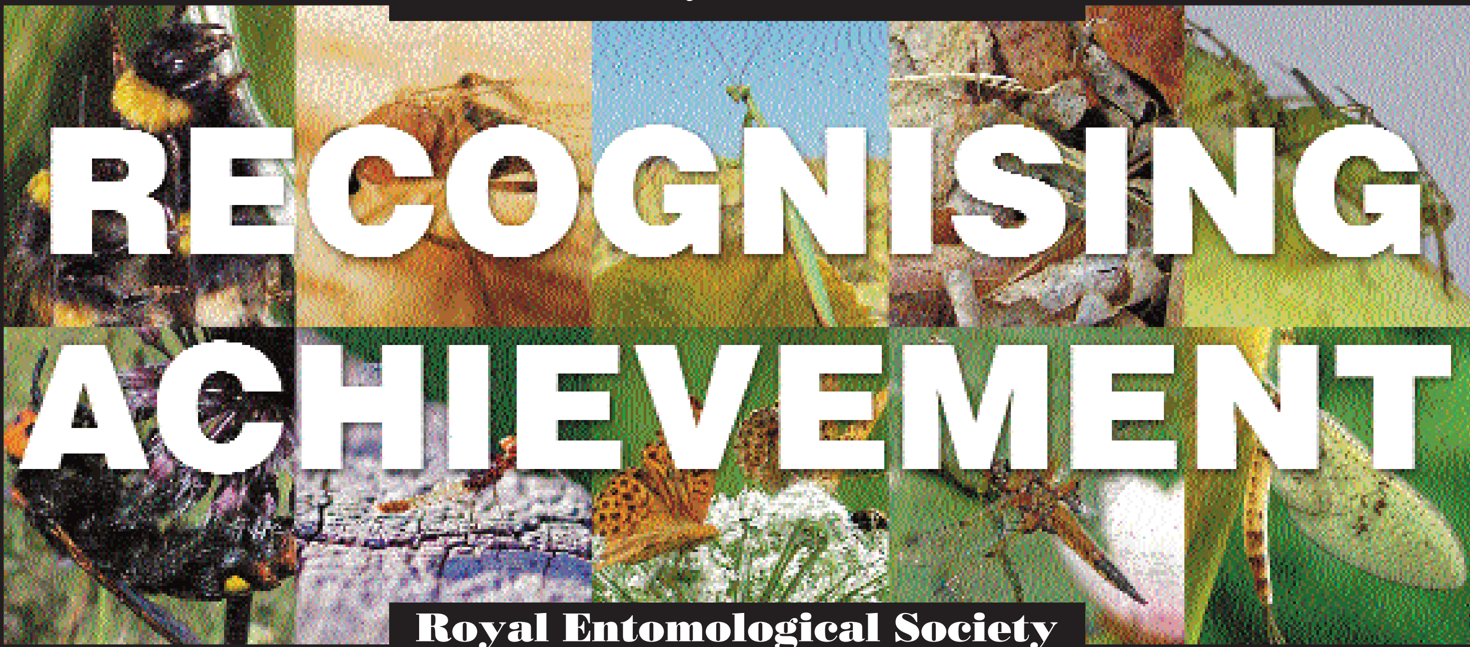
Subscriptions and correspondence concerning back numbers, off-prints and advertising for the seven principal journals of the Society should be sent to the publishers, Wiley-Blackwell Publishing Ltd, 9600 Garsington Road, Oxford OX4 2DQ. (customerservices@blackwellpublishing.com)

Antenna (Bulletin of the Society). Free to Members/Fellows. Published quarterly at an annual subscription rate of £40 (Europe), £42 (outside Europe), $70 (United States). This journal contains entomological news, comments, reports, reviews and notice of forthcoming meetings and other events. While emphasising the Society's affairs, *Antenna* aims at providing entomologists in general with a forum for their views and news of what is going on in entomology. Subscriptions and advertising enquiries should be sent to the Business Manager at The Mansion House, Chiswell Green Lane, Chiswell Green, St. Albans, Hertfordshire AL2 3NS and any other enquiries to the Editors.

Handbooks for the Identification of British Insects. This series now covers many families of various Orders. Each Handbook includes illustrated keys, together with concise morphological, bionomic and distributional information. A full list of Handbooks with order form is available. See website www.royensoc.co.uk

Symposia. Nos. 1-3 were published by the Society; Nos. 4-10 by Blackwell Scientific Publications: Nos. 11-17 by Academic Press and No. 18 by Chapman & Hall, No. 19 by Kluwer, No. 20, 21, 22 and 23 by CABI.

www.royensoc.co.uk



Royal Entomological Society
– Society Awards –

For more details on these Society Awards please see www.royensoc.co.uk

THE ROYAL ENTOMOLOGICAL SOCIETY STUDENT AWARDS

Award Criteria: Any article about an Entomological topic that would be of interest to the general public. The article to be easy to read, in a popular style and no longer than 800 words.

Prize: Winner £300, runner up £200, third place £100, all three articles published in *Antenna*.

RES JOURNAL AWARDS SCHEME

Award Criteria: The best paper published in each Society Journal over a two year period. Each of the Society Journals participate biennially.

Prize: £500 and Certificate for each participating Journal.

THE LJ GOODMAN AWARD FOR INSECT BIOLOGY

Award Criteria: For advancing the education of the public in the knowledge, understanding and appreciation of all aspects of Insect Physiology, thereby promoting the control and conservation of insect species.

Prize: £1,000, also additional awards may be given.

THE MARSH AWARD FOR INSECT CONSERVATION

Award Criteria: For an outstanding contribution to Insect Conservation; on the basis of 'Lifetime Achievement', or 'Considerable and Exemplary Contribution' to a significant project or undertakings. In exceptional circumstances two prizes may be awarded to reflect each criterion.

Prize: £1000 and Certificate.

POSTGRADUATE AWARD: THE ALFRED RUSSEL WALLACE AWARD

Award Criteria: For post-graduates who have been awarded a PhD, whose work is considered by their Head of Department to be outstanding. The research involved should be a major contribution to the Science of Entomology.

Prize: £750 plus Certificate, plus one year's free Membership. The winner will also be invited to present their work at a Society Meeting.

JO WESTWOOD MEDAL – AWARD FOR INSECT TAXONOMY

Award Criteria: The best comprehensive taxonomic work on a group of Insects, or, related Arthropods (including terrestrial and freshwater Hexapods, Myriapods, Arachnids and their relatives). Typically, this will be a taxonomic revision or monograph.

Prize: A specially struck silver gilt medal inscribed with the winners name. Also costs incurred in attending the International Congress of Entomology, European Congress of Entomology, or other major meeting (specified by the Adjudicators) to present his/her work.

THE WIGGLESWORTH MEMORIAL LECTURE AND AWARD

Award criteria: The outstanding services to the science of Entomology. The award will be made to a researcher who has contributed outstanding work to the science and who best reflects Sir Vincent Wigglesworth's standards of personal involvement in every aspect of his/her research.

Prize: A specially struck gilt medal inscribed with the winners name. Also the costs of attending the International Congress of Entomology to give the Wigglesworth Lecture.

BOOK PURCHASE SCHEME FOR FELLOWS AND MEMBERS IN DEVELOPING COUNTRIES

Award Criteria: To provide assistance in purchasing specialist Taxonomic books, that will assist in the identification of Insect groups being studied in developing countries and their regions. Applicants will be required to demonstrate need and specify particular texts.

Prize: Any one applicant may be awarded up to £200 in a three year period. The Society will purchase the texts awarded and send them to the applicant. The applicants may, themselves, provide any additional funds in excess of the amount awarded.

OUTREACH AND CONFERENCE PARTICIPATION FUNDS

Award Criteria: ORF: Grants to support activities which further the Society's aims. This may range from, help to purchase equipment, to help in funding expeditions/meetings. CPF: Grants to assist applicants who are participating in a meeting or conference in some way, e.g. presenting a paper/poster.

Prize: ORF: Monetary grant. CPF: Monetary grant.

MARSH AWARD FOR EARLY CAREER ENTOMOLOGIST

Award Criteria: For an early career contribution to Entomological Science (up to 30 years of age, or, in the early stage of a research career) that is judged to be outstanding or exemplary with single or ongoing impact on the science. The Award is 'open' and not restricted to any particular discipline or specialised area of entomological science.

Prize: £1000 and Certificate

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