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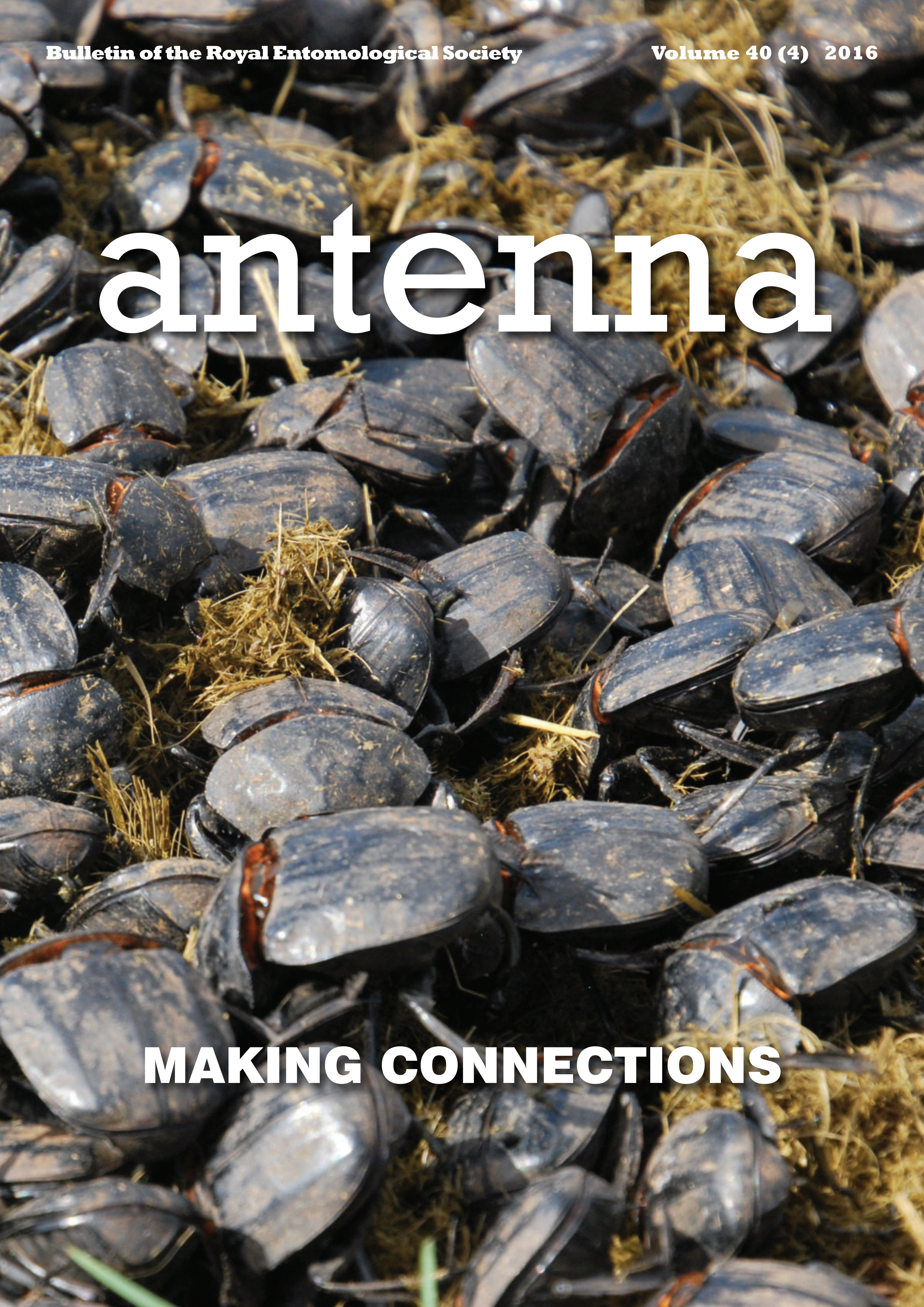
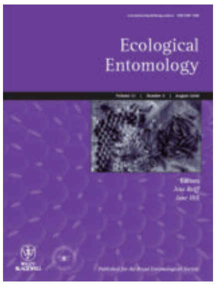
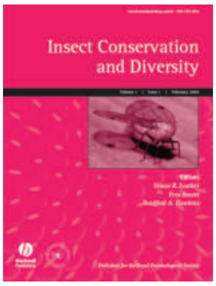
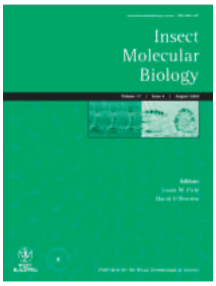
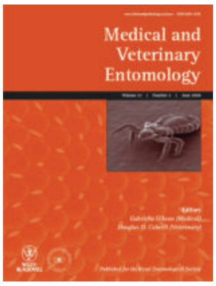


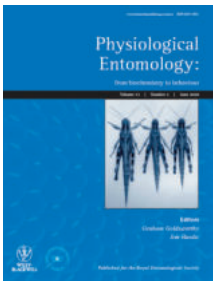
MAKING CONNECTIONS











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Bulletin of the Royal Entomological Society

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EDITORIAL

Hello and welcome to *Antenna* **40** (4). As the year draws toward its end we're pleased to bring you another issue full of interesting and informative content to keep you entomologically entertained through the long winter evenings. As we approach the end of 2016 and near the start of 2017, it's perhaps fitting that the topic of 'making connections' runs through this issue, albeit in a broader sense than linking one year to the next via twelve midnight on New Years Eve.

We begin this issue with correspondence from Helmut van Emden highlighting a not-to-be-missed opportunity to support early-career entomologists wishing to make new connections at the 2017 Verral Supper. Thanks to the "van Emden Bursary Fund", the Entomological Club will award up to two bursaries to support attendance at this ever-popular entomological gathering. Brian Taylor has also written in to acknowledge how connecting with the RES has enabled him to negotiate a ten-year contract for the hosting of www.antsofafrica.org web site (which Brian founded and curates - see *Antenna* 37:4). Zoe Randle has also been in touch, looking to establish new connections in the form of micro-moth recorders, as has Henk Geertsema, connecting an article in Antenna 40 (3) to a new host plant record for emperor moths.

The first of our main articles is another thought-provoking piece from regular *Antenna* author, Hugh Loxdale. In addition to providing a riveting read based on his Ento '15 presentation 'Ghost of the Clones', Hugh also makes connections of his own in this offering – in this case between his graphical depictions of aphid multilocus genotype data, published in 2010, and the 'Willis Curve' of John Christopher Willis, produced in the 1920s. We follow this with a short article summarising butterfly status at Honeysuckle Cottage, home of author Nigel Simpson. 'Connections' feature here too, as Nigel seeks to link changes in on-site butterfly visitation since the 1970s to changes in local flora and land management. Connections at a landscape scale are the focus of our next article, 'Insect diversity sustained by large-scale ecological networks', provided by Michael Samways *et al.* as a synopsis of many years of work to conserve African biodiversity by creating habitat linkages and corridors. Our final article is the next instalment in Richard Kelly's connected series on entomological collections throughout the UK, the Royal Cornwall Museum being Richard's latest port-of-call.

This issue also features our usual collection of Society News, Book Reviews, Meetings Diary and Announcements. 'Connections' continue here; between two separate entomological exhibitions attended by *Antenna's* own Peter Smithers, linked by their shared focus on insects in art, and between science and the public at the Royal Society Summer Science Exhibition, where Josephine Parker could be found contributing to the 'Mosquito Diaries'. We even feature a set of connected book reviews from Peter Smithers in his 'An invertebrate hat trick from Reaktion Books'.

Finally, it also gives me great pleasure to report that *Antenna* has been making some connections of its own recently, with the appointment of three new Assistant Editors. We're extremely pleased to have welcomed Tom Pope, Alice Mockford and Hugh Loxdale to the *Antenna* Team (from issue 40(3)) and look forward to the positive impact their involvement is sure to have.

Wishing you all Seasons Greetings
and a Happy New Year,
Dave

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

Verrall Supper Bursaries for 2017

From the "van Emden Bursary Fund", the Entomological Club will award up to two bursaries to registered students and other early-career entomologists in connection with the Verrall Supper on Wednesday 1st March 2017. The aim of the scheme is to introduce to the Verrall Association promising young entomologists who are likely thereafter to wish to continue their membership themselves. A bursary funds a one year membership of the Association and the Supper, as well as up to £40 of any travelling expenses incurred. Perhaps more importantly, the award recognises merit, and can be included on future CVs.

Proposals for bursaries must come from academic supervisors or other relevant managers with some standing in entomology, and proposals should be submitted to entclub@yahoo.co.uk by 10th February 2017.

There is no prescribed format for proposals. One side of A4 may well be enough, and the following list gives guidance as to what might be included:

Name, date of birth, postal and e-mail address of person proposed.

Subject of research study or other entomological work, stage reached, source of funding and achievements so far, evaluation of future promise.

Any evidence of interest in entomology at an earlier age and any previous practical involvement.

Helmut van Emden

Hon. Treasurer, Entomological Club (www.entomologicalclub.org)

Micro-moths and the National Moth Recording Scheme

Butterfly Conservation's National Moth Recording Scheme (NMRS) is now accepting verified micro-moth records. This exciting development has followed several years of consultation with the key micro-moth experts and the National Taxa Schemes who were unanimously supportive in Butterfly Conservation taking the lead in this venture. To ensure that their micro-moth records enter the NMRS, moth recorders 'on-the-ground' are simply required to continue to submit their records to their County Moth Recorder.

As some species of micro-moth present an identification challenge Regional Verification Panels have been established to support County Moth Recorders with the verification process where required. A National Verification Panel has also been established to support the Regional Verification Panels. In addition to this, guidance notes to help with micro-moth verification have been drawn up, including a species grading system. It is hoped that these documents will help the verification process run smoothly and make recorders aware of the possibility that their records could be questioned or require further evidence to corroborate them.

Liquorice Piercer, *Grapholita pallifrontana* (Windmill Hill, Worcs 2012). Photo courtesy of Oliver Wadsworth.

To date we have received micro-moth records from at least 18 vice-counties, seven of these datasets have been imported, equating to 310,162 micro-moth records. The very first record to be added was of *Mompha miscella* recorded in Montgomeryshire (central Wales) in 1929. We thank all of the County Moth Recorders concerned and their dedicated moth recorders for sending in their records.

The incorporation of micro-moths into the NMRS is a milestone and will support the conservation of threatened micro-moths and, in due course, will enable the calculation of distribution trends. Further details, including the verification guidance notes and species grading notes can be found on the Moths Count website (www.mothscount.org).

UK Moth Recorders' Meeting 2017

Our next annual UK Moth Recorders' meeting will be held on Saturday 28 January 2017 at the Birmingham and Midland Institute, central Birmingham. The full programme will be available in due course, please check www.butterfly-conservation.org/UKMRM for details. Advance booking is essential via www.butterfly-conservation.org/UKMRM. The registration fee is £10.00 per person and includes morning tea/coffee and a buffet lunch all subsidised from Butterfly Conservation budgets. Of course if you do not have access to the internet alternative arrangements can be made on request.

Zoe Randle

Madagascan 'wild' silk

Dear Editors,

As usual, the latest edition of *Antenna* [40(3)] is again filled with excellent articles of general interest. As I am interested in silk and silk moths, the contribution by Peter S. Cranston on *"Madagascan 'wild' silk"* was a great read, but it appears that the author must have mislaid some of his slides to illustrate his article; the Figures 2 A-B do not show the caterpillars of *Borocera cajani* (Vinson), but rather, and most certainly, the caterpillars of *Bunaea aslauga* Kirby (Saturniidae). The depiction of these caterpillars, shown feeding on *Uapaca bojeri*, however, is an addition to the list of host plants of emperor moths.

The caterpillar of *B. cajani* has been illustrated by Razafimanantsoa, T. M. *et al.* (2013) as published in *African Entomology* **21**, 137-150.

Kind regards,
Henk Geertsema
Stellenbosh, South Africa

Ants of Africa

Dear Editors,

Very apposite in view of the headline on the last issue of *Antenna*: "Digital Entomology – Entomology for All" is the good news that the RES has generously enabled me to negotiate a ten-year contract for the hosting of the www.antsofafrica.org web site that I founded and curate (see *Antenna*, 37 (4), 164-5). So perpetuity and accessibility should be guaranteed until 2026, with the additional security that a largely complete copy of the main text pages is conserved by the UK WebArchive.

A short update is desirable, not least because I have added type images harvested and collated from the superb work of the www.antweb.org project, led by Dr Brian Fisher of the California Academy of Sciences. That effort means that the total number of named species = 2132 and all but 58 are illustrated – 1,984 with photographs and 90 with drawings. The Ants of Africa, however, is much more than a digital museum primarily because my approach, from its inception in 1998, with roots in my own field work in 1974-76, is pragmatic with the central objective of enabling anyone studying African ants to be able to identify the species by name and not to have to fall back on "morphospecies". The latter, in my opinion, is not far off useless to any subsequent researcher trying to evaluate the impact of ants, say, on the environment.

http://www.antsofafrica.org/ homepage

As an unbiased observation, there is a debate raging within the ant world at present over the merits of "phylogenetic classifications" versus "evolutionary classification" (Linnaean taxonomy). Perhaps because even DNA had not got into the A level syllabus in my long ago school days, even though Francis Crick was a former pupil, I feel unqualified to judge. What I can say, however, is that 'updating' and largely lumping taxa makes for difficult cataloguing and, in some cases, to enormous unwieldy keys. One peculiarity is the abandonment by the ant systematists of the historic subgenera and use of what they term "species-groups". The difference seems one of semantics but has the added confusion that the International Code of Nomenclature seems to use "species-group" as a term for what elsewhere are called simply "species".

So my thanks to the Society for its support and I welcome any feedback from members.

Dr Brian Taylor FRES

References:

Seifert B, Buschinger A, Aldawood A, Antonova V, Bharti H, Borowiec L, Dekoninck W, Dubovikoff D, Espadaler X, Flegr J, Georgiadis C, Heinze J, Neumeyer R, Ødegaard F, Oettler J, Radchenko A, Schultz R, Sharaf M, Trager J, Vesnic A, Wiezik M, Zettel H (2016) Banning paraphylies and executing Linnaean taxonomy is discordant and reduces the evolutionary and semantic information content of biological nomenclature. *Insectes Sociaux*, 63:237–242. doi:10.1007/s00040-016-0467-1

Ward, P.S., Brady, S.G., Fisher, B.L. & Schutlz, T.R. 2016, Phylogenetic classifications are informative, stable, and pragmatic: the case for monophyletic taxa. *Insectes Sociaux*. on-line DOI 10.1007/s00040-016-0516-9.

Ghosts of the Clones

Hugh D. Loxdale, Hon. FRES

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It was late Friday afternoon and I had promised to meet up with my wife Nicola for a meal and a beer in the local pub (more correctly Wirtschaft), the *Alt Jena*, having cycled the two kilometres or so from the Institute of Ecology, Jena, Germany to the Marktplatz in the centre of town. As I remember it, this particular event occurred sometime in the autumn of 2009, during my two-year tenure as Professor of Ecology at the Institute. On entering the pub, greeting Nicola, and waiting whilst the waitress took my order for a dunkelweizen beer (dark wheat beer), my favourite tipple at the time, sitting at the scrubbed oak table by the window facing the market square, I started to discuss with Nicola what I had been thinking… and plotting (graphically speaking) in my office just before I left work at around 5.30pm. I showed her the graph and said "I think I have invented a new graph. I cannot remember ever seeing one like this in any scientific paper or book I have read." It was a bold, and as it turned out unsubstantiated claim! What I had plotted, using multilocus genotype (MLG) data obtained on surveying (using polymorphic microsatellite markers) local highly specialised aphid populations of *Macrosiphoniella tanacetaria* (Kaltenbach) and the ant-attended *Metopeurum fuscoviride* Stroyan, both feeding on tansy, *Tanacetum vulgare* L. (Fig. 1a-c) (Box 1), was in effect a Willis curve. Although I didn't know it at the time, this graphical relationship is named after the long-lived English, Cambridge University–based botanist, John Christopher Willis FRS (1868-1958) (website 1; Fig. 2). In his original representations, published in the early 1920s in two publications (Willis, 1922; Willis & Yule, 1922), Willis had plotted the *Number of genera* (y-axis) *vs.* the *Number of species in the genus* (x-axis), to produce a negative exponential relationship. This graph, originally produced to explain botanical data derived from a study of the flora of Ceylon (Sri Lanka), seems to be common to many taxa of living organisms. According to the American botanist, K.W. Hilu (2006) in a review article about the taxonomy of grasses published in the Systematics Association Special Volume, *Reconstructing the Tree of Life: Taxonomy and Systematics of Species Rich Taxa*, eds. Hodkinson & Parnell, 2006, Willis & Yule…

> "… dubbed this pattern the hollow curve distribution (HCD) and indicated that such a pattern exists at all taxonomic levels. Willis and Yule asserted that the longer the group has existed, the more area it will occupy. They further stated that monotypic genera are in general 'beginners' and are descendants of larger ones. The HCD was later demonstrated in other organisms, such as arthropods, birds and mammals. Although this skewed pattern is evident across a broad range of biological diversity and at all taxonomic levels, explanations of its causes vary, and different hypotheses and models have been proposed (see Hilu, 2006 and references therein to Chapters 1, 10 and 16 in the same book)."

Willis is especially known for his 'Age and Area' hypothesis and criticism of natural selection, published in 1922. Later in 1940, as a sequel, he courted further controversy in another book entitled *The Course of Evolution by Differentiation or Divergent Mutation Rather Than by Selection*. Here Willis argued that natural selection of chance variations as a major factor in evolution was inadequate to explain the process and, rather, supported mutations as the main mechanism of evolution, including chromosome changes which he posited as being the predominant cause of such mutations. He opposed the ideas of gradualism as proposed by Darwin and Wallace and favoured saltational evolution (see below). As a consequence, he was criticised by such luminaries as the famous American ichthyologist Carl L. Hubbs (1894-

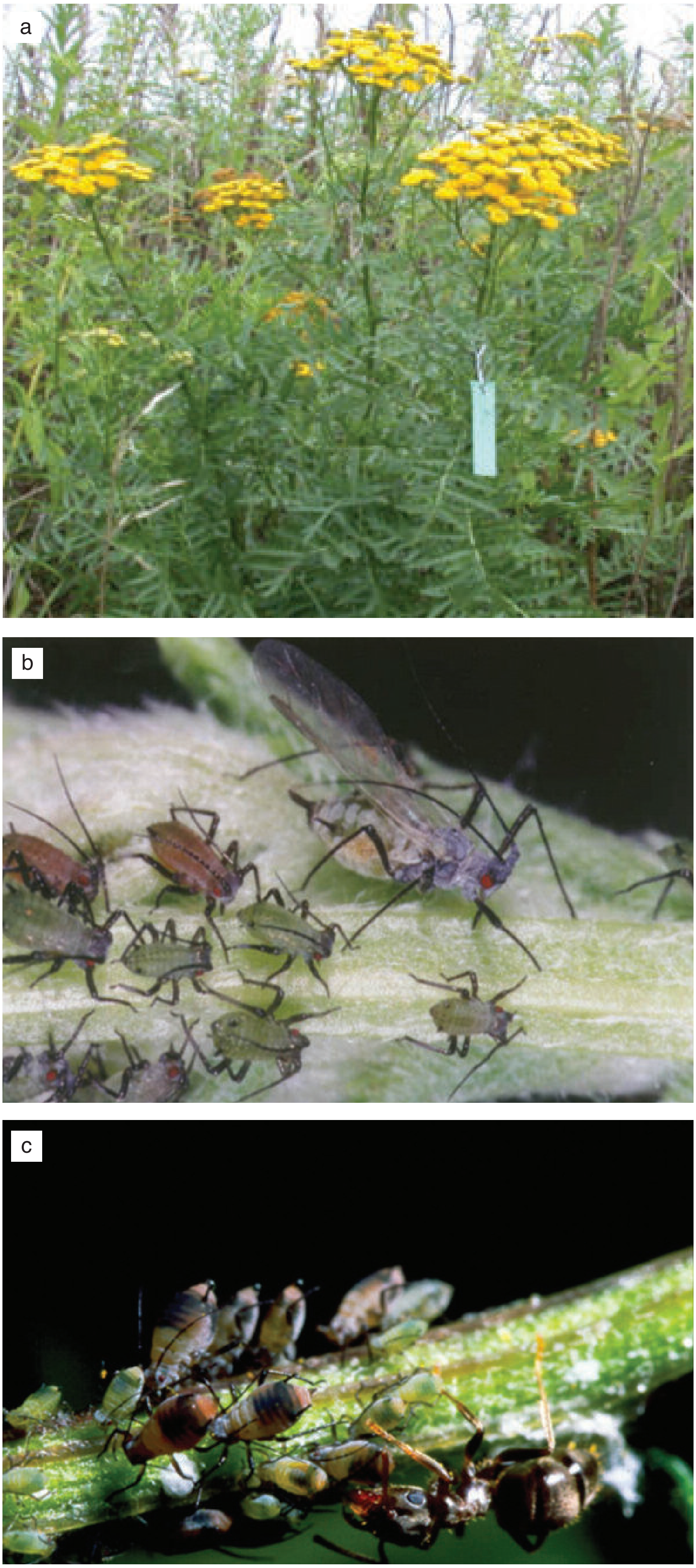


Fig. 1a-c. (a) Tansy plant, *Tanacetum vulgare* and two of the main aphid species that feed upon it: (b) mixed colony of *Macrosiphoniella tanacetaria*, showing winged asexual female and green and brown nymphs; (c) mixed colony (green and brown) of ant-attended *Metopeurum fuscoviride*. Both aphid species form metapopulations on tansy, the former species primarily attacking the top of the plant, especially the new flush leaves and composite flowers, the latter, the stem.

1979) for advocating some form of orthogenesis and no less a leading light on genetics and evolution than Sewall Wright (1889-1988), who thought him clearly to believe in saltatory evolution (see website 1 and references therein and websites 2, 3).

Now to me, whatever other biologists may deduce from this particular graphical relationship, I think it clearly says something rather interesting about generalism *versus* specialism in nature. In this, it also graphically presents the creation over time of biodiversity as a result of adaptive radiation giving rise to numerous species per genus, perhaps over an expanding geographical range, and their decline over time in terms of the number per genus until one species exists per genus, followed ultimately by extinction of that taxa – unless the species in question is able to re-radiate, which it may or may not be able to do. One thinks here of such animals as the Coelacanth, the Duck-billed Platypus, and the Aardvark, all once thriving groups but now reduced to one (or two) living representatives, and likewise in the case of plants, the Dawn Redwood, *Metasequoia*. With insects,

Fig. 2. John Christopher Willis

Box 1. Molecular markers to explore aphid genetic fidelity and population genetics and dynamics

☐ RAPDs, AFLPs, probes $(GATA)_4$, microsatellites, SNPs, sequencing.

☐ Microsatellites = simple sequence repeats (SSRs).

☐ Tract of repetitive DNA with certain motifs (ranging in length from 2-5 base pairs), e.g. (CA)n, (CT)n, (AAT)n, etc.

☐ Typically occur 5-50 times.

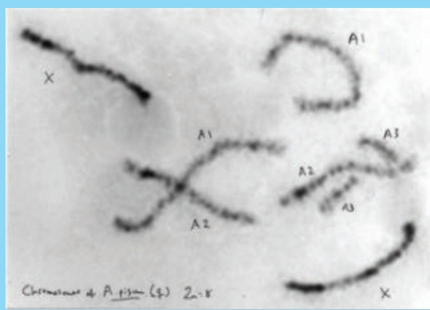
☐ May occur at thousands of locations in the genome.

☐ Notable for their high mutation rate and high diversity in populations, including insects.

(see Loxdale & Lushai, 1998 for further details and for microsatellites specifically, Goldstein & Schlötterer, 1999).

Box 2. Rapid evolution of aphids

In aphids, as in many animals and plants, changes of karyotype, including chromosomal fissions/fusions, and hybridisation/introgression, can be a mechanism/s for speciation. In effect, instant speciation!



☐ Pea aphid, *Acyrthosiphon pisum* (Harris) asexual adult female with nymphs and chromosomes (2n =8)

Box 3. Asexual lineages of aphids = 'clones' *sensu lato*

☐ Yes, derived from asexual (parthenogenetic) female foundress, in the spring the fundatrix (first stem mother) hatching from the overwintering sexual egg.

☐ But no, not genetically identical *sensu stricto*.

☐ Highly unlikely because of huge reproductive potential of asexual aphids (one asexual generation in 7-10 days; 10-100 offspring) compounded with dynamic genome.

☐ This rapidly mutates due to a plethora of mutational processes: DNA point mutations (errors in transcription/translation), inversion polymorphisms related to transposon 'hot spots', insertions/deletions, fusions/fissions.

☐ Unlikely that huge genome (~530 Mb in pea aphid) of an individual aphid can be copied each time with exact fidelity between stem mother and offspring.

☐ If it could, this would be truly fantastic!

and not forgetting this article is appearing in an entomological journal, an example may well be the extant forms of the recently discovered Rock Crawlers or Gladiators, members of the carnivorous family Mantophasmatidae within the order Notoptera, discovered in Africa in 2001 and which may have had a much wider range some 45 million years ago during the Eocene epoch (Klass *et al.*, 2001; Arillo & Engel, 2006; website 4).

In the ongoing debate about the relative importance of generalism *versus* specialism (e.g. Loxdale *et al.*, 2011; Loxdale & Harvey, 2016), the fact that most taxa, when displayed graphically in the form of a Willis curve, are seen to occupy the *low end* of the *Number of species per genus* axis (i.e. 1-4, especially 1 and 2) strongly argues the case for specialism. There are seen to be rather fewer examples of the *Number of species per genus* exceeding 5-6, although this may not be true of taxa such as aphids which undergo adaptive radiation/speciation, essentially onto new plant hosts, probably rapidly via various mutational processes including chromosomal translocations, fissions and fusions (e.g. Blackman, 1980; Brown & Blackman, 1988; Monti *et al.*, 2012; see also White, 1978; Loxdale, 2010). If this view is correct, maybe Willis was not so very wrong when he emphasised the role of mutational processes, including chromosome changes, as governing forces in evolution. And indeed, maybe such radiations sometimes really do occur in a saltatory manner, as originally proposed by the famous evolutionary biologists, Étienne Geoffroy Saint-Hilaire (1772-1844) and Thomas Henry Huxley PRS, FLS (1825-95) (website 2; Lyons, 1999), rather than a gradual manner à la Darwin and Wallace. This may hold especially true in insects, which often have short generation times/life cycles such as in aphids (Hemiptera: Aphididae; Blackman, 1981; Dixon, 1978) and are subject to intense selection, more especially predation pressure (e.g. Loxdale, 2014; Wheelwright, 2016; Boxes 2, 3).

Following that visit to the *Alt Jena*, and after publishing the tansy aphid MLG data collected in Jena during 2000-08 in 2010 (Loxdale *et al.*, 2010), I had largely forgotten about my own Willis curve. One of the main conclusions of this work had been that in these two species (*M. tanacetaria*

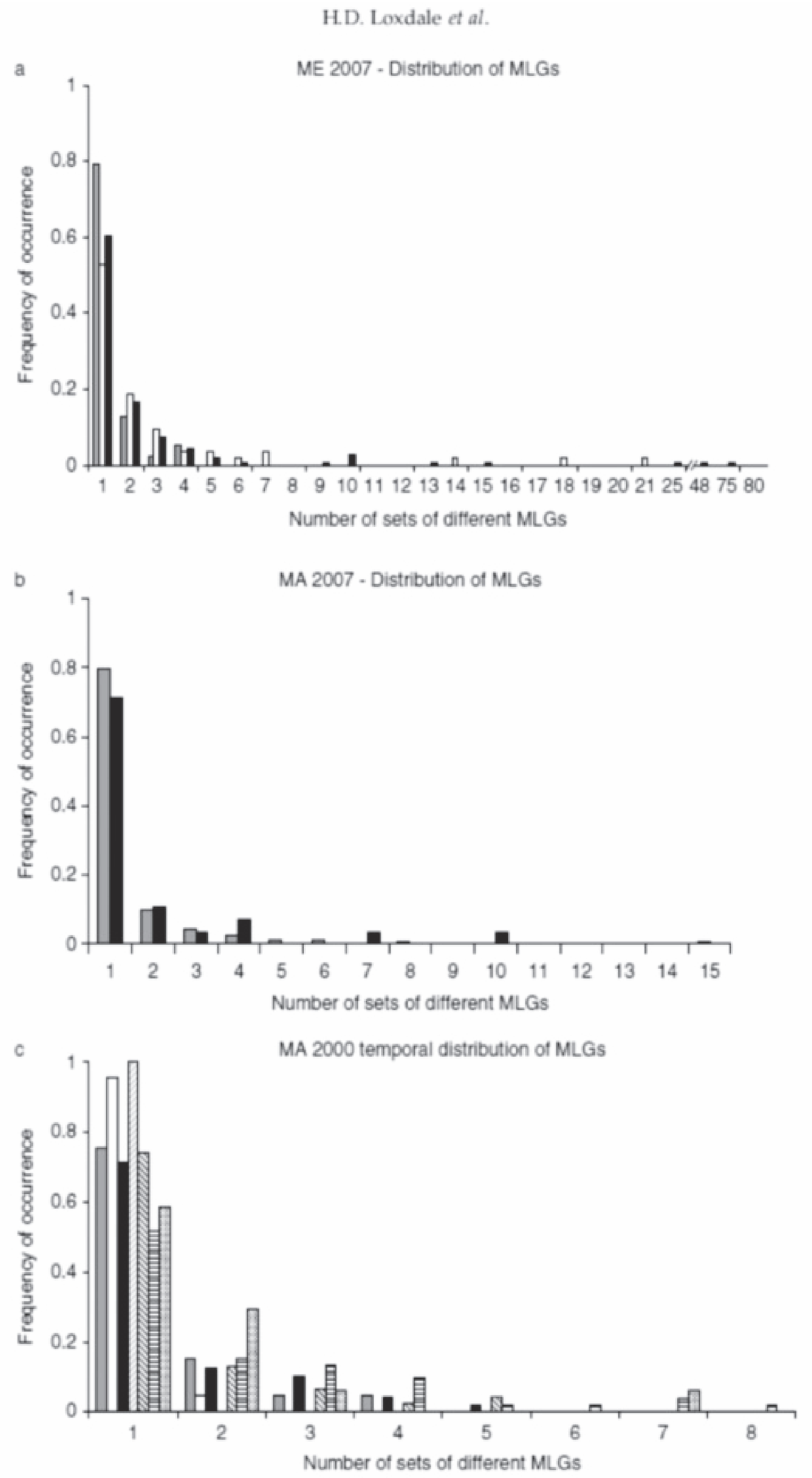


Fig. 3a-c. Hollow curve distributions for tansy aphids collected in Jena. (a) *Metopeurum fuscoviride* (ME) collected in 2007; (b) *Macrosiphoniella tanacetaria* (MA) collected in 2007; (c) MA collected in 2000. Data from Loxdale *et al.* (2010) (their Fig. 2a-c). Basically these graphs show that populations of these two aphid species comprise very few clones (i.e. multiple MLGs); rather they are dominated by unique or low copy number repeat MLGs (i.e. 1 to <4 copies of a particular MLG), as indeed are field populations and 12.2 m high Rothamsted suction trap samples of the grain aphid, *Sitobion avenae* (data for this last species not presented, but see Loxdale *et al.*, 2010 for further details, including the figure legend for the above figure). Axes: y, Frequency of occurrence (of the sets of different MLGs) vs. x, Number of sets of different MLGs.

Box 4. Multilocus genotypes (MLGs) = 'clones' *sensu lato*

Typically > 4-20 microsatellite loci are tested in population genetic studies

In the present example, the MLG comprises 8 different microsatellite loci, each bearing two alleles per locus:

Locus 1 a,b

Locus 2 a,c

Locus 3 c,d

Locus 4 a,h

Locus 5 c,e

Locus 6 e,f

Locus 7 a,b

Locus 8 a,c

Box 5. Example showing categories of microsatellite MLGs – unique (1 copy, found only once in the sample/s tested) and multiple copies, here show as, for example, 2, 3, 4 and 8 copies of any particular MLG found

Subscript letter refers to a specific MLG

☐ **1 x MLG ('uniques'):** MLG^{A}, MLG^{B}, MLG^{C}, MLG^{D}, MLG^{E}, MLG^{F}, MLG^{G}, MLG^{H}, MLG^{I}

☐ **2 x MLG:** MLG^{J}, MLG^{K}, MLG^{L}, MLG^{M}, MLG^{N}, MLG^{O}, MLG^{P},

☐ **3 x MLG:** MLG^{Q}, MLG^{R}, MLG^{S}, MLG^{T},

☐ **4 x MLG:** MLG^{U}, MLG^{V},

☐ **8 x MLG:** MLG^{Z}

etc.

Box 6. Sympatric evolution (adaptive radiation) of aphid species

Sitobion fragariae, holocyclic (i.e. with sexual phase). Host alternates mainly between wild grasses and bramble.

Chromosomes of both *S. fragariae* and *S. avenae,* 2n = 18

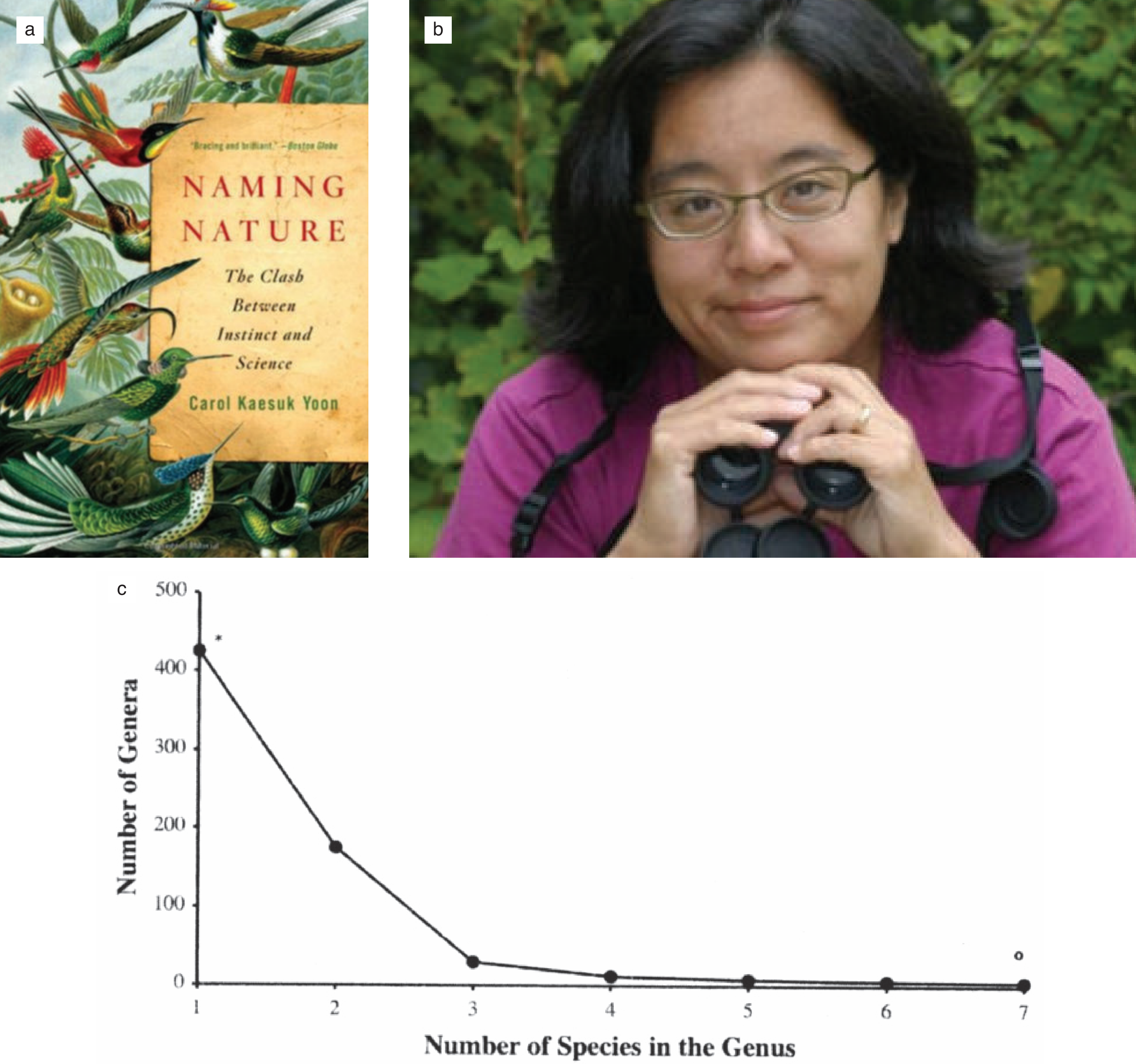
Can get asymmetrical introgression/hybridisation between these 'species'.

In addition, presumably the primary host bramble acts as sieve, so that only 'compatible' host adapted grass-cereal strains/clones survive as viable eggs following mating of sexual forms. Lost ones (precursors) also become ***ghosts of the clones.***

Small and large scale mutations (chromosomal translocations). The latter can lead to non-disjunctions on the metaphase plate during meiosis preventing breeding of mutants with original source parental population.

Sitobion avenae, predominantly anholocyclic (asexual) on cereals and grasses on which it remains all year.

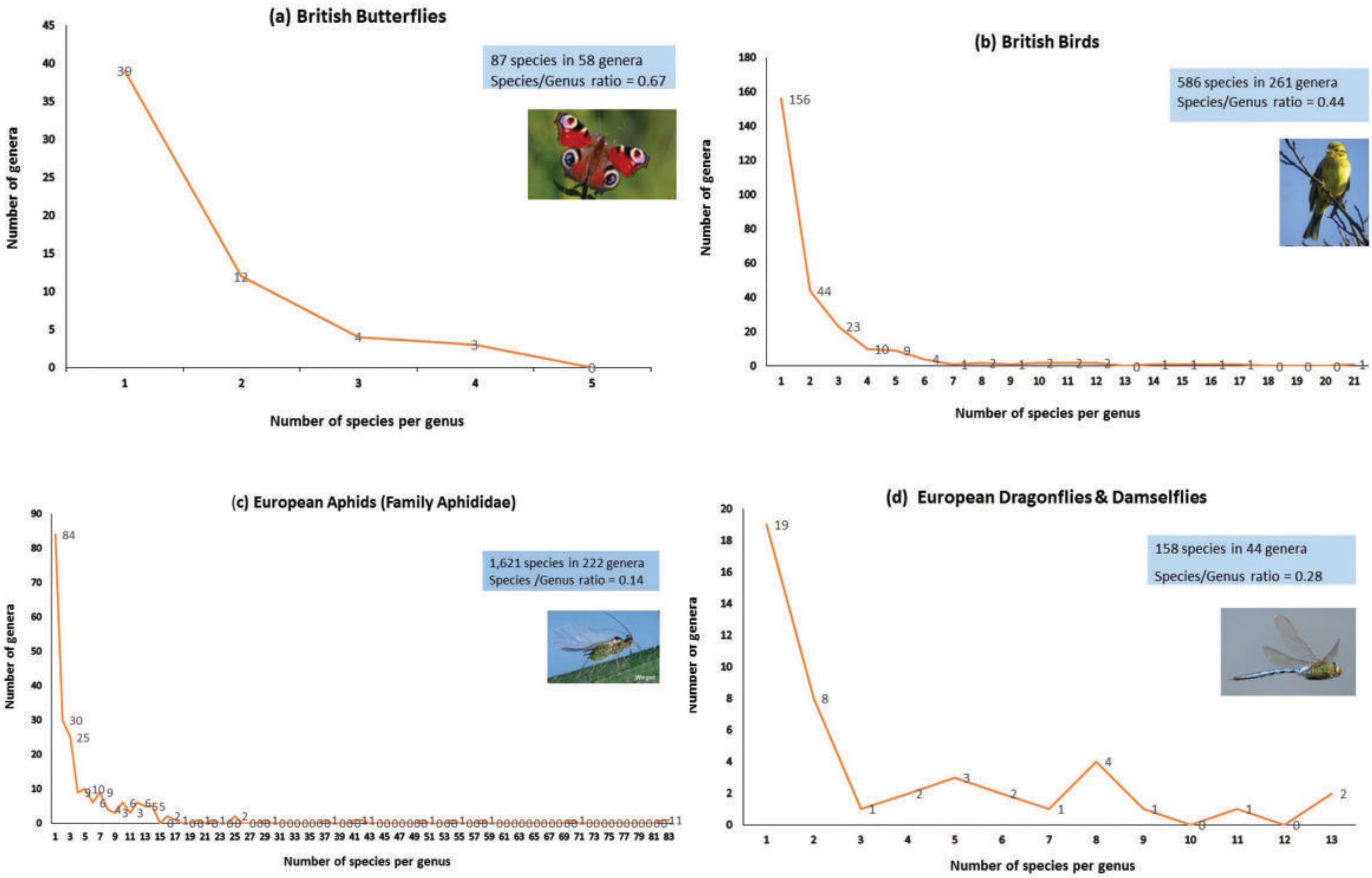
Compatible inversion polymorphisms /gene regions may reinforce this process.



Figs. 4a-c. (a) Naming Nature; (b) Carol Yoon; (c) Willis hollow curve distribution as produced on p. 143 of her book.

and *M. fuscoviride*; Figs. 3a-c) and in the grain aphid, *Sitobion avenae* (F.), since not many MLG repeats (i.e. 'clones' *sensu* Loxdale, 2008; see Boxes 3-5) exceeded about 4 then clearly there were mechanisms eliminating clones during the plant host growing season. The conclusion drawn from the available data sets was that new MLGs were produced either by a process of sexual reproduction during the annual autumnal-winter sexual phase (Dixon, 1998; Massonnet *et al.*, 2002, 2004; Loxdale *et al.*, 2011) or by direct mutations of various kinds during asexual propagation over the spring and summer months. However they were produced, selection, perhaps including clonal competition, caused most genotypes to swiftly disappear within natural populations, including meta-populations (Hanski, 1999), as exemplified by tansy aphids, such that most populations comprised one or a very few MLGs in terms of the *Number of sets of different MLGs*. In other words, most populations sampled were dominated by a very few clones (Fig. 3a-c; Boxes 4-5).

I had for Christmas 2013 given Nicola a copy of the book *Naming Nature: The Clash Between Instinct and Science* by the American taxonomist/evolutionist and latterly science journalist Carol K. Yoon (2009) about the difficulties inherent in classifying living organisms (Fig. 4a,b). Due to the pressures of her natural history publishing activities Nicola hadn't yet had time to read it all, although had started it and reported it suitably interesting and stimulating, which it surely is. Whatever, she certainly hadn't got to page 143. I eventually got to the said page and there it was, an illustration showing the Willis curve in black and white for all to see… and many no doubt had (Fig. 4c). Yoon duly described the salient features of this graph in the text. I was amazed, to say the least. There in essence was the very graph I had drawn independently and shown to Nicola back in the pub four years before. In fact, it was well known among the taxonomic-systematic fraternity, but seemingly not among molecular



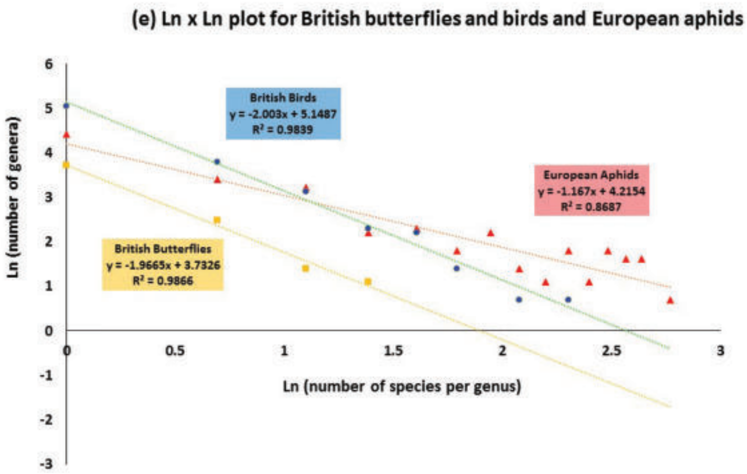


Fig. 5a-e. Willis hollow curve distributions for (a) British butterflies; (b) British birds; (c) European aphids; (d) European dragonflies & damselflies; and (e) regressions based on natural log transforming the data and re-plotting as Ln x Ln plots.

ecologists, perhaps including insect molecular ecologists, and certainly not by me.

In light of this discovery, and being curious about how aphid taxa might be represented using this form of graph, I downloaded the species data for several animal taxa from the worldwide web – British butterflies, British birds, European aphids (Superfamily: Aphidoidea; Family Aphididae), and European dragonflies and damselflies (Suborders Anisoptera and Zygoptera), initially identified on the basis of morphological features alone (Fig. 5a-e; websites 5-7) (although in recent years, some of these organisms, especially if closely related to other species in the same genus, or suspected of being morphologically cryptic species, have been tested by high resolution molecular DNA markers of one kind or another, including microsatellites). I later also plotted the data for the European mammals in this way (website 8), which gave a very similar plot (not shown). Hilu (2006) presents a typical graph for plants, in this case wild grasses, family Poaceae (his Fig. 11.1). For such data to be meaningful, clearly the distributions of the organisms in question must be of unified or coherent groups. For example, it would be pointless comparing the British and Brazilian birds in this way, as they have evolved on different continents under very different ecological conditions (one assumes), both abiotic and biotic.

Since the curves appeared to be negative exponentials, I next plotted them as natural log. *vs.* natural log. plots (Ln or $\log_e$). As shown in Fig.5e, the resulting linear regressions have high correlation coefficients ($R^2 \geq 0.86$). The slopes for the bird and butterfly regressions are similar, although the aphid graph is shallower. This may reflect the fundamental shape of the original Willis curve for the aphids, which involves many more species (and subspecies) along the x-axis at the higher (right hand) end of that x-axis, i.e. displayed a longer tail (see below). The European mammals data gave a similar curve (data not presented graphically; 409 species and subspecies in 113 genera; minimum class = 52 genera each with one species per genus; maximum class = one genus with 42 subspecies-species; for the purposes of the regression, the maximum class plotted comprised 8 genera each with 6 species-subspecies; y = - 1.4887x + 3.39852, R^2 = 0.87). In the case of the British butterflies, the R^2 value is very high at ~ 0.99 and there are no more than 4 species per genus (minimum class = 39 genera each with one species per genus; maximum class = 3 genera each with 4 species; for the purposes of the regression, the maximum class plotted comprised 3 genera each with 4 species). With the British bird relationship, R^2 is again high: ~ 0.98 (minimum class = 156 genera each with one species per genus; maximum class = 1 genus with 21 species-subspecies; for the purposes of the regression, the maximum class plotted comprised 10 genera each with 2 species-subspecies). In contrast, the correlation coefficient is weaker for European aphids (R^2 = ~ 0.86) as can be seen by the scatter of points at the high end (more species per genus) of both the original Willis curve and the regression derived from it (Figs. 5c and e, respectively; minimum class = 84 genera each with one species per genus; maximum class = one genus with 82 species-subspecies; for the purposes of the regression, the maximum class plotted comprised 16 genera each with 2 species-subspecies). The regression (not shown) produced for the European dragonflies and damselflies from the Willis curve (Fig. 5d) is also weaker (more scattered) with a lower correlation coefficient (minimum class = 19 genera each with one species per genus; maximum class = 2 genera with 13 species; for the purposes of the regression, the maximum class plotted comprised 8 genera each with 4 species; y = -1.0965x + 2.7763; R^2 = 0.71).

Conclusions

Generalism vs. Specialism debate

Most Willis curves have a high percentage of unique species, i.e. *one species per genus*: For British butterflies 44.8% of species fit this description, for British birds 26.6%, for European dragonflies and damselflies 12.0% and for European aphids 5.2% (of the total species per all genera sampled). Thus the butterflies appear the most extremely specialised, aphids the least. Perhaps this reflects the taxonomy of these groups and that many European aphids and dragonflies and even (but much less likely) British birds comprise as yet unrevealed cryptic species and sub-species (Loxdale *et al.*, 2016). As the process of specialism continues, the well-represented genera ultimately give rise to the unique category, the ultimate lot of all species prior to their eventual extinction?!

Of the four taxa investigated, the ‘species to genus ratio’ was as follows: for British butterflies 87 species in 58 genera = 0.67; for British birds 586 species in 261 genera = 0.45; for European aphids 1,621 species in 222 genera = 0.14; and for European dragonflies and damselflies 158 species in 44 genera = 0.28. Of course, the maximum ratio value (1.0) represents the same number of species per number of genera: there cannot be fewer species than genera, hence the ratio cannot exceed 1.0. However, as the value of the ratio increases towards 1.0, the number of species and genera increases towards parity, or in other words towards increasing and, ultimately, unique specialisations. The end result equates to one species per genus – resulting either from the decline of species numbers within a genus to one, or radical evolution of a new species from the parent population from which it derived to (initially at least) occupy its own genus.

The aphid microsatellite data show a similar trend to the data based on morphological criteria (Fig. 3a-c), the initially ‘generalist’ MLGs ultimately becoming selected out over time for one reason or another (abiotic and biotic), perhaps also due to plant host secondary chemical constraints related to specific plant chemotypes (e.g. see Benedek *et al.*, 2015). Even highly insecticide resistant clones appear often to decline in frequency in populations due to a lowering of fitness. This is apparently due to several reasons, including pleiotropic ones, related to lowered flight activity and reduced responsiveness to inclement weather and alarm pheromones, the latter leading to greater susceptibility to predators and hymenopterous parasitoids (see Fenton *et al.*, 2010 for details). The large number of *Species per genus* in the aphids (the end of the Ln x Ln graph) may represent the ‘ghost of the clones’, as adaptive radiation goes on apace and these ‘precursor’ genotypes become true species in their own right. A similar pattern appears present with the MLGs, whereon clones are selected over time such that there are very few MLGs with multiple copies > 10 left at the end of the growing season, or after a few seasons. If true, the Willis curve may be seen to represent a kind of ecological-evolutionary ‘machine’ in action, whereby clones or species expand and adaptively radiate, only later to ‘collapse’ over time to yield fewer and fewer MLGs per MGL class, i.e. *number of sets of different MLGs*, or *species per genus*, ultimately ending with one *MLG per class* or one *species per genus*, respectively.

A last point worth mentioning is that the process of plant adaption in aphids can potentially be very rapid (Boxes 2 & 6). In the cereal aphids, the blackberry-grain aphid, *Sitobion fragariae* (Walker) is holocylic (i.e. has an annual autumnal sexual phase leading to mating of the sexual forms and laying of cold hardy overwintering eggs on the primary woody host) and its sister species, the grain aphid, *S. avenae*, predominantly anholocyclic (asexual), persisting as live virginoparae on grasses and cereals all year round, but also producing some sexual forms under the influence of short day, lowered autumnal temperature conditions (i.e. 8 hr light: 16 hr dark; < 15°C) and ultimately some overwintering eggs. Interestingly, both species share the same chromosome number, 2n=18. Perhaps a mutation occurred sometime in the past that enabled certain Blackberry-grain aphid strains to propagate on the secondary host Poaceae all year round…. that is, without going back to the primary woody host in the autumn. In effect this would represent an act of instant speciation, since the precursor *S. fragariae* population and resultant evolved *S. avenae* population would be henceforth – to all intents and purposes – reproductively isolated, the former species on native grasses, the latter on cultivated cereals, especially wheat (Box 6; see also Loxdale & Brookes, 1990a and Delmotte *et al.*, 2001). Years ago I observed (with Cliff Brookes), from allozyme marker evidence, that certain strains of *S. fragariae sensu lato* (*s.l.*) collected on wild grasses, especially cocksfoot grass, *Dactylis glomerata* L., did not return to the primary host, bramble (Loxdale & Brookes, 1990b). So this change, or a similar one, may have occurred several times in *Sitobion* aphids, and may well have pre-dated the widespread growing of cereals by humans in ancient times, some 6,000-8,000 years ago (Website 9). Microsatellite and mitochondrial DNA analysis of UK *Sitobion* populations has shown that *S. fragariae* and *S. avenae* can nevertheless still occasionally hybridise (introgression), but that this is asymmetric: more female *S. fragariae* apparently mate with *S. avenae* males than vice versa (Sunnucks *et al.*, 1997). Other examples are well known where larger scale chromosomal changes lead to speciation, including host adaption – for example in the largely asexual corn leaf aphid, *Rhopalosiphum maidis* (Fitch) (Brown & Blackman, 1988).

If aphids such as *S. fragariae s.l.* undergo host adaptation when propagating asexually on grasses and cereals in the spring and summer growing season, induced by minor or major genetic mutational changes, then such adaptation is likely to be lost during sexual recombination. For such host adaptation to survive mating, it is probable that some kind of compatible chromosome regions bearing the newly-evolved host adapted regions need to be aligned during fertilization of the gametes to form the diploid zygote with pairing of the homologous parental chromosomes. In this way, during the next round of sexual recombination with formation during meiosis of haploid gametes by males and females to produce sperm and egg, respectively, successful crossing over of homologous chromosomes can occur at these particular regions (the process of synapsis of prophase I). One way this could happen is via homologous compatible regions, perhaps brought about by chromosome inversions induced by transposon 'hotspots' along the genome, as previously suggested for asexual, grass feeding and host adapted forms of gall-forming wasps, *Tetramesa* spp. (Hymenoptera: Eurytomidae) (Al-Barrak *et al.*, 2004). If this is so, then the holocyclic clones giving rise to the surviving new host adapted aphid strains, which may ultimately become biotypes or higher levels of ecological-evolutionary divergence (races, semi-species, sub-species, species) in their own right, are also some kind of '*ghosts of the clones*'. In other words, they are the precursors that initially had the relevant mutations but duly evolved – here via 'compatible' sexual recombination – to form colonies of 'bright new things' in an adaptive sense.

Acknowledgements

I acknowledge with gratitude the species list data available online (URLs as below) for British butterflies by Steven Cheshire, British birds by the British Trust for Ornithology (BTO; 2013 list) and for European dragonflies and damselflies, European mammals and European aphids (Aphididae) on the *Fauna Europaea* website co-ordinated by Dr Jan van Tol, Professor Dr. Weielaw Bogdanowicz and Professor Juan M. Nieto Nafria, respectively.

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I thank Nicola for taking the picture of me on 30th May, 2016 at Westonbirt Arboretum, Gloucestershire, U.K.

References

Al-Barrak, M. S., Loxdale, H.D., Brookes, C.P., Dawah, H. A., Biron, D.G. & Alsagair, O. (2004) Morphological and molecular studies on *Tetramesa* species (Hymenoptera: Eurytomidae) with a key to the genus *Tetramesa* and their parasitoids. *Biological Journal of the Linnean Society*, **83**, 509-525.

Arillo, A. & Engel M.S. (2006) Rock Crawlers in Baltic Amber (Notoptera: Mantophasmatodea). *American Museum Novitates*, **3539**, 1-10.

Benedek, K., Bálint, J., Salamon, R.V., Kovács, E., Ábrahám, B., Fazakas, C., Loxdale, H.D. & Balog, A. (2015) Tansy plant (*Tanacetum vulgare* L.) chemotype determines aphid genotype and its associated predator system. *Biological Journal of the Linnean Society*, **114**, 709–719.

Blackman R. L. (1980) Chromosomes and parthenogenesis in aphids. *Insect Cytogenetics*. Proceedings of the Royal Entomological Society Symposium no. 10 (ed. by R.L. Blackman, G. M. Hewitt & M. Ashburner), pp. 133-148, Blackwell, Oxford, U.K.

Blackman, R.L. (1981) Species, sex and parthenogenesis. *The Evolving Biosphere* (ed. by P.L. Forey), pp.75-85, British Museum (Natural History), Cambridge University Press, London & Cambridge, U.K.

Brown, P.A. & Blackman, R.L. (1988) Karyotype variation in the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), species complex (Hemiptera: Aphididae) in relation to host-plant and morphology. *Bulletin of Entomological Research*, **78**, 351–363.

Delmotte, F., Leterme, N., Bonhomme, J., Rispe, C. & Simon, J-C. (2001) Multiple routes to asexuality in an aphid. *Proceedings of the Royal Society of London B*, **268**, 2291-2299.

Dixon, A.F.G. (1998) *Aphid Ecology*, 2nd edn. Chapman and Hall, London.

Fenton, B., Margaritopoulos, J.T., Malloch, G.L. & Foster, S.P. (2010) Micro-evolutionary change in relation to insecticide resistance in the peach–potato aphid, *Myzus persicae*. *Ecological Entomology*, **35** (Suppl. 1), 131–146.

Goldstein, D. B. & Schlötterer, C. (1999) *Microsatellites, Evolution and Applications*. Oxford University Press, Oxford, U.K.

Hanski, I. (1999) *Metapopulation Ecology*. Oxford University Press, Oxford, U.K.

Hilu, K.W. (2006) Skewed distribution of species number in grass genera: Is it a taxonomic artefact? Chapter 11 *Reconstructing the Tree of Life: Taxonomy and Systematics of Species Rich Taxa*. Systematics Association Special Volume No. 72 (ed. by T. Hodkinson & J.A.N. Parnell), pp. 165-176, CRC Press (Taylor & Francis Group), Abingdon, Oxon., U.K.

Hodkinson, T. & Parnell, J.A.N. (eds.) (2006) *Reconstructing the Tree of Life: Taxonomy and Systematics of Species Rich Taxa*. Systematics Association Special Volume No. 72, CRC Press (Taylor & Francis Group), Abingdon, Oxon., U.K.

Klass, K.D., Zompro, O., Kristensen, N.P. & Adis, J. (2002) Mantophasmatodea: a new insect order with extant members in the Afrotropics. *Science*, **296**, 1456–1459.

Loxdale, H.D. (2008) The nature and reality of the aphid clone - genetic variation, adaptation and evolution. *Agricultural and Forest Entomology*, **10**, 81-90.

Loxdale, H.D. (2010) Rapid genetic changes in natural insect populations. *Ecological Entomology*, **35** (Suppl. 1), 155-164.

Loxdale, H.D. (2014) Musings on the birds and the bees …and flies and butterflies too. *Antenna*, **38**, 219-225.

Loxdale, H.D. & Brookes, C.P. (1990a). Prevalence of *Sitobion fragariae* (Walker) over *S. avenae* (Fabricius) (Hemiptera: Aphididae) on wild cocksfoot grass (*Dactylis glomerata*) in south-east England. *Bulletin of Entomological Research*, **80**, 27-29.

Loxdale, H.D. & Brookes, C.P. (1990b) Genetic stability within and restricted migration (gene flow) between local populations of the blackberry-grain aphid *Sitobion fragariae* in south-east England. *Journal of Animal Ecology*, **59**, 495–512.

Loxdale, H.D. & Harvey, J.A. (2016) The 'generalism' debate: misinterpreting the term in the empirical literature focusing on dietary breadth in insects. *Biological Journal of the Linnean Society*, **119**, 265–282. (available online at doi: 10.1111/bij.12816).

Loxdale, H.D. & Lushai, G. (1998) Molecular markers in entomology (Review*). Bulletin of Entomological Research*, **88**, 577-600.

Loxdale, H.D., Davis, B.J. & Davis, R.A. (2016) Known knowns and unknowns in biology. *Biological Journal of the Linnean Society*, **117**, 386–398. (Available online at: doi: 10.1111/bij.12646).

Loxdale, H.D., Lushai, G. & Harvey, J.A. (2011) The evolutionary improbability of 'generalism' in nature, with special reference to insects. *Biological Journal of the Linnean Society*, **103**, 1-18.

Loxdale, H.D., Massonnet, B. & Weisser, W.W. (2010) Why are there so few aphid clones? *Bulletin of Entomological Research*, **100**, 613–622.

Loxdale, H.D., Schöfl, G., Wiesner, K.R., Nyabuga, N.N., Heckel, D.G. & Weisser, W.W. (2011) Stay at home aphids: comparative spatial and seasonal metapopulation structure and dynamics of two specialist tansy aphid species studied using microsatellite markers. *Biological Journal of the Linnean Society*, **104**, 838–865.

Lyons, S.L. (1999) *Thomas Henry Huxley: The Evolution of a Scientist*. Prometheus Books, Amherst, New York, U.S.A.

Massonnet, B. & Weisser, W.W. (2004) Patterns of genetic differentiation between populations of the specialised herbivore *Macrosiphoniella tanacetaria* (Homoptera: Aphididae). *Heredity*, **93**, 577-584.

Massonnet B., Simon, J.-C. & Weisser, W.W. (2002) Metapopulation structure of the specialised herbivore *Macrosiphoniella tanacetaria* (Homoptera, Aphididae). *Molecular Ecology*, **11**, 2511–2521.

Monti, V., Lombardo, G., Loxdale, H.D., Manicardi, G.C. & Mandrioli, M. (2012) Continuous occurrence of intra-individual chromosome rearrangements in the peach potato aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae). *Genetica*, **140**, 90–103.

Sunnucks, P., De Barro, P. J., Lushai, G., Maclean, N. & Hales, D. (1997) Genetic structure of an aphid studied using microsatellites: cyclic parthenogenesis, differentiated lineages, and host specialisation. *Molecular Ecology*, **6**, 1059–1073.

Wheelwright, M. (2016) Moths – the masters of mimicry (1st prize winner, Student Essay Competition). *Antenna*, **40**, 84-85.

White, M.J.D. (1978) *Modes of Speciation*. W.H. Freeman & Company, San Francisco, California, U.S.A.

Willis, J.C. (1922) *Age and Area: A Study in Geographical Distribution and Origin of Species* (with chapters by H. de Vries, H. B. Guppy, E. M. Reid, J. Small). Cambridge University Press, Cambridge, U.K.

Willis, J.C. & Yule, G.U. (1922) Some statistics of evolution and geographic distribution in plants and animals and their significance. *Nature*, **109**, 177- 179.

Willis, J.C. (1940) *The Course of Evolution by Differentiation or Divergent Mutation Rather Than by Selection*. Cambridge University Press, London, U.K.

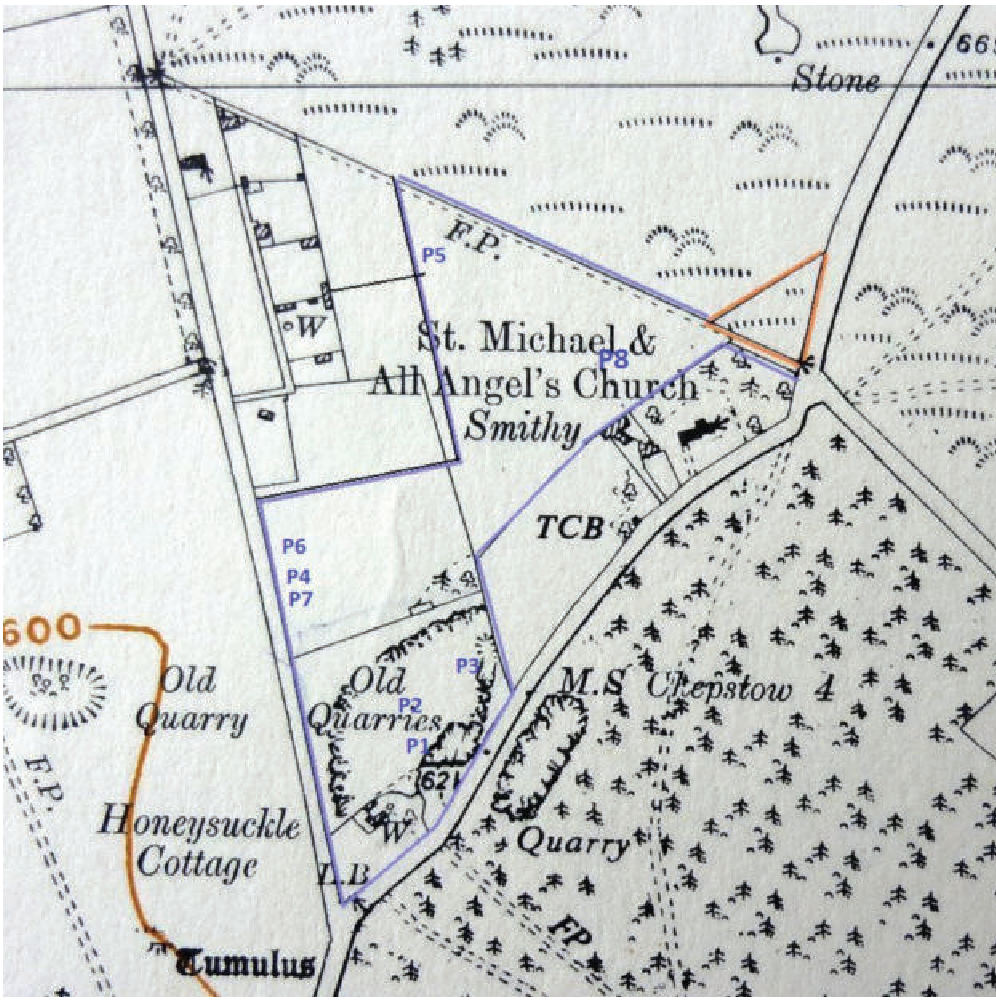
Yoon, C.K. (2009) *Naming Nature: The Clash between Instinct and Science*. W.W. Norton & Co., Inc., New York., U.S.A.

Websites cited

1. https://en.wikipedia.org/wiki/John_Christopher_Willis
2. https://en.wikipedia.org/wiki/Saltation_(biology)
3. https://en.wikipedia.org/wiki/Orthogenesis
4. https://en.wikipedia.org/wiki/Mantophasmatidae
5. http://www.britishbutterflies.co.uk/species-list-vernacular.asp
6. http://www.bou.org.uk/wp-content/uploads/2016/07/British-List.pdf
7. http://www.eimagesite.net/s1/gst/run.cgi?action=page;p=L16
8. http://www.faunaeur.org/species_list.php
9. http://www.bbc.com/news/science-environment-31648990

Butterfly status – Honeysuckle Cottage, Tidenham Chase – some notes

Our patch, which we have occupied since 1970, is about 11 acres, managed as a 'nature reserve' of highest practical diversity. It is between 600 and 650 ft above sea level, but the Wye gorge is adjacent and the river at sea level is only about 700 yards away. Of this 11 acres, 0.7 is 'garden' around the house, 2 acres is a defunct limestone quarry, behind the house only 10-20 feet deep, a woodland - part ancient, and part planted by me 25 years ago makes up about 2 acres, and a natural meadow covers about 6 acres with some 1000 yards of hedges around it, all planted by me in *ca* 1990. This land is half on Carboniferous Limestone and the other half is Old Red Sandstone. The meadow is of high botanical diversity, and is mowed annually *ca* end August by a contractor and the hay removed. It is not grazed (it was lightly summer



Our property (above outlined in blue)

Dr Nigel Simpson

Aerial photo, 2008. Our house is by the bottom left hand corner. The meadow had just been cut. Numbers indicate ponds.

grazed between 1975 and 1985 but not since). We have about 6-8 thousand orchid flowers each year, of which 5-6K are Common Spotted, 1K are Twayblades, and of the rest between *ca* 1 to 100 each of Bee, Pyramidal, Broad-leaved Helleborine, Heath-Spotted, Green-winged, Southern Marsh, and Early Purple (in ascending number-order).

The four neighbours of our place are a dairy farm, a Forestry Commission 100 acre plantation (The Park), which was of Scot and Corsican pines, now mainly removed, and is a heathland restoration project managed by Gloucestershire Wildlife Trust (Glos WT), and two *ca* 80 acre 'allotments' made as a result of the Enclosure acts. Of these, one (Parsons Allotment) is a deciduous Forestry Commission plantation, mainly beech and oak, and the other is an SSSI (Poor's Allotment), jointly managed by the local Council and the Glos WT. The Wye gorge slopes below (below the dairy farm) are a mix of Glos WT Nature reserve, and Forestry Commission.

Butterfly list

(30 species – regular or occasional)

(a) Still present on our land:-

Small Tortoiseshell, Red Admiral, Comma, Peacock, Painted Lady, Brimstone, Orange-tip, Speckled Wood, Ringlet, Meadow Brown, Gatekeeper, Marbled White, Small White, Large White, Green-veined White, Small Heath, Small Copper, Small Skipper, Essex Skipper, Large Skipper, Dingy Skipper, Grizzled Skipper, Holly Blue, Common Blue, Green Hairstreak, Purple Hairstreak, White-letter Hairstreak, Silver-washed Fritillary, White Admiral, Clouded Yellow

(b) Now extinct (4 species - all present in the 1970's):-

Small Pearl-bordered Fritillary, High-brown Fritillary, Brown Argus, Wall

(c) Vagrants (2 species – observed once or twice in 46 years):-

Dark Green Fritillary, Wood White

Comments:- General significant decrease in populations of several species, in particular Speckled Wood (up to 50 could be seen on a good day in 70/80s – now more like 5 to 10 max.) and Common Blue (which were also very abundant into the 1980s – I could easily find grass stalks near the house with 5 to 10 sleeping common blues on them, not any more). With the development of our 6 acre meadow Common Blues have recovered somewhat, with usually *ca* 10 to 20 visible in August (but this year seems not good at all – max count so far for the 2nd brood flying is 3). Purple Hairstreaks used to be common, and a short walk on a decent day in August could typically provide *ca* 20 individuals, but in 2014 I saw only two despite hours of searching, and in 2015 none. Same with White-letter

Hairstreak which was super-abundant in the early 70s. One big Wych elm by our house had hundreds of butterflies on it and thousands of eggs, but it died in the late 70s. The species diminished with the Elm trees dying, but could still be seen annually with up to 10 adults in the 90s and up to *ca* 2005, without excessive searching. Numbers have steadily declined since; in 2014 I saw only one, and in 2015 none at all. However, today (Aug 7th) two slightly worn White-letter Hairstreaks were feeding on their usual Hemp Agrimony just behind the house. These have only just come into flower, and this plant was the easiest way to see both Purple and White-letter Hairstreaks in these recent diminished years. Green Hairstreaks seem to vary in number from year to year, though Holly blues numbers seem fairly steady – I have seen three this August.

Marbled White were regular in the 70s and 80s then almost vanished, but since the evolution of our natural meadow slow increases have been observed. Last year the maximum one-day count had increased to *ca* 20 in our field. Higher numbers occurred again in 2016, with 20+ seen most days in July. Essex Skipper, which I found in our meadow in 2014 having been advised to look for it, continues to be present. Dingy and Grizzled Skippers are still around in our field and across the road on Parson's Allotment, but need careful searches and are fewer now than in years gone by. White Admiral is still present annually but only once or twice a year now, more easily seen in the 1980/90s.

Ringlets and Meadow Browns remain very numerous. Brimstone, Orange tips, Red Admiral, Small Tortoiseshell, Peacocks, Large, Small and Green-veined Whites are all more or less unchanged. Small Heath and Copper appear somewhat reduced in recent times and now quite scarce. Large and Small Skippers are also reduced in numbers (perhaps due to increased shade from trees).

Small Pearl-bordered and High-brown Fritillary were regular in the 70s and early 80s but then vanished. Up to about 10 Small Pearl-bordered could be seen in the early 1980s. High-browns I think depended on regular coppicing of the nearby Forestry Commission land, but this doesn't happen anymore (pit-props for the Welsh coal mines no longer being required!) It is more or less the same situation with Wall and Brown Argus, which were present in the 70s and into the 80s, but have not been present for 20+ years. For these species loss of local habitat is at least partially responsible for disappearances; the only rock-rose is now in our patch, only *ca* 4sq metres, whereas there were once larger areas nearby which have now vanished.

Moth list

Compiled in 1976 by two 'semi-professional' researchers, moth lists can be supplied for Honeysuckle Cottage and for six other locations nearby. *Ca* 100 species were found at Honeysuckle Cottage at this time. All large moths are vastly reduced in abundance now since the 1970s. Curiously Large Red Underwing has appeared on the identical square foot of the wall of our house during the last 40 years on four occasions, most recently in 2015. Hawk moth caterpillars are never encountered in our land these days, despite being very easily found in the 70s. Humming-bird Hawk moth is neverthless still seen about once a year, though other Hawk moths (e.g. Elephant Hawk) are no longer encountered. Even Cinnabar moth seems to be on the verge of disappearing, but Burnet Moths remain quite abundant in the meadow.

Dragonfly list

(14 species)

Southern Hawker, Common Hawker (occasional), Emperor, Black-tailed Skimmer (regular in early years, now seen less often as all vegetation-free edge has gone, but still present on a nearby 'new' pond on The Park), Broad-bodied Chaser, Black Darter (also regular in autumn on the pond in The Park), Ruddy Darter, Common Darter, Banded Demoiselle (occasional visitor from Wye below), Emerald Damselfly, Large Red Damselfly, Blue-tailed Damselfly (very scarce), Common Blue Damselfly, Azure Damselfly.

We have 8 ponds on our land, all 'home-made' during the period 1975 to 1990 and lined as the land is completely porous. This pond creation has resulted in increased dragonflies, and it is possible that Emperor and Southern hawkers (both present) consume some of our butterflies. Nevertheless, I have only once seen an Emperor catch and consume a Marbled White in 20 years, but maybe they are more active when I'm not looking. Our Marbled White 'colony' is close to our biggest pond (*ca* 100 ft diameter) and seems to be steadily increasing.

Reptiles and amphibians are also regularly seen and include; all 3 newt species in nearly all the ponds, common frog and toad, adder - now very rare but abundant in the 1970s (I suspect Pheasants which are also abundant may be a possible cause of declines), grass snakes, abundant slow worms, and some common lizards.

Insect diversity sustained by large-scale ecological networks

Michael J. Samways
James S. Pryke
René Gaigher

Improved actual and functional connectivity across the landscape is purported as one of the hallmarks of successful insect conservation, but how successful is it, and what is the evidence? Prior to the Anthropocene, the southern tip of Africa had few forests and not enough timber to meet the needs for early ship repairs, pit props in the gold mines, and the growing demand for paper pulp. Plantation trees were established on a large scale, mostly alien pines and eucalyptus. Inevitably this had a major impact on the local biodiversity. Much of this biodiversity is irreplaceable, with South Africa having three of the world's 34 global biodiversity hotspots. During the 1970's and 1980's there was such a high demand for pulp that trees were planted 'wall-to-wall', where every spot possible was planted up, including feeder streams and local areas of high natural value.

Developing new approaches

Something had to be done to address this earlier unsustainable approach, and it had to be done fast and decisively. After intense discussions some years ago among many people and organizations, it was decided to take a new approach in this Maputaland-Pondoland Global Biodiversity Hotspot. This involved setting aside of remnant land between newly established plantation blocks in the form of interconnected corridors which crisscross the landscape as ecological networks (ENs). This land is mostly indigenous grassland but also natural

Fig. 1. A large-scale ecological network of plantation pine trees in a matrix of indigenous remnant grassland at a higher elevation. At the left middle, adjacent to a pine block, is a naturally small patch of native forest rich in a complementary insect fauna to that of the grassland. The brown patch on the right is an area where the pine trees have been felled.

forest patches which are sprinkled across this grassland landscape. Today, on average, a third of the land is set aside, making up over half a million hectares of what is considered to be land devoted to biodiversity conservation and ecological processes so as to maintain sustainable and resilient landscapes well into the future.

While plants and large mammals have been investigated, it has been the focus on insects and other soil inhabiting arthropods that has enabled so much progress to be made. The reason for this is that insects and other arthropods are sensitive indicators of land and freshwater quality as well as general ecosystem health. Using insects has also led to solving of one of the greatest insect conservation questions: do ecological networks really work in practice? This is a question of both national and international importance, with the approach to insect conservation described herein forming part the National Biodiversity and Strategic Action Plan, as well as feeding into the international Aichi Biodiversity Targets.

Demonstrating the value of ecological networks

The best way to prove that these ecological networks really do work was by establishing that the natural ecosystems in ENs are functioning as well as ecosystems in fully natural protected areas (PA). This was done by working closely with the large forward-thinking forestry company Mondi, who were looking for options to optimize timber production while maintaining ecological processes for long term sustainability well into the future. It was always necessary to test the value of ENs against a reference condition, which was to be found in the PAs. Fortunately, it was always possible to find major PAs, including a World Heritage Site, adjacent to ENs to illustrate functional equivalence of PAs and ENs, as well as to show the extent to which ENs function as extensions of PAs. Using aerial insects and other ground-living arthropods, over many years of research, it was finally possible to show categorically that these ENs do in fact play an enormous role in the conservation of fauna, and of insects in particular, including their food plants and habitats.

Many principles were uncovered by this entomological effort, including the relative importance of design vs. management, where both are important on this naturally fire driven landscape. Wide corridors, especially those over 64 m wide, that have high levels of habitat heterogeneity, including much micro-topographic variation, and cover a range of elevations, were equivalent in insect and plant diversity in the PAs vs. the ENs. Not only that, but the ENs effectively increased the size of PAs. This finding has subsequently led to improved resilience in the quality of land and freshwater which has now been set aside way beyond the boundaries of PAs, with huge benefit to

Fig. 2. A primary aim of these ecological networks is to maintain a natural hydrology, and so also the insect fauna. Rare and threatened endemic species are also conserved in these networks such as the Yellow Presba *Syncordulia gracilis* (inset one) Red Listed as Vulnerable, and Balinsky's Sprite *Pseudagrion inopinatum* (inset two) Red Listed as Near Threatened (Photo: Alan Manson).

insect diversity in general. This also means improved resilience in the face of global climate change.

Recognition of the value of insects in large-scale conservation projects

This research has been done under the auspices of the Mondi Ecological Networks Programme at the Department of Conservation Ecology & Entomology, Stellenbosch University, which recently won the National Science & Technology Forum-GreenMatter Award for its contribution towards biodiversity conservation, sustainability and a greener economy from the Minister of Science and Technology, Ms Naledi Pandor. So why should insects receive such high level recognition? Not only are they so diverse and represent such a large swathe of biodiversity and many of its interactions, but they are also valuable sentinels for ensuring sustainable agroecological development among responsible large corporates, like Mondi, and a way forward at a time when we are unlikely to see the proclamation of many more PAs, and where the current challenges for insect conservation now exist across transformed and novel landscapes.

Acknowledgements

We thank Peter Gardiner of Mondi Group, UK, for continued support and inspiration for this ongoing research, as well as many foresters in Mondi (South Africa) for access to sites and supporting our research in many ways.

Fig. 3. This seemingly insignificant pool in a lowland ecological network among eucalypts is a breeding pool for one of the world's largest dragonflies, the magnificent Black Emperor, *Anax tristis*, which can reach more than 12 cm in length (inset).

Fig. 4. These ecological networks host many native large mammals which deposit much dung and so attracting a host of dung beetle species. The dung beetle *Heliocopris primal* arrives in large numbers as soon as this yummy food source is available (inset).

Fig. 5. Megaherbivores have a strong influence on vegetation structure and patterning, so influencing insect dispersion patterns. Where there is high grazing pressure from hoofed animals (inset one) certain species benefit, such as the grasshopper *Jasomenia sansibara* (inset two).

Fig. 6. Cattle alongside native megaherbivores graze some of the higher elevation ecological networks where there is a rich sward of grasses and herbs, attracting a wide variety of flower visitors, such as the African carpenter bee *Xylocopa caffra* (inset one) and the Novice, *Amauris ochlea* (inset two).

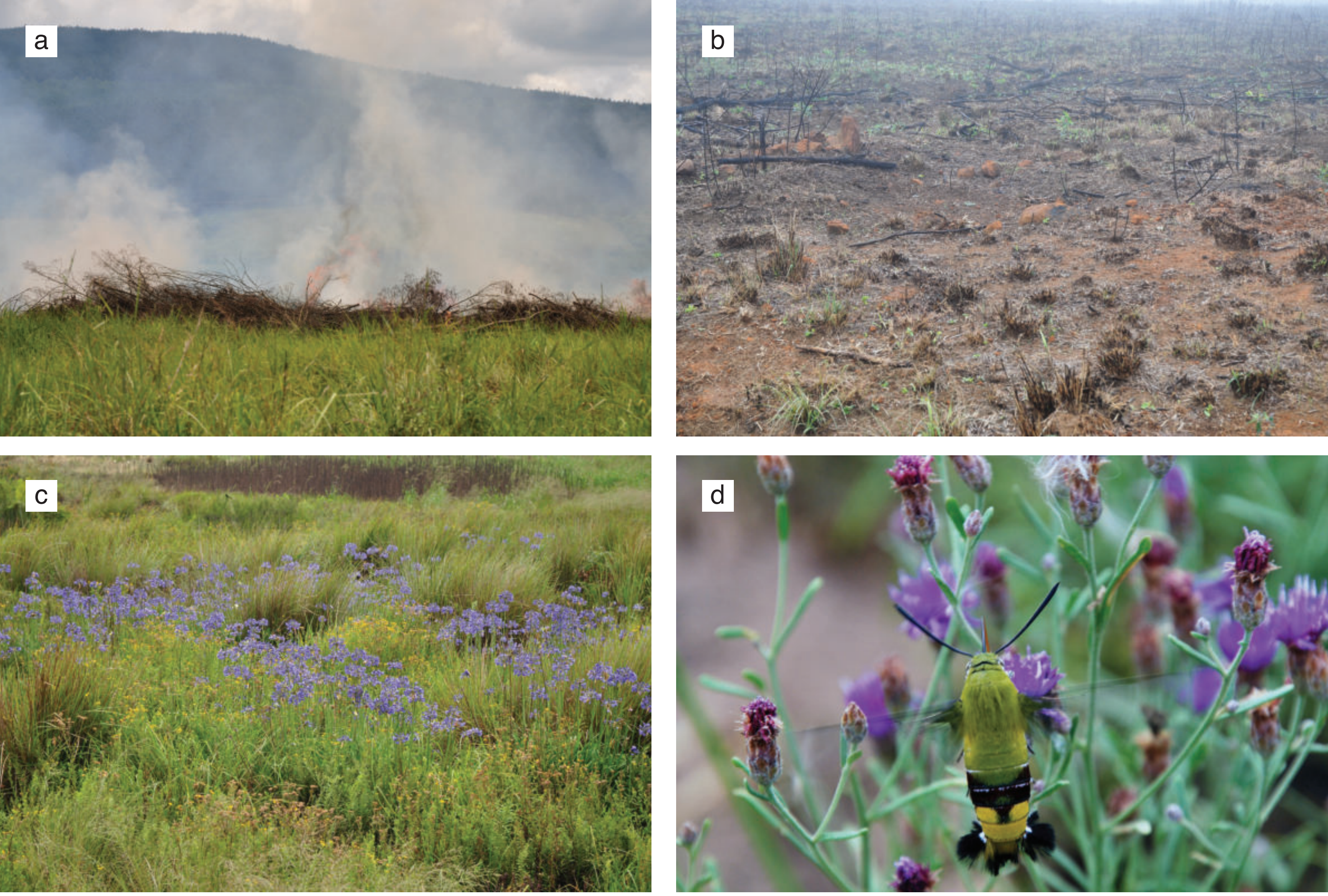


Fig. 7. These ecological networks at all elevations are naturally fire driven, giving rise to a grassland matrix with small sharp-edge forest patches. But the ENs are also burned to simulate the natural condition (a), leading to a visually bleak landscape (b), which regenerates into a rich meadow, (c) attracting some interesting flower visitors such as this Coffee grinder hawk moth *Cephanodes hylas* (d).

Fig. 8. Some of the higher elevation ecological networks are situated on a tourist route known as The Midlands Meander, the logo (on the left of the sign) of which is the Karkloof blue butterfly *Orachysops ariadne* Red Listed as Vulnerable (inset one) (Photo: Sheng-Shan Lu). The best way to monitor this very rare species is to count the eggs which are deposited on a specific variety of its food plant. Inset 2 shows a monitoring team working under guidance from Ezemvelo KwaZulu-Wildlife (Photo: Adrian Armstrong).

Fig. 9. One important finding from the research is the importance of the toposcape at many spatial scales, from a few metres to a few kilometres, maintaining insect diversity in this global biodiversity hotspot. Features of this landscape play a critical role in generating patterns of insect diversity and heterogeneity.

Further reading

Bazelet, C.S. and Samways, M.J. (2011). Grasshopper assemblage response to conservation ecological networks in a timber plantation matrix. *Agriculture, Ecosystems and Environment* **144:** 124-129.

Bazelet, C.S. and Samways, M.J. (2011). Identifying grasshopper bioindicators for habitat quality assessment of ecological networks. *Ecological Indicators* **11:** 1259-1269.

Bazelet, C.S. and Samways, M.J. (2011). Relative importance of management vs. design for implementation of large-scale ecological networks. *Landscape Ecology* **26:** 341-353.

Bazelet, C.S. and Samways, M.J. (2012). Grasshopper and butterfly local congruency in grassland remnants. *Journal of Insect Conservation* **16:** 71-85.

Bazelet, C.S. and Samways, M.J. (2014). Habitat quality of grassland fragments affects dispersal ability of a mobile grasshopper, *Ornithacris cyanea* (Orthoptera: Acrididae). *African Entomology* **22:** 714-725.

Crous, C, Samways, M.J. and Pryke, J.S. (2013). Exploring the mesofilter as a novel operational scale in conservation planning. *Journal of Applied Ecology* **50:** 205-214.

Crous, C., Samways, M.J. and Pryke, J.J. (2013). Associations between plant growth forms and surface rockiness explain plant diversity patterns across an Afro-montane grassland landscape. *South African Journal of Botany* **88:** 90-95.

Crous, C., Samways, M.J. and Pryke, J.S. (2014). Grasshopper assemblage response to surface rockiness in Afro-montane grasslands. *Insect Conservation and Diversity* **7:** 185-194.

Crous, C., Samways, M.J. and Pryke, J.S. (2014). Rockiness determines meso-scale conservation of butterflies in Afro-montane grassland. *Journal of Insect Conservation* **18:** 77-83.

Grant, P.B.C. and Samways, M.J. (2016). Ecoacoustics of a production/protected area mosaic for better conservation. *Conservation Biology* (in press)

Joubert, L., Pryke, J.S. and Samways, M.J. (2014). Annual burning drives remnant grassland ecological networks in an afforested landscape. *South African Journal of Botany* **92:** 126-133.

Joubert, L., Pryke, J.S. and Samways, M.J. (2016). Past and present disturbances influence the biodiversity value of subtropical grassland ecological networks. *Biodiversity and Conservation* **25**: 725-737.

Joubert, L., Pryke, J.S. and Samways, M.J. (2016). Positive effects of burning and grazing on grasshopper diversity. *Insect Conservation and Diversity* **9**: 290-301.

Kietzka, G., Pryke, J.S. and Samways, M.J. (2015). Landscape ecological networks are successful in supporting a diverse dragonfly assemblage. *Insect Conservation and Diversity* **8:** 229-237.

Pryke, J.S. and Samways, M.J. (2012). Conservation management of complex natural forest and plantation edge effects. *Landscape Ecology* **27:** 73-85.

Pryke, J.S. and Samways, M.J. 2012. Ecological networks act as extensions of protected areas for arthropod biodiversity conservation. *Journal of Applied Ecology* **49:** 591-600.

Pryke, J.S. and Samways, M.J. (2015). Conserving natural heterogeneity is crucial for designing effective ecological networks. *Landscape Ecology* **30:** 595-607.

Pryke, J.S., Samways, M.J. and De Saedeleer, K. (2015). An ecological network is as good as major protected area for conserving dragonflies. *Biological Conservation* **191:** 537-545.

Pryke, S.R. and Samways, M.J. (2001). Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* **101**: 85-96.

Pryke, S.R. and Samways, M.J. (2003). Quality of remnant indigenous grassland linkages for adult butterflies (Lepidoptera) in an afforested African landscape. *Biodiversity and Conservation* **12**: 1985-2004.

Samways, M.J. (2007). Implementing ecological networks for conserving insect and other biodiversity. In: Stewart, A., Lewis, O., New, T.R. (Eds.) *Insect Conservation Biology*. 127-143. CABI, Wallingford , Oxon, UK.

Samways, M.J., Bazelet, C.S., and Pryke, J.S. (2010). Provision of ecosystem services by large-scale corridors and ecological networks. *Biodiversity and Conservation* **19:** 2949-2962.

Samways, M.J. and Pryke, J.S. (2016). Large-scale ecological networks do work in an ecologically complex biodiversity hotspot. *Ambio* **45:** 161-172.

Samways, M.J. and Simaika, J.P. (2016). *Manual of Freshwater Assessment: The Dragonfly Biotic Index*. South African National Biodiversity Institute, Pretoria, South Africa.

Yekwayo, I., Pryke, J.S., Roets, F. and Samways, M.J. (2016). Conserving a variety of ancient forest patches maintains insect diversity. *Biodiversity and Conservation* **25:** 887-903.

Yekwayo, I., Pryke, J.S., Roets, F. and Samways, M.J. (2016). Surrounding vegetation matters for arthropods of small, natural patches of indigenous forest. *Insect Conservation and Diversity* **9:** 224-235.

Touring Entomology collections in the UK: Royal Cornwall Museum

(*Gwithti Kernow Kurun*)

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In the very south-west of Britain at the tip of a long hilly peninsula lies Cornwall (Cornish: *Kernow*), jutting out from the rest of the island into the Celtic Sea. Relatively remote and largely rural, the region has developed a distinct character of its own over the millennia, rooted in the pre-Roman Celtic cultures of prehistoric Britain. Known for its stunning coastlines which include the Lizard Peninsula, it is arguably one of the most beautiful areas in England and home to a unique and diverse range of flora and fauna, including the Cornish Chough (fig. 1), one of the rarest birds in Britain.

The Royal Cornwall Museum (RCM) is found in Cornwall's only city, Truro, and that is where I headed to for this instalment of my tour of entomology collections in the UK. This series aims to explore and discuss the different collections of insects found in all the areas of the UK to highlight the resources on offer and the content of regional and smaller collections for research purposes. I will discuss specific historical collections in each museum and give a general overview of the whole collection. In past issues I've visited the Cole Museum of Zoology, Reading; National Museum of Wales, Cardiff; Bristol Museum & Art Gallery; Birmingham Museum & Art Gallery and Yorkshire Museum and have found large collections of potentially important insects. The series has already helped to establish links

Figure 1: A Cornish chough (*Pyrrhocorax pyrrhocorax*) in the displays at Royal Cornwall Museum.

Figure 2: The Discovery Centre allows kids (or big kids) to look at insects under the microscope.

between potential researchers and collections, and the hope is that future issues can do the same.

The RCM was set up alongside the Courtney Library by the Royal Institute of Cornwall to promote the county's industry and art. The museum building was constructed in 1845 as a bank, later to become a mining school and then in 1919 to begin housing the museum. RCM is known for its world famous mineralogy collections, but it also houses exhibitions on local history, including geology and archaeology, arts and world cultures, the latter featuring a British Museum-supported exhibition on Greek and Egyptian culture. I was hosted at the museum by Sara Chambers, the Collections and Exhibitions Manager.

Cornwall has an old and very long history with strong ties to other Celtic nations of the UK and Europe with particularly close ties to Brittany, which even has a region called Cornouaille (Breton: *Kernev*). This Celtic origin is still evident in the distinctiveness of Cornish culture, including a language that is very similar to Breton and close to Welsh. Cornwall was considered a separate country until around 500 years ago and during mediaeval times was widely known as a distinct land; Cornish was still in popular usage and there were distinct styles of dress and food quite different to England. Polydore Vergil from Urbino, Italy, wrote in his history of Britain of the four 'parts' of the island. He discusses England, Scotland, Wales and Cornwall (Northern Ireland was yet to exist) as well-known and distinct nations "which all differ emonge them selves, either in tongue, … in manners, or ells in lawes and ordnaunces" (Vergil, 1535).

England now administers all constitutional matters for Cornwall, though there are continuing debates about the cultural, ethnic and legal distinctiveness of Cornwall and whether the region should have further autonomy, akin to Wales, Scotland and the much younger Northern Ireland. Much of the integration into England could have been due to the loss of the language; the other Celtic nations of the UK still have their native languages and bilingualism is common in many areas. The Council of Europe has recently granted the Cornish ethnic minority status similar to that held by the Scottish, Welsh and Irish and although the UK government does not recognise this they have provided funds to the Cornish Language Partnership to ensure

Figure 3: Weevils. Main photo *Liophloeus tessulatus* and inset (bottom) one unknown British weevil both in Curculionidae and the other (top) a rather spectacular snout weevil of the family Brentidae (c: gwedhan min Sumatra).

Figure 4: Beetles labelled as *Helmis* in Dryopidae but may be the riffle beetle *Elmis aenea* in *Elmidae*.

Figure 5: The rhinoceros beetle (Lucanidae: *Sinodendron cylindricum*) and a scarab beetle (Scarabaeidae: *Aphodius haemorrhoidalis*).

that the Cornish language is not lost completely. Perhaps with the resurgence of the language and the greater desire for Cornish distinctiveness to be accepted Cornwall may soon be recognised as the 5th nation in the union. Where Cornish translations are present in this article, they have been taken from the Lexilogos online dictionary unless they are taxa names, which can be attributed to Loveday Jenkin and Pol Hodge, the Chairman of Terminology (Kaderyer of the Termonieth) with the Cornish Language Board.

Natural history on display

(*istori gnasek en displetya*)

The displays in Truro Museum are largely concerned with the history of Cornwall, leading from the early geological history of the rocks beneath and the formation of valuable metals, which were to seal the fate of the Cornish as tin miners and traders throughout the Roman and Medieval periods (Gerrard, 2000), into the society that was to follow. The rocks which make up Cornwall are very old, the majority being deposited during the Devonian to Carboniferous some 300-400 million years ago, with most tin formation occurring in the older Devonian. Younger Permian rocks begin appearing closer to the border with Devon.

The Rashleigh Gallery has an extensive and renowned collection of minerals and a smaller less known collection of fossils from Cornwall with some examples from other places. There are a few examples of craneflies (Tipulidae) (c: *kelyon garan*) preserved in Baltic amber. There is also a small but diverse fossil collection of other taxa with reconstructions.

The Bonythan Gallery is the natural history section and displays examples of flora and fauna from present day Cornwall. The Discovery Centre is an area for children to explore the world through a microscope and there are lots of examples of insects in resin to take a close up look at, including flies, bees, moths, butterflies and beetles (fig. 2). Accompanying each microscope is a little booklet with an introduction on microscope use and the basic anatomy of different insects.

Past the Discovery Centre there are several reconstructions of different habitats common in Cornwall. The Towans (c: *teweynn*) are Cornwall's sand dunes, which are described as some of the highest sand dunes in Britain and home to diverse wildlife when allowed to flourish undisturbed. This wildlife includes crickets (c: *grylles*) such as the Great Green Bush Cricket (*Tettigonia viridissima*) and butterflies (c: *tykkiow Duw*) such as the Brown Argus (*Aricia agestis*) and Sliver-studded Blue (*Plebejus argus*).

Next is Rivers and Estuaries with a section on conservation efforts for oysters in the area and how river pollution is affecting otters. The Woodland section follows with an introduction to some of the more common tree species in Cornwall, including Willow, Hazel, Oak and Hawthorn, and a section teaching people how to age a tree using its rings. There is then a whole section on the butterflies of Cornwall, which is the only section with pinned insects on display. Here a visitor can learn how to tell the difference between a moth and a butterfly, the conservation status of butterflies in Cornwall and about the life cycle of the Large Blue butterfly (*Phengaris arion*). There are lots of examples of common local butterflies on display with information about which plants they may be spotted on at particular times of the year.

The Moorland section introduces Cornwall's relatively young moors and discusses the effects of agriculture on surrounding land. The Narrow-bordered Bee Hawkmoth (*Hemaris tityus*) makes its home here alongside cotton grass and insectivorous plants such as the Common Sundew and Western Butterwort.

Then there is a really inspiring section on how to encourage different kinds of wildlife into your garden. There are introductions to making your garden a safe haven for local wildlife. Planting tobacco plants and night-scented stock is recommended here to attract moths (c: *godhanes*), as is developing a pond to attract all sorts of wildlife including dragonflies (c: *nadres margh*), frogs (c: *kwilkynyow*) and birds (c: *ydhyn*). Finally there is a very interesting display discussing migrations of butterflies, dragonflies, fish and locusts with a more detailed story about the European eel.

Behind the scenes collections

(*kuntellow a-dhelergh dhe*)

The biological collections in Truro are estimated to house around 65,000 specimens, 25,000 of which are entomological. There are a further 7000-10,000 palaeontological specimens, but these are poorly documented and do not contain any insects as far as I could see from my visit.

The insect collections here are similar to most other collections visited so far in that there is a majority of Lepidoptera but also plentiful Coleoptera and Diptera with some Hemiptera and small amounts of other orders. There is a propensity for either local insects or for collections from colonial voyages to Africa or the Andaman and Nicobar Islands, Indian islands off the coast of Myanmar in the Bay of Bengal. There is also a small collection of Swiss Lepidoptera. The Coleoptera have recently been organised and moved into new cabinets, whilst the Lepidoptera and other orders remain in their original cabinets. The majority of the collections are well catalogued with accession cards, some of which record excellent amounts of detail.

Bannister's beetles

(*hwiles an Bannister*)

Roderick Thompson Bannister (1898-1976) was one of the most prolific collectors and cataloguers of beetles in Cornwall working in the early 20th century from Penzance. Bannister authored several articles relating to beetles (Bannister, 1975; 1976) and bugs (Bannister, 1968) from Cornwall. The Environmental Records Centre for Cornwall and the Isles of Scilly (ERCCIS) state that he recorded some 16,000 beetles, the majority from Cornwall. Around 11,000 of these specimens, accompanied by catalogues, a card index and numerous other documents, were donated to the Royal Cornwall Museum and are now organised taxonomically into 22 drawers of the new cabinets. The collection contains voucher specimens for Cornish species recorded by ERCCIS and so represents a key reference resource. There are many specimens of rove beetles (Staphylinidae) including *Ontholestes*, *Tachyporus* and *Creophilus*, weevils (Curculionidae) (fig. 3) including the rather fantastic snout weevil (inset) and ground beetles (Carabidae), with examples of Cucujidae, Cryptophagidae, Dryopidae (fig. 4), Pselaphidae, Orthoperidae, Phalacridae (*Phalacrus* and *Olibrus*), Colydiidae (*Aglenus*, *Colydium* and *Teredus*) and Scarabaeidae and

Lucanidae (fig. 5) also present. There are several additional drawers of beetles in the EH Davies collection (fig. 6) and also some more exotic stag beetles (Lucanidae) from Japan (fig. 7).

Rollason's British butterflies

(*tykkiow Duw bretednek an Rollason*)

W.A. Rollason was a Lepidoptera collector based in The White House in Truro working a little earlier than Bannister. He published several records of Cornish butterflies in *The Entomologist* (for example: 1901, pp. 23, 313, 315, 318, 353; 1907, p.40) most of which are available as digital downloads from the Biodiversity Heritage Library website. There are seven cabinets of his butterflies held at the museum, mostly collected from Cornwall but also from other areas of Britain. It includes fritillaries such as the Small Pearl-bordered (*Boloria selene*) and Weaver's (*Boloria dia*); Old World Swallowtail (*Papilio Machaon*) (fig. 8); Orange Tip (*Anthocharis cardamines*); and Milkweed butterflies of the family Nymphalidae such as *Danus plexippus* and the Clouded Buff moth (*Diacrisia sannio*). There are also examples of Erebidae, Notodontidae including the puss moth (*Cerura vinula*) (fig. 9) and Nolidae including the Scarce Silver-line (*Bena prasiana*) (fig. 10).

There are two additional collections of Lepidoptera specifically associated with Cornwall. One is of resident butterflies of Cornwall (fig. 11) and another is of migratory moths which land in Cornwall for a portion of the year (fig. 12).

Sargent's bees, flies and bugs

(*gwenen, kelyon ha pryv an Sargent*)

The majority of the Sargent collection is Diptera and Hymenoptera, including some ants, but there are also examples of Hemiptera and Coleoptera. Sargant has made valuable contributions to the knowledge of the Cornish entomofauna, including a book on the natural history of Porthlevan (Sargent, 1961) which contributed to the development of the ERCCIS checklist of occurrences of Hemiptera in Cornwall and the Isles of Scilly (Alexander, 2008). The collection consists of five drawers of Diptera including blowflies (Calliphoridae) (fig. 13a), hoverflies (Syrphidae) (fig. 13b) and beeflies (Bombyliidae) (fig. 13c). Examples of Hemiptera are also present, such as milkweed bugs (Lygaeidae), shieldbugs (Pentatomidae) and mirid bugs (Miridae) including *Leptoterna ferrugata*. There are also a number of Hymenoptera including bees such as *Halictus* (Halictidae), *Anthophora* (flower bees) and *Megachile* (Megachilidae) (fig. 14); ants (Formicidae) of the genera *Myrmica* (fig. 14a), *Stenamma*, *Tetramorium*, *Lasius* and *Formica* and wasps such as *Oxybelus* (Crabronidae) (fig. 14b) and *Vespa* (Vespidae); and lots of bumblebees (Apidae). There are also many examples of ichenumonid wasps.

There are several further smaller collections including Cornish and Swiss Lepidoptera collected by Pugh, some poorly documented Hymenoptera and Diptera collected by Bignall and Lepidoptera from Africa in the Rev. Rogers collection. There are also several boxes of Lepidoptera from the Andaman and Nicobar Islands and Kenya collected by Gilbert Rogers at the turn of the 20th century. These are still in the paper triangular pockets in which they were transported back to the UK (fig. 15). These specimens have obviously not been inspected since their collection and packing and there could be any number of interesting species hidden away in these boxes. There are a few boxes with at least several dozen pockets each. Finally, there are a few older cases of Hemiptera (fig. 16), mostly consisting of Miridae, but also featuring Nepidae, Velidae, Notonectidae and Hydrometridae.

In addition to the main research collections there are boxes of the more flashy insects put aside for education handling and 'Mini Beasts' workshops run by the museum. There are lots of very colourful butterflies and moths, stag beetles, honey and bumble bees and a selection of leaf mimicing and camouflaged insects including crickets, katydids, phasmatids (Phyllidae), fulgorids and moths (fig. 17).

Palaeoentomology in Cornwall

(*Kernow preves menhesen*)

Although Cornwall has a long and famous association with minerals, fossils are less common and usually poorly preserved. The first fossils to have been recorded from Cornwall were shells collected by Rev. J.J. Conybeare and William Buckland in 1813. Charles Peach also collected in Cornwall finding crinoids, shells and fish remains. Fossils collected from Cornish deposits are very old, coming from rocks from the Carboniferous or earlier (over 300 million years ago). There are records of fossils from the Carboniferous (300-360 million years ago) (Whiteley, 1981); Devonian (360-420 million years ago) (Fox, 1905) and even the Silurian (420-440 million years ago) (Green, 1904).

Fossil insects, however, are rare if not absent from Cornwall, with only a few vague notes in the literature (Smith, 1817; Box, 1844; Henwood, 1873) pointing to possible fossil beetles, although they may all refer to subfossils from relatively recent times. As the majority of Cornwall outcrops are Carboniferous one might expect to find blattodeans (Duncan, Titchener and Briggs, 2003), stem group orthopterans or odonatans (Whalley, 1979), or the extinct Paleodictyoptera (eg: Prokop *et al.*, 2006), all of which have been collected from Carboniferous deposits in England.

The collections in the Royal Cornwall Museum represent a plentiful resource for anyone interested in the insects of Cornwall. With additional specimens from the rest of Britain, treats from Colonial age exploration in Africa and India and a few Japanese giants, the collection is impressive for a smaller, remote museum. The presence of voucher specimens from original records of Cornish insects makes the collection even more useful for anyone looking to compile data on the insects of the south of England or of Cornwall in particular. Sara tells me that she is looking to further develop the records for the collection in the future, but doesn't see the collection growing as resources are stretched at present. There are still plenty of boxes of insects collected during Victorian times to organise with records that need bringing up to date. Significant potential exists here for even more interesting information to be gleaned from the collections.

In the next instalment of the series I will be visiting another museum in the UK to discuss their insect collections. The location is not yet set, so if you are a curator or manager of an interesting entomological collection that you would like featured in a future article, then please get in touch and I would be happy to arrange a visit.

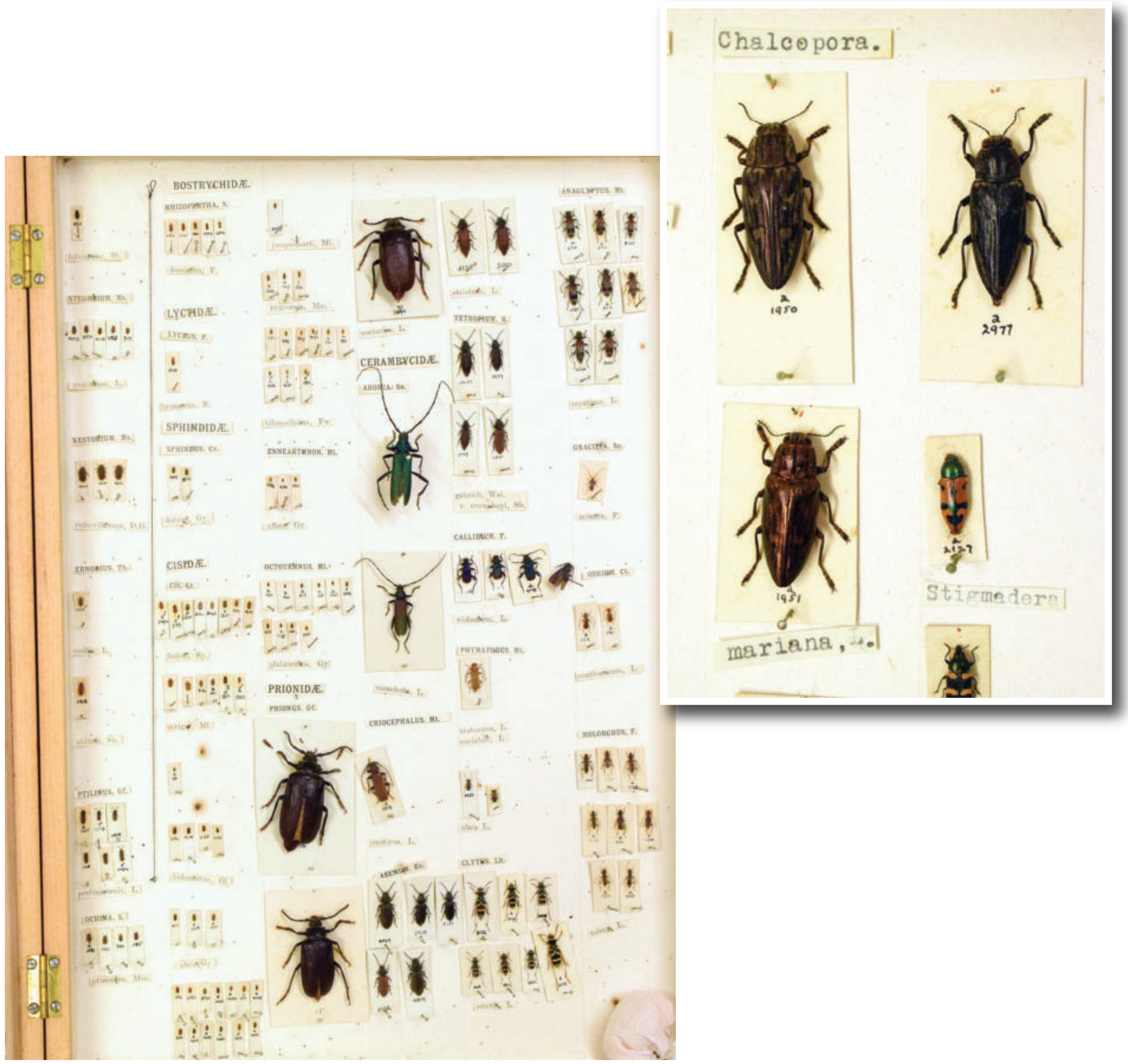

Figure 6: Beetles from the Davies collection including some jewel beetles (Buprestidae (c: hwil gem)) inset.

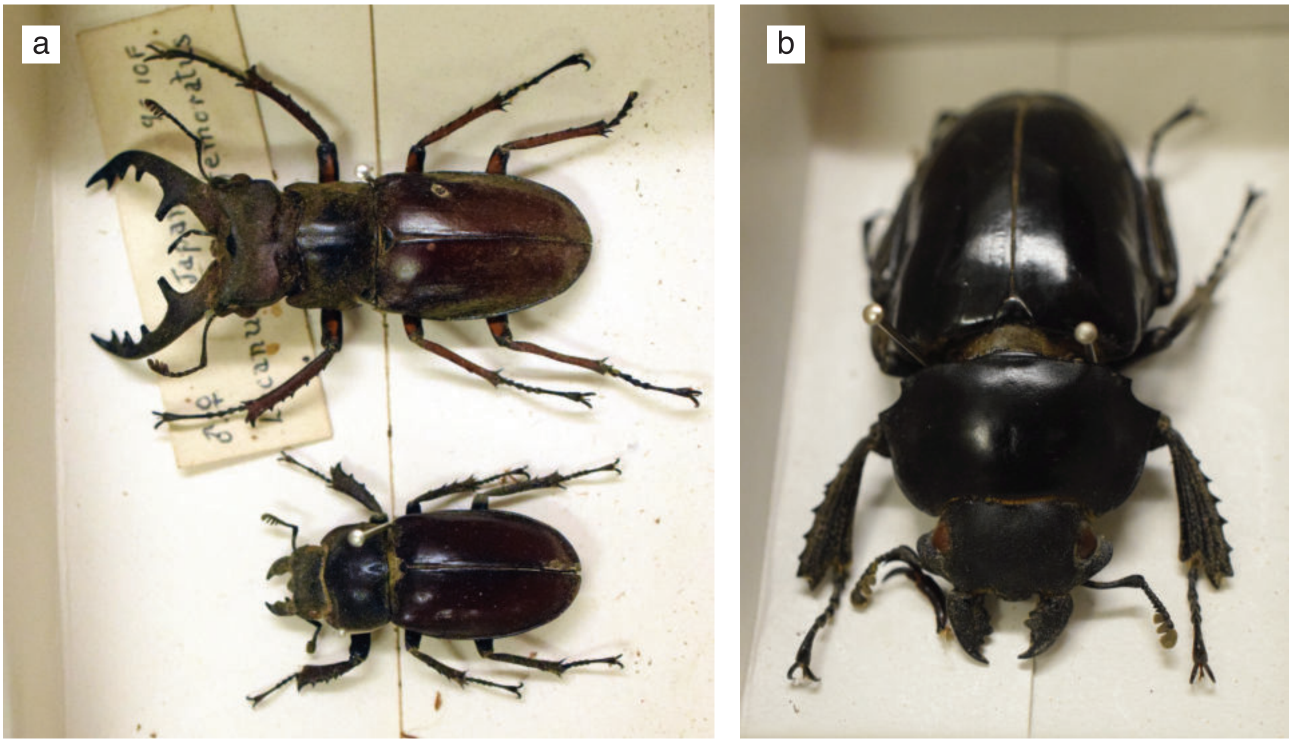

Figure 7: Stag beetles (Lucanidae) from Japan: a) male and female Miyama stag beetles (*Lucanus maculifemoratus*) and b) *Dorcus amamianus*.

Figure 8: The Old World swallowtail (Papilionidae: *Papilio machaon* (c: gwenelek bys koth)) Britain's largest butterfly may be seen feeding on umbellifer flowers such as parsley or wild carrot.

Figure 9: A particularly stunning puss moth (Notodontidae: C*erura vinula* (c: godhan kathik)) apparently named after its likeness to a cat. The caterpillar of this species is particularly striking with a large colourful 'face' and pinkish extendable twin tails.

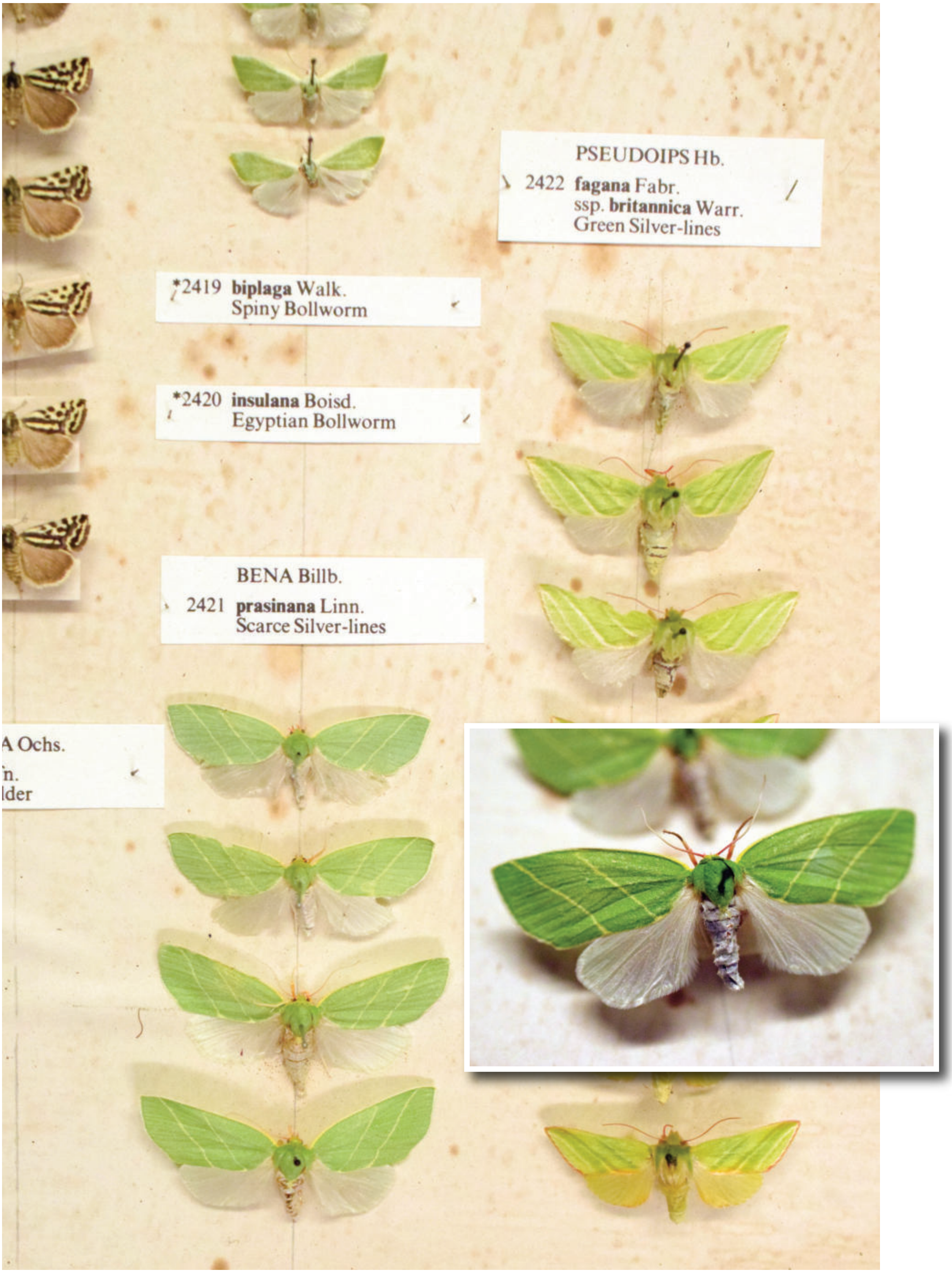

Figure 10: Scarce silver-line moths (Nolidae: labelled as *Bena prasiana* but perhaps *Bena bicolorana*).

Figure 11: Butterflies from Cornwall with the purple hairstreak (*Neozephyrus quercus*) inset seen feeding on oak trees.

Figure 12: Migratory moths seen in Cornwall with the privet hawkmoth (*Sphinx ligustri*) inset. This moth's stunning pink stripes are also seen in its caterpillar stage.

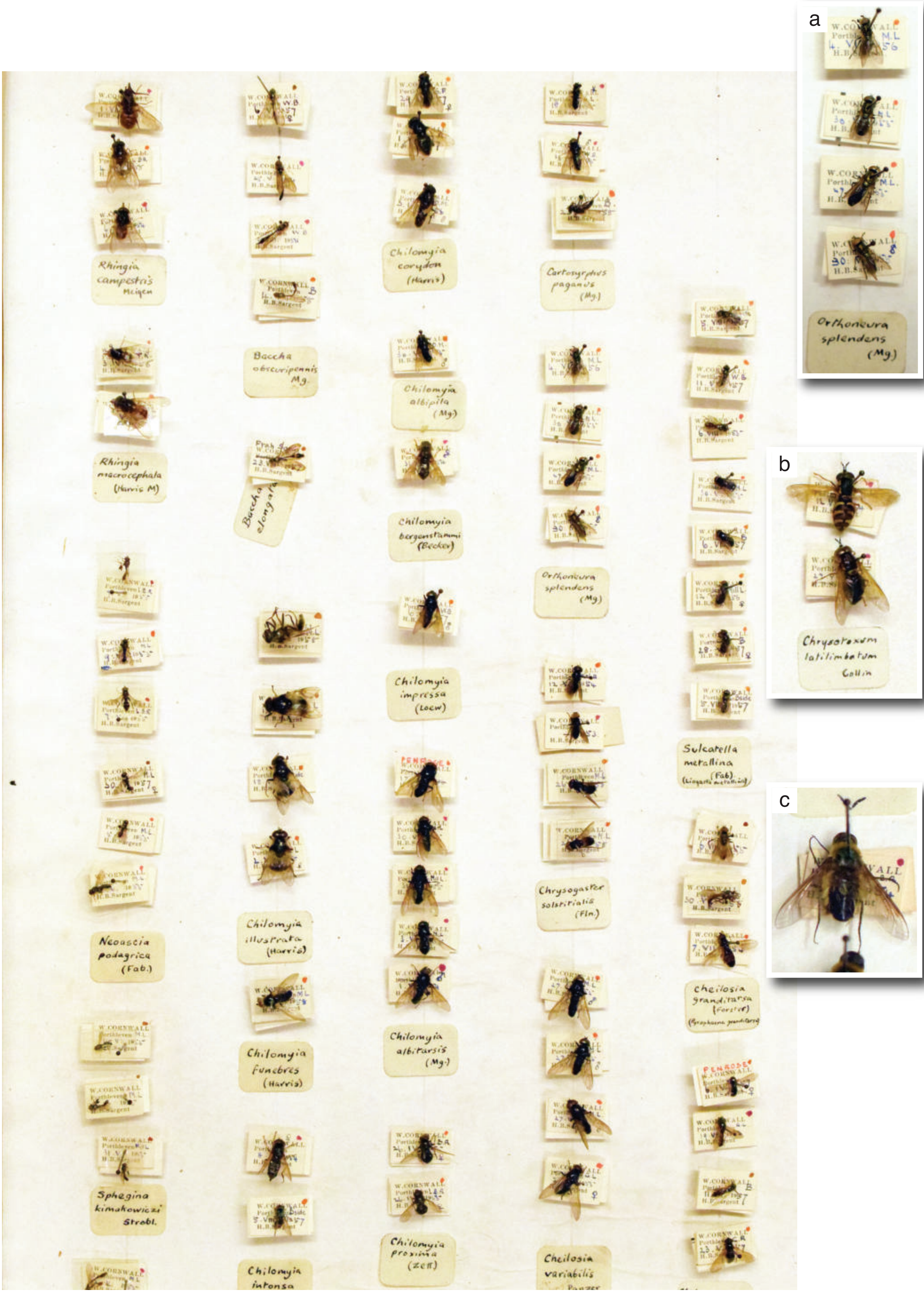

Figure 13: Diptera from the Sargent collection. Inset: a) Calliphoridae: *Riponnensia splendens* (labelled as synonym *Orthoneura splendens*); b) Syrphidae: *Chrysotoxum latilimbatum*; c) Bombyliidae: *Villa paniscus*.

Figure 14: Hymenoptera from the Sargent collection. Main photo of flower bees (Apidae: *Anthophora plumipes*) and mason bees (Megachilidae: *Megachile* and *Osmia*). Inset: a) European fire ants (Formicidae: *Myrmuica rubra* (c: moryonennow rudh Europa)); b) digger wasps (*Oxybelus mucronatus*).

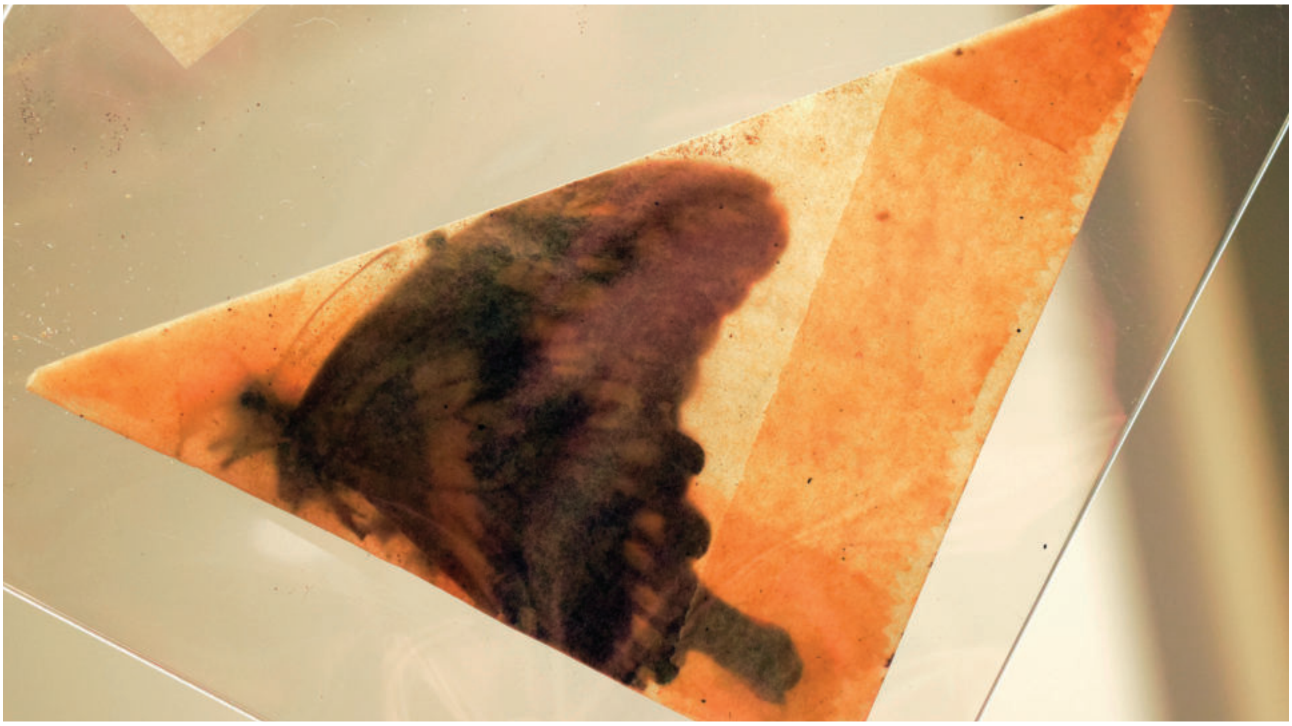

Figure 15: Lepidoptera from a Victorian aged voyage to India and Africa still wrapped for transport.

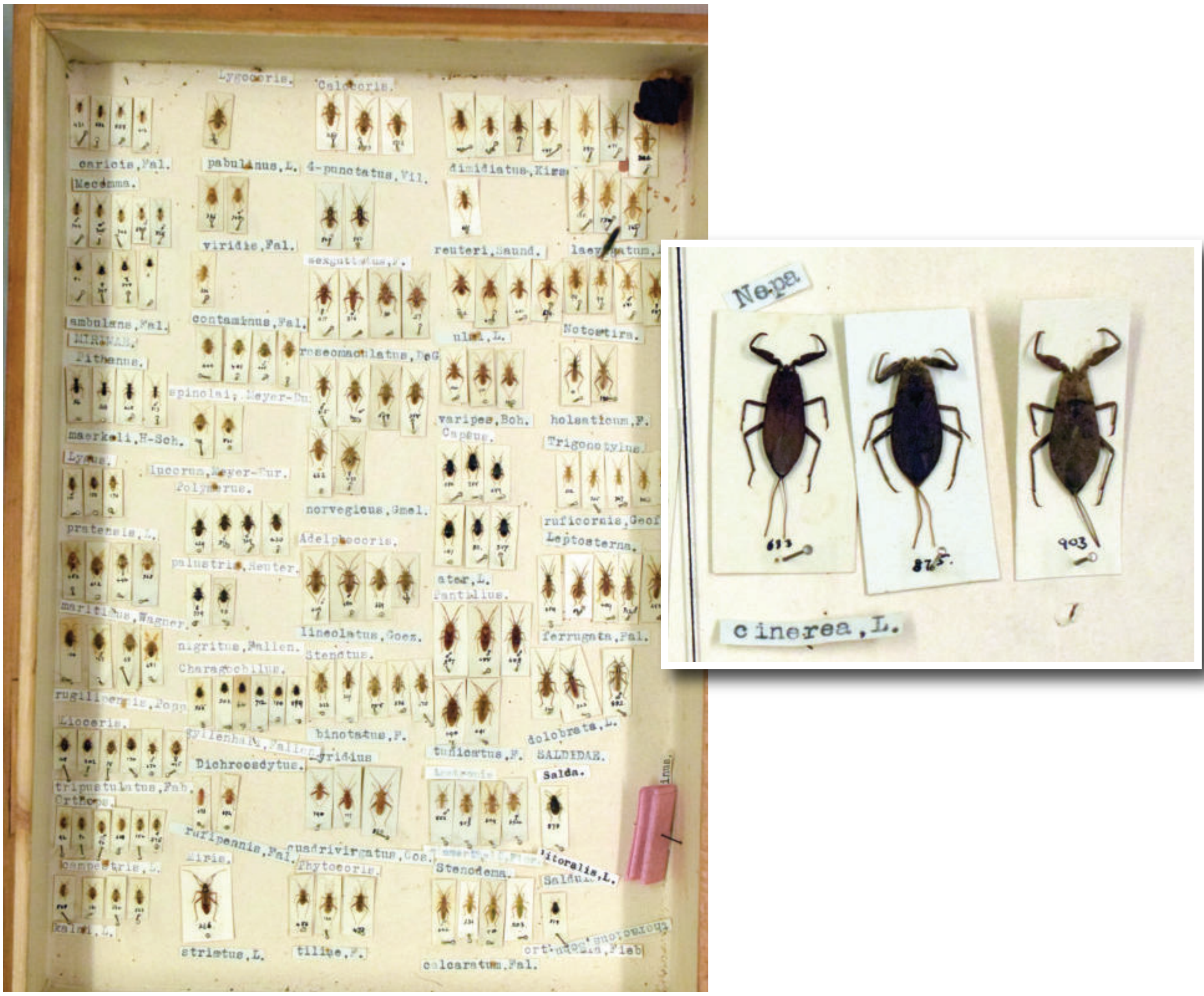

Figure 16: Hemiptera. Main photo: Miridae, inset a water scorpion Nepidae: *Nepa cinerea*.

Figure 17: Collection of flashy insects for workshops including bugs (Fulgoridae: *Pyrops sp.* from SE Asia), leaf insects (Phyllidae), katydids (Tettigoniidae inset) and a peculiar looking thing with a horned white shell that I couldn't find an identification for.

Contacts and links

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RCM website: http://www.royalcornwallmuseum.org.uk/

RCM contact email: enquiries@royalcornwallmuseum.org.uk

References

Alexander, K.N.A. (2008). The land and freshwater bugs (Hemiptera) of Cornwall and the Isles of Scilly. CISFBR and ERCCIS Occasional Publication no.2.

Bannister, R.T. 1968. Halticus macrocephalus Fieber (Hemiptera, Miridae) in Cornwall. Entomol Mon Mag.

Bannister, R.T. 1975. Some additions to the Coleoptera of Cornwall. Entomol Mon Mag.

Bannister, R.T. 1976. Eysarcoris aeneus (Scop.)(Hemiptera, Pentatomidae) and several Coleoptera new to Cornwall. Entomol Mon Mag.

Gerrard, S. (2000). *The Early British Tin Industry*, Stroud: Tempus Publishing.

Rollason, W.A. (1901). *The Entomologist* **34**, pp. 23, 313, 315, 318, 353.

Rollason, W.A. (1907). *The Entomologist* **40**, p. 40.

Sargent, H.B. (1961). *A Natural History of Porthleven in the County of Cornwall*. Privately published, Porthleven.

Smith, E. (1817). On the stream works of Pentowan. *Transactions of the Geological Society of London* **4**, pp. 404-409.

Box, W.H. (1844). Notice of a submarine forest near Looe. *Annual report to the Royal Institute of Cornwall* **22**, p.36-37.

Henwood, W.J. (1873). On the Detrital Tin Ore of Cornwall. *Journal of the Royal Institute of Cornwall*. pp. 191-254.

Vergil, P. (1535). *Anglica Historia*.

Society News

A Tale of Two Exhibitions

***Maria Merian's Butterflies* at The Queen's Gallery Buckingham Place and *Microsculpture* at the Oxford Museum of Natural History.**

Peter Smithers

For Editors of *Antenna* to receive envelopes franked Buckingham Palace is extremely rare, so it was with a certain surprise and intense curiosity that I opened the one that landed on my door mat. Relief, not an invitation to a small room in the tower but an invitation to a private breakfast view of the two current exhibitions in The Queen's Gallery. These were *Scottish Artists 1750-1900: From Caledonia to the Continent*, and the one that really piqued my interest, *Maria Merian's Butterflies*. Breakfast would be served at 8.00am with talks at 8.30am. Eager to view these legendary works I left my hotel in South Kensington and flagged down a taxi which whisked me across rush hour London. At the entrance I was greeted warmly, my name ticked off the guest list, and I was ushered into the reception hall. Two short but very grand staircases swept up to the next floor where Jonathan Marsden, the Director of Royal Collection Trust introduced himself and directed me into the breakfast room where coffee and bacon croissants awaited the early rising guests. The curators then gave a short introduction to the exhibitions, explaining the origin, relevance and importance of painting in the 21st century. We were then given free rein to peruse the exhibitions for the remaining hour and a half before the public arrived. The Merian works on display had been commissioned by a wealthy patron (as yet unknown). They are part print part watercolour on vellum, and are based on her now famous book, *Metamorphosis Insectorum Surinamensium*, but the arrangements of the insects were subtly rearranged to make them different from the originals. These paintings had passed through the ownership of the physician Richard Mead and the botanist John Hill before ending up in the collection of George III.

The works are of course a tour de force; they are the works that changed the way that the scientific world considered invertebrate illustration. Often proclaimed as the first ecological work, Merian's book was an illustrative milestone that took a holistic view of the butterflies that she studied, presenting a complete lifecycle including food plants and often other invertebrates found on the same plants. I had viewed a copy of Merian's book in the RES library and been impressed, but to see the re-designed plates displayed as an exhibition was a visual feast. The detail and vibrancy of the images were astounding considering their age. While these images retain the formality of their times they capture not only the life cycles of these insects but also offer a glimpse of their behaviour, with the larvae and adults displayed in feeding and resting stances.

The exhibition also presented the opportunity to inspect the images at close quarters, plus the chance to be able to walk between them and compare one directly with another, which was a rare treat. This was a great opportunity to view a number of the plates from her legendary book plus a selection of her earlier work on European Lepidoptera. Also on display were several books that made reference to Merian's *Metamorphosis*, thus providing an insight into the way that Merian's work had been received at the time. I could have spent hours there

Views of the Queens Gallery

Left: Achilles Morpho butterfly on west Indian cherry; Right: Red cracker butterfly on Frangipani plant

but the public were arriving. So one last walk around the gallery, and then I stepped out into the morning sunshine amid the gathering tourists marching determinedly to the palace gates. Pausing at the foot of the Victoria memorial I admired the face of our national treasure. Then, out of the park rides a detachment of the household cavalry in full regalia, silver breastplates and helmets flashing in the morning light. A fittingly regal conclusion to an excellent morning.

Moving from the beginning of modern scientific illustration to the very edge of what is currently possible, I visited the *Microsculpture* exhibition at Oxford where Darren Mann and Scott Billings had arranged an after-hours viewing for me. This is an exhibition of insect macro-photography by Levon Biss. While Merian's work had been presented sedately in the Georgian grandeur of the Queens Gallery, *Microsulpture* was set beneath the black iron arches of the vast Victorian cathedral of nature that is the Oxford University Museum of Natural History. The exhibition is a dramatic contrast to its surroundings, as its enormous images of insects are displayed side by side with a diverse range of vertebrate skeletons.

These images, which dwarf many of their vertebrate counterparts, are a revelation. Printed on the scale of an advertising hoarding, the photographs allow every nook and cranny of the insects to be revealed and the definition is such that not a single seta or elytral pit has gone unrecorded. These images reveal details that were previously only observable while looking down a microscope. This technique is surely the future of insect macro photography; images such as these are so precisely defined that their use as a tool in research and education is assured. They also instantly convey the staggering beauty of the insect microcosm, transforming scientific specimens into arresting works of art. However, these incredible images are hard won. Levon Biss uses a very small macro lens to photograph tiny areas of the surface of each insect. This process can utilise up to 8,000 images to document the whole animal – a time-consuming process! Photography at this scale also means that any imperfections become a blot on the digital landscape; a speck of dust is a boulder in the final image. The entomologist on this project, Dr James Hogan, had the task of placing each of the specimens under a microscope and carefully picking off any debris with a fine brush. The time consuming nature of both the preparation and the photography meant that only a small number of specimens could be photographed, meaning difficult choices for James as he selected candidates from the vast number of specimens that the museum holds. Twenty-three insects were finally selected, based on their unusual morphology, dramatic colours, historical significance, or for being 'ordinary'. These include a jewel beetle collected by Wallace, a burrowing ground beetle of the genus *Scarites* (described by Fabre as a fearless ruffian), a bizarre tree hopper from Brazil, lantern bugs from Tanzania, tiger beetles from Borneo and the UK, plus a British blowfly to name but a few - a wonderful selection that offers a tantalising glimpse of the diversity and beauty of the insects. *Microsculpture* will tour the UK over the next year, details of the venues can be found at the website http://microsculpture.net

The work in both of these exhibitions was or is cutting edge at the time the work was made. They are excellent examples of how a new approach to the way that insects are imaged can lead to a shift in perspective for entomologists. With these two exhibitions to visit over the summer it has indeed been *the best of times*.

Top: Darren Mann and Scott Billings add scale to the Orchid Cuckoo Bee.

Views of the exhibition.

Mosquito Diaries: Kicking the Bloodsuckers out of your Bed

Josephine Parker

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Josephine.parker@lstmed.ac.uk

Up until last year the sum of my public engagement experience had totalled a few dalliances at small museum events, and trying to explain my research to my friends at parties, so it was with some trepidation that I launched into planning an exhibit for this year's Royal Society Summer Science Exhibition. The exhibition, hosted at the Royal Society's London headquarters, has been running in one form or another since 1778. This year, with help from a Royal Entomological Society Outreach Grant, we presented the Mosquito Diaries, an exhibit featuring work conducted at the Liverpool School of Tropical Medicine (LSTM) in collaboration with the University of Warwick.

The Summer Science Exhibition is a free week-long event in which scientists demonstrate their work to the public through interactive exhibits designed to involve and excite people about science. The 2016 event featured 22 exhibits from across the UK, with topics that included cleaning up space junk, spider silk, and surgery with robots. 14,000 visitors came to the exhibition this summer, ranging from children in pushchairs to Royal Society Fellows. At the Mosquito Diaries, working with a team of demonstrators from the LSTM and Warwick, we used games, videos, craft, and live mosquitoes to engage visitors and discuss the science surrounding malaria and mosquito control.

Bednets and Computer Games

In the Mosquito Diaries I demonstrated research from my PhD, in which infrared cameras were used to track mosquito flight around insecticide treated bednets. We have applied this novel camera system to observe how insecticide affects the host seeking behaviour of mosquitoes around bednets in experiments in the UK and Tanzania. Flight tracking reveals whether chemicals used on nets are repellent or irritating to the mosquito, factors which determine whether a mosquito will contact a treated surface for long enough to suffer a lethal exposure to an insecticide. We also use flight tracking to see where mosquitoes attack the net, information that will help guide the design of new bednets, telling us which bednet surfaces are most important in delivering insecticide. It is hoped that this camera system could be used in future to evaluate and test new bednet designs.

Such development is necessary since mosquitoes are becoming resistant to insecticides used in mosquito control. Insecticide resistance has been detected in over 60 countries, and this adaptation threatens the continued success of vector control, which relies on these chemicals to kill mosquitoes. We may be able to prolong the usefulness of insecticides by testing mosquito populations for insecticide resistance and deploying alternative insecticide classes where possible. The LSTM Engaging Tools for Communication in Health (ETCH) group have developed a digital game to help teach proper insecticide resistance management strategies to people involved in mosquito control. This game, called ResistanceSim, allows players to take charge of a district control program, testing virtual mosquitoes for insecticide resistance, and taking appropriate action to manage spread of resistance. The game will be used as an educational tool to help teach concepts surrounding insecticide resistance management.

Our Mosquito Diaries exhibit at the summer exhibition introduced visitors to live mosquitoes, explaining the different life cycle stages and biting habits of the insects. Craft activities for children offered them the chance to make their own mosquitoes whilst learning about mosquito anatomy. Flight tracking work was illustrated with a competitive buzzwire game based around the flight track of a

Left: The entrance to the Royal Society Headquarters in London; Right: Visitors to the Mosquito Diaries stand (Photographs: Royal Society) hungry mosquito attacking a bednet, and with videos of the mosquitoes in flight. Playing the ResistanceSim mini game, gamers caught virtual mosquitoes in a cage using a mouth aspirator and tested whether these mosquitoes were resistant to insecticides using World Health Organisation and Centre for Disease Control bioassays, then completed a quiz to test their knowledge of mosquitoes and malaria.

Our giant mosquito, made by Liverpool Lantern Company, loomed over the exhibit, forming an eye catching centrepiece to the stand (Photograph: Natalie Lissenden)

Protecting yourself on holiday

Though by nature a festival may have a more limited reach than a blog post, the exhibit provided a valuable chance to have face to face interactions where people could ask their own questions about mosquitoes and disease research. Many people wanted to know why they were more attractive to mosquitoes than their friends, a variation that can generally be attributed to a person's smell. Other questions involved the use of the sterile insect technique, whether insecticides are safe, the ethics of using insects in research, and what would happen if we eradicated mosquitoes entirely. Though some of these questions didn't have simple answers, we enjoyed having engaging debates with visitors on these topics, and hopefully encouraged them to think about the challenges of mosquito control and the place of research in disease prevention.

Showing visitors live *Anopheles gambiae* mosquitoes (Photograph: Elli Wright)

In talking to us about mosquitoes, visitors to our exhibit volunteered a number of foods that could be eaten to repel mosquitoes, including oranges, bananas, garlic, lemongrass and, of course, marmite. Regrettably such healthy eating hasn't been shown to have any impact on mosquito behaviour. To date the only foodstuff I'm aware of that's been experimentally shown to affect mosquito responses to humans is beer, which can make you more attractive to mosquitoes, though the risk effect isn't severe enough to make it onto the prevention advice given by the NHS! We made sure to discuss the proper use of DEET based repellents, and bednets when travelling.

In ResistanceSim digital gaming, visitors conducted WHO and CDC bioassays for insecticide resistance (Photograph: Josie Parker)

In talking to the public we encountered some more important misconceptions about malaria and mosquitoes. Several people believed malaria vaccines were already in use, and available for travellers. Another person told us about a vaccine to stop mosquito bites (those of us working in insectaries can only dream of the day!) Perhaps most valuable of such conversations was that had with a visitor who wanted us to explain if GM mosquitoes had caused the Zika outbreak. The event offered us the opportunity to address some of the less effective ideas about how to protect oneself from bites when travelling, update people on the progress of the malaria vaccine and have useful discussions on the risks of other diseases transmitted by mosquitoes.

Our Take Home Messages

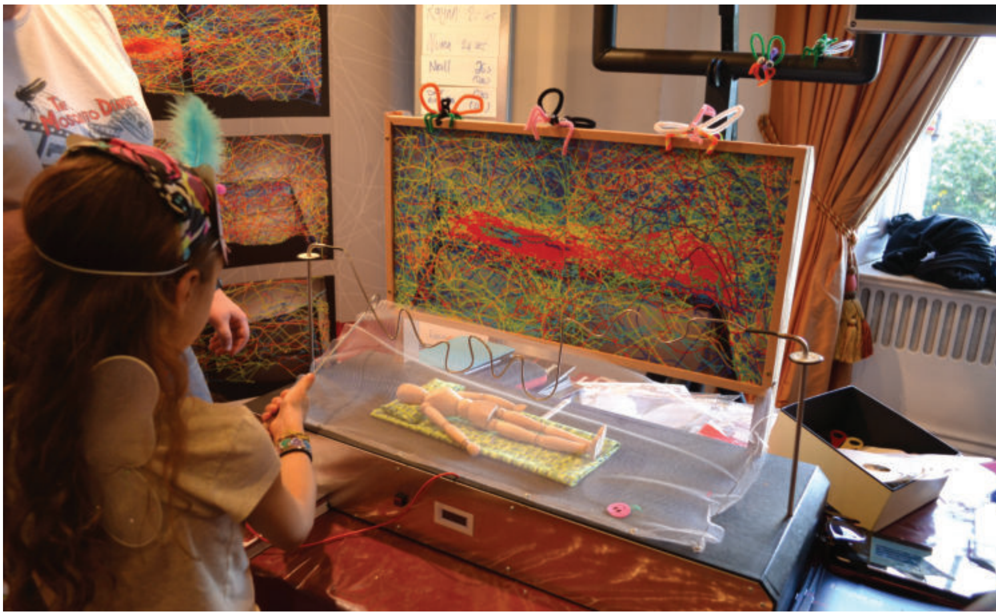
Conducting and analysing surveys of the crowd we found that after visiting the exhibit people were significantly more informed about the use of insecticide-treated bednets in preventing mosquito bites and disease transmission, and knew more about the growing threat of insecticide resistance in mosquito populations. The live mosquitoes attracted a lot of attention, as people enthusiastically examined the different stages of the mosquito's life cycle from egg, through larva and pupa to adult. Visitors left the stand having learnt how to tell the difference between male and female mosquitoes, what cues attract mosquitoes to people and about the research being done at the LSTM.

Interestingly, our surveys revealed that whilst almost all visitors knew that mosquitoes transmitted malaria, just 51% could identify that mosquitoes transmit dengue, and in spite of the media coverage, only 81% were aware that mosquitoes transmit Zika. So whilst the mosquito's relationship to malaria is well known, it seems there's great potential for further events on other vector-borne diseases; start planning for the 2017 festivals now!

Acknowledgements

The exhibit was made possible thanks in part to an outreach grant from the Royal Entomological Society. This funding can be applied for by RES members wishing to use the award for the "improvement and diffusion of entomological science" in outreach activities. Funding for this outreach event was also received from the MRC, Royal Society, Awesome Foundation and AvecNet. AvecNet is financed by the European Commission's Seventh Framework Programme under the specific programme: FP7-Africa-2010. Thanks to all the volunteers who demonstrated at the event.

We exhibited images and videos of mosquito tracks flying around a bednet. Tracks are displayed as individual coloured lines, moving around the silhouetted volunteer and bednet. (Photograph: Robbie Prendergast)



A buzzwire game shaped like a mosquito flight track 'bouncing' across the bednet was used to help start conversations about how bednets are used in mosquito control, and why we track flight (Photograph: Natalie Lissenden)

Younger visitors made mosquito masks, complete with proboscis and antennae. By the end of each day we had swarms of small mosquitoes running around the exhibition (Photograph: Josie Parker)

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at September 2016

New Honorary Fellows
Professor Jane Hill
Professor Hugh D Loxdale, MBE
Professor Dame Linda Partridge, CBE, FRS, FRSE
Professor Phillip G Mulder
Sir Paul M Nurse, FRS

New Fellows (1st Announcement)
Professor Dr Swaminathan Raguraman
Mr James Peter Rummey
Mr Gary Paul Needham
Dr Warusapperuma Karunaratne

Upgrade to Fellowship (1st Announcement)
Associate Professor Olaf Schmidt

New Fellows (2nd Announcement and Election)
Dr Alex Eapen
Professor Andrew William Taylor-Robinson

Upgrade to Fellowship (2nd Announcement and Election)
None

New Members Admitted
Miss Emma Mairi Siobhan Lord
Miss Charlotte-Anne Chivers
Ms Mary O'Connell
Dr Deepa Balan
Mr Benjamin Michael Isherwood
Mr Fergus John Chadwick

New Student Members Admitted
Mr Marco Benucci
Ms Isobel Judith Ronai
Mr James Ryalls

Re-Instatements to Fellowship
Professor Paul Reiter

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

Deaths
Mr G D Browne, 1964, Ceredigion
Dr D D Chadee, 1986, Trinidad

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 5th October 2016

New Honorary Fellows
None

New Fellows (1st Announcement)
Agr. Moreno Dutto
Dr Jonathan Adam Newman
Dr Christoph Thomas Zimmer

Upgrade to Fellowship (1st Announcement)
None

New Fellows (2nd Announcement and Election)
Professor Dr Swaminathan Raguraman
Mr James Peter Rummey
Mr Gary Paul Needham
Dr Warusapperuma Karunaratne

Upgrade to Fellowship (2nd Announcement and Election)
Associate Professor Olaf Schmidt

New Members Admitted
None

New Student Members Admitted
Ms Rachel Farrow
Mr Liam Crowley
Miss Fryni Drizou

Re-Instatements to Fellowship
None

Re-Instatements to Membership
None

Re-Instatements to Student Membership
None

Deaths
Professor C D Michener (Hon.Fellow), 1974, USA

OBITUARY

Professor Ilkka Hanski

1953-2016

The celebrated Finnish ecologist and conservation biologist Ilkka Hanski died from cancer on 10th May 2016. Ilkka made many contributions to ecology and was renowned as both an experimentalist and theoretician. From his boyhood he was a keen natural historian with a particular interest in insects, especially butterflies and moths. His love of the group informed his science and the design of some of the most important ecological studies of the last 50 years.

By the time Ilkka became a biology student at Helsinki University he was already an accomplished entomologist who had added new Lepidoptera to the Finnish list. After his first degree he moved to Oxford for a doctorate on the ecology of dung beetles supervised by Malcolm Coe. Even in the relatively species-poor British Isles there are a multitude of species (in particular members of the genus *Aphodius*) co-existing on dung. Though some species clearly occupy different niches, those of others seem largely to overlap. Ilkka quickly became interested in how spatial processes allowed species to coexist, and the influence of space on population ecology became the theme underlying most of his research.

In 1978, while a student, Ilkka first visited the tropics studying dung beetle diversity along an altitudinal gradient in the Gunung Mulu National Park in Sarawak, part of an expedition organised by the Royal Geographical Society. Nearly four decades later he returned to Sarawak and repeated the transect, observing an altitudinal shift in some species' distributions that is most likely explained by a warming climate. Ilkka has written about the bittersweet nature of revisiting an old haunt and meeting up again with his research assistant, and the sadness of discovering that the rainforest which once extended way beyond the Park was now just restricted to the protected area. Later in his career he worked again on tropical dung beetle communities, this time in Madagascar where the Helsinki University has a field station. He was able to reconstruct the different waves of dung beetle colonisation of the island and to point to species recorded in the recent past that sadly probably no longer exist because of the dramatic loss of natural habitat.

In thinking about spatial population ecology Ilkka was much influenced by a conceptual model developed by Richard Levins, an American mathematical ecologist. Levins envisaged a population that occupied a series of patches, each of which was relatively short-lived. Potentially habitable patches wink on and off like blinking lights. A sub-population in a specific patch has a finite lifespan but if it can dispatch enough colonists to occupy at least one newly-formed patch than the ensemble of sub-populations or "metapopulation" can persist. Very ephemeral patches (like dung) are a type of metapopulation but it was not clear whether spatiotemporally more extensive metapopulations existed.

Ilkka began looking for an experimental system to explore metapopulation biology. Informed by his knowledge of Finnish butterflies (and he recalls the fortuitous present of a new book on Finnish butterflies from his wife Eeva) he picked the Glanville Fritillary butterfly (*Melitaea cinxia*) on the Åland archipelago off the Finnish Coast. The islands are wooded but contain many small meadows of different size in which the butterfly breeds. Larvae live in conspicuous communal webs and occupied meadows are thus relatively easy to identify and census. Beginning in 1991 Ilkka, his colleagues and a small army of Helsinki students, surveyed all potential butterfly breeding sites. Over the years they were able to document extinctions and colonisations and show the butterfly did indeed occupy a metapopulation. They developed mathematical models of the metapopulation that have now been applied to many other species (including human disease – we as individuals are an ephemeral patch to our parasites and pathogens). And of particular importance they showed how metapopulations might be managed to increase the probability they persist. Habitat change means that many of our most endangered animals and plants that once occupied broad swathes of habitat now exist in metapopulations.

Like all great ecologists Ilkka was adept at maximising the insights from a field study. The Glanville Fritillary has specialist parasitoids (and generalist hyperparasitoids) and these two form part of the metapopulation (or metacommunity). His group showed that there was genetic variation in colonising ability (and identified the gene responsible) and explained how the variation was spatially structured. They sequenced the complete genome of the butterfly and Ilkka will be remembered as one of the founders of the new field of ecogenomics.

Ilkka worked on other systems and made important contributions to different questions in theoretical ecology, both directly and indirectly through the Metapopulation Research Group he founded and led for two decades in Helsinki. He received all the major honours available to ecologists including the Crafoord and Balzan Prizes. Beginning with his PhD and a year as a post-doctoral fellow at Imperial College at Silwood Park, he was a frequent visitor to the UK and a friend to British science; he was an Honorary member of the Royal Society, the Royal Society of Edinburgh, the Royal Entomological Society and the British Ecological Society. In my view he is without doubt one of the most influential ecologists of the last half century.

I would like to finish on a personal note. I first met Ilkka when I was an undergraduate and got to know him well a few years later at Silwood. Over the years I had the good fortune of talking science and natural history with him in the field in Borneo, Åland, the Finnish arctic and elsewhere, as well as at home in Helsinki with Eeva and his children, Katri, Matti & Eveliina. He was immensely stimulating company, and very good fun. He cared deeply about science and the environment, something that comes out strongly in the book he wrote during his final illness (*Messages from Islands: A Global Biodiversity Tour*, Chicago) which will be published in late 2016. We have lost a major scientist and a very decent human being.

H Charles J Godfray
Department of Zoology,
Oxford University

Book Reviews

An invertebrate hat-trick from Reaktion Books

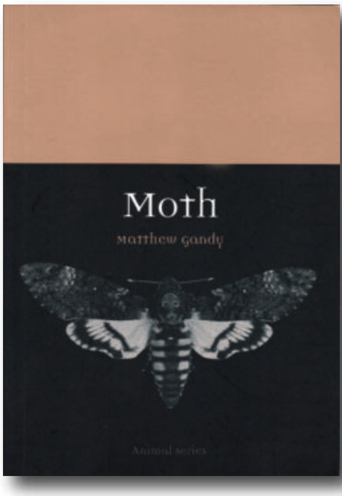
The Reaktion Animal series is at risk of becoming a legend in both the worlds of publishing and zoology. These alternative reviews of our planets fauna are refreshing, informative and very entertaining. A unique blend of science and culture, they are essential reading for any researcher who would like a holistic appreciation of the organisms they are studying, or for anyone who would like a new perspective on the natural world. The scope of this series is staggering and has so far produced overviews of 81 taxa, with each of these books focusing on a clearly defined species, family or order of animals. Their latest trio of offerings all focus on invertebrates, examining the Moth, the Beetle and the Scorpion.

Moth

Matthew Gandy

Reaktion Books

£12.95 • ISBN 9781780235851



Moth examines the nocturnal Lepidoptera revealing their rich scientific history, fascinating biology and their place in western culture.

The opening chapter of *Moth* defines what a moth is and explores the diversity of these nocturnal insects before examining their current decline. In the next chapter, “Appellations”, their taxonomy and classification are considered along with diversity and origins of moth common names, an extraordinary lexicon for anyone who is not familiar with the group. The history of the study of moths is revealed in the following chapter, providing an outline of the principal lepidopterists and the major books that were milestones on the journey to our current understanding of these insects. The chapter “Drawn to the Flame” examines the unique attraction to light that moths exhibit, offering a chronology of the scientific explanations of this behaviour and some of the man moth interactions that result from it. “Visitations” explores the cultural relationship that European societies have had with moths, ranging across the visual arts to literature. Colour is the next topic with an analysis of how moths generate colour and what they use it for and is followed by an examination of the morphologies that moths deploy to avoid predation. The penultimate chapter examines silk production, looking at why it evolved and how man exploits it, followed by a review of our attitudes towards moths.

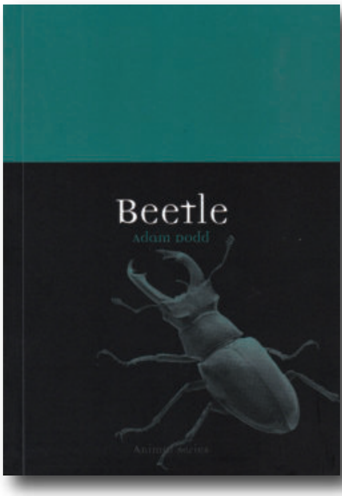
As always the latest offering in this series is a joy to read, offering a journey from Moses Harris to Damian Hurst, from Maria Sibylla Merian to Virginia Wolf and Henri Fabre to the Silence of the Lambs. *Moth* should bring the beauty of the butterflies’ nocturnal cousin to a whole new audience.

Beetle

Adam Dodd

Reaktion books

£12.95 • ISBN 9781780234885



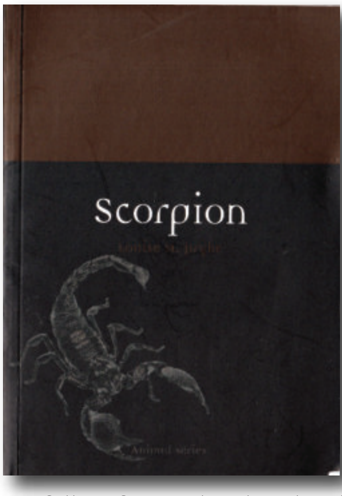
Beetle begins with an introduction that defines beetles in terms of their morphology and diversity, outlining their roles in natural systems and offering an overview of our relationship with them. “Sacred beetle”, the second chapter, explores the role that beetles have played as religious icons across human history. These range from scarab beetles as the sun god Ra in Egyptian mythology, to the ladybeetle as an agent of the Virgin Mary in European folk lore and Albrecht Durer’s stag beetle as a metaphor for the resurrection. “Scientific beetle” examines the transition from religious icon to an object of scientific study, offering a history of the rise of entomology from Pliny’s natural history, via Thomas Moffett’s “*Theatre of Insects*”, Maria Sibylla Merian’s “*Metamorphosis*” to Darwin’s love of beetle collecting, revealing on the way how the mass production of pins heralded the birth of modern beetle collections. “Managing beetles” looks at the dark side of our relationship with beetles, revealing a constant battle with a small number of beetle species that compete with us for various crops. It also explores the strange world of beetle cybernetics, offering a glimpse of a disturbing future where beetles can be controlled via implanted microchips. “Popular beetles” explores the cultural roles that beetles have acquired. Examples are as wide ranging as manga comics, video games, the animated films of Starewicz (‘*The Cameraman’s Revenge*’), Microcosmos, a visual tribute to the work of Henri Fabre, the elytral art work of Fabre’s grandson, Jan Fabre, and even the iconic Volkswagen Beetle.

Scorpion

Louise M. Pryke

Reaktion Books

£12.95 • ISBN 9781780235929



Scorpion begins with an introduction to Scorpion biology outlining their diversity, taxonomy, reproduction, feeding, predation and fluorescence. The book then examines the fossil record and the perception of scorpions in ancient civilisations. This is then expanded in a chapter which explores the relationship between kings and scorpions. Their role as weapons of war and tools of persuasion are then discussed, followed by their place as constellations in the night sky as recognised by many early civilisations. Scorpions have a high profile in the arts, as the next chapter demonstrates with a discussion of scorpion films, painting, sculpture and literature. The final chapter examines the more intimate human interactions with scorpions, discussing scorpion tattoos, the pharmaceutical applications of scorpion venom, threats to wild populations from the exotic pet trade and their role as a gastronomic delicacy. The author presents scorpions as an organism with an aggressive nature, as revealed in the fable of the frog and the scorpion, but it is one that we have and should continue to respect.

All three of these books are of course lavishly illustrated with black and white prints plus colour photographs. They also have all the normal features offered by this series: they are fully referenced, indexed and have the usual Reaktion timeline for all of the events mentioned in the books. These latest offerings are an excellent synthesis of our relationship with three of the world's most charismatic invertebrates.

Peter Smithers

The Five-Year Butterfly Hunt

Phil Hall

Brambleby Books, 2016

£9.99 • ISBN: 978 1908241 467

There is a spectrum of obsession amongst the butterflying community and I reckon that Phil Hall sits somewhere in the middle. Many have tried (and some succeeded) in seeing every British species in a single year. At least one, Robin Page, has written a book about it (The Great British Butterfly Safari, Bird's Farm Books, 2003). Phil's aim was less ambitious – to find and photograph all 58 butterflies which breed in Britain (he didn't go for Irish Wood White) in five years. A relatively modest goal, maybe, but one of the delights of the book is seeing how this can be achieved whilst holding down a job and without overly impinging on family life. Indeed, part of the idea was for Phil to bond more strongly with his daughter, Vicki, cricket having achieved that with his son. Phil's second wife seems to go along with it all quite happily!

Although interested in natural history since the early nineties, Phil's butterfly quest began in 2005 when on holiday in Pembrokeshire. Out with Vicki, he found a butterfly that he didn't recognise and, on returning home, identified it as a Grayling. He and Vicki were hooked and together they hatched the five-year plan (although bit by bit Vicki's ponies trumped the butterflies). Many of the moments of elation described by Phil may seem a little mundane to seasoned butterfly watchers, but I remember clearly the intense thrill of seeing my first Orange-tip when aged eight. This book shows that somebody who didn't start young can develop a keen interest and a sound understanding of butterflies, and experience the euphoria. The book should be targeted at the susceptible and continues Brambleby Books' excellent record in enthusing newcomers.

The book is an easy and gentle read, it's 224 pages being broken down into 73 bite-sized chunks, each describing a particular outing and most going something like: "set out, weather not great, got better, found it just as I was about to give up". Lady Luck gets several mentions. There is also a list of the places and dates each species was seen and a reminder of Phil's 12 favourite butterfly locations. Bearing in mind that the goal was to photograph all the species, I found it a tad disappointing to see only 35 small black and white butterfly pictures, all the originals of which, Phil says, are worthy of hanging on his wall. At under a tenner, though, I'm really not complaining, and those wishing to see full colour pics can use the texts referred to, or the many others available.

Did he clock the whole set? I shouldn't be a spoiler but, had he not, the cynic in me says that this book would probably have been called *The Six-Year Butterfly Hunt*! I, incidentally, have still not seen Large Heath anywhere, or High Brown Fritillary or Chequered Skipper in Britain. I guess I'm somewhat to the left of Phil on the spectrum, and my 54-year butterfly hunt continues!

Richard Harrington

Diary

Details of the Meetings programme can be viewed on the Society 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 typically 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.

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

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

2016

Dec 16 **Infection & Immunity SIG**
Venue: Emmanuel College, Cambridge
Convenors: Frank Jiggins (fmj1001@cam.ac.uk), Alexandre Leitão, Sinead English
Keynote speaker: Sylvia Cremer
For meeting details and registration please visit http://infectionandimmunity.strikingly.com/

2017

Feb 2 – 3 **PG Forum**
Venue: Sheffield University
Convenors: Scott Dwyer (**s.dwyer@warwick.ac.uk**); Vicki Senior (**vsenior1@sheffield.ac.uk**)

Feb 22 **Northern Meeting and Meeting of the Post-Harvest SIG**
Pre- and Post-harvest insect pest management
Venue: Stockbridge Technology Centre, Cawood, YO8 3TZ
Convenors: David George (david.george@stc-nyorks.co.uk), Jennifer Banfield-Zanin, Maureen Wakefield (maureen.wakefield@fera.gsi.gov.uk), Steven Belmain (s.r.belmain@gre.ac.uk)

May 16 **Insect Genomics SIG**
Venue: Rothamsted Research, Harpenden, U.K.
Convenors: Ramiro Morales-Hojas, Martin Williamson

Sep 12 – 14 **Ento' 17 Annual Science Meeting and International Symposium**
Entomological Networks: Ecology, Behaviour and Evolution
Venue: Newcastle University
Convenors: Gordon Port, Darren Evans, Geraldine Wright, James Gilbert
Symposium speakers: Lars Chittka (QMUL), Sheena Cotter (Lincoln), Markus Eichhorn (Nottingham), Mathieu Lihoreau (Toulouse), David Shuker (St Andrews), Allen Moore (Georgia), Yoshifumi Yamawaki (Kyushu)

Oct 24 **Insect Pollination SIG**
Venue: National Museum of Scotland, Edinburgh
Convenors: Drs Jenni Stockan (jenni.stockan@hutton.ac.uk); Michael Garrett (m.p.garratt@reading.ac.uk)
Confirmed speakers: Dr Adam Vanbergen (NERC Centre for Ecology and Hydrology); Dr Lorna Cole (SRUC).

Other Meetings

2017

Jan 28 **UK Moth Recorders' Meeting**
Venue: Birmingham and Midland Institute, Birmingham
For further details please visit: http://butterfly-conservation.org/13194/uk-moth-recorders-meeting.html

Mar 25 **BENHS AGM**
Venue: Oxford University Museum of Natural History, Parks Road, Oxford, OX1 3PW
For further details please visit: http://www.benhs.org.uk/events/

Jul 9-12 **9th International Conference on Urban Pests**
Venue: Conference Aston/Aston University, Birmingham, UK
Convenor/Chair: Dr Matthew Davies (Killgerm Chemicals Ltd)
For further information on the ICUP conference please refer to: http://www.icup2017.org.uk/

Sep 4 – 8 **26th International Conference of the World Association for the Advancement of Veterinary Parasitology (WAAVP 2017)**
"Combating Zoonoses: Strength in East - West Partnerships"
Venue: Kuala Lumpur Convention Centre, Kuala Lumpur, Malaysia
For further details please visit: www.waavp2017kl.org

2018

Jul 2-6 **European Congress of Entomology**
Venue: Expo Convention Centre, Naples, Italy

The Leverhulme Trust

2017 EMERITUS FELLOWSHIPS

LEVERHULME EMERITUS FELLOWSHIPS enable retired academics from UK institutions to complete a body of research for publication. Up to £22,000 is available for research costs directly related to the project. Applicants must have retired by the time of taking up the Fellowship and no longer have a normal contract of employment, but they may hold a part-time position of up to 0.5 FTE. Approximately 35 fellowships are available in 2017.

ELIGIBLE COSTS INCLUDE:

- Travel and subsistence costs for periods away from home;
- Employment of a research, clerical or secretarial assistant to support (rather than conduct) the work of the applicant;
- Photocopies;
- Photographic expenses;
- Office and laboratory consumables.

DURATION:

Fellowships are tenable for between 3 and 24 months, and the current round of awards must commence between 1 August 2017 and 1 July 2018.

CLOSING DATE:

Thursday 2 February 2017

DETAILS AND APPLICATIONS:

www.leverhulme.ac.uk/funding/grant-schemes/emeritus-fellowships

MORE INFORMATION:

For more information please call **020 7042 9861/9862** or email **grants@leverhulme.ac.uk**

Alfred Russel Wallace Award 2016

For post-graduates awarded an outstanding PhD in Entomology!

Photo credit: Wallace's Cyriopalus beetle (*Cyriopalus wallacei*) by Tim Cockerill

ROYAL ENTOMOLOGICAL SOCIETY FOUNDED 1833

Requirement

For post-graduates who have been awarded a PhD, and whose work is considered by their supervisory team to be outstanding. The research involved should be a significant contribution to the science of entomology.

Who Can Enter?

All post-graduates who have been awarded a PhD degree, on the basis of a thesis written in the English language, within the period 1st October 2015-31st December 2016.

Prizes

First Prize: £800 plus Certificate, plus one year's free Membership to Royal Entomological Society. The winner will also be required to present their work at a Society Meeting (all expenses paid) and submit an article to *Antenna*.

Runners-up: Up to four runners-up will have their names and abstracts published in *Antenna*.

Entries

The candidate's supervisor or external examiner should complete the entry form available on the student pages of our website, have it signed by the Head of Department, append a copy of the abstract of the thesis, and send it to:

The Registrar, Royal Entomological Society,
The Mansion House, Chiswell Green Lane,
St Albans, Herts, AL2 3NS

Please do not send the thesis itself until requested to do so.

The candidate will at that stage be asked to provide a 500 word statement expressing in layman's terms the contribution that their work has made to entomology and selected entries will be asked to submit their theses.

Following thesis submission, up to 5 candidates will be invited to The Mansion House in person (UK travel will be paid), or virtually if not UK-based, to deliver a 20 minute presentation and engage in a 20 minute question/answer session with the judges.

The Judges

The judges' panel will consist of a group of senior Fellows of the Royal Entomology Society. The judges decision is final.

Closing Date

The closing date for entry is 31st December 2016. Winners will be announced in the Spring 2017 edition of *Antenna* and on the RES website **www.royensoc.co.uk**

author guidelines

We are always looking for new material for *Antenna* – please see below if you think you have anything for publication

AIMS AND SCOPE

As the Bulletin of the Royal Entomological Society (RES), *Antenna* publishes a broad range of articles of relevance to its readership. Articles submitted to *Antenna* may be of specific or general interest in any field related to entomology. Submissions are not limited to entomological research and may, for example, include work on the history of entomology, biographies of entomologists, reviews of entomological institutions/methodologies, and the relationship between entomology and other disciplines (e.g. art and/or design).

Antenna also publishes Letters to the Editor, Meeting Reports, Book Reviews, Society News, Obituaries and other items that may be of interest to its Readership (e.g. selected Press Releases). *Antenna* further includes details of upcoming entomological meetings in its Diary Section and features information and reports on RES activities including National Insect Week, Insect Festival and National, Regional and Special Interest Group meetings. Details of RES Awards and recipients are also covered, as is notification of new Members (MemRES), Fellows (FRES) and Honorary Fellows (HonFRES).

READERSHIP

Antenna is distributed quarterly to all Members and Fellows of the RES, as well as other independent subscribers.

INSTRUCTIONS FOR AUTHORS

Standard articles are normally 2,000-6,000 words in length, though shorter/longer submissions may be considered with prior approval from the Editorial Team. The length of other submitted copy (e.g. Letters to the Editor and meeting reports) may be shorter, but should not normally exceed 2,000 words. The use of full colour, high quality images is encouraged with all submissions. As a guide, 4-8 images (including figures) are typically included with a standard article. Image resolution should be at least 300 dpi. It is the responsibility of authors to ensure that any necessary image permissions are obtained.

Authors are not required to conform to any set style when submitting to *Antenna*. Our only requirement is that submissions are consistent within themselves in terms of format and style, including that used in any reference list.

PAGE CHARGES

There is no charge for publication in *Antenna*. All articles, including images, are published free-of-charge in full colour, with publication costs being met by the RES for the benefit of its membership.

REVIEW AND PUBLICATION PROCESS

All submissions are reviewed and, where necessary, edited 'in-house' by the *Antenna* Editorial Board, though specialist external review may be sought in some cases (e.g. for submissions that fall outside the Editorial Boards expertise). Receipt of submissions will be provided by email, with submitting authors of accepted articles being offered the opportunity to approve final pdf proofs prior to publication. Where appropriate, authors will be requested to revise manuscripts to meet publication standards.

SUBMISSION PROCESS

All submissions should be sent electronically to 'antenna@royensoc.co.uk', preferably in MS Word format with images sent as separate files (see above). Image captions and figure headings should be included either with the text, or as a separate file.

EDITORIAL BOARD