Bulletin of the Royal Entomological Society Summer 2011 Volume 35 (3)

antenna

INSECTS IN MESOAMERICAN ART AND CULTURE

THE BIOBLITZ

meetings of the society

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2011

Sept 7-9	Ento'11 Symposium on 'Chemical Ecology' and National Meeting **Venue: University of Greenwich, Medway Campus, Chatham Maritime, Kent** Symposium Convenors: National meeting convenors:		Profs David Hall, Bill Hansson & John Pickett Dr Gabriella Gibson & Prof David Hall
Sep 14-16	A joint meeting with the Soil Ecology Society **Venue: The National Marine Aquarium, Plymouth** Convenor:		Prof. Rod Blackshaw
Sep 21	Aphid Special Interest Group **Venue: James Hutton Institute (formerly SCRI) Dundee, Scotland** Convenors:		Drs Brian Fenton, Gaynor Malloch, Jorunn Bos & Jon Pickup
Oct 12	Sustainable Agriculture Special Interest Group **Venue: British Ecological Society, London** Convenor:		Dr John M Holland
Nov 1	Infection and Immunity Special Interest Group **Venue: University of Sheffield** Convenor:		Dr Jens Rolff
Nov 2	Orthopterists' Special Interest Group **Venue: Natural History Museum** Convenors:		Dr. David Robinson Mrs Judith Marshall
Nov 10	Biology of Lepidoptera **Venue: Rothamsted Research, Harpenden, Herts.** Convenors:		Dr Jason Chapman Dr James Bell

2012

Feb 1-2	Postgraduate Forum **Venue: Liverpool (tbc)** Convenor:		Mr Steven Parratt
Mar 7	Verrall Lecture **Venue: Flett Lecture Hall, Natural History Museum** Professor Ilkka Hanski (University of Helsinki) on the topic of: The Glanville fritillary butterfly: ecology meets evolution		
Jun 6	**RES Annual General Meeting**		
Jun 25 – 1 Jul	**National Insect Week**		
Jul 18 – 20	Ento'12 – the National Meeting of the RES **Venue: Anglia Ruskin University, Cambridge** Convenor:		Dr Alvin Helden
Aug 19 – 25	ICE 2012 - XXIV International Congress of Entomology **Venue: Daegu, Korea**		

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

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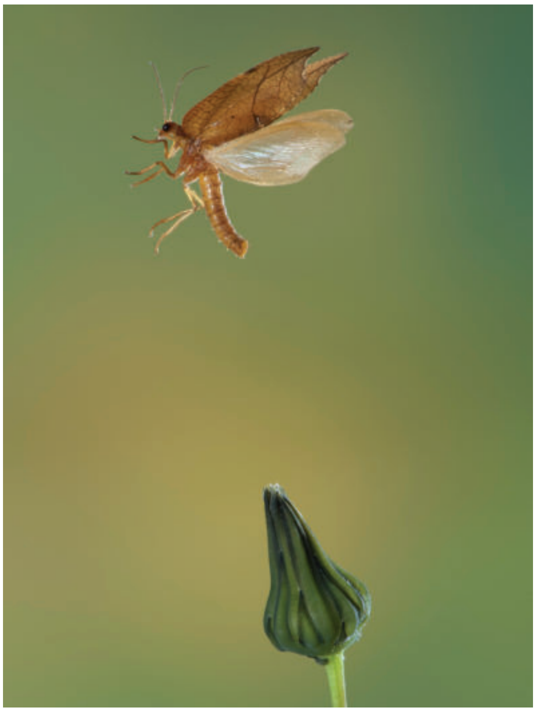

COVER PICTURE

The cryptic lacewing *Drepanepteryx phalaenoides* in flight. See page 139.

Photograph by Robert Pickett

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EDITORIAL

Welcome to the summer edition of *Antenna*, we have another diverse array of articles which we hope will keep you entomologically informed and entertained on those long hot summer evenings. Michele Woodger's article describing Insects in Mesoamerican Art reveals an amazing richness of cultural references to insects in ancient central American societies. References that indicate an awareness and appreciation of the importance of insects that our own culture is still struggling to attain. Clive Betts returns to entomology with a discussion of the latest craze for biosocial gatherings that is sweeping the country. The Bioblitz has arrived. Is this a wonderful opportunity to bring biologists of all disciplines together and map a day in the life of a particular site or a reflection of our frantic working lives in modern society, with a high pressure skim across the surface of the fauna and flora of a chosen location. I am playing devil's advocate here but while I have thoroughly enjoyed the bioblitzs I have attended, I sometimes wonder at how effective they really are at illuminating the fauna and flora of the chosen place in a meaningful way?

We have the contentious problem of wind turbines and insects, which is either a problem to battle with or an arrow in your armoury depending on where you stand. Also as part of our continuing historical perspective Richard Baker offers a history of Herbert Wormsley the father of Australian acarology. The opening quote of which has a coincidental resonance with the earlier discussion of the bioblitz.

We also feature this year's winners of the student essay competition which have produced a series of informative and entertaining entomological articles. The judges report a bumper number of entries this year which is excellent news. We hope this trend will continue and produce a generation of entomologist who regularly communicate their science to the wider world.

It is gratifying to note that entomologists have recently been recognised in both the New years and the Queens birthday honours lists. The society extends its congratulations to Richard Lane and Jeremy Thomas on being awarded the OBE, and Charles Godfray CBE. All three have been honoured in recognition of a lifetime contribution in their field.

Perhaps this recognition at the highest level combined with rising interest from younger biologist and the arrival of massed field meetings (where entomology is a major player) indicate that entomology has turned or has the opportunity to turn a corner and make a comeback as a significant player in UK science and natural history. This will be, in some ways, an underlying theme for the next Antenna, out in October, which focuses on Outreach.

Peter Smithers

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

Insect Field Guides

When entomologist go on vacation they are always curious about the local insect fauna that they encounter and having a local field guide is always a handy reference. With this in mind I would like to assemble a list of insect field guides to various regions of the world. If you know of, or have any can you send me the titles and a supplier if possible, plus any comments? The final list will then appear in a future edition.

Many thanks, Peter Smithers

How many insect species? Long live phenodiversity!

Stuart Reynolds

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In my previous column for *Antenna* I pondered on the number of individual insects that might exist in the world. The numbers were unimaginably large and the calculations depended on a lot of assumptions. Perhaps it got a bit silly. Let's just say that I estimated that there are a lot of insects and therefore they must play an important role in the global natural economy.

But insects are also important because there are so many different kinds of them. In fact, insect evolution has been so notoriously prolific that no one knows how many species there are. All we know for sure is that their diversity dwarfs that of any other macroscopic Class. More than half of all known animals and plants are insects, and perhaps 40% of these are beetles, implying the Creator's "inordinate fondness" for this Order, as one of my biological and political heroes JBS Haldane is famously supposed (perhaps apocryphally) to have observed.

Around one million species of insects have been described, but everyone knows that many more remain uncatalogued. A famous past attempt at enumerating the world-wide set of insect species was made by the Smithsonian Institution taxonomist Terry Erwin (1982), who on the basis of tree fogging experiments in Panama found that the number of beetle species contained in one hectare of tropical rain forest exceeded 41,000, a high proportion of which appeared to live on only one species of host plant. Extrapolating from this he concluded that the world tally of insect species might be as many as 30 million. Erwin's figure was so mind-bogglingly large that it provoked a long-lived thread of interest, and total citations of his original report currently exceed 600 (not something that normally happens to a paper in the *Coleopterists Bulletin*!). Present opinion (see Ødegaard, 2000, for example) is that Erwin's estimate was overenthusiastic, mainly because he overestimated the extent to which insect herbivores are specialists, and that there are probably considerably fewer than ten million insect species.

But it's still true that there are a lot of different kinds of insects out there. Perhaps the most careful follow-up study is that by Hamilton *et al.* (2010) based on geographically separate tropical forest data sets, which respectively predicted world totals of 3.7×10^6 (median value, range 2.0 – 7.4) species and 2.5×10^6 (median, range 1.1 - 5.4) insect species. Let's take the mean of these two figures which gives us a figure of 3.1×10^6 species. This means that two out of every three insects are at present unknown to science. (I might add in a Rumsfeldian manner, that because we have not found them yet, they are unknown unknowns…).

Even this dismaying level of ignorance is probably a low estimate. If we just rely on recognising morphological differences that are obvious to the eye, then we will certainly underestimate the true total extent of species-level variation, because differences exist that we can't see. This is where "DNA barcoding" comes in: by determining the DNA sequence of a 648-base pair region of the mitochondrial cytochrome-*c* oxidase subunit 1 (*COI*) gene (which is a length of DNA that is known to vary between species to just the right extent – like Goldilocks, not too much and not too little), we can spot the existence of "cryptic species" (i.e. those that can't be distinguished by eye). A recent study (Hausmann et al., 2010) suggests that around 5% of conventionally recognised lepidopteran species actually comprise two or more populations, each of which differs by 2% or more in its barcode sequence from the other. We know that this kind of variation in DNA sequence can only be sustained by significant barriers to gene pool mixing within morphological "species", and so the DNA is probably revealing the existence of cryptic species. It doesn't seem unreasonable to suppose that other Orders of insects will have a similar proportion of cryptic species. If there are really another 5% of insect species that conventional taxonomy misses, then the total number of insects rises to something like 3.26×10^6 species. If that doesn't sound like much of an adjustment, then please notice that the above calculation has just added a mere 155,000 extra probable insect species to the world list!

At this point I have to admit that there are other complications that almost certainly mean that even the above figure for the total number of species is too small. One of these is the "mountain problem". Genoveva Rodríguez-Castañeda and her colleagues (2010) have recently pointed out that most estimates of insect herbivore biodiversity in tropical forests are too low because they have been have been made from data obtained only from lowland study sites. She found that the degree of herbivore specialisation in tropical forest montane regions is considerably greater than at otherwise comparable lowland sites. It is too soon to attempt a correction of the total insect biodiversity figure, but it's definitely going to be more species rather than less.

Why does this apparent over-enthusiasm of nature for insect speciation matter? Well, for one thing, it means that the biology of macroscopic organisms is basically just entomology. Most total biodiversity estimates reckon that more than half of all kinds of macroscopic organisms are insects. Clearly if you are interested in insect collecting then this is wonderful news; you're highly unlikely ever to run out of new insect species to collect! And if you are interested in conserving the diversity of life then it follows that most of what needs conserving will belong to the Class Hexapoda. The next time a non-entomologist asks you at a party why you study insects, you can just tell them that numerically nothing else in the natural world matters as much.

On the other hand, the existence of so many insects makes entomology an expensive business. Brazilian biologists Fernando Carbayo and Antonio Marques (2011) have recently tried to estimate the probable cost of describing all previously undescribed animal species. In doing so they note that this is obviously a job for biologists from tropical countries because that's where most of the world's unknown animals are found (in tropical rainforests). Taking account of the necessary time and resources, they reckon it takes US$ 39,000 to describe each new species. Applying that figure to my estimate of the number of species, the cost of extending the world catalogue from the presently known 1.0×10^6 insects to the probable total of 3.26×10^6 would be a mind-boggling US$127 billion. No less than US$6.2 billion of this sum would be devoted just to detecting cryptic species. (And remember that even these figures are probably going to have to be revised upwards because of the mountain problem).

It seems obvious to me that the task of describing all insect species isn't going to be accomplished by conventional taxonomic means (i.e. going on an expedition with a butterfly net or tree-fogging kit, and then looking at the catch through a binocular microscope). There are neither enough entomologists nor enough money (and probably not even enough microscopes…). Massive barcode sequencing programmes have been advocated (Jinbo et al., 2011), but this seems to be beside the point. What use would it be to describe a new species in terms of its DNA sequence if we don't know what it looks like? There has to be more to a species description than that! Perhaps we may have to wait until computer graphics has advanced to the point that a fully inspectable digital hologram of the insect can be quickly and efficiently produced. Perhaps the point here is that although DNA barcoding might not give us all the answers, it can certainly tell us a lot about how much we don't know.

But in any case, the genes used in producing bar codes just aren't the ones that are important from the point of view of either the traditional taxonomist or those interested in what insects actually do for a living. Consider this: the important thing about biodiversity is that all these species are *biologically distinct*. Not only the appearance but also the behaviour and ecology (i.e. the phenotype) of each species is in itself in some way different. We might call this "phenodiversity". And obviously, this must come from the insects' genes. But which genes? Certainly not all of them. Most genes will have much the same job specification in any pair of congeneric species, or even within much larger taxonomic groupings. About the only thing we know here is that the barcode genes like COI are unlikely candidates for the specification of phenodiversity. Barcode genes are deliberately chosen to be "housekeeping" genes.

Despite the immense progress made in genetics over the last 60 years (since Watson and Crick's discovery of the DNA double helix, that is) we still don't really pay enough attention to this question of the genetics of speciation. And because of the overwhelming numerical and taxonomic predominance of insects, it's a question that we entomologists can't duck.

Ever since Darwin, it has been supposed that natural selection drives the formation of new species; but speciation remains a very hard topic in evolutionary biology. According to Dolph Schluter (2009) there are two types of speciation, ecological speciation and mutation-order speciation. In the first, different environments select genes that encode functional adaptations. In the second, mutations arise randomly that are then stochastically fixed by the same selective forces acting in different environments. The relative importance of these two processes is unknown. And in any case, even when this kind of genetic adaptation has taken place, we cannot recognise it as speciation until other genetic changes arise that prevent the evolving population from backcrossing with its ancestral population. We still know very little about the genes that actually govern reproductive isolation (Wu and Ting, 2004); probably most speciation genes affect the viability or fertility of the offspring of interspecific unions through their effects on reproduction or early development.

Kevin Winker (2009) has pointed out that the genetic processes underlying reproductive isolation are essentially stochastic, and unrelated to (ecological) natural selection and (behavioural) sexual selection, the two major forces affecting phenotypic evolution. Consequently, he argues, we should not expect that understanding speciation (i.e. the maintenance of reproductive isolation) will tell us much about the diversification of phenotype. But as far as looking and acting differently go, it is those genes that affect size, shape, colour, biochemistry, physiology and behaviour that count. COI and other barcoding-scheme genes are no use at all for this. But genes like those that affect wing pattern and colour in mimetic butterflies (Wu et al., 2010) or the diversification of sexual ornaments in beetles (Moczek and Rose, 2009) are very interesting indeed. Surely it's time for taxonomists to get seriously interested in these genes.

Long live phenodiversity! There's a whole new field of molecular insect science waiting to be done out there. But I'm not sure that it's going to help with the species description problem.

Next time: Insects and the food supply.

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ARTICLE

Figure 1. Hedge-rich sites often have high levels of bat activity as bats use these features for navigation and foraging purposes.

Wind turbines, insects and wildlife interaction

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Chloe recently obtained her PhD in Bioacoustics at Loughborough University. Her thesis work focussed on the interactions of echolocating bats with operational turbine rotors from an acoustics perspective; her work has been reported in the BBC and world media. In addition to acoustics, Chloe also specialises in biological science and she has research interests in ultrasound and small mammal communication.

Abstract

Over the last decade, concern has been steadily growing over the phenomenon of wildlife-wind turbine interactions, particularly at some installations where significant bird and bat mortality is occurring on an annual basis. While it is clear that wind turbines are becoming an important source of renewable power, they have been identified as potentially problematic to some animal species worldwide. Many of these species are insectivores and recent evidence suggests that insects may have some role to play in the matter at turbine sites. This article reviews some of the recent literature on the phenomenon, with the aim of drawing attention to the fact that further research into insect-turbine interaction is urgently needed.

Introduction

Wind energy is the fastest growing global energy technology, with a yearly growth rate of around 30-40% (BWEA, 2001; EWEA, 2009). Wind power is seen as a clean, environmentally friendly renewable energy source; wind turbine generators have undergone many changes since their invention in 1881 (Wolff, 1888). Although wind turbines have undergone rapid development over the last 30 years (Twidell, 2003), it is only relatively recently that their impact on wildlife has been brought to scientific and public attention, perhaps due to their increasingly widespread deployment over a wider range of habitats than ever before. The phenomenon initially asserted itself with incidents of bird strike at early experimental large-scale turbine installations in the 1980s (Erickson et al., 2002), with studies into bird mortality at wind plants developing throughout the US well into the late '90s and beyond. As the majority of bird-strike surveys were conducted during the day, when most birds are active, it was not until early 2000 that bat-strike at wind plants began to be noticed during ground carcass surveys, with many hundreds of bat carcasses turning up, at some plants outnumbering bird carcasses by almost 7:1 (Kerns & Kerlinger, 2004). Further study revealed that the phenomenon of bat-turbine mortality was widespread throughout the US and reports of similar incidents began to appear from Europe and other countries worldwide. In fact, the first reported bat-turbine incident was at an Australian wind plant in 1972, when 22 white-striped free tailed bats (*Tadarida australis*) were found dead around turbines over a period of four years (Hall & Richards, 1972), although this report remained largely ignored until some thirty years later.

The causality behind wildlife interactions at wind turbine installations still remains largely unclear. Location of the turbine or wind farm seems to play a key role in wildlife mortality rate, particularly those on mountain ridgetop locations (Kunz et al., 2007), deforested areas (Kunz et al., 2007), wetlands (Erickson et al., 2002) or installations in previous hedge-rich areas (Bach, 2001) (Figure 1). It has previously been suggested that there may be a link between such locations and insect activity (Johnson & Kunz, 2004; Ahlén, 2004; Rodrigues et al., 2006; Kunz et al., 2007), as high insect-dense 'pockets' may be luring in insectivorous bird and bat species. Interestingly, the majority of avian deaths around turbines are insectivorous species (Erickson et al., 2002). Echolocating bats associated with turbine mortalities are also insectivores, relying on their sonar to detect and hunt insect prey (Figure 2).

Figure 2. Echolocating bats such as the brown long-eared bat (*Plecotus auritus*) navigate and hunt insects by emitting high-frequency pulses of sound and interpreting information contained in the reflected echoes. This species has particularly large ears to listen for faint echoes while hunting amongst vegetation (image source: Sterndale (1884)).

Notable studies of wildlife-turbine mortality

The vast majority of early turbine-wildlife research concerns bird strike, which predominates the field (Bach, 2001), and indeed much of the preliminary bat death data (particularly that originating from the USA) comes from bird-turbine monitoring studies (Kunz et al, 2007). There are some similarities between bat and bird collisions, however bats are somewhat unique with regard to habitat (Westaway, 2007) and data suggests bats are much more vulnerable to turbines than birds (Tuttle, 2003), despite records for avian fatalities having been kept for longer (Westaway, 2007). Avian activity data has previously been used as a guideline for placement of new turbines (Erickson et al., 2002) and guidelines are gradually evolving to take bat data into consideration, although some marked differences between bat and bird impacts exist. Visual turbine effects problematic to birds such as blade motion smear (Hodos, 2003) are thought to have little relevance to bats and the ability of birds to 'hear' turbines (e.g. Dooling, 2002) is likely to be entirely dissimilar to the acoustic profile presented to bats (e.g. Long et al., 2010). Bat interaction with turbines is, however, one of the most prominent areas of impact, and the most difficult to prove in the field (Harbsuch & Bach, 2005). Although most data on bat-turbine mortality comes from the US (Dürr & Bach, 2004), European bat turbine mortality studies are on the increase. Several notable findings taken from studies of both bat and bird turbine mortality are outlined in the following portion of this section.

Bach (2001)
Germany

This study investigated the impact of 70 planned turbines (30 m height, rotor diameter 30 m) on local bat species at a proposed hedge-rich wind plant site in Germany (Windpark Nidlum). In some cases the hedges were only 10 m from the nearest turbine; hedgerows are used by many bat species for foraging and navigation (e.g. Verboom & Huitema, 1997). After installation of the turbines, a significant reduction in the number of serotine *serotinus*) hunting in the area was observed, although serotines were still occasionally observed hunting in the immediate vicinity of the turbines. The number of observed serotines flying around the site post turbine erection decreased during the study, despite the number of serotines in the wider area remaining constant throughout. This seems to suggest that the installation of the turbines directly impacted the local serotine population in that area. However, it was also noted that during turbine construction, a number of hedgerows had to be removed and there was a large amount of scrub clearance, which could also have had a direct impact on the serotine's hunting environment in this area. Conversely, the number of hunting common pipistrelles (*Pipistrellus pipistrellus*) in the turbine study area was actually observed to increase significantly after construction. The total area utilised by this species also increased during the course of the study. Common pipistrelles in the area were not noticed to avoid the active turbines in the same way as the serotines did. A further interesting finding of this study was that the common pipistrelles were observed to alter their reactions to the turbines with varying wind direction. When turbine rotors were parallel to the hedgerow along which pipistrelles were hunting, the bats did not alter their flight path at 2-10 m in height and would not approach the turbine closer than 4-10 m. On the other hand, when rotor blades were perpendicular to the hedgerow, the pipistrelles were observed to dive underneath the rotor region to a height of 0.5-1 m, although possible reasons for this were not given.

Erickson et al. (2002)
North America

This industry report documented several species' mortality figures for a variety of US turbine plants, including California (0.05-0.1 raptor fatalities $year^{-1}$ $turbine^{-1}$); Minnesota (613 bat fatalities $year^{-1}$); Wyoming (138 bat fatalities $year^{-1}$) and Oregon (28 bat fatalities $year^{-1}$). Waterfowl mortality was found to be relatively low (5% of collisions), excepting where turbines were placed near substantial bodies of water. Passerines (a broad classification of insectivorous 'perching birds') were the birds most commonly killed by turbines (comprising over 80% of all avian collisions), consisting of both resident and migratory species. The study also presented a review of the relative passerine mortality rates for various man-made structures, including wind turbines (0.01-0.02%), communications towers (1-2%), buildings/windows (25-50%) and vehicles (15-30%).

Johnson et al. (2003)
North America

This study documented 184 US bat collision fatalities at a wind farm in Minnesota between 1996-1999, most of which were Hoary bats (*Lasiurus cinereus*) and eastern red bats (*L. borealis*). The mortality rate was estimated at 0.07-2.04 fatalities $year^{-1}$, and it was suggested that most fatalities were migrant rather than resident breeding bats. While 24% of all US bat species have been discovered in turbine collisions, Hoary bats account for nearly half of these (Erickson et al., 2002; Johnson & Kunz, 2004). This species is considered to manoeuvre poorly in flight and this may put them at higher risk of blade strike (Erickson et al., 2002). Other species of bat killed by turbine interactions in the US include silver-haired (*Lasionycteris noctivagans*), northern long-eared (*Myotis septentrionalis*), western red (*Lasiurus blossevillii*), Brazillian free-tailed (*Tadarida brasiliensis*), long-eared myotis (*Myotis evotis*) and seminole (*Lasiurus seminolus*) bats (Johnson & Kunz, 2004); Kunz et al., 2007; Arnett et al., 2005), as well as big brown (*Eptesicus fuscus*), little brown (*Myotis lucifugus*) and eastern pipistrelle (*Perimyotis subflavus*) bats (Erickson et al., 2002; Kunz et al., 2007; Arnett et al., 2005). None of those US species reported were at that time endangered (Johnson & Kunz, 2004), although it is entirely possible that other bat species are being killed at different times of year to those previously studied (Arnett et al., 2005) since year-round assessments are uncommon.

Dürr and Bach (2004)
Germany

In Germany, all published data relating to bat and bird turbine mortality is held in a national database at the Landesant Brandenburg (Staatliche Vogelschutzwarte). In 2004 Dürr and Bach performed analysis on all the bat data held, which listed 207 bat-turbine mortality incidents from 10 species throughout Germany, up to the date of the study. It was found that the most frequently killed species was the noctule (*Nyctalus noctula*) (47.8%) and Nathusius' pipistrelle (*Pipistrellus nathusii*) (19.3%), with the genus *Pipistrellus* alone contributing to 31.5% of recorded bat fatalities in Germany. The fact that noctules as a species had the highest mortality rate is interesting, since bats in the genus *Pipistrellus* are generally considered to be more common with a widespread distribution throughout Europe (e.g. Mayer & Von Helversen, 2001). It is therefore possible that certain bat species are at a greater risk of turbine mortality than others. A marked mortality peak was observed between June-August, although the data may be skewed since carcass surveys were not regular or evenly distributed throughout the year. The data demonstrated that most bat carcasses were found under turbines that were >50 m from trees, however dead bats were also reported at distances up to 200 m between the turbine site and the nearest forest. Of the 292 turbines investigated, it was found that mortality occurred around all types of turbine with an axle height over 51 m. No mortality was found to occur when the rotor axle height was below 50 m, although this was thought to be due to the smaller turbines in the study being positioned along shorelines where bat densities were very low. Bat deaths were found to occur at every rotor blade diameter between the 21-90 m measured, but there appeared to be no correlation between blade size and the number of bats killed at that site.

Arnett et al. (2005)
North America

Arnett and colleagues investigated bat interactions at two wind energy plants (a total of 64 turbines) in Pennsylvania

September) of the year of study. Thermal imaging camera observations were taken during August night monitoring to make 2,398 recorded turbine passes, of which 41% were bats, 20% were insects, 1% were birds and 35% were unknown. Detailed analysis of thermal images showed that bats were both attracted to and investigated the moving (and stationary) blades, and were in some cases directly struck by them. There were even captured shots of bats attempting to or actually landing on stationary blades and masts, and it was hypothesised that the bats were curious about investigating the turbines as potential roost sites or gleaning opportunities. It was found that there were significantly more adult male bat fatalities (~60%) than adult females (~25%), juvenile males (<10%) or juvenile females (<5%) ($p<0.001$), and that bat fatalities were highly variable throughout the study. This may indicate a variation in site use by male and female bats, which could have interesting implications for population impacts on a larger scale. As with other US studies, most bats observed and killed were Hoary and eastern red bats. No bat carcasses were found around the one turbine not in operation during the course of the study. Nightly bat passes ranged from 9-291 per turbine. The highest recorded carcass injury type was wing damage (20%), whereas 42% had no visible sign of external injuries. A small percentage of carcasses had lacerations to the head or back; some bats were found grounded around the turbines but alive, and were later released. An average of 0.8 bat carcasses were found per turbine per night during the study. Analysis of site fatality distribution revealed that 88.5% of all carcasses were discovered <40 m from the turbine bases.

Baerwald et al. (2008)
Canada

Hoary and silver-haired bat carcasses were retrieved from a wind farm in Canada and post mortem carcass examinations conducted to look for evidence that changes in pressure (barotrauma) could be causing bat deaths rather than direct physical blade strike. Of 188 carcasses, 46% had no evidence of external injury that could cause death (such as broken bones, lacerations, etc.). Of these, 57% had internal haemorrhaging and 17 bats with lung tissue examined histologically demonstrated lesions consistent with barotrauma. The authors concluded that it is possible that some bats are killed by pressure fluctuations behind turbine blades, although there is recorded evidence that bats are also being struck directly by blades (e.g. Arnett et al., 2005).

Table 1 lists the projected yearly mortality rates calculated using figures from the current literature. The average worldwide mortality rate for birds is estimated at 1.23 deaths per turbine per year, while for bats the estimate is 67.32 deaths per turbine per year. It is important to note the figures given may massively underestimate the actual fatality rates per turbine due to lack of systematic studies conducted throughout the year, and lack of annual repeatability (Bach & Rahmel, 2004; Tuttle, 2004; Kunz et al., 2007). Reports that produce small figures for bat mortality rates can be misleading due to assessment error (Tuttle, 2004); bats may be overlooked during carcass searches due to their small size and inconspicuous colouration (Kunz et al., 2007), and studies previously designed for bird carcass searches may have initially disregarded bat bodies. Potential problems exist when estimating turbine mortality rates based on carcass retrieval due to scavenging predators and inefficiency of searchers

Projected figure	Species fatality	Projection context	Location	Author(s)
0.07-2.04	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Minnesota)	Johnson *et al.* (2003)
3.40	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Entire)	Johnson and Kunz (2004)
4.60	Bat deaths	$MW^{-1}\ yr^{-1}$	USA (Entire)	Johnson and Kunz (2004)
3.07	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Minnesota)	Erickson *et al.* (2002)
2.00	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Wyoming)	Erickson *et al.* (2002)
0.74	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Oregon)	Erickson *et al.* (2002)
15.30-41.10	Bat deaths	$MW^{-1}\ yr^{-1}$	USA (Eastern)	Kunz *et al.* (2007)
5110.00	Bat deaths	$Wind\ Plant^{-1}\ yr^{-1}$	France	MEDD (2004)
328.50	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (West Virginia)	Arnett *et al.* (2005)
259.15	Bat deaths	$Turbine^{-1}\ yr^{-1}$	USA (Pennsylvania)	Arnett *et al.* (2005)
1.19-1.5	Bat deaths	$Turbine^{-1}\ summer^{-1}$	USA (Oklahoma)	Piorkowski (2006)
5.96	Bat deaths	$Turbine^{-1}\ yr^{-1}$	Europe	Rydell *et al.* (2010a)
3.81	Bat deaths	$MW^{-1}\ yr^{-1}$	Europe	Rydell *et al.* (2010b)
Up to 40.00	Bat and bird deaths	$Turbine^{-1}\ yr^{-1}$	France	MEDD (2004)
0.33-0.66	Bird deaths	$Turbine^{-1}\ yr^{-1}$	USA (Minnesota)	Obsorn *et al.* (2000)
0.04-0.12	Bird deaths	$Turbine^{-1}\ summer^{-1}$	USA (Oklahoma)	Piorkowski (2006)
2.15	Bird deaths	$Turbine^{-1}\ yr^{-1}$	USA (Massachusetts)	Vlietstra (2007)
2.19	Bird deaths	$Turbine^{-1}\ yr^{-1}$	USA (Entire)	Erickson *et al.* (2002)

Table 1. Projected wildlife mortality rates for different turbine sites taken from various studies. All figures calculated to give annual projection, although not all reported figures were taken from studies conducted regularly throughout the entire year. Not all studies included a figure corrected for scavenging or carcass retrieval error.

(Morrison, 2002), but many studies now typically include a retrieval error correction to allow for this. Bats are considered to be particularly susceptible to such wide-spread mortality events due to their slow generation rates; usually only one bat pup is born to each female per year, and young adult bats do not become reproductively active until they are 10-15 months old (Hutson et al., 2001). It should be considered that total bat mortalities in the first year of life may be as high as 40-50% (Hutson et al., 2001), independent of turbine incidents. The potential impact of increased bat mortality rates through turbine collisions on already threatened bat populations, therefore, is high. However, it must be considered that turbines not only pose a direct risk to bats (and birds) through fatal interaction, but also an indirect risk due to loss of foraging habitat, interruption of commuting routes and disturbance of roost sites (Bach, 2001), as well as potentially affecting the positioning of roosts and breeding sites (Bach, 2001; Cryan, 2008). Collision with rotor blades is thought to potentially have a very high impact on bat populations during migration (Rahmel et al., 2004) and wind turbine projects therefore have the potential to impact susceptible species on a global scale. Kunz et al. (2007) state that: "significant cumulative impacts of wind energy development on bat populations are likely"; With even relatively small numbers of bat deaths at turbine sites potentially having a significant impact on bat population growth rates (Betts, 2006). However, as pointed out by Bach and Rahmel (2004), it is impossible to make an assumption on the effect that turbine mortality will have on individual bat species or populations, since relatively little is currently known about bat-turbine interactions. What is known is that insectivorous bats play an important role in insect population control (Hutson et al., 2001), and the knock-on effects of any significant reduction in bat populations on insect species levels (or other insectivore populations) could have dramatic consequences on the ecosystem.

Figure 3. The colour yellow is strongly attractive to many insect species, most likely because this is the colour of flower pollen, found at the centre of the flower where the nectar is located.

Insects and Wind Turbines

Although some studies have noted the presence of insects around wind turbines (e.g. Ahlén, 2004; Arnett et al., 2008), few studies to date have investigated the possibility that insects may be attracted to turbine structures, thus attracting insectivorous wildlife through foraging opportunities. Rydell et al. (2010b) noted that there may be a link between the migration of insect swarms, high-altitude insectivore foraging and wind turbine mortality. It was suggested that favourable conditions around turbines created a 'hilltopping' effect (Shields, 1967), leading to the congregation of large numbers of insects around or above the turbine rotor region ('strike zone'). Insectivorous species are known to take advantage of these high-altitude swarms, such as the noctule bat (*Nyctalus noctula*) (Kronwitter, 1988), which may then put them at risk of being struck by moving blades during foraging. Another theory, recently investigated by the author (Long et al., 2011), suggests that the colour of the turbine structure itself could be acting as a visual lure to insects in the vicinity of the structure. Wind turbines are most commonly painted in shades of white or light grey; these colours were found to be significantly more attractive to a variety of insect species than the other nine colours tested- that is with the exception of the colour yellow, being the most attractive overall (Figure 3). Extreme-spectrum colour components, such as ultraviolet and infrared were also found to influence insect activity. Alternatively, thermal emissions from the hub and rotor housing of the turbine may act as a lure to some insect species, such as tabanid flies (Thorsteinson, 1958) – operational turbines can generate strong thermal signatures on thermal imaging cameras (Arnett et al., 2005). It is entirely likely that a combination of these factors may be drawing insects toward wind turbines, a phenomenon which may well be underpinning wildlife-turbine mortality and which clearly warrants further study.

Mitigation

Erickson et al. (2002) state that "some" wildlife mortality can be expected at most wind generation installations worldwide. Bat fatalities due to turbine interaction have been recorded anecdotally or formally at almost every wind farm in the US (Arnett et al., 2005), so it is clear that efforts to help reduce this phenomenon are urgently required. While the National Wind Coordinating Collaborative (NWCC) (2007) recognises that completely avoiding turbine wildlife mortality is an unrealistic expectation, there may be ways to reduce the impact significantly given a greater understanding of the problems surrounding this area. Mitigation options currently include strategies such as blade 'feathering' (pitching the blade to present the least forward air resistance) on low wind speed nights (NWCC, 2007); changing the operational cut-in wind speed of turbines to over 5 m s^{-1} (this has been found to be particularly beneficial in lowering the number of bat deaths) (Arnett et al., 2009); placing turbines a minimum distance away from important habitats like forests and hedgerows (Bach & Rahmel, 2004); creating more acoustically 'bat detectable' rotor designs (Long et al., 2010b) and installing acoustic deterrent devices on turbine towers (Szewczak & Arnett, 2007). Changing the colour of the turbine mast and rotor may even help to reduce insect attraction to the structures (Figure 4), which could help reduce insectivore activity at these installations (Long et al., 2011). Although more research is still needed to diagnose the effectiveness of these strategies in reducing wildlife-turbine mortality, initial studies have shown that some do appear to have beneficial effects in terms of mitigation.

Figure 4. Microturbine with red rotor blades. Simple changes like this to the colour of a turbine may help to reduce insect attraction to the structures.

Conclusions

Because there is not yet a thorough understanding of the nature of wildlife interaction with wind turbines, it is clear that much more research is required. It is crucial to explore not only the interaction of birds and bats with turbine installations, but also to investigate in more detail the role that insects may have to play in the matter. Study in this area is of importance to decision makers in the wind industry in order to negate complications with planning issues obstructed by the lack of scientific knowledge. Benefits of developing this knowledge will be to understand and minimise the ecological impact of global turbine distribution.

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Figure 1.

Insects in the Art and Mythology of Ancient Mesoamerica

(Part 1)

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ARTICLE

In 1954 the art-historian Kubler commented that "the monumental portrayal of insect forms, such as grasshoppers and fleas, is peculiar to Aztec civilisation". Indeed, as Sarton (1949) mused in his journal Isis, only the Egyptians can be said to have produced comparable monuments some 3000 years earlier, with their unmistakable colossal scarabs.

The little-studied topic of insects in Mesoamerican art and mythology is as fascinating as it is obscure. The Mexica or Aztecs (who inhabited the central Mexican basin in the three centuries preceding the Spanish conquest in 1521 AD) considered all life forms as sacred (Heyden and Baus Czitrom 1991), and as such, their art reflects a relationship with nature which was respectful, intellectually curious and imaginative. The same can be said of other Mesoamerican groups such as the Maya who inhabit the tropical lowlands of southern Mexico, Guatemala, Belize and Honduras.

Although they appear less frequently in Mesoamerican art than jaguars, dogs and snakes, arthropods appear in a wide variety of media, including stone, ceramic, feather-work, murals, painted documents and jewellery, and often in highly valuable materials such as gold or jade. What follows is an overview of the ways in which insects were conceptualised and visually represented in pre-Columbian Mexico so as to illustrate the complex and fascinating ways in which humans and insects interact on a cultural level.

Butterflies

The butterfly, known as papalotl in nahuatl (the Aztec dialect), has been an enduring theme of Mesoamerican visual culture from its early history to the current day. A Mixteca-Puebla vase **[Fig 1]** about 600 years old depicts a particularly vibrant Monarch butterfly (*Danaus plexippus*) at its centre; the Mexican 50 peso note still features this insect on its reverse.

These bright orange butterflies, which migrate remarkably on an annual basis from Canada to Mexico, resemble flames when alighting, en masse, on trees. This visual phenomenon can still be witnessed at the El Rosario butterfly sanctuary at Michoacán, and is arguably why, in the art of Teotihuacan, butterflies are closely connected with the element of fire.

Archaeology from this famous site near Mexico City, which flourished between the 1st Century BC and the 8th Century AD, is replete with images of butterflies painted on ceramic vases, as feet or stands for vessels, and as flat, and stylised terracotta pieces known as adornos used to embellish braziers, known as xantiles, depicting warriors with butterfly headdresses. These braziers are often found alongside statues of the fire deity Huehueotl who is also depicted with butterflies in his centre, or headgear (Berlo 1983; Heyden and Baus Czitrom 1991).

The Aztecs believed that the soul's destiny was determined by the manner of death rather than earthly behaviour. Those who died a watery death such as drowning, were destined for the paradise of the rain-god Tlaloc, a realm of fertility, lush surroundings and rejuvenation, associated with the life-bringing rains. For this reason, a large mural at Tepantitla, Teotihuacan (100-700 AD), is known as the Tlalocan. This mural displays what are thought to be newly-arrived souls, weeping and carrying leafy branches, set in a scene populated by all manner of vegetation and insect life.

The butterflies in this scene are often interpreted as human souls (Pazstory 1976; de la Fuente 1995), due to a passage written by the early colonial Spanish ethno-historian Fray Bernardino de Sahagún, who conducted extensive study of the nahuatl speaking population of Mexico at the time of the Spanish conquest. In his Florentine Codex (Book 3), he records that the Aztecs believed that the souls of certain people would return to earth as hummingbirds or butterflies to pollinate plants and accompany the sun, Tonatiuh, on its daily course across the sky.

According to Sahagún, it was specifically victims of human sacrifice, warriors on the battlefield and women giving birth who were destined for reincarnation as butterflies and the butterfly-warrior concept was an enduring Mesoamerican theme. Xantiles similar to those from Teotihuacan have been found as far as Escuintla, Guatemala, in the Maya zone. Amongst the Toltecs of Tula, Hidalgo (c 800 – 1000 AD), warriors were depicted with large, butterfly-shaped chest-adornments known as 'pectorals'. Columnar statues bearing butterfly pectorals can still be seen in situ.

The Codex Mendoza and the Codex Matritense **[Fig 2]** – painted manuscripts from the 17th Century which record aspects of indigenous life - list several types of 'butterfly mantle' donned by different ranks of Aztec warriors depending on how many sacrificial victims they captured on the battlefield. The butterfly was "the second rank that brave Mexicans could achieve" (Codex Mendoza folio 64r).

One of the most important deities in the Aztec pantheon, Itzpapalotl **[Fig 3]**, whose name means 'Obsidian butterfly', embodied the concepts of war and sacrifice. Her fearsome appearance is illustrated in Codex Telleriano Remensis and Vaticanus A where she has jaguar claws, wings of obsidian flint-blades of the type used in human sacrifice, skeletal bodily features and the pelt of an eagle. Itzpapalotl's butterfly features have been likened to the appearance of the moth *Rothschildia orizaba* which bears marks

Figure 2.

Figure 3.

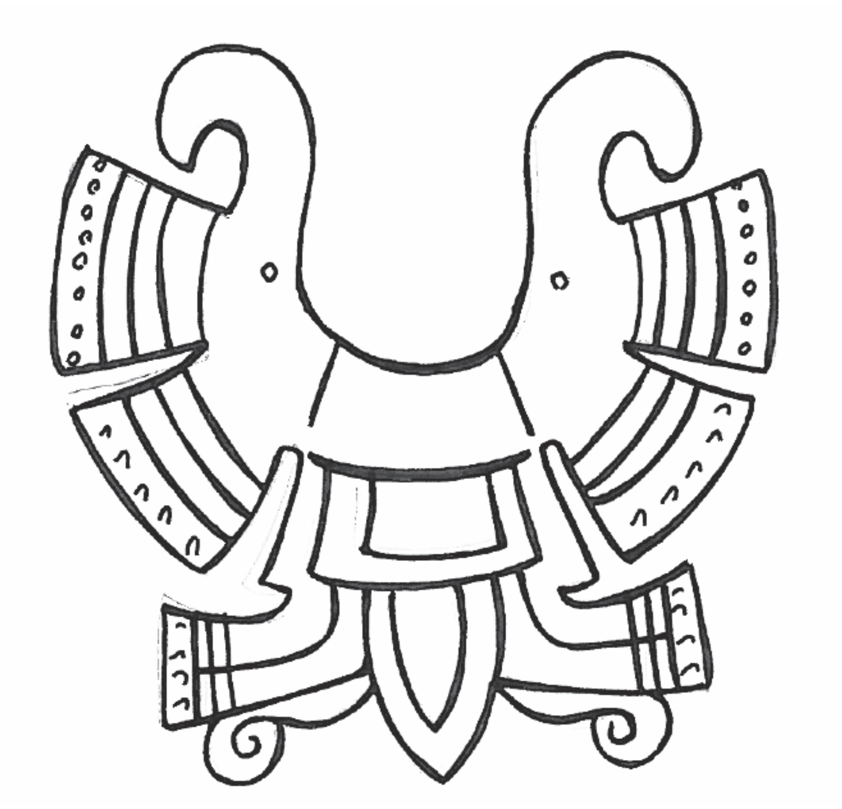

Figure 4.

on its wings resembling obsidian blades (Heyden and Czitrom 1991).

A central tenet of Aztec ideology assumed that sacrifice, war and fertility were linked in the belief that human blood sustained the earth and promoted fertility (Nicholson 1979). These concepts are well illustrated on the 'Altar to Itzpapalotl' – a stone cube with a carved image of a butterfly with prominent fangs and anthropomorphic hands in which it holds human hearts. The marks on the butterfly wings denote sacrificial blades. Surrounding the butterfly are dismembered human body parts including a mutilated hand, the tip of a severed femur with streams of blood and the underside, the surface in contact with the earth, reveals skulls and disembodied feet (Ojeda Díaz 1986).

Fray Diego Durán, a colonial-period Friar who made extensive observations of the Mexica way of life, describes a funerary ritual carried out for deceased warriors in which statues of these men were taken to a room, and their widows placed in front them a dish of a stew known as tlacatlacualli or 'food of human flesh' and special tortillas called papalotlaxcalli meaning 'butterfly bread' (Durán 1588 [1994]). Alvarado Tezozomoc, a colonial Nahua nobleman, records a similar domestic ritual whereby wives of warriors made tortillas in the shape of butterflies and kept these near the hearth until their husbands returned from battle.

The Aztecs also associated butterflies with their deity Xochipilli the god of flowers and dancing who is often represented with skull-like face, and his female counterpart Xochiquetzal. The worship of these gods placed emphasis on music, dancing, fertility and altered states of being. The plinth of one Xochipilli statue reveals a butterfly alighting on what is ostensibly a flower. This unusual plant however is now thought to represent a circle of the psychotropic mushrooms *Psilocype aztecorum* (Díaz 1999). Xochipilli's body is replete with flora, most of which have been identified as mind-altering species consumed by humans, such as the hallucinogens *Turbina corymbosa* and *Heimia salicifolia*.

Butterflies also appear frequently on stamps, sellos, used for printing on amatl (bark) paper or decorating the human body. Other means by which butterflies were used as bodily adornment include gold nose plugs, or yacapapalotl **[Fig 4]**. Few examples of these survived the conquistadors' plundering, yet images of noblemen and women wearing butterfly nose-plugs can be seen in the codices. A beautifully intricate and colourful feather-work fan, which survives today in the Kunsthistorisches Museum, Vienna, also supports the conviction that butterflies were important symbols associated with status and wealth.

Grasshoppers

Chapolin is a nahuatl term used to categorise several related species. Sahagún's Florentine Codex reveals that the Mexica had a good understanding of the Orthoptera's incomplete metamorphosis, observing that when the eggs hatch, "when they come forth, they are already small locusts" (Florentine Codex Book 11). One example, the Xopan Chapolin – large, black, green or variegated in hue and an attacker of crops – may well refer to the *Schistocerca piceifrons* which displays different colouring depending on whether it is gregarious or solitary, and is a serious agricultural pest. Another variety, the seemingly harmless Çacatecuilichtli, was noted solely for its tendency to sit, chirruping, in the grass (Florentine Codex Book 11).

Grasshoppers held a special place within Aztec tradition, as illustrated beautifully by a colossal cornelian

Figure 5.

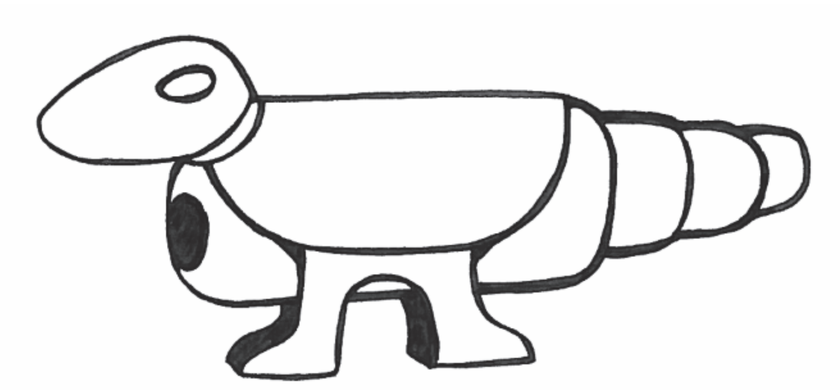

Figure 6.

prominent display at Mexico's Museo Nacional de Antropología. Measuring some 50cm in length and weighing about 22 kg, it is incredibly naturalistic, with wings, joints, leg hairs and antennae, carved into its compact form. This could well be the Yectli Chapolin which was "chilli-red", "ruddy" and "edible". This sculpture was excavated from a reservoir at Chapultepec ('Grasshopper hill'), now a district of Mexico City, where the anthropology museum itself is located.

Chapultepec was a site of particular significance in the Aztecs' quasi-mythological migration account, as illustrated in several codices, being one of the last destinations that the wandering Mexica settled in prior to founding their capital Tenochtitlan, the huge imperial city from which they would dominate the entire surrounding area.

Chapultepec is represented in glyphs as a hill with a grasshopper at its summit. Indeed, the Aztecs often named their environs after the arthropods which lived there, including Ocuilan (place of the caterpillars), Xaltocan (place of the spiders), Azcapotzalco (place of the ant hills) and Papaloapan (place of butterflies), which demonstrates the role that insects play in defining a landscape.

In some instances, grasshopper sculptures seem to have had religious functions. One such statue, carved from a precious blue-green stone, is displayed at Vienna's Museum für Völkerkunde. This creature bears the insignia of the wind-god Ehecatl-Quetzalcoatl on its front, though its significance is unknown. Another rather endearing artefact is a small, stone, grasshopper-shaped pipe bowl (currently housed at the Smithsonian Institute, Washington DC) which was possibly used in ritual contexts. Apparent on its back are the tripartite body structure and folded wings **[Fig 6]**.

One interpretation of such items is that they functioned as offerings to assuage a destructive insect pest: in 1446 a plague of locusts caused the most catastrophic famine in Aztec history (Hassig 1981). This insect's destructive capacity was the topic of a rather grim Mexica morality tale in which a man who has attained considerable wealth from maize farming becomes so avaricious that he refuses hospitality to his own impoverished and aged mother, hiding his food to eat it himself (Bierhorst 2002). In punishment, a swarm of locusts descends on his crops. After destroying them, the avenging insects then turn their attention to the farmer himself, his wife and children, eating them alive. The gruesome tale continues with a description of the decomposition of the bodies and the worms which finally polished off the corpses and the remaining corn, and ends with the explanation: "and that is how it came to be that not everything gets eaten. Although they will strip a cornfield bare, other places they will attack in swarms but not eat at all" (Bierhorst 2002). Evidently this tale sought to rationalise, by introducing a moral dimension, the otherwise seemingly arbitrary circumstance of losing one's crops to insect pests.

Yet while they wreaked destruction, decimating crops and ruining livelihoods, these insects also provided a useful source of food, providing a valuable protein source in an otherwise corn-based diet. Grasshoppers continue to be eaten in Mexico to this day – they are a speciality of Oaxaca commonly toasted and seasoned with lemon and salt (Ortíz de Montellano 1990).

Other notable insects eaten since pre-Hispanic times include jumiles – 'stink bugs' of the species *Atizies taxcoensis*, native to Taxco in Guerrero, eaten live; escamoles – scrambled Liometopum ant larvae; and maguey worms – the larvae of the *Hypopta agavis* moth which inhabits the plants of maguey leaves – which are also sold in bottles of mezcal liquor (Coe 1994; Ramos Elorduy 1999). Whereas Sahagún mentions 96 edible insect varieties, one modern study counted a total of 457 species currently consumed in Mexico (Ramos Elorduy 1999).

Bees

The bees native to Mesoamerica, which the Maya term ko'olel kaab, are stingless bees of the Trigona or Meliponidae families (Kritzky and Cherry 2000). Honey was mostly produced in the southern regions, and accordingly, bees feature prominently in Maya codices where they display hairy legs, striped, segmented bodies, antennae, and a single pair of wings, and often with a stylised face (Tozzer 1919). In the Madrid Codex – from the southern Mayan lowlands of Guatemala – bee keeping practices are illustrated, complete with improvised hives and suspended honeycombs of quadrilateral or hexagonal cells **[Fig 7]** (Tozzer 1910).

The introduction of the stinging variety of honeybee *Apis mellifera* to Mexico was established only by the Spanish in the 1500s, and with the introduction of European apiculture, the Maya reserved the honey of the indigenous bee for medicinal and ceremonial purposes (Schlesinger 2001). Mayan bee-keepers fasted during the month of Zotz (late September) in preparation for a bee celebration in the following month Tzec (Schlesinger 2001). Honey was used as paint in ritual painting, offered with copal (resin) to the gods, and even consumed fermented and mixed with

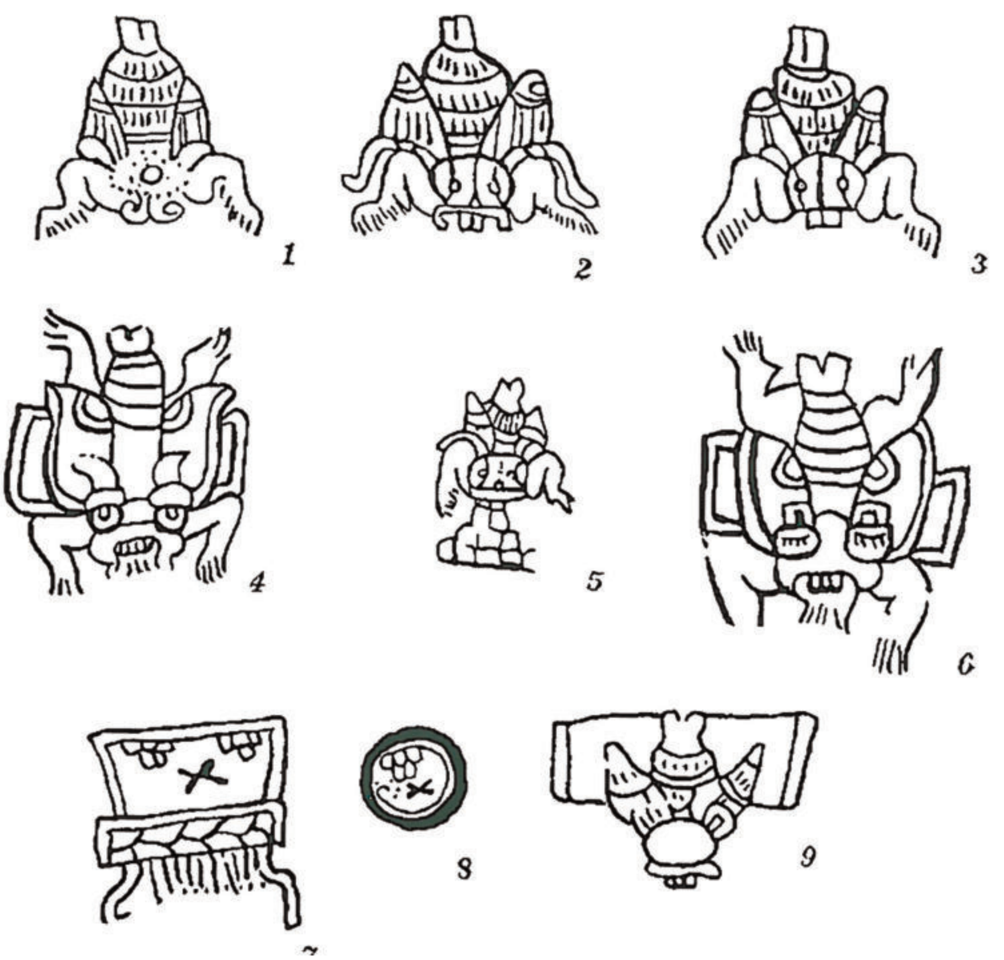

Figure 7. These images are from the Madrid Codex, a Maya painted manuscript, which was interpreted by Tozzer (1910) as follows: (1-6) are all bees with anthropomorphised faces, except (1) which has only antennae. Tozzer suggests this "faceless" example may be a drone. Figure (5) is interpreted as a bee atop a honey comb and Figure (8) is a comb. The X shape which appears in connection with the hives and comb is thought to be represent the bee itself, since in most examples, the bee has only four limbs which, if simplified, would form an X shape (6 is the best example). It is possible that the page in the Codex on which these bees are seen is relating to the bee god, as (7) and (8) bear some resemblance to the Cauac sign which is associated with him. Image 9, it is another faceless bee, but the rectangle behind it has not been explained or

water as a drink called balche (Schlesinger 1999).

Bees also appear in the ‘Medicine talud’ mural at Teotihuacan, where they flit between medicinal varieties of plants, such as cacao, poppies and St Johns Wort (Lozoya 1999).

Amongst the Aztecs, honey was consumed in hallucinogenic cocktails. Sahagún records a feast held in honour of the Aztec patron deity Huitzilopochtli in which the participants ate a concoction of psychotropic mushrooms, honey and chocolate, then gathered to discuss their visions (Florentine Codex Book 9).

Bees also feature in Aztec myths. As with most Mesoamerican groups, the Aztecs believed that their own epoch was preceded by earlier cycles of creation and destruction. Those living at the time of the Spanish conquest believed themselves to be inhabiting the era of the ‘Fifth sun’, the four previous ones having been destroyed by natural disasters and the human population transformed into animals. The Leyenda de los Soles relates a version of this myth in which bees were intrinsic to the restoration of human life.

In the tale, Quetzalcoatl, a foremost deity of the Aztec pantheon whose name means ‘Feathered Serpent’, descended to the underworld to retrieve the bones of the dead men where the god of death, Mictlantecuhtli, had been hoarding them. The Lord of the Underworld, not wanting to relinquish the bones, set his adversary an impossible challenge, namely to blow through a solid conch-shell horn. Not deceived by this attempt at trickery however, Quetzalcoatl summoned both worms and bees to hollow out the conch, and blew through it successfully. The underworld deity was obliged to concede the remains, and thus were human beings successfully resurrected (Bierhorst 1998).

Bees were also important to the Aztecs due to the trade in their products. Jars of honey, honey combs and entire hives were paid as tithes to the Aztecs by the various tribute states (Durán 1588 [1994]). Honey tributes are recorded in numerous codices such as the Codex Mendoza which records in painstaking detail (almost like a pictogram) the hundreds of “little pitchers” that demonstrate the considerable economic value of this commodity.

Beeswax was a fundamental ingredient in the ‘lost wax’ method of metal casting used in the creation of elaborate jewellery and artwork, the process of which Sahagún describes in length. Thus were bees directly responsible for facilitating the gold metallurgy which made the New World so alluring to the Spanish conquistadors.

Acknowledgements

I would like to thank Elizabeth Baquedano for her help during my postgraduate studies and Simon Leather for his entomological advice.

To be continued...

BioBlitz: a tool for the promotion of entomological science

ARTICLE

Clive Betts,

Harriet Sjerps-Jones

and Nick Baker

Biographies

Clive Betts is a keen amateur entomologist, an environmental consultant and Fellow of the RES. In the 1980s Clive worked in the Natural History Museum as a taxonomist for (what was) the Commonwealth Institute for Entomology. Returning to Exeter in 1989, he held the post of RES Youth Development Officer from 1990 to 1992. Family commitments and full-time jobs managing technical teams and (currently) in staff development, have only recently allowed Clive to return to his lifetime passion for insects.

Harriet Sjerps-Jones is Sustainability Curriculum Development Manager at the University of Exeter. She has previously worked for Somerset Wildlife Trust as Director of Education & Community Engagement.

Nick Baker, an alumnus of the University of Exeter and now Honorary Fellow in the College of Life and Environmental Sciences, helped (with Clive Betts) establish what has become "the Bug Club". Nick is a popular author and broadcaster (see *Antenna*, volume 31 (2): p84-86).

Purpose

This article but is aimed at raising awareness of the value of what has been broadly labelled "citizen science" (see Silvertown, 2009[16]) for promoting entomological interest in young people and the public at large. Specifically, this article concentrates on a technique, the BioBlitz, which forms one aspect of the Biodiversity Enhancement Plan (BEP) deployed by the University of Exeter for its own campus grounds.

We hope that, by the end of the article, readers will not only have a better idea of the value of BioBlitzes but will also see the need to be proactive in offering their help with such events whenever the opportunity arises.

The case of the University of Exeter

The University of Exeter's Streatham campus is well known for its spaciously landscaped grounds. Part of the green lung of the city of Exeter, these grounds provide a wide range of habitats for local wildlife. Viewing historical records, however, has shown that some species more vulnerable to environmental change have disappeared from the campus grounds in recent years, for instance the grizzled skipper butterfly (*Pyrgus malvae*).

Major investment at the University is enabling the Streatham campus to undergo re-development, expanding its capabilities, and providing new buildings and infrastructure for its future security, but this will inevitably place greater pressures on the campus wildlife. This concern, however, is on the radar of the planners and the University aims to help restore the natural habitats that will be impacted. It further intends to create wildlife corridors that will link its flora and fauna with other green spaces in the City of Exeter thus helping wildlife to permeate through the built environment.

To give this strategy focus and momentum, last October a biodiversity enhancement campaign, called the 'Birds & Bees', was launched in partnership with Devon Wildlife Trust, Exeter Wild City and other community stakeholders. The start of the campaign was celebrated with a BioBlitz event, led by broadcaster and naturalist Nick Baker. A group of over 150 volunteer students, Bioscience academics, experts[a], enthusiasts and members of the public joined Nick, a University of Exeter graduate, for what also been called a 'speed census' of species on the Streatham campus. The aim was to find as many species as possible and collate these data with existing records to build better knowledge of the biodiversity present.

An important additional aim of the BioBlitz was to educate participants in conservation and the science of wildlife. This was in support of the University's Education for Sustainability Strategy that includes formal and informal learning about sustainability and addresses issues that include climate change, social and economic fairness, and protection of biodiversity. Volunteering students, academics and other experts helped members of the public with finding and then identifying organisms as accurately as possible. The next phase of the Birds & Bees campaign is to write a biodiversity enhancement plan in collaboration with Devon Wildlife Trust and to further engage academics and students through surveying and habitat management projects.

A concrete example of what can be done is how the BioBlitz has informed further surveying work. The data collated on the day, although far from complete, gave an indication of the poor quality of biodiversity in the ponds. A group of students volunteered to help with the survey of one of the bigger ponds that was due to be dredged because there was a health problem with the carp. The analysis of the survey has informed our estates team how the pond can be improved for the carp as well as for wildlife.

What are the opportunities and benefits?

There are many benefits of the scheme for the University's students, academics and the local community. For students, working with the public offers them the opportunity to translate specialist knowledge of biological diversity into easy to understand basic principles. They also get to learn practical

[a] We use this term here in the sense of individuals who have demonstrated, or volunteered, a high degree of knowledge and experience with particular animal and/or plant groups.

leadership skills, develop surveying knowledge, and enjoy enriched co-curricular learning. It gives students opportunities too for the development of citizenship and enables them to help make a real difference for biodiversity on their 'home patch'.

For the academics there are benefits too. The Natural and Environmental Research Council (NERC) is recommending that funded researchers get involved with such initiatives. This is echoed by the UK Research Council's statement "that public engagement should be a part of every skilled researcher's portfolio. Engaging with a non-specialist audience can enhance skills including improved communication and influencing skills." (RCUK, 2011[15]). Further, it gives academics the opportunities to really help make a difference in the protection and conservation of the natural environment. For the general public, it provides an opportunity to learn what biodiversity is about, how it all works and why it is important. For all concerned, academics, students and public alike, the scheme intends also to help provide a sense of place, ownership and an enhanced engagement with the environmental sustainability agenda.

BioBlitz concept

BioBlitzes have been around since the term was first coined in 1996 during an event in Washington DC (see Wright, 2010[11]) and have been held worldwide. National Geographic[9] reports that

"The BioBlitz engages students and members of the public in experiential ecological education, and demonstrates why it's so vital to conserve our natural resources".

Commenting on a large BioBlitz held in Connecticut in 2003, one of the original organisers (Sam Droege, a wildlife biologist at USGS Patuxent Wildlife Research Center) captures the spirit of BioBlitzes:

"…a lot of publicity, kids are involved, the press comes – they whoop it up".

Anyone can organise and run a BioBlitz although there is a formal home for UK BioBlitzes at the British Natural History Consortium (BHNC)[5], which co-ordinates major BioBlitz events and engages volunteer experts from all over the UK.

A contributing factor to the success of BioBlitzes is the competitive element, a race against the clock, that contrasts a traditional field studies approach. A BioBlitz restricts the time frame in which to find as many species as possible. To get deep knowledge of the biodiversity requires time for study, but the aim is more to create engagement and help to raise awareness. In the case of the University of Exeter, other elements included in the hunt were to find the ugliest, prettiest and deadliest species on campus. Of course beauty and ugliness are subjective, but a candidate for the prettiest was surely the kingfisher, and for the ugliest, one of a myriad bugs (ie hemipterans) with oversized eyes. The 'deadliest' was a rather passive hornet although another strong contender was a fly agaric.

Benefits for entomological science

The big picture

Much has been reported and discussed in Antenna over recent years about the decline in entomological science and the loss of field work and "whole-animal" studies from compulsory and post-compulsory education, summed up well by Doring in 2009[2]. Getting youngsters and the wider public engaged with entomology has also been recently aired in Antenna by Wootton et al. (2010)[18], although the topic has a long history.

By working at University level, engaging academics as well as students and bringing in families and young people, BioBlitz events have a real chance of sparking deeper interest in entomology, especially if there are entomologists present to direct and inform. Even more so if these entomologists are also members of the organisation running the event.

Areas of particular value

Recording presence, absence, frequency and associations of insects. At Exeter we used the presence and the absence of particular species to determine the relative "health" of individual habitats (eg through "key indicator" species and diversity analysis such as that used in the University's Reed pond assessment) and of the habitat mosaic of the whole area being surveyed.

The value of BioBlitzes to identify invasive species has been noted in Edwards (2010)[3]. Our Exeter event was no exception with the first find of the day being a specimen of *Leptoglossus occidentalis*, a large "leaf-footed bug" (Hemiptera: Coreidae) which is pest of pine trees imported from the USA that has become established in Europe and the UK in the last 10 years[10]. Luckily a local expert, and Devon Wildlife Trust volunteers had encountered this bug before as a pest and could confirm its identity.

Presence/absence is also of interest to national recording schemes (a key feature of BioBlitzes – see the BHNC website[5]) and to regional and local specialist groups who may also have historical data for added value. For such data to be of use, however, there needs to be high confidence of its validity, which can be an issue for such events (explored further below). The University's event recorded two new regional records (as far as we can tell), one for the recently established bumblebee *Bombus hypnorum* and another for the diving beetle *Acilius sulcatus*. Confident determination of these two records depended on local bumblebee expertise and time for an experienced freshwater biologist to check the diving beetle through a key.

Educating the wider public and raising awareness. BioBlitzes attract lots of people of very wide backgrounds and ages: our Exeter event included local residents, staff and their families and students on campus from a range of academic disciplines. One of the most rewarding observations was the way bioscience students were helping those who had come just along for a "pond-dip" identify the diverse freshwater invertebrates and share nuggets of their recent learning.

Educating young people – the future for entomological science. Clive Betts, as RES's Youth Development Officer ran a number of successful "field trip" style events which were organised to focus solely on education. The BioBlitz approach swaps the focus from education onto finding and recording which means expert help is fundamental to BioBlitzes; education is

still an aim but is linked subtley to the discovery aspect of the event. Linking up with schools and colleges is a good way to further this cause but is not essential providing effective marketing is in place to attract different age groups

In reality, of course, a single BioBlitz consists of many field-trip events stitched together and the overwhelming sensation is one of tremendous activity (coupled with some chaos) but with a real purpose. Part of the attraction of BioBlitzes is that, if experts are available, non-specialists can make an important find and so have an impact beyond the limits of the level of their own knowledge and understanding.

The value of the biological data

In the University's BioBlitz we had records ranging from small mammals to midge larvae via plant galls and fungi. The volume of the records (272 in total from two hours of blitzing), and the confidence of the data therein, was dependent purely on the experts we could find to volunteer on the day. Members of the public were given forms to complete, based on the record structure used by the Devon Wildlife Trust (to increase the value of the data to the region) that gave them a chance to record the English and Latin names of all their finds along with the location either marked on a 1:1000 O/S map (courtesy of EDINA[7]) or as a grid reference. We added a basic measure of abundance (ACFOR scale) but this did not prove very useful, especially as there was no simple way of checking that records submitted were not repeated observations from another recorder. The upshot was that we only recorded one instance of each unique record (ie per location).

When determining the validity of data captured during BioBlitzes someone has to decide on the authority of the identifiers. Enthusiastic amateurs can have a wide variety of identification ability and whilst the "pedigree" of professional experts may be more certain, their specialism may be much narrower and no more reliable than an amateur working in the field for most of his or her life. Roger Morris (2010)[13] discusses this topic in an excellent, hard-data account of the value of mapping schemes (with a focus on digital data). He comments:

"Information on the relative worth of data submitted to biological recording schemes has yet to be fully compiled and, so far as I am aware, only the Hoverfly Recording Scheme has attempted such analyses. The results are disturbing."

Roger's account shows that records of common, easily identifiable species are increasing and those for harder and/or less common species are declining. In turn the general level of "taxonomic competence" is declining as identification increasingly relies upon images and photographic records rather than sometimes rather inaccessible keys and voucher specimens. This is exacerbated by the loss of field skills through attrition of courses in FE and HE as identified in Doring (2009)[2].

Consequently, converting data captured during a BioBlitz into useful research data requires effort both during and after the event, to confirm records (based on the experience of the recorder) and also to communicate records to the relevant bodies (in our case the Devon Wildlife Trust). If determinations are confident then baseline data can be established for regular BioBlitzes, providing evidence of changes that can be mapped within and across the whole BioBlitz area. Focusing on groups or individual target species can also increase the value of the data (aspiring perhaps to a study such as Conrad et al., 2004[1]), although it is arguable whether such surveys would then strictly be BioBlitzes.

At Exeter we are now observing how the use of i-Spot (the Open University's online identification, wiki-style resource)[8] can help with the both the accuracy and volume of determinations, particularly for invertebrate groups, during and after BioBlitz events. A major project in the South West is also now working with the Open University to augment the i-Spot resource to develop more localized information (i-Spot Local) alongside the existing BioBlitz area already provided.

BioBlitz Logistics

Equipment

We were fortunate to have volunteers from the University's Biosciences department who supplied a range of field kit including beating trays, kite nets, sweep nets, Petri dishes, freshwater nets and a stereo microscope. Devon Wildlife Trust, along with some local specialists also supplied keys and field guides. With over a 100 members of the public a large volume of field kit was important, as were copies of the record forms, although only the experts employed the keys. We also had a clean mains supply which needs to be factored in for some equipment and, especially if tools like i-Spot are going to be used, a network connection may also important.

Expertise

An excellent local knowledge is very important to weed out "impossible" and "unlikely" records: members of local natural history societies and recording schemes can be of great value. We had members of Devon Wildlife Trust, The Devonshire Association, current and retired staff from the University's Biosciences department and environmental consultants.

On the day

As it was the first time that the University organised such an event, the expectations were not set very high. With poor weather forecast we prepared for indoor activities with a slide presentation on standby and all computers and microscopes under cover. We also prepared for large numbers of participants with plenty of student stewards to help with crowd management and data collection. As it happened, the weather was good and there were more participants than expected. With so many participants we became concerned that the collection of data sheets could be chaotic so a last minute draw was organised as an incentive to hand in the forms at the end of the afternoon.

During the event all our experts contributed to the party atmosphere with anecdotes and loud revelations ("look at the legs on that…" referring to a specimen of the chrysomelid beetle *Psylliodes* under a microscope). Judging our special finds of the day (mentioned above) added a great sense of fun and sparked heated debates amongst the experts. Specimens were displayed on tables and experts gave a five minute round-up of their favourite finds at the end of the day.

According to the British Natural History Consortium that coordinated BioBlitzes around the same time, we had a high number of participants compared to other events. Of course it was a great advantage that the event was spearheaded by a well known television presenter (Nick Baker), but feedback tells us that the public were also drawn by the opportunity to learn from experts including lecturers and professors. We received many requests to repeat the event from expert volunteers, students and members of the public alike.

Conclusions and what next?

We are convinced that running BioBlitzes on campus will prove to be a valuable environmental planning and assessment tool for the University's Biodiversity Enhancement Plan. Our Estates team are engaged with the plan and willing to learn what improvements can be made and deliver recommended changes. Our job is to make sure we have an appropriate strategy in place so that changes are indeed improvements and deliver greater biodiversity.

Identifying precisely what "improvements" means is not simple and includes consideration of a wide range of factors such as land usage, our quasi-urban location and even our legal covenants (Nilon, 2011[14] includes such factors in an interesting perspective on urban biodiversity). Our current focus is a "birds and bees campaign": both are visibly affected by recent campus changes and both are recognised as important indicators of habitat health (eg Williams et al., 2010[17]; Gregory and van Strien, 2011[4]). Our BioBlitz data were fairly good for birds, almost absent for bees. With bees in particular we run headlong into the data quality issue. Even the commoner bumblebees can be misidentified fairly easily and the rarer/declining solitary species, which would be of greater interest, require authoritative determination.

However, we are taking small steps and will try to address all these issues as we encounter them: any action is better than none, providing we are careful with the changes we recommend for the benefit of particular taxa and can join up our work with other local projects (for instance the "Exeter Wild City" project[6] run by Devon Wildlife Trust).

So, what about entomologists? We urge you all to get involved with all such events as often as possible: your skills and enthusiasm are greatly needed and are always hugely appreciated.

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ARTICLE

Field Club, natural history society and the evolution of a naturalist. Herbert Womersley (1889-1962) – acarologist and entomologist. His early life in England and his appointment in Australia

"Like the devotees of any other cult or enthusiasm, we prefer to share it with fellow converts as often as we can, meeting those we have written to or whose work we have read, exchanging gossip, comparing records or collections, listening to lectures or passing on tips" " (Allen, 2000)

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Introduction

Herbert Womersley is regarded as the father of Australian acarology and a world authority on mites. Having emigrated from England to Australia in 1930, he spent the rest of his life there, initially in Perth and then in Adelaide. He was 'head hunted' for work at the Council for Scientific and Industrial Research by R. J. Tillyard who was on a recruiting mission in England in 1928. Womersley's life and acarological work in Australia has been well documented in several obituary notices and works by Southcott (1963a, 1963b, 1964, 1965) and more recently Halliday (2001). Before he emigrated to Australia he had a career as an industrial chemist in Warrington, his home town, and then in Bristol, and during both these periods he was a very active amateur entomologist of some note and regarded as the expert on Collembola. These activities in his formative years are considered here.

Warrington

For a short but important period in the eighteenth century Warrington had a Dissenting Academy of international importance where, amongst others, Joseph Priestley and Johann Reinhold Forster taught. In the nineteenth century, ministers at the Unitarian chapel included Philip Pearsall Carpenter (Baker, 2004) and Thomas Hincks (Baker, 1999, Calder, 2009) both eminent naturalists, the latter a Fellow of the Royal Society. Other local naturalists such as Linnaeus Greening (Baker, 2007), made a notable contribution to natural history beyond the local level. This legacy of scholarship and learning lived on into the late nineteenth and early twentieth centuries and the considerable adult scientific activity in the town (Stephens, 1980) during that period was in part be due to the influence of these earlier developments.

By the time Herbert Womersley was born, the town's population had reached around 65,000 (Crosby, 2002) and had been growing steadily. The Manchester Ship Canal was completed in 1894, public health and sanitary conditions were improving and there was a mixture of employment. Soap was an important element in Warrington's industrial growth. In 1891 Crosfield's soap works employed about 750 people (Crosby, 2002) and the wire making industry was another important employer, as well as tanneries and leather trades. Two of these industries were to become important to the Womersley family. Herbert Womersley joined Joseph Crosfield and Sons at Bank Quay at the age of 18, as a trainee industrial chemist

Figure 1. Photograph of Herbert Womersley and his wife taken from their passport, dated 16 June 1930 prior to their emigration to Australia. This is held in the possession of the Womersley family and is their copyright. The author is grateful to them for their permission to use.

and the 1901 Census indicates that Herbert's father Fred, who was then 47 years old, worked as a 'Wire drawer' and described as a 'journeyman' on Herbert's birth certificate (copy of birth certificate from the Womersley family).

Herbert spent the first 30 years of his life in this town. He was born on 10 April 1889 at 21 Gladstone Street, Warrington, Lancashire. His father was Frederick Womersley and his mother Annie Womersley, formerly Annie Baines. The Womersley family came from the West Riding, specifically the Brighouse, Huddesfield, Elland areas of what is now West Yorkshire. His father was born in Manchester in 1855 and the family then moved from Manchester to Warrington, where Herbert was born. In 1920 Herbert left Warrington for Bristol and spent ten years there before moving to Australia in 1930 where he became a professional acarologist of world importance. Figure 1 shows his passport photograph prior to emigration.

The Warrington Field Club

Field clubs developed rapidly in the towns and cities of England in the middle of the nineteenth century. Unlike the 'Lit and Phils' they owned no property, could charge modest fees and fieldwork was their main aim (Allen, 2000). This generated local records and an interest in taxonomy. There was a dazzling array of local journals often short lived and limited to a region of the country. From 1907 the *Lancashire Naturalist* was published, the journal changed to the *Lancashire and Cheshire Naturalist* in 1913 and the *North Western Naturalist* began in 1925 (Shercliff, 1987).

Warrington Field Club was founded in April 1884 and Fred Womersley was one of the 16 founder members. As the first Annual Report of the Field Club **(Note 1)** indicates, field work was not the only objective, "a special feature of our work is the development of the natural history department of the museum". Warrington had one of the first municipal museums and the curator at this time was Charles Madeley **(Note 2)** who was one of the founders of the Field Club and president on two occasions. By 1907 the total number of invertebrates, largely insects, on exhibition at the museum had reached 8422 and those in cabinet collections 25,141 **(Note 2)**. Figure 2 shows Warrington museum and library as it is today, the building dating from 1857.

Herbert's father Fred was an amateur Lepidopterist and both Fred and Herbert were active members of the Club in the years prior to the First World War, Fred being President in 1903 and in 1907. No doubt, Herbert's father had given his son this love of nature and Herbert began to study insects. Herbert's name first appears as a member in 1907 and a note in the minutes in 1909 indicates that he submitted his Diptera records for the year with notes on their habits. By 1910, Womersley junior was described as "a promising young student of insect life… [who]… has taken up the study of the Diptera" (Dunlop,1910). In 1911 he lectured on Diptera and this was his first full paper to the club. He was a regular participant at exhibitions, attended field meetings and acted as honorary secretary for a period.

Herbert Womersley also became interested in microscopy and after meeting Abraham Flatters (1848-1929) was taught about slide making, staining, cutting sections, insect preparation and microscopy, during evening classes at the Manchester School of Technology, where Flatters was a lecturer and demonstrator for 32 years. Abraham Flatters was an important early influence on Herbert and "Until the end of his life Womersley remembered Flatters with affection" (Southcott, 1964). Flatters held the evening course, for two and a half hours one evening a week, at a fee of £1-1s-0d (pers.comm. James Peters to author 28 October 2010). It was said of Flatters that, "No member of any Natural History Society ever visited him without coming away from him richer in knowledge" (Bradshaw, 1929 and **Note 3**). The knowledge gained about microscopical techniques later helped Womersley to specialize in small insects groups like the Collembola, Protura and

Figure 2. Warrington museum and library where meetings of the Warrington Field Club were held. The present building dates from 1857 and holds many of the collections of local entomologists. It was the first rate supported library (1848) in the country and one of the first municipal museums.

The Field Club held special subject nights in microscopy and entomology and had an annual exhibition with lantern slides, microscopical exhibits and a display of the fauna and flora of the district. One of these meetings for example included "a number of beautifully coloured ticks taken in a Warrington tan yard from South African hides" exhibited by William Mounfield (Dunlop, 1910). The summer programme included collecting trips to local areas of scientific interest such as Norton Marsh, Hatchmere, Appleton Dingle, Statham Marsh and the River Weaver Valley (**Note 4**).

The entomology section (which included the arachnid specialists) was particularly strong and active at this time and included several members of importance beyond the local area. They included Guy Dunlop (1868-1930) (Manson, 1933), J. F. Dutton (1859-1937), Linnaeus Greening (1855-1927) (Baker, 2007), William Mounfield (1853-1945) and the two Womersleys. Greening's main interest was in spiders. By the end of the first decade of the twentieth century, their annual entomological reports were being published in the *Lancashire Naturalist* (**Note 5**). In 1910, both Fred and Herbert exhibited specimens, the former butterflies and the latter "a box of interesting species of Diptera…[and]…the life history stages of a species of Acalyptrate muscid which he bred out from a *Boletus*" (**Note 6**). In 1912, Womersley junior read a paper on "Short notes on the scent scales of butterflies" using drawings and microscope slides" (**Note 7**).

The World War interrupted Herbert's entomological work but his knowledge of chemistry and microscopy meant that he was in demand. In 1914 he was sent to Fort Chatham to take charge of a laboratory carrying out routine clinical tests and bacteriological work, and was in the Royal Army Medical Corps at that time. In 1916 he was a corporal in the Royal Engineers (Chemical Corps) serving in France and working on gas warfare. He found time to marry in the following year. He married Alice Spencer, a qualified teacher from Burnley, at Holy Trinity Church, Parish of Habergham Eaves, on the 2nd July 1917. He was transferred again and worked in the munitions industry. At the time of his marriage his address, on the marriage certificate, was given as "C1 Hostel East Riggs" [Eastriggs] a cordite making weapons factory near Annan in Scotland (copy of marriage certificate from the Womersley family).

During the war Womersley was unable to pursue his interests but others, notably John W. Shoebotham and R. S. Bagnall, published work on

Apterygote insects. In 1920 Herbert Womersley left Warrington to take up a new post in Bristol.

Bristol

Bristol, situated on the River Avon, is a major cathedral city and port and was a much larger place than Warrington when Womersley arrived in 1920. Shipbuilding, glass and paper making, soap manufacture and other chemical industries had developed and Bristol was the terminus of the Great Western Railway. Since 1910, when the British and Colonial Aeroplane Company was formed, Bristol has been a major centre for aircraft production.

Herbert Womersley moved to Bristol to continue his career as an industrialist, working for another soap manufacturer, Christopher Thomas and Bros., Ltd. at Broad Plain, in charge of their boiler department, where he was manager (Southcott, 1964). He had an address in Westbury Park and latterly at "Sunny Meads", West Town.

The Bristol Naturalists' Society

On arriving in the city Womersley joined the Bristol Naturalists' Society. The Society was founded in 1862 and maintained close links with the university of Bristol (founded as University College, Bristol in 1876) and with the city museum **(Note 8)**. Members published work on the geology, plant life, insects and other invertebrates, birds, mammals and sea and estuarine life of the district. Like Warrington, the entomology section was strong having been founded in May 1864. Specialist workers included C. Bartlett (Coleoptera and Lepidoptera), G. C. Griffiths (Lepidoptera), J. V. Pearman (Psocoptera), C. Tuckett (Mallophaga), and Miss Selman (Odonata). The *Annual Reports and Proceedings of the Bristol Naturalists' Society* from 1920-1930 give a good indication of Womersley's activities.

Womersley must have impressed the members, because within two years of arriving in Bristol, he was made President of the Society succeeding Sir Ernest Cook. Past presidents included eminent scientists and naturalists, Fellows of the Royal Society or the Linnean Society, or men with medical, science or law degrees, whereas Womersley had none of these. His two Presidential addresses were entitled, 'The Chemistry of the cell' and 'The modern study of entomology' (Womersley, 1924) and reflect both his professional training and amateur pursuits. In the latter he discussed life histories, metamophosis, and the origin and the evolution of the arthropods, an indication that he was not only a taxonomist, but was also interested in the general biology of insects and their function.

The 1926 report documents an important lecture given by him on "Insect pests and their biological control" (Womersley, 1927b) showing his developing interests in the economic/applied aspects of entomology, presaging later work. He began the lecture with the following statement, "At the present time the study of entomology has become more than the collecting of butterflies, moths and other insects. The scientific investigation of their life-histories and their economic effect on agriculture has in recent years become a matter of increasing importance... the why and wherefore of an insect's existence, what it lives on, and its effect on other forms of life have become increasingly important" (Womersley, 1927b). Here he was combining his knowledge of entomology and biological control to the increasing demands for the eradication of harmful insects, citing successful examples from abroad including work in Australia and New Zealand. He ended with a warning that unless carefully monitored, introduced species might become pests themselves. He was ahead of his time and beginning to think on a global scale.

At Bristol he exhibited specimens, led excursions, gave lectures, chaired meetings and wrote a large number of papers. He led by example, stimulated others and was an exemplar in that society. It was said of him that "with his knowledge of Entomological subjects… [he]… has brought about continued activity amongst those workers" **(Note 9).** He was also deeply involved in the foundation of the South-Western Union of Naturalists acting as their secretary until the time he moved to Australia.

Womersley's interests at this time were in Apterygote insects and he published extensively (1925a, 1925b, 1926, 1927a,c,d,e, 1928a, 1928b, 1930a,b) in journals such as the *Annals and Magazine of Natural History*, the *Entomologists Monthly Magazine*, *The Bristol Naturalists' Society* and several others. Work on the Protura (1927c, 1927d, 1927e) and Thysanura during this period meant that he was becoming "recognized in all parts of the world as a reliable authority on these [Apterygota] minute and difficult insects" **(Note 10).** He described and named several new species, recognizing the help of other entomologists such as R. S. Bagnall and J. M. Brown.

During the late 1920s and early 1930s, Womersley published several papers on Collembola (for example 1925a, 1928b) including important descriptions of those from Ireland (Womersley, 1930a). The latter was accomplished in several different ways. There was a short collecting trip to Ireland in 1929; he had the help of other collectors there, notably Arthur Wilson Stelfox (1883-1972) of the Dublin Museum who became a good friend, and the collections of Collembola in the Dublin Museum, made by George Herbert Carpenter (1865-1939), were loaned to him. Womersley recorded 67 Irish species, adding 17 to the 50 previous known, with one new to science. The work was aided by a grant from the Royal Irish Academy and brought him in contact with several Irish naturalists including Robert Lloyd Praeger (1865-1953). By the time Womersley left for Australia, he was regarded as an expert on the group.

The Annual Report and Proceedings for 1930 reported that the society had "suffered a loss in the departure from Bristol… [of such]… a staunch supporter of the Society". The Entomological Section report ended, "Mr. H. Womersley, who for the past ten years has been one of our most active members, left in July to take up an appointment in Economic Entomology with the Australian Government. Our good wishes go with him" **(Note 11)**. He was made an Honorary member in 1930.

Womersley became a Fellow of the Royal Entomological Society of

Figure 3. The Entomology Department at Imperial College, London in 1930. Herbert Womersley is on the back row, fifth from the right. He attended a course at the College in the 1929-1930 session as well as working at the museum. There has been a close relationship between the Natural History Museum and entomology at Imperial College for teaching and research. The author is grateful to the Womersley family for providing this photograph. The copyright is the photographers Wicksteed and Palmer. Every effort has been made to trace the copyright holder for permission to publish this image.

until his death and he donated copies of his main publications to the library. A brief biography was compiled for the Society by R. V. Southcott for Womersley's obituary notice, which was read by the President and published in the Proceedings. In 1929 he was elected an Associate of the Linnean Society of London (Honoris Causa.) for the original work he had carried out on Apterygote insects.

Before leaving for Australia, Womersley had produced over 40 papers (listed by Southcott, 1964) including those on Diptera, Collembola, Protura and Thysanura. Other papers on British species were to follow after his move to Australia. What had been an energetic and tireless hobby now became a full time occupation.

He did make at least one return visit to England, probably in 1947, although the year can not be confirmed. A grant from the United States National Institute of Health enabled him to make a round the world tour visiting research institutions and universities in the US and Canada in connection with his work on Scrub Typhus.

The move to Australia

When Robert ('Robin') Tillyard (**Note 12** and Baker, 2010), Head of the Division of Economic Entomology for CSIR (now CSIRO), visited England in 1928 he interviewed many "aspiring entomologists" (Upton, 1997) for posts in Australia. Apart from Womersley, the others he thought were unsuitable but wrote "I feel sure I could make a fine entomologist of Womersley if I had him continually under my eye" (Upton, 1997). There was however some opposition to his appointment. He was an industrial chemist by profession and only an amateur entomologist and Tillyard and A. C. D. Rivett (**Note 13**) disagreed. When eventually advice was sought from London about his appointment, although R. B. Poulton (**Note 14**) thought Womersley would be suitable, both S. A. Neave (**Note 15**) and A. D. Imms (**Note 16**) were not so impressed with Womersley's publications (Upton, 1997). A comment from a current specialist on the Collembola might give something of a clue, when he points out that Womersley, "added some useful records and his summary of Irish Collembola was especially useful, but he did publish in some very obscure places" (pers.comm. Peter Shaw to author 28 October 2010).

Tillyard kept up his advocacy of Womersley and eventually he was appointed to work on a three year contract in the Division of Economic Entomology, Commonwealth Council for Scientific and Industrial Research **(Note 17)** in Perth, Western Australia. This was on the understanding that he first of all spent a few months' study at the British Museum (Natural History), (now the Natural History Museum, London), learning more about the systematics of Collembola and mites, especially those of economic importance **(Note 18**). He also attended a course in entomology at Imperial College, London at the same time (Figure 3). In a memo to Rivett, Tillyard wrote, "I would like Womersley to come out to Australia fully equipped with expert information on those groups…which are of economic importance" (Upton, 1997). He sailed for Perth with his wife and two boys **(Note 19)** in July 1930, stopped off in South Africa for a short time and arrived in Perth on 25 September. His initial work was on insect pests, specifically a collembolan called the "Lucerne flea" (*Sminthurus viridis*) and a plant feeding mite and agricultural pest, *Halotydeus destructor* referred to as the "red legged earth mite", which was accidentally introduced from South Africa in the early 1900s and is a major pest in Australia.

Womersley however did not see out his three year contract. Owing to the premature death of A. M. Lea **(Note 20),** an entomologist at the South Australian Museum, Womersley was offered that post. Tillyard advised him to accept, since he was unable to make Womersley's position with CSIR a permanent one and told him that he would probably become unemployed after the three year period (Upton, 1997). Womersley resigned his post with CSIR at the end of 1932 and started work at the South Australian Museum in January 1933 as their entomologist **(Note 21).** However, it was not insects but mites which gained him a world wide reputation and on which he specialized in Australia.

He became President and Council member of the Royal Society of South Australia and an Honorary Fellow. Womersley stayed in Adelaide for the rest of his career and died there on the 14 October 1962.

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Notes

1. Warrington Municipal Library Search Room contains the annual reports, newspaper cuttings, entomological reports, notices of meetings, summer programmes, excursions and exhibitions of the Warrington Field Club at PS9(a) and PS9(b). The first Annual report is dated May 1885. The relevant Field Club Minute books referred to in the text are WMS 770 (1890-1907 book 2), WMS 1080 (1907-1921 book 3).
2. Report of the Museum sub-committee 1907. The Warrington Museum curators during this period were Charles Madeley (1849-1920) who was Curator from 1874 to 1920 – see *The Lancashire and Cheshire Naturalist*, 1920 13(1): 3-6 and Gavin Dunlop (1868-1933) who was assistant curator and then curator following Madeley – see Manson (1933). Hancock and Pettitt (1981) list some Field Club members, museum staff and natural history holdings at Warrington museum.
3. Flatters was a Fellow of the Royal Microcopical Society (1902), a member of the Manchester Microscopical Society and the Manchester Literary and Philosophical Society. Until 1912 he was a Director of Flatters and Garnett, biological suppliers and slide makers, and then traded under a new name, "Accurate".
4. Summer programme for 1906. See note 1.
5. *The Lancashire Naturalist* 1909: 283-284, 1911: 350-356.
6. *The Lancashire Naturalist* 1911 3: 350-351.
7. Diptera records in Warrington Field Club, *The Lancashire Naturalist* 1912 5: 294-295.
8. Womersley's hoverfly collection is held in the Bristol Museum (pers.comm Rhian Rowson to author 22 October 2010).
9. Bristol Naturalists' Society 1923. *Annual Report and Proceedings of the Bristol Naturalists' Society* for 1922 5(5): 230.
10. Bristol Naturalists' Society 1929. *Annual Report and Proceedings of the Bristol Naturalists' Society* for 1928 Fourth Series 7(1): 9.
11. Bristol Naturalists' Society 1931. *Annual Report and Proceedings of the Bristol Naturalists' Society* for 1930. Fourth Series 7(3): 154 and 159.
12. Robert (called 'Robin') John Tillyard (1881-1937). Much of the information on Womersley's appointment in Australia is from Upton (1997). Baker (2010) provides information about Tillyard. Womersley had previously demonstrated an interest in the biological control of insects (Womersley, 1927b).
13. A. C. D.Rivett was part of a three man executive committee of the CSIR at this time. He was Professor of Chemistry at Melbourne University.
14. Edward Bagnall Poulton (1856-1943) FRS. Entomologist and evolutionary biologist. The Hope Professor of Zoology at Oxford from 1893.
15. Sheffield Airey Neave (1879-1961) an experienced entomologist with service abroad, mainly in Africa, before moving into scientific administration. He was Assistant Director of the Imperial Bureau (later Institute) and Director of the Commonwealth Institute of Entomology. He was a President and Special Life Fellow of the Royal Entomological Society of London. See Baker and Bayliss (2009).

16. Augustus Daniel Imms FRS (1880-1949). Author of standard works in entomology. Chief entomologist at Rothamsted (1918-1931). Reader in Entomology at Cambridge (1931-1945).
17. Now the Commonwealth Scientific and Industrial Research Organization.
18. The Natural History Museum, London, has a small amount of correspondence from Womersley, one from Bristol, the others while in Australia, catalogued at DF ENT/300/130 and DF ENT/340/26/6 and dated 1929, 1936, 1938, 1953. These consist of five letters from Womersley and two sent to him. They concern new species of collembola from Southern Rhodesia and fleas from the South Australian museum collections.
19. Womersley married twice. Two sons from his first marriage were born in England and named John Spencer Womersley (1920-1985) and Hugh Bryan Spencer Womersley (1922-2011). Both were to become important Australian botanists.
20. Arthur Mills Lea (1868-1932), born in Australia, was the museum entomologist at the South Australian Museum at this time. His special interest was in Coleoptera. He died suddenly in Adelaide on 29 February 1932.
21. Both the South Australian Museum (reference AA872) and the State Library of South Australia (reference PRG 146) hold archival material on Herbert Womersley, covering mainly the Australian part of his career from1930. There is material prior to 1930 at the State library (Mortlock Library of South Australiana,) which although studied by R. V. Southcott has not been examined by the author. The South Australian Museum holds two cine films, an apterygote card catalogue and a minute book of the "Entomological Club of South Australia" as well as a photograph of Herbert Womersley.

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ICZN – an Increasing Concern for Zoological Nomenclature?

ARTICLE

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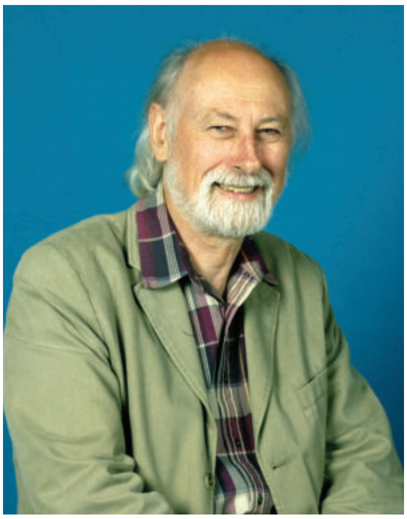

Biosketch

Dick Vane-Wright is an Honorary Fellow of the RES, Scientific Associate of the Natural History Museum, Honorary Professor of Taxonomy at the University of Kent, and a contributor to *Antenna* since its first appearance in 1977.

A world without nouns (1)

Try to imagine a world in which our languages have no nouns. How well could we communicate? This challenge was posed by Michael Dixon, Director of London's Natural History Museum, to an audience of nearly 700 people gathered at the Royal Geographical Society on 16th December last year.

Almost all human languages operate on the classic sentence formula subject – verb – object, or some variant. *Sylvester sat on the mat. A flea bit him. Fleas are parasites.* Without nouns, common, proper, pro-, collective, countable and uncountable, to symbolize persons, organisms, places, things and abstract ideas, communication would be difficult, perhaps even impossible. We depend on our vast and ever-growing lexicon of names for rapid and effective communication. "Noun" literally means a word or group of words used for naming. Naming is closely related to the philosophers' concept of *ostension*: we can simply point to an example of what is signified by a term to convey its meaning. And if we don't have a name or a noun for pointing out or referring to a thing or an abstract concept, we bestow one, an appropriate existing one, or simply make one up: *Jack* or *Jill* for the new baby, *Splendeuptychia mercedes* for a new butterfly from Peru, *Newtown* for a new town when your local council is devoid of inspiration, *Kindle* for a novel electronic book reader (derived from the verb meaning to inspire), *rheomode* (Bohm, 1980: 39) for an experimental mode of language (more of this later).

What was the occasion for Michael Dixon's challenge?

Despite cold and rainy London weather, the Ondaatje Theatre at the RGS was filled to capacity as Michael Dixon introduced a very special double bill: Sir David Attenborough and Professor Richard Fortey (Michel, 2011). There was a real sense of anticipation as the audience waited to hear these superstars of natural history. Were we expecting to learn about new insights into *Life on Earth* or the discovery, perhaps, of another mass extinction? No. Quite remarkably, all of us had come to hear why a particular class of nouns is important. We had come for a celebration of the work of the International Commission on Zoological Nomenclature, and its vital role in managing the names we apply to the millions of animals, alive and extinct, that occur or have occurred on our planet.

The presentations began with a lively exposition from Richard about why biological nomenclature is so critical and how the Commission works. He continued with examples from his work on trilobites to demonstrate the rich background and meaning that lies behind taxonomic names. The audience were greatly amused by examples of names that seem to say it all, about the organism or the taxonomist, and what was really being expressed by the choice of a particular name. Sir David followed by giving examples of scientific names each of which could tell a tale, bringing life to his stories about nouns for animals by the addition of adventure, farce, surprise, competition, irony and beauty (Michel, 2011). Both speakers evoked the somewhat disquieting feelings of honour coupled with uncertainty when taxa are named in your honour. In their personal experience, the revelation that a giant flat trilobite, an extinct beast covered in prickles, or the first vertebrate known to have copulated has been given your name tends to give rise to questions you don't really want to answer!

One conclusion of the evening was that, in the right hands, the topic of nomenclature can be made stimulating and entertaining, even for a general audience (Knapp & Wheeler, 2009, offers another example). The event was

Left: David Attenborough onstage at the Royal Geographical Society, 16.xii.2010, gets passionate about how it was Linnaeus came to name the first known bird of paradise *Paradisaea apoda*. Photograph: E. Michel/NHM Interactive Media Film Unit. Right: Professor Richard Fortey and Sir David Attenborough signing books after their joint performance at the RGS – appropriately for entomologists, Sir David was autographing copies of *Life in the Undergrowth* (Attenborough, 2005). Photograph: Sandy Knapp.

indeed intended as a step towards increasing public awareness of the importance of the work that ICZN carries out on behalf of everyone interested in life on earth, its history and diversity, ecology, utility, intrinsic value and conservation. The evening demonstrated the existence of public goodwill for the work of managing the scientific names of the myriad animals on Earth (Michel, 2011). However, there was another, rather more urgent reason for such a grand occasion.

Richard Fortey is not only a renowned geologist as well as a world expert on trilobites (e.g. Fortey, 2000), in his "spare time" he is also a highly accomplished specialist on British fungi and their culinary uses. Richard is seen here holding a fine giant puffball, *Calvatia gigantea*. Photograph: R.I. Vane-Wright.

The pressing need to support ITZN

Robert May once said, "to a first approximation all animals are insects". Entomologists have to manage more names than all other zoologists put together, so the efficient, effective and continuing work of ICZN is of special importance for those of us who study Hexapoda. So the thought that ICZN, founded 116 years ago (Melville, 1995), might suddenly disappear is a shocking idea for anyone concerned with animal names and their orderly management. But that is exactly what is at issue right now: ICZN could founder simply due to a lack of funds available to its 'parent' body, the International Trust for Zoological Nomenclature (ITZN).

So, in addition to the pure enjoyment of the moment, the RGS event yielded other, and hopefully lasting and effective successes. Sir David agreed to become a patron of the ITZN fundraising campaign, joining Ed Wilson in giving high profile support for the work of the Commission. Michael Dixon is the Trust's Chairman. A modest profit was realised on the evening, subsequent donations were received, connections were made with further potential promoters – and one audience member was even moved to volunteer to run a marathon with charitable fundraising on behalf of the Trust! A professional film made of the lecture is being distributed to potential benefactors and the wider taxonomic community. It is hoped that by following up and consolidating the valuable connections made by the event that ITZN will be able to identify and maintain sustainable funding sources for the future (Michel, 2011).

A world without nouns (2)

A potential problem with taxonomy is that taxa are clearly not "persons", "things" or "places". Nor do they seem to be "abstract ideas" or merely hypotheses: they appear to have concrete reality in the manifestation of individual organisms. We can be sure that the name *Splendeuptychia mercedes* will always apply, at the very least, to the holotype specimen from Peru.

One way of looking at this problem is to invoke the difference between what David Bohm (1980) called explicate and implicate order. Consider a smoke-ring. Is a smoke-ring a "thing"? It is an outward, explicate sign reflecting a dynamic process – an underlying "implicate order" created by millions of moving molecules and smoke particles obeying the laws of gaseous and fluid dynamics. Moreover, a smoke-ring has a beginning, a period of semi-stability, after which it begins to decay and finally ceases to exist as the underlying processes and particles move to new and different equilibria. Not unlike living beings perhaps, which could be seen as temporary, "explicate" forms in the unfolding whole that is the single totality of organic evolution. Species appear, survive for a while, and can be named – but the ultimate fate

Splendeuptychia mercedes Huertas, 2011. This specimen is deposited in the Natural History Museum, London, and was designated as the holotype by the author (Huertas, 2011). If there is ever any uncertainty regarding which taxon the name *Splendeuptychia mercedes* applies to, by the rules of zoological nomenclature enshrined in the 'Code' (ICZN, 1999), it must at the very least include this particular specimen. This is in effect a special form of definition by ostension: if there is doubt, we point to the primary type as the ultimate arbiter. Because they have this special role, primary types are often referred to as "name bearers". Photograph: NHM Photo Studio.

all is to go extinct. Yet, despite millions of extinctions, life goes on and has gone on, continuously, for some 3.5 billion years.

Bohm was concerned that our understanding of the world is hampered by normal language which, because of the dominant role of nouns, arguably focuses too much on the seemingly fixed and immutable things around us, the explicate order, and fails to give sufficient attention to the underlying dynamic flux, the implicate order that is actually responsible for all that we experience. Paying too much attention to fixed or separate "things" may cause mental fragmentation, and so interfere with our understanding of the endless and always interconnected processes on which everything depends, and of which the explicate order is just a sequence of transient expressions.

In a radical attempt to overcome what he saw as this limitation of typical languages (Blackfoot is a striking exception: Peat, 2002: 87), Bohm tried to create an alternative or additional syntax in which new verb-forms could take the dominant role instead of nouns. He called this new mode of language the *rheomode* – literally the "flowing mode [of language]".

Bohm's thought experiments with this approach were very interesting, but quite difficult to apply. However, his desire to refashion language to make it more fit for describing fundamental reality reminds us that we need to separate, as far as possible, the symbolic functions of words from whatever our current understanding of nature and reality happens to be. Our creation of taxonomic nouns arguably can influence us to think in terms of species as "things" (and thus definable in some way, which they are not), or "individuals" (like individual humans, to be "christened"), whereas they actually reflect a complex and endlessly ongoing process that we witness directly only through the transient manifestation of individual organisms. Only by sticking them on a pin, for example, and preserving them in a museum can they be transformed into "objects": unfoldings frozen in time.

Scientific understanding *versus* names as symbols

Now it so happens that ICZN, as manifest by its flagship publication, the 4th *International Code of Zoological Nomenclature* (ICZN, 1999), fully appreciates this gulf between scientific understanding and names as symbols. The *Code* is based on eight principles, of which only the first two need concern us here: "(1) The Code refrains from infringing upon taxonomic judgment, which must not be made subject to regulation or restraint; (2) Nomenclature does not determine the inclusiveness or exclusiveness of any taxon, nor the rank to be accorded to any assemblage of animals, but, rather, provides the name that is to be used for a taxon whatever taxonomic limits and rank are given to it."

Indeed, the main point of ICZN and its Code is to manage and regulate the formation and application of scientific names for animal species, genera and families so that they can be applied unambiguously to the conclusions produced by whatever taxonomic methods we care to apply – be we so-called typologists, barcoders, evolutionary systematists, pheneticists, cladists or what-have-you – even "rheomodologists" if there be such thinkers and they have a need to name explicate parts of the unfolding totality of life.

The Commission in action

Thus, with respect to the regulation of names, which has unavoidably become quite a complex issue, ICZN serves not just the taxonomic community but everyone who has a need to know and use scientific animal names. Significantly, recent changes to the Code, as manifest in the 4th edition, have led to a situation where more of the rules of zoological nomenclature can, within limits, be interpreted flexibly to avoid potentially unnecessary name changes otherwise brought about by too rigid application of certain formal procedures.

"Perhaps the most significant operational change which the Commission has approved, is to introduce a number of automatic courses of action in cases which previously called for intervention by the Commission" (ICZN, 1999: xxvi). Several of these are summarised under the rubric "Measures empowering authors to act in the interests of preserving established usage" (p. xxviii). If so, is a permanent Commission, with all the costs entailed, still necessary? To this question we have to answer a resounding "yes" – the complexities of zoological nomenclature and the vagaries of 250 years of practice since Linnaeus published the 10th *Systema* ensure that, as systematics continues to advance in so many different ways, nomenclatural problems continue to arise for which specific actions by the Commission offer the only realistic resolution.

The recent furore concerning *Drosophila melanogaster* offers a good example. *Drosophila* includes about 1500 known species, with many more yet to be named. With increasing knowledge of their interrelationships based on biochemistry, morphology, development, physiology, ecology and behaviour, the time has more or less come when it is possible to divide this huge assemblage, currently one of the largest animal genera, into smaller generic units. Unfortunately the type species of *Drosophila* is not THE fruitfly, *D. melanogaster* Meigen, innumerable millions of which have been gainfully sacrificed in the cause of genetics. Far worse is the realisation that the actual type species is remote from *melanogaster* within the omnibus genus. If and when *Drosophila* is split, the species name *melanogaster* will be recombined with another generic name – most probably the existing subgeneric name *Sophophora*, of which *D. melanogaster* is the type species, to become *Sophophora melanogaster* (Meigen).

Alert to this possibility, in 2007 a group of seven *Drosophila* researchers put forward a case to the Commission requesting that the current type species designation for *Drosophila* be set aside and replaced by *D. melanogaster*. The proposal gave rise to heated debate, for and against, with many good arguments on both sides. Finally, in autumn 2009, the 28 ICZN Commissioners were asked to cast their votes: 4 were in favour, 23 against, with one unavailable (Opinion 2245, 2010). So, if or when *Drosophila* is formally split, it will almost certainly be a case of RIP "*Drosophila melanogaster*" (Michel, 2010). But the point here, regardless of any personal opinion, is that the arguments were fully explored, and a decision was fairly and openly reached. Without the Commission to act and decide on such cases, nomenclatural anarchy is the only likely alternative.

More than just maintaining the Code and 'policing' names in cases of dispute, in recent years the Commission has become active in other ways. A significant direction signalled in the 1999 Code is towards adopted lists. One way to legislate against changes caused by the rediscovery of ancient and long-forgotten names is the adoption of new baseline lists (as introduced by the bacteriologists years ago), rather than insist that every name published since 1758, even if it has not been dealt with adequately throughout the intervening period, has the potential to displace well established synonymous or homonymous names now in regular use.

A major step towards this longer term goal is represented by ICZN's *ZooBank* (http://www.zoobank.org/), launched significantly at midnight GMT on January 1st 2008 (Pyle & Michel, 2010), and "intended as the official registry of Zoological Nomenclature". Effective name registration is being achieved by harnessing what Johnson (2007) has termed biodiversity informatics, and this is being linked in turn with the Encyclopedia of Life initiative (http://www.eol.org/; Hanken, 2010; Polaszek & Michel, 2010). The future for zoological nomenclature and its integration into global online biodiversity databases that really work looks very bright indeed – until you recall that the very existence of ICZN is under threat.

How can you help?

Fancy running a marathon in aid of ITZN? After all, it is a Registered Charity, number 211944! More realistically, what is really most needed is ideas – ideas for fund-raising, yes, but more than that. In our international world where communication is so important, and the issues of biodiversity value and loss so pressing, it seems absurd that such a fundamental Commission is dependent on continual fund raising and charitable giving. Right now fund-raising efforts are vital, as the coffers at ITZN have run perilously low. But longer term there must be a better solution, one that could and should be embraced by the international community of biologists.

As a quick look at any issue of *Antenna* will instantly reveal, entomologists have a need for and make use of literally millions of names. As the largest user-group for ICZN services, can we come up with some really good ideas to help get the Commission funded on a more secure basis? So, answers on a postcard please, to the Executive Secretary, ICZN, the Natural History Museum, Cromwell Road, London SW7 5BD, UK (or by email to <iczn-em@nhm.ac.uk>). Good thinking!

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Meeting Reports

The Great Hall of the monastery

Aphidophaga 11

Helmut van Emden

The author at Assizi.

Some extremely rewarding entomological conferences are in the series *Aphidophaga*, subtitled "The ecology and behaviour of natural enemies of aphids". The Czech coccinellid specialist Dr Ivo Hodek founded the series in 1965 with a first meeting in Liblice castle near Prague, and meetings have been held, usually at three-year intervals, ever since. The meetings have been in Europe, with the exception of one in the Azores from which was spawned a meeting in Japan with the theme enlarged to include coccids. The *Aphidophaga* meetings take the form of four intensive days of oral and poster presentations, split by a central social day of tourism. It's an agreeable formula.

Aphidophaga 11 was held in the 16th century St. Peter's Abbey in Perugia, Italy from 19-24 September 2010. The abbey was a superb setting, with the posters displayed in one of the cloistered courtyards and the sessions in the Aula Magna, the Great Hall of the Abbey. Coffee breaks were taken in another of the courtyards and it was also here that the dining tables for lunch were moved from the dining hall on the last two days of the meeting. This was truly delightful. The Abbey was chosen as the conference venue as it is also the home of the Faculty of Agriculture of Perugia University.

Perugia is a hill city of several levels, with footways that shortcut the winding roads – the meeting will long be remembered by the participants by the amount of walking required, especially all the stairs involved. There were also two other pedestrian routes to the city centre – escalators (of which more later) and lifts.

The conference was as ever highly international, with somewhat over 100 entomologists from 30 countries attending. There were just two people who had been at Liblice castle in 1965; both were from the UK and now Emeritus Professors, Tony Dixon and myself. Three years ago, following the previous meeting in the shades of the Acropolis in Athens, *Aphidophaga* had associated itself with IOBC, and this umbrella organisation had provided money to enable several younger scientists from poorer countries to attend. Overall, there was an excellent age mix; about one-third were PhD students or otherwise near the start of their careers.

Monday began with an opening ceremony of welcoming speeches by civic and university dignitaries, after which Helen Roy paid a moving tribute to the late Mike Majerus of Cambridge University. Mike had sadly prematurely died of cancer since the previous meeting in Athens, and indeed our conference in Perugia was dedicated to his memory. We were all much surprised when Dr Roy and others of the platform party donned Perugia academic dress for the tribute. Colourful, yet unexplained.

There seems little point in trying to go into the detail of the scientific programme. Topics ranged from the taxonomy of parasitoids, through the endosymbionts of aphids that confer resistance to parasitisation, and modelling of coccinellid behaviour, to the practicalities of classical biological control of soybean aphid. Probably the topic mentioned most often was intraguild predation. There were nine keynote papers of 20 minutes and over 70 ten-minute oral presentations; there should have been over 30 posters, but several display boards remained blank throughout the conference. Although sessions were themed, the themes were arranged to accommodate all the offered papers which the organisers had selected for acceptance. Such selection ensures that *Aphidophaga* meetings maintain scientific content of a pretty high standard, especially when one considers that the organisers have only brief abstracts on which to base their decision. All in all, they did pretty well. However, I was surprised at how many typos were in the Powerpoint presentations. In one, the "woolly" of "woolly aphid" was spelt three different ways and there were a number of species in the aphid genus "Apis", but my favourite has to be the "Hoover Fly". Well, I suppose the larvae do leave clear tracks through aphid colonies! Every participant will particularly recall a different selection of papers so, if I pick out just two that were especially novel for me, this is in no way a reflection on the other presentations. I had never before come across the endosymbionts in coccinellids other than the male-killers (Vorburger, Switzerland) and I was fascinated by the links between the detailed morphology of the mouthparts of different coccinellid species and their feeding behaviour (a beautifully illustrated talk by Ricci, Italy).

"Accompanying persons" had a varied daily sightseeing programme, but then joined us for more tourist activity after our sessions and for the evening meals. Professor Carlo Ricci, the local organiser, had obtained sponsorship for the meeting from no less than 40 sources, and even before arrival we had noticed from the advance programme that every meal to be taken at the conference would be accompanied by wine donated by a different regional winery!

On Monday afternoon, after the sessions, we visited the Abbey church of the monastery. The site was consecrated in 969 AD, but the present building is a highly decorated 16th century one. We were shown round by the priest, who pointed out that the organ was one of only two 16th century ones in Italy, and then proceeded to play it for us. But his multi-tasking did not end there. He took us down to the cellars, where he metamorphosed into the university Professor of seismology, surrounded by a high-tech. earthquake-recording laboratory. We even saw the Perugia record of the devastating Asian tsunami of a few years ago. We then moved on to a garden built over the ancient road to Rome from Perugia, and developed in 1996 to show how medieval gardens were landscaped and planted to convey symbolic meaning.

After the Tuesday sessions we all walked into the centre of Perugia, gaining height by a series of modern escalators set into the structures of a rising series of 13th to 18th century towers and palaces to reach the National Gallery of Umbria located in the upper floors of the complex. Here we had a guided tour of the mainly religious paintings, including works of famous Renaissance artists like Giotto and Raphael. Dinner at a restaurant in the city centre ended the day.

The Wednesday sightseeing excursion in two coaches started with Assizi, and the 14th century Basilica of St. Francis. Here the guide had to explain its history and art before we entered, as there is a strict code of absolute silence inside. Bizarrely, this was broken quite frequently by a booming electronic voice shouting "Silence, Silencio!" whenever the sound detectors picked up any signal of coughing or whispering. The next stop was at the Chiorri vineyard, where a charming couple are maintaining a 200 year old family tradition of wine-making. A most pleasant lunch platter of traditional Umbrian food was accompanied by a wine-tasting; a really delightful occasion. Then we had a tour of the ceramic museum at nearby Deruta – a lot of the exhibits were made 1500 years ago – we were looking at a collection of mind-blowing monetary value.

The conference banquet was held a coach trip away in a restaurant on the outskirts of the city. Leaving at 8, I got back to my hotel at 1.30! It was an impressively staged event, with an extremely talented American female soprano singing (to piano accompaniment) items from grand opera to musicals between courses. The main course, a huge roast pig, was brought in on a long dish with flaming brandy by two waiters, and paraded around the tables with the lights dimmed. It was quite something!

In this report, I have concentrated on the events outside the scientific porgramme. This is partly because it is impossible to detail well over 100 contributions, but there is another reason. This conference had a much fuller social programme than most meetings I have attended; in fact, during it there was only one night when we were left to make our own arrangements for an evening meal. However, what this meant was that, on very many occasions, one sat on a coach seat or at a dining table next to entomologists one had never met before, and often from a different culture and generation. I don't think I've ever made so many new friends! It certainly worked.

Any meeting like this involves prodigious effort in planning and organisation by many people. Professor Carlo Ricci of Perugia University was the head of the local organising committee, and we cannot adequately express our thanks to him and his secretariat for the wonderful experience of *Aphidophaga 11*, both in scientific and human terms. I am sure there were problems and even crises – all I can say is that his guests were not aware of any, other than one gentle panic when the coaches at Assizi could not leave since several folk had not returned from their wandering around the town, and could have been anywhere! The catering staff at the University were quite superb! The food was excellent and the service smiling and efficient; I made a few new friends there as well.

The other person I must single out for thanks is Professor J.P. Michaud of Kansas State University, USA. JP was the chairman of the international group charged at the previous meeting with assisting the local team in Perugia in their planning. He put in many hours of work in giving advice and helping with the selection of contributions and arranging the programme. We owe him a great deal, and hope the success of *Aphidophaga 11* is some reward for both him and Carlo Ricci.

Society News

Council Matters March 2011

The first Council meeting of the New Year was convened as usual in the RES Mansion House and chaired by the President Prof. Stuart Reynolds.

The President reported on digitising out of print RES Handbooks and how these would be made available. The decision of the Publications Committee was to release the PDFs on a members' section of the Society's website, which could be accessed using a PIN from the library, as per the library database. Unfortunately, the President explained how this arrangement was not to everyone's liking and that he and the Honorary Editorial Officer had received extensive correspondence from some quarters. The issue had got unnecessarily heated. However, he felt that the matter had now been more or less resolved and stressed that the Society had acted according to proper practice. In addition, he felt that the aims of those who wished more open access and those of the Society were ultimately the same, in terms of disseminating entomological knowledge.

The President commented on the working group that had been established to look at the governance of the Society. In particular, he referred to discussions about updating the Bye-Laws and asked Honorary Officers and Committee Chairs to examine the sections of the Bye-Laws related to their responsibilities and recommend changes, if any.

The Honorary Editorial Officer had pleasure in listing the following RES Journal Award winners:

M.H. REISKIND and
L.P. LOUNIBOS

'Effects of intraspecific larval competition on adult longevity in the mosquitoes *Aedes aegypti* and *Aedes albopictus*'

Medical and Veterinary Entomology (2009), **23,** 62-68.

CHARLES W. FOX
and JORDI MOYA-LARANO

'Diet affects female mating behaviour in a seed-feeding beetle'

Physiological Entomology (2009), **34,** 370-378.

SHAUN L. WINTERTON,
NATE B. HARDY
and BRIAN M. WIEGMANN.

'On wings of lace: phylogeny and Bayesian divergence time estimates of Neuropterida (Insecta) based on morphological and molecular data'

Systematic Entomology (2010), **35,** 349-378.

These papers are available at www.royensoc.co.uk/awards/RES_journal_awards.htm.

The Honorary Editorial Officer also circulated the winners of the RES Student Essay Awards 2010. Prof. Field commented that there had been a very high level of entries, which were 'stunningly good'. The winners were:

BEATRICE COCKBAIN -
Magdalen College, Oxford
'How to Attract a Mate: Stomach Swelling and the Risks of Sex'

BEN JARRETT -
Imperial College London
'Sleeping Beauty'

NICK BALFOUR -
Imperial College London
'Of Kings and Queens'

Dr Tilley gave an update of both the Insect Festival in York and plans for National Insect Week in 2012. The President, on behalf of the Society, thanked Dr Tilley for his enthusiasm and all the organising he and his fellow convenors have put in to make these events run smoothly. The Honorary Secretary gave an overview of Ento'12, which will be held in Anglia Ruskin University, Cambridge in July and convened by Dr Alvin Helden. The Registrar explained he would be visiting the site soon to make provisional bookings.

The Registrar advised that Prof. Haines had stepped down as Chairman of the Membership Committee. Council gratefully acknowledged the considerable input of Prof. Haines to this role. After discussion amongst members of the Committee, Dr Gordon Port had been put forward to Council as a new Chairman. Council unanimously ratified the appointment of Dr Port.

The Honorary Treasurer, on behalf of the Finance Committee, forwarded the recommendation that the 2012/13 subscription rates to the Society be maintained at their current levels. This was ratified by Council.

The Registrar reported on the opportunity of purchasing land adjacent to the Society. This was a strip of land along Chiswell Green Lane that extends across our entrance to the side of the car park and incorporates the former toilet block for the Gardens of the Rose and a derelict area behind Bonehill Cottages. Council discussed this opportunity and studied the valuations. There was some debate about the requirement of this land but the the Registar commented that it effectively 'squared off' the site and would prevent others from developing it. Professional opinion was to purchase. Council endorsed the purchase of this land.

Council Matters May 2011

The Registrar reported that he had visited Dr Alvin Helden at Anglia Ruskin campus in Cambridge and that all facilities were suitable for Ento'12. There was one proviso, in that the new lecture theatre would be offered to us when completed. The date for Ento'12 has been agreed as 18th to 20th July, inclusive. Dr Tilley had tendered his apologies but sent on the minutes of the planning meeting for National

Insect Week and a progress update on the Insect Festival at York. Council were pleased to note that all matters seemed to be in hand and congratulated Dr Tilley on his hard work.

The Registrar forwarded the recommendation from the Conservation Committee that Mr Steve Cham had been selected as the recipient of the Marsh Award for Insect Conservation. The Registrar further reported that he and Dr Stewart had met with Mr Marsh who had offered, on behalf of the Marsh Christian Trust, a second award for an 'early career entomologist'. This news was warmly welcomed by Council and there was some discussion about what constituted 'early career' nowadays.

The Honorary Editorial Officer, Prof. Lin Field, gave an update of the activities of the Publications Committee. The reports received from the scientific journals were good with plenty of copy and satisfactory impact factors. One new editor, Dr Thomas Simonsen of the NHM, had been appointed to *Systematic Entomology*. The Handbooks Series are progressing satisfactorily but *Antenna* suffers from a lack of copy-flow. The Honorary Editorial Officer urged the Council and by extension all Fellows / Members to support *Antenna* by providing articles, photographs and commentary.

Student Essay Competition 2010

This year the judges report an exceptionally large number of entries at a very high standard which is extremely gratifying. As a result of these high numbers the decisions were more difficult and much discussion ensued. Following a vigorous debate the following list of winners were agreed upon. The judges and the RES would like to thank all of the students who took part and offer their congratulations to the three winners and the two runners up.

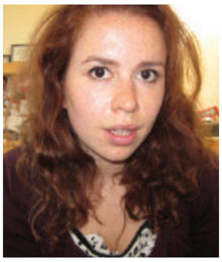
First Prize: How to Attract a Mate: Stomach Swelling and the Risks of Sex, by Beatrice Cockbain

Second Prize: Sleeping Beauty, a Tale of the Periodical Cicadas ,by Benjamin Jarrett

Third Prize: Of Kings and Queens, by Nicholas James Balfour

Highly Commended

Puddling' the Dirty Dinner Habits of Butterflies, by Rudi Verspoor



1st Prize

How to attract a mate: stomach swelling and the risks of sex

Beatrice Cockbain, Magdalen College, Oxford

So you're getting ready for a big night out: put on your highest heels, your favourite little black dress and lashings of mascara. Feeling a bit porky? Pop on some magic knickers to hold that tummy in. So can you imagine puffing up your stomach to get the boys? Not the sort of thing suggested in Cosmopolitan, is it? But that's how female dance flies attract their mates. For dance fly males have the hots for fatter females. Why? Because fatness is a sign of fertility. Reminiscent of ancient fertility symbols, plump females are also thought to be a better bet for breeding in the insect world. In dance flies female body size correlates well with egg size, so a larger body implies that a female is more ready to mate. Like heels used to artificially lengthen and slim the legs, female dance flies have got around this male selection strategy. They have developed a trick to draw males to them making them think they are really fertile, even if they are not endowed with a big belly: puffing themselves up with air.

Why do females want to deceive males like this? Well, at mating males give them a nuptial gift: a mating present. In katydids this nuptial gift consists of 20% their body mass. Which, when converted into human terms would mean that a 10 stone man would be giving away two stone of ejaculate. Lovely. Gross as it may sound, this excess ejaculate is often critical for male mating success: in bush crickets it takes the female around 50 minutes to scoop out the nuptial gift and devour it, which is the same time it takes for the sperm (the first part of the gift) to inseminate her. So, by the time she reaches the sperm inside her, it has already fertilised her: any smaller gift would have her eating the sperm too early and the male would not achieve his aim. Nuptial gifts are an important source of nutrition for females but very energetically expensive for males to produce. This is why males need to carefully select their mates. Unlike in peacocks, where the gaudy male plumage acts to attract females, for these insects males are the choosy ones. Females, like male peacocks, therefore need to develop strategies to ensnare their men, though this might not just be for mating, but also for a free meal. By filling their stomachs with air, less fertile females can get some extra nutrition, the equivalent of eyelash batting at a barista to get an extra large latte. Males, therefore, need to watch out for such trickery to ensure that their nuptial gift isn't going to waste.

Various studies have shown that male choosiness is positively related to their investment. Thus the more they invest in females (for example by way of nuptial gifts): the choosier they are likely to be. Male choosiness can be affected by other factors apart from female size. To deter others from mating with their chosen female, or to reduce the chances of other males' mating success, male insects can deploy a number of different strategies. Among the more unusual are those of the damselfly and the green vein butterfly. The damselfly has a specially barbed penis which scrapes the female's reproductive tract to stimulate it to release any previously stored sperm, thus flushing out competitors' gametes before introducing his. The green vein butterfly, meanwhile, synthesises and transfers methyl salicylate to his mate which has the delightful effect of making her smell like a male and thus reducing her chances of mating again. The equivalent of being post-coitally doused in aftershave...

If being made to smell like a man wasn't bad enough, the female fruitfly's longevity is reduced through sex. In their seminal fluid, male fruitflies secrete pheromones known as accessory gland proteins (Acps) which act in various ways, including to reduce female attractiveness after mating. If making her undesirable wasn't bad enough, some of these have the added side effect of reducing her life expectancy: putting a high price on promiscuity.

So, female insects can have a tough lot, but it's not all bad news for the ladies as the female Chinese mantis would know. They devour their mates when the act is over, so for males finding a full female means a better chance of survival. For them, fatness is a sign of satiety so a bigger female lowers the risk of him becoming her post-coital snack. Well, eating your mate is one way of ensuring nobody else steals him.

2nd Prize

Sleeping Beauty a tale of the periodical cicadas

Benjamin Jarrett, Imperial College London

Under the ground, attached to the roots of trees in towns across America, there lives a mass of strange alien creatures. Red-eyed and sinister-looking, they emerge rarely, but when they do they overwhelm the villages and cities. They have interrupted music festivals, inspired haiku poetry and can be made into a delicious stir-fry (allegedly). They are the periodical cicadas.

Colloquially, but incorrectly, known as '17-year locusts', the cicadas are true bugs, from the same taxon as aphids and shield bugs. The lifecycle of the periodical cicada is quite different to that of a bog-standard cicada, which emerges once a year. Around late May the young cicadas, or nymphs, emerge from the eggs embedded into tree branches. They fall to the ground and dig downwards, towards the roots of the tree. There they stay, underground, feeding on the vascular tissues of tree roots, taking in water and amino acids from the xylem using their long, piercing mouthparts. For seventeen years.

There are seven known species of periodical cicadas that differ from each other by the length of development (13 or 17 years) and species-specific songs. A cicada brood is a reproductively isolated population of one or more species that emerge at the same time. There are 15 broods in northern America. When a brood does emerge, the cicadas swamp the area creating a moving carpet of up to 370 individuals per square metre. Only the males produce the distinctive cicada trill so often heard in rainforests, and only do so to serenade a mate. And with 185 individuals per square metre singing, they can create quite a racket. With such a spectacle it is no wonder that the periodical cicadas have inspired such fear and awe in equal measure.

Dr John Cooley, a specialist in cicadas from the University of Connecticut, describes the emergence as like "nothing else you have ever seen", with the noise levels as "awesome – in the truest sense of the word". Even orchestras struggle to compete with the cicadas; so much so that the Chicago Symphony Orchestra had to reschedule concerts from May to July in 2007 after the emergence of Brood XIII. These insect maelstroms do serve a purpose; the cicadas improve their mating success and, with such a large swarm, it does not matter if predators feast freely, as there are enough individuals for the population to survive – a strategy known as predator satiation. The prime lifecycle of a periodical cicada (13 or 17 years) is another weapon of defence against predation; a predator can exploit a host with a non-prime periodicity by using a periodicity that is a multiple of the host's, something that cannot happen when the host has a prime periodicity.

The red eyes and alien appearance of cicadas leave some people scared, but others amazed. They are not known to cause large amounts of damage and so are not the focus of ill feeling. In fact, in some countries, they are revered. The Japanese associate the cicada's trill with hot summers and, because of the cyclical lifecycle and moulting process, use the cicada as a symbol for reincarnation. The cicada has also been immortalised in the Japanese poetry form of haiku. Cicada-inspired haiku competitions have taken place throughout Japan and America, with poems detailing facets of the cicada's lifecycle. Second place in the 2007 Chicago Cicada Haiku Contest went to Penny Roman with:

'*Ugly little bugs / Beautiful to each other / Cicada romance*'

Christopher Conwell sums the life of a cicada rather well in the following seventeen syllables:

'*Seventeen year wait / A short time to find a mate / Good luck cicada*'

The Native American tribe, the Onondaga, too, have special reverence for the periodical cicadas. Tradition has it that during one war with the 'English' colonialists, the 'English' burned the Onondaga tribe's crops. This, however, did not seem to affect the natives who, it appeared, fed on the cicadas throughout the hard time. Eating insects may sound strange but is getting more common in the western world. Entomophagy, as it is known, exploits the masses of cicadas when they do emerge. The trick, according to Dr Jenna Jadin of the University of Maryland, is to collect the newly emerged adults before their exoskeleton hardens, and boil them for five minutes. From then they can be incorporated into curries, pizza, dumplings and can be covered in chocolate – Dr Jadin's favourite.

Whether you are a budding poet wanting inspiration; an adventurous foody wanting to try a deep-fried cicada; or an appreciator of nature, the mass emergences of cicadas provide the world with one of the most amazing natural phenomena that, I think, every person should experience. I am planning my visit. I suggest you do too.

3rd Prize

Of Kings and Queens

Nicholas James Balfour, Imperial College London

In the sciences we are always looking to the future and for the most part, rightly so. At times however, we must take a moment to look back and appreciate those who laid the foundations on which we stand today. One such immortal is François Huber. His *New Observations on the Natural History of Bees* was first published in 1792 and is probably the oldest entomological text regularly printed today. The honeybee (*Apis mellifera*) has long fascinated man, its industry admired and honey coveted. Research on honeybees dates back to the Roman writer Columella and beyond, but key discoveries regarding their behaviour remained few, until Huber. His judiciously adapted experiments provided strictly logical conclusions that rendered previous works mere myth.

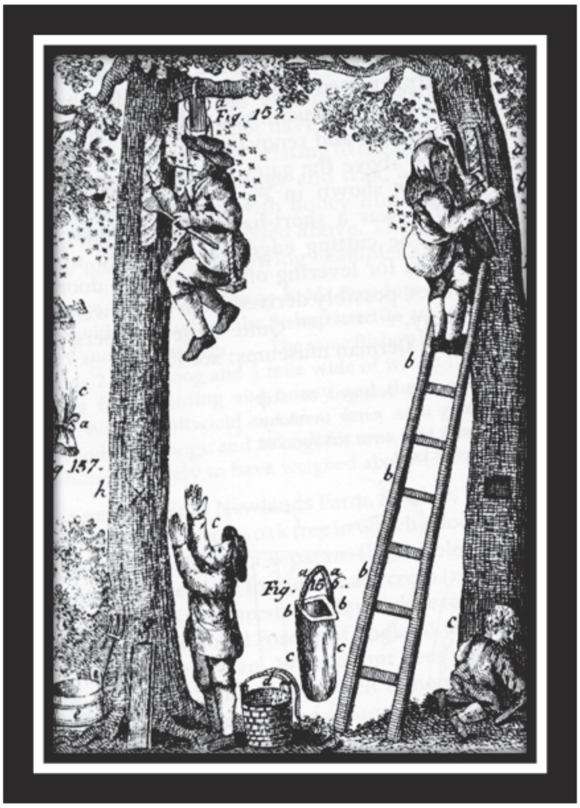
One mystery that had long frustrated his predecessors was honeybee mating: how could a queen lay hundreds of fertilised eggs a day without any naturalist having ever witnessed her fecundation? During years filled with setbacks, interspersed with fireside meditations, Huber painstakingly reproduced and corrected the errors in the leading honeybee mating studies of the time. His series of investigations proved past speculations specious and culminated in the surprising discovery that a queen need only mate once in her lifetime, this event taking place at great height on a still, warm summer evening. Huber also revealed how a queen bee induces swarming. Moving her way among her relations, she vigorously shakes her abdomen, exciting them to follow suit until the hive temperature reaches almost 100°C. This forces half of the colony to rush toward the exits and follow their mother to pastures new.

Moreover, Huber described the fascinating dynamics of fighting between two queens. The workers intervene and separate the two when it seems likely that both will perish, ensuring that only one will remain to preserve the empire. Huber's studies, among other things, confirmed the existence of royal jelly, described the massacre of drones by the workers in early autumn and showed how bees employ their antennae and olfactory senses. His ingenuity, featuring extensive use of glass, knew no bounds, and included observation hives, hexagonal glass cells for viewing larval development, a nine foot high glass chamber built in hope of witnessing mating and narrow glass tubes that allow workers to pass to and from the hive whilst excluding the larger queen.

These insights into the workings of a hive provided the foundations of modern apiary management. The post-Huberian world was quite different for apiarists. Most notably Huber's hive, designed with removable frames and later improved by Reverend Lorenzo Langstroth, meant that it was no longer necessary to kill the inhabitants of a colony to extract their honey. Although he is primarily remembered as the godfather of beekeeping, Huber deserves credit for bringing scientific rigour into the broader arena of animal behaviour and thus was well ahead of his time. Darwin referred to his work in the *Origin of Species* some 60 years later but it would be almost 150 years before Sir Ronald Fischer *et al*. formalised such basic field experimentation principles as a replication of Huber's work. Huber, a rational thinker, adhered to these ideas instinctively, noting that an observer '*should repeat all his experiments a thousand times to obtain the certainty of seeing facts as they really exist*'. Like Fischer, Huber also believed in asking Nature only one question at a time, employing serial investigations, with only moderate modifications, to ascertain singular facets of honeybee behaviour. To provide a historical perspective; Huber's father was a friend of Voltaire, his uncle spent his entire means chasing the philosopher's stone.

Indicatively, when frustrated that his fellow naturalists had been ascribing human sentiments and passions to insect behaviour, Huber contended that Nature guides their instincts leaving them '*no combination to be followed, no foresight to exercise, no knowledge to acquire*'. These words show a deep appreciation for the influence of an insect's life-history in determining their behaviour and hint at an understanding of genetics and natural selection many years before these ideas were conceived.

Finally, what makes Huber's work even more impressive is that he was blind throughout his adult life (his research carried out with the assistance of his servant François and wife Marie). Indeed, he was famous for hiding this condition and carrying out physical tasks undeterred by his disability. Despite this obstacle, his work was deeply considered and he employed an empirical approach to problems, isolating all variables from his experiments; all at a time when the science of animal behaviour was in its infancy. Huber's approach is still relevant to today's entomologists and his spirit and drive an inspiration to us all.



Pre-Huber: Illustration of Tree Beekeeping, practiced in Northern European forests from 2000 or 1000 BC to AD 1700 or later (image taken from *Oekonomische Encyklopädie*, 1774)

Highly Commended

'Puddling': the Dirty Dinner Habits of Butterflies

Rudi Verspoor

Butterflies are undoubtedly among the most majestic creatures in the insect world, famous for both their beauty and grace. However, scratch below the surface of their visual appeal and some interesting and unexpected behaviours can be found. My first encounter with the quirky world of butterfly habits came in central British Columbia, Canada, where I observed a number of Compton's tortoiseshell (*Nymphalis vaualbum*) and Green comma (*Polygonia faunus*) feeding on exposed and decomposing Pacific salmon (*Onchorynchus spp.*) carcasses on stream banks (Figure 1). My curiosity triggered, I investigated further into their feeding behaviour and found that bizarre dietary habits are actually fairly common amongst butterflies.

The general behaviour within insects, of feeding to collect specific micronutrients, is known as 'puddling' and originated from descriptions in the 1930's of butterflies congregating and collecting nutrients from mud puddles. In fact, puddling is widespread across insects, ranging from the romantic, with bees feeding on human tears, to the morbid, where cicadas indulge in cannibalism. However, this behaviour has been particularly well documented in butterflies. Although many butterflies feed predominantly

Figure 1.

Figure 2.

on floral nectar, along with tree sap and other sugar-based foods, a diverse range of alternative and unpleasant food sources are exploited by many species including faeces (Figure 2), animal sweat, and carrion. For example, a British visitor, the Purple Emperor (*Aptura iris*) is frequently seen feeding from faeces. Yeuch! It makes one wonder what other strange habits butterflies may be hiding…

So this gives us some appreciation for what tickles the taste buds of these 'puddlers', however like any dirty habit, it is important to look for an explanation. Just why exactly do butterflies practise puddling? Studies have shown that the behaviour allows butterflies to collect key nutrients which are otherwise scarce in their regular diets. Evidence suggests that the primary nutrient targeted by puddling is sodium, although nitrogen and phosphorus rich compounds may also be important. This seems logical, as many puddling food sources provide far higher levels of these nutrients compared to many floral or sugar based food sources. However, reason alone doesn't confirm science, and identifying and differentiating the particular cocktail of nutrients collected by different species of butterflies and linking this to their physiological function remains a challenge.

So, what exactly do butterflies need these additional nutrients for? In response to this, two main theories have been posted to explain the importance of puddling in butterflies. The first one proposes that the additional nutrients play an important role in the basic metabolism of many insects. Indeed, sodium has been suggested to be important for a variety of physiological processes in insects, for example in aiding amino acid uptake during digestion or in facilitating neuromuscular activity. Mmm… nothing like a rotten fish smoothie to keep your metabolic machinery running smoothly.

The second theory proposes that the additional nutrients are important for male butterflies, allowing them to better provision their spermatophores, which are given as a nuptial gift to the female during courtship. In support of this, research has shown that puddling is predominantly (though not exclusively) a male trait in many butterfly species. In addition, males nutrients transferred to the females are known to affect offspring, for example larvae of the skipper (*Thymelicus lineola*) survived better, when the eggs received extra sodium, provided to the females by males that had the opportunity to puddle. However, studies directly linking nutrients collected by puddling and their exact function, either regarding physiology or courtship, are still lacking for many butterfly species and much remains to be explored in this area.

Nonetheless, the potential importance of the nutrients obtained by puddling, combined with the fact that the behaviour is widespread across butterfly species, raises some interesting questions. Could the limited spatial and temporal availability of gourmet puddling resources differentially affect the fitness of butterfly populations? What role does the ability of males to provision the female with a nutrient rich treat affect her mate choice? It seems that many puzzles remain to be resolved.

Whether it is for a generous, if slightly bizarre choice of nuptial gift, or the butterfly equivalent of a double espresso to get their metabolism going after a hard day, puddling is undeniably a fascinating behaviour. Yet regarding certain aspects of this phenomenon many questions remain unanswered. While science does its part in answering these, the next time your garden is graced with a visit from a butterfly, imagine how many more secrets they're hiding, and perhaps take a few moments to look and see what's on their menu today. Consider what secrets remain hidden, and if nothing else, remember that the majestic butterfly does in fact have a few dirty dinner habits; surely only adding to their character and charm.

Postgraduate Forum 2011

Cathleen Thomas

Postgraduate Representative
University of Hull

Earlier last year, I became one of the postgraduate representatives of the RES, and I was asked to organise the 2011 postgraduate forum. It was held in the Royal Hotel in Hull, and over the course 2nd-3rd February, 38 delegates attended. The days were broken up into four sessions of talks, each containing one talk by an invited speaker, as well as talks by the students, and we had a poster session.

During the first session, Dr. Helen Roy spoke to us about her 'life as an entomologist'. I first met Helen at the first PG Forum I attended, at Rothamstead in 2008, and she has since become a close collaborator and friend. Helen is very passionate about her work, and discussed her time spent as a child attending local natural history meetings on the Isle of Wight through to her career as a lecturer at Anglia Ruskin University, and now as an ecological entomologist at the Centre for Ecology and Hydrology. It is also nice to see that Helen has managed to achieve a balance between a successful career and happy family life!

The first student talks came from Matthew Carroll, who spoke about 'climate change and upland ecosystems: effects of soil moisture and moorland drainage on cranefly populations', Heather Campbell, who spoke about 'cohabitation on an ant-plant: colony distribution of four ant species within swollen thorns of *Acacia erioloba* in Namibian savannah', and Dan Jeffries, who spoke about 'factors affecting the dispersal of the invasive harlequin ladybird, *Harmonia axyridis*, in the UK'.

After coffee, we had a further three student talks. I opened the session by speaking about my PhD research on 'The global invasion of the harlequin ladybird (*Harmonia axyridis*)', and found that it's actually a little difficult to chair the session that you are in, and try to keep yourself to time! I then handed over to the other RES PG rep., Toby Fountain, who spoke about 'Weaving resistance: silk and disease resistance in the weaver ant *Polyrhachis dives*'. Finally, Vicky Hartley spoke about 'Genetic differentiation in the twin spotted wainscot moth (*Archanara geminipuncta*) from four UK *Phragmites* reedbeds'.

Dr. Roger Key spoke to us about his 'inordinate fondness for beetles - UK insect biodiversity through the eyes of an insect photographer'. This was a whistle stop tour of the insect class, accompanied by amazing photographs illustrating interesting members of each group. We also learnt how to tell the difference between a grasshopper and a cricket! I found this talk very interesting, and learnt that the folding mechanism of the solar panels on the space shuttle is actually based on the folding mechanism of earwig wings. Is there no end to what we can learn from insects?!

The first day's talks were rounded off by Dr. Luke Tilley, who told us about the benefits of student RES membership, such as access to the RES library and services of the librarian, a subscription to Antenna magazine, and monthly meetings on various entomological topics.

Delegates at the PG Forum 2011

After a quick cake break, we had a poster session. Eleven posters were offered by the students, on diverse subjects such as 'community ecological assessment of reclaimed coal sites' by Kevin Rich, 'biology and control of currant-lettuce aphid (*Nasonovia ribisnigri*)' by Gemma Hough, and 'identification of UK blowfly species using a SNaPshot™ multiplex reaction based on the cytochrome oxidase I gene' by Helen Godfrey.

The conference dinner was held at Hitchcock's Vegetarian Restaurant in the old town area of Hull, which was attended by 30 delegates. I was a little worried how people would react to the lack of meat, but the delicious Carribbean-style food went down a treat, and was followed by 'all-you-can-eat' desserts. I highly recommend their yummy banoffee pie!

The second day started with Prof. Stuart Reynolds and Prof. Rod Blackshaw talking to us about scientific writing and publishing. Approaching writing a PhD thesis can seem like a mammoth task, and Stuart and Rod advised starting with the easy bits, such as materials and methods, results, acknowledgements and references. They also offered advice on tricky subjects such as how to deal with reviewers comments on submitted papers. They suggest not to get too emotionally involved, and to come back to the comments again after a day – good advice! I am very grateful to them both for stepping in at short notice to give this talk.

Three more student talks then followed. Claire Dooley spoke about 'patterns in population dynamics over space', Simon Segar spoke about 'convergent evolution of community structure across three continents' and Rachel Pateman spoke about 'niche expansion at the northern range

boundary of the butterfly *Aricia agestis* in response to recent climate warming'.

After coffee, the final invited speaker, Dr. Richard Gill, spoke to us about his 'life as a PostDoc'. Rich was previously a PhD student at University of Hull, working on social evolution of ants, and then continued this work as a postdoc at University of Leicester, and is now about to start a second postdoc at Royal Holloway to study the decline of bees. As someone who has recently finished their PhD, Rich was able to tell us about the things he would have done in hindsight, and his recommendations for getting that elusive postdoctoral position.

We then had a final five student talks, with a lunchbreak in the middle. Rory O'Connor spoke about 'the ecology of the adonis blue and chalkhill blue butterflies: one plant, ants and patchy landscapes', Jennie Garbutt spoke about 'RNA interference in the tobacco hornworm, *Manduca sexta*', Richard Comont spoke about 'ladybirds in the UK: can biological traits explain distribution patterns?', Bobbie Johnson spoke about 'understanding insect diapause: a metabolomic analysis, and finally Stuart Hands spoke about 'plants, pests and parasitoids: effects of host plants on the third trophic level.

All in all, I think the forum went really well and I was glad to see everyone survived their night in Hull. We even managed to escape the snow this year, which was becoming a bit of a forum tradition! I just hope all the delegates enjoyed the conference as much as I did.

Acknowledgements

I would like to thank Kirsty Whiteford for her help during the organising process, as well as Toby Fountain and Dan Jeffries, for their support, their help during the conference, and for generally putting up with me! I would also like to thank all of the invited speakers for some brilliant talks, and of course to all the students who spoke and who brought posters. Without the students, the conference would not have been such a triumph!

PG Forum 2011 Prize winners

We were very grateful to the RES for offering four student prizes, which were won by:

Best talk: Rachel Pateman

Runner up talk: Cathleen Thomas

Best poster: Andres Arce

Runner up poster: Emma Wright

Thank you to Profs. Stuart Reynolds and Rod Blackshaw for judging the competition, and congratulations to all the prize winners. Their abstracts are below.

Shifts in habitat associations in response to recent climate change

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Many species are responding to climate change [1, 2], with responses most commonly documented being changes in phenology and shifts in geographic distribution. One area that has been largely ignored, however, is that of possible shifts in habitat associations [3].

Many species have more restricted niches towards the edges of their geographical distributions (Brown 1984) where they occupy a narrower set of habitats, microhabitats or host plants, for example, than at their range core. In many cases this appears to be due to climatic conditions becoming more marginal for species as they approach their range edges. Oliver *et al.* (2009) found, for example, that it is a common pattern for butterfly species in the UK to occupy fewer habitat types in less climatically suitable parts of their range.

This observed pattern may be because fewer habitats provide microclimatic conditions that are required for survival and development, near the range boundary. Several butterfly species that reach their northern range edge in the UK, for example, become restricted to south-facing slopes with short turf [4-6], which are the warmest sites in the landscape, whereas in the core of their range they are able to occupy sites of a wider variety of aspects and with a wider variety of turf heights [7]. Alternatively, these patterns might arise because species become restricted to the best quality habitats in the landscape, for example those with the highest resource density, because these habitats can support positive population growth despite increased climate related mortality at the range edge [3].



Left: Speckled wood; centre: Rockrose; right: Chalk grassland

As geographic variation in species habitat associations is related to spatial variation in climate, we might expect that as climate changes through time, habitat associations also change. As climatic conditions "improve" at species' cool range boundaries, individuals may be able to occupy previously unsuitable habitats or microhabitats. Increase in habitat availability would lead to larger, less fragmented populations and a more stable metapopulation structure [7].

Such shifts in habitat associations have already been demonstrated in one species, the silver-spotted skipper *Hesperia comma*, which was previously restricted to south-facing slopes in the UK where it reaches its northern range limit [5]. In recent years individuals have been able to colonise sites on east-, west- and south-facing hillsides as an increase in ambient temperature has meant microclimatic conditions for egg-laying are now suitable on these aspects [8, 9].

My project focuses on two rapidly expanding butterfly species in the UK, and investigates whether apparent recent shifts in habitat use in these species are related to climate change and what the mechanisms driving these patterns are. The brown argus butterfly *Aricia agestis* is unusual in that it has expanded the range of host plant species it uses during its northwards expansion. This species uses common rockrose *Helianthemum nummularium* and several species of the Geranium family as host plants in the core of its range. In the UK, however, where the butterfly reaches it northern range boundary, it was historically largely restricted to using common rockrose. Since the early 1990s, however, it has shown a substantial increase in its use of *Geranium* (Cranesbills) and *Erodium* (Storksbill) species in the UK. The speckled wood butterfly *Pararge aegeria* has shown a different pattern of habitat shift. Historically it was restricted to woodland in the UK but along with a rapid expansion of its range it is also now found in a wide range of habitats such as hedgerows, parks and gardens [10].

A better understanding of the relationship between climate and species' habitat associations is important for predicting responses to climate change. Changes in habitat availability may, for example, alter rates of range expansion [11]. Furthermore, if species' habitat associations change in response to climate warming, conservation management plans may need to be altered to adapt to this.

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The global invasion of the harlequin ladybird (*Harmonia axyridis*)

Cathleen E. Thomas[1], Renate Zindel[2], Eric Lombaert[3], Remy Ware[4], Alexandre Aebi[2], Arnaud Estoup[3] and Lori Lawson Handley[1]

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Species invasions have wide ranging ecological and economic impacts, and are one of the greatest threats to biodiversity, agriculture and human health. Despite this, there is still much we do not understand with regard to why only certain species become successful invaders, what determines their success and their impacts on other species. The successful invasion of different continents by *Harmonia axyridis* (harlequin ladybird) provides a unique opportunity to investigate the invasion history of a highly invasive species, and to attempt to identify common factors underlying invasion success.

Molecular genetic data can provide vital insights into invasion dynamics. During my PhD, I have collected mitochondrial DNA sequence data to investigate the global invasion of *H. axyridis*. By analysing individuals from native and invasive populations we aim to understand: (1) the source(s) and routes of spread of the species and (2) the genetic characteristics of the founding population(s). This data builds on microsatellite data that has already been gathered on the same populations. We are also gathering data on the presence of bacterial endosymbionts carried by individuals within these populations. Together this will provide a powerful dataset, making this one of the best case studies for understanding species invasions.

The microsatellite data suggest there were at least two introductions from the native range into North America, one into the east, and one into the west (see Figure 1). The eastern North American population then acted as a 'bridgehead' population for subsequent introductions into Europe (admixed with biocontrol), South America and South Africa[1]. Unfortunately, our ability to identify potential source populations in the native range is limited by the low levels of structuring shown by the microsatellite data. Higher differentiation in mitochondrial DNA data potentially provides greater resolution to investigate the invasion history of the species. This work is currently ongoing.

Further work on this subject will investigate dispersal in the native range, to understand what might be causing the observed population structure by identifying barriers to ladybird dispersal, such as geographical or climatic features. This will help us to further understand the dispersal capability of the species. We are also investigating the spread of the ladybird in the UK, which will provide a detailed insight into invasion routes and temporal dynamics.

[1]Lombaert et al. (2010). Bridgehead effect in the worldwide invasion of the biocontrol harlequin ladybird. *PloS one* 5:e9743-

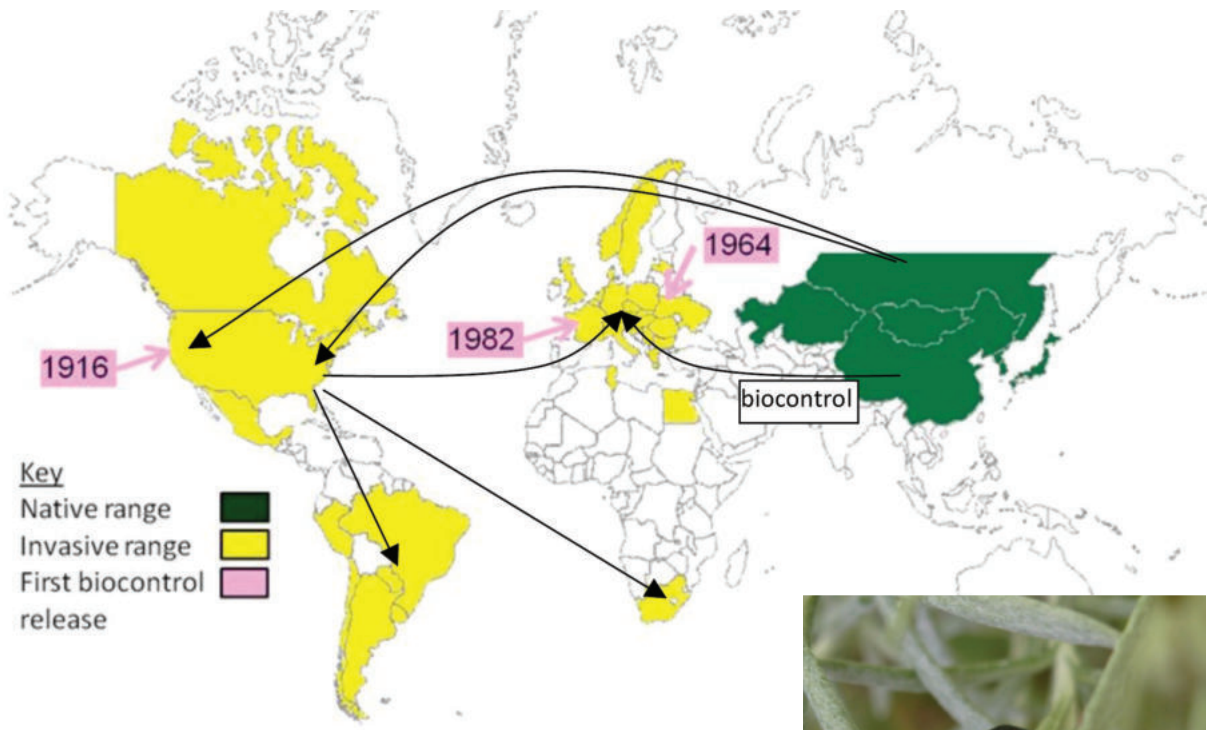


Figure 1. This map shows the range of the harlequin ladybird, with the native range in green and the current invasive range in yellow. The numbers in pink boxes show the year of the first biocontrol release in that area. The black arrows indicate the global invasion routes, including the contribution of biocontrol populations in Europe (after Lombaert et al., 2010).

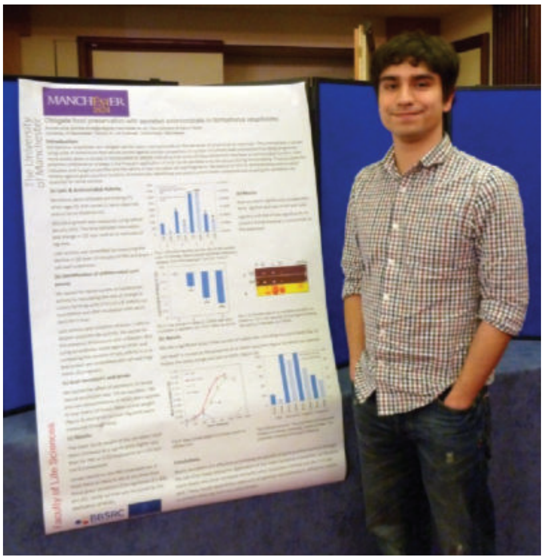
Obligate food preservation with secreted antimicrobials in *Nicrophorus vespilloides*

Andres Arce
University of Manchester

My project studies competition between kingdoms, focussing on how bacterial decomposers and animal scavengers interact with each other for access to shared resources. The project is broadly based on a paper from 1977 by Daniel Janzen. His key insight was that microbes that specialise on high value, rare and ephemeral resources, such as fruits, seeds and carrion, are particularly vulnerable to animal competitors who also utilize these same resources. When the resource is consumed by an animal the bacterial specialists lose not only the resource but also potentially their lives while passing through the animal's digestive system. In order to avoid this fate, Janzen hypothesized that bacteria should evolve responses that deter animals from an otherwise attractive resource, usually through the use of warning cues or toxins.

Photo credit: Rachel Antwis

On the other hand, animals should evolve strategies that minimise the negative effects of bacterial competition, for example by avoiding contaminated foods or by detoxifying or neutralising the chemical defences of the bacteria.



Andres with his prize winning poster
(Photo credit: Cathleen Thomas)

We are studying the interactions Janzen considered using the carrion beetle *Nicrophorus vespilloides.* The larvae of this species are reared upon and require carrion in order to survive. However, before larvae arrive at the dead mouse we offer them, it has already been found and colonized by bacteria which begin transforming it as soon as the mouse dies. In the lab, we can manipulate the level of bacterial colonization by allowing mice to rot and putrify; this ensures that larvae growing upon these carcasses enter a world that is more fiercely defended than their conterparts growing upon fresher meat. We have found that larvae reared on rotten carcass do less well than those reared on a fresh one, but what is not known is which bacterial species are responsible and what mechanisms these microbes use to harm the beetles. We also know that the beetles, through the provision of parental care, can partly mitigate the effects of microbial harm, but how this is accomplished remains largely unknown. We have begun to uncover the mechanisms of this inter-kingdom give and take by bringing this system into the lab where we can closely control the environment in which our experiments occur. This enables us to use a range of methods from traditional behavioural ecology and biochemistry to next generation sequencing.

The poster I presented at the postgraduate forum in Hull showed the results of a set of experiments designed to characterise a part of the beetle's antimicrobial response against microbial antagonists. Previous work indicated that parent beetles apply anal secretions to the carcass during breeding that have anti-fungal properties and the ability to break down bacterial cell wall fragments. However, there has been no work done to specifically characterise the nature of the secreted compounds, nor any effort to examine their effects on live microbial cells. More important, in no case has any causal link been made between these secretions and larval fitness. Our work has shown that *Nicrophorus* secretions are highly effective at killing gram-positive cells largely due to the presence of an insect lysozyme. We also found that antimicrobial activity of secretions is plastic, peaking when larvae are present but then declining again as the larvae disperse indicating that the response is clearly a form of parental care. Finally, we demonstrate experimentally that secretions are directly required for larval growth and survival, a result that can be mimicked using hen egg white lysozyme as a secretion-substitute. From this we conclude that the application of anal secretions is an antibacterial strategy that is initiated by breeding that has evolved to improve beetle fitness by directly inhibiting bacteria.

This work increases the already extensive repertoire of parental care behaviours known in *Nicrophorus* beetles. It is, to our knowledge, the first description of parental care in this genus dedicated to reducing microbial competition and as such is our first step in building up an understanding of the animal-microbe interactions in this system.

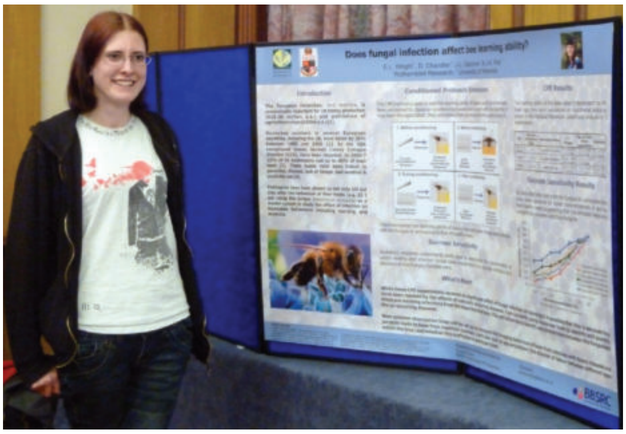
Does fungal infection affect bee learning ability?

Emma Wright[1,2], David Chandler[2], Juliet Osborne[1] & Judith Pell[1]

[1]Rothamstead Research [2]University of Warwick

The European honeybee, *Apis mellifera*, is economically important, not just for honey production, but also as a crop pollinator. Insect pollinated plants represent about one third of the food eaten worldwide[1]. However, honeybee numbers in some areas are declining. Last year British beekeepers lost an average of 17% of their colonies[3], and in the USA over the winter of 2006-7 it was estimated that 23% of beekeepers lost up to 45% of their colonies[2].

A range of interacting factors are thought to be involved in colony losses including pathogens and parasites, loss of forage, pesticide use, bad weather and limited genetic variability[5]. Many pathogens can also affect host behaviour; for example activation of the honeybee immune system (associated with pathogen challenge) decreases learning ability[4]. These premortality and sublethal effects of disease may contribute to colony declines[5] and are the focus of my research.



Emma with her prize winning poster.
(Photo credit: Cathleen Thomas)

I have used the 'Conditioned Proboscis Extension' (CPE) response[4] to examine learning ability in infected and healthy honeybees. This involves classical conditioning; teaching the bees to associate a particular scent with a food reward so that they extend their proboscis in response to that scent alone. I have been comparing hive and forage bees challenged with the fungal pathogen *Metarhizium anisopliae*. Although *M. anisopliae* is not a co-evolved pathogen of honeybees, it is virulent against them and easier to deliver in controlled doses than the co-evolved diseases. This makes it a useful model to compare learning ability over the course of infection and in conjunction with co-evolved disease.

So far my results have shown no difference in the learning behaviour of *M. anisopliae* infected bees of either age when compared to healthy bees. However, infected bees were more responsive to lower concentrations of sucrose showing that they may be energetically stressed and thus hungrier. Further analysis of this work is ongoing using molecular diagnostics to identify the naturally occurring pathogens that might also have been affecting the tested individuals. This will allow me to consider interactions between the fungus and the co-evolved diseases.

Next summer I will use observation hives to monitor the behaviour of honeybees in a more natural environment, comparing small colonies of healthy bees and bees heavily infested with parasites and disease.

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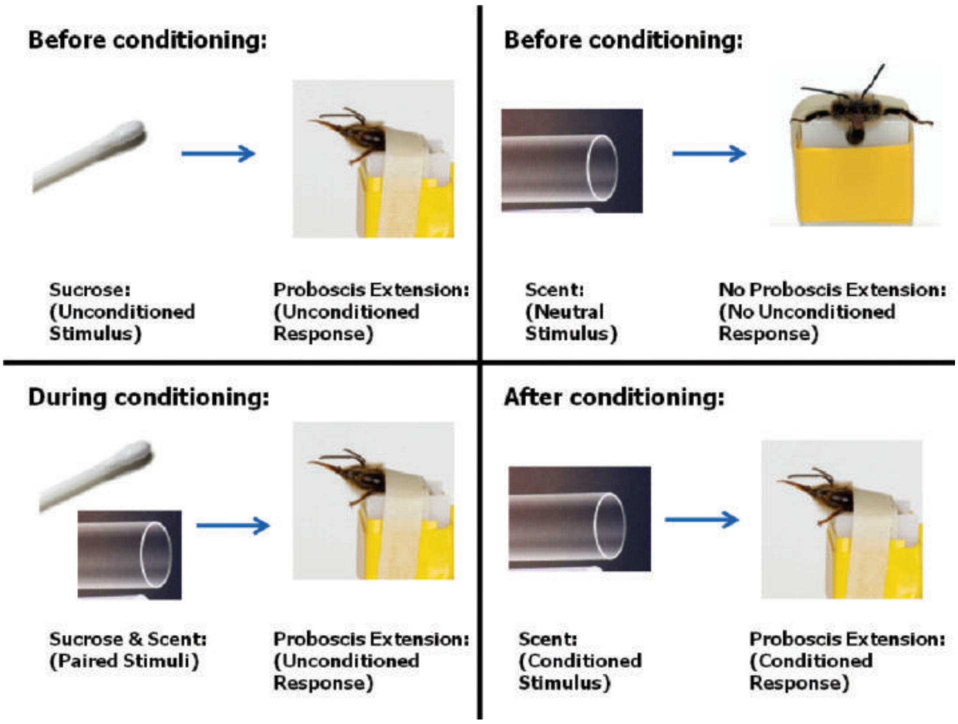
[3] The Guardian (2010). UK honeybee numbers suffer further decline after harsh winter. http://www.guardian.co.uk/environment/2010/may/24/honeybees-winter-decline

[4] Mallon, E. B., A. Brockmann, et al. (2003). Immune response inhibits associative learning in insects. Proceedings of the Royal Society of London Series B-Biological Sciences 270(1532): 2471-2473

[5] Oldroyd, BP. (2007). What's killing American honey bees? PLOS Biology 5 (6): 1195-1199.






Soil entomology – the dark side of insect ecology?

Rod Blackshaw and Phil Murray

Ask any entomologist and you will be told that not enough attention is paid to their speciality. There is an argument though that soil entomology is truly a Cinderella subject. A huge number of species have a soil dwelling stage (some people have estimated more than 80%) but these are not the charismatic adults that are the subject of the RES Handbook series. The effect of this bias can be clearly seen if you consider the number of papers published on adult lepidoptera compared with their larvae (let alone eggs!).

So why should this be? Well, the first problem is that studying soil insects presents serious sampling challenges. Soil is a cryptic habitat and direct observation is rarely possible. We do not always know where these insects are so soil sampling is resource intensive with lots of zeros in the data. Secondly, soil as a habitat forces a morphological convergence that minimises surface structures. This is essential for animals that have to push their way through soil but does mean that identifying larvae is harder than the same task for adults. Molecular sequencing may, in the future, provide a tool to address this problem but it will still be necessary to match larvae with adults to name a specimen.

The consequence of these challenges is relatively few entomologists who study soil insects. It is also noticeable that those who do tend to work on agricultural (herbiverous) species because of their economic importance.

But is there any other reason to study them?

The soil ecosystem has been described as a 'poor man's rain forest' because the biodiversity is huge and is often orders of magnitude greater than that above ground. It is one of the last ecological frontiers and globally there are increasing efforts to open up the 'black box' that it has always been assumed to be. In this context insects are useful model organisms for understanding the interplay of biology and environment on soil invertebrates and testing hypotheses.

Soil entomology occasionally features at general entomology meetings (e.g. there was a session at the last European Congress of Entomology in Budapest), but is a very rare topic in general soil ecology conferences. To address this gap we have organised a joint meeting between the Royal Entomology Society and the Soil Ecology Society which will be held at the National Marine Aquarium in Plymouth from 14-16 September this year. The Soil Ecology Society is an international organization which is interested in the advancement and promotion of soil biology and ecology. Our aim with this meeting is to create a forum that brings together all aspects of the study of soil biota, and facilitates the development of soil entomology in its ecological context.

CALL FOR PRESENTATIONS

Soil has been described as the 'poor man's rainforest' because of the huge biodiversity that exists under our feet. It remains a scientific frontier of great importance to our understanding of processes essential to the maintenance of above-ground systems, and is key to the sustainable exploitation of land.

The Royal Entomological Society and Soil Ecology Society are organising their first joint meeting on soil biology. The aim is to bring together scientists from a range of biological backgrounds (microbes, mesofauna, macrofauna) to share experiences and understanding, and promote interdisciplinary thinking.

The organisers invite offers of papers and poster presentations on any topic relating to *soil entomology* or *ecology*.

Authors are requested to provide a title, abstract and full contact details by email to Linda Jewell on: linda.jewell@bbsrc.ac.uk

Further Conference details are available from the Royal Entomological Society website at: http://www.royensoc.co.uk/content/meeting-14-16th-September-2011

We look forward to seeing you in September.

Rod Blackshaw, Phil Murray & Pete Smithers


SEE11

A JOINT MEETING BETWEEN THE ROYAL ENTOMOLOGICAL SOCIETY AND THE SOIL ECOLOGY SOCIETY

Soil Entomology and Ecology

14-16 September 2011

National Marine Aquarium, Plymouth

PLYMOUTH AND THE CONFERENCE VENUE

Plymouth is an exciting and vibrant waterfront city with a long maritime history. It has a compact city centre which is entirely accessible on foot. With over 250,000 residents it is the largest city in the region and this is reflected in the facilities on offer.

Whilst there is much to do and see in Plymouth, the surrounding countryside and nearby coastline are renowned for their scenic beauty. Finishing the meeting on a Friday makes it convenient to stay on for the weekend and explore the area.

Details of what the city has to offer can be found at: www.visitplymouth.co.uk

The National Marine Aquarium (www.national-aquarium.co.uk) is the venue for the meeting. It is on the waterfront in the Barbican area of the city where there is a range of restaurants and bars. Nearby are the historical Mayflower Steps, the departure point of early American colonists.

The meeting will be held entirely in the Aquarium, in purpose built conference facilities consisting of meeting rooms, breakout spaces and an area for posters. There will be a guided tour of the Aquarium before the conference dinner which will be held in one of the display rooms.

Further details of the meeting are on the Society's web pages.

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 4th May 2011

New Fellows (1st Announcement)
Mr Andrew Jukes
Professor Philip Edwin Howse
Dr Raul Narciso Carvalho Guedes
Dr Muhammad Mazhar Ayaz
Dr Thomas Johannes Simonsen
Dr Falko Pieter Drijfhout
Professor Claudio Ricardo Lazzari

Upgrade To Fellowship (1st Announcement)
Mr Adrian Peter Knowles
Dr Elva Joan Hilda Robinson

New Fellows (2nd Announcement And Election)
None

Upgrade To Fellowship (2nd Announcement And Election)
Dr Ioannis Eleftherianos
Dr James Edward Jepson (First Reading As At 02. 03. 11)

New Members Admitted
Mr David Allan
Dr David Alan Sheppard
Dr Sarah E J Arnold
Dr Christopher Sanders
Mr Jasper Hubert
Dr Sumera Afsheen
Mrs Una Celine Garland

New Student Members Admitted
Mr Benjamin Jarrett
Mr Jonathan Parrott

Re - Instatements To Fellowship
None

Deaths
None

SCHEDULE OF NEW FELLOWS AND MEMBERS

as at 1st June 2011

New Fellows (1st Announcement)
Mr Jonathan Hugh Delf
Dr Sinnathamby Noble Surendran

Upgrade to Fellowship (1st Announcement)
Mr Jason Kurt Easter

New Fellows (2nd Announcement and Election)
Professor Philip Edwin Howse
Dr Raul Narciso Carvalho Guedes
Dr Thomas Johannes Simonsen
Dr Falko Pieter Drijfhout
Professor Claudio Ricardo Lazzari

Upgrade to Fellowship (2nd Announcement and Election)
Mr Adrian Peter Knowles
Dr Elva Joan Hilda Robinson

New Members admitted
Mr Scott Greig Dodd
Dr Muhammad Mazhar Ayaz

New Student Members admitted
Miss Frances Madeline Hawkes (as at 4.5.11)
Mrs Kristina Nord us (as at 4.5.11)
Miss Stine-Marie Simensen
Mr Sam Jones
Mr Zayed Saud Abdullah
Mr Matthew William Dray
Mr Donald A'bear

Re – Instatements to Fellowship
None

Re – Instatements to Membership
Dr Ben Webster (as at 4.5.11)
Mr Robert Tanner

Deaths
None

J. O. WESTWOOD MEDAL AND AWARD FOR INSECT TAXONOMY

– CALL FOR NOMINATIONS –

In response to the urgent need to expand the research effort in insect taxonomy and to encourage monographic revisionary work, the Department of Entomology of the Natural History Museum, and the Royal Entomological Society, launched a new joint award for excellence in insect taxonomy in 2006. The medal will be awarded biennially, for the best comprehensive taxonomic work published on a group of insect or related arthropods, typically a taxonomic revision or monograph, as judged by an independent international panel of experts and agreed by representatives of the two organisations. The award of this medal recognises only the highest standards in descriptive taxonomy. The winner of the first award was Dr Marianne Horak, Australian National Insect Collection, CSIRO Entomology, Canberra, Australia, for her study of "The Olethreutine Moths of Australia" (2006, *Monographs on Australian Lepidoptera*, 10: 1-522, CSIRO Publishing).

We here announce that the third award will be made in 2012 and for which we now request nominations. The medal will be awarded for an outstanding recently published revision or monograph on a group of insects or related arthropods. The work nominated should have been published between 1st January 2009 and 1st January 2011. It is open to authors from any country in the world who demonstrate the highest standards in descriptive taxonomy in the work nominated. All interested in applying themselves, or in nominating another author, should submit a nominating letter, letters of support from two acknowledged experts, and at least one copy of the work by no later than 30 September 2011, to Westwood Medal, Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK, or electronically to j.westwood@nhm.ac.uk. We shall hope to announce the winner early in 2012 and to make the award at the International Congress of Entomology in Korea, from 19th to 25th August 2012.

The award has been named in honour of the leading 19th century British entomologist, John Obadiah Westwood (1805-1893). Westwood was the inaugural holder of the Hope Chair of Entomology at the University of Oxford, when it was established by the Reverend F.W. Hope in 1863. Westwood was one of the original group of founding members of the then Entomological Society of London in 1833 and served as President for three separate periods, 1851-52, 1872-73 and 1876-77. In 1883 he was elected to the unique position of Honorary Life President of the Society. He was a prolific author and published on most groups of insect and illustrated his own works, and those of many others, with his exquisite drawings and paintings.

Perhaps his most influential work was *An Introduction to the Modern Classification of Insects* published in two volumes in 1839, pp 1-462, and 1840, pp 1-587, by Longman, Orme, Brown, Green and Longmans, London. As a major appendix to volume 2 he added his *Synopsis of the Genera of British Insects*, pp 1-158. In this latter he first clearly established the concept of a type species for a genus, analogous to the type specimen for a species, and thus helped to provide a stable foundation for insect nomenclature. It is particularly appropriate that our award should be dedicated to this early pioneer of insect taxonomy.

Archie Murchie, Honorary Secretary, Royal Entomological Society

Andrew Polaszek, Keeper of Entomology, the Natural History Museum, London

ENTOGRAPHY

Tony Harman and Robert Pickett

tony.harman@tesco.net
library@papiliophotos.com

On 22nd April I took a specimen of *Drepanepteryx phalaenoides* at a light trap in our Beechwood at Turville Heath, Bucks. This is only about the third specimen I have ever seen and was collected in exactly the same place as the two previous specimens recorded over a twenty year period. This species seems to be associated with Beechwoods and has to be amongst the most cryptic of all our insects with its body shape at rest is similar to the Beech seed or nut. It is considered rare in Britain but, as can be seen, is easily overlooked when motionless amongst tree litter.

One of the members of Thanet Countryside Trust suggested he might like a picture of this rare beast for his library. I took the lacewing to Robert Pickett who runs a wildlife photographic business in Monkton where he took a few pictures then asked if he could take it home to his studio. He brought it back the next day and presented me with a photograph of the beast in flight.

Tony Harman

All the photographs (static & flight) were taken using Nikon D700 cameras and Nikon macro lenses, with a dual flash lighting so that shadows are kept to a minimum, without making the image too flat.

The flight photography utilises specialised High Speed Flash equipment that is used for all our high speed work to capture the creatures in motion. The trick is to understand the behaviour of the insect and to pre-determine when and how it flies. With that in mind we then build a set with particular flowers or foliage which is placed near a triggering beam and in this particular case the insect was encouraged to walk up the plant to a point where it then felt the only way forward was to fly off. This should then break the beam and set off the flash and camera to take a picture, and hopefully the insect is in the focal area that has been pre-determined and we end up with a sharp natural picture of the insect in flight.

We have been useing this type of photography for some time now and have been getting some stunning high speed results with various insects, it still amazes me seeing the way that various creatures fly and move, and we think the picture rewards are great. However it is not for the faint hearted. It is worth remembering that all the creatures we photograph are all released to their home environment, unharmed during their journey to photographic stardom.

Book Reviews

Fossils in Amber: Remarkable snapshots of prehistoric forest life

by David Penney & David I. Green

226 pages, 21 x 15 cm, 127 colour photos, soft cover.

Siri Scientific Press, 2011; in English.

ISBN 978-0-9558636-6-0.

Available directly from the publisher at http://www.siriscientificpress.co.uk;

Price £35.00 (includes p+p).

Fossils in Amber provides an excellent insight into the biodiversity and ecology of extinct tropical forests and represents an invaluable resource for understanding global change over tens of millions of years. There are many books on fossils in amber, but very few have such visually stunning photographs, which is where the current work stands out from the rest.

The book begins with an interesting introduction to amber, giving an insight into exciting new techniques, such as X-ray computed tomography and synchrotron scanning, for studying inclusions. This is followed by a summary of the relative diversity of different groups of arthropods within amber, and a lament for the often ignored inclusions of copal (sub-fossil resin), which is unfortunately considered too young and not worth studying by many palaeontologists. However, the authors point out that copal can be informative at many different levels, including as a repository of genetic data to pre-date any existing museum collections, as a proxy for understanding bias of the amber fossil record, and also as a record of recent extinctions. A brief but informative summary of each of the world's major amber deposits is given, highlighting the idiosyncrasies of each with references for the most up-to-date reviews. The introduction ends with a figure showing which orders of arthropods are present and in which amber deposits they occur; a world map is also included with these major deposits labelled. This is a valuable resource allowing a quick visual comparison of the biodiversity of the different amber deposits, as well as how common/rare certain organisms are in each amber deposit. These summary data are provided for the following deposits: Dominican, Mexican, Bitterfeld, Baltic, Australian, Ukrainian, Indian, Sakhalian, Oise (all Tertiary) and Canadian, Raritan (New Jersey), Russian, Ethiopian, Charentese, Burmese, Spanish, Lebanese and Jordanian (all Cretaceous).

A section on photography of amber fossils follows the introduction, highlighting the difficulty of taking good photographs and how to overcome these problems.

The main body of the work is laid out as a full page, close-up macrophotograph of a specimen(s) on the right hand page and text related to the specimen(s) on the left hand page. The photographs, over 100 in full colour, are exquisite in detail and were produced using the latest automontage techniques. This method overcomes the problems often associated with photographing fossils in amber. They are presented on a full page and the skill of the photography shows the fossils in life-like fidelity, with the tiniest details visible. The text is arranged in a consistent manner for each of the photographed fossils; the identification of class, order, family and species is given and paragraphs introducing the organism and their fossil record in general, also including non-amber fossils. The arthropods (mainly from Baltic and Dominican amber) covered in the book provide a very comprehensive coverage of those likely (or even unlikely, i.e. very rare inclusions) to be found as fossils in amber: crustaceans, myriapods, arachnids (spiders, harvestmen, pseudoscorpions, scorpions, camel spiders, whip scorpions, whip spiders, ticks and mites), springtails, bristletails, insects (silverfish, mayflies, damselflies and dragonflies, stoneflies, webspinners, crickets, stick insects, earwigs, rock crawlers, cockroaches, termites, preying mantises, bark and book lice, thrips, true bugs, snakeflies, alderflies and dobsonflies, lacewings, beetles, twisted-wings, ants, bees, wasps, fleas, scorpionflies, flies, caddisflies and moths), with representatives from each order figured. For large and diverse orders such as Araneae, Diptera, Hymenoptera, Coleoptera, Hemiptera to name but a few, several different taxa are illustrated, whereas for the less diverse and rare orders in amber only a single taxon is illustrated, e.g. for Siphonaptera, Strepsiptera. This section also provides images of examples of palaeoethology (fossilized behaviour), including mating, egg-laying, parasitism, commensalism and predation. The identities of many of the specimens illustrated in the book have been determined by world recognized entomologists, who are listed in the acknowledgement section.

Fossils in Amber: Remarkable snapshots of prehistoric forest life is a well written and spectacular visual guide to amber palaeontology, combining the different talents of the two authors; Dr David Penney is a world renowned amber palaeobiologist and Dr David Green is a highly skilled expert in photomicroscopy. It is fully referenced throughout and written in a clear, easily understandable manner, which makes it accessible to amateurs as well as professionals. It should have a broad appeal, and will be of interest to both amateur and professional entomologists, palaeontologists and anyone interested in natural history and photography, or to those with a general interest in amber.

James E. Jepson
School of Earth, Atmospheric and Environmental Sciences
University of Manchester, Manchester M13 9PL

Photographing the Microworld

by Svetlana Belorustseva and Andrei Sochivko

Tranlation by David Hefford in association with First Edition

Published by Vivays Publishing

Original Russian Edition Publisher: Art-Rodnik Publishing House

ISBN: 978-1-908126-00-9

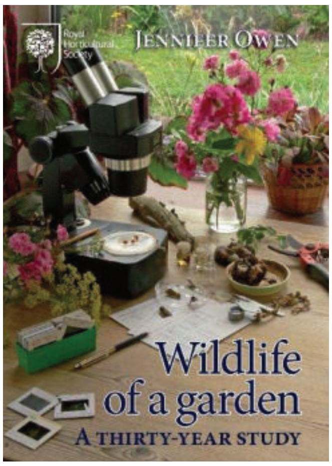
Price: £12

This book provides useful information on the mechanics of photographing nature, explaining the different lighting techniques necessary to obtain the "perfect" picture. Although the title and front cover appear to be referring to the insect world, actually the main focus of this book is photography and the insects featured are not always very well described or distinguished. As an amateur photographer I found the book both insightful and surprising, explaining the lengths professional photographers go to, changing backgrounds and manipulating the subjects. The book provides many recommendations for equipment and describes the techniques necessary to obtain the types of photographic effects pictured.

Many of the images in this book are described as being unique or that the creatures featured are being introduced to the public for the first time. This is probably true for the "general public" but the entomologists or biologists amongst us are more likely to have seen specimens like these before. There are many close-up photographs included of species that are relatively rarely seen though, and the breadth of species featured from a range of ecosystems was impressive. One of my favourite chapters was "Water in its Many Forms" which focused on the intricacies of photographing water droplets.

Overall, this book is very good value for money, being both inexpensive and a great coffee table book, to quietly flip through from time to time. I did find it quite a difficult read though, possibly because the "essence" of the book may have been lost during the translation process.

Felicity Crotty
University of Plymouth



Wildlife of a garden. A thirty year study

Jennifer Owen

Published by the Royal Horticultural Society.

ISBN 9781907057120

Price £30.00

When Jennifer Owen's previous book The Ecology of a Garden was published in1991 it was considered a milestone, the result of a herculean study. It received such praise that it was hard to imagine any improvements. Fifteen years on we are presented with an astoundingly detailed update and summary of a life's work and one that I am sure continues.

Wildlife of a garden is a superb account of the wildlife encountered in a Leicestershire garden over thirty years. It is superbly presented with an abundance of colour photographs to enhance the text. The opening chapters set gardens in the context of the local landscape and introduce the layout of the garden, catalogue its flora , discuss the local climate and the sampling techniques employed.

Subsequent chapters deal with specific groups of animals. Each one beginning with a brief account of their natural history before tabulating with notes, the species recorded. Each chapter concludes with tables and graphs of the abundance of the recorded species followed by a discussion.

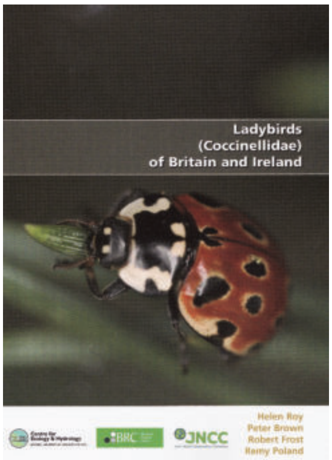
The final chapters discuss the ecology of gardens, gardens as conservation areas the trends displayed by the thirty-year study.

While dealing with the fauna of gardens it reflects the diversity of invertebrates that is only too familiar to entomologists but that many gardeners may not be aware of, with eight of the nine chapters dealing with the garden fauna devoted to invertebrates.

Anyone with even a casual interest in the natural history of gardens will find this book fascinating. It both introduces and catalogues a gardens fauna and flora. It is a mine of information for anyone with a growing interest in garden natural history. It is a book to keep available, a first port of call on returning from ones garden.

Chris Packham says in his forward "this is the handiwork of an endangered species", the field naturalist. We hope that wildlife of a garden will inspire a new generation of gardeners to take a more holistic view of their gardens, managing them for a wider clientele and investigating their faunas.

Peter Smithers



Ladybirds (Coccinellidae) of Britain and Ireland

Helen Roy, Peter Brown, Robert Frost & Remy Poland

ISBN 978-1-906698-20-1

Published by Centre for Ecology & Hydrology (CEH)

Price 19.50

This atlas is destined to become the key reference for anyone with an interest in British Ladybirds. It is a comprehensive account of this well known and much loved group of beetles and the survey that documented them.

The introduction contains a series of articles that detail the biology of ladybirds, their role in biological control and the impact and status of alien species. The history and mechanics of the recording scheme are explored in the following two sections.

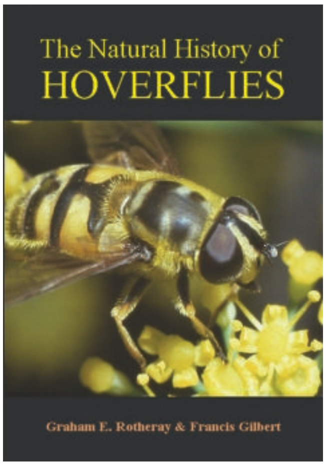
These are followed by the species accounts, each of which comprise a distribution map based on 10km squares which present records in three temporal classes, pre 1990, before and after 1990 and post 1990. There follows a review of the natural history of the species, photographs of the adult and in almost every case the larvae and pupae. Also notes on critical features to aid identification, a phenogram which presents the abundance of records across the seasons, notes on habitat, host plants and preferred foods. Each species account concludes with its distributional status and trend.

The final section of the atlas has an article on occasional and potential new arrivals, natural enemies including parasites and pathogens, a glossary of terms, references and an index.

The atlas is superbly illustrated with a wealth of colour photographs. It is an example of natural history publishing at its best, an authoritative volume packed with useful information presented in an attractive and easy to use format.

The book is dedicated to the memory of the late Michael Majerus and is a testament to his unbounded enthusiasm and dedication which has inspired a new generation of ladybird hunters. This atlas is a legacy of which he would have been very proud.

Peter Smithers



The Natural History of Hoverflies

Graham E. Rotheray & Francis Gilbert. 2011.

Forrest Text, Tresaith, Wales, UK, xiii + 333 pp (with 34 colour figures, two half-tones and 22 line figures, all in the text).

Paperback (ISBN: 978-0-9564692-1-2). RRP £32.50. Available through specialist bookshops.

Hoverflies are diverse and beautiful and their habits
and behaviour provoke both wonder and curiosity
Rotheray & Gilbert (2011: xi)

Hoverflies are the butterflies of the two-winged horde. With their bright colours and spectacular behaviour they offer a relatively accessible entrée to the fascinating but challenging world of the Diptera. However, at about 150,000 words, this book offers far more than a little dipterological titillation: it is a profound but also very personal introduction to the natural history of Syrphidae, based on the accumulated knowledge and experience of two leading hoverfly specialists, Graham Rotheray and Francis Gilbert. Their knowledge, they generously admit (p. xii), has also been primed and enhanced by their contact with numerous other specialists, including Chris Thompson, Martin Speight, Alan Stubbs, Jennifer Owen, Malcolm Edmunds, and the remarkable Dick Vockeroth, to mention but a few.

Following the fourteen page introduction, which discusses basics such as what hoverflies are and their four most characteristic attributes (hovering, visiting flowers, mimicry, larval biology), the rest of the book is divided into eleven chapters: adult form and function, early stages, evolution and classification, British hoverflies, colour and mimicry, relationships with flowers, syrphids as predators, syrphids as saprophages and phytophages, life-cycles and populations, habitats and communities, and finally hoverflies in ecosystem services and conservation. The book is completed with references, and species and subject indexes.

Adult form and function sounds as if it could be tedious, but it is presented in a most engaging style, including some very interesting observations on torpor and behavioural thermoregulation. The discussion of flight, so characteristic of 'hoverflies', is excellent (including the observation that the pipunculids, sister-group of the Syrphidae, may be even better aeronauts). The authors introduce an interesting biomechanical argument for the evolutionary trend to wing-vein reduction seen in the Diptera and actively flying insects generally: "Weight for weight, a single strengthened vein creates a more effective solution than two veins side by side". Given that they also acknowledge that the 'corrugation' of alternate long veins is another important contributor to wing strength, there has to be a limit to

Spilomyia digitata, a 'pefect' wasp mimic (photograph by Graham E. Rotheray).

vein reduction, but they do not discuss this trade off. They also point to the addition of the *vena spuria* (which has apparently been suggested to be formed at the boundary between the anterior and posterior wing compartments), and is a striking autapomorphy for the entire family.

Here and in many places in the book, there is a lack of referencing. While this is very understandable in a work of this kind, it is also frustrating, as it becomes difficult to distinguish the authors' own ideas (with which I suspect this book is replete) from existing, 'received wisdom'.

It has often been observed that entomologists are preoccupied with their genitalia. Well, you know what I mean! Apparently syrphydologists are no exception – the final six pages of Chapter 2 offer an excellent account of the almost baffling complexities of rotation, reduction, fusion and loss affecting the sclerites responsible for the endless variations observable in the syrphid male hypopygium. In this context, it is also notable that, in a way even more extreme than in butterflies, duration of copulation (T_f in John Burns terminology) in the hoverflies varies enormously. As Burns also suggested for butterflies, this may relate to relative vulnerability – according to Rotheray & Gilbert, T_f may last several hours in species of *Blera*, *Xylota* and *Eupeodes*, but only a few seconds in hoverflies that adopt the high-risk strategy of mating in flight (those not familiar with this aerobatic feat might like the remarkable image available at: http://en.wikipedia.org/wiki/File:Hoverflies_mating_midair.jpg).

The eternal shame of entomologists is the poverty of our knowledge of early stages. In Chapter 3, the authors estimate that life-histories remain unknown for more than 90% of the world fauna of *ca* 6000 hoverfly species. For Europe as a whole just over one-fifth are known, and in the British Isles just over half its fauna of some 260 species. In trying to address why this should be so, the authors point towards a view that adults are not only easier to find but also that, for the purposes of classification at least, "early stages are not required" (p. 45). They then rapidly disabuse us of any such notion: "The main hoverfly groups are in fact, more distinctively characterised by the structure and biology of their early stages than by adult features" (page 46).

Knowledge of early stages is not only of use with respect to more recondite matters of phylogenetics and evolution, but even to the seemingly more mundane matter of biological recording. The authors give the very nice example of *Callicera rufa*, so rarely encountered in the adult stage that it was given endangered status in the 1987 *UK Insect Red Data Book*. However, based on Ralph Coe's discovery of the larvae of this species in pine-tree rot-holes, *C. rufa* has since been found in numerous localities in northern Scotland, and taken off the endangered list – making the important point that the promotion of relatively common species to 'rare' status due to low encounter rate with the adults potentially diverts limited conservation resources away from more deserving causes. Chapter 4 includes numerous examples of the many fascinating peculiarities of syrphid life histories now known – but with less than 10% of species known worldwide, one can hardly guess at what remarkable early stage biology remains to be discovered.

Chapter 4 starts with an excellent introduction to the issue of what is involved, and what is possible in trying to understand the origin, evolution and diversification of any group of organisms – the interplay of history and ecology. According to previously published accounts by the authors, the (Pipunculidae + Syrphidae) form the sister-group of the higher cyclorrhaphous Diptera. This insight not only allows comparison with the other 'grade' families of the lower Cyclorrhapha (Lonchopteridae, Platypezidae, Phoridae), but also allows interesting comparisons to be drawn between the two focal groups – the pipunculids, which are parasitoids that hunt visually for their hosts (mostly leaf-hoppers and allies, but also adult craneflies), and the syrphids, which are never parasitic. The outstanding vision and flight control seen in both groups potentially represent different potentials inherent in the ancestral

"Microdontines . . . distinguished by their larval characteristics . . . develop in ant nests" (remarkable round larvae of *Microdon eggeri* in ant nest under bark of fallen pine tree: photograph by Richard Lyszkowski).

A male *Esoeristalis nemorum* displaying amazing powers of flight by hovering just above a feeding female (photograph by Ellen Rotheray).

potentials inherent in the ancestral enhancement of one or both of these systems – in the case of the syrphids, perhaps as an aid to defence against visually hunting predators. This leads to an interesting discussion of the relative 'success' of the two groups. The rest of the chapter is devoted to hoverfly phylogenetics and classification, feature evolution, and of origins. I was fascinated to learn that as many as 100 hoverfly fossils are known – testament, no doubt, to the heuristic value of the *vena spuria!*

Chapter 5, on the hoverflies of Britain and the rest of Europe, will no doubt be of particular interest to many readers of *Antenna*. But what is the exact extent of the British hoverfly fauna? The authors state that "since 1983 more species have been added to the British [list] than at any time since 1900." Although some of these appear to be recent immigrants, most are long-term residents that have simply been overlooked until now. These themes are explored in sections on resident hoverflies, summer visitors, strays or vagrants, and introductions. With respect to the last of these, the authors (p. 124) discuss the possibility that the spectacular Golden Hoverfly (*Callicera spinolae*), known in Britain only from the East Anglian region and a species of conservation concern, was quite possibly "introduced into Suffolk after the First World War" in timber imported from the continent – although they do not rule out autonomous migration. Alan Stubbs and Stephen Falk's milestone work on *British Hoverflies* (1983), together with the National Hoverfly Recording Scheme (1976) that Alan did so much to create, have been key stimuli for the flow of new discoveries about the British fauna over the past three decades. The need to place our knowledge of British hoverflies in the context of the west Palaearctic fauna as a whole is rightly emphasised.

The section on colour and mimicry addresses a number of topics, the stated aim being "to understand and explain the importance and diversity of colour patterns in the lives of hoverflies." In reality this chapter largely focuses on visual mimicry and hoverfly predation, ending with much shorter but still significant discussions on the roles of colour patterns in crypsis, thermoregulation and communication.

In my view this section of the book is not entirely successful in explaining the widely discussed issue of so-called "perfect" versus "imperfect" mimicry in the Syrphidae. This may stem in part from focusing almost entirely on the well-established theoretical distinction between Batesian and Muellerian mimicry to the exclusion of various other dynamics, together with an unjustifiably narrow definition of mimicry as something only to do with predators and predation.

The great value of this chapter, however, lies in the authors' accounts of several very important pieces of empirical research, notably those by the German biologist Gerhard Mostler and others by the Russian G.M. Dlusskii. Following discussion of what they see as the two major issues – the unexpected finding that the so-called imperfect mimics often appear far more abundant than their models, and the issue of imperfect mimicry itself, the authors come down in favour of explaining the latter by a combination of signal detection theory and the existence of multiple models. While I agree that the evidence is in favour of the hypothesis that the colour patterns of 'imperfect-mimic' hoverflies really do confer a defensive advantage due to mimicry *per se* (and not some other possible benefit), what is still lacking is a satisfactory explanation of so-called 'perfect' mimicry. Very interesting in this context is an observation due to Dlusskii reported by the authors: that spotted flycatchers are able to distinguish between social wasps and supposedly 'perfect' mimics such as the syrphid *Temnostoma vespiformis*. It appears that we have yet to discover which predators or other operators are really responsible for the more 'perfect' forms of mimicry.

The following chapter, on flowers and pollination, reflects the alternative vernacular name for the Syrphidae: flower flies. It commences with a brief but very nice review of the history of our understanding of the role of insects in pollination, from the initially discredited work of Christian Sprengel (1750–1816), via Charles Darwin to the current realisation initiated by Fritz Schneider's work in the late 1940s that pollen-feeding is vital to the fecundity of both sexes of many species of Syrphidae. Nectar and honeydew are mainly energy sources for flight. And, rather like butterflies and many other insects, various hoverflies also feed on plant sap, obtain salts and other minerals from dung, urine and mud, and drink plain water.

Blera fallax, an endangered British hoverfly thought to have been an early coloniser of Britain after the last ice age. (Photograph by Ellen Rotheray)

Chapter 7 goes on to look at a number of issues concerning the relationships between Syrphidae and flowers, both entomophilous and anemophilous, how the insects find them, specificity and preferences, factors affecting the utilisation of nectar versus pollen, foraging behaviour, hoverflies as pollinators (apparently significant, even in comparison to honeybees) and, intriguingly, "flowers as more than food" – mainly as sites for mate location and courtship, but also for shelter and thermoregulation. In high latitudes and mountains it seems that heliotropic flowers may offer hoverflies a particular important heat resource.

The following two chapters address the three major feeding ways of larval hoverflies: predation (Chapter 8) and saprophagy and phytophagy. The predators include the remarkable Microdontinae that feed on ant brood, the numerous familiar Syrphinae that prey on aphids and coccids, but sometimes even on beetle larvae and adult insects, and a few specialised members of the Eristalinae that prey on aquatic insect larvae in pitcher plants or, as in the case of *Volucella*, on the brood of social bees and wasps.

The final three chapters look at the population biology and ecology of hoverflies, with the last mainly devoted to the ecological services that hoverflies offer to humans – notably as pollinators, as predators of aphids and other plant bugs, of mosquito larvae, in weed control, and in the clean-up of organic wastes. Against this good-guy roll-call we have to set the fact that a few phytophagous species can cause significant economic damage, including the narcissus bulb flies (*Merodon* spp.), which can attack onions and other economically important plants as well as ornamental bulbs, and *Cheilosia* spp. on artichokes – most likely opportunistic host-switching from native Asteraceae such as burdock. The last part of Chapter 12 addresses various conservation issues, finally concluding (page 303): ". . . who can resist the lure of these curiously energetic little insects, so richly endowed in colours, beneficial qualities, survival mechanisms and biological phenomena?"

What did I like least about this work? At times the authors seem uncertain of their audience. I am not sure someone willing to read such a substantial account of a single family of flies needs to be told that insect bodies are divided into head, thorax and abdomen (page 20). Typos seem relatively few, but I did notice that the pointed-wing flies on Figure 4.2 have suffered some form of family suffix-ectomy and also been called, rather awkwardly, "pointed winged flies", while in the same figure the Phoridae have be shorn of their 'h'. Some of the original line drawings are rather un-aesthetic to my taste, and the book does not handle well – it is a constant battle to keep it open at a given page, unless you are prepared to do some real violence to the spine. The work is completed by 170 references – which may sound a lot, but is not really sufficient for the very extensive content.

What did I like most? Almost all of it! This is what I call a 'real' book – it's not a pot-boiler, but an account that flows directly from the authors' profound personal knowledge and great enthusiasm for these wonderful insects. Moreover, the approach of highlighting the major biological features of the group, and then refining these issues in the form of a series of interrelated questions at the beginning of key chapters, offers an excellent model for anyone wanting to write a book about the general biology of any group of organisms.

This last point raises a challenge to which some readers of this review might respond. The commissioning editor would like to see this book become the first in a series on the scientific natural history of a variety of insect groups. To match *Hoverflies*, additional works would ideally come from equally knowledgeable and passionate authors. However, texts even less than half the length of this work, from about 60–70,000 words upwards, would be welcome.

Forrest Text (http://www.forrestext.co.uk) specialise in short-run digitally printed books, with a strong emphasis on biological subjects. This publication method keeps initial costs low, a huge help with getting specialised works of this sort into print. Anyone interested in making an insect natural history book proposal to Forrest Text should contact Bryan Sherwood (bryansherwood@ymail.com).

In final conclusion, this is a most notable contribution to the entomological literature. Anyone with an interest in the natural history of Diptera in general, and obviously Syrphidae in particular, amateur or academic, should have a copy of this book.

R.I. Vane-Wright
Entomology, the Natural History Museum, London SW7 5BD;
and DICE, University of Kent, Canterbury CT2 7NR, UK


"Remarkable... quietly spellbinding."
Variety
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Edition Rise and Shine and November Films

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BEETLE QUEEN CONQUERS TOKYO

A film by Jessica Oreck

List of screenings for Beetle Queen

http://www.beetlequeen.com/screenings.html

www.beetlequeen.com

"Observes the phenomenon with a curious, incisive eye."
– The New Yorker

BEETLE QUEEN CONQUERS TOKYO is a documentary feature which delves into the ineffable mystery of Japan's mystery age-old love affair with insects. A window on to the nature, beauty, philosophy and culture that might just make you question if your instinctive repulsion to bugs is merely a trick of western conditioning.

Sold live in vending machines and shops, plastic replicas included as prizes in the equivalent of a McDonald's Happy Meal and the subject of the No.1 videogame, *Mushiking*, insects inspire an enthusiasm in Japan seen nowhere else in this world. BEETLE QUEEN CONQUERS TOKYO discovers why Japan developed this rich and enriching social relationship with insects.

For Director Jessica Oreck, the idea had an immediate appeal. "My aim is to challenge the way westerners view nature, beauty and the hectic monotony of our day-to-day routine. It is my intention to inspire a new sense of wonder - one that does not overwhelm, but acts, like some gentle war of attrition, to slowly but substantially coax us into rethinking how we live our lives. As with Japanese culture, the film is subtle, but it functions as a passageway to a wholly different world of senses.

BEETLE QUEEN CONQUERS TOKYO premiered at SXSW and went on to screen at festivals from Glasgow to Melbourne. Alongside the film's release, there will be a programme of outreach screenings.

BEETLE QUEEN CONQUERS TOKYO will be released in UK cinemas on 1st July with previews from the 31st of May, followed by release on DVD in September 2011.

For a full list of previews, screenings and Q&A's go to the BEETLE QUEEN CONQUERS TOKYO Website http://www.beetlequeen.com/screenings.html

Running time: 90 mins / Cert: U
www.beetlequeen.com

For further press information / interviews please contact:
James Collie at November Films 0207 193 6580
james.collie@novemberfilms.co.uk

Diary

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

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

MEETINGS OF THE ROYAL ENTOMOLOGICAL SOCIETY

2011

Sep 7-9 **Ento'11 Symposium on 'Chemical Ecology' "Reception, Detection and Deception" and National Meeting**
Venue: University of Greenwich, Medway Campus, Chatham Maritime, Kent
Symposium Convenors: Prof. David Hall, Prof. Bill Hansson & Prof. John Pickett
National meeting convenors: Prof David Hall & Dr Gabriella Gibson
The meeting will consist of three plenary sessions running in the morning of each day, which make up the International Symposium on Chemical Ecology, followed by themed sessions in the afternoons which make up the National Meeting. There will be a general entomological session, along with a number of specialist topics.
Contributors include:
John Pickett (Rothamsted Research, UK)
Walter Leal (University of California, Davis, USA)
Laurence Zwiebel (Vanderbilt University Medical Centre, USA)
Dean Smith (University of Texas Southwestern Medical Center at Dallas, USA)
Bill Hansson (Max Planck Institute for Chemical Ecology, Jena, Germany)
Neil Vickers (Interdepartmental Program in Neuroscience, University of Utah, USA)
Mark A Stopfer (Laboratory of Cellular and Synaptic Neurophysiology, National Institutes of Health, Bethesda, USA)
Rickard Ignell (Swedish University of Agricultural Sciences, Alnarp, Sweden)
David Hall (Natural Resources Institute, University of Greenwich, UK)
Jim Miller (Department of Entomology, Michigan State University, USA)
Ring Cardé (University of California, Riverside, USA)
Murray Isman (University of British Columbia, Canada)

Sep 14-16 **A joint meeting with the Soil Ecology Society**
Venue: The National Marine Aquarium, Plymouth
Convenor: Prof. Rod Blackshaw
Soil has been described as the 'poor man's rainforest' because of the huge biodiversity that exists under our feet. It remains a scientific frontier of great importance to our understanding of processes essential to the maintenance of above-ground systems, and is key to the sustainable exploitation of land. The RES and Soil Ecology Society are organising their first joint meeting on soil biology. The aim is to bring together scientists from a range of biological backgrounds (microbes, mesofauna, macrofauna) to share experiences and understanding, and promote interdisciplinary thinking.
Contributors include:
Sina Adl (Dalhousie University)
John Dighton (Rutgers University)
Penny Hirsch (Rothamsted Research)
Matthew Shepherd (Natural England)

Sep 21 **Aphid Special Interest Group**
Venue: James Hutton Institute (formerly SCRI) Dundee, Scotland
Convenors: Drs Brian Fenton, Gaynor Malloch, Jorunn Bos & Jon Pickup
We anticipate running transport from Edinburgh airport to and from the Institute to coincide with the meeting. We have provisionally arranged sponsorship to cover the costs of the airport transport and an international speaker.

Oct 12 **Sustainable Agriculture Special Interest Group joint meeting with British Ecological Society Agricultural Ecology SIG**
Venue: British Ecological Society, Charles Darwin House, 12 Roger Street, London
Convenor: Dr John M Holland

Nov 1 **Infection and Immunity Special Interest Group**
Venue: University of Sheffield
Convenor: Dr Jens Rolff
Contributors include: Rebecca Rosengaus (Boston)
Lena Wilfert (Edinburgh)

Nov 18 **Searching for Unicorns, the problems with investigating rare or difficult invertebrates**
Venue: University of Plymouth
A joint meeting of the RES and the Peninsular Invertebrate Forum
Duncan Allen, The hunt for Nothyphantes, Plymouth's rarest spider
John Walters, Entomology on the run, investigating potter wasps.
For more information contact psmithers@plymouth.ac.uk

Nov 2 **Orthopterists' Special Interest Group**
Venue: Natural History Museum
Convenors: Dr. David Robinson and Mrs Judith Marshall

Nov 10 **Biology of Lepidoptera**
Venue: Rothamsted Research, Harpenden, Herts.
Convenors: Drs Jason Chapman & James Bell
This is one-day meeting covering all aspects of the biology of butterflies and moths, from physiology to population dynamics and flight behaviour.
Contributors include:
Ken Wilson (Lancaster) – Keynote Address
Richard Fox (Butterfly Conservation)
Jane Hill (York)
Jeremy Thomas (Oxford)
Jason Chapman (Rothamsted)
Melanie Gibbs (CEH)
Chris Thomas (York)

2012

Feb 1-2 **Postgraduate Forum**
Venue: Liverpool (tbc)
Convenor: Mr Steven Parratt

Mar 7 **Verrall Lecture**
Venue: Flett Lecture Hall, Natural History Museum
Professor Ilkka Hanski (University of Helsinki)
Title: The Glanville fritillary butterfly: ecology meets evolution
Demographic population dynamics, gene flow and local adaptation may influence each other and lead to coupling of ecological and evolutionary dynamics especially in species inhabiting fragmented heterogeneous environments. Studies on the Glanville fritillary butterfly *Melitaea cinxia* in Finland have documented reciprocal influence between ecological and evolutionary dynamics in dispersal, in inbreeding and population extinction, and in female host plant preference and population establishment. The most striking example involves genetic polymorphism in the gene phosphoglucose isomerase *Pgi*, which is associated with dispersal, recolonization and local population dynamics. In this case extinction-colonization metapopulation dynamics influence allele frequency changes in *Pgi* and vice versa. Eco-evolutionary spatial dynamics in heterogeneous environments may not lead to directional evolutionary changes, unless the environment changes, but eco-evolutionary dynamics may contribute to the maintenance of genetic variation due to fluctuating selection in space and time.

Jun 6 **RES Annual General Meeting**

Jun 25 – 1 Jul **National Insect Week**
National Insect Week (NIW) is coordinated by the Society and supported by almost 40 partner organisations. The aim of NIW is to encourage the public to take an interest in insects as one of the most abundant and accessible forms of biodiversity surrounding us. This is achieved through a variety of talks, 'bug-hunts', demonstrations, open days and workshops.
www.nationalinsectweek.co.uk

Jul 18 – 20 **Ento'12 – the National Meeting of the RES**
Venue: Anglia Ruskin University, Cambridge
Convenor: Dr Alvin Helden

Aug 19 – 25 **ICE 2012 - XXIV International Congress of Entomology**
Venue: Daegu, Korea

Diary of other Meetings

2011

Sep 5 - 7
Resistance 2011
Venue : Rothamsted Research, Harpenden, Herts
I:www.rothamsted.bbsrc.ac.uk/Research/Centres/Content.php?Section=Research&Page=Resistance2011
Email: resistance2011@bbsrc.ac.uk

Sep 8th
The role of behaviour in evolution: One-day international meeting
Venue : Linnean Society
I:http://www.linnean.org/fileadmin/events2/attachments/1305907153_Evolut ion%20Registration%20Form.pdf

Oct 2 - 5
Sixth International Symposium on Molecular Insect Science
Venue : NH Grand Hotel Krasnapolsky, Amsterdam, The Netherlands
I: www.molecularinsectscience.com/

Oct 11th
Aberdeen Entomological Club
Insects in amber - Andrew Ross, National Museum of Scotland
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

Oct 18-19
Wood Ant Symposium
Venue: James Hutton Institute (formally Macaulay Institute), Aberdeen, Scotland
I: http://www.hutton.ac.uk/events/wood-ant-symposium

Nov 8th
Aberdeen Entomological Club
Pinewood invertebrates - Hayley Wiswell, BTCV
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

Dec 6th
Aberdeen Entomological Club
Tbc -Veronique Forbes, University of Aberdeen
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

2012

Jan 10th
Aberdeen Entomological Club
Soil invertebrates - Hannah Urpeth, BTCV
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

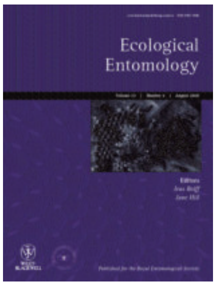
Feb 7th
Aberdeen Entomological Club
Saproxylic Diptera - Iain MacGowan, SNH
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

Mar 6th
Aberdeen Entomological Club
Phenological changes in the insect world - Gabor Pozsgai, The James Hutton Institute
Venue: The James Hutton Institute, Aberdeen
Contact: Jenni Stockan jenni.stockan@hutton.ac.uk

July 23-29
Combined Annual Meeting of the Lepidopterists' Society and the Societas Europaea Lepidopterologica
Venue: Denver Museum of Nature & Science, Denver, Colorado, U.S.A.
Registration opens from 1 December 2011.

Publications of the Royal Entomological Society

Agricultural and Forest Entomology provides a multi-disciplinary and international forum in which researchers can present their work on all aspects of agricultural and forest entomology to other researchers, policy makers and professionals.
2012 print or online prices: UK £625, Euroland €1,311, USA $1,908, Rest of World $2,225
2012 print and online prices: UK £719, Euroland € 916, USA $1,331, Rest of World $1,551



Ecological Entomology publishes top-quality original research on the ecology of terrestrial and aquatic insects and related invertebrate taxa. Our aim is to publish papers that will be of considerable interest to the wide community of ecologists.
2012 print or online prices: (with Insect Conservation and Diversity) UK £1,031, Euroland € 1,311, USA $1,908, Rest of World $2,225
2012 print and online prices: UK £1,186, Euroland € 1,508, USA $2,195, Rest of World $2,559

Insect Conservation and Diversity explicitly associates the two concepts of insect diversity and insect conservation for the benefit of invertebrate conservation. The journal places an emphasis on wild arthropods and specific relations between arthropod conservation and diversity.
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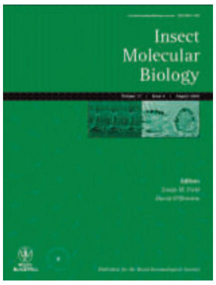

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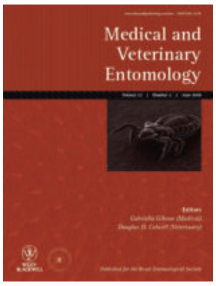
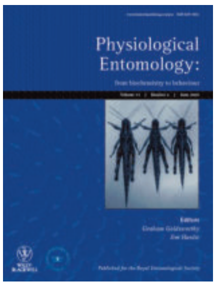
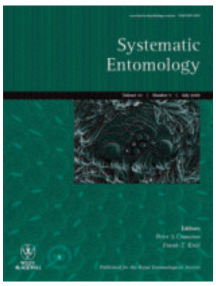
2012 print and online prices: UK £1,199, Euroland € 1,524, USA $2,217, Rest of World $2,585



Medical and Veterinary Entomology is the leading periodical in its field. The Journal covers all aspects of the biology and control of insects, ticks, mites and other artropods of medical and veterinary importance.
2012 print or online prices: UK £600, Euroland €765, USA $1,111, Rest of World $1,297
2012 print and online prices: UK £690, Euroland € 880, USA $1,279, Rest of World $1,492



Physiological Entomology is designed primarily to serve the interests of experimentalists who work on the behaviour of insects and other arthropods. It thus has a bias towards physiological and experimental approaches, but retains the Royal Entomological Society's traditional interest in the general physiology of arthropods.
2012 print or online prices: UK £553, Euroland €704, USA $1,023, Rest of World $1,194
2012 print and online prices: UK £634, Euroland € 810, USA $1,177, Rest of World $1,373



Systematic Entomology encourages the submission of taxonomic papers that contain information of interest to a wider audience, e.g. papers bearing on the theoretical, genetic, agricultural, medical and biodiversity issues. Emphasis is also placed on the selection of comprehensive, revisionary or integrated systematics studies of broader biological or zoogeographical relevance.
2012 print or online prices: UK £996, Euroland €1,267, USA $1,844, Rest of World $2,151
2012 print and online prices: UK £1,145, Euroland €1,458, USA $2,120, Rest of World $2,475

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

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

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

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

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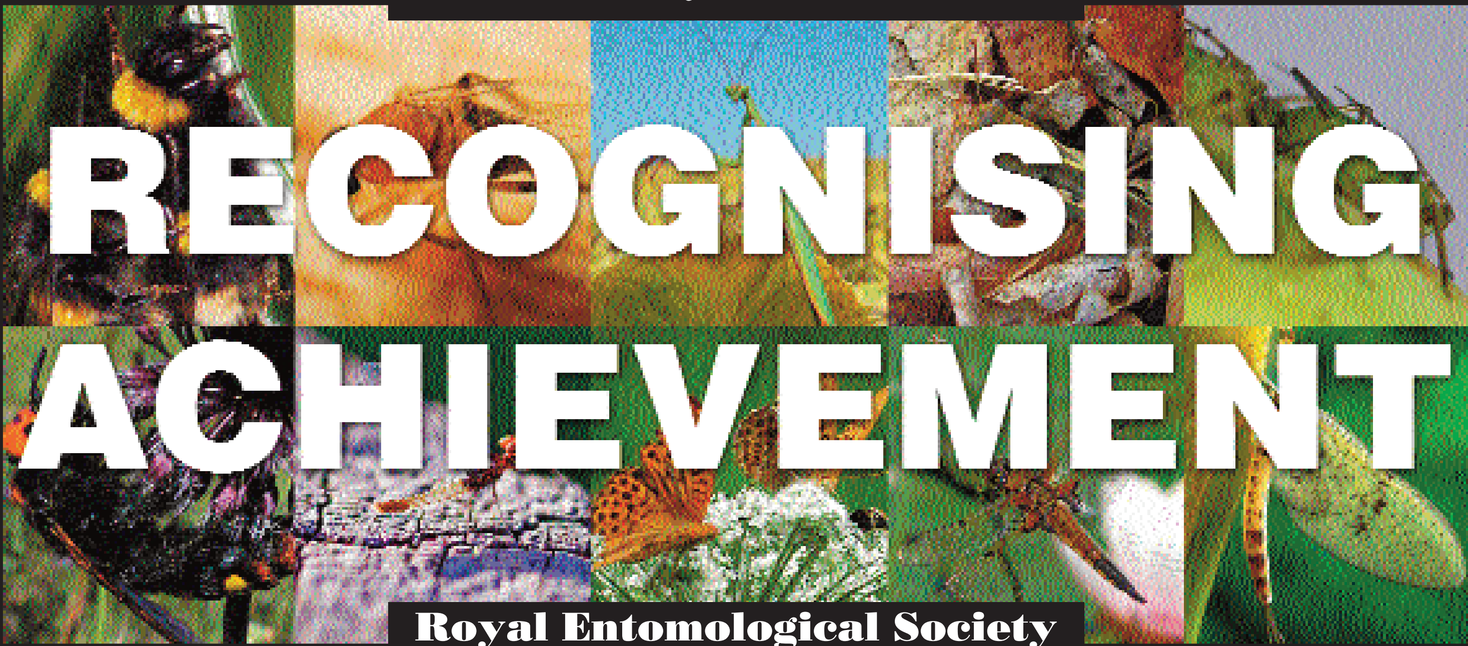

Royal Entomological Society
– Society Awards –

THE ROYAL ENTOMOLOGICAL SOCIETY STUDENT AWARDS

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

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

THE LJ GOODMAN AWARD FOR INSECT BIOLOGY

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

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

THE MARSH AWARD FOR INSECT CONSERVATION

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

Prize: £1000 and Certificate.

THE MARSH AWARD FOR EARLY CAREER ENTOMOLOGIST

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

Prize: £1000 and Certificate.

POSTGRADUATE AWARD: THE ALFRED RUSSEL WALLACE AWARD

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

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

JO WESTWOOD MEDAL – AWARD FOR INSECT TAXONOMY

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

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

RES JOURNAL AWARDS SCHEME

Award Criteria: The best paper published in each Society Journal over a two year period. Each of the Society Journals participate biennially. **Prize**: £500 and Certificate for each participating Journal.

THE WIGGLESWORTH MEMORIAL LECTURE AND AWARD

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

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

BOOK PURCHASE SCHEME FOR FELLOWS AND MEMBERS IN DEVELOPING COUNTRIES

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

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

OUTREACH AND CONFERENCE PARTICIPATION FUNDS

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

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

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

ROYAL ENTOMOLOGICAL SOCIETY · FOUNDED 1833

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