Bulletin of the Royal Entomological Society Winter 2011 Volume 35 (1)

antenna

MARINE AND COASTAL ENTOMOLOGY

meetings of the society

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

2011

2 March	2011 Verrall Lecture Venue: Natural History Museum, London
31 March 2011	Medical & Veterinary Entomology Special Interest Group Venue: The Linnean Society of London, Burlington House, Piccadilly
13 April 2011	South East Regional Meeting Venue: Brogdale Farm, Faversham, Kent
12 May 2011	Conservation Special Interest Group Venue: Rothamsted Research, Harpenden, Herts
1 June 2011	Royal Entomological Society Annual General Meeting Venue: The Mansion House, Chiswell Green Lane, St Albans, Herts
30 June 2011	Northern Irish Regional Meeting Venue: Ulster Museum
3 July 2011	Insect Festival Venue: York Museum Gardens, York
7-9 September 2011	Ento '11 International Symposium on Chemical Ecology "Reception, Detection and Deception" and National Meeting Venue: Natural Resources Institute, University of Greenwich, Medway Campus, Chatham Maritime, Kent
14-16 September 2011	Joint Meeting with the Soil Ecology Society Venue : National Marine Aquarium, Plymouth
21 September 2011	Aphid Special Interest Group Meeting Venue: The James Hutton Institute (formerly SCRI), Dundee
October (TBC) 2011	Sustainable Agriculture Special Interest Group joint meeting with British Ecological Society Agricultural Ecology SIG
10 November 2011	Insect Behaviour Special Interest Group Venue: Rothamsted Research, Harpenden, Herts.
3 - 8 August 2014	10th European Congress of Entomology Venue: York

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

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Henestariua laticpes and Hornet robberfly feeding.

Photograph courtesy of John Walters

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Bulletin of the Royal Entomological Society

Editors:
Gregory J. Masters
(Ecological Conscience Ltd)
and
Peter Smithers
(School of Biomedical and Biological Sciences
University of Plymouth)
with
Vanja Cvetanovic

The Royal Entomological Society
The Mansion House,
Chiswell Green Lane, Chiswell Green,
St. Albans, Hertfordshire AL2 3NS
E-mail: antenna@royensoc.co.uk

Assistant Editors:
Duncan Allen
Business Manager: Bill Blakemore
E-mail: bill@royensoc.co.uk

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The Royal Entomological Society
The Mansion House, Chiswell Green Lane,
Chiswell Green, St. Albans, Hertfordshire AL2 3NS.
Tel: 01727 899387 • Fax: 01727 894797
E-mail: info@royensoc.co.uk

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EDITORIAL

Welcome to the winter edition of *Antenna*. In this edition you will find reports of meetings, news of a new butterfly centre in the USA and a series of articles dealing with marine and coastal insects. We also have an appreciation of the life and work of Paul Freeman which follows from the obituary in the last edition.

Please keep your copy on all aspects of entomology coming in, the editors are keen that the content of *Antenna* reflects the broad front on which our discipline is advancing. So articles from the frontiers of insect science and invertebrate natural history are very welcome. With this in mind we are particularly pleased to offer the articles on intertidal arthropods and marine insects featured in this edition. Remember articles in *Antenna* are not an alternative publication venue but an additional one, a chance to present your work to a wider entomological audience.

We have a new set of deadlines for copy; these have been put in place to bring *Antenna* back in line with its original publication dates. However if you miss one of these deadlines you are safe in knowledge that you are in plenty of time for the next edition.

The copy dates are; 1st Jan, 1st March, 1st July and 1st October.

Events for the diary are due five days before each of the above dates.

After many years in the post Craig Mcadam has stepped down as editor of the *Antenna* diary. We would like to offer an enormous vote of thanks for his dedication and hard work in pulling the diary together for each issue and wish him well for the future. The new diary editor is Duncan Allen who is a well known figure having worked with the post graduate forum and the insect festival. We offer him a very warm welcome and look forward to working with him. Events for the diary should be sent to Duncan at antennadiary@gmail.com

Coastal and marine entomology

Insects are well known as the dominant fauna of terrestrial ecosystems and as a vital component of freshwater systems. There is however a perception that once the strand line is approached insects play little part in natural processes and that the crustaceans, annelids and echinoderms become the major groups of invertebrates. Few biologists it seems have explored the role of insects between the tides and beyond. We hope that this selection of articles and those that will follow in future issues will raise the profile of insects in and on the margins of marine habitats and encourage more entomologists to take an interest in this neglected area.

This collection of articles has arisen from two meeting held in the SW over the last four years. One was a joint meeting of the RES and the Marine Biological Association, held in the MBA's laboratories on Plymouth Hoe. The other a follow on session from this at the society's annual meeting which was held at the University of Plymouth in 2008. Both of these meetings examined a wide range of subjects ranging from the biology of oceanic hemiptera to the entomology of the strand line and shingle invertebrates. Many of the articles presented here have arisen from presentations made at these meetings while others have been commissioned to fill some of the gaps.

This area of entomology has been pioneered and championed by Lanna Cheng at the Scripts Institute of Oceanography, San Diego. We would like to thank her for her support and encouragement while put this edition together. Early work in this field is summarised in her book Marine Insects, which is now available as a free downloadable PDF from http://www. escholarship.org/uc/item/1pm1485b #page-3. While recent work in this area can be found at the marine insect home page http://cgi.unk.edu/hoback/marine insects/home.html

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

THE PRESIDENT

Professor Stuart Reynolds is the new President of the Royal Entomological Society. He is Emeritus Professor of Biology at the University of Bath (which means that he has recently retired from his full-time academic job – he comments that not being paid any more doesn't seem to have made much difference to his workload!). Stuart has been a Fellow of the Society since 1974. He previously served on the RES Council during the 1980s. He co-organised (with Glenda Orledge) the Society's 2006 National Meeting at Bath, and also (with Jens Rolff) its 2009 Symposium at Sheffield. His special area of research is in insect disease, and he has up until recently been co-convenor of the Society's Infection and Immunity Special Interest group. He has published more than 120 scientific papers.

Stuart comments, however, that his research career has been notable for shape-shifting among a number of different areas of insect science. He studied both as an undergraduate and a research student at the University of Cambridge where he did his PhD (1970-73) with Professor Simon Maddrell FRS in the Department of Zoology. He originally worked on the mechanical properties of insect cuticle, an interest that led him to migrate to the University of Bristol to work as a Science Research Council postdoc (1973-75) with Charles Neville, then the doyen of insect cuticle specialists. Realising that one of the most important functions of the cuticle is in moulting, Stuart then spent two years (1975-77) as a Harkness Fellow in the USA at the University of Washington, Seattle, where he worked with James Truman and Lynn Riddiford on the hormonal control of moulting behaviour, a topic that he was surprised to find closely involved cuticle mechanics.

Stuart has been at the University of Bath since 1977 as a member of what is now the Department of Biology and Biochemistry. He has been a visiting Professor at the University of Nevada in the USA, and also serves on the scientific advisory board of the Institut de Biologia Evolutiva in Barcelona, Spain. During his time at Bath, as well as being an enthusiastic teacher, Stuart acted as Head of Department, Head of the Natural Sciences Programme, and Chair of Quality Assurance, as well as being a member of both Senate and Council. During this time he continued to do research on caterpillars, publishing papers on the nervous and hormonal control of the heart; on feeding behaviour and food choice; on fungal toxins affecting insects; on the mode of action of several different insecticides; on the biochemistry of enzymes involved in moulting; on the programmed cell death of insect muscle cells during metamorphosis; and on the biology of lepidopteran sperm.

At the turn of the twenty-first century, Stuart comments, he finally decided to cut down on these diverse research interests, and has since 2000 published mostly on just one topic - the interaction between the virulent insect bacterial pathogen *Photorhabdus luminescens* and the insect immune system. He comments that insect diseases are particularly well suited to experimental investigation, and that it is both scientifically productive and intellectually rewarding to try and sort out what is going on when two or more organisms interact in disease processes. Disease is something that affects every multicellular organism and the virulent adaptations of pathogens and the immune defences of their hosts must have been among the earliest adaptations to evolve among eukaryotes, billions of years ago. Stuart considers that disease is just one end of a continuum that stretches all the way from pathology to symbiosis.

However, he admits that old habits die hard, and that he found it impossible not to be interested in everything entomological. So from 1998 to 2010, Stuart was co-editor (with David Denlinger) of the *Journal of Insect Physiology*. During this time he edited literally hundreds of papers. He comments that this very positive experience enabled him to keep up with a wide range of insect research. But eventually, he says, he thought that it was about time he gave someone else a chance to do this wonderful job.

Stuart has continued to be very interested as an amateur in other aspects of entomology. He says he enjoys probing the biology of insects that specialise in eating Fungi. First among these are the tiny beetles of the Family Ciidae, all of which live their lives almost entirely inside the fruiting bodies of wood-rotting fungi. Another "amateur" interest is a group of flies in the Family Cecidae, the paedogenetic larvae of which also specialise in wood rotting fungi, but in this case living in the very hostile environment at the interface between the mycelia of competing fungi. These insects are not only almost unkillable with very toxic insecticides, but also have quite extraordinary genetic systems, which are much too complicated to explain here. Stuart says that he expects to go on being very interested in both ciids and cecids now that he doesn't have to justify this interest to anyone else!

He also comments that he takes considerable satisfaction from the fact that during his career he has worked with insects from several different Orders – at Cambridge with the (in)famous blood-sucking bug *Rhodnius*, at Bristol on desert locusts and blowflies, and in Seattle on the very large caterpillars of sphingid and saaturniid moths. He is now probably most closely associated, however, with the tobacco hornworm moth *Manduca sexta*, a culture of which he established under licence at Bath for his own research, and from which he also supplied many other researchers in the UK and Europe. Stuart comments "Nowadays, interest in insects in Universities and Institutes is very strongly dominated by work on *Drosophila melanogaster*. I don't dispute that it has been very valuable in recent years to concentrate research efforts on the molecular genetics of fruit flies, but it would be a great mistake to regard this workhorse model insect as the only insect that we need to know about. *Drosophila* is not a typical insect, and now that DNA sequencing has become so easy and cheap, there's no excuse for not knowing about a wide range of insects. I'm not talking about just pests either. There are other insect models that are well worth studying intensively for their own sake, not to mention ecologically important insects such as pollinators and parasitoids. There are more insects than all other animals put together, and I am determined as President of the RES to make policy makers understand that we humans ignore the diversity of hexapods at our peril. The more we know about the immense range of form and function among insects, the better."

Taking over the RES Presidency at the Society's AGM at Rothamsted on 2nd June 2010, it wasn't long before Stuart was in action helping to launch National Insect Week at Butterfly World, St Albans (21st June), co-convening a Society SIG Meeting in Oxford (22nd June), and then speaking at Westminster Central Hall on the same day on behalf of the Society at the launch of the joint Research Council Insect Pollinators research grant initiative, not to mention composing a daily blog for NIW. He's now looking forward to

CORRESPONDENCE

Weevil identification

Dear Editors,

I have identified the insect figured on p. 162 of *Antenna* 34(4) as *Coniocleonus excoriatus* (Gyllenhal). It is a weevil (Curculionidae) and belongs to the subfamily Lixinae (formerly Cleoninae). This species occurs throughout the Mediterranean region, westwards to the Canary Islands and eastwards to Turkey. Its habits are unknown but its relatives live, as larvae, in the stems of herbaceous plants, commonly thistles or umbellifers. I would also like to compliment Mr Cook on his superb photograph which made the identification possible.

Yours faithfully,

R. T. Thompson

Dear Editors,

I respond (rather tentatively) to the request by Colin Cook (34 (4): 162) for identification of the cleonine weevil depicted. Unfortunately, the image shows the insect in profile, whereas a dorsal view would have been more informative. My suggestion is either Coniocleonus excoriatus (Gyllenhal) or C. nigrosuturatus (Goeze).

Regards,

Dr Mike Morris (1183)

Butterfly names

Dear Editors,

I was interested to read the article by Pol Grymonprez and Leigh Plester in the latest *Antenna* ('A rose by any other name', 2010, 34(3), 123-125) discussing the etymology of the word 'butterfly'.

The article mentions that the Welsh term for butterfly is *Pili Pala*, derived from the old root for flying in the Indo-European language family (*pl). The term *Bili Bala* has also been used, according to one dictionary; the letter 'p' can undergo a soft mutation to 'b' in Welsh, but I have never heard this variant used.

In north west Wales during my youth the metaphorical term *Glöyn Byw* ('living gem') was most commonly used. Other metaphorical Welsh terms for 'butterfly' include *Iar Fach yr Haf* ('little bird of summer') and *Plufyn bach yr Haf* ('little feather of summer').

Dafydd Lewis

Paul Freeman DSc, ARCS, Hon FRES. Seated here at his desk in the Keeper's Office on the fourth floor of the old NHM Entomology Building, Paul is eyeing the camera in a style absolutely typical of his manner when interviewing or questioning staff. If you had anything to hide it could be quite unnerving!
Photograph: NHM Photo Studio, *ca* 1975.

An appreciation of Paul Freeman

DSc, ARCS, Hon FRES

(26.v.1916–31.vii.2010), with a bibliography of his published entomological works

Richard P. Lane, Roger L. Blackman, Brian H. Cogan, Cindy Cogan, Peter S. Cranston, Roger W. Crosskey, Peter M. Hammond, David Hollis, Anthony M. Hutson, Laurence A. Mound, Adrian C. Pont, Klaus Sattler, W. Gerald Tremewan and Richard I. Vane-Wright

Paul Freeman, like so many biologists of his generation, was fascinated by natural history from early childhood. Paul's first hand knowledge of insects, gained in local hedgerows, ponds and woods, laid a solid foundation for the culmination of his scientific career, as Keeper of Entomology at London's Natural History Museum.

Childhood and Education

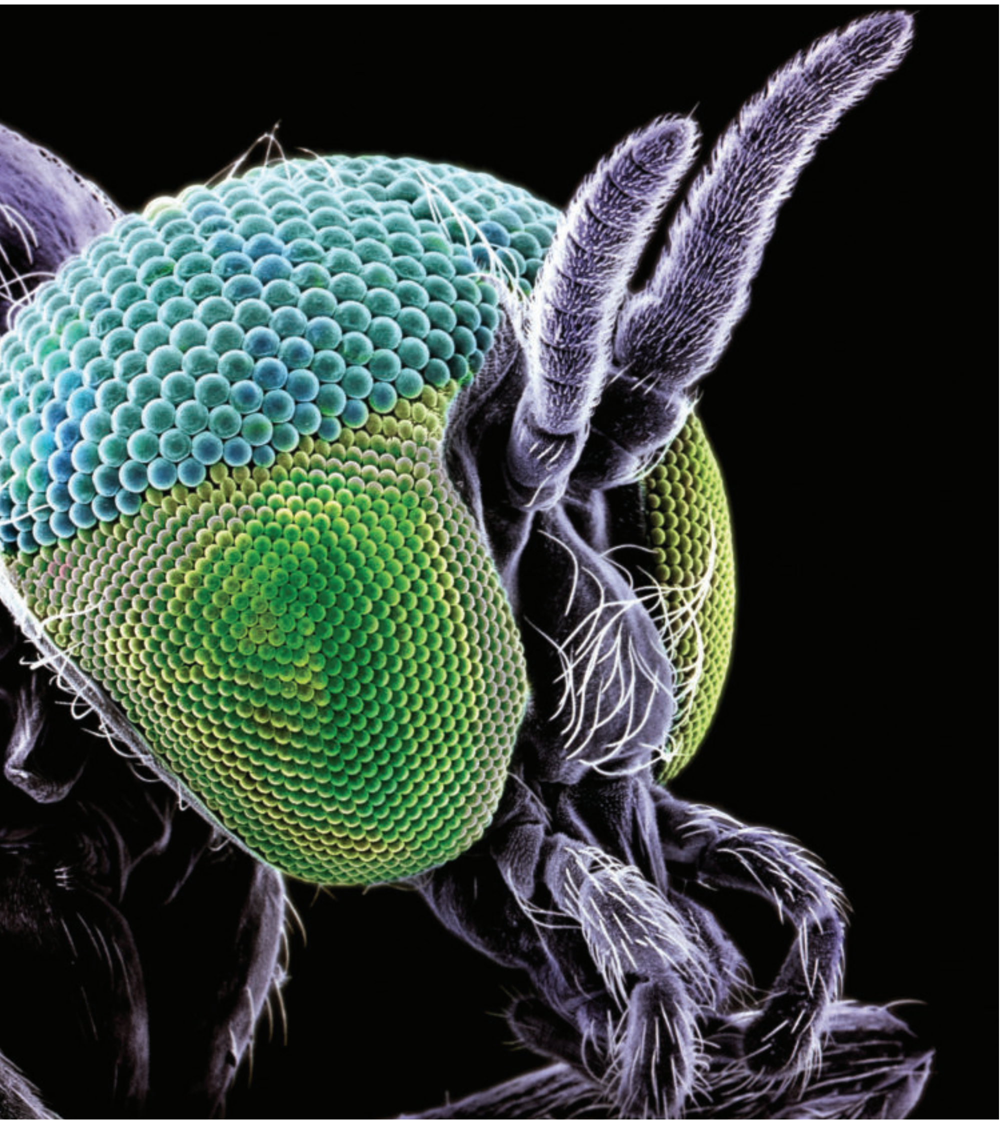
Paul was born at Brentwood, Essex, on 26th May 1916, son of a London Post Office engineer. He attended Sir Anthony Browne's School at Brentwood from 1921-1934. Following award of an Essex Education Committee open Exhibition and Board of Education studentship, Paul enrolled as an undergraduate at Imperial College of Science and Technology (University of London), at South Kensington. Three years later, in summer 1937, he graduated with First Class Honours in Biology (Entomology), became an Associate of the Royal College of Science, and was awarded the Marshall Prize as the best biology student in his year.

(Above) A female *Simulium (Edwardsellum) damnosum* Theobald – the last but probably most important blackfly dealt with in *The Simuliidae of the Ethiopian Region* (1953).

Photograph: Stefanie Meredith.

(Below) Although not much attracted to simuliids, it was on this family that Paul Freeman produced his outstanding taxonomic achievement, *The Simuliidae of the Ethiopian Region*.

Photograph: false-coloured SEM of the head of *Simulium (Boophthora) erythrocephalum* (De Geer), by Carolyn Lowry. NHM Picture Library.



Paul's first professional position (1937-1939) was as a Demonstrator at Imperial College, where he was also employed as a research assistant on African cotton pests. During this period he was elected to the Fellowship of the Royal Entomological Society of London, in 1938.

As WWII became inevitable, Paul volunteered for the Royal Artillery. Commissioned in 1940, he was initially posted to anti-aircraft duties, and spent two years as Brigade Intelligence Officer. In 1942 he was seconded to the Ministry of Supply's Army Operational Research Group, based in Petersham, Surrey, where he spent the rest of the war, reaching the rank of Captain. In this role he spent several months in Belgium engaged on counter-measures against Nazi V2 rocket attacks.

As soon as the war ended in Europe, Paul returned to Imperial as a Lecturer in Entomology and resumed work on the taxonomy of Old World cotton insects – notably various Pentatomidae and Pyrrhocoridae. His publications soon earned him an MSc, awarded in 1946.

At the Natural History Museum

In 1947 Paul moved the few hundred yards separating Imperial from the Entomology Department of the British Museum (Natural History) (now Natural History Museum: NHM), to take up a Senior Scientific Officer post in the footsteps of the late Frederick W. Edwards, the Museum's former specialist on lower Diptera – the so-called "Nematocera". However, unlike Edwards, Freeman was not given responsibility for the mosquitoes, which were entrusted to a colleague, Peter Mattingly, who had been offered an SSO post the previous year. Mattingly proved to be an outstanding mosquito taxonomist who also had great insight into the biology of mosquito-borne diseases. A third graduate member of the Museum's Diptera team at that time was Harold Oldroyd, a specialist on "Brachycera", and for many years Paul and Harold were close friends as well as professional colleagues.

Over the following 50 years, in a total of some 80 publications on Diptera, Paul described more than 500 new species, with an emphasis on Simuliidae, Mycetophilidae, Sciaridae, Scatopsidae and Chironomidae (see Bibliography, below). Paradoxically, since Paul was not much attracted to the simuliids, it was on this important family that he produced his outstanding taxonomic achievement, *The Simuliidae of the Ethiopian Region* (1953). This book was the outcome of a symbiotic arrangement between Paul and Botha de Meillon, an entomologist at the South African Institute of Medical Research. They never met but nonetheless produced a seamless volume – the joint publication dictated because many of the type specimens were in Johannesburg. Paul, however, was the mastermind. The great virtue of the work was that, after years of frustration, medical entomologists could identify Afrotropical blackflies, or at least set about the task with confidence. The work remains of special value to fieldworkers involved with onchocerciasis ('river blindness'), a human filarial disease which has undergone an explosion of research

(Above) A long view of one wall of Freeman's Insect Gallery at the NHM, taken just before it opened in October 1968. The contemporary, cool, almost 'Scandinavian' style is notable, as are the very large etched images of insects created from Arthur Smith line drawings. To the right is part of the "butterfly screen".

Photograph: NHM Archives.

(Right) The so-called "butterfly screen". In reality this eye-catching display, designed to draw visitors into the cul-de-sac gallery, comprised many sorts of large, impressive and colourful insects. Also intended to evoke a sense of wonder and curiosity, the rationale of this wonderful display was totally lost on the coming generation of exhibition specialists, who foolishly denigrated it for its supposed lack of didactic content!

Photograph: NHM Picture Library.

and in which "Freeman & de Meillon" played a key part – a book with landmark status. In addition to the written work, in the late 1940s and early 50s Paul was the key person for simuliid identification, and generous with his time. More than a few entomologists of the old Colonial Service, with specimens brought home on leave from Africa, were grateful for his expertise – "Take it to the B.M., Freeman will know what it is."

One third of Paul's scientific publications concerned the Chironomidae. His work on this major family of non-biting midges helped underpin much environmental research into freshwater quality. However, to contemporary specialists he is now best known for his outstanding contribution to untangling the taxonomy of the chironomid fauna of sub-Saharan Africa. The results were published as four parts of the Entomology series of the *Bulletin of the British Museum (Natural History)*, in 1955, 1956, 1957 and 1958. These major works were followed by large papers on the Chironomidae of New Zealand in 1959, and of Australia in 1961 (see Bibliography). Later, in collaboration with Peter Cranston, he wrote the Chironomidae part of the *Catalogue of the Diptera of the Afrotropical Region* (NHM, 1980), a Diptera Section project to which he gave his keenest blessing—and stoutly defending the editors when it inevitably took longer than planned.

In his work on the African midge fauna, Paul was confronted with the problems posed by Abbe J.J. Kieffer, whose work he described as "very erratic", noting his "very uncertain" concepts of genera, paucity of illustrations, and re-descriptions of the same species "over and over again not only in different papers but even in the same one". Although Paul examined as many of Kieffer's types as could be found (many are lost amongst the 300 Kieffer described from the region), and he disentangled the taxonomic confusion as best he could, he concluded that more collecting was needed at the various type localities. Unfortunately much still remains to be done in this regard, even more than 50 years on.

In a different role, Paul's efforts on behalf of the 12th International Congress of Entomology, held in South Kensington in 1964, were another outstanding step in his career. He was Organiser and Honorary Secretary for the Congress, 1960–1964, at which some 800 papers were presented, with 1800 delegates from all over the world.

As a result of his research productivity and proven organisational ability, he was promoted in 1953 and again in 1965, when he became one of the department's two "Deputy Keepers". Then, in 1968, he was appointed Head of Department, or Keeper of Entomology. In 1971 Paul reached his final Scientific Civil Service rank of Deputy Chief Scientific Officer, after which he continued as head and leader of NHM entomology until his retirement ten years later, at the age of 65. Just days before his retirement, he was formally presented to the Queen during the royal visit that marked the 1981 centenary of Waterhouse's great museum at South Kensington.

Paul Freeman: the man

In his private life Paul was interested in theatre and literature, especially poetry and the works of William Shakespeare. Paul was also a very enthusiastic gardener, and encouraged both his daughters in this pursuit. Practical (he was very keen on 'DIY' around the home), possessed of great energy and enthusiasm (he rarely used a lift, preferring to bound up stairs several at a time), above all he was a devoted family man. In 1959, when awarded his DSc by the University of London, he told colleague Roger Crosskey that he was more pleased for his parents than himself, as they had sacrificed so much to give him a good education.

Paul also had a great and frequently wry sense of humour, and his characteristic laugh could often be heard about the Department. Roger Crosskey recalls: "One day Paul and I were walking through the public galleries when we passed an anthropology exhibit that featured a naked figure of a small Neanderthal woman. Her left hand was grasping a long upright stave, while her right hand was curved round it, almost touching the tip. 'Just look at her' Paul exclaimed, 'she's chalking her billiard cue!'."

Paul Freeman: his influence and legacy

Paul Freeman's contribution to entomology extended far beyond his own research. Three years before his appointment as Keeper, Paul had been given special responsibility to replace the NHM's antiquated and run-down entomology exhibition. The new Insect Gallery opened to the public in October 1968 – the same month in which he was appointed Keeper. In place of the former serried rows of browning insects and turgid text the new gallery charmed and informed the public with a colourful display that highlighted the remarkable diversity of insects as the most abundant life form on Earth. Drawing on his remarkably broad entomological knowledge, he engaged the public with the simple beauty and extra-ordinariness of insect life. He was the last NHM Keeper to mastermind and create a major gallery at the Museum, being responsible not only for the content and storyline but also the display of material. In the final stages of the gallery's preparation he was to be found personally placing specimens in their new cases and checking the labels and illustrations for their ability to inform.

A curiosity about Paul's influence in this context is that, despite his great knowledge of general entomology, based in part on his childhood experience, he was not enthusiastic about his staff doing research on British insects. After about 1948 he did very little fieldwork – in the UK or abroad. Paradoxically, at this same time and again much later he made significant contributions to the RESL *Handbooks for the Identification of British Insects* series (publications [14-19] and [77-80] in the Bibliography). Another oddity was his standpoint on artwork. A competent illustrator himself, he insisted that any researcher should be able to illustrate his or her own papers. In this regard he was less sympathetic than usual towards his colleagues, even though it was undeniable that taxonomists vary greatly in their artistic abilities.

Another very individual, one could even say idiosyncratic approach to his job as Keeper was the way in which Paul handled the Department's interface with the general public. He seemed to see himself very much as a public servant, which meant, for him, giving a high priority to the museum's collections and core research activities and, perhaps above all else, its direct dealings with the "outside world". However, he was not interested in entrepreneurial ventures as such, even though some of his younger staff were beginning to look for ways to make museum work more valued.

Realising that Paul spent a good part of almost every morning dealing personally with public correspondence and telephone calls, Peter Hammond recalls asking him if it might be a good idea to make some of this the job of a dedicated enquiry service – thereby relieving him of routine tasks, being a bit more proactive, and even generating income. Although this sort of arrangement eventually came to be, Paul was not keen on the idea – and explained why.

Paul personally handled most 'general' enquiries from the public himself, identifying virtually all the common pests sent in, and only going to other members of staff to double-check or if he was in doubt. As a result, a large part of the Department's interface with the outside world was handled by him personally. Paul claimed, with much justification, that this kept his feet on the ground, his finger on the public pulse – and also led to daily dealings with many of his staff, some of whom he might otherwise have had little contact. When pressed he admitted that this could be useful in management matters, as it did provide him with insights into just how knowledgeable, clear-thinking, literate and efficient members of staff were, even the most junior. Paul added that he also simply enjoyed this sort of activity – he felt he was good at it (and indeed he was) and that the public, our masters, deserved the best!

Paul made very significant contributions to the Royal Entomological Society of London, and to a number of international committees. For the RESL he was a Finance Committee Member 1954-1957, a Council Member 1963-1965, Chairman of Publications Committee 1955-1957, Vice President in 1956 and again in 1957, and Honorary Secretary 1958-1962. He served on the Permanent Committee of the International Congresses of Entomology (ICE) 1964-1976, was an honorary secretary and entomology representative to the International Union of Biological Sciences, and a member of the World Health Organization's Expert Advisory Panel on Parasitic Diseases. Through these activities, and in particular his active role within the RESL and for ICE, he contributed a great deal to the networking that underpins any successful scientific discipline. This was later recognised in 1984 by Honorary Fellowship of the Royal Entomological Society, and appointment in 1988 as an Honorary Member of the Council of the International Congresses of Entomology.

Permanent Committee of the International Congresses of Entomology, Washington DC, 1976. Paul is seated, second on the left, next to the man in blue.
Photograph: courtesy of Laurence Mound.

As a researcher his output on the Simuliidae and Chironomidae had influence because of the great importance of these groups for medical entomology and ecology, respectively. His general knowledge of natural history and entomology informed his passion for the Insect Gallery which, created in collaboration with a small team that included John Abraham and artist Arthur Smith, was a very forward looking, attractive and informative exhibition – sadly demolished long since, and incomparably better in the opinion of many than the arthropod gallery which has now replaced it.

In the post-WWII era, the Keeper of Entomology position at the NHM was one of a handful of influential posts in insect science worldwide. Soon after his appointment to the keepership in 1968, Paul had the idea that the Department should mount a major entomological expedition. He sounded ideas from senior colleagues, and West Africa was favoured. But once detailed plans were drawn up, and vehicle hire, hotels and other expenses taken into account, he was aghast at the total cost.

Not wishing to be defeated, Paul asked dipterist Brian Cogan to sound out junior members of the Department to see if a different and more cost-effective way of mounting an expedition might be possible. As a result, five younger staff, including Brian, came up with a plan that involved buying a surplus three-tonne army truck, converting it to a mobile laboratory by themselves, shipping it to Cape Town, and then undertaking an 8000 mile journey through Namibia, Angola and Botswana. In hope rather than expectation they went back to Paul. To their amazement, when he understood their vision (and the much reduced total cost!), he backed what to many at the time seemed a totally hare-brained scheme, inevitably doomed to failure. However, the Entomology Department's South Western Africa Expedition 1971-1972, no doubt to Paul's relief, was a great success. Moreover, all members of the team not only returned in good health but also hugely improved as fieldworkers – and all went on to

Paul and Audrey Freeman in 2007. Photograph: courtesy of Margaret Evans.

further enrich the Museum's insect collections through subsequent expeditions, and also training new staff in turn.

In retrospect it still seems remarkable that Paul backed this scheme. However, it can now be understood in terms of his attitudes to younger staff and their development – perhaps reflecting his own earlier needs as a young scientist from a relatively humble background, and the faith that his parents and others around him had in his own native ability.

Paul was fortunate in that he led the department at a time of financial expansion, enabling him to increase the staff from about 60 to almost 100. However, as NHM Director Ron Hedley later pointed out, with a flat budget and extrapolating from the increasing costs of the library in the 1980s, the number of scientific staff would have to fall drastically. Following Paul's retirement this proved to be true. At the time of Paul's retirement he was responsible for 97 Museum staff – almost double the number of entomologists paid for directly by the Museum now. The golden age of descriptive taxonomy in the department was over.

However, as staff numbers grew during the late 1960s and 1970s, managerial change became a necessity. Against a backdrop of anachronistic hierarchy Paul had a genuine interest in his staff as individuals. Quite typically he later commented: "it was important to look after the junior staff as the senior staff can look after themselves". His style might have appeared paternalistic at times, drawing on his experience as a deeply committed family man, but his actions were always well intentioned. His fostering of young scientists led to a cohort of entomologists who went on to make a significant impact internationally.

This is well demonstrated by the career of Peter Cranston. In 1971 Peter applied to join the NHM to work as an assistant on birds, but at interview was told the post had already been filled. Paul suggested he should consider working on insects instead, pointing to the Museum's generous policy on work-release to pursue higher education, and extolling the pathways that an enthusiastic junior member of the staff could pursue as a career. So persuaded, and shortly after joining the Museum, Peter became an assistant on Nematocera and was encouraged to curate part of the chironomid collection in light of Sepp Fittkau's major 1962 work, *Die Tanypodinae*. Peter faced a steep learning curve – it was in German for a start (no Google translator to assist in those days!) and dealt with features that could only be seen on good slide mounts with very high power magnification.

When Peter decided to undertake a PhD, it was natural to stay with the Chironomidae. With continuing guidance from Paul, and input from university ecologist Alan Hildrew, he chose to work on immature Orthocladiinae. This was all before the days when museums saw a role for themselves in higher education. But, as promised at Peter's original interview, Paul was very supportive throughout. Peter feels very strongly that his career owes its entirety to the recruitment promise made and delivered by Paul Freeman.

Paul also had a more general influence on the research careers of those around him. Long before the 'publish or perish' dictum came to be an all-consuming influence on young scientists, Paul made it clear that he thought research was wasted if it was not written up and published – and it should be done so in a timely manner. This seemed, rather like his desire to give public enquiries high status, more moral conviction than management mantra. Simply put, he felt that if the taxpayer had paid for the research then there was an obligation to complete the work by publishing it. He also made the point that research was a "habit" – a habit that needed to be developed early if a scientist's career were to be successful. Paul expected each of his research staff to have at least a couple of short papers in press at any one time, with a substantial publication every three years. He often said that he wished he could have training in how to select staff in order to get "winners", as he liked to put it.

In many ways Paul Freeman's approach to staff and science management was instinctive, and he was also blessed with an abundance of common sense. Although not renowned for being the most overtly 'scientific' leader, many of those who worked in the NHM over the past 50 years agree that Paul Freeman was the best Keeper in the 100-year history of the Museum's Department of Entomology, as four of his former staff have reminisced: "I remember my time under his keepership as the happiest I had in the museum"; "[he] always supported any proposal that one might make providing he agreed with you"; "in retrospect it is clear that I would have achieved little without the backing and encouragement that he gave to younger members of staff; he was also a most sympathetic man-manager";

"Paul Freeman was a dynamic individual and undoubtedly the best Keeper of the four that I served under – there is no doubt that he did more for the development of the Department than anyone I can think of. At a personal level, he did much to further my career; moreover, he was always willing to listen and if I put my case convincingly, he took positive action immediately."

A specific example of Paul's supportive approach is recalled by Roger Blackman: "Acting on advice from Vic Eastop and Laurence Mound, he recruited me in 1972 as a research fellow to study aphid intraspecific variation and cytogenetics, a new departure for the Department. He ensured that funds were available for all the new laboratory equipment and insectary facilities that were needed, and above all he was always ready to listen to any new ideas, however unorthodox or foreign to his own experience they might have seemed. I remember going to see him in the mid-1970s with the idea of employing Paul Beranek from Royal Free Hospital for a few weeks to set up a laboratory for starch gel electrophoresis, which was then the latest way forward for aphid genetics. He readily agreed to this, probably because he was impressed that we had found a way to do this on a minimal budget of, I think, about 250 pounds – which was not a lot, even then!"

On 10th April 1942 Paul married Audrey Margaret Long, his wife of 68 years. He is survived by Audrey, daughter Margaret, four grandchildren and two great-grandchildren. Clare, his first daughter, predeceased him in 2005. His funeral, which took place on 9th August 2010 at Beckenham Crematorium, was followed by a memorial service at the Church of St Francis of Assisi, close to the family home in Petts Wood, Kent.

Finally, Roger Crosskey has identified a blackfly that was biting two of the entomologists present during Paul's funeral as *Simulium* (*Simulium*) *noelleri* Friederichs. Apparently this is quite an interesting record and the specimen, suitably labelled, is now on its way to the NHM collection! Needless to say the captors included members of the SWA expedition.

The following obituaries and notices have appeared:

Paul Freeman. *The Telegraph* (http://www.telegraph.co.uk/news/obituaries/science-obituaries/7960471/Paul-Freeman.html). 23.viii.2010.

Lane, R. 2010. Paul Freeman obituary. *The Guardian* (http://www.guardian.co.uk/environment/2010/ aug/25/paul-freeman-obituary). 25.viii.2010.

Evans, M. 2010. *Imperial College London Alumni Obituaries*. Dr Paul Freeman DSc, A.R.C.S, F.R.E.S (Biology 1937). http://www.imperial.ac.uk/alumni /Page.aspx?pid=1575. 6.ix.2010.

Dr Paul Freeman. *The Times*. 14.ix. 2010.

Cranston, P.S. 2010. Paul Freeman—an appreciation of his studies of Chironomidae. *Chironomus – Newsletter on Chironomidae Research* 23(2010): 17–19.

The authors of this memoir are very grateful to members of Paul's family, especially Audrey Freeman, Margaret Evans and son-in-law Paul Evans, for their willing and generous help. Paul's grandson Gwyn Evans also very kindly agreed to inclusion of "For Grandpa", first read at the memorial service. We also acknowledge the help of Val McAtear at the RES, and Daisy Cunynghame, Eloise Donnelly and Sharon Touzel at the NHM.

Bibliography: the entomological publications of Paul Freeman

F. Christian Thompson[1] and R.I. Vane-Wright[2]

[1]*Department of Entomology, Smithsonian Institution, MRC-0169 NHB, PO Box 37012, Washington DC 20013-7012, USA*

[2]*Department of Entomology, Natural History Museum, Cromwell Road, London SW7 5BD, UK*

Within his total of 86 publication Paul Freeman introduced many new taxa: 35 new genera (36 names) of Diptera, all accepted today as valid today, 565 new species (576 names) of Diptera, of which 524 are still accepted as valid, and 3 new species of bugs (Hemiptera). There are more names than taxa because some names, at the time of introduction, were homonyms for which he later proposed replacements. As with all taxonomic work, it can be important to know exact dates of publication. Any additional information on precise publication dates would therefore be welcome.

Where we have found printed information from journals regarding month of publication we have added this in square brackets at the end of the entry. Thus [05] following a citation indicates that publication is claimed to have occurred during May of the year stated. Where we have information for both month and day, this is added in the form [05.31] (indicating publication on 31st May in the given year). If our only information comes from a date-of-receipt stamp or equivalent source, and it is thus certain that publication could not have been later than the date given but was probably earlier, we indicate this with the word 'by'. Thus [by 1984.02.16] signifies that we have found proof of publication by the given date (16th February 1984), but it may well have occurred earlier. The particular paper in question is normally cited as "1983", which in this case we continue to accept. The list is presented in the order of publication indicated by the dates we have found, or, where we are uncertain, in the sequence we believe is most likely to represent the correct order.

We are most grateful for help received not only from Paul Freeman himself, many years ago, but also Roger Crosskey and Julie Harvey.

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For Grandpa

Gwyn Evans, 5th August 2010

It's hard to catch the memories,
Most of my life, you both retired,
You'd planned your future thoughtfully
and had the living room rewired

A garden perfect for a child
with pond and fountain, wood and briars,
Clean shirts upon the washing line
that swung on hangers as they dried.

You made the best of stuff you had,
Building your own as you required,
The custom kitchen cupboards housed
arrays of tupperware and tins,
Sticky flapjacks. Murray mints,
Special treats for special days
With lemon barley, ticking clock,
In hallways of serenity
Up where the stairwell led the way
To wooden graves where insects lay
Immobilised, and skewered by pins and
Speared in corners of the world
When stalked and taken by surprise
For entomology they died
those little bugs with nasty stings or
Stripy shiny thoraxes
Fine lacy wings and spiny legs
Antennae and proboscises,
Male and female side by side,
With Latin names immortalised:
Drowned in ether. Organised.

"I don't take condiments!" exclaimed
Before each meal, the table laid with
Butter, eggs and marmalade and
Coloured pills and sky-blue plates.
To break the fast in formal ways
Little routines that kept the pace
While lazy grandchildren slept on
Still undisturbed by rattling trains.

And as the years rolled by you'd sit and
Think, and read, apply your mind
in your front room - the draughty bit - with
Cryptic clues words hard to find.

You'd shout if Audrey couldn't hear
As she prepared the daily meals,
Routines where you would wash the plates
In yellow gloves, relentless heat

It must have been frustrating to
remember when you walked and ran
And cycled all the way to school
Day in day out with discipline,
Reciting Shakespeare when you could
And watching bugs in rotting wood.

Perhaps the time had come at last
When life jumped on at twice the rate
And playing catch-up tiresome aches that
Bothered you, became a strain with
Memories that could not wait,
Took hold of you,
Controlling you,
Set in their ways,
Compelling you,
Calling you back from modern life to
Where you were when you were young,
Confusion and irrelevance
Kept cropping up in turbulence
Things going wrong,
Life not the same,
And as the lights began to fade
As shadows grew,
Your wife remained to
Pray for you and hold on tight
In love with you and by your side
To hold your hand and help you fight
To comfort you 'til
End of life.

Above: Male Queens (*Danaus gilippus*) avidly nectaring on *Chromolaena* at the National Butterfly Center. Photo: R.I. Vane-Wright

Below: Tawny Emperors (*Asterocampa clyton*) jostling for the best spot to feed on rotting oranges in a hanging basket, National Butterfly Center, 28th October 2010. The hostplant *Celtis laevigata* (sugar hackberry) grows well at the NABA site, where this apaturine is exceptionally abundant. Photo: Larry Gilbert

Caught in the act. Jeff Glassberg cuts the tape to signal the official opening of the National Butterfly Center at Mission, Texas, 28th October 2010. Jane Scott is at left holding tape, holding tape. Photo: R.I. Vane-Wright.

United States National Butterfly Center opens at Mission, Texas

Dick Vane-Wright

Founded in 1992, the North American Butterfly Association (NABA) is a non-profit organization that now represents the largest group of people in North America interested in butterflies. NABA's mission to its four thousand members is disarmingly simple: to increase public enjoyment and conservation of butterflies.

In 2000 NABA acquired 100 acres of land on the north bank of the Rio Grande, at Mission, Hidalgo County, Texas. The area is mostly open, but has a fine grove of trees running along an irrigation dyke, and stands right next to a wooded 1000 acre federal wildlife reserve.

A small centre was soon established, and part of the 30-acre northern part of the site was planted with caterpillar hostplants and numerous local native flowers to attract adult butterflies - regularly supplemented with rotting bananas and oranges for fruit-feeding nymphalids. Being right on the Mexican border, at latitude 26° 13' N, it is almost as far south as you can go in the USA, and has a very rich fauna, including many Mexican butterflies at the limit of their northern ranges. In total about 300 species of butterflies occur in the Lower Rio Grande Valley, some 40% of all butterfly species known to occur in the USA. Of these, 150 can *only* be seen in the LRGV region within the US. Of the LRGV total, over 200 have already been seen at the centre, including several rarities and first US records. In just one day during the October 2009 butterfly count over 100 species and almost 200,000 individual butterflies were

Disorder at the Border. Opening the butterfly centre was the focal event of a five-day NABA field meeting. This photograph of the Lower Rio Grande was taken at Roma, Starr County, Texas, looking toward Mexico on 31st October 2010. Note recent flood deposits and dead trees on the Mexican side that resulted from a September hurricane and major flooding in the region. Photo: Larry Gilbert.

Although much of the butterfly centre is relatively open, a grove of trees running beside an irrigation ditch offers ideal conditions to observe many different species, including spectacular iridescent Pipevine Swallowtails (*Battus philenor*), weakly-flying Common Mestras (*Mestra amymone*), and various charaxine Leafwings (*Anaea* spp.). Photo: R.I. Vane-Wright.

Native scrubland vegetation forms 70% of the NABA site – an area that will be managed only for good butterfly habitat. Photo: R.I. Vane-Wright.

Hours to go. Last minute preparations around the new National Butterfly Center main building, shortly before the opening ceremony. Photo: R.I. Vane-Wright.

Butterflies of a different sort – delegates at the NABA meeting banquet, Mission, Texas, 30 October 2010. Photo: R.I. Vane-Wright

No entomological celebration seems complete without a suitably decorated cake! Photo: R.I. Vane-Wright

NABA's intention from the outset was to develop a full-scale butterfly facility at Mission. With the official opening of the "National Butterfly Center" at 3333 Butterfly Park Drive on 28th October 2010, this long-term goal has now passed a critical stage. The new, very attractive but low-impact building, designed by Wendy Evans Joseph (who designed the Holocaust Museum in Washington, DC) and Chris Cooper in collaboration with NABA directors Jeffrey Glassberg and Jane Scott, will serve initially as an exhibition and orientation centre for visitors - expected to include many school parties. At the opening ceremony three of the walls of the main hall were covered by a very affective and beautifully illustrated account about the value of butterflies and natural ecosystems in general, together with an excellent overview of butterfly biology and classification. More buildings are planned, and in future the function of this adaptable building may change. A mini-bus service will also be instituted, to take visitors across the canal that separates the centre from the 70 acres of native scrubland vegetation that forms the major southern portion of the NABA site - an area that will not be developed in any way other than being managed as good butterfly habitat.

However, the next priority is to create a far more extensive set of butterfly gardens on much of the land running between the new building and the existing centre, some 400 m apart, with a number of areas carefully designed to attract and support breeding colonies of local species. Most native habitat is now gone in LRGV and the remaining fragments or restored patches are islands that accumulate butterflies dispersing northwards from Mexican source populations. As already one of the best butterfly oases for many miles around, the centre will continue to attract and demonstrate the occurrence of numerous southern butterflies in the Lower Rio Grande Valley.

The new facility will make a major contribution to the education of not only its own members, but also to many school-children in this politically rather sensitive part of the USA. It is also apparent that local politicians and the business community in Mission, and in the nearby town of McAllen, are very supportive of this initiative. McAllen has an excellent airport only 70 minutes from the major airline hub at Houston, and it will be very easy for those from abroad, as well as US citizens, to visit the new butterfly centre. There are numerous good hotels in the area, as well as other wildlife attractions, such as Falcon State Park only 80 km distant. NABA's *National Butterfly Center* at Mission will surely become a very appealing destination for ecotourists keen to sample something of the fauna and flora of southern Texas and northern Mexico. Moreover, sad to say, it is also the case that the current drug-related violence on the Mexican side of the border has led a rapid growth of interest in eco-tourism destinations on the Texas side. Thus one can only anticipate increasing success for the NABA centre.

The subtropical climate means that there are always butterflies to be seen, no matter what time of year you visit the LRGV. As the NABA website boldly - but in my view correctly claims, the centre is now "the premier location in the United States to experience the beauty, drama and emotion of wild butterflies" (http://www.nationalbutterflycenter.org/). Recent diagnostic field guides based on excellent photographs of the living insects, notably Jeffrey Glassberg's own *Swift Guide to the Butterflies of Mexico and Central America* (Sunstreak Books, 2007) cover all the species known or likely to be found in the LRGV, including numerous and otherwise baffling skippers. The NABA website (http://www.naba.org/chapters/nabast/photoschecklist.html) also offers a great deal of information, including many photographs and a list of species recorded, and gives details of ways in which NABA's work at Mission can be supported by becoming a Friend of the National Butterfly Center.

DVW wishes to thank Jeff Glassberg and Jane Scott for unfailing help and good humour throughout the NABA meeting, all the more impressive because of the stresses of organisation upon them. Larry Gilbert was also a great companion, both at Mission and later at the University of Texas at Austin, and kindly made all of his "Mission" pictures available for this

Common Mestra (*Mestra amymone*) pauses momentarily in the grove.

Photo: R.I. Vane-Wright

The exquisite Silver-banded Hairstreak, *Chlorostrymon simaethis*, on one of its hostplants, the Balloon Vine *Cardiospermum halicacabum*. National Butterfly Center, 30th October 2010.

Photo: Larry Gilbert.

Roadrunner (*Geococcyx*) at Falcon State Park, near Roma, southern Texas, during NABA fieldtrip, 31st October 2010. This most engaging bird, photographed by Larry Gilbert, appears to be eyeing up a small snake but, moments later, we watched it leaping into vegetation to catch a large insect. Larry was also a featured speaker, on "Ecological perspectives on butterfly movements in southern Texas and northeastern Mexico", during the NABA meeting.

Above: A remarkable riodinid, the Red-bordered Pixie (*Melanis pixe*), settled on hostplant *Pithecellobium dulce* at the National Butterfly Center, 30th October 2010. Photo: Larry Gilbert

Below: Like most swallowtails, the Pipevine (*Battus philenor*) is a restless creature while feeding from flowers, continually flapping its wings. National Butterfly Center, 30th October 2010. Photo: Larry Gilbert

Sun, sea and special insects – hard-rock coasts and their invertebrates

ARTICLE

Keith N A Alexander

59 Sweetbrier Lane,
Heavitree,
Exeter EX1 3AQ
keith.alexander@waitrose.com

Watching television programmes about the coast, the average viewer may be forgiven for thinking that coastal invertebrates are all marine species. Coastal 'zoologists' enthuse about seals, seabirds, fish, and – if they mention invertebrates at all – oysters, mussels, crabs and shrimps. But the producers are missing a trick – they are missing the wealth of unusual land and freshwater invertebrates that are also there to be explored. The hard-rock coasts attract entomologists and other invertebrate specialists for their wealth of interest, and there is so much that the average television viewer would be amazed by. They are very special places for nearly all the variety of land invertebrates – Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, spiders and so on, and even for wetland groups. Indeed, the hard coastal cliffs of west Britain support a western oceanic invertebrate fauna of European significance (Maddock, 2008).

Setting the scene

Hard-rock sea cliffs and maritime slopes provide one of the ecologically most interesting and most diverse situations for wildlife. It is wrong to refer to this situation as a 'habitat' type as it is actually a landscape type which provides many vegetation types and many habitat opportunities for invertebrates:

- Vegetation structures range from bare rock and bare earth, through pioneer plants, grasslands and heaths, to scrub and even woodland.
- The exposed underlying geology may range from the hard acid Granite (West Penwith, Cornwall), through base-rich rocks such as the Serpentenite (the Lizard Peninsula of Cornwall), to the hard calcareous Limestone (at Torbay in Devon and across east Dorset) and the softer Chalk (from East Devon across to Kent).
- Soil depth may vary considerably and mask these influences, especially landward.
- A wide range of wetlands may also be present, with flowing water habitats provided by small seepages, spring-fed streams, as well as pools and peatlands resulting from impeded drainage.
- Coastal exposure: the vegetation is also strongly influenced by key factors which are absent from more inland situations, notably exposure to weather coming off the sea, with its regular on-shore and salt-laden winds.
- Exposure keeps larger plants back from the very edge, and there is generally a clear succession from open ground through short vegetation to taller vegetation landwards.
- The regular battering from sea and storm causes steady erosion and even land-falls and slips, exposing soils and bedrock.
- The exposed soils and rock warm up quickly and hold their heat, especially in the winter when the sun is low in the sky but catches any cliffs with southerly aspect.
- Windblown sand containing broken material from sea shells may accumulate and provide calcium-rich soils on otherwise acid rocks.
- Proximity to the sea also provides:

  relatively frost-free conditions and a relatively constant high humidity;

  high light levels due to reflection off the water.
- The permanent coastal grasslands as a result tend to be lush, sweet and very nutritious, attracting large herbivores which graze, browse and trample.

The relatively mild climate along the coast enables many southern species to maintain populations here, and are poised for spreading inland as climate becomes more suitable for them. It is also important to appreciate that the hard-rock/soft-rock divide is not entirely separate – the distinction blurs for many species.

This is a truly dynamic environment.... but also one of interesting contrasts. The topic is clearly epic and would easily fill an entire book. In this article it is only possible to highlight some of this wealth and to provide examples of the many special interests. This article is as much concerned with issues of habitat definition and ecology as with hard-rock coasts per se, and aims to provide no more than a flavour of the manifold interests.

Maritime therophyte zone – the sparsely vegetated cliffs brows

Vegetation ecologists have not only acknowledged the existence of an important feature of rocky coasts but they have provided a term for it. Most entomologists will be unfamiliar with the term but many will recognise that it refers to the places where they go to find their special quarry. In southern Britain, and especially the south-west, the shallow soils along the cliff edge – and wherever else the bedrock is close to the surface – are prone to summer drought and an open vegetation of specialist plants develops. This is the 'MC5' of the vegetation ecologists (Rodwell, 2000) and represents a maritime extreme with an assemblage of coastal plants which are intolerant of competition. A key plant in the maritime therophyte zone is Buck's-horn Plantain *Plantago coronopus* as this is thought to be an important insect food-plant.

Coastal erosion and exposure are more or less constants, and continually provide open and sparsely-vegetated ground for specialist invertebrates. Away from the coast, such open habitats are less predictable. Whereas inland equivalents are the domain of pioneer, highly mobile species which need to be as dynamic and flexible as the factors which periodically create the open vegetation they require (Key, 2000), coastal bare ground is the domain of less mobile species. As on islands, there is selection pressure for flightlessness, as being active in the air on exposed coasts runs the risk of being blown inland. Many true coastal bare ground specialists therefore have reduced flight capacity – the ground

Pentire Point sparse vegetation and outcrop and inset, *Henestarius laticpes* © John Walters

weevils are good examples, with their fused elytra and no functional wings, and especially the *Cathormiocerus* species.

Cathormiocerus weevils are conspicuously restricted to the very western edge of the Palaearctic, from the southern coasts of Britain around to the western Mediterranean, centring on Spain and Morocco (Morris, 1993). Four species are currently recognised from Britain: the rarest *C. attaphilus* is confined to the exposed coasts of the Lizard and SW Devon, while *C. socius* is confined to Hampshire and the Isle of Wight; *C. maritimus* and *C. myrmecophilus* occur more widely along southern coasts (Morris, 1997). These are sluggish beasts, largely indistinguishable from the tiny clods of earth amongst which they are found. While the therophyte zone of hard-rock cliffs provide ideal habitat for them, they are also able to exploit sparely-vegetated areas on head cliff and even periglacial deposits covering hard-rock geology.

Another flightless ground weevil provides a curious variant on the story *Anchonidium unguiculare*. It too is an extreme western species and is similarly poorly known ecologically. In Britain, at least, it is a coastal species but has been found in two very different situations: old oak coppices on cliff-slopes in west Cornwall and hard-rock coastal grasslands in SW Devon (Morris, 2002). The food-plants are not known but it is found in association with sheep's sorrel *Rumex acetosella* on the cliff grassland sites (T. Eccles, pers. comm.); it lives amongst loose leaf litter at the Cornish sites.

In contrast to the weevils, the seed bugs (Lygaeidae) are more flamboyant insects. The most characteristic of the maritime therophyte zone – and also most widespread – is *Henestaris laticeps*, which feeds on buck's-horn plantain and especially small poorly-grown plants (Kirby, 1992). It may be found actively running about amongst the sparse food-plant in warm sunshine and has a similar distribution to the *Cathormiocerus* weevils, spreading up along the Atlantic coasts of Europe from the Mediterranean into southern Britain. While the therophyte zone provides suitable habitat for many other seed bugs – including rarities – these tend not to be confined to the situation, occurring in other coastal situations with bare ground such as sand dunes, and some also occurring inland. The therophyte zone in West Cornwall is a good place to seek Thyme Lacebug *Lasiacantha capucina*, which needs mats of thyme *Thymus* growing over bare ground to create the right temperature conditions; the bare ground may be hard-rock or loose sand. Only the brachypterous form of the adult has been found in Britain (Southwood & Leston, 1959) - elsewhere in Europe it also occurs inland and part of the population has the capacity for flight.

These droughted cliff brows are also important for another assemblage of insects which – like *H. laticeps* - prefer their food-plants to be seriously stressed before they will feed on them, Presumably the plant is less able to produce defensive chemicals when under physiological stress. The Thrift Clearwing Moth *Bembecia muscaeformis* is a good example – the larva develops in the crowns and roots of thrift *Armeria maritima*, but generally in small stunted plants growing on almost bare rock rather than large luxuriant clumps (Skinner, 1984).

Ant associations

Hard-rock seacliffs are excellent places for ants, with loose rocks and crevices providing very suitable nesting habitat for many species. The southern seacliffs are amongst the richest ant landscapes in Britain, and many rarities are found in this situation. The abundance and species-richness of the ant assemblages makes the situation ideal for more parasitic lifestyles. *Solenopsis fugax* is a thief ant, preying on the brood of larger ants such as *Lasius* and *Formica* species, as well as tending root aphids; worker ants steal larvae and pupae from the nest of the larger ant via tunnels connecting their nest with that of their host – these tunnels are too small for the host workers to enter (Orledge, 2009).

Tetramorium caespitum is a particularly characteristic species of rocky seacliffs in Britain and has its own assemblage of associates. *Anergates atratulus* is a workerless ant species which lives as a social parasite in its colonies. It requires a large stable population of its host species (Hoy, 2002). Occupied colonies die out within a few years, although the cause and effect is not clear – the rapid turnover for the *Anergates* is part of the reason that they need large stable populations of the host ant. *Strongylognathus testaceus* is another parasite of *T. caespitum* although its habits are much less well understood. *Callilepis nocturna* is a spider which appears to specialise in hunting ants and especially *Tetramorium*.

Rock ledge assemblages

The bare rock of coastal cliffs provide special habitat for species able to exploit crevices, plants as well as invertebrates. The steeper examples are characterised by luxuriant development of the crevice-rooted plants, out of reach of any large herbivores that may be active on the cliff slopes. This is where many herbivorous insects are able to thrive, in contrast to the poorer habitat provided by the browsed or droughted examples of their food-plants elsewhere. Weevils are again a feature of special interest, with a good example being the tiny *Trichosirocalus dawsoni* which favours the crevice buck's-horn plantain over the therophyte plants. The rocky cliff ledges are also the places to find the pretty *Sibinia arenariae* with rock spurreys *Spergularia* and *S. sodalis* with thrift *Armeria maritima*.

Habitat is a curious term, much abused by people. It is important to appreciate the key factors which determine the presence or absence of a particular species before pronouncing on its 'habitat'. The tephritid fly *Myopites eximia* develops in a gall in the capitulum of Golden-samphire *Inula crithmoides*, and in this case it is the food-plant that determines the situation where it is found – the habitat of the fly is flowering stems of Golden-samphire. Golden-samphire is confined to brackish coastal situations – in south-east England it grows in saltmarshes while elsewhere in Britain it is more typical of sea-cliff ledges (Halliday, 2002). The fly exploits its foodplant in both situations so it is incorrect to refer to its habitat as saltmarsh, and yet many authors make this mistake.

Seepages

Seepages of freshwater over vertical rock-faces provide an important specialist habitat for many Diptera in particular but also caddis flies and water beetles (Boyce, 2002). The dolichopodid *Liancalus virens* is the most abundant fly found in this situation in Britain but may be found

Golden Samphire, Chapel Porth

species are not only characteristic of the situation but confined to sea-cliff examples. The cranefly *Dicranomyia goritiensis* may be found in this situation around much of the western coasts of Britain and also in Ireland, and its status in Britain as a rarity (Falk, 1992) reflects more the rarity of access to its habitat for entomologists than its true conservation status. Another specialist coastal cranefly *Geranomyia unicolor* is also characteristically found at these seepages. The water beetle *Ochthebius poweri* is even fussier, favouring the small seepages on red sandstone cliff faces in the south-west of Britain.

Maritime grassland

Back from the more exposed brows, rocky seacliff slopes tend to be dominated by dense mats of maritime grassland, usually dominated by fescues with some thrift and sea carrot *Daucus carota*. The maritime influence declines as distance from the cliffs increases. Maritime and coastal grasslands can be extremely flowery and provide excellent habitats for insects, although the proportion of specialist coastal species tends to be less than that found on the cliff edges and brows. The seed bug *Trapezonotus ullrichi* is an example of a coastal species in Britain which has a much more widespread food-plant. It has a Mediterranean distribution but with localised populations along the cliffs of SW Britain, where it is strongly associated with oxeye daisy *Leucanthemum vulgare* – it is often to be found on the flower-heads on sunny days. In contrast, the weevil *Microplontus campestris* is also an oxeye daisy specialist but occurs much more widely across the full range of its food-plant.

Another important aspect of the hard-rock coasts is that they are much less influenced by people, particularly through agriculture and development. Steep coastal slopes – while traditionally used as pasture – have generally been avoided by intensive

Trapezonotus ullrichii © Dr B Nau

ground it is rarely worthwhile applying man-made chemicals to 'improve' the pasture or ploughing to the very cliff edge due to most modern commercial crops not growing well in such situations. This has meant that many species which have no natural reason to be coastal in their distribution have become increasingly confined to the coast due to habitat loss and degradation inland. This is especially the case for bees which require large areas of flowery grassland to maintain viable populations – maritime grasslands may occur in narrow zones but they often extend for many miles. The bee assemblages of hard-rock coasts include substantial populations of oil beetles *Meloe* spp as well as other dependent insects. In many districts the maritime grasslands are often the only native grasslands remaining. A good example is provided by another weevil *Tychius tibialis*, one of the many insects of old lowland meadowland which have become increasingly confined to the coast through intensification of agriculture. It is associated with hop trefoil *Trifolium campestre* – certainly not a coastal plant – and was formerly widespread across southern Britain but is now virtually confined to coastal grasslands.

The deeper soils back from the cliff edges enable plants such as bracken *Pteridium aquilinum*, gorse *Ulex europaeus* and blackthorn *Prunus spinosa* to invade unless controlled by grazing and browsing herbivores. Even these ubiquitous plants can produce habitat of interest for coastal entomologists, with gorse and blackthorn especially rich in insects. Pockets of deep humus-rich soils provide an unusual larval habitat for Rose Chafer *Cetonia aurata*, otherwise better known from wood mould in old hollowing trees. These beautiful chafers thrive in the vegetation mosaic of hard-rock cliffs and are most often seen nectaring amongst the flowery maritime grasslands.

Dung and carrion

Little appears to be known about the insects associated with seabird colonies but a few carrion insects do appear to be coastal specialists. The exceedingly rare beetle *Trox perlatus* provides a

The hornet robberfly *Asilus crabroniformis* © John Walters tantalising glimpse of the delights that await the brave researcher. This species has only ever been found in Britain on sea cliffs and was last reported many years ago on the skins of young dead lambs. Carrion has become much rarer throughout the countryside in modern times due to excessive hygiene regulation and species such as this must be seriously threatened. Dung fauna are similarly threatened through the ignorant complaints from modern visitors to coastal lands about the dung left behind by livestock. The hornet robberfly *Asilus crabroniformis* is a good example of a dung associated insect pushed back to the very edge of survival through habitat loss – its strongest British populations today are along hard-rock coasts where livestock grazing is being maintained largely for conservation reasons.

Threats and nature conservation

While sea cliffs might be considered an excellent example of an entirely natural habitat which require no management for their maintenance, in reality the cliff-top fauna may be critically dependent on the management of the area of land behind the cliff edge (Kirby 1992). In the south-west of Britain, for example, areas of land which were previously grazed either now receive no management - and in consequence suffer from extensive invasion by bracken and scrub – or have been ploughed or otherwise agriculturally improved to very close to the cliff edge. The cliff-top habitats which once formed broad bands behind the cliff edge, are now all too often confined to a very thin line along the very edge of the cliffs. Wherever possible a broad band of grazed vegetation stretching inland to unimproved grassland should be maintained above cliffs if we are to protect and maintain the special invertebrates of this interesting landscape (Kirby 1992).

People that claim that grazing with livestock is somehow 'un-natural' and should have no place in wildlife conservation are missing the point that the cliff lands would have been prime areas for grazing and browsing by wild herbivores long before the early peoples arrived with their livestock. It would have been much easier to establish livestock grazing on land already maintained as open vegetation by wild herbivores than to clear dense woody growth. Rocky coasts combine sweet grazing with strong breezes for keeping parasitic flies off – wild herbivores always tend to favour such places and keep them open. Now that the wild herbivores have been removed by people, the best approach to conserving the surviving valued grasslands is to use livestock to maintain them in good condition. This is especially important for the native carrion and dung fauna which is seriously threatened across the landscape through modern hygiene and veterinary systems.

One aspect of the mild coastal climate that is a double-edged sword for conservation is that cliff lands are particularly prone to the establishment of non-native plants and animals brought into the region by people either intentionally or incidentally. Plants such as Hottentot-fig *Carpobrotus edulis* have become a serious threat to parts of the Cornish coast by swamping and stifling the native vegetation and invertebrates.

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Centipedes and other arthropods on sea-shores

ARTICLE

Large cluster of the littoral centipede *Strigamia maritima* at a site near Inverness.
(Photo: Michael Davidson)

Tony Barber

Rathgar Exeter Road,
Ivybridge
PL21 0BD
abarber159@btinternet.com

Sea shores are typically associated with a wide diversity and large numbers of crustaceans, molluscs, annelids, etc. all presumably of marine origin and typical seashore studies, at least in temperate locations focus on these. However, sometimes on the upper zone around high tide level on a sea-shore in Britain or elsewhere in northern Europe one can turn over a rock and find large numbers of what appear to be reddish brown annelid worms but on closer examination can be seen to be centipedes, *Strigamia maritima* (Leach, 1817), which rather rapidly disappear into their surroundings. Unexpected, perhaps, because, after all, as everyone knows, centipedes are land animals but in fact there are a whole range of such "terrestrial" arthropods that occur in littoral sites around the world, spiders, scorpions, solifugids, false-scorpions, millipedes, pauropods, springtails, beetles, etc. (see, for instance, Lanna Cheng's *Marine Insects*, 1976).

Some of these are apparently now only found in the littoral zone as is *S.maritima* and might be termed obligate halophiles (*halofili genuini* of Silvestri, 1903). Others occur both in typical terrestrial habitats and on the shore as, for instance, another centipede, *Pachymerium ferrugineum* (C.L.Koch, 1835) widespread in Europe but occurring in littoral sites as well (the very few British records are all from beach shingle). These might be called "facultative" halophiles (*halofili indifferenti*). An then there are the chance occurrences of species which are not normally found on the shore but might have transported e.g. by wind or wandered into a shoreline site. These we might call "accidentals" (*halofili accidentali*) and must represent a wide and rather unpredictable range of species. In the higher insects there is also the opportunity to spend only part of the life cycle on the shore and more than 150 species have immature stages that appear to be restricted to the Intertidal zone (Hinton, 1966).

Myriapods, scorpions and other arthropods (including the superficially spider-like trigonotarbids & possibly spiders and early insects) were some of the earliest land arthropods and date back to the Silurian with clear terrestrial millipede fossils from the Devonian (Shear & Selden, 2001). Evidence for tracheal systems dates from the Mid Silurian (Wilson & Anderson 2004). The earliest centipede remains date from the

Upper Silurian and a clearly recognisable spider from the Devonian (Shear & Selden, 2001). Since these early times, the myriapod / hexapod / chelicerate arthropods have gone on to become diverse and successful occupying a large range of terrestrial niches. Although they have not been able, for whatever reason, to successfully return to the seas (apart from Acari and a small group of open-ocean, surface-dwelling Heteroptera), nevertheless, as noted above, in very many groups a small proportion have been able to successfully re-enter (or, if they had colonised the land via fresh water, enter for the first time) littoral habitats.

Why did "terrestrial" arthropods return to the sea shore?

Colin Little in his book *The Terrestrial Invasion* (1990) has a telling diagram of the food web of the thysanuran *Petrobius brevistylis*, itself, presumably, of terrestrial origin, which is almost confined to the maritime zone and feeds on maritime plants. However its main predators are of terrestrial origin, *Lithobius* (a centipede) and *Zygiella* (a spider).

Does this give us a clue as to why so many different groups of terrestrial animals might have invaded the littoral zone? Intertidal areas are likely to be highly productive. Both larger algae (seaweeds) and microscopic forms colonise many seashores and estuaries and the latter are often rich in nutrients brought down by rivers. Seashores also receive quantities of (mostly) plant material, often in large amounts, brought in by the tides and there can also be a significant amounts of guano from seabirds in some sites. In various stages of decomposition, all this material offers potential nutrition for a range of herbivores and detritivores which in turn are available to carnivores. There are various examples in the literature of what appear to be energy flow from littoral to terrestrial habitats in this way. Polis et al (2004) have discussed the whole issue of trans-boundary transfer between habitats, including that of sea to land. In an extreme case of this transfer, Catenazzi and Donnelly (2007) report on the relationship between the terrestrial desert and the highly productive marine environment at Paracas Bay, Peru. Consumers in the night-time intertidal food web include Collembola, Thysanura, Diptera, Coleoptera, Talitridae, Chilopoda, Solifugi, Aranea, Scorpionidae and Reptilia. The centipedes (*Thindyla littoralis* Kraus, 1954)) were recorded at an average density of over 4 per square metre with a maximum noted of 49 m^{-2}.

Even if, perhaps, in other locations, there is actually no net energy transfer between marine-littoral and terrestrial food webs at the interface, shoreline production and washed up material would broaden the overall resource base for terrestrial animals and could entice them into the littoral zone for food.

Logically, assuming the adaptational problems of living in this habitat could be overcome then, in terms of energetics, it could be advantageous to remain there throughout part or the whole of their life cycle on a permanent or near-permanent basis.

Other factors could also be implicated in this move from land to the seashore. In addition to food resources, rocky shores can provide crevices for shelter and could trap air in them as could burrows in mud and sand. Shingle provides sheltered interstices and the drift line a possible rich, if more temporary, shelter (and food resource). Such environments can provide a degree of protection against weather and predators as well as a relatively humid environment and the sea itself will have an ameliorating effect on climate in the littoral zone. The possible absence of parasites due to unfavourable conditions for their alternate hosts might also be a factor in favour of entry of species into this habitat (Lewis 1981) as could possibly reduced interspecific competition.

As a transitional stage to the fully littoral lifestyle, one can visualise animals living above the high-tide line moving down onto the beach at low tide to seek food in the way that *Lithobius* and *Zigiella* have been described. This would, in general, be a pattern to be shown by relatively fast moving animals such as larger spiders and the non-geophilomorph centipedes. As a further example, the wolf spider *Pardosa lapidicina* Emerton, 1885 has been shown to live above the tide line on shingle beaches on Rhode Island and migrate up and down the beach with the tide to actively hunt in the low intertidal for Diptera, Collembola and amphipods (Morse, 1997). For the slower moving forms such as the geophilomorphs and for smaller animals such a transition seems less likely and it is possible that such animals are "pre-adapted" in some way for assuming a littoral role.

Adaptation to littoral habitats

Terrestrial arthropods invading the seashore will need to be adapted to move around and avoid the physical effects of wave action and, in the case of shingle, sand or mud, substrate movement. Essentially terrestrial arthropods will have similar body plans to their crustacean cousins and will be able to use similar methods of movement and protection. Interestingly *Strigamia* and other geophilomorph centipedes, as well being able to use their legs in locomotion, have been described as having annelid like movement (Manton, 1965) which parallels that of some segmented worms and a recent paper on the littoral pauropod *Decapauropus remyi* (Bagnall, 1935) (Scheller & Fjellberg, 2010) refers to it as "worm like".

Animals will need to be able to tolerate (or avoid by migration or survival in air spaces or possibly by floating or swimming) the effect of inundation with its consequential respiratory and osmoregulatory implications. Animals will be immersed in seawater twice daily for a shorter or longer time depending on their location on the shore-shore although not normally continuous 24 hour immersion. In estuarine conditions there will be changing salinity, generally below that of full sea-water.

Gaseous exchange directly via the cuticle, by tracheal systems / spiracles acting in some way as gills or through plastron respiration are all possible solutions whilst the capacity to build up a temporary oxygen debt (as possibly in some centipedes) could be advantageous. Alternatively the trapping of a bubble of air to be used as an oxygen source as, for example in some marine spiders or by taking refuge in suitable crevices or in burrows with a reserve of trapped air (as probably is the case in littoral scorpions) are possibilities. Burrows of less than a certain diameter will prevent water ingress because of surface tension effects (creating a calculated as 3mm; the saltmarsh beetle *Bledinus spectabilis* Kraatz, 1857 lives in burrows which flood if of more than a certain diameter but can be backed up by making a physical seal to the burrow through plastering substrate around its neck (Maitland & Maitland, 1994). J-shaped burrows, as used for instance by the crab *Ocypoda quadrata* (Fabricus, 1798), presumably an animal of more directly marine origin will also, by their nature, provide an air reserve. Tolerance of more or less severe hypoxia in insects (which will be advantageous during submergence) is greater than in most vertebrates (Hoback & Stanley, 2001; Schmitz & Harrison, 2004) and the apparent capacity of at least some centipedes to build up an oxygen debt is indicated.

Littoral animals, originating from land, may have body fluids dissimilar to that of seawater and will need to have mechanisms for regulating body water volume/composition or be able to tolerate changes in the concentration of their body fluids (unless they avoid this problem by hiding in air-pockets during immersion) as indeed will littoral animals of marine origin which are exposed to air. Animals exposed to both sea water (possibly of varying strengths) and to air this will, potentially suffer dessication and an increase in body fluid concentration which could be overcome, as in teleost fish, by the intake of seawater in food and/or "drinking" and then removal of excess ions by some mechanism (Binyon & Lewis, 1963) or by tolerance of changing body fluid concentration.

THE RANGE OF LITTORAL ARTHROPODS FROM "TERRESTRIAL" GROUPS

INSECTA

No attempt will be made here to deal in detail with littoral insects. *Marine Insects* (Cheng, 1976), although published more than thirty years ago, provides extensive data on this group in relation to the seashore environment but the author comments that about 3% of insect species have aquatic larval stages but of these, only a fraction, perhaps several hundred species, are marine or intertidal. There is reference in this volume to both the non-insect groups and to Apterygota (Collembola & Thysanura), Heteroptera, Trichoptera, Diptera and Coleoptera.

The marine millipede *Thalassisobates littoralis* at Seil Island, Scotland.
Photograph Tony Barber

MYRIAPODA

Representatives of all of the four myriapod classes have been recorded from littoral sites (Barber, 2009) and each is dealt with separately here:

Pauropoda

These are very small myriapods, less than 2mm in length so unsurprisingly there are few records of them from the seashore. R.S.Bagnall (1935a, b) refers to *Decapauropus remyi* (Bagnall, 1935) from below high tide level in Scotland, described from France and probably not exclusively halophilic and Scheller & Fjelberg (2010) report and re-describe it from Norway. Bagnall also listed two other valid species from Mediterranean France and Scotland whilst P.Remy (Remy, 1954) listed three from the Mediterranean. *Amphipauropus rhenanus* (Hüther, 1971) is reported from sand-dunes near the sea in Denmark, Norway and Sweden (Anderssen et al, 2005).

Symphyla

There are a few records of these animals which resemble small, whitish, centipede-like herbivores (up to 8mm or so) for littoral sites. R.S.Bagnall reported three species from more-or-less littoral sites in northern England in the early part of the 20th century (Bagnall,1911,1912,1915), apparently not exclusively littoral. More recently there are records of *Symphyella essigi* Michelbacher, 1939 from the beach at highest tide level from California (Roth & Brown *in* Cheng 1976) and of report *Symphylella vulgaris* (Hansen, 1903) from an halophilous habitat on the Black Sea Coast of Bulgaria (Scheller & Stoev, 2006).

Diplopoda

Presumably, in suitable conditions, millipedes occur in coastal habitats around the world but either because of their rarity or the difficulty in collecting them, few are recorded and only a small number of species from various different orders are known. These include the "snake millipedes" *Thalassisobates littoralis* (Silvestri, 1903) from the western Mediterranean, sites around the British coast and a single Swedish location (Kime, 1990) as well as the Atlantic coast of the United States to which it may have been introduced (Enghoff 1987) and *Dolichoiulus tongiorgii* (Strasser, 1973) on the Mediterranean coasts of France and Italy (Enghoff 1992). Both species would appear to be *halofili genuini*. In addition, *Orinisobates soror* (Enghoff, 1985) has been recorded from shingle and debris on Sakhalin and the Kuril Islands, Far-Eastern Russia (Mikhaljova, 1998) and the polydesmoid ("flatback") *Lissodesmus orarius* is described as coastal down to high tide level (including being in company with intertidal crabs) in Tasmania (Mesibov 2005).

The bristly millipede *Polyxenus lapidicola* Silvestri, 1903 is included in the list of halophiles from near Naples (Silvestri, 1903) although subsequent records of this species are not exclusively littoral and apparently actually refer to *Polyxenus macedonicus* Verhoeff, 1952 (R.D.Kime *pers.comm.*). Lawrence (1984) refers to a species of *Chilexenus*, another member of the Penicillata at Port Alfred, South Africa which is "probably able to tolerate a certain amount of salinity".

There are also records of typically terrestrial species on beaches: Bob Mesibov (*pers.comm.)* reports the introduced *Ommatoiulus morleti* (Lucas, 1860) in large numbers walking over intertidal sand in NW Tasmania in 2007 and *Leptoiulus belgicus* (Latzel, 1884) has been described as having been seen in large numbers in dunes and under stones on coastal beaches in the intertidal zone well below the high watermark in Wales (Golovatch and Kime, 2009).

From Japan, Shinohara (1961) listed 6 species of diplopod from the supra-littoral at Manazuru and Takano (1980) includes 7 species, none inter-tidal, in an account of species from Japanese seashores. In NW Europe, *Cylindroiulus latestriatus* (Curtis, 1845) is commonly but by no means exclusively found close to the sea shore but not, it seems, inter-tidally.

Chilopoda

The four centipede orders that are widespread can be viewed as two main types, relatively long- legged, short bodied generally fast moving types with up to 23 leg-pairs (Scutigeromorpha, Scolopendromorpha, Lithobiomorpha) and the more worm-like burrowing forms with more than 30 leg pairs (well over a hundred in some cases) (Geophilomorpha). Scutigeromorph centipedes are seen in coastal localities in various parts of the world; in Jersey *Scutigera coleoptrata* (Linné, 1758), the so-called "house centipede" has been collected amongst large pebbles above high water mark

The littoral centipede *Hydroschendya submarina* from a rock crevice at Wembury, Devon. Photograph Tony Barber

and seems to occur in similar situations on the French coast (Barber 2006). In the *Provisional Atlas of British Centipedes* (Barber & Keay 1988) some 10 lithobiomorphs and the scolopendromorph *Cryptops hortensis* (Donovan, 1810) are all recorded at least once from sea shore sites. These include both the ubiquitous *Lithobius forficatus* (Linné, 1758) and also *Lithobius melanops* Newport, 1845, a species also common in gardens and similarly disturbed sites. None of the species, however, appear to be truly halophilic. Takano (1980) shows *Lithobius ellipticus* Takakuwa 1939 as intertidally recorded in a figure but it is not clear whether this is not an accidental. However a species of halophilic scolopendromorph *Campylostigmus plessisi* has been described from New Caledonia (Demange, 1963).

In contrast to the other centipede orders, at least six, possibly more, of the families of the elongate Geophilomorpha contain genera, one or more of whose species appear to occur in the littoral zone with a total number of *genuini* or *indifferenti* species around the world in excess of 40 (Barber, 2009). Interestingly, not only does the halophilic habit occur in so many different families but within individual families several genera may include halophiles. All this would suggest that invasion of the sea-shore habitat must have occurred a number of times within the order. Although there are apparently monotypic littoral genera such as *Hydroschendyla* and *Thindyla*, in many cases only a relatively small proportion of members of a genus are halophilic although in *Pectiniunguis* at least a quarter of the described species are identifiable as such and in *Tuoba* more than two-thirds.

Some of these species are apparently confined to littoral habitats as in the case of *Strigamia maritima* or *Hydroschendyla submarina* whilst others occur in terrestrial sites as well as for instance *Pachymerium ferrugineum* and *Geophilus flavus*. There are also species which appear to be halophilic in one region but found inland in another as for instance *Schendyla peyerimhoffi* (Brolemann & Ribaut, 1911) and *Schendyla monodi* (Brolemann, 1924), seashore species in NW Europe (England, France) but having been found inland in Iberia (Portugal, Spain).

It is interesting to speculate on why there are so many littoral species in this group and why so many different families and genera should have littoral representatives and as to whether there are specific features of these animals that "pre-adapt" them to life on the shore. The fact that a number of species are *myriapodi halofili indifferenti* also suggests that there are no major problems for animals to overcome to live in both the terrestrial and littoral they are not quite so well adapted as the *myriapodi halofili genuini*.

Most, if not all, of the experimental work on the osmoregulatory and respiratory physiology and life cycles of littoral myriapods as compared with non-halophilic species was carried out some time ago and has been reviewed by the present author (Barber, 2009). Geophilomorphs do seem to have a greater degree of tolerance of both desiccation and immersion than the Lithobiomorpha and experiments with *Strigamia maritima* and *Hydroschendyla submarina* (Grube, 1869) demonstrate their capacity both to survive in sea water and to regulate body fluid concentrations better than the essentially terrestrial *Stigmatogaster subterranea* (Shaw, 1789).

There are also interesting contrasts between *S. maritima* and *H.submarina* representing different degrees of adaptation to littoral habitats. When immersed in seawater, after an initial period of immobility, *S.maritima* becomes active within 2 hours at 16-19°C whereas *H.submarina* remains more or less stationary overnight. This reflects the fact that *S.maritima* is a mobile species, concentrating in areas that are climatically favourable and have a good food supply. Immersed in seawater, young eggs of *S.maritima* shrink rapidly although older eggs are more tolerant and egg-laying corresponds to minimum spring tides and least stormy part of year (May-June). Males migrate up the beach to deposit their spermatophores and all stadia migrate to the top of the shingle bank to moult. *H.submarina* eggs, on the other hand are impermeable to seawater and in this species egg laying and moulting can take place in the littoral zone.

Probably, the use of trapped air bubbles is not significant in geophilomorph survival under water but there is some suggestion that cuticular respiration may occur or that the spiracles could act as physical gills. There is also some evidence for possible oxygen debt in submerged animals.

In addition to physiological adaptation, their body plan does seem to adapt geophilomorphs to a burrowing and crevice-dwelling life (Manton, 1965) which would be valuable on the shore. When walking they proceed relatively slowly with little lateral undulation, feeling their way forward with their antennae and with the capacity for backward movement as required. This allows them to explore crevices in search of prey or shelter and to retract as necessary and, when sheltering, their flexible multi-segmented bodies allow them to coil up and occupy a limited volume. However they are also able to burrow in an earthworm-like manner having a large number of short segments each of which can shorten and thicken and allow extension and contraction of the trunk regions.

CHELICERATA

Seashore species have been reported in a most of the terrestrial arachnid orders although I have found no references to littoral Opiliones.

Scorpiones

Densities of 8 -12 per square metre were found for the Intertidal scorpion *Serradigitus littoralis* (Williams, 1980) (*Vaejovis littoralis*) on Baja California (Due & Polis, 1985). It is diurnally active (as well as nocturnally) and its prey includes isopods (*Ligia*), spiders, pseudoscorpions, centipedes and beetles. Interestingly, it can survive 12 - 24 hours submergence (as can terrestrial scorpions) and it is likely that it occupies air-pockets within the crevices of the drift-line provide a retreat if necessary. There are other seashore scorpions reported from China, Africa and the Mediterranean (Roth & Brown *in* Cheng, 1976).

Pseudoscopiones

Marine Insects lists some 28 species of false scorpion from 8 families from Europe, North America, West Indies, Pacific, Japan, & SE Asia (Roth & Brown *in* Cheng, 1976). *Neobisium martitimum* (Leach, 1812) is found in rock crevices and under stones from the top of the upper shore and in the splash zone down to the *Ascophyllum* level around Britain, Ireland and western France (Legg & Jones, 1988).

Araneae

There is evidence that terrestrial spiders, if trapped in their silk nests with a bubble of air are able to use this bubble as a physical gill in the same way as the aquatic *Argyronecta aquatica* (Clerk, 1757), drawing in oxygen from the water and allowing survival for a much longer period than would be possible by just using that in the original bubble (Rovner, 1987). Roth & Brown (*in* Cheng, 1976) comment that the use of air films or plastrons is common among intertidal spiders. These authors list representatives of 11 families consisting mainly of species which live in the upper intertidal and supralittoral zones or amongst halophytic plants in saltmarshes with a few living in the wrack or lower intertidal. They include *Idioctis littoralis* (Abraham, 1924), a trap-door spider that lives in a burrow closed by an air-tight door in mangrove swamps in Malaya and *Mizaga racovitzai* (Fage, 1909) from the shores of the Mediterranean Sea living in tubular retreats which are closed by silken webs when submerged by the incoming tide.

Spiders of the genus *Desis* are found in marine habitats from SW Pacific and Indian Oceans north to Japan. *Desis marina* (Hector, 1877) lives in silk-lined retreats in hollows under the holdfasts of Bull Kelp (*Durvillaea antarctica*) around mean sea level on the New Zealand coast using air from in and around this nest which has been shown to be adequate even during the most extreme periods of submergence (up to 19 days). Mate location in this species is restricted to periods when the nest is exposed to air and the female produces successive broods, spreading recruitment over time and reducing the risk of total loss due to storms (McQueen & McLay, 1983, McLay & Hayward, 1987a, b). *Desis formidabilis* (Pickard-Cambridge, 1890) has been shown to have highly concentrated haemolymph (930mOsm/l) which may reflect a diet of marine crustaceans (Moloney & Nicholson, 1984).

Paratheuma interaesta (Roth & Brown, 1975) (*Cortreza interaesta*), another member of the Desidae, from the Mexican coast (Gulf of California), uses empty barnacle shells containing air-pockets and they have been seen at sites likely to be covered with between 3 and 5 feet of water at high tide (Roth & Brown, 1975).

Solifugae

As referred to above (Catenazzi & Donnelly (2007), a solifugid, *Chinchippus peruvianus* Chamberlin, 1920, formed part of the intertidal feeding community at Paracas Bay, Peru and was found to be present in the samples taken within the intertidal zone to which it appeared to be restricted and was never found more than 10m landward from the shore. An endemic species of solifuge is also known to live and forage in the intertidal in Namibia.

Palpigradi

Three intertidal species of these small (1-2mm) whipscorpions have been reported from the Red Sea and Madagascar (Roth & Brown *in* Cheng, 1976).

Acari

There are large numbers of marine and intertidal mites, all small (between 0.1 & 2mm) occupying a large number of niches throughout the world. The relatively large and distinct (2mm) red velvet mite *Neomolgus littoralis* (Linné, 1758) of the N. Atlantic & N.Pacific wanders both day and night on damp rocky shores and algae covered boulders feeding upon dipterous larvae and oligochaete worms (Roth & Brown *in* Cheng, 1976).

Desidae, South Africa. © Peter Smithers

DISPERSAL AND ISOLATION

Littoral "terrestrial" arthropods are found around the world with often widespread genera and species. This present distribution, their occurrence on isolated islands and their presence on both sides of oceans could be accounted for by a number of possible explanations including continental drift, climate change, transport by birds or other animals (zoochory), aerial dispersal, human activity (anthropochory), and passive transport by water (rafting),

In the case of Neotropical geophilomorph centipedes there are suggestions that a few taxa have the traits of an old Gondwanian faunal element but the bulk of the group belong to wide-ranging groups, possibly recent immigrants to South America (Pereira et al. 1997) and Verhoeff (1935) in first describing *Strigamia japonica* from Japan, suggested that there may have been a continuous occurrence of a population of *Strigamia* along the Siberian coast during the last warm period which was later broken up by climate change which led to the separation of the European and Asian maritime forms.

Transport by birds has been suggested for the certain freshwater millipedes (Golovatch & Kime, 2009) but there is no definite evidence of this being a common mechanism for dispersing littoral arthropods although it certainly remains an intriguing possibility. Small organisms are always at risk of aerial transport as dust, etc. is picked up and carried in the atmosphere, possibly for long distances. Flying insects and balooning spiders will especially be likely to be carried aerially. Dispersal by human activity is always likely and almost certainly accounts for some of the dispersal of myriapods and other arthropods although animals associated with agriculture or similar practices would seem to be more likely to be spread this way than sea shore organisms.

Accidental dispersal by rafting of animals e.g. on plant debris (hydrochory) is seen as a likely dispersal mechanism for animals and littoral species are in an optimum situation for this. Crabill (pers.comm. cited by Roth & Brown *in* Cheng 1976) describes the centipede *Orphaneus brevilabiatus* (Newport, 1845) as found in protective cocoon-like structures in or on twigs floating or awash on beaches. It occurs throughout the larger landmasses and islands of the tropics and this can possibly be explained by tolerance of saltwater and Suomalainen (1939) reported on *Pachymerium ferrugineum* floating on sea water for as long as 31 days before sinking and long survival when submerged in such water (up to 178 days at 6-12°C). Interestingly, this latter species is probably the most widespread centipede in the world. Fossil evidence suggests that rafting occurred in palaeo-oceans and during recent centuries the composition and abundance of floating items has been strongly affected by human activities; it is suggested that rafting continues to be an important dispersal in present-day oceans (Thiel & Gutow, 2004).

There is, in fact, very limited quantitative data on the extent to which insects (for instance) actually survive as drifters. Drifting vegetation has been found up to 16km offshore which supported many insects although only 25% of it had living terrestrial animals and no living insects were found in vegetation collected 160km offshore. Colonies of ants have been reported in drifting wood (Bowden & Johnson *in* Cheng 1976). Even if the chances of survival are small, the possibility remains for transport in this way. The pseudoscorpion *Apocheiridium pelagicum* Redikorzev, 1938 was first collected 200 miles (320km) at sea in plankton nets; its habitat is in reefs constantly submerged by the sea (Roth & Brown in Cheng 1976). The fact that species of the heteropterous bug, *Halobates* (ocean skaters) can live on the surface of the open ocean suggests also that there is no fundamental reason why arthropods of terrestrial origin should not be able to survive in this environment for a period of time and be dispersed over wide distances.

Pereira & Minelli (1993) commented that "The scattered and often wide-ranging distribution of halophilous centipedes has been commented upon several times. Such species are very probably dispersed across very large distances, although in a very unpredictable way. It is possible to think of dispersion by rafting across the Atlantic Ocean for e.g. *Schendylops*. This was Crabill's (1960) hypothesis and we see no reason to dispute it" and Pereira et al. (1997) wrote "There is a single specimen of *Schendylops* in the Natural History Museum in London, too damaged for allow for confident specific identification, but good enough to allow a confident identification as a member of a genus occurring, with many species, on both sides of the Atlantic. This specimen was collected long ago from Ascension Island, midway between Africa and South America, along the route of the westbound South Equatorial Current"

The varied nature of coasts will tend to break up species into isolated populations which may favour genetic divergence. Dispersal across oceans and to isolated islands could accentuate this effect. This may be reflected in variations in characters between populations at different sites. Geophilomorph centipedes are useful animals in which to study differences between populations as the number of leg-bearing segments varies within species (but is constant throughout the life of individuals). This was described by Lewis (1962) for *Strigamia maritima* and Shinohara (1961) for *Tuoba littoralis* and Arthur & Kettle (2000) demonstrated a latitudinal cline in segment number in *Strigamia maritima* in Britain. They suggested that climatic selection and local adaptation could be responsible; Vedel et al (2008) showed that, in laboratory experiments, temperature regime influences the number of leg-bearing segments that develop and which could provide an explanation for this phenomenon.

CONCLUSIONS

The littoral marine appears to offer an appropriate environment for many arthropods to colonise despite osmotic and respiration problems. Possible reasons for this include an abundance of food, humid and more equable local climate, opportunities for shelter and the absence of parasites and predators.

Whatever the mechanisms of survival, it seems possible that species might be dispersed, possibly across considerable distances, by rafting and this could account for the distribution of genera and families in different parts of the world. Isolated populations, however they came

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ARTICLE

Lanna Cheng
Scripps Institution of Oceanography,
University of California San Diego,
La Jolla, CA. 92093, USA.
Email: lcheng@ucsd.edu

Martien Baars
Royal Netherlands Institute for
Sea Research,
P.O. Box 59, Den Burg, Texel,
The Netherlands.
Email: martien.baars@nioz.nl

Anthony Smith
Winterwood, George Eyston Drive,
Sleepers Hill, Winchester,
Hants SO22 4PE, England.
Email: amls3141@gmail.com

Halobates male and live eggs on a *Spirulla* shell. Eggis in orange are almost ready to hatch.

Life on the high seas – the bug Darwin never saw

Introduction and historical background

Among millions of insect species known in the world only five species of *Halobates* (Heteroptera: Gerridae) are able to live in the high seas. The general public is probably not aware that there are insects living on the open ocean and even most marine scientists have never seen a live or preserved specimen with their own eyes. The genus *Halobates* was first collected during a Russian oceanographic expedition around the world between 1815 and 1818. It was described by an Estonian naturalist who served as the physician during the voyage. The paper was published in German in a rather obscure journal (Eschscholtz 1822). It has brief descriptions of 85 insects including three species of *Halobates*: *H. micans*, *H. sericeus* and *H. flaviventris*. There was no information on their biology or distribution. We presume that the 22 years old Charles Darwin was unaware of this publication when he set sail on the HMS Beagle with captain Robert Fitz-Roy on 27 December 1831. As far as we could determine Darwin never saw any *Halobates* during the voyage that lasted almost 5 years (completed on 02 October 1836). He suffered seasickness almost all the time and even observations on seabirds and sea mammals were very scarce in his diaries. Although he was among the first to use a plankton net, no effort was made by the Beagle to sample specifically the sea surface community, the pleuston (Cheng, 1975), to which *Halobates* belongs.

General information on *Halobates*

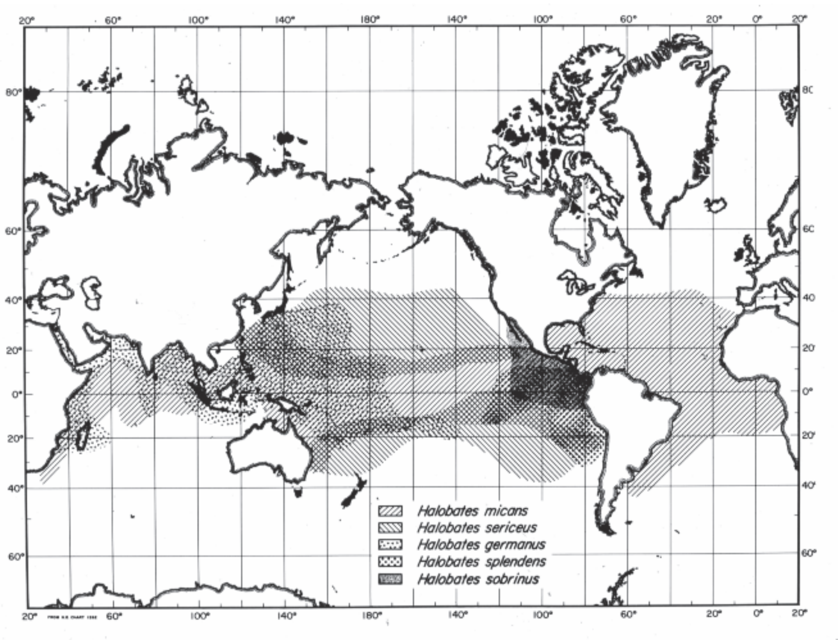
Halobates remained largely unknown after its first description except for the addition of several new species, many have later been synonymised (see Herring 1962). The first monograph on the genus, comprising 11 species, appeared some 60 years later when additional collections and observations were made on the H.M.S. Challenger during 1872-1876 (White 1883). Sir John Murray, the assistant scientist on the Expedition and founder of modern day oceanography, made the very first observation on their biology and distribution (Murray 1879). It is possible that Darwin might have been aware of their existence just before he died on 09 April 1882.

Forty five species of *Halobates* are now known worldwide (Andersen and Cheng 2004). Most are found in coastal habitats around tropical islands associated with mangroves or other land plants. Only five species are oceanic in habitat: *H. micans*, *H. sericeus*, *H. sobrinus*, *H. splendens* and *H. germanus*. They occur in tropical and subtropical regions of all three major and 40°S, where the sea surface temperature in winter is above 20°C. All five species can be found in the Pacific Ocean, two, *H. micans* and *H. germanus* occur in the Indian Ocean, but only *H. micans* occurs in the Atlantic Ocean (Cheng 1989).

Although morphologically rather similar, coastal and oceanic *Halobates* are quite different in their life styles. Coastal species depend on terrestrial insects which fall to the sea surface for food, lay their eggs on rocks or tree roots and almost never venture out to the open water (Birch *et al.* 1979). Oceanic species, on the other hand, spend all their lives in the open sea thousands of kilometers away from land and never come to shore except when they are blown by onshore storms (Cheng 1985). They live in a two-dimensional world at the sea-air interface with no apparent physical barriers. Wings have never been found on any *Halobates* species. Unlike freshwater Gerridae where wings are present in dispersal morphs, ocean skaters have no need for wings. In theory they could skate over the ocean surface from shore to shore with nothing to prevent their movements.

There are five juvenile stages from egg to adult. The exact duration of each stadium is unknown as we have not been successful to culture them in the laboratory so far. Each larval stage probably lasts from 7-10 days, depending on water temperature. Adults measure only 5-6 mm in body length. Eggs are about 1 mm long and resemble miniature rice grain. They are laid on any floating material the females could find. Oviposition substrates may be hard to come by or limiting. Some 30,000 eggs have been found on a plastic milk jug in the eastern tropical Pacific (Cheng & Pitman 2002). They would feed on any organism trapped at the sea surface but little is known of their food preferences. We have not found their abundances to be related to densities of zooplankton organisms upon which they feed. In fact, in the Banda Sea (Indonesia), higher numbers were captured in oligotrophic waters during the NW monsoon than in the upwelling waters of the SE monsoon (Cheng et al. 1990). Although they have been found in the stomachs of sea turtles and several fish species, seabirds are their main predators (Cheng *et al.* 2010). Although much is known about their biology and distribution there are

Halobates gemanus - female (above), male (below)



Distribution map of oceanic *Halobates* spp. (From Cheng 1985)

still many aspects of their life history that we know nothing about, e.g. what do the first instar nymphs feed on, how long the adults live, how the sexes find each other at sea in order to mate, etc. (Cheng 2008). Few photographs of pelagic *Halobates* exist in print and they have never been filmed in their natural environment, the open ocean.

The Dutch Beagle Voyage

An opportunity to study oceanic sea skaters in the wild came by an ambitious project of the Dutch broadcasting company VPRO. They planned a 35-part TV documentary "Beagle, On the Future of Species" to mark Charles Darwin's 200th birthday and the 150th anniversary of the publication of 'On the Origin of Species'. VPRO chartered the Clipper Stad Amsterdam for a voyage following the route of the HMS Beagle. The construction of the 70 meters long, three-masted clipper was completed in 2000. It followed the classic design of the Cutty Sark but with modern modifications such as a diesel motor, bow thruster, water desalination plant, luxurious air-conditioned cabins, etc.. For the Beagle Project, the clipper was further modified to house two complete TV studios, satellite dishes and web cams. These were installed to ensure 24x7 contact with the public. Since she set sail from Plymouth on 1 September 2009 the Stad Amsterdam has carried an international cast of scientists, philosophers, historians, artists and biographers. Two of us (LC and MB) were invited to participate as scientists on the leg between Tahiti and Sydney to try and capture *Halobates* and to carry out some experiments on board. AS was invited as the resident artist/photographer for the entire voyage. We also challenged the film crew of VPRO to be the first to film *Halobates* in the wild.

Stad Amsterdam in the Galapagos.

Before we (LC and MB) joined the Stad Amsterdam we spent five days working at the Gump Station in Moorea. The station is operated by the University of California, Berkeley. It is situated on the western shore of Cook's Bay and has excellent facilities for conducting fieldwork. Our aim was to collect specimens of the coastal *Halobates hawaiiensis* to take on board so that we could carry out comparative studies between coastal and oceanic species. *H. hawaiiensis* is known to occur in some abundance in Cook's Bay and had been collected in previous visits by luring them to the dock by light at night (Tsoukatou *et al.* 2001). For some unknown reason we only collected two adult specimens during four nights of hunting! Survey of near shore habitats from land and by boat from the sea revealed no populations. We did encounter quite a large patch of flotsam consisting of coconuts, uprooted macro-algae, terrestrial plants, etc.. We are puzzled by the near absence of *H. hawaiiensis* around Moorea during our visit in mid January 2010. We are not sure whether this is a seasonal effect or due to environmental changes of their habitat.

Collecting at the entrance of Cook's Bay (above)

Stad Amsterdam leaving Plymouth (below).

Work on board

In order to capture *Halobates* at sea we need to use a net that is specifically designed to sample animals at the sea-air interface. On the Stad Amsterdam we deployed a David-Hempel neuston net. It looks like a mini-catamaran with the two hulls made of hollow aluminum shells packed with foam. One or two nets could be strung between the two wings. Each net, measuring 5 m long with a 300 um mesh size, tapers towards the end which is attached to a plastic cod end. The net opening is stretched over a rectangular aluminium frame measuring 30 cm x 10cm. It is towed off the side of the vessel away from the bow waves at a speed of between three and four knots. During operation the lower bar is kept underwater such that it skims over the sea surface at all times during the tow. It is only operable with a sea state of four or less when the wave heights are below two meters. The maximum speed of the ship must not exceed four knots otherwise the catamaran tends to flip over or be damaged.

We were able to launch the net the night after we sailed from Papeete when the wind dropped and the

David Hempel net in operation

clipper was on motor. We towed the net for 30 min at three knots and caught 11 specimens of *H. germanus* (one male, two females and seven nymphs). Only the three adults and one final instar female were caught alive. The remaining nymphs did not survive the tumbling in the net while it was being towed.

The four live specimens were allowed to dry themselves on filter paper before being released onto a small aquarium with fresh seawater. When placed on water they proceeded almost immediately to preen themselves with their front legs, presumably to spread water-repellent chemicals over the appendages. They start by cleaning the antenna first, holding each between the front tarsi and stroking it from the base to the tip. This was done several times for each antenna. The middle legs were preened in the same way next, followed by the hind legs. While cleaning the middle legs the female tipped over. It was able to right itself by somersaulting. Preening took about five minutes to complete. Afterwards the insects were observed to skate normally. However, they soon began to hit themselves against the aquarium wall. Since they never encounter physical barriers in their natural habitat they continued to hit the wall until they tired.

After settling down somewhat the male was observed to mount one of the females. We were not sure whether mating was successful. The pair separated after about five minutes. In the Galapagos Islands mating pairs of the coastal species, *H. robustus*, have been observed to remain in copula for over nine hours (Foster and Treherne 1980). We added several floating plastic pieces to the aquarium to provide oviposition substrates but no eggs were found after four days. On a previous expedition to the Eastern Tropical Pacific females of *H. sobrinus* collected by dip net have been observed to lay eggs almost immediately upon capture when placed on wet blotting paper (Cheng, unpublished). Perhaps the females we captured were not sexually mature. We managed to keep the specimens alive on board for only seven days.

Winds and waves

After our successful net tow on the night of 25 January we were unable to launch the net again for more than 10 days. We were followed by 20-25 knot winds, rough seas, and several tropical cyclones. Even if all the sails were down the clipper would still be sailing at five to six knots, much too fast a speed for us to tow the net. We were making such good speed towards Sydney that would advance our arrival by three days. This was not acceptable since various arrangements made to welcome our arrival could not be changed. To our great delight our request to make a stopover at Lord Howe Island was granted by the Australian authorities. We all looked forward with great anticipation to a visit of this paradise. Sadly our joy was short lived. There is a quota of 400 visitors at any one time and passengers from cruise ships were not allowed to land on the island. As the clipper was registered as a cruise ship we were unable to go to shore. We resigned ourselves to viewing the island from about 500 m away and to enjoy a few days of respite from the rolling sea.

Lord Howe Island Interlude

Lord Howe island was created by a volcanic eruption some seven million years ago. It is about 600 km away from mainland Australia. The island is only about 1 km long and up to 2 km wide at its widest part. There are two towering peaks at one end of the lagoon which harbours the southernmost coral reef in the Pacific. Much of the island is still covered by original vegetation. With some 300 inhabitants the chief income is from tourism. We were visited by Clive Wilson, a descendant of one of the earliest settlers on the island. He was apparently instrumental in the campaign to eradicate all the wild pigs in the island thus protecting the native

Lord Howe Island

thousands of seabirds nesting on various parts of the island. We spotted masked booby, shear waters, petrels, tropicbirds, etc. Masked boobies appeared to be the tamest and would glide close by the clipper, seemingly to observe us. While we were anchored in the lagoon at Lord Howe we spent several hours dip-netting at night. However, we did not spot, nor caught any *Halobates*.

Final push towards Sydney

After a two-day rest we left Lord Howe Island and continued our journey towards Sydney. The wind dropped so we were able to launch the net again that night. We caught many specimens of *H. sericeus*, the species with an amphi-tropical distribution (Cheng 1997). The calm weather continued the following day. A two-hour day tow produced more than 100 individuals of *H. sericeus*. It was likely that there may be aggregates of the sea skaters on the ocean near us. It would have been a wonderful opportunity for us to launch the Zodiac and try to film them. However, the weather did not cooperate. The challenge of filming these unique creatures in the wild remains elusive.

We conclude that these tiny ocean skaters are apparently rather common organisms at the sea surface. Had we been able to carry out net tows more often during our voyage after leaving Papeete we probably would have caught them in every tow. They could be easily observed on a calm day if one were specifically looking for them and be captured if one has the appropriate net. Darwin never saw them but we felt sure he would have looked for them had he known about their existence.

Footnote - Beetles on board

On 05 February, around 0400 hr, the crew discovered a dozen or so beetles on board. Six were captured alive and photographed. They appeared similar to the Burnt Pine longhorn beetle *Arhopalus ferus* (Mulsand) (Cerambicidae) reported as a forest pest from New Zealand. The clipper was at approximately 33° 19' S and 168^0 37'E, some 200 miles north of the North Island of° New Zealand. There was a easterly wind blowing at 20-25 knots all night. We suspect the beetles to have been blown from N.Z.

Acknowledgements

We are most grateful to the VPRO team for inviting us to participate in the Dutch Beagle voyage. We are especially indebted to the captain and crew of the Stad Amsterdam who have been most helpful and accommodating in helping us with our research needs. LC and MB wish to thank the staff of the Gump Biological Station in Moorea for providing excellent facilities for their short stay on the island.

Beelte on board (scale in inches).

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Author biographies

Anthony Smith taking pictures of *Halobates* on board the Clipper Stad Amsterdam.

Lanna Cheng studied terrestrial insect population ecology at Oxford University. Her interest in marine insects began fortuitously when she married a phycologist and found herself attached to an oceanographic institute. "Marine Insects" which she edited and published in 1976 remained the only reference book on the subject. It is now out of print but is available on the University of California E-scholarship repository web site: http://repositories. cdlib.org/sio/techreport/48/. She has devoted her studies to *Halobates*, especially the five open ocean species and has published widely on the subject. At least five marine insects have been named in her honour. The bulk of her collection of *Halobates* have been deposited at the Zoological Museum, University of Copenhagen, which has the largest collection of this genus in the world. She has been a fellow of the Royal Entomological Society since 1966 and was one of four women who attended the first Verrall Supper opened to female entomologists in 1967.

Martien Baars is a zooplankton scientist at the Royal Netherlands Institute for Sea Research on the island of Texel but he did his PhD ('Running for life') on locomotory activity and population dynamics of carabid beetles on the moorland of Drenthe. During the preparation of the Indonesian-Dutch Snellius-II Expedition 1984/1985 he was requested by Lanna Cheng to collect *Halobates* in the Banda Sea. After cruises in both the SE and the NW monsoon, the eastern Indonesian waters were no longer a blank area on the *Halobates* distribution maps. Since then, *Halobates* has also been collected during Dutch cruises in the northwestern Indian Ocean betweem 1992-2000. During the planning stage of the Dutch Beagle Voyage Martien succeeded in getting the broadcasting company VPRO interested in trying to film H*alobates* in its natural environment.

Anthony Smith is an artist, naturalist and photographer from Cambridge, UK. He studied Zoology at Cambridge University, and has a particular fascination for animal behaviour and evolution. Anthony is also a long time Darwin enthusiast. After graduating from Cambridge he began a career as an artist – first specialising in wildlife subjects, and now also doing human figurative work. On the bicentenary of Darwin's birth in 2009, HRH Prince Philip unveiled a life-sized bronze statue that Anthony sculpted of The Young Darwin, for Christ's College Cambridge. He is a Fellow of the Linnean Society of London, and an Associate of the Royal British Society of Sculptors.

Illustrations - almost all taken by Anthony Smith

Library News

Val McAtear

RES Librarian

I hope most of you read the new additions to the library page on the RES website but, for those who have not, below are listed the most recent additions to the library.

There are so many new Entomological titles published each year and there is only so much money and, possibly even more importantly, so much space in the library to shelve them that selecting what we should buy is a difficult task. I am very grateful to the members of the Library Committee who advise me on the books we should purchase. However, I am always glad to hear the opinions of all Fellows and Members as to titles that they feel merit a place in the library. Please do let me know. Of course a lot of the Library budget is spent on our serials collection and these also have to be reviewed on a regular basis. We will be doing that next year.

I am glad that more of you have requested PIN Numbers as the library database is a wonderful resource and shows the extent of the library collection. There is still much to do to it especially with our extensive reprint collection. I have recently added a collection of older and rarer reprints / pamphlets to the database including material dating back to the 18th Century. Although of little entomological merit, the tiny hand printed catalogue of insects from Brazil produced by Princess Charlotte and presented to her mother Queen Caroline in 1810 is a fascinating item. There is now so much available on the internet but I think the library still has many items that are not to be found anywhere on the Web. Please make time to have a look at the Library either through its database or even better by paying a visit to The Mansion House.

New Additions to the Library

Crawforth, A.(2010) The Butterfly Hunter: Henry Walter Bates FRS 1825-1892

Blackman, Roger (2010) Aphids-Aphidinae (Macrosiphini)

Capinera, John L (2010) Insects and wildlife: arthropods and their relationships with wild vertebrate animals

Dunbar, David (2010) British Butterflies: a history in books.

Elliott, John Malcolm (2010) Mayfly larvae (ephemeroptera) of Britain & Ireland keys and reviews of their ecology

Fibiger, Michael (1997) Noctuidae Europaeae v. 3 Noctuinae III

Fibiger, Michael (2007) Noctuidae Europaeae v. 9 Amphipyrinae, Condicinae, Eriopinae, Xleninaea

Gordon, Deborah (2010) Ant encounters:interaction networks and colony behaviour

Gregory, Steve (2009) Woodlice and Waterlice (Isopoda:Oniscidea & Asellota) in Britain and Ireland

Kuchlein, Joop. H. (2010) Identification keys to the Microlepidoptera of the Netherlands

Lawrence, John F. (2010) Insects and Wildlife: Arthropods and their Relationships with wild vertebrate animals.

Lee, Paul (2003) Myriapods, Chilpoda and Isopoda- Millipedes, Centipedes and Woodlice

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Putshkov, Pavel V. (2009) Hemipteres Reduviidae d'Europe Occidentale

Pacheli, Tomaaso(2010) Papilionidae Pt. 2 Sub Family Papilioninae Tribe Troidini

Svensson, Bo W. (2010) Stovslandor Psocoptera Denn volym Omfattar samtliga nordiska arter

Thomas, Jeremy (2010) Butterflies of Britain & Ireland 2nd edit.

Meeting Reports

Insect Parasitoid Special Interest Group

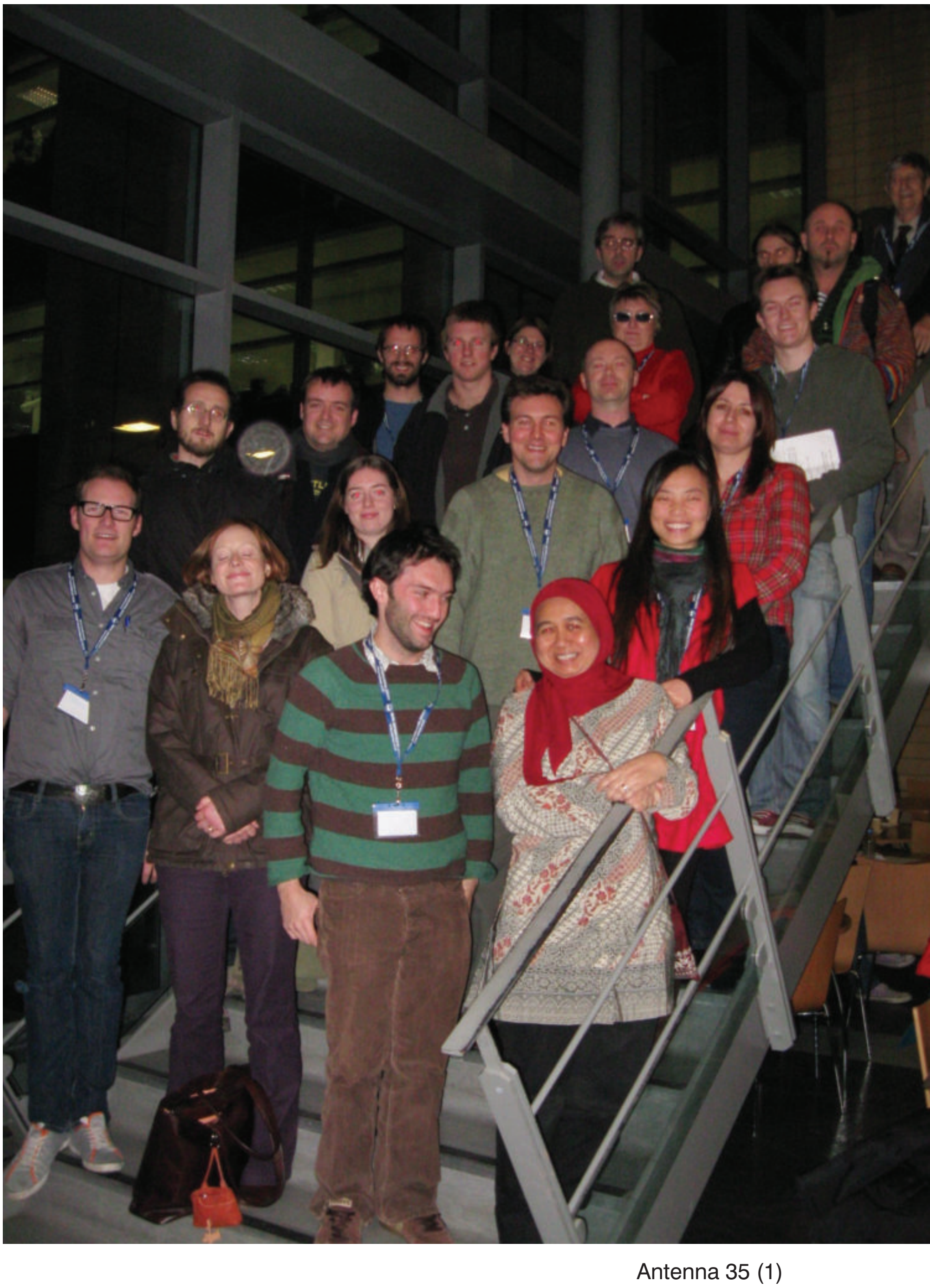
November 26th 2010
Department of Biology, University of York

Peter Mayhew (Organizer)

Thirty five delegates contributed to this enjoyable day at York which featured a wide variety of research talks and posters, all on the common theme of insect parasitoids. Despite the best efforts of the November blizzards, all speakers managed to make it in.

The morning session kicked-off with Pavel Saska of the Crop Research Institute in Prague. Pavel described his efforts to discover the life cycle of Bombadier beetles, which, in the laboratory, he was able to rear successfully on pupae of a particular carabid beetle genus. The Bombadiers have planidial (mobile, actively foraging) larvae and, having found a host, grow as ectoparasitoids upon it. The lab experiments are supported by a growth model which predicts correctly the field phenology of the host and parasitoids. This excellent start to the day reminded us of how little is known of the life cycle of so many parasitoid species, as well as the fact that not all parasitoids are Hymenoptera.

This was followed by Wen-Juan Ma (University of Groningen), who described breeding experiments on four braconid species of the genus *Asobara*, aimed at unravelling the mechanism of sex determination. She compared the observed sex ratios after several generations of inbreeding, with those predicted under single and multi-locus complementary sex determination, the only other mechanisms previous described from Braconidae. The observed sex ratios were not male biased enough to be consistent with single locus CSD, or with simple forms of multi-locus CSD, suggesting a novel mechanism in this genus.



Clive Darwell (University of Reading) gave an interesting talk about pollinators and parasitoids of the fig, *Ficus rubiginosa*, from eastern Australia. The fig is currently thought to possess at least four pollinator wasp species and at least 18 parasitoid, inquiline and gall-making non-pollinator wasps. Clive outlined molecular genetic evidence for the existence of several cryptic species of both pollinators and parasitoids, suggesting considerable unappreciated diversity in this system.

Andrew Polaszek (Natural History Museum, London), brought us up to lunch with a whistle-stop tour of the biology of *Encarsia*, a genus of aphelinid chalcidoids that is widely used in biocontrol. Andrew covered a wide range of topics including their species richness (equivalent to that of many families), extraordinary life cycles (males usually using alternative hosts to females, and frequently females themselves), as well as progress in phylogeny and biocontrol.

Over lunch, we warmed ourselves with hot drinks, and were able to peruse posters on the optimal seed mix for agricultural field margins (D.R. George & Felix Wackers, Lancaster University), determining whitefly parasitoid distributions in the UK (Simon Springate, Natural Resources Institute, University of Greenwich), attraction of natural enemies to *Brachiaria* plants (Toby Bruce, Rothamsted Research), and horizontal transfer and parasitoid host diversity of the bacterial symbiont *Arsenophonus*.

Proceedings after lunch continued with Robert Jacobson (RJC Ltd), who described challenges with IPM in pepper crops in protected culture, where aphid pests are often knocked back by parasitoids initially, but which then themselves suffer hyper-parasitism which decreases their effectiveness as control agents. We were left to ponder how to prevent this troublesome phenomenon.

Sahand Khidr (University of Nottingham) then described the effect of time-since parasitisation on the suitability of hosts of the bethylid wasp *Goniozus nephantidis*. Suitability decreases since parasitisation as witnessed by decreased longevity of hosts, and acceptance and defence-tenacity of female wasps. Mass spectroscopy was introduced as a way to investigate the metabolic correlates of these changes.

Simon Segar (University of Reading) presented the global phylogeny of Sycoryctine fig-wasps, themselves parasitoids, and showed how the phylogeny supported geographic origins in Asia or Australasia in contrast to the usual Neo-tropical origins of the pollinating wasps.

Leading up to tea, Ian Hardy (University of Nottingham) presented work on field studies attempting to elucidate the sources of mortality in the encyrtid wasp *Metaphycus luteolus*. The translucent bodies of the host allow mortality to be ascribed to several sources, and the resulting patterns of sex ratio, and virginity are not fully consistent with the predictions of current theory, demanding new theoretical models.

After tea Annette Anderson (University College Dublin), described studies of agricultural grassland arthropod diversity in Ireland, in which the abundance of parasitoid Hymenoptera predicted quite accurately the diversity of other arthropod groups. Furthermore, the relationships found could be used to accurately predict arthropod diversity at other sites, raising the hope that simple numerical counts of individuals could be used to track arthropod diversity in such systems.

Tim Cockerill (University of Cambridge) described surveys of parasitoids in forest borders and palm-oil plantations in Borneo. Parasitoid diversity declined rapidly across the forest border and into the plantation. This information is pertinent to the suggestion that remnant patches of forest might boost the local supply of natural enemies and potentially aid pest management.

Finally, Luke Tilley (Stockbridge Technology Centre and University of York) described three pieces of evidence that the native braconid wasp *Aphaereta debilitata* can control shore flies in glasshouses: glass houses with large numbers of wasps tended to have low numbers of flies; the wasp life cycle and fecundity was sufficiently fast to enable fly control, and in trial releases in greenhouses, fly numbers were depressed significantly after wasp release.

The meeting continued afterwards in the pub in Heslington village. I would like to thank Kirsty Whiteford for advertising the meeting, organization registration and running the registration desk on the day, the Department of Biology at the University of York for generously waiving the usual room-hire fee, and all the attendees for making this an enjoyable and productive meeting.

We now have a facebook site up and running for the SIG, which you can link to here: http://www.royensoc.co.uk/sig/insect_parasitoid.htm. If you "like" the site (press "like" once there), you can then post parasitoid news and information in the form of text or links. Adverts of relevant meetings, papers published, jobs and studentships on offer would be welcomed. We hope that the site will serve to keep us in touch with each other and our research between meetings.

Book Reviews

A Manual of Central American Diptera, volume 1

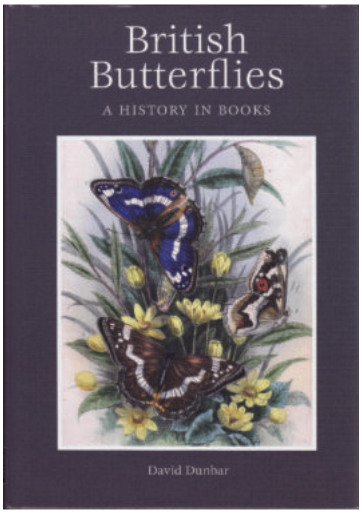
Edited by B. V. Brown, A. Borkent, J.M. Cumming, D.M. Wood, N.E. Woodley, M.A.Zumbado.

Published by NCR Research Press Ottawa

ISBN 978-0-660-19833-0 Price £67.00

The Manual of Central American Diptera is a magnificent project that brings together and updates our knowledge of the dipteran fauna of this region. Volume one deals with the nematocera and lower brachycera while the pending volume two will cover the remaining brachycera and the cyclorrhapha. The first volume has introductory chapters dealing with adult, morphology, natural history, economic importance and phylogeny. It also contains keys to the adult and larvae of all the families covered in both volumes. These are richly illustrated with line drawings and the text is written in plain English keeping technical terms to a minimum. The key to adults is followed by a gallery of colour photographs illustrating the diversity of dipteran forms encountered in central America. The remainder of the book is devoted to the forty one families of the nematocera and lower brachycera found in the region. Each of these chapters introduces a family and most provide a key to the genera. The volume is lavishly illustrated with a truly beautiful collection of line drawings that both inform and enhance the text. While many of the chapters confine their attentions to central America some cover much wider areas. Whist this two volume work is aimed at entomologist who are studying the central American fauna, the combination of the well produced keys and the wider coverage of many chapters mean it will also prove invaluable to as an introduction to dipteran families almost anywhere.

Peter Smithers



British butterflies. A history in books.

By David Dunbar

Published by The British Library

ISBN 9780712350969 Price £45.00

David Dunbar's book chronicles the development of the British love of butterflies by presenting a history of the books that deal with them. This is a fascinating journey that takes us from Thomas Moffet's Insectorum Theatrum in 1634 to the diversity of butterfly books available today. This is a multifaceted journey that examines our changing attitudes towards the natural world, the development of observational entomology, the advance of printing technology, the popularisation of entomology and the provision of books for children. In his forward Dick Vane-Wright states that this history creates a new perspective, a sentiment with which I concur. Viewing the history of British butterflies through the lens of the books that have been written about them provides a new insight into our relationship with them. Books are the milestones on this journey and clearly mark the progress we have made in our understanding of our butterfly fauna.

The book has five sections;

Butterflies and books,

The 17^{th} & 18^{th} Centuries; The golden age of discovery,

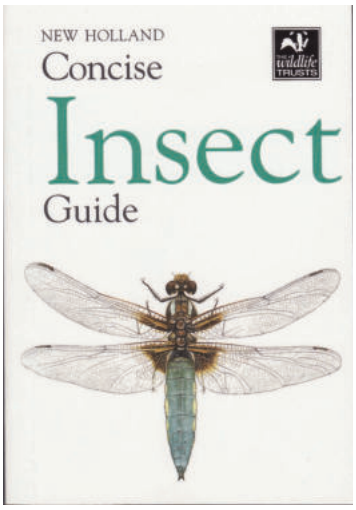
The 19^{th} Century; Collectors and scientists,

The 20^{th} & 21^{st} Centuries; Towards conservation, and,

Butterflies in other contexts; Art & romance.

For me the book was more than a history, it was steeped in nostalgia. From my first Observers book of butterflies to my cherished and hard won copy of South British Moths and of course the cigarette cards collections of my grandparents and tea cards of my childhood. As entomologists our journey from childhood fascination to scientific investigator are marked by the books that inspire us. David Dunbar's book demonstrates this vital and poignant connection.

Peter Smithers



The New Holland Concise Insect Guide

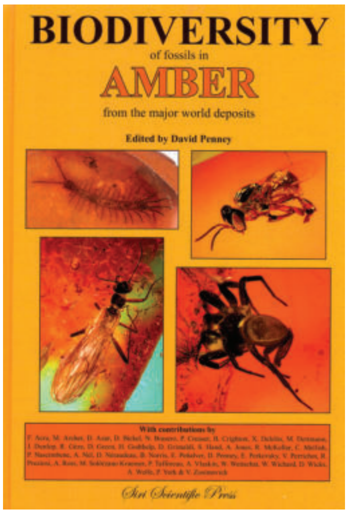
Published in association with the Wildlife Trusts
ISBN 978-1-84773-604-8
£4.99

If you know a budding or potential young entomologist this is a good little book to spur them on. It covers a wide range of insect groups providing examples of the major orders and giving examples of typical species within them. Each of these accounts has a synopsis of its biology and distribution accompanied by an excellent illustration.

The book is pocket sized, comes with a plastic cover and is accompanied by a foldout sheet on which all of the illustrations in the book are reproduced at a fifth of the original size, facilitating rapid reference.

The guide opens with an introduction to insect structures, followed by a descriptions of the main features of the principle orders. It is difficult to offer a concise guide to one of the most diverse groups of organisms on the planet and to attempt to cover so much territory in so little space is challenging. This guide has been successful in providing a brief overview that should stimulate an interest in protoentomologists.

Peter Smithers



Biodiversity of fossils in amber from the major world deposits

Edited by David Penney
304 pages, 157 colour tables of photos and drawings, 24 16.5 cm. Hard-cover.
Siri Scientific Press, 2010; in English.
ISBN 978-0-9558636-4-6
Obtainable from Siri Scientific Press <siri.press@live.co.uk>; cost £85 plus postage. Further details online at: <http://siriscientificpress.co.uk>.

The international entomological community can welcome a new book devoted to global diversity of terrestrial amber arthropod fossils (Insecta, Arachnida, Myriapoda and Crustacea). The compiled volume presents a comprehensive synopsis of the following thirteen major fossiliferous amber deposits: Dominican, Mexican, Germany (Bitterfeld), Australian, Baltic, Ukrainian, French (Tertiary and Cretaceous), Canadian, American (New Jersey), Burmese, Spanish and Lebanese ambers. This book is a unique edition, because much of the amber-related information that was previously scattered in a great number of academic journals and rarely available to laymen or interested amateurs has been gathered in a single volume for the first time. The book is fully referenced and richly illustrated by 157 colour figure plates of 451 individual photos, schemes or maps. It is safe to assume that the audience of this book is potentially very broad and will include not only palaeontologists and entomologists, but also students and all amber enthusiasts.

The book is a collection of 15 papers, with each one starting as a new chapter from a new page and having dedicated figure numbers and reference lists (of which surprisingly there is very little overlap between chapters). Thirty seven authors, who are leading world experts on the relevant deposits, from ten countries contributed to this volume. Although the book does not contain a separate list of all authors with their contact details, these are available at the beginning of each chapter. Unfortunately, there are no chapters on the Russian, Chinese and Japanese amber deposits. As mentioned in the Foreword by the editor, contributions from these countries were invited but no submissions were received.

The introductory chapter of the book is devoted to methodological aspects, such as, tissue and DNA preservation, methods of separating amber from copal and fakes, various preparation methods, photo-microscopy and imaging techniques, and the curation of amber collections. The reader will certainly be impressed, as I was, by the research potential of the application of high resolution X-ray computed tomography or the phase contrast X-ray synchrotron imaging to the study of amber inclusions, even from completely opaque amber pieces. Both methods are non-destructive and generate 3D reconstructions of the inclusion that otherwise maybe impossible to view using traditional techniques (impressive examples of such reconstructions are given on pp. 15-17 (e.g., the spider *Cenotextricella simoni*) and p. 77 (the scolytid beetle from Cape York amber). For some kinds of the amber (e.g, from the Charentese deposit) X-ray synchrotron imaging seems to be the main current method of study (pp. 198-199). The generated 3D images can even be used for making plastic models of the studied creatures, exemplified in the book by the model of the psychodid fly *Trychomyia lengleti* (p. 17, Fig. 8).

Each of the following chapters is devoted to one of the aforementioned amber deposits and is written in a semi-standardized format: an introduction, information on the geological setting, methods of amber collection, palaeohabitat, the resin producing tree, age, physical and chemical properties, diversity of inclusions and finally a checklist of the fossils described (as an appendix to almost all chapters). Taxonomic checklists vary in detail: some of them (e.g., those for the New Jersey, Burmese or Lebanese amber deposits) are provided with complete species lists, whereas others (Baltic, Rovno, Canadian, Spanish deposits) list families only. It is a bit unfortunate that in the latter case no references to the main sources from which species lists can be obtained were given, and thus the reader is to seek them through the main text and reference lists of particular chapters. Although the Baltic amber checklist is limited to families, it contains exact counts of genera and species described from each order. The chapter devoted to the Austarlian Cape York amber has no checklist at all, though in the text (p. 69) it is said that at least 25 families of terrestrial arthropods have been recorded. However, as noted, this is a newly discovered deposit and only one fossil species has been formally described.

In most deposits, the highest palaeodiversity relates to the Diptera, followed by the Hymenoptera. Yet, sometimes the Coleoptera (in Burmese amber, p. 211) or even Araneae (in Baltic amber, p. 100) can be the second richest group. A notable disadvantage of the reviewed volume, to my mind, is the absence of a general chapter summarizing the existing data on amber palaeodiversity and/or presenting a general overview of the current state of knowledge of the amber Arthropods from various deposits. Based on the figures extracted from the reviewed book, here I have produced a comparative table giving an indication of the comparative arthropod palaeodiversity of the 13 amber deposits.

	Amber deposit	Age	Orders	Families	Species
1	Dominican	Early-Middle Miocene (15-20 mya)	35	296	1,000+
2	Mexican	Early-Middle Miocene (15-20 mya)	23	195	120
3	German (Bitterfeld)	Late Oligocene (23.8-25.3 mya)	28	160	?
4	Australian Cape York	Late Miocene (12 mya)	11	25	133
5	Baltic	Late Oligocene-Middle Eocene (44-49 mya)	44	539	3,068
6	Ukrainian (Rovno)	Late Eocene (44-49 mya)	32	296	~2,000
7	French (Oise)	Early Eocene (53 mya)	14	64	~300
8	Canadian	Late Cretaceous (78-79 mya)	23	130	132
9	American (New Jersey)	Late Cretaceous (90-94 mya)	15	61	~250
10	French (Charentese)	Early Cretaceous (c. 100 mya)	28	85	~1,500
11	Burmese	Middle Cretaceous (100-106 mya)	36	216	228
12	Spanish	Early Cretaceous (120 mya)	22	82	57
13	Lebanese	Early Cretaceous (125-130 mya)	19	127	164

Obviously, the comparative figures given in the table actually reflect the current state of knowledge of each deposit rather than its real diversity. The best studied are the Baltic and Dominican amber deposits; the most promising of the recently discovered deposits, in terms of its potential palaeodiversity, is the Rovno one in Ukraine. The oldest amber deposits presented in the book are those from France (Charentese), Myanmar, Spain and Lebanon. While reading this book, I got the feeling that there is great potential for any active entomologist, myself included, to become involved in the study of amber arthropod taxonomy and diversity.

Overall, the volume makes a very good impression with regard to its comprehensiveness and clarity, and I wish to congratulate the authors and editor for such fine work. For this impressive book constitutes a reliable source of information on the palaeodiversity of amber arthropods, it will beyond doubts become a reference handbook for all amber students and general entomologists. It is a must-have for all entomological libraries. I recommend this book to both amateur and professional entomologists alike.

Dmitri V. Logunov
Curator of Arthropods
The Manchester Museum

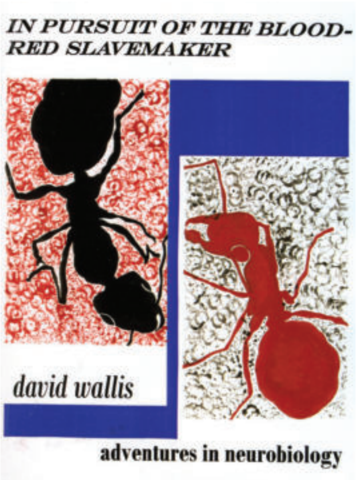
People, Places and Species — a History of the Study of Wasps, Ants and Bees in Watsonian Yorkshire

By Michael Archer

Vespid Studies, York, 78 pages, A5 spiral-bound paperback, Price £3 (+£1 P&P)

Rather than the usual annotated local species list, Michael Archer has added a human face (well, several actually) to what is, after all, a very specialist subject. From the mid-19th century monographs of Smith and Shuckard, the trail of Yorkshire entomologists runs past gentleman founder of the Yorkshire and Lincolnshire Naturalists' Union (William Roebuck) and Doncaster MD (Herbert Corbett), through Scarborough schoolmaster (George Walsh) and Keighley brass founder (John Wood), down to the present incumbents, including former coal miner (John Burn) and university lecturer (Archer himself). An eclectic miscellany of places and people, it contains a curious mixture of detailed species comments (recent taxonomic splits and difficult identifications) and personal anecdotes, like Bill Ely's boyhood fascination with the exotic spiders, crickets and cockroaches in the Leeds banana warehouses near his home. The aculeates are a fascinating and moderately well-studied group of insects in Britain, but we need to know more about the people studying them. Yorkshire has been a good place to start.

Richard Jones



In Pursuit of the Blood-Red Slavemaker. Adventures in Neurobiology

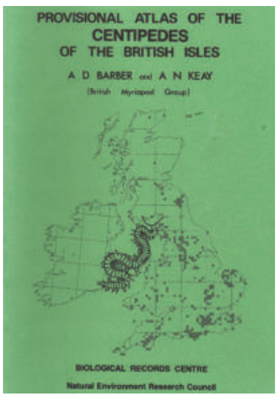
by David Wallis

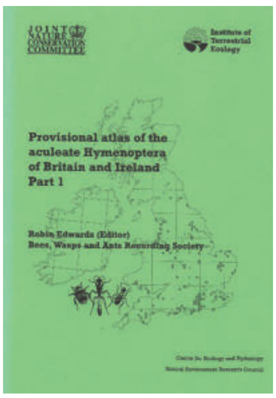
Bioline, Cardiff School of Biosciences. 146pp. paperback. ISBN 978-0-9545756-1-8.

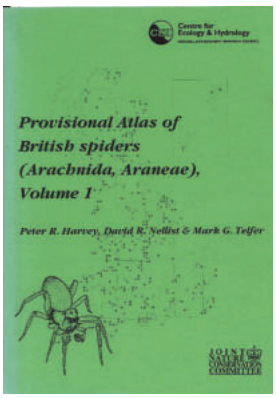
Available from David Wallis (david.wallis@homecall.co.uk) or by post from 86 Plasturton Avenue, Cardiff CF11 9HJ. Price £10.

David Wallis, Emeritus Professor of Physiology at Cardiff, has written a short, entertaining biography of his early years in research in entomology and animal behaviour, copiously illustrated with his own line drawings. He provides a highly personal account of his research progress in Cambridge and Pennsylvania in the 1950s and 1960s, during which he investigated slave-making ants, blowflies and insect chemo-receptors. Directly or indirectly, he encountered Tinbergen, Lorenz, Thorpe, Hinde, Roeder and Dethier. There are deft accounts of slave-making ants, the making of ant cocoons, birdsong with aggression, and blowfly chemoreceptors. His account is peppered with quotations, dripping with obvious enthusiasm and brought up to date with plenty of references. Even youngsters will find this account revealing, because it reeks of the halcyon days when intelligent young researchers could follow their inclinations and use their imaginations, instead of merely acting as research assistants in a pre-ordained project.

Tim King
Wolfson College, Oxford







Atlases of the distribution of British Insects

For anyone interested in the distribution of British insects, the Centre for Hydrology and Ecology have just made all of their atlases available as PDF's which are downloadable from their website free of charge.
http://www.ceh.ac.uk/products/publications/publicationsbrc.html

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**.

Recently, Special Interest Group (SIG) meetings have been held at Rothamsted, Harpenden and usually begin with registration and refreshments at 10am for a 10.30am start. Details of the day's programme can be downloaded from the RES website (www.royensoc.co.uk) and include a registration form, which has to be completed in advance so that refreshments can be organised. All meetings finish by 5pm.

Some SIG or monthly meetings may begin after lunch and be held at a different location, so it is best to consult the diary or the RES website for full details. Regional meetings, by definition, will be held locally.

2011

March 2 Verrall Lecture
By Professor Jane Memmott, Bristol University
'The conservation and utilisation of entomological interactions'
Venue: Flett Lecture Theatre, the Natural History Museum, LondonTime: Tea will be served at 16:00, followed by the lecture at 16:30, closing at 17.30.

March 31 Medical & Veterinary Entomology Special Interest Group
'Novel Methods of Vector Control'
Venue: The Linnean Society of London, Burlington House, Piccadilly from 10.00 to 17.00
Convenors: Prof. Stephen Torr,
Prof. Steve Lindsay
Dr Mary Cameron

Apr (tbc) South-East Regional Meeting
Convenor: Mr John Badmin

May 12 Conservation Special Interest Group
'The impact of climate change on insect conservation'
Venue: Rothamsted Research, Harpenden, Herts.
Convenor: Dr Alan Stewart
Climate change is widely regarded as one of the most serious threats to global biodiversity. There is already good evidence that insects are responding through changes in range and phenology. This meeting will explore how a changing climate will impact upon insect conservation and what measures might be taken to mitigate adverse effects on insect species and communities.

June 1 RES Annual General Meeting
Venue: The Mansion House, St Albans.

June 30 Northern Irish Regional Meeting
'Invasive insects: implications for plant health, animal health, public health and the environment'
Venue: Ulster Museum
Convenor: Dr Archie K. Murchie
Confirmed speakers:
Jolyon Medlock (Health Protection Agency)
Helen Roy (Centre for Ecology & Hydrology)
Roy Anderson (Environmental Consultant)
John Kelly (Invasive Species Ireland)

Jul 3 **Insect Festival**
Venue: York Museum Gardens, York
Convenor: Mrs Julie North

Sept 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. Alan Cork,
Prof. Bill Hansson,
Prof. John Pickett
National meeting convenors: Dr Gabriella Gibson & Prof David Hall
Contributors include:
John Pickett (Rothamsted Research, UK)
Bill Hansson (Max Planck Institute for Chemical Ecology, Jena, Germany)
Walter Leal (University of California, Davis, USA)

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.

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 (tbc) **Sustainable Agriculture Special Interest Group joint meeting with British Ecological Society Agricultural Ecology SIG**
Convenor: Dr John M Holland

Nov 10 **Insect Behaviour Special Interest Group**
Venue: Rothamsted Research, Harpenden, Herts.
Convenors: Drs Jason Chapman & James Bell

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

Diary of other Meetings

2011

April

12 **Society for General Microbiology Spring Conference (Insect symbiosis session)**
Venue: Harrogate International Centre
I: www.sgm.ac.uk/meetings/mtgpages/HA10.cfm

July

2 - 6 **3rd International Symposium on Insect Physiology, Biochemistry and Molecular Biology (IPBMB)**
Venue: East China Normal University, Shanghai
I: www.sippe.ac.cn

August

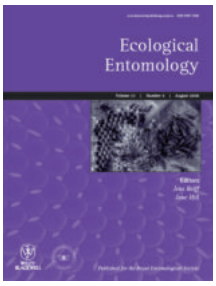
1 - 5 **Tenth International Conference on Juvenile Hormones**
Venue : Tsukuba, Japan
I: www.nias.affrc.go.jp/JH10/

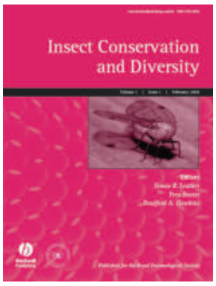
September

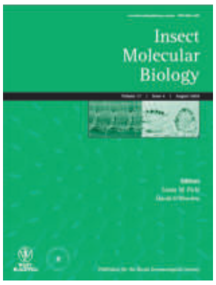
5 - 7 **Resistance 2011**
Venue : Rothamsted Research, Harpenden, Herts
I:www.rothamsted.bbsrc.ac.uk/Research/Centres/Content.php?Section=Research&Page=Resistance2011
Email: resistance2011@bbsrc.ac.uk

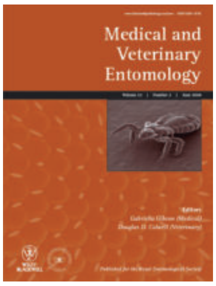
October

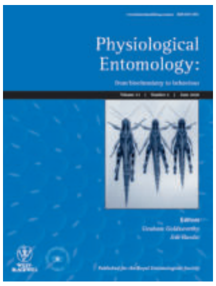
2 - 5 **Sixth International Symposium on Molecular Insect Science**
Venue : NH Grand Hotel Krasnapolsky, Amsterdam, The Netherlands
I: www.molecularinsectscience.com/

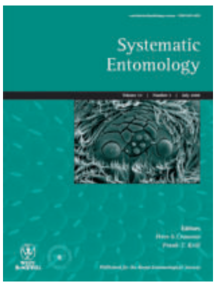












Publications of the Royal Entomological Society

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.
2011 print or online prices: UK £590, Euroland €751, USA $1,091, Rest of World $1,272
2011 print and online prices: UK £679, Euroland € 864, USA $1,255, Rest of World $1,463

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.
2011 print or online prices: (with Insect Conservation and Diversity) UK £973, Euroland € 1,236, USA $1,800, Rest of World $2,099
2011 print and online prices: UK £1,119, Euroland € 1,422, USA $2,070, Rest of World $2,414

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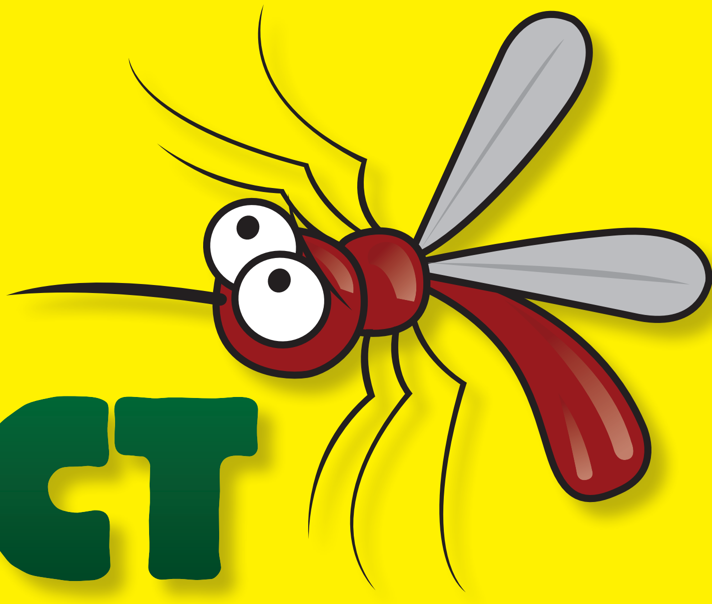

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