The LINNEAN SOCIETY of London

The Linnean

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THE LINNEAN SOCIETY OF LONDON

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THE LINNEAN

Newsletter and Proceedings
of the Linnean Society of London

Edited by Brian G Gardiner

Editorial

This issue contains a lot of news about recent Tercenenary events, including the Society's very successful stand at Chelsea Flower Show.

The Linnean Society's stand at Chelsea Flower Show, May 2007.

There are also two full length articles and one much shorter note. The first article concerns the seed plants and the alternation of generations which became the unifying principle in plant reproduction, leading to our understanding of the evolutionary origins of the spermatophytes. The paper concludes with how, by mean of recombinant DNA Technology, several novel genes have been introduced into seed plants for making products useful to mankind that accumulate in the seeds viz "Golden Rice". The second main paper concerns Gilbert White and the Natural Theology of Selborne, a lecture delivered for the John Ray Trust, on 18 July 2006, by the Rev Nigel Cooper. Gilbert White's *The Natural History of Selborne* is said to be the fourth most published book in the English Language. Nigel Cooper believes we still read White because of its secondary simplicity and also because White's cultured nature offers a spiritual insight. Cooper concludes with a quote from John Mulso, "the novelty and elegance, the tenderness, and the piety of the natural part will be the fort of the performance. As many others have said in different ways, it is a saintly book".

The shorter note concerns "The Linnean Society and Parasitology 1788-1900". In this note John Marsden points out how a woman (Mrs I Cobbold) has a paper presented to the Society entitled "Remarks concerning the *Fasciola hepatica*". He also notes that Sir James Paget discovered the nematode *Trichenella spiralis* in the muscle of a cadaver.

The Picture Quiz article on William Hincks in the April issue should have been attributed to both David Smith and George Fussey. Our apologies to the latter whose name was omitted. As I noted in the last Linnean, we are replacing the Picture Quiz with interesting letters “From the Archives”. Our second such offering takes the form of a letter to the President of the Linnean Society – Thomas Bell. It concerns the production of rulers for the army in the Crimea. The letter came from King’s College laboratory who found that the hair of the turner (who worked on green ebony *Brya ebenus*) had turned green, as had his urine! The laboratory asked for the sure return of their specimen bottle.

BRIAN GARDINER

Society News

Since I last wrote our joint activities with other organisations to celebrate the Linnaean Tercentenary have proceeded apace. We had a very successful joint meeting with the Geological Society on Dark Energy on the afternoon of 23rd April. That was followed by a stimulating series of presentations and a dinner at the Zoological Society of London on 8th May. A number of us then went up to Liverpool on 11th May to join the Liverpool Athenaeum for a most enjoyable celebratory evening.

Towards the end of May came the culmination of our celebrations. We had an extraordinarily busy ten days – looking back it is amazing how much everyone was able to achieve, and I would like to pay tribute to the immense hard work of the Officers and staff which enabled us to deliver all the events successfully.

It started on Sunday 20th May when the King and Queen of Sweden came to lunch with us and we were able to brief them on all the projects the Society is implementing during the Tercentenary Year. Almost at the same time some of the team were putting the finishing touches to our stand at Chelsea Flower Show. That was well worthwhile and it was hugely gratifying to discover on the morning of 22nd May that we had been awarded a Silver Gilt Medal. It was an impressively interesting and attractive display which was much praised and got very good press coverage. We are very grateful to all those who rallied round to help staff the stand over the following five days.

The day after we had a very successful launch of the book *Order out of Chaos* by Charlie Jarvis. A huge amount of work has gone into this project which is a real landmark in Linnaean studies. It was therefore very pleasing that the Mike Dixon, the Director of the Natural History Museum (the joint publisher) drew on his own experience of publishing when he said that this was one of the best produced scientific publications he had seen. We have already sold nearly 200 copies – please contact Victoria Smith here if you would like to buy one yourself.

Hot on the heels of the launch came the Anniversary Meeting on Thursday, 24th May. We said farewell to six Council members – Dr Louise Allcock, Prof John Barnett, Prof Janet Browne, Mr Aljos Farjon, Dr Michael Fay and Dr Keith Maybury. All of them have contributed a great deal to our work and we shall miss them. In their place we welcome Dr Pieter Baas, Professor Richard Bateman, Dr Andy Brown, Dr John David, Dr Malcolm Scoble and Dr Max Telford. We also honoured the achievements of Tom Cavalier-Smith and Phil Cribb, who both got Linnean Medals, Max Telford who got the Bicentenary Medal, John Tennent (H H Bloomer Award), Lionel Navarro (Irene Manton Prize) and Jan van Os (Jill Smythies Award).

It was also hugely satisfying for us all to surprise Gren Lucas who received the Linnean Gold Medal, which has only been awarded twice before. Anyone who has worked with Gren knows how committed he is to the Society and how well he deserved the Award. It was equally gratifying to honour Charlie Jarvis by making him a Fellow *honoris causa* in recognition of his work as Botanical Curator and his outstanding achievement in the Linnaean Plant Name Typification Project which has culminated in *Order out of Chaos*.

The following day we joined together with the organisers of the Swedish garden at Chelsea Flower Show for the afternoon seminar A Tribute to Linnaeus and his Legacy. This cemented a very productive relationship with the Swedish organisers of the Linnaean garden at Chelsea.

Our May Tercentenary celebrations culminated with a visit by our Honorary Member, the Emperor of Japan, accompanied by the Empress. The Emperor gave a keynote address, and then saw displays on what we are doing. Their Majesties took a real interest in the work of the Society and enjoyed a very convivial lunch with Officers and distinguished guests including Sir David Attenborough. At the end of the visit we presented the Emperor with a copy of Order out of Chaos and the new Tercentenary Medal, and the Empress received flowers and a Wedgwood medallion. There was extensive press coverage of the visit both in Britain and Japan.

June started with another collaboration with Sweden, when we hosted a scientific meeting In Linnaeus' Wake in connection with the visit by the replica Swedish East Indiaman Götheburg III. In the evening we had a most interesting visit to the ship which hosted a reception for all the participants.

At the time of writing we are still looking forward to our next joint symposium Unlocking the Past – Linnaean collections past, present and future with the University of Uppsala on 11th-15th June, and the joint meeting with the Royal Society on The Evolution of the Animals on 18th-19th June.

The summer will also be the occasion for a number of social events, starting with a celebratory evening at Kew on 7th June. There will also be a tour and reception at Chelsea Physic Garden on 3rd July. However, you may like to note that the Linnean Society will not now be participating in the planned special viewing of the Royal Academy Summer Exhibition on 1st August.

One social event which everyone should enjoy is the Conversazione, which will be in Oxford this year, on 29th September. We do encourage all Fellows to attend and assure you of a friendly welcome – please use the enclosed information or contact Victoria Smith in the office if you would like to book a place.

Amidst all the activity there is one area where we would appreciate help from all of you. We can increase our impact and our income if we have more Fellows. All the events and activities this year provide an excellent opportunity to recruit new members so please take advantage of any opportunity to encourage colleagues or acquaintances with an enthusiasm for natural history to join the Society – Fellowship packs are always available from the office.

Finally, I should mention that this will be the last Society News that I shall contribute – I shall be moving on to other things in August. I have had a most interesting time at the Linnean Society. It has been very gratifying to see the profile of the Society rising and so much development on every front – from design and the website through to the digitisation of our collections to the increase in the grants we can award. I wish the Society every success in the future.

ADRIAN THOMAS

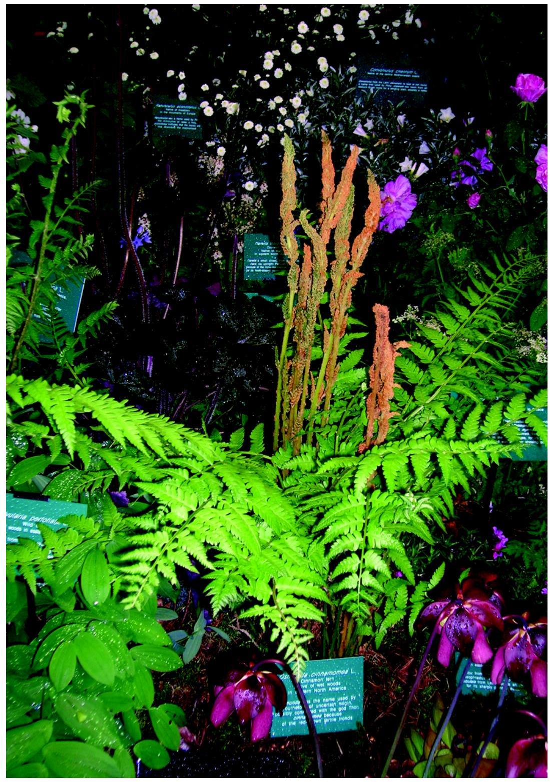
Development Report

The Society is enjoying a wonderful celebration of the tercentenary of Linnaeus' birth, with numerous events and activities scheduled. One of the major highlights has been the RHS Chelsea Flower Show where Linnaeus' passion for the natural world was celebrated with two exhibits. The first was commissioned by the Swedish Government and coordinated by the Linnaeus National Tercentenary Committee in Stockholm and was the "Tribute to Linnaeus" show garden – designed by eminent Swedish landscape architect Ulf Nordfjell, and winner of a Gold Medal. The second exhibit, organised by the Society, was a display in the Lifelong Learning Section entitled "Linnaeus' Legacy – 300 years of naming nature", which was awarded a Silver-Gilt Lindley Medal.

The Society's exhibit was designed to explore the development of the Linnaean binomial system that led to the current system of scientific naming and how this system provides the tool to communicate effectively about the natural world. Martyn Rix designed the elegant planting scheme and provided the informative texts for the labels and Nigel Rowland of Long Acre Plants, grew and sourced the plants and, together with his colleague Paul Coles, realized the design most successfully. Sally Seeley designed the beautiful panels and brochure. A miniature U-shaped glaciated valley of North American and European plants swept up to the focal point of the exhibit – the new bust in bronze of the young Linnaeus examining a butterfly – which was unveiled at the show by Roy Lancaster OBE on Monday 21st May. The bronze, created by the artist and zoologist Anthony Smith, celebrates the youthful Linnaeus' love of nature, his curiosity and spirit of enquiry. The President of the RHS, Peter Buckley, gave Their Majesties Carl XVI Gustaf and Queen Silvia a tour of both the Linnaean exhibits. Their Majesties were delighted with the Linnean Society's display and viewed it in detail.

Roy Lancaster OBE with Anthony Smith FLS and his bust of "The young Linnaeus" and ©David Cutler

The exhibit was a tremendous success and received substantial press coverage, including satellite television, national newspapers and the BBC, with Alan Titchmarsh announcing the Society's new publication of *Order out of Chaos* on May 23rd, and Carol Klein presenting a feature on the Society's stand and plants. The Society is



Osmunda cinnamomea L. Cinnamon fern, on the Society's stand at Chelsea Flower Show © Elaine Shaughnessy.

particularly delighted that it achieved this success through the contributions of its own Fellowship, friends, Officers, Council, Curators and staff and we thank all those who have given their time and expertise in the realization of this project. The volunteers contributed greatly to the smooth running of the stand and to the public's enjoyment and understanding of Linnaeus and of the Society itself. This was greatly enhanced by the very fine coloured brochure sponsored by our Publisher, Wiley-Blackwell.

The Society has received very successful press coverage throughout the tercentenary celebrations in both the national and international media. Some of the recent highlights include articles in *The Daily Telegraph*, *The Independent*, *Nature*, *The New York Times*, and *The Times*. The articles can be viewed on line on the Society's website (www.linnean.org) under "Media & Events/ Recent Coverage". We have also received extensive BBC Radio 4 coverage including the *Today Programme* and *Material World* as well as being featured on the *Guardian Unlimited Science Weekly* podcast for June 4th.

The Society is moving strongly ahead on its strategic planning process and the President will lead the next phase of consultation in early August. We will also be moving ahead on our fundraising and development plans now that the major part of the tercentenary celebrations have been successfully realized and the Society's public profile has been considerably strengthened. The digitisation programme for the Society's specimens and correspondence is progressing well and the massive data management system is being designed by the University of London Computer Centre. The Society hopes that building work will begin on installing the new Library air-management system replacing the ceiling glass in August.

ELAINE SHAUGHNESSY

Linnaea borealis L. © Sandra Knapp

Catalogue of Life

The One Million Species Catalogue of Life Presentation & One-day Symposium, Thursday 29 March 2007 University of Reading, Reading, UK

The Catalogue of Life (Bisby *et al*., eds.) is a project undertaken by the not-for-profit organisations Species 2000 and ITIS (Integrated Taxonomic Information System) to compile an electronic catalogue freely available on the Internet and on CD of all known species of organisms on Earth by the year 2011. The project issues a regularly expanded and updated Annual Checklist; the seventh edition of which was officially presented at the meeting by Manuela Soares (DG Research (Environment) of the European Commission) to five representatives of major users of the data (GBIF, IUCN-SSC, UNEP World Conservation Monitoring Centre, Consortium for the Barcode of Life, BGCI). This 2007 Annual Checklist now contains information on 1,008,965 species. With an estimated 1.7 million known species there is still a long way to go, but a milestone has been reached and the rate of increase of data in the Catalogue of Life is accelerating from previous versions, with 10 new databases added in the 2007 version. Thus far, information has been provided by 47 taxonomic databases from around the world covering a great variety of organisms from viruses and Trichomycetes (protozoan fungi that live in the guts of insects) to Conifers (from this author's Conifer Database) which contain both the largest and longest lived individual organisms in the world. However, there remain some glaring gaps: plant families like Orchidaceae (to be added in 2008) and Proteaceae are still missing (from a random search done on 31 March 2007) and, of course, one still searches in vain for most beetles (Coleoptera). So far, the editors have been dependent on the goodwill of compilers of authoritative checklists and databases to share (parts of) their information. Each database is fully identified, often with the aid of a specific logo, and acknowledged, while the data and their updates remain both the property and responsibility of their authors. Apart from the ITIS database, which is incorporated, most contributions are specialist databases that hold global data on a taxonomic group of organisms. Regional databases have the general disadvantage of being taxonomically inconsistent and to be used at all would require the scrutiny of global experts or consortiums of experts. Such experts are not available for all groups of organisms. The existing global species databases (GSDs) have not yet been exhausted (Frank Bisby and Thomas Orrell at this symposium) but there will come a point at which regional data will have to be used in some way to reach the goal by 2011. Fellows with an interest in this project should visit http://www.catalogueoflife.org/annual-checklist/2007/ and sample the 2007 Annual Checklist. Better still, they might want to point out omissions and where to obtain the information to the editors.

The well-attended symposium offered a number of short presentations both from individuals and organisations involved in the compilation of relevant or similar databases and of the users of those data. The information content of the Catalogue of Life varies with the databases used (and to what extent their compilers wanted to share information) but it minimally contains names data (accepted scientific names and synonyms) and occurrence data (geographical distribution). James Edwards (GBIF, Copenhagen) stressed the importance of the "Species Name" as the linking element to all other information now being accumulated in numerous biological databases around the world. He referred to the Global Species Information System (GSIS) as well as the Encyclopedia of Life and its electronic version "ePedia of Life" (EOL) for which under leadership of E.O. Wilson USD 25 million has been raised. The challenge is to make this link with the names in the Catalogue of Life happen; I noted that some hands were shaken across the floor between some key players pledging to follow this up. A major user of names is IUCN The World Conservation Union (specifically its Species Survival Commission) and SSC's Simon Stuart gave a presentation of the global Red List project and its Biodiversity Assessment Projects focussing on key groups of organisms, e.g. Amphibians, Reptiles, Birds and Mammals and among plants Cycads and Conifers. Taxonomy, and therefore names applied to organisms, is crucial and previous Red Lists have been demonstrated to be erroneous for want of a rigid application of taxonomy. To have an authoritative Catalogue of Life on which IUCN-SSC can rely is crucial for its conservation efforts to achieve the Convention on Biodiversity's (CBD) aims and targets. The point was demonstrated by Ghillean Prance with examples of numerous names in the plant family Proteaceae, of which he had recently revised the Neotropical species. Many names that turned out to be mere synonyms had appeared as valid species in Red Lists and in inventories. It is therefore extremely important to maintain and curate specimen collections in herbaria and museums, as Simon Tillier (EDIT, Musée d'Histoire Naturelle, Paris) pointed out, because names of organisms are linked to these specimens by their types. No description can replace the specimens and even images of them can only help to a limited extent if it comes to determine the correct application of a name or the circumscription of a species.

Other contributions nevertheless demonstrated the value and usefulness of taxonomic databases. Particularly impressive was Rainer Froese's demonstration of FishBase, which has contributed to the Catalogue of Life and contains detailed information on all the known 29,400 fish species in the world. His analysis of who the users of this – and by implication similar – databases turn out to be was very revealing. It receives some two million hits per month and most of the users are individuals, either professional, student or amateur; governments and NGOs are minority users. He had some sound advice to give: keep it simple, give common names as well as scientific names where possible, adopt a "yes" attitude, be opportunistic, give more credit than was expected to providers of data, and promptly deal with errors reported. One of the tasks that should be completed before 2010 is Target 1 of the Global Strategy for Plant Conservation (GSPC) a Checklist of the World's Plants. As Sara Oldfield (BGCI, Richmond) explained, the Royal Botanic Gardens, Kew have taken the lead in this challenge, working with 120 institutions and individuals to achieve it. We may by that time finally settle the hotly debated question of how many species of plants the world actually has (give or take those not yet discovered or since made extinct by our destructive habits). For the vast majority of organisms and especially the more cryptic ones it is unlikely that they will ever enter the Catalogue of Life. But to record what we now know is nevertheless an important undertaking, and one I became more optimistic about after this meeting than I must admit I was before.

ALJOS FARJON FLS

Library

During the period from March to the end of May we have been open for 61 days and we have welcomed 205 visitors to the Library, of whom 98 were Fellows (an average visitor level of 3.4 each day). Between March and May the Linnaean Collection Store has been visited by 152 people involved in curatorial or digitisation work, and 123 other visitors, giving a total of 275 (over 4 a day on average). This partly reflects access to implement digitisation projects now underway. We have seen an increasing number of Swedish visitors, with 47 recorded so far; the numbers of individual visitors being highest during the early Spring school break, with parents and children coming into the Society because of Swedish school projects focussing on Linnaeus. A number of pre-booked tours included a group from Biblis, with links to the Royal Library in Stockholm, a Swedish Garden visit and student groups from Sweden, the UK and USA. The new notice board on the railings outside has also brought in several visitors "off the street", curious to see what they have been walking past when visiting the RA. There has been a constant demand for images and an immense amount of work undertaken by Lynda in supplying images to magazines, exhibitions and newspapers worldwide for Linnaean Tercentenary features.

The Reading Room was used for large displays of posters relating to the Tercentenary for Linnaeus's Global Reach in January, and more recently for Imperial and Royal visits, the launch of Order out of Chaos and Tercentenary meetings. Apart from this, the display cases were also used to show material from the collections for Discovering the Forsters and Dark Energy (including St George's Day) this Spring and the art work of Jan van Os, the winner of the 2006 Jill Smithies award for botanical art.

Our new Assistant Librarian, Ben Sherwood, who will have special responsibility for the Content Management for the CARLS project, started on 14 May and was immediately involved in Linnaean Tercentenary events, ranging from furniture moving to supplying urgent image requests. We have not yet filled the post for a temporary cataloguer but short term staff have been employed to check, sort and pack an entire run of the Society's journals which will go to India for digitisation.

Our team of volunteers is now checking the catalogue entries for manuscripts relating to Society Papers and adding them to the on-line catalogue. Alan Brafield and Enid Slatter have been checking the documentation against the actual manuscripts and John St Quinton is now adding the electronic records. Our most recent volunteer, John Sellick, is now working on transcriptions of letters to William Swainson as well as the William Kirby letters to MacLeay. Jeanne Pingree has finalised her listings of the Cuthbert Collingwood papers, B. Smythies papers and J.C.Willis papers and is moving on to other miscellaneous archive collections. Iris Hughes continues to catalogue boxed reprints and Val Vivekananda rejoined us recently and is helping to sort out other miscellaneous collections of reprints and biographical material.

The replacement of the photocopier in March required installation of a new network connection and the opportunity was taken of adding additional power sockets and network connections with the result that the Librarian's desk is now able to have a computer terminal. This took some time and included clearing, emptying and dismantling the whole of the large table case for most of March. That is still clear but we now have more boxes of books waiting to be catalogued wherever we have managed to find storage space.

Work on installing an air management system for the Reading Room is scheduled to begin in early July but we hope that, once scaffolding is in place, “normal” services will resume beneath. We plan to have the summer students working in basement stores to sort out journal holdings but there may be periods when the Reading Room may be in use for book re-shelving.

GINA DOUGLAS

Donations

With a very large influx of Linnaeus-related publications presented recently to the Library, and the space constraints of this issue, priority has been given to recognising those Linnaean presentations in the list here. Apologies for any omissions, these will be in the October issue.

Dr F.W.G. Baker: Valderrama, Fernando *A history of UNESCO*. 460 pp., illustr., Paris, UNESCO, 1995 ISBN 92-3-103134-1.

Carina Bergqvist: Åberg, Leif (Editor), *Från Linné till DNA.* 225 pp., col. illustr., map., Stockholm, 08 Tryck AB, 2007 ISBN 078-91-86510-57-2.

Biblis: Kåhrström, Olof, *Från Pier de’Crescenzi til Albrecht Thaer… Kugl, Skogs-och Lantbruksakademiens bibliotek alder boksamling…*276 pp. illustr. some col., Stockholm, Kungl. Skogs-och Landbruckksakademiens, 2007. ISBN 91-85205-34-6.

Dr John Cortes: Hodges, J.K. & Cortes, J. *The Barbary Macaque: biology, management and conservation.* 282 pp., figs, maps, Nottingham, Nottingham University Press, 2006. ISBN 978-1-904761-31-0.

Perez, Charles, E. *Biodiversity Action Plan, Gibraltar: planning for nature.* 192 pp., col. illustr., maps, Gibraltar, Gibraltar Ornithological & Natural History Society, 206. no ISBN.

Dr D.T.Donovan: Cuvier, *Lecons d’Anatomie comparee*, ... Recuiellies et publiees par G. L. Duvernoy. 2nd Edition, 8 vols in 9, Paris, Masson, 1835-1846.

Field Studies Council: Hopkins, Steve P. *A key to the Collembola (Springtails) of Britain and Ireland.* (Occasional Publication 111) 245 pp., illustr., some col., Shrewsbury, FSC, 2007. ISBN 978-1-85153-220-9

Croft, Paul and Roberts, Carol. *Guide to British Freshwater fishes* (OP 110) 8 pp. col. illustr., Shrewsbury, FSC, 2006. ISBN 1-85153-219-6.

The Hakluyt Society: Rivière, Peter (Editor) *The Guiana travels of Robert Schomburgk 1835-1844.* Vol.II: *The Boundary survey 1840-44.* 266 pp., maps, London The Hakluyt Society, 2006. ISBN 978-0-904180-88-6.

Harnesk, Helena: Harnesk, Helena, *Linnaeus, Genius of Uppsala.* 123 pp., col. illustr., Uppsala, Hallgren & Fallgren, 2007 ISBN 978-91-7382-825-3.

Dr Keith Harrison: Harrison, Keith. *Your body, the fish that evolved, the amazing story of Man’s origins.* 213 pp., illustr., London, Metro, 2007. ISBN 978 1 84454 379 3.

Nigel Hughes: Delacour, Jean & Amadon, Dean. *Curassows and related birds*, 476 pp., col. illustr., maps, Barcelona, Lynx Editions, 2004. ISBN 84-87334-64-4.

Japan, His Majesty Emperor Akihito: Akihito, Emperor of Japan *Early cultivators of science in Japan.* Reprint from *Science* pp. 578-580, Vol. 258, 23 October 1992.

Nakabo, Tetsuji (Editor) *Fishes of Japan with pictorial keys to the species* (English edition). 2 Vols. 1749 pp., illustr., maps, Tokyo, Tokai University Press, 2002. ISBN 4-486-01570-3.

Norinomiya Sayako (Editor) *Catalogue of the birds in John Gould's Folio Bird Books,* xlviii, 236 pp. col. illustr., Tamagawa Press, 2005 ISBN 4-472-12000-3.

Dr Charlie Jarvis: Jarvis, Charlie. *Order out of Chaos, Linnaean plant names and their types.* 1016 pp., illustr., some col., London, Linnean Society of London & Natural History Museum, 2007, ISBN 978-0-9506207-7-0.

Marita Jonsson: Jonsson Marita & Jonsson, Helga. *Linné på Gotland, Frå dagboken i Linnean Society i London till våra dagars Gotland.* 200 pp. col.illustr., map, Burgsvik, GotlandsBoken, 2006. ISBN 91-967508-0-3.

Prof. Per-Magnus Jørgensen: Jørgensen, Per-Magnus (Editor) *Botanikkens historie i Norge*.396 pp., illlustr., some col., Bergen, Fagbokforlaget, 2007 ISBN 978-82-450-0499-1.

Dr John Marsden: Diggs, George (and others) *Illustrated flora of East Texas,* Vol. 1. 1594 pp., illustr. some col. , maps, Forth Worth, Botanical Research Institute of Texas, 2006. ISBN 1-889878-12-X.

Prof. H.Walter Lack: Lack, H. Walter, *Aus dem Land der blauen Hortensie, Japanische Pflanzen in Europa* (exhibition catalogue) 45 pp., col. illustr., plan, Berlin, Botanisches Museum Berlin-Dahlem, 2006. ISBN 978-3-921800-60-7.

Dr Martin Nickol: Christian-Albrechts *Universität zu Kiel, Neuer Botanischer Garten der CAU, festschrift…*72 pp., col. illustr., Kiel, Christian-Albrechts Universität zu Kiel, 2005. ISBN 3-529-05779-7.

Annika Olsson: Lindell, Torbjörn, *Carl von Linné, den fulländade forskaren.* 104 pp., col. illustr., Lund, Historiska Media, 2007. ISBN 978-91-85377-71-8.

Dr Kerstin Ramm: Kretzschmar, H., Eccarius, W. & Dietrich, H. *The orchid genera Anacamptis, Orchis and Neotinea. Phylogeny, Taxonomy, Morphology, Biology, Distiobution, Ecology and Hybridisation.* 543 pp., col.illustr., maps, Bürgel, EchinoMedia Verlag, 2007. ISBN 978-3-937107-12-7.

Royal Botanic Garden, Edinburgh: Noltie, H.J. *Robert Wight and the Botanical Drawings of Rungiah & Govindo.* 3 vols., col.illustr., map, Edinburgh, 2007, ISBN 978-1-906129-02-6.

Pauline Snoeijs: *Snoeijs, Pauline, Linnés brudkammare/ The bridal chambers of Linnaeus.* 240 pp., col. illustr., Ryd, Artéa Forlag, 2007. ISBN 978-91-85527-05-2.

Royal Botanic Gardens, Kew: Cowley, Jill, *The genus Roscoea* (A Botanical Magazine monograph) 190 pp., col. Illustr., maps, Kew, Royal Botanic Gardens, 2007, ISBN 978-1-84246-134-1.

Niki Simpson: Simpson Niki & Peter Barnes, *Digital diversity, a new approach to botanical illustration.* 12 pp., col. illustr., Guildford, privately, ISBN 978-0-9554917-0-2.

Swedish Book Review: *Linnaeus Tercentenary issue. 2007:1.* 65 pp., University of East Anglia, Norwich, ISSN 0265-8119.

Swedish Institute: Broberg, Gunnar, *Carl Linnaeus.* (new edition) 44 pp., col. illustr., Stockholm, Swedish Institute, 2006. ISBN 978-91-520-0912-3.

Swedish Linnaeus Society: *Secretariat of Linnaeus 2007, The Linnaeus Legacy: The Disciple, The Conqueror, the Collector, The Legend.* 4 x 32 pp., Uppsala, Hera Forlag, 2007. ISBN 978-91-976751-4-7, ISBN 978-91-976751-5-4, ISBN 978-91-976751-6-1, ISBN 978-91-976751-7-8.

Swedish Post Museum: Jönsson, Ann-Mari & Nyström, Eva *Carl von Linné Brevskrivaren.* (Meddelanden från Postmuseum, nr. 56), 52 pp., col.illustr., Stockholm, Postmuseum, 2007, ISBN 978-91-975051-4-5.

Sekretarite för Linné 2007, *Lärjungen, Linné-minnen från barndom och skolgång I Småland.* 32 pp., col illustr., map, Stockholm, Kungl. Vetenskapskademien, 2007. ISBN 978-91-976751-0-9.

Sekretarite för Linné 2007, *Erövraren, Linné-minnen från bergmansgården Sveden.* 32 pp., col illustr., map, Stockholm, Kungl. Vetenskapskademien, 2007. ISBN 978-91-976751-1-6.

Sekretarite för Linné 2007, *Samlaren, Linné-minnen från Huset och Trädgården I Uppsala*. 32 pp., col illustr., map, Stockholm, Kungl. Vetenskapskademien, 2007. ISBN 978-91-976751-2-3.

Sekretarite för Linné 2007, *Legenden, Linné-minnen från gårdarna Hammarby och Sävja*. 32 pp., col illustr., map, Stockholm, Kungl. Vetenskapskademien, 2007. ISBN 978-91-976751-3-0.

University of Pisa: Beretta, Marco & Tosi, Alessandro, Eds. *Linnaeus in Italy: the spread of a revolution in science,* 340 pp., illustr., Sagamore Beach, Science History Publishing, (Uppsala Studies in the History of Science 34) 2007. ISBN 0-88135-393-0.

Prof. Dick Vane-Wright: Spence, Cathryn & Brown, Daniel, *Thomas Robins the Elder (1716-1779) an introduction to his life and work*. 31 pp. illustr. some col., Bath, Everything Curious Company, 2006, ISBN 0-9552543-0-2.

Wallenquist, Arend & Wallenquist, Inga, *Carl von Linnés Lärjungar i Östergötland : Idé och handling*. 219 pp., col.illustr., Linköping, Linköping Stadsbibliothek, 2007, ISBN 978-91-633-0236-7.

A curiosity from the archives

The following letter, dated 27 january 1857, was sent from King's College London to the President of the Linnean Society, Thomas Bell (President from 1853 to 1861).

My dear Mr Bell,

A turner of the name of Ford, employed by the government to turn several thousands of round rulers for the army in the Crimea[1]. presented himself in the laboratory of King's College one day, in great distress about his hair. He was called upon to attend a funeral, and was scandalized at his somewhat ridiculous appearance in consequence of the curious green tint of his hair. Our people in the laboratory washed his head with all the common reagents which occurred to them, but without effect. Being informed of this curious fact, and being interested in it as having some sort of bearing on the question of identification, I called on Mr Ford, and found him in the state described. His hair, which is naturally a light chestnut, was changed, except towards the roots, of a bright yellow-green, with a very decided and curious green tint. His children, whose hair is of a similar tint, were similarly affected. He told me that his hair and that of his family had always been affected in the same way when engaged in turning round rulers from the wood known as Green Ebony[2] – a wood, as he says, generally used for that purpose. His wife's hair which is black undergoes no change. The exposed parts of the skin undergo the same change of colour, as does the urine. He also told me that one of his children was born with a very remarkably deep green tinted skin, which disappeared in time. As one of our porters passes Broad Street[3], I send you a specimen I have had put up, showing a bit of the wood, a tube-full of turnings and three specimens of hair – the two on the left showing the natural colour of the hair of Mr Ford and one of his children, the specimens on the right the same hair discoloured by the wood, and a single specimen from his own head showing the usual dark colour at the root, and the green tint towards the points. The appearance of the whole head of hair, and the contrast of the roots with the rest of the hair are much more striking than the specimen itself might lead you to expect.

Please to arrange for the sure return of the bottle when you have done with it. and believe me yours very truly William A Guy

P.S. If you use this, and print it, please let me correct the proof.

This paper was read at the Linnean Society meeting of 7 April 1857, communicated by the President. It was published in the journal of the Proceedings of the Linnean Society of London. Vol. II, p41. 1858, entitled "Note on a singular case of Colouring of the Human Hair. By William A. Guy, M.B. Extracted from a Letter addressed to the President."

ALAN BRAFIELD

[1]The Crimean War was fought from 1854 to 1856 by Britain and France against Russia.
[2]Green ebony is *Brya ebenus* (Leguminosae).
[3]Bell lived at 17 New Broad Street.

Correspondence

From: DR DAVID WILLIAMS Botany Department, NHM.

My note concerns the article in the recent Linnean on the Hooker lectures by Sam Berry. I am sure many will offer the same information but two of the missing presentations (Bower and Seward) were published in the *Journal of the Linnean Society Botany* rather than the *Proceedings*.

Bower, F.O. 1918. On the Natural classification of plants, as exemplified in the Filicales. *Journal of the Linnean Society (Bot.),* 4:107-124.

Albert Charles Seward 1922. A study in contrasts: the past and present distribution of certain ferns. *Journal of the Linnean Society (Bot.)*, 46:219-240.

I have no knowledge of the Elwes paper.

You might ask why I know this. I had looked at the Bower paper some while ago and it had somehow lodged in my brain. I need to get out more.

From: PATRICK F. JAMES Swallow Cliffs, Salisbury SY3 5PW

Regarding Dr Cloudsley-Thompson's article. I used to believe that migration, first to the planets, moons and asteroids, and thence to the stars would ensure our survival as a species but as he suggests, the genome would become so attenuated and inbred we should lose our already weak hold on intelligence.

We could take, together with our domestic animals, frozen ova, sperm and embryos but that I think would only be a temporary expedient even if we used the mammals to implant human embryos.

On the earth we would really need to lose one random third of the population quite quickly. China has done its best but brought more trouble on itself.

A radiation war would leave too many of the survivors genetically crippled. Perhaps one could allow all drug-addicts, from alcohol to opium, delayed self destruction, and for those who cannot breed naturally to achieve parenthood only by adoption.

It would be no good relying upon the United Nations but each country would have to impose upon its own population, as much as it would allow; and there is a danger in that.

The trouble is, we are an aggressive species, and that is why we dominate, hence the elevation of pacifism by most of the world's religions. Let us hope "eternal rest" is not an option.

I still think space-settlement is the best chance, coupled with 'faster than light' machines.

From: MR ALJOS FARJON, FLS RBG, Kew

I have taken issue with an article in the latest Linnean because of pertinent errors therein. On page 30, the author quotes Jared Diamond (2005) as saying that the current population growth in China is "still some 9 percent per annum". If you look up Diamond (p. 360) he actually gives 1.3% annual population growth in 2001, reached in a 15 year period of birth restrictions imposed. Apart from this misrepresentation of an author (and a nation!) who is vastly better qualified to write about these matters than this author in the Linnean, anyone who is vaguely familiar with demographics knows that an increase in human population of a large country of 9% p.a. is impossible; our gestation period is far too long and only mice and lemmings can achieve this.

On page 31, the author first states that the El Niño Southern Oscillation is "almost certainly caused by it" i.e. the rise in CO_2 since the beginning of the Industrial Revolution. Then he asserts that it is "now generally accepted that El Niño was responsible for the disappearance of the advanced Moche civilisation of South America." So I looked this up again (Diamond, 2005) and found that this civilisation disappeared around CE (AD) 600! That is at least 1100 years before the Industrial Revolution.

These are just two examples that demonstrate that this author is ignorant of the facts and just writes nonsense. It is not relevant whether or not I share his concerns with overpopulation and climate change and the rest. What is relevant is that the Linnean Society discredits itself by publishing such badly researched and evidently poor articles. I know that contributions to the Linnean are not peer reviewed but that should not mean that the editors should print it uncritically.

From: PROF. J.L. CLOUDSLEY-THOMPSON Hon. FLS London N1 1TE

Thank you, Brian, for giving me an opportunity to answer Mr Aljos Farjon. May I deal with the criticisms of my article 'Thoughts on climate change and human extinction'.

Many of the figures about population growth that I cited were quoted from an article in *Biologist* (2006) by Rosamund McDougall, a member of the Advisory Council of the Optimum Population Trust. An estimation of the current population growth in China today on a BBC TV programme last year was given as in the region of 0.9% p.a. (quoted as 9%, in error), somewhat lower than the 1.3% quoted by Jared Diamond for the year 2001. I apologise for this typing error which Farjon spotted. (In another misprint K.P. Schmidt's name appears incorrectly on p.36 as Schmiedt!). Incidentally, it is difficult to recognise any logic in Farjon's priggish claim that my article is simultaneously 'badly researched' and 'nonsense'.

Mr Farjon is correct that I am not an expert on demographics nor do I pretend to be one; but he seems to have confused two issues in his second criticism. These are the vast increase in atmospheric CO_2 since the Industrial Revolution, and all the damage to the environment caused by human activities since the cultural revolution about a million years ago (Erlich & Erlich, 1970). The Moche people suffered considerably more from El Niño around 600 AD (as informed people would know), than did others whose civilizations were less advanced and, consequently, less destructive.

In the words of Marcus Aurelius, written some 18 centuries ago, and which I have quoted previously in *The Linnea*n, 'If…. I do err, I will most gladly retract. For it is the truth that I seek after …' It is naturally preferable, however, to have ones mistakes, if any, pointed out in a courteous manner – as we have come to expect in the Journal that you founded and edit.

On seeds

Michael Black

The chances are high that fairly shortly before or after reading this you have consumed or will consume something made from seeds – bread perhaps, beans on toast, rice, pasta, cornflakes, coffee, chocolate, a glass of beer or even a scotch. A good deal of our food comes from seeds: indeed, it has been estimated that worldwide about 70% of it is taken directly in the form of seeds – pulses or rice, for example. And to this must be added the huge quantities that are used for animal feed, and the sustenance that seeds provide for much of the animal world. Seeds are a highly concentrated package of nutrients, principally proteins, starch and oil, in different proportions according to the species, and also potassium, calcium, magnesium and other mineral ions as well as vitamins. This feature – the deposition of storage reserve nutrients during their development – is just one of the properties of seeds that confers upon them a significance in the evolution of land plants comparable with the acquisition of vascular tissue. The seed plants (spermatophytes) evolved to become some of the most important organisms on earth, to a large extent because of the properties of their seeds; arguably all terrestrial life is shaped by the activities of the these plants, divided arbitrarily into two groups, the gymnosperms and the flowering plants – the angiosperms or Anthophyta.

The food reserves, laid down within, adjacent to or surrounding the embryo as the seed develops within the protective tissues of the mother plant, are the legacy that the nascent seedling, after germination, uses to support its establishment until it becomes photosynthetically self-sufficient. Another seed property that accounts for the success of the spermatophytes is the seeds' ability, in most cases, to withstand desiccation, often down to 5-10% water content, and to survive in this dry, quiescent state for many years. Desiccation tolerance is a highly interesting phenomenon, the mechanism of which we are now beginning to understand. Seeds possess various biochemical and biophysical devices for the protection of cellular membranes, DNA and protein from the damage that would otherwise result from dehydration, and also for the repair of any damage that does happen to occur. The embryo – the next, independent generation – is thus dispersed in a dry, resistant state, its metabolism barely detectable, able to withstand the rigours of the environment, later to germinate when conditions are right. Survival in this state might be for astonishingly long times. A striking example, authenticated by carbon dating, is the 1280 years-old Indian or sacred lotus (*Nelumbo nucifera*) seeds found in a dried lake bed in Laoning Province, China, that were still able to germinate a few years ago. The resuscitation from a seemingly lifeless form appeared to the ancients to be almost magical and so in many cultures seeds came to feature prominently in myth and religion. In Greek myth, for example, the long germination time of parsley occurs because the seeds have to make several journeys to the underworld before they become fully able to revive. And the bursting into life of 'dead' seeds perhaps inspired the creation story of the Maya. The story relates that when the time came to make Man, the creator gods first tried to fashion him out of wood and clay, but were successful only when they modelled him out of the dough made from maize seeds – and so humans came to be. To the Maya, then, maize seeds were not just the staple food but also the very stuff of life itself.

In early cultures, seeds had important roles besides their uses as food and in agriculture, as weights and measures, for example. The carob seed (*Ceratonia siliqua* L.), because of its reputed uniformity of size, many hundreds of years ago became the standard weight for gemstones and gold, from which the carat unit is derived, the word coming from *keration* and *qirat*, respectively Greek and Arabic for carob. And even later, in 1202, the renowned mathematician, Leonard of Pisa (Fibonacci), recorded the complex weight system of the time, based on seeds: "Pisan hundredweights….. have in themselves one hundred parts each of which is called a roll, and each roll contains 12 ounces and each of which weighs one half of 39 pennyweights: and each pennyweight contains six carobs, and a carob is four grains of corn (i.e. barley or wheat – MB.)" (from Sigler, L.E. [2002]. *Fibonacci's Liber Abaci: A Translation into Modern English of Leonardo Pisano's Book of Calculation*. Springer Verlag, New York). Seeds were also used to define linear dimension, so that in China in 1000 BC, for example, the foxtail millet grain served as a length standard, including for strings in various musical instruments. And the barley grain ('barleycorn') was a unit in Anglo-Saxon and post-Norman England, to become in 1305, the defined inch of three grains laid end to end from which the length of the foot of 12 inches was eventually derived.

The earliest recorded scientific interest in seeds in Europe is attributed to 'the father of botany', the Greek Theophrastus (371-287BC), some of whose extensive writings on botanical matters can be read in his surviving works, known from their Latin translations, *Historia Plantarum* and *De Causis Plantarum.* He investigated and described the origins of plants from seeds, carried out many experiments on germination and had an understanding of many aspects of seed biology that was remarkable for its time. For example, he seems fully aware of the existence and function of seed storage reserves when he writes, "….. every seed contains in itself a certain amount of food. This is why they are able to survive for some time and do not, like the seed ('semen') of animals, perish directly on separation from the parent" (*De Causis Plantarum* I. 7.1).

That plants originate from seeds (as Theophrastus had said) was thought for many centuries to be true of all plants, even ferns. Indeed, the French botanist de Tournefort wrote in 1694, "The views of those who believe that all plants have seeds are founded on very reasonable conjecture": and he attributed this property even to fungi. But this belief gave rise to a serious problem: if ferns, for example, have seeds (for how else could they reproduce?) where are they? The answer, at least in Shakespeare's time, was that fern seeds must be invisible. And, moreover, tradition had it that anyone possessing such seeds would him- or herself be rendered invisible. The Bard makes use of this presumption in Henry IV, Part 1, Act 2, Scene 1, where Gadshill, the collaborator of Prince Harry and Falstaff, is trying to persuade another villain to participate in a robbery, assuring him they will not be seen for "we have the receipt of fern seeds, – we walk invisible". And just a few years after this play was published, Ben Jonson in 'The New Inn' reiterates the traditional belief in the lines, "I had no medicine, Sir, to walk invisible / No fern seed in my pocket".

The notion that ferns have true, but invisible seeds began to tumble in 1794 when, in the *Transactions of the Linnean Society* (2: 93-100), John Lindsay reported his observations on these plants. He had previously unsuccessfully searched the soil where ferns grew for objects resembling seeds but in this paper he reported the eventual appearance of fern plants when the 'dust' from the under surface of the fronds was sown on to soil, concluding that this 'dust' was the true fern seed. But Lindsay had failed to realize the significance on the soil of "small scales which gradually enlarged …. somewhat bilobate…. like some small lichens or liverworts….. At last there arises from this membrane a small leaf, different from it in colour and appearance…. Now each succeeding leaf grows larger than the last, till they attain the full size and are complete in all the parts and discriminating characters of their respective species". Some 50 years after Lindsay's report, the German botanist von Naegli and the Pole Leszczyk-Suminski, showed that these green 'scales' produce sex cells and are therefore the sexual stage in the reproductive cycle of the fern. We now know the 'scales' as the prothalli. Thus, the myth of fern seeds was put to rest.

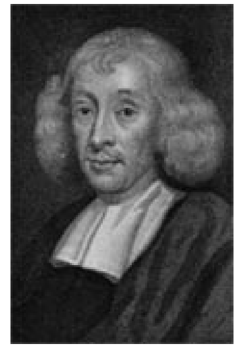
But the death of fern seeds helped to give birth to a profoundly important concept published in 1851– the alternation of generations – conceived by the distinguished German botanist, Wilhelm Hofmeister, which became the great unifying principle in plant reproduction that led us to understand the evolutionary origins of the true seeds of the spermatophytes. Hofmeister realized that the life cycle of land plants consists of two separate generations, the asexual sporophyte from whose spores arise the sexual gametophyte. Later, it became clear that the sporophyte contains the diploid chromosome number while the gametophyte is haploid. Which generation is the dominant, recognisable plant varies with the group. In liverworts and mosses, the plants are the gametophytes (often bisexual), which produce a dependent, short-lived sporophyte; whereas in ferns the recognisable plant is the sporophyte which produces ephemeral, relatively insignificant, free-living gametophytes, the prothalli. In the spermatophytes, the individual plant is also the sporophyte: but what and where are the gametophytes? During evolution of the land plants, the spores become differentiated (heterospory) into the microspores giving rise to the microscopic, male microgametophytes and the megaspores producing the larger (though still barely visible to the naked eye) female megagametophytes, as seen in the extant club mosses: the latter gametophytes, upon fertilization by the motile, swimming, male gametes from the microgametophytes, produce the new sporophyte. Initially, then, both of the gametophytes are free-living and the male gametes are motile but during evolution the megaspores become reduced in number and are retained on the parent sporophyte: and therefore the megagametophytes develop *in planta* – each within a novel organ, the ovule, which in angiosperms is in the ovary of the flower. The microspores are still released from the parent sporophyte but now as pollen grains – the incipient microgametophytes. Pollination is the transfer of the male microgametophytes by wind or animal agents to the ovule housing the female megagametophyte, where fertilization by the male gametes occurs. In all extant seed plants but the cycads, the male gametes are not free-swimming so surface water is not required. Another important development, setting the angiosperms apart from the gymnosperms, is the delivery, in the former, of two sperm 'cells' (actually almost entirely nuclei) from the microgametophyte to the megagametophyte. One sperm cell fuses with the egg cell, restoring the diploid chromosome number and initiating the formation of the embryo, the new sporophyte, while the second sperm cell fuses with two haploid, so-called polar cells of the megagametophyte, to produce a unique, triploid cell that becomes the endosperm of the developing seed. Fertilization thus transforms the ovule into a seed. Seeds of both angiosperms and gymnosperms therefore contain a diploid embryo of maternal and paternal genetic composition. In the gymnosperms, the embryo is surrounded by storage tissue that develops from the haploid megagametophyte cells, the whole being bounded by the seed coat of diploid, maternal, sporophytic tissue. The angiosperm seed is genetically more complex as in addition to the diploid (maternal and paternal) embryo and the diploid (maternal only) coat, there is the triploid (two maternal and one paternal gene sets) endosperm. It should be noted, though, that in many angiosperm seeds, such as in many legume species, the triploid endosperm is resorbed during seed development and is therefore absent from the mature seed. It does, however, develop prominently to maturity in the grasses (cereals), for example.

The seed habit therefore provides for: a) the protection by the parent sporophyte of the female megagametophytes, a potentially vulnerable stage in the plant's life history, and partial protection of the male microgametophytes; b) liberation from the need for external water for transfer of the male gametes (except in the ancient group, the Cycadales, and *Ginkgo*); c) development of the new sporophyte within protective tissues of the parent sporophyte; d) access by the developing sporophyte (the embryo) to a continuous supply of metabolites from the parent plant, for deposition as reserves in well-developed storage tissue; e) formation of a resistant seed that in most cases can tolerate desiccation, to become a long-lived dispersal unit; f) dispersal of an already-formed sporophyte. The seed habit can be dated to about 350Ma: the earliest seeds in the fossil record are from the late Devonian and early Carboniferous (300-350 Ma), represented by the seed 'ferns' – trees with fern-like leaves – and Cordaites. Flowering plants appeared about 125 Ma and a second radiation occurred in the Palaeogene (starting 65 Ma).

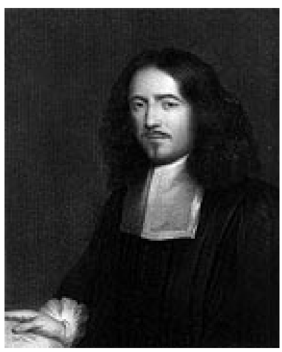
Although it was not until the latter part of the 19th century that the ontogeny and evolutionary significance of seeds became apparent, other aspects of seeds received study from much earlier times, such as by Theophrastus, as we have seen. The next notable contributor was Pliny the Elder (AD32-79) who drew from Greek, Roman and Carthaginian sources. In agreement with Theophrastus, for example, he commented on the special germination behaviour of mistletoe seeds – "But universally when mistletoe seed is sown it never sprouts at all, and only when passed in the excrement of birds, particularly the pigeon and the thrush: its nature is such that it will not shoot unless it has been ripened in the stomach of birds". On the practical side, various observations on seed behaviour were made, and advice was given concerning the handling of seeds in agriculture, some arising from Theophrastus's awareness of the problems posed by the death of seeds (i.e. loss of viability) in storage. On field germination, Pliny the Younger (AD 62-115) writes that "when individual leek, kale, lettuce, celery, endive and watercress seeds were placed inside hollowed pellets of dung they all come up wonderfully", a preview of the 20th century seed technologies of pelleting, encrusting and coating, devices for the easier handling of small seeds and for delivery of growth regulators, mycorrhizae etc to the seedling. In all probability quite independently, the Chinese too were aware of the benefits of such seed treatments. A Chinese agricultural treatise of the 6th century describes the coating of grains with a

Nehemiah Grew
(1641-1712)

Robert Hooke
(1635-1703)



John Ray
(1628-1705)



Marcello Malpighi
(1628-1694)

Antoni van Leeuwenhoek
(1632-1723)

Figure 1. Scientists of the 17th century who studied seeds.

concoction of extracts of horse bones (collagen) and aconite (to deter mammalian pests). A treatment to improve seed performance was described much later by John Evelyn in his *Silva, or a Discourse of Forest Trees* (1664), who remarked that "your Acorns, Mast and other Seeds may be prepared for the Vernal by being barrell'd, or potted up in moist Sand or Earth stratum during the Winter, at the expiration whereof you will find them sprouted;". Evelyn had thus described a method for the removal of seed dormancy by chilling, an aspect of seed physiology that we will come to later.

But we can find relatively little more scientific interest in seeds until the burgeoning of biological enquiry in the 17th century. Notable among those who included seeds in their studies were Nehemiah Grew (1641-1712), Robert Hooke (1635-1703), Antoni van Leeuwenhoek (1632-1723), Marcello Malpighi (1628-1694) and John Ray (1627-1705) (Fig. 1). The first four made detailed observations on seeds, aided by the optical technology that was then emerging. Malpighi and Grew presented their findings to The Royal Society in 1671, published later in *Anatome Plantarum* (Malpighi, 1675), and *Anatomy of Plants* (Grew, 1682 – mostly a collection of previous publications), works that contain carefully observed drawings of seeds, accompanied by comments on various aspects of their biology (Fig. 2). This passage from Grew is an illustration of the studies carried out by these scientists: “If we then take a bean and dissect it, we shall find it cloathed with a double vest or coat. These coats, while the bean is yet green are separate and easily distinguished. Or, in an old one after it hath lay’n two or three days in a mallow soil; or been soaked….. in water….. When ‘tis dry they cleave so closely together, that the eye not before instructed, will judge them but one; the inner coat (which is of the most rare contexture) so far shrinking up, as to seem only the roughness of the outer, somewhat resembling wafers under maquaroons.” And, commenting on other structural features: “At the thicker end of the bean, a very small Foramen presents itself, even to the bare eye. … In dissection, ‘tis found to terminate against that part which I call the radicle”. Later, still describing the bean: “The main body is not one entire piece, but always divided into two halves or lobes ….” The foramen that Grew described was later, in 1821, named the micropyle (Gk., ‘little

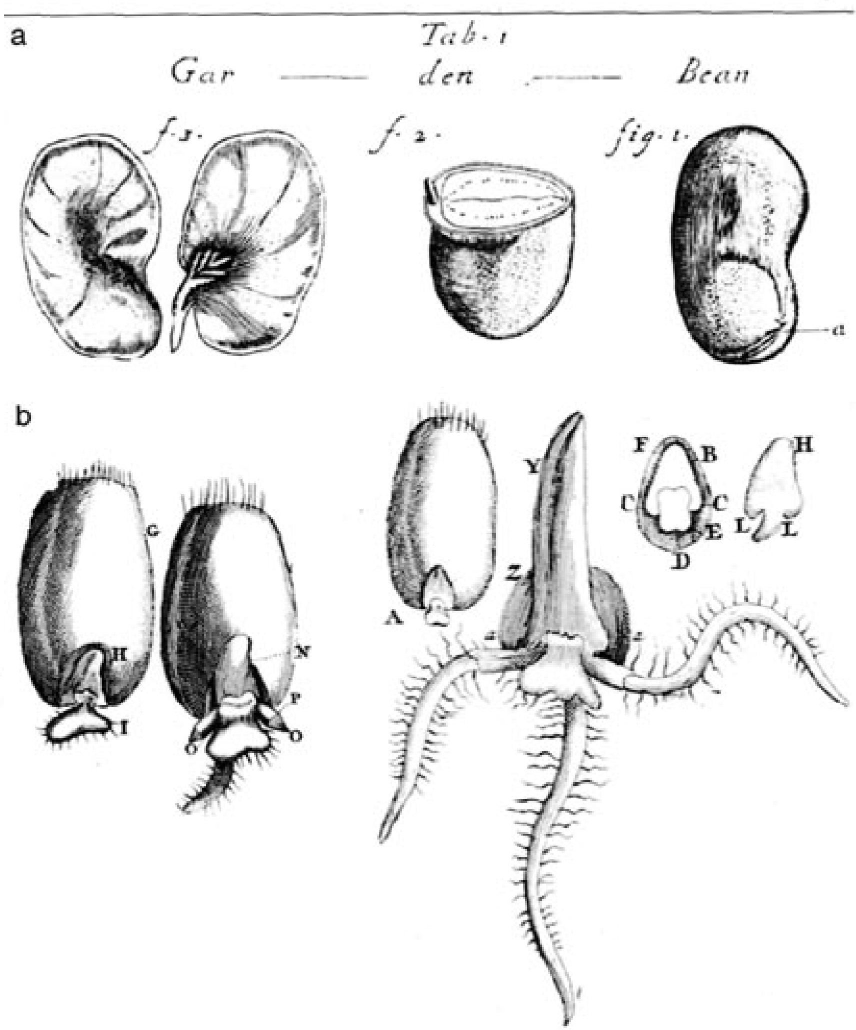


Figure 2. Drawings of, a) bean seeds by Nehemiah Grew (from Grew, N. *The Anatomy of Plants*, 2nd edition, London, 1682: reprint edition edited by C. Zirkle (1965) Johnson Reprint Corporation, New York): b) Wheat seed germination and seedling by Marcello Malpighi (from Malpighi, M. *Anatome Plantarum*. John Martyn, London,1675)

gate') by de Candolle and Sprengel, and the two "halves or lobes", the cotyledons, – a term first used in relation to seeds by Linnaeus in 1751, who imported it from zoology and physiology, where it referred to the nutritive, foetal chorion of ruminants. Linnaeus, Grew and Malpighi were all physicians who frequently drew analogies between plant and animal functional anatomy.

The function of the cotyledons or seminal leaves, as they were generally called, received comment from van Leeuwenhoek, referring to the cassia seed. These, he wrote, "have been made so exceedingly large in order to provide nourishment for that part of the root and the beginning of the young plant…." This was mostly a conjecture, but John Ray, in *Methodus Plantarum Nova* (1682), went further, proposing an experiment to elucidate the function of the seminal leaves, writing, "… it would be a simple experiment to find out by cutting the leaves or lobes as soon as the little plant comes forth from the earth and to compare it to another plant of the same age whose lobes or leaves remain". But Ray later learned that Malpighi, who was, according to Ray, "a most sagacious and incomparable philosopher" had actually carried out the experiment, which he (Malpighi) describes thus: "Also, in the month of May, I put other seminal plants of Faba and Phaseoli (beans – MB) for incubation with two seminal leaves removed, in the same way, of which only one little plant of Faba sprouted….. After twenty one days the plant wasted away. I planted afresh many other seminal plants of Faba with every seminal leaf pulled off, of which none grew." After experimenting with several species, Malpighi concluded, "Therefore from these things it is possible to conjecture that the twofold leaves as fat as possible, which cling to the seminal plant, perform the service of uterine placenta". These seem to be the first experiments showing that the cotyledons play an essential role in supporting the growth of the embryonic axis after the seed has germinated. Although Ray may have been disappointed that Malpighi had performed the experiments that he (Ray) had also thought of, he did in fact go on to make an important discovery relating to early nutritional mechanisms in cereal grains and grasses. Ray drew attention to seeds "in which no pulp or pith is contained" and "those in which besides the seminal plant other things are also contained". Though not so-named by him, the 'pulp' that Ray was referring to was the endosperm, and his understanding that this tissue served an essential role in the nutritional budget of such seeds is revealed when he writes, "The seminal plants in these (wheat – MB) equals in magnitude hardly a tenth part of the pulp or pith of the seed. The remaining pulp or grain of the plant, while somewhat tender, serves to nourish, even after the roots have grown". And he set up an experiment with wheat to demonstrate this: "For if you uproot the plant when it has first sprouted, you discover the pulp in the grain nearly intact; but, at the same time, if you continue to pluck sewn plants from day to day, you will observe the pulp or flour to be perceptibly diminished daily until nothing is left but an empty little follicle clinging to the bottom of the plant". This is an accurate description of what we would now call endosperm mobilization – the start of which is understood as the basis of the malting process, for example in barley. We now realise that a major part of this mobilization is the conversion of the stored starch of the endosperm to maltose and some glucose by enzymes secreted by the aleurone layer surrounding the endosperm – the tissue partly comprising the 'little follicle' of Ray. The endosperm, then, is converted into a sugary solution, a process that Ray was clearly aware of, when he continues: "Moreover, the pulp or grain of the seed after germination combining with the moisture of the earth percolated through the pores of the covering turns into plant juice not unlike the sap extracted from a plant". This is, for its time, a remarkable perception of the changes occurring during endosperm mobilization to furnish nutrients for the germinated embryo. Some 300 years later, the process became the model system for studying the mechanism of reserve mobilization in seeds, leading to an understanding of the biochemical and hormonal basis of this critically important post-germination event and to the discovery of the hormonal regulation of gene expression in plants.

Ray's interest in cereal and grass grains also generated an idea that went on to become a foundation stone in flowering plant classification, foreseen in these words: "A general distinction of plants is able to be deduced from this division of seeds and this distinction, in my judgement, is the first and best by far: between those that have double-leaved seminal plants and those which have a seminal plant analogous to the adult plant" – possibly the first explicit statement of the basic taxonomic division of the angiosperms into the Dicotyledons and the Monocotyledons. In fairness, however, it should be noted that Nehemiah Grew had hinted at the idea in his earlier writings on plant embryos.

While Grew, Malpighi and Ray primarily concerned themselves with the general biology of seeds, Robert Hooke studied their microscopic structure, writing about them with obvious admiration (*Micrographia*, 1665): "...' we come at last to the Seeds; and here indeed seems to be the Cabinet of Nature, wherein are laid up its Jewels. The providence of Nature about Vegetables, is in no part manifested more, than in the various contrivances about the seed, nor indeed is there in any part of the Vegetable so curious carvings, and beautiful adornments, as about the seed; this in the larger sorts of seeds is most evident to the eye; nor is it lest manifest through the Microscope, in those seeds whose shape and structure, by reason of their smallness, the eye is hardly able to distinguish". Though these carvings and adornments are now strikingly revealed by modern microscopy, Hooke's early observations are still much to be admired (Fig. 3).

Many of the structural features that Hooke observed are related to the particular properties of seeds, such as the hard coats that confer resistance to inclement factors and the various devices associated with dispersal. Knowledge about both of these is an aid to understanding plant distribution and biogeography. In this context, Charles Darwin was interested in the extent to which seeds were resistant to sea water. "I have begun making some few experiments on the effects of immersion in sea water on the germinating power of seeds, more especially in regard to the same species being found in many cases in far outlying islands and on the mainland. Will any of your readers be so kind as to inform me whether such experiments have already been tried?…. The results at which I have already arrived are too few and unimportant to be worth mentioning." He wrote this in his first letter in 1855 to *The Gardeners' Chronicle and Agricultural Gazette*, followed by three other communications in that year on the same theme. In the second he observed that "all the 40-50 seeds that I have as yet tried sink in sea water: this seems at first a fatal obstacle to the dissemination of plants by sea currents." He nevertheless persisted in his experiments and read a paper in 1857 to The Linnean Society, later published in the *Journal of the Proceedings of the Linnean*

Figure 3. Seeds: ancient and modern**.** A. Drawings by Robert Hooke.
Top, Corn violet (*Campanula* sp.): middle, Purslane (*Portulaca oleraceae*): bottom, Poppy (*Papaver* sp.) (From Hooke, R. *Micrographia*. John Martyn, London,1665: facsimile reproduction edited by R. Gunther (1961) Dover Publications Inc., New York)
B. Scanning electron micrographs of seeds.
Top, *Stellaria holostea* (seed, 2.2mm long): middle, *Polygala arenaria* (seed, 2.2mm long): bottom, *Papaver rhoeas* (seed, approx. 0.9mm long) (by Wolfgang Stuppy, Millennium Seed Bank, Wakehurst Place, Royal Botanical Gardens, Kew; with grateful thanks. From Rob Kesseler & Wolfgang Stuppy. *Seeds – Time Capsules of Life* , Papadakis Publisher, London, 2006, in collaboration with the Royal Botanic Gardens, Kew, ISBN 1901092666)

Society of London (Botany) 1:130-140, 1857. He begins by asking how long seeds can tolerate sea water, regretting that botanists had not investigated this, and continuing modestly, "… botanists would have been far more capable of doing this than myself." But after noting that the botanist de Candolle in his *Géographie Botanique* voices similar regrets, he goes on, more confidently, "….had he known the few facts here to be recorded some of his opinions on the means of distribution of particular families would have been slightly modified." Darwin reported on the behaviour of seeds of 87 species, finding survival times in sea water from just a few days to over 100 days, for example in oats. (All of Darwin's published material is taken from The Complete Work of Charles Darwin Online – *http://darwin-online.org.uk/*). Darwin's experiments are not only of great historical interest but they are also among the first to provide good evidence for the powers of resistance and survival possessed by seeds.

Seeds are at the heart of cultivation practices in agriculture and horticulture and to a large extent we tend to think of them in that context. The start of agriculture and the birth of the major world civilizations depended on plant domestication. And since some of the most important events in the domestication syndrome involved changes in the properties of seeds, their biology has a central role in the beginnings of agriculture. Early in the development of agriculture, edible seeds, such as those of certain wild grasses (ancestors of the cereals), wild legumes (giving rise to the pulses), nuts etc., were gradually selected for nutritional content and size. And so the present-day cultivated seed types are substantially larger (and therefore more nutritious on a unit seed basis) than their wild progenitors (Fig. 4). Agriculture also succeeded because of a change in one of the basic, natural properties of seeds – their dispersability. A key biological feature is that seeds are released from the parent plant to be dispersed, sometimes over great distances. This release is achieved by the formation of an abscission layer, such as at the base of each grass (cereal) grain, or by the dehiscence of the pod in legumes, processes that come under the general term, shattering. At the dawn of agriculture, 8-15,000 years ago in the western hemisphere, non-shattering mutants of wild food plants that had emerged naturally were chosen for cultivation because the seeds that remained on the plants were easier to harvest. It is thought that non-shattering alleles were first introduced into the early wheats from mutant forms of the primitive wheat, einkorn, but later other components of the genomes that went to build the much more recent hexaploid bread wheats also contributed alleles. In wheat, then, the non-shattering characteristic of modern forms is determined by multiple genetic factors. In rice, also, it appears that mutations in 2-3 genes on chromosomes 4 and 7 are involved in the loss of the shattering character that is present in ancient wild-type rice; and genes on other chromosomes have also been implicated. A few years ago, non-shattering mutants were produced experimentally in *Arabidopsis thaliana* (the most commonly used species for molecular genetic studies) and thereby shattering genes were identified and isolated, giving us the opportunity to learn more about the molecular basis of the phenomenon.

A particularly instructive example of seed modification in domestication is provided by maize. The wild ancestor of modern maize is held to be a species called teosinte, possibly *Zea mays* subsp. *mexicana*. In teosinte, there are two rows of fertile spikelets on the floral axis – and therefore, after fertilization, two rows of (shattering)

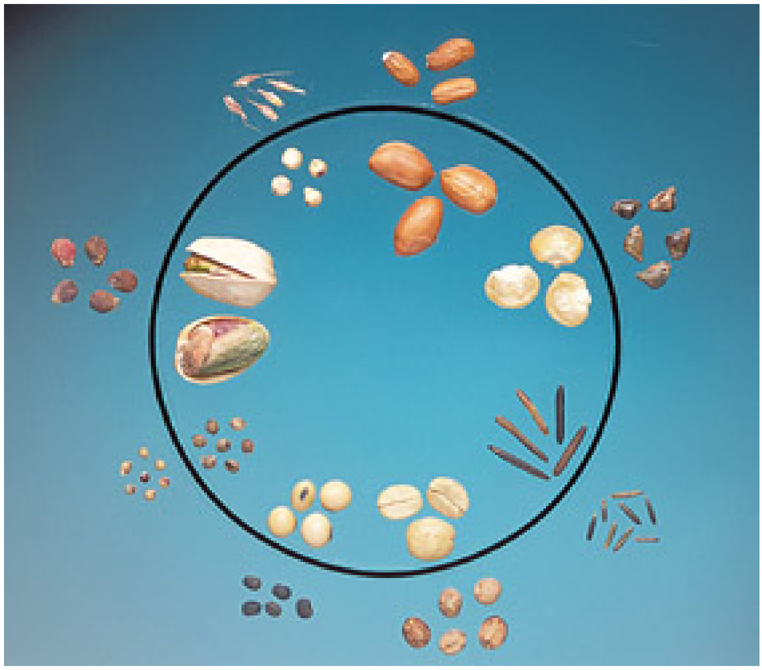


Figure 4. Seeds of wild ancestors and domesticated forms. Seeds from domesticated crops (inside circle) are usually larger, more uniform in size and shape and lighter in colour than their wild relatives (outside circle). Clockwise from top: peanut, maize, rice, coffee, soybean, hops, pistachio, sorghum. (By Stephen Ausmus, USDA, ARS Photo Library)

grains, each grain covered by a hard casing (the glume). During domestication, the rows of fertile spikelets increased to between eight and twenty, the glumes softened and the shattering character was lost (Fig. 5). Genetic analysis indicates that these changes result from mutations of four genes. Superimposed upon these are mutations affecting the type of starch in the endosperm and grain size and colour which together furnish a large range of modern cob and grain types, such as dent, flint, popcorn, blue corn and others.

Domestication also led to changes in germination behaviour, particularly to the loss of seed dormancy – an innate property of many species that delays germination of a hydrated, metabolically-active seed, sometimes for many months or years. It is understandable that early agriculturalists would have viewed delayed germination as an undesirable trait and so it was gradually selected against: and the consequence is that seeds of most modern crop plants possess little or no dormancy. But what is dormancy for? Dormancy is a seed property that should be added to the array of characteristics that make seeds fit to carry out their role as repositories and initiators of the next plant generation. Dormancy regulates when and where the seed germinates – at the right time and in the right place for the seedling to emerge into the world. To achieve this, the seed contains an intricate and wondrously effective package of signal transduction mechanisms through which its position in the soil is sensed, its disposition in relation to other plants, and the time of year. Through the action of the photoreversible receptor molecule, phytochrome, seeds of many species detect the spectral composition of light to which they are exposed, especially the red and far-red wavelength regions: red light breaks dormancy and favours germination and far red inhibits it. How does this operate in nature? If a seed is shaded by the green leaves of other plants the far-red component of the incident light is relatively high, because chlorophyll filters out the red light letting the far red pass. This is manifestly an unfavourable situation in which a new seedling might emerge, since it requires red light for its photosynthesis, but the operation of the phytochrome system ensures that germination of seeds beneath a leaf canopy does not take place. Or perhaps the seed is several millimetres deep in the soil: far red penetrates to this depth but the red wavelengths are attenuated, so again germination is inhibited. This is especially important for a small seed that contains storage reserves sufficient to support only a relatively small amount of seedling stem extension growth through the earth before it emerges into the light and can begin to photosynthesise. In these scenarios, germination would be promoted only if the red light component were relatively high, enough to activate the photoreceptor which then sets in motion a signal transduction pathway that eventually promotes the expression of germination-inducing genes.

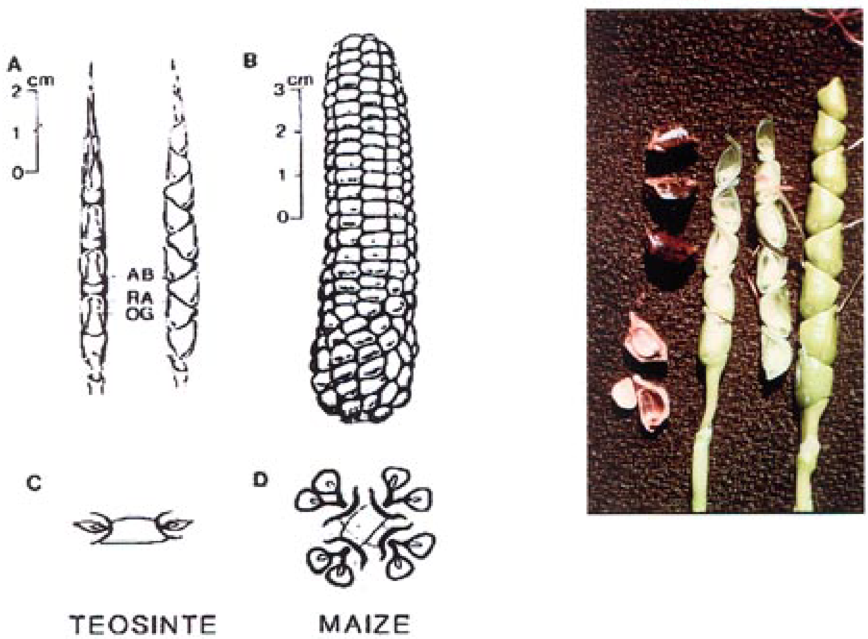


Figure 5. Domestication of maize. Seed heads of teosinte (A and photograph on right) and domesticated maize (B). Diagrammatic cross sections of teosinte (C: showing two fertile spikelets, each producing one grain) and modern, domesticated maize (D: maize ear showing four cupules each with two fertile spikelets, each producing one grain) From Doebley, J., Stec, A., Wendel, J. and Edwards, M. Genetic and morphological analysis of a maize-teosinte F_2 population: implications for the origin of maize. *Proceedings of the National Academy of Sciences USA* 87, 9888-9892, 1990: with permission. The photo shows intact and dissected immature teosinte (*Zea diploperennis*) ears: note the hard, woody ‘ fruit cases’(glumes around grains) on the far left, two at the bottom cracked open to reveal the grains (photo by Hugh Iltis, from http://www.wisc.edu/teosinte/images.htm**)**

The sensing of alternating temperatures is another device for detecting overlying vegetation. Night-day temperature differentials in soil are set up by the absorption of solar radiation; and temperature amplitudes of a few degrees in the diurnal cycle are often required by seeds of some species for promotion of germination, possibly by releasing seeds from dormancy. A vegetation cover substantially reduces the temperature differential as it dampens absorption of radiation by the soil, and hence seeds that are so covered remain ungerminated. But on bare earth, the requirement for an alternating temperature is satisfied; it is here that the seeds are stimulated to germinate, free of potential plant competitors. Temperature also plays a part in another germination-permitting mechanism, one in which hydrated seeds require exposure to several days or weeks of low temperature, generally below 5°C, for the removal of dormancy. This device allows germination to proceed only after the cold of winter has been experienced so that emergence of a delicate seedling takes place in improving, less harsh temperature conditions.

One gene regulated by the red light-induced form of phytochrome is for an enzyme promoting the synthesis of a particular type of gibberellin – a plant hormone that stimulates germination. In fact, it now seems that germination and dormancy are regulated by the balance of action of the promotive gibberellins and the inhibitory hormone, abscisic acid. There is evidence that this balance may be set by environmental factors such as light, as we have seen, and also by temperature, both ultimately operating through effects on gene expression.

In conclusion, I will return to a point made at the start of this article – that on the mother plant, seeds accumulate storage reserves to provide for the early days of seedling life after germination. The physiology of developing seeds is in fact highly geared to this storage function and they have enormous activity as sinks, attracting materials from the rest of the plant which they transform into storage compounds. This property is now being exploited in the new age of human utilization of seeds, in the age of biotechnology and genetic modification. By means of recombinant DNA technology, several novel genes have been introduced into plants for making products useful to mankind that accumulate in the seeds. An exciting example to hit the headlines is so-called 'Golden Rice', rice that is engineered to produce high concentrations of ß-carotene in the endosperm of the grains (a compound that normally is absent) giving them a yellow-orange colour. ß-carotene is metabolised in the human body to vitamin A, so the Golden Rice is effectively providing vitamin A, which normal rice grains do not. Deficiency of vitamin A is a serious problem affecting millions of people in developing countries, especially children who may consequently become blind. The normal daily portion of rice, taken as a Golden Rice, can provide almost the entire recommended intake of vitamin A, and, moreover, it is consumed in a food that is a staple component of the diet. The high-carotene lines have been distributed free to agricultural and scientific institutes in rice-dependent countries for breeding into the local rice types, so soon golden rices will become important dietary components. Seeds have also been transformed to produce several medically and pharmaceutically important proteins, such as antibodies, vaccines, lactoferrin, lysozyme and even human insulin. Recently a gene from the Newcastle disease virus affecting chickens has been introduced into maize. Chickens eating the transformed maize grains produce antibodies against the virus. The ferritin gene has been introduced, for example into rice, leading to the accumulation in the grains of elevated levels of iron and zinc – important for countering ion deficiencies. The medically-useful anti-coagulant peptide from the leech, hirudin, has been inserted into the protein oleosin, which is specific to the membrane surrounding seed storage oil bodies. The fusion protein is therefore targeted to oil bodies, for example in *Brassica napus* (rapeseed) from which it can be purified by relatively simple flotation techniques and used as a source of hirudin. One achievement that could prove to be extremely important is the recent introduction of the human insulin gene into safflower seeds: it has been suggested that this means of insulin production has some advantages (eg. cost) over the current bacterial production system.

Seeds can therefore be used as production systems for many pharmaceuticals, medicinals and nutraceuticals, and indeed they offer many advantages over conventional production modes. Vaccines, antibodies etc can be targeted into the sterile seed intracellular compartments, where they are stable: and the host seeds are storable under relatively simple conditions for long periods of time. Seeds are economical producers with well tested and readily available cultivation technologies. At the present time, none of the above examples is in commercial production, partly because of the controversy surrounding genetic modification. But we can envisage that once these problems have been resolved, the production of vaccines, antibodies, nutraceuticals and other substances will be added to the repertoire of seeds. In the future, seeds may not only make us full but also make us well.

Gilbert White and the natural theology of Selborne

Lecture given to the John Ray Trust, 18 July 2006 by the Rev Nigel Cooper FLS

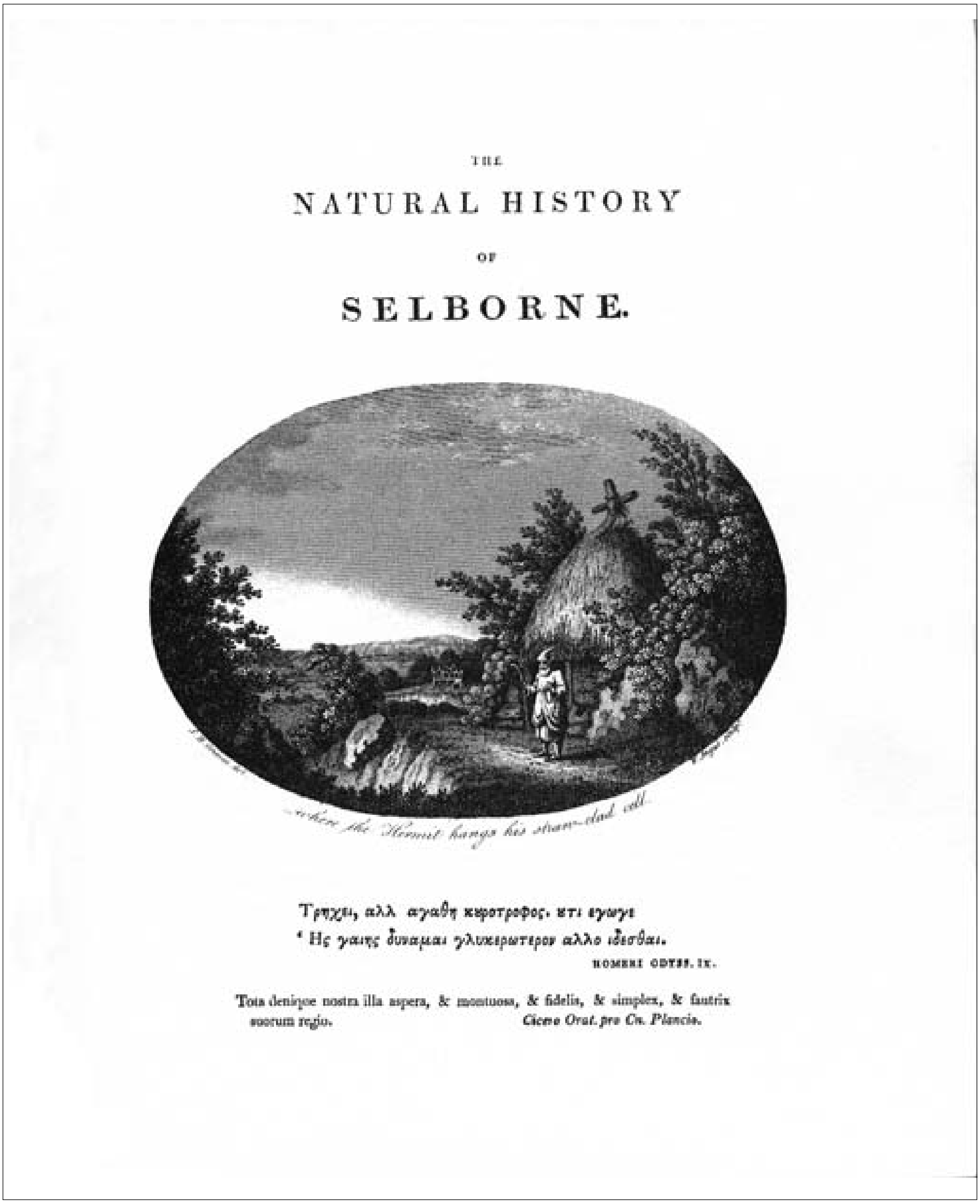
Gilbert White's "The Natural History of Selborne" is the fourth most published book in the English language – that is the (unfounded) claim! Certainly it is a frequently published part of the canon of English literature. It has just featured as a programme on BBC4 presented by Michael Wood, for example. There have been several editions of the book since 1990 alone. But why? "Who now reads Cowley?" – that is Abraham Cowley, the seventeenth century poet whose epitaph in Westminster Abbey claimed he was the Pindar, Horace and Virgil of the English Nation: a partner with eternity. "Who now reads Cowley?" was White's question as he awaited the reading public's reaction to his own publication (in his poem "To myself commencing author"). "Why do we still read White?" is the perennial question in Selborne studies.

Before I take my turn in addressing this question, let me provide you with a quick overview of both the book and the man.

"The Natural History and Antiquities of Selborne" was published in 1789 by White's brother, Benjamin, a London publisher specialising in natural history. It sold for one guinea. It is set out as three series of letters. Forty-four purport to be to Thomas Pennant who we might now call a populariser of natural history; sixty-six to the Hon Daines Barrington, a well-connected gentleman with a deep interest in natural history who helped White in many ways and suggested publishing the correspondence; and thirdly, twenty six un-addressed letters with several appendices on Selborne's antiquities – this last series is omitted from about 80% of the editions of "Selborne". The natural history letters are substantially edited versions of real letters plus two poems, and there are specially composed letters to introduce and conclude the natural history part of the book.

The book, White's only book, was the culmination of his life, published when he was 68 (he died five years later). It was twenty-one years in the making, if we count from the date of his first letter to Pennant in 1767. Other significant start dates are 1768 when he began to use Barrington's format for a Naturalist's Journal (and it is from entries in this journal that White composes much of his letters) and 1765 when he purchased William Hudson's "Flora Anglica" and started marking it up. White was then 45.

White's residence in Selborne was the context for what in retrospect was his life's work. He was born there in 1720 in the vicarage, his grandfather being vicar. His parents shortly moved away but came back to live with his grandmother after his grandfather's death. She had moved across the street to a house previously used by the Wake's family and so called "The Wakes" (which now houses the museum). Gilbert White had spells away from Selborne. In his late teens he boarded in Basingstoke for schooling. He went up to Oriel College, Oxford when he was 20, was elected a fellow


THE

NATURAL HISTORY

OF

SELBORNE.

Τρηχει, αλλ αγαθη κουροτροφος. ουτι εγωγε
Ἧς γαιης δυναμαι γλυκερωτερον αλλο ιδεσθαι.
HOMERI ODYSS. IX.

Tota denique nostra illa aspera, & montuosa, & fidelis, & simplex, & fautrix suorum regio. *Cicero Orat. pro Cn. Plancio.*

The title page of the Ray Society's facsimile edition of The Natural History of Selborne.

at 24, and then at 27 he was made deacon and left Oxford (but not his fellowship) for a curacy with his uncle elsewhere in Hampshire. He took time for travels around the south of England. Back in Oxford, he was junior proctor for a year; some years later he made an unsuccessful bid for the provostship of his college. He was also unsuccessful in obtaining his uncle's living when he died. He could never be appointed to the living of Selborne, as it was a Magdalen parish; instead he busied himself with several curacies nearby while residing at the Wakes. In his last years he was curate of Selborne in the absence of the vicar.

With a lack of preferment, and also matrimony, White turned his attention to the garden at the Wakes. He started keeping a Garden Kalendar in 1751 in which he recorded the goings-on, including a few natural history jottings. The Kalendar was superseded by the Naturalist's Journal, though this in turn continued to include garden entries. Kalendar and Journal are still extant and we are fortunate to have a good selection of White's correspondence with his family (almost all of whom also had an interest in natural history) and with friends and colleagues. We have the letters from his life-long friend, John Mulso, to White, but not White's replies. He also left a bit of poetry and some sermons.

The Wakes, Selborne

So why do we still read White?

Many who tackle this question are hagiographers, as is Michael Wood and those who appear with him on the BBC. Yet even they cannot agree on the cause of White's greatness. Is it his simplicity or his artfulness? Richard Mabey seems to have shifted from the former opinion to the latter, judging by the series of introductions he has written over the years for different editions of the "Natural History of Selborne." (1977-1993)

Rarely, a critic has shown his hand. In the nineteenth century White was criticised for his plurality, holding the living of Moreton Pinkney in absentia and retaining his college fellowship, while all the time residing in Selborne. His supporters have successfully demonstrated that, according to the customs of the day, White was very modest in holding just these two posts, alongside working as a clergyman curate close to home.

Contemporary critics castigate White for ignoring the plight of the rural poor and instead supporting the social inequalities of the status quo. And he did this cryptically, according to these critics, by presenting an ideology of a rural idyll. For these critics White's appeal is simple bad faith; as industrialism intensified social conflict, from the 1830s "Selborne" was turned to for solace and escapism. Today it is a disturbing book as we contrast White's Selborne, "full of birds", with the paltry numbers there now.

The position does not seem clear-cut to me. White was an Anglican Tory. "You cannot abhor the dangerous doctrines of levellers and republicans more than I do! I was born and bred a Gentleman, and I hope I shall be allowed to die such," he once wrote to Robert Marsham (BII:297). But he deplored the morals of high society, likening them to tame pigeons which "are apt to forget the strict rules of chastity, and follow too often the example of people in high life." (BII:124) He quotes with approval Lord Botecourt returning the bow of a Negro slave (LII:189). He includes no dedication to a wealthy or powerful patron.

On one point Gilbert White seems to have identified with the villagers against the landed interest. Although he was in favour of agricultural improvement, he tried successfully to thwart a possible act of enclosure by Magdalen College organised by a Mr Fisher in 1793. White claimed he had a decree in the Court of Chancery that the wood and commons belonged to the tenants (LII:258ff). A few years before he had also supported the re-opening of a disputed bridle path (LII:260ff) calling himself "an ancient inhabitant and native of Selborne". And yet he can also seem rather complacent and indifferent to the plight of the poor. Perhaps we could say White was a man of his class and time, and a peaceable one at that.

We know of no great feuds or scandals and he seems to have been an easy person to get on with. He is not moralistic in his writing, and a quiet, self-deprecating humour shows through. One of my favourite examples of this comes in the last letter of the Antiquities (A:26). He is explaining how the building materials of Selborne Priory had largely disappeared. "Wantonness, no doubt, has had a share in the demolition; for boys love to destroy what men venerate and admire. A remarkable instance of this propensity the writer can give from his own knowledge. When a schoolboy, more than fifty years ago, he was an eye-witness, perhaps a party concerned, in the undermining a portion of that fine old ruin at the north end of Basingstoke. The notion of doing some mischief gave a zest to the enterprise."

So, why do we still read White? In my view White's greatness does not lie in a primitive naïveté, but in a secondary simplicity. White's voice is a thoroughly educated one and his text is a work of culture. His eye and ear are well trained, in the process he deepens his embodiment in the material world. Because of White's facility in both culture and nature he offers us a spiritual insight. This is not as a supplement to nature and culture, even less despite them, nor even through them. White reveals to me the spiritual value of nature as nature, as itself, and does so using the tools of culture, which is no less alien to the spirit.

In the search for Gilbert White's spirituality, let us begin at the obvious place of his theology, especially theology as it applied to science.

White was in good company as a clergyman pursuing science. Just one example was Stephen Hales, pioneer physiologist and Minister of Teddington and a family friend. As White wrote to John, one of his younger brothers, "Nat: Hist: when considered in a physico-theological light is no ways foreign to the pursuits of a clergyman." (JW:30/8/1770) Although there were concerns that burgeoning science might undermine religion, most science was undertaken not just within a Christian framework but as a Christian calling or duty.

White nowhere uses the Design Argument, though everywhere refers to Physico-Theology. This title for the movement came from one of the works of John Ray, after whom this lecture is named. Ray was the systematiser of the movement and the author of its textbook, "The Wisdom of God manifested in the Works of Creation" 1691, recently re-published by the Ray Society. Ray, a clergyman naturalist of Black Notley in Essex, sometimes dubbed the father of natural history, is White's hero: "Our countryman, the excellent Mr Ray." (DB:10) White frequently quotes also from William Derham, vicar of Upminster and Ray's interpreter. White's science owes an immense amount to Ray. He builds on Ray's observations and follows his advice "to be an out-door naturalist, one that takes his observations from the subject itself, and not from the writings of others." (DB:1) It is probably through Ray that White absorbs his philosophy of science and his interest in how things work together, i.e. ecology, not just in the naming of things, "The standing objection to botany has always been, that it is a pursuit that amuses the fancy and exercises the memory, without improving the mind or advancing any real knowledge." (DB:40)

White uses many of the theoretical ideas of Physico-Theology. These include: (a) the Great Chain of Being, e.g. "Earth-worms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm." (a tip Darwin followed up) (DB:35); (b) The Principle of Plenitude, "all nature is so full, that the district produces the greatest variety that is the most examined". (TP:20); (c) The Economy of Nature: the dung from cattle cooling in Woolmer pond is food for insects so that "the recreation of one animal is the support of another!" (TP:8); (d) Plastic Power as an active life-force delegated by God: "was there ever a time when these immense masses of calcareous matter [he is speaking of the South Downs, equal to the Alps in Ray's estimation] were thrown into fermentation…; were raised and leavened into such shapes by some plastic power?" (DB:17)

Gilbert White's desk

My favourite passage is in the 59th letter ostensibly to Barrington. The last paragraph of DB:59 begins, “The evening proceedings and manoeuvres of the rooks are curious and amusing in the autumn”. White then goes on to repeat with few changes an account in his Journal (J:5.11.86) how they fly and call and how this sound is softened when it reaches the village below. He makes a number of effective comparisons to describe the quality of this noise. He then adds, “We remember a little girl who, as she was going to bed, used to remark on such an occurrence, in the true spirit of physico-theology, that the rooks were saying their prayers; and yet this child was much too young to be aware that the scriptures have said of the Deity – that ‘he feedeth the ravens who call upon him’.” According to a note made by Thomas White junior in his copy of his uncle’s book, this ‘little girl’ was his sister Mary whom Gilbert White addressed as Molly. To add to this touching scene, it was Molly as a young woman who first received this composed letter in her capacity of editorial assistant.

How are we to read this? Did White think her comments were a true example of Physico-Theology, or did he realise that Ray and his followers would have disagreed, believing that rooks and other creatures praise their Creator by stimulating the wonder and praise of humans? This was not merely a supplement found just in Ray’s position, it was the foundation of the whole movement: to find in the design of nature evidence of God’s handiwork to prompt those who saw the evidence to praise their maker.

White owes this contrary judgement to poets like Milton, or perhaps to scripture itself. After all he quotes scripture as we have just heard in the rooks passage, Psalm 147, verse 9. Of course, White shows an easy familiarity with the bible, as one would expect. Outside his sermons, though, he tends to use biblical quotations not for theology but as a source of allusions and reminiscences (e.g. LII:179). Just two examples from his book: TP:22 refers to the taming of toads and sees it as fulfilling the truth of James 3.7, that all beasts have been tamed. White refers to James as “an ancient author, though no naturalist”. As an amusing contrast, DB:4 likens the cuckoo to the ostrich in Job 39.16f, and in this instance Job is called “a very ancient and sublime writer”. This exalts him far above St James, presumably on the ground that Job was a naturalist.

Scripture says that God is a gardener and John Prest (1981) has described how the tradition of the botanic garden began as a re-creation of Eden. So what is to be learned of Gilbert White’s theology from his gardening? After all, his natural history grew out of his interest in gardening. I think that White worked on his ‘outlet’, as he called it, partly with the view to recreate a model of Paradise.

By the 18th century it was no longer possible to envisage a garden, particularly in inclement England, containing all the plants of the world – there were just too many of them. Nevertheless, White was a plantsman and a collector and took particular delight in growing tender species. Although White fully shared the popular enthusiasm for garden design, the science of horticulture was of more interest to White; his “Garden Kalendar” is full of planting and blooming and harvesting. Mark Laird has shown that not all 18thC gardening was grand design and that plantsmanship was also appreciated. He particularly relied on Philip Miller’s “Gardeners Dictionary” (bought in 1747) with its emphasis on science; he exchanged plants with Miller. The Edenic garden was a place of sacred labour for Miller: “The gardener when digging is singing praises to God," and gardening "brings a good man to [knowledge] of his Great Maker". White was not afraid of labouring alongside his servant Thomas Hoare. White the gardener was also learning how to watch his flowers, both in the appreciation of their beauty, taste and smell, and to respond to their least setbacks, alert to unfavourable weather, pests or the depredations of birds.

If the fullness of Eden was beyond reach, its fruitfulness remained a possibility. White was determined to get good crops. He had a particular fetish for melons and cucumbers, widely shared at the time. The melons particularly needed hotbeds and White bought in loads of manure, e.g. in 1765 he had thirty-one wagon-loads of dung delivered between February and June. Despite much tender love and care the results seem less than the effort to me, but White always comes across as delighted.

Another depiction of Paradise, whose fame lasted into White's time and beyond, is that of John Milton. The description of Eden in "Paradise Lost" (Bk IV) is surely echoed in a number of White's own poems about his native village: 'a rural mound', 'hairy sides with thicket overgrown, grotesque and wild', 'a woody theatre of stateliest view', 'prospect large into his nether empire'. And, of course, the Whites built a hermitage on the Hanger, the beech-covered scarp behind his house, and even put the relevant quotation from Milton's "Il Penseroso" as an apt inscription on its door.

Find out the peaceful hermitage…
Where I may sit and rightly spell…
… every herb that sips the dew,
Till old experience do attain
To something like prophetic strain.

White's youngest brother, Harry, acted the part of a hermit for visitors and is illustrated in costume on the title page of "Selborne". In a skit of a poem, brother John, who had done most of the physical work in constructing the hermitage, pokes fun at the indulgent lifestyle of modern hermits guzzling melons, though he does agree it is preferable to the life of ascetic prayer of the ancient hermits. A versifier, John Scrope, describes White turning into a melon in "The Metamorphosis", published in the "Gentleman's Magazine" in 1783, but written in 1748.

Hermitages were one of many popular emblems placed around gardens in the 18th century. White also erected along his principle vista a flat wooden statue of Heracles (or Hercules) killing the dragon. This is a reference to the Hesperidean garden at the Western edge of the world whence, for his eleventh labour, Heracles had to fetch the golden apples. This statue, therefore, signified that the garden was a classical arcadia as well as a biblical Eden, and indeed a garden that was won through much labour. White also demonstrated his admiration for their simple virtue by installing a cynic's tub.

It is right to mention that the hermitage (or rather, there were two, one a replacement) was not built on White's own land as the Hanger was common land owned by Magdalen College, but White was on good terms with them. White seemed to treat the whole parish as his estate. In the long-term absence of a vicar, and with an Oxford college as the Lord of the Manor, White was the leading gentleman of the village. On the hanger, in addition to the hermitages, he had both a zigzag and, later, a

Selborne from the Hanger.

gentler path called the bostal built. The former was, and remains, obvious. He was not nearly wealthy enough to have built his own follies, but he may have conceived of the parish as containing emblematic monuments as at gardens like Stowe (a garden he visited). So the Antiquities part of Selborne, with its discussion first of the functioning parish church (representing the freedom of Anglicanism), and the ruined priory (representing the folly of Catholicism) is White's equivalent to the temples and ruins constructed by wealthier gardeners. Ruins and hermitages were also thought to evoke the sublime, the sense of awe before God.

White 'called in the country' by building a ha-ha in 1759, a visual device for extending the gentleman's purview over the whole estate. White also built a drawing room with a very large window to look out over the ha-ha to the Hanger. Horace Walpole in 1771 claimed that with the ha-ha William Kent (an inaccurate attribution) "leaped the fence, and saw that all nature was a garden". This linkage of nature and gardening was part of the moral aim of 18th century gardening. The naturalised garden guides the perambulator and viewer to the truth of nature and thence to its Creator. It was the construction of an ideal world, a 'rural retreat', a place of hermitage where a man could escape the evils of the city and learn the meaning of life.

The contrast between country and city had been made before by Virgil – the Cowley of the Roman Empire, you may remember. To the question, "Who now reads Virgil?", the answer in the 18th century was everybody – well, everybody that mattered. The whole century could be thought of as a translation of the Augustan poet and the English countryside was modelled on his Georgics. White's interest in cucumbers echoes that of Virgil; his interest in science is in obedience to Virgil's beatitude: "Happy the Man, who, studying Nature's Laws,/ Thro' known Effects can trace the secret Cause." (II:490, Dryden's translation) White's poetry is part of the movement of the English georgics and he quotes from the other poets such as James Thomson's "The Seasons" and John Philip's "Cyder" as well as multiple quotations from Virgil himself.

Virgil combines a practical realism with artistic elegance. His love for his native countryside and his patriotic trust in his country are felt also by White, among many others of his time. There were, however, differences between White and Virgil that his admiration for the poet did not obscure. Virgil has a stoic belief in self-sufficiency and the power of humans to control life. His deities are just personification of a fairly supine Nature that is brought under the discipline of the Roman farmer. For the English poets, God and Nature are both powers to be reckoned with; the issue is the relationship between the two. Take Pope,

> All are but parts of one stupendous whole,
> Whose body Nature is, and God the soul…
> He fills, he bounds, connects, and equals all. (Essay:I.267)

James Thomson's views changed as he gradually enlarged "The Seasons" over the years, beginning with a more Christian understanding, but eventually adopting a more deist position. Presumably White would have had a copy of the later versions of the poem. For all that, Thomson's views are not that different from Pope's, e.g.

> Inspiring God! Who, boundless spirit all,
> And unremitting energy, pervades,
> Adjust, sustains, and agitates the whole. (Spring.853)

All this is very similar to White in his poem "On the Early and Late Blowing of the Vernal and Autumnal Crocus",

> The God of Seasons! Whose pervading power
> Controls the sun, or sheds the fleecy shower;
> He bids each flower his quickening word obey,
> Or to each lingering bloom enjoins delay.

The start of this must surely be an allusion to many passages in Thomson like the quotation above.

The poets were very interested in science. Thomson, in particular, gives a great deal of scientific information based on the work of Newton. Yet this science has a spiritual purpose. Thomson in his preface to Winter (2nd ed) begins, there is "no Subject more elevating, more amusing; more ready to awake the poetical Enthusiasm, the philosophical Reflection, and the moral Sentiment, than the Works of Nature".

By small degrees the Love of Nature works,
And Warms the Bosom; till at last arriv'd
To Rapture, and enthusiastic Heat,
We feel the present Deity, and taste
The Joy of God, to see a happy World. (Spring, 1st ed:860)

Does White not describe this emotion more accurately?

These, NATURE'S works, the curious mind employ,
Inspire a soothing melancholy joy:
As fancy warms, a pleasing kind of pain
Steals o'er the cheek, and thrill the creeping vein!

(used both in the Summer Evening Walk and in the Invitation to Selborne).

White brought his love and training in poetry to his book. As a contemporary reviewer remarked, "The book is not a compilation from former publications, but the result of many years' attentive observations to nature itself, which are told not only with the precision of a philosopher, but with that happy selection of circumstances, which mark the poet". (LII:194)

It is about time we turned to the 'attentive observations' of White and examined his science. This section owes much to the work of Trowbridge (1979) and Dadswell (2003).

As well as being a work of devotion in the 17th and 18th centuries, science also held out the prospect of utility, as was emphasised by Francis Bacon the century before. And the "Natural History of Selborne" is "a work that professes never to lose sight of utility". (DB:61) White judges that "he would be the best commonwealth's man that could occasion the growth of 'two blades of grass where one alone was seen before'" (DB:40) – using the phrase of the agricultural improvers. Yet despite this utilitarian aim, White offers little practical advice apart from a note in the index on how to kill slugs. I cannot resist as an aside to give you White's comments on his index: "I am still employed in making an Index – an occupation full as entertaining as that of darning of stockings, tho' by no means so advantageous to society." (BII:168) His brother Thomas criticised him for the lack of utility and for not drawing more general conclusions in his review of the book for the "Gentleman's Magazine" for 1789. However, this misunderstood White's assessment of the state of science, that it was largely still in the first phase of the Baconian programme, i.e. the collation of detailed facts.

There is no need to suppose that White read Bacon himself; Bacon's ideas permeated so many of the books White was turning to for his scientific education, especially in the approach of Ray and Hales. White's reading was extensive. He is constantly referring to the latest works in natural history, both British and Continental, obviously being at ease at reading Latin and, probably, French. He adopts Linnaeus' system, but thinks John Ray the greater scientist.

The scientific enterprise involved a number of steps. Its foundation was the accumulation of first-hand observations – no reliance on authorities, however ancient or fashionable. Where possible these observations should include measurements or counts, and it has been said that White had a mania for measuring. To be of use these observations had to be freshly recorded as they were made, not relying on memory, as

White criticises some for doing. Fortunately we have White's records in the Naturalist's Journal, which include his daily log of meteorological measurements and other observations. At times, White tells us, he even carried a field notebook around with him so that he could jot down immediately he heard a migrant bird for the first time. The Journal enables us to see White at the second step: 'examine them comparatively' for positive and negative instances (again, a Baconian method). Most obviously this involved comparing one year with another, and so White goes back in his Journal to record a comparative event next to an original observation. Sometimes it involves designed observations, what could be called an experiment, and White was much better than many of his contemporaries at including controls, even in his gardening phase. A good example is when he experiments with his hot beds and frames to discover if a basal vent improves the atmosphere in the frames. He was particularly interested in what could be learned from comparing 'congeners', i.e. two or more species that were closely related but led very different lives: the swallow-kind were a case in point. The grandest comparison was with other parts of the country, the world, even. "Monographers, come from whence they may, have, I think, fair presence to challenge some regard and approbation from the lovers of natural history; for, as no man can alone investigate all the works of nature, these partial writers may, each in their department, be more accurate in their discoveries, and freer from errors, than more general writers; and so by degrees may pave the way to an universal correct natural history." (TP:31) White may have concentrated on Selborne, but he was familiar with other parts of England and eager to place his work in the context of the discoveries being made by naturalist explorers such as Joseph Banks.

Bacon also advocated tables to sort data, and this tradition is evidenced in the Journal's tabular framework devised by Daines Barrington. Barrington's gift of the "Naturalist's Journal" in 1767 came at an opportune time as White had just been reading Stillingfleet's "Miscellaneous Tracts" which seems to have persuaded him to take part in the great 18th century project of finding a natural calendar by which crops could be sown and harvested more reliably. The idea was that if people kept a note of the weather and when plants came into leaf or flowered or birds arrived, a better prediction of future conditions for crop growth would be achieved than by the celestial calendar alone.

Mulso despaired of the Antiquities portion of the book, calling it in prospect "A Farrago of Antiquities routed out of the Rusts and Crusts & Fusts of Time". (M:189) But David Baker (1993) restores faith in White's good sense in his antiquarian endeavours. Baker shows how White gathered the evidence of original documents and topographical information, while not being credulous over these. He then uses this material to build a narrative that places the material in a context, not leaving it merely as anecdote. However, White avoids the temptation of his age to fit the evidence into pre-conceived historical theories. Much as in the natural history, White grasps that his age is not yet ready to come to a grand theory. Of course, he is influenced by his loyalty to the Church of England to a degree of partiality, but in his judgements of the mediaeval church he is humane, and balances them with criticisms of his own age, e.g. "If the bishop was so offended at these sporting canons, what would he have said to our modern fox-hunting divines?" (A:14) From his Advertisement, it is clear that

The manuscript of *The Natural History of Selborne*.

White was trying to expand the scope of the tradition of local history writing by supplementing the customary antiquities with the natural history – both humans and the non-humans are proper subjects of a parochial history.

So what were White's contributions to the 'universal correct natural history'? At a straightforward level, they were not numerous or significant. He identified the harvest mouse (though not the first to publish the description), and a bat we now know as the noctule; he separated the leaf-warblers into three species, mainly on the basis of their songs, and also the lesser white-throat; he established that the ring-ousel is migratory and that the genetic ancestor of the domestic pigeon was the blue rock-dove. Dadswell (2003) attempts to establish White's scientific achievement as the first ethologist, giving accounts of animal behaviour far in advance of his time, so much so that they were not taken up again until the 20th century. "Foreign faunists are content if they can get a specimen, & describe it exactly, & can clap a few synonyms underneath: but you will be able to shew them in many instances that the life & manners of animals are the best part of Nat: history." (JW:6/4/1771)

Others see White as the first ecologist, particularly in his letter on worms, a work that Darwin followed up while dismissing White's contribution early in his own monograph. John Lawton (1993) identifies White's question over how bird population numbers remain the same year on year despite their reproductive output each summer as prescient of Malthus and Darwin (DB:39). White's achievement was to spot something that was not happening, i.e. the relentless increase in bird populations as they bred each year. Interestingly, Lawton reported that there were still eight pairs of swifts in the church tower, 1993, as in White's time.

Yet, if White's achievement had been limited to his science he would, I think, be relegated to a footnote in the history of the subject. Even if his discoveries, like those of Ray, had been more substantial, even elevating him to the status of a genius deserving of a chapter, we would still not be reading his book today. I hazard a guess that several in the audience today have read "Selborne" for pleasure, while only a few will have read Ray, and then more in the line of work. Paul Foster (1993) makes reference to Thomas De Quincey writing in 1848 to explain this phenomenon. All books that are part of the 'Literature of Knowledge' are provisional works, which are instantly superseded as knowledge increases; whereas the feeblest works in what De Quicey called the 'Literature of Power… survive as finished and unalterable among men.' The science in "Selborne" is part of the literature of Knowledge, long since outdated. Within the literature of Power, "Selborne" is no feeble work, because, according to White's own intention, it gives us power to attend more readily to the works of creation. It helps us see with the vision White had attained.

John Burroughs at the start of the 20th century probably speaks for most first-time readers of "Selborne". "There is indeed something a little disappointing in White's book when one takes it up for the first time, with his mind full of its great fame. It is not seasoned quite up to the modern taste." So why do people still commend it? Is it just a desire for rural escapist literature? A truncated quotation from Virginia Woolf (1950) points to a more profound answer:

> It is one of those ambiguous books that seems to tell a plain story, the Natural History of Selborne, and yet by some apparently unconscious device of the author's has a door left open, through which we hear distant sounds....

It is impossible to give a flavour of White's greatness by reading snippets. It is an effect of the whole, built up by re-reading. But Woolf is right to qualify White's skill, his unconscious device, as 'apparently'.

White put effort into his work and might be a little aggrieved to think that his success depends on an unconscious device. He wisely chose the format of a series of letters. Never mind if his first promptings to chose this way came from the "Daemon of Procrastination" and laziness, it proved an ideal genre for his task. As Gifford (1990) has explained, the epistolary form is peculiarly appropriate for a pioneer natural historian; they are open ended, imply dialogue, accept the limitation of knowledge and could encompass all detail when there were few criteria for distinguishing trivial from significant observations. It was a way of organising, or rather giving permission not to organise, the reality of that 'wild disordered tangle of the hedge' of rural life (Keith 1975). A monograph might have been the obvious choice, but the letter was a familiar form in science, such as Derham's collection of Ray's "Philosophical Letters". The letter form also allowed White to include all manner of material, including a degree of theological reflection as Hasselquist had done in his letters from Levant. It gave permission to be intimate, as to a friend.

White manages a friendly empathy with his fellow creatures, whether human or animal, that is usually without sentimentality. One example comes from a letter supposedly written by his tortoise, Timothy (or Timothea, as her post-mortem revealed), to Mulso's daughter. In it he has the tortoise complain of the indignities he is put through for the sake of science, such as being regularly weighed, or "That contempt shown for my understanding which these Lords of the Creation are very apt to discover, thinking that nobody knows anything but themselves. I heard my master say that he expected that I should some day tumble down the ha-ha; whereas I would have him to know that I can discern a precipice from plain ground as well as himself." (LII:125ff)

White's studentship of poetry, he believed, helped his prose style. It had simplicity, directness and precision, perhaps in his "Naturalist's Journal" even more than his published book. Take as examples the following:

Larks frolic much in the air
Crocus's in high glory
Green woodpecker laughs at all the world
Field-crickets crink; their note is very summer-like, & chearful
Clouds put up their heads
The air is soft. Violets blow. Snow lies under hedges. Men plow.

But if, as Flaubert taught, 'style is a way of seeing', White's vision is involved as well as his language. How much he consciously put the two together, how much any great person can generate their genius by effort and planning, is hard to say. There was a discipline about White's looking, e.g. his notebook to record birdsong (DB:3), just as there was about his use of language, but may there also have been a gift that was grasped? "You are more able to see with your own Eyes than any man I know," wrote Mulso to White. Mulso also wrote "at… Landscape Painting I think You a great & masterly Hand," referring to White's skill with word pictures (M:23). It is a rare gift, but through his book White helps us to see through his eyes and hoped too that he might have induced us "to pay more ready attention to the wonders of the Creation, too frequently overlooked as common occurrences". (NHS:Advertisement) White uses the word 'wonder' or 'wonderful' sixty-four times in the "Natural History". Paul van Burren has written, "The decisive point to be made is that some men are STRUCK by the ordinary, whereas most find it merely ordinary". So White can write, "The methods of Providence are not subjected to any mode or rule, but astonish us in new lights, and in various and changeable appearances". (DB:4)

Gilbert White's grave

Evelyn Underhill, the Anglican mystic, once claimed, "The condition of all valid seeing and hearing… lies in a self-forgetting attentiveness, a profound concentration, a self-merging which operates a real communion between the seer and the seen – in a word, in contemplation". (1911) Does this not describe White, including his commitment to hearing as much as to seeing?

How did this come about? In one way it was a lifetime's work, but

Paul Foster (1988), the pre-eminent White scholar of our time, believes there was also something of a Damascus Road experience for White when he was 21 years old. The young Gilbert was an inveterate huntsman. It is interesting to speculate whether his fondness for ‘field diversions’, as he called shooting, was also an education in vision; consider the attentiveness of a hunting cat. The mature White abhorred hunting for pleasure, “seeing harmless creatures in the agonies of death”. (BII:295) And as an older man, White frequently likened himself to an animal on a different hunt, the Matinian bee of Horace, labouring to harvest the sweet nectar of the flowers of nature.

> ego Apis Matinae
> More modoque
> Grata carpentis… per laborem
> Plurimum… [Frontispiece of 1789 edition]

This is how Gilbert White recounts his early experience to Daines Barrington: (DB:23)

> On September the 21st, 1741, being then on a visit, and intent on field-diversions, I rose before daybreak: when I came into the enclosures, I found the stubbles and clover-grounds matted all over with a thick coat of cobweb, in the meshes of which a copious and heavy dew hung so plentifully that the whole face of the country seemed, as it were, covered with two or three setting-nets drawn one over another. When the dogs attempted to hunt, their eyes were so blinded and hoodwinked that they could not proceed, but were obliged to lie down and scrape the incumbrances from their faces with their fore-feet, so that, finding my sport interrupted, I returned home musing in my mind on the oddness of the occurrence....
>
> About nine an appearance very unusual began to demand our attention, a shower of cobwebs falling from very elevated regions, and continuing, without any interruption, till the close of the day. These webs were not single filmy threads, floating in the air in all directions, but perfect flakes or rags; some near an inch broad, and five or six long, which fell with a degree of velocity which showed they were considerably heavier than the atmosphere.

Just note the way White speaks of his attention being ‘demanded’.

It is the quality of this vision that shines through the book and marks it as great. John Constable’s judgement is expressed in a letter of 1821, “The mind and feeling which produced the ‘Selborne’ is such an one as I have always envied… it only shows what a real love for nature will do - Surely the serene and blameless life of Mr White must have fitted him for such a clear & intimate view of nature”.

Who now reads Ray, Derham and Paley and all the other apologists? White’s enduring value is that his theology is only a veneer and his science is not reduced to the narrow field of Stephen Hales’s statical enquiries.

As John Mulso wrote to our author, “The novelty and elegance, the tenderness, & the piety of the natural part will be the fort of the performance”. (M:182) As many others have said in different ways, it is a saintly book.

References

References to White's own work are coded as follows:

TP, DB, A followed by a number is the numbered letter to Pennant, Barrington or on Antiquities as in the published book.

BII is the page in the second volume of Thomas Bell's edition of the Natural History and Antiquities, published in London in 1877.

J followed by the date of entry in the Naturalist's Journal (A convenient recent edition in three volumes is edited by Francesca Greenoak, 1986-89, London, Century Hutchinson Ltd).

JW followed by the date of the letter to John White (Published by P. Foster, in *Notes and Queries* June, September and December issues of 1985).

LI or LII is the page in the first or second volume of "The Life and Letters of Gilbert White" edited by Rashleigh Holt-White, published in London by John Murray in 1901.

M followed by the number of the letter from John Mulso to White (Published by R Holt-White in London in probably1907).

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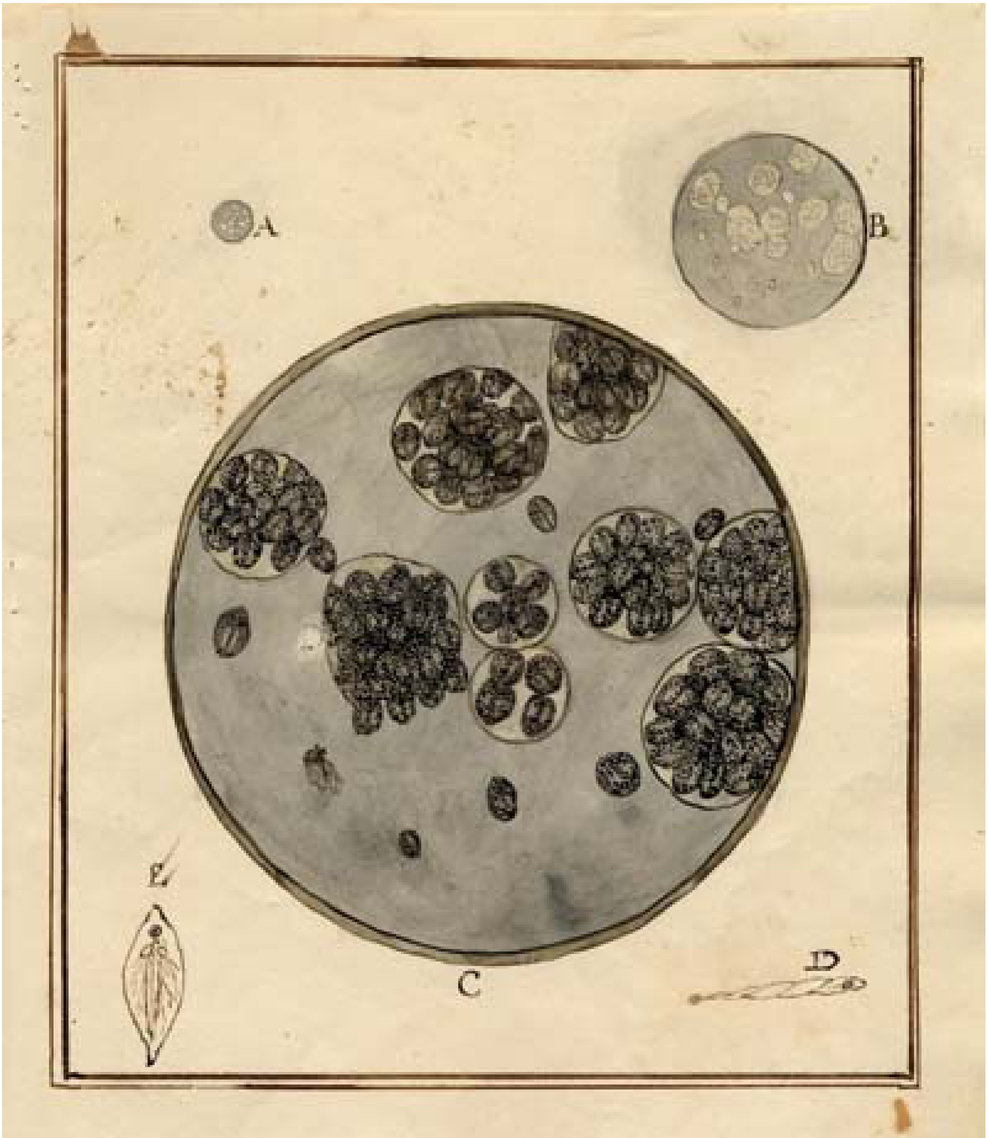
The Linnean Society and Parasitology 1788-1900

The 18th century was the cradle of modern parasitology. The Linnean Society's foundation coincided with a burgeoning of knowledge of parasites, their ubiquity in nature, and the beginnings of an understanding of their life cycles. Linnaeus himself had recognised and named some of the more obvious ones, e.g. mammalian tapeworms such as *Taenia solium*[1]. In fact, Linnaeus wrote a review of *Taenia*, which is in the Society's Library[2]. In 1792 Anthony Carlisle (1768-1840; later Sir Anthony Carlisle FRS, an eminent surgeon and scientist, also lecturer in anatomy at the Royal Academy) reported his findings on *T. solium* to a meeting of the Linnean Society; they were subsequently published in the second volume of the Society's Transactions in 1794[3]. A Russian, Mr Tatischeff, was troubled by *Taenia* and he "applied to a noted woman in Switzerland, who gave him medicine with much parade and secrecy". Later he voided a complete specimen of *T. solium*, which he presented to a Mr Watson for his collection. This was one of the specimens that Carlisle was able to examine and from which he deduced that there were more than one species of *Taenia*. *T. solium* are passed to carnivores in uncooked pork; various species of *Taenia* are associated with other intermediate hosts.

Carlisle found no brain in the tapeworm, but its motility indicated a nervous system. He confirmed Linnaeus' observations that *T. solium* was likely to produce eggs, which Linnaeus claimed to have observed. Whilst Carlisle was unable to find any eggs, he noted that each segment (now *proglottid*) contained oscula which might serve as oviducts, since they were associated with genitalia, both male and female. The average number of proglottids for a worm two metres long was 400. It has been estimated that each *T. solium* can produce 10 billion eggs in its lifetime[4]. Carlisle wondered at this fecundity and made the following comment on it in his 1794 paper: "*The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistence, must be very small: hence the necessity for being so prolific. If they had the same powers of being prolific which they have now and their ova were afterwards readily hatched the multiplication of these animals would be immense, and become a nuisance to the other parts of the creation.*" For reference, the first edition of Malthus' *An Essay on Population* appeared anonymously in 1798.

In general, *T. solium* infections are without adverse symptoms, but occasionally they can cause discomfort. Carlisle relates the tale of a girl, 14, who came to England from Switzerland to undergo purging for a *Taenia* infection, a process lasting 8 years! During this time she voided a dozen pieces of worm, then called *T. lata**, each two yards long, but all without the head of the parasite. Finally, she returned to Switzerland, took a secret remedy, voided a complete worm and was cured. Clearly in the 18th century, the Swiss had *Taenia* chemotherapy taped, but the nature of the agent(s) was not disclosed. It is likely to have incorporated the rhizome of a fern, e.g. the male fern, *Dryopteris filix-mas*, although this is not without toxic side effects. Other

* *T.solium* according to TS Cobbold. 1879. *Parasites: A Treatise on the Entozoa of Man & Animals*. London: J&A Churchill. p.96



Fasciola hepatica Cobbold

antihelminthics include *Allium* and *Artemesia* species. Electric shocks to the abdomen were also tried, indeed, Carlisle himself wrote a treatise on *Galvanic Electricity*. The effectiveness of such taenifuges might have been supposed to be accessible to experiment even in the 18th century, yet Linnaeus was driven to remark in connection with such treatments that they were little more than old wives' tales (*ei a vetula offertur*)[2].

In April 1810, in a most unusual event for the Linnean Society at that time, a lady of Ipswich gave a paper. Mrs I. Cobbold's paper, in beautiful copperplate, which she neither read herself, nor heard delivered, has survived in the Society's archives and is entitled *Remarks concerning the* Fasciola hepatica. Mrs Cobbold had been asked to examine the carcass of a Suffolk sheep. She found the liver riddled with hydatid cysts, a disease caused by the *Echinococcus* parasite, but also numbers of the liver fluke, *Fasciola hepatica.* These were known by butchers as 'plaice' from their microscopic resemblance to the fish. The fluke causes serious, and often fatal, disease in sheep – 'sheep rot' or 'liver rot'. From her observations on sheep infected by *Fasciola hepatica*, Mrs Cobbold surmised that they became infected by grazing on wet pasture. She was right; we now know that the cercariae (larvae) of the fluke, released from their intermediate host, the snail, *Lymnaea truncula*ta, encyst on water plants, whence they are eaten by the sheep; if the plant is watercress, humans may be infected[5].

Although he did not publish in the Society's journals, nor, indeed, become a Fellow until 1872, by which time he was a distinguished scientist, physician and surgeon, Sir James Paget (1814-1899) is generally credited with the discovery of the nematode trichina, *Trichinella spiralis.* Aged 21 and a second year student at Bart's, he noted small specks in the muscle of a cadaver. In 1835, Bart's could not muster a microscope for a more detailed examination of the specks. Paget obtained a letter of introduction to the head of the Natural History Department of the British Museum, a Mr Children, but he could not oblige either. He took the young student to see the great Robert Brown. Brown volunteered that he had no experience of parasitic worms ("thank God!"), but "he let me look at my specimens with his little single microscope – the same, I think, that he had done his own grand work with." and Paget was able to show that they were an entozoan – an encysted worm. That same microscope is now in the display case on the ground floor of the Society's Rooms. Paget published his observations in a paper to the Abernethian Society, a medical and philosophical society at Bart's; specimens were also sent to Richard Owen, who named the nematode in a paper to the Zoological Society later[6].

Trichinella spiralis is also passed to man from eating uncooked pork. The larvae in the gut become adults, copulate and produce many larvae, which find their way to the muscles. We now know that within their hosts' muscles, trichina larvae indulge in angiogenesis – the formation of blood vessels – forming a placental structure for their own survival[4]. Such, too, is the ability of solid tumours. Studying the genes by which *Trichinella* subverts its hosts' physiology might offer useful insights into a vexed problem in cancer research.

Thomas Spencer Cobbold (1828-1886) was also from Ipswich; it is hard to believe that he was unrelated to the Mrs Cobbold mentioned above. The Cobbolds were an affluent family in Suffolk. After qualifying in medicine at Edinburgh, he opted for a scientific career; he became Professor of Botany and Helminthology at the Royal Veterinary College in 1856. This was hardly a prestigious post, but he had sufficient private means to do what he wished. He was by far the most catholic parasitological contributor to the Society, much dedicated to recording new species in the Society's Transactions from 1857 onwards, and addressing many Society meetings. He examined 70 host species – amphibia, birds, fish and mammals – for the presence of entozoa and found 45 had worms of some kind.

Dissection of various carnivorous animals had shown that, in addition to tapeworms, the gut of these animals contained encysted cercariae, *cysticercoids*. These were also present in the flesh of prey species such as rabbits, cattle or pigs. They had been seen as other species of parasite and the genus *Cysticercus* had been created for them. Cobbold showed that feeding nine cysticercoids (*Cysticercus pisiformis*) from a rabbit to a dog and sacrificing the dog after a fortnight produced six tapeworms; he concluded that *Cysticercus pisiformis* was a larval form of *Taenia* which underwent metamorphosis in the gut of the definitive (final) host, a carnivorous mammal[7,8]. This supposition did not go unchallenged at the time and the genus remained in existence for some years after Cobbold's discovery.

The stranded Napoleonic army in Egypt at the end of the 18th century was known as the "army of menstruating men" from the bloody urine which most excreted. In a German journal in 1853, Theodor Bilharz (1825-1862) traced the condition to a worm, which he named *Distoma haematobium*. Cobbold, four years later in a letter to *The Lancet,* noted that Bilharz's worm was not a *Distoma* and suggested the name *Bilharzia* in honour of its discoverer. Subsequently the name *Schistosoma* was recognised as having priority. Cobbold also indicated for the first time that *S. haematobium* might be responsible for fatal illness after finding it in a dying ape in the London Zoo. Like many other parasitic infections, schistosomes are a major cause of human morbidity in tropical countries[6].

Cobbold was also involved in the story of the filariases (below). He died in 1886 at the early age of 58.

Contemporary with T.S. Cobbold was Henry Charlton Bastian (1837-1915). His first paper – *Flora of Falmouth and Surrounding Parishes*[9] – was published in 1856 when he was just 19 years old. He published his second paper in the Linnean Society Transactions of 1863, entitled *On the Structure and Nature of* Dracunculus *or Guinea Worm*[10]. Bastian was a student and professor at London's University College, where, aged 30, he became Professor of Pathological Anatomy. Identified, like Cobbold, as a rising star, and sympathetic to Darwin's theory, he became a member of the X Club, formed to support Darwin's evolutionary ideas. The Club was peopled by such luminaries as John Tyndall, Herbert Spencer and Thomas Henry Huxley, who became Bastian's nemesis. In a letter to Hooker in 1862, Darwin had said that "It is mere rubbish thinking at present about the origin of life; one might as well think about the origin of matter." Bastian had the temerity not only to think about the origin of life, but also suggested that abiogenesis was going on all the time. In 1872, Darwin wrote to Hooker "... all the conditions for the first production of a living organism could be met… in some warm little pond with all sorts of ammonia, and phosphoric salts, light, heat, electricity, etc. present". Darwin went on to write (and this is often ignored, amongst others by ourselves in these pages[11]) "… thus a protein compound was chemically formed, ready to undergo itself such complex changes; at the present day such matter would be instantly devoured or absorbed, which would not have been the case before living creatures had formed". Bastian fell foul of the tenets of the master on two counts and was denounced by Huxley at the BAAS meeting in 1871. Bastian also disputed with Louis Pasteur, Tyndall and Robert Koch that life could be completely extinguished by boiling in water[12].

Our views on Bastian in these pages, when writing about Herbert Spencer's will, that "he was an early author on the origin of life, but not really much beyond spontaneous generation", were clearly economical with the truth[13]. Bastian generated much controversy and lost credibility with his trenchant views. The discovery of heat-resistant spores went some way to salvaging his scientific reputation. Spencer (d.1903) alone did not dismiss his ideas out of hand and, while he was not overzealous in his support, he did make Bastian a trustee of his estate.

Bastian himself realised that he was doing himself no favours with the scientific community with his controversial views. From the mid-1870s, he devoted himself to clinical research in neurology. In this, the medical profession greatly appreciated him; he published the first papers on what came to be called Wernicke's aphasia, a speech defect brought on by stroke, on the functioning of the spinal cord and other novelties of the spinal column. He retired from his chair in 1897 and again took up the last he had put down a quarter of a century before. This time his subject was *heterogenesis*, the creation of new life from the remnants of other organisms. He was embittered by the refusal of the Royal Society to publish any of this work (he had been made an FRS aged 31 and published with the Royal Society in the 1870s) so, from 1901 to 1904, he published a massive tome *Studies in Heterogenesis*[14], a copy of which is in the Society's Library. In support of his view that heterogenesis was necessary to account for the existing biosphere, he cited the recent rediscovery of Mendel's work, ideas on mutation, not to mention Lord Kelvin's erroneous calculation, when President of the Royal Society, to the effect that the Earth was a mere few tens of millions of years old.

It is tempting to suppose that Bastian's early experience with *Dracunculus* sowed the seeds of his belief in continuous abiogenesis, or at least heterogenesis. He was following work on *Dracunculus* by George Busk, the Society's factotum who had delivered the Darwin-Wallace paper in 1858. The specimens Bastian examined came from Bombay; Busk's came from Equatorial Guinea. The parasite is common in tropical Africa and Asia. The life cycle of this massive nematode is complex[4]. Males and females are ingested from water containing the intermediate host, a minute crustacean. Within the definitive host (man, dog or horse) the male disappears after copulation, leaving the female as the only pathological manifestation of the disease. Over a year or so, she grows without symptoms in the body cavity or connective tissue, gradually migrating to the skin of the lower limbs, where the head of the worm, now 90 cm long, breaks the skin. For several weeks the female disgorges threadlike larvae into any water with which the skin comes into contact and the life cycle via the crustacean starts again. In places where *Dracunculus* is found, the adult worm is slowly removed from its human host by gently winding it round a twig. Any damage to the adult, or premature release of the larvae within the host, can be fatal. Little of this was known to Bastian or Busk, who might have seen the threadlike larvae they observed as of unorthodox origin within the female worm.

The connection of (Sir) Patrick Manson (1844-1922) with the Society was a single publication in 1884[15]. He was not an FLS and the paper was introduced by his friend, T.S. Cobbold. Manson had qualified in Aberdeen and after a brief sojourn in Durham, he worked for the Chinese customs service (then staffed by Britons) for 23 years, initially to earn some money. His work formed a part of the considerable worldwide effort to understand the disease elephantiasis and certain similar disorders. The blood of a patient with elephantiasis contains literally a few million embryonic (microfilarial) nematode worms. They had first been observed in 1866 by O. Wucherer in Brazil, then in 1870 by T.R. Lewis in Calcutta. The embryonic nature of these microfilariae had been noted by Cobbold from specimens sent to him by Joseph Bancroft of Brisbane, whom he asked to search for the adults. In this Bancroft was quickly successful; the adults were blocking parts of the lymphatic system, leading to the clinical symptoms and producing embryos at the same time. Bancroft (1836-1894) was an Australian immigrant, who was born in Manchester, qualified at St Andrew's and practised in Nottingham before coming to Brisbane, where, in addition to being a highly respected GP, he became one of Queensland's leading scientists, studying leprosy and making valuable ethnobotanical discoveries in the state, as well as researching filariasis. Subsequently this species of nematode was named *Wuchereria bancrofti*, a tribute to its discoverers.

Manson saw that, given the numbers of microfilariae, they couldn't all become adults without killing off their host. So they didn't mature in the host. A secondary host must be sought. Manson speculated that this might be a mosquito. Manson fed some mosquitoes on the blood of a servant suffering from filariasis. Subsequent examination of the mosquitos led Manson to write: "I shall not easily forget the first mosquito I dissected. I tore off its abdomen and succeeded in expressing the blood the stomach contained. Placing this under the microscope, I was gratified to find that, so far from killing the *filaria,* the digestive juices of the mosquito seemed to have stimulated it to fresh activity." Indeed, the microfilaria were metamorphosing to adult worms, ready to be injected back into the host, although Manson did not suspect this latter point – he thought they were ingested with water in which mosquitos had drowned. Nor could he have known that his finding an insect vector for a parasitic disease provided the inspiration for Sir Ronald Ross's successful search for the malarial mosquito.

This was such revolutionary stuff that Cobbold communicated Manson's findings (initially published in an obscure Chinese medical journal) to a meeting of the Linnean Society in March 1878. Manson also noted the disappearance of microfilariae from the circulating blood of the patients at certain times of the day (they go into the lungs), noting: "It is marvellous how Nature has adapted the habits of the filariae to those of the mosquito. The embryos are in the blood just at the time the mosquito selects for feeding." At the 1878 meeting of the Society, this latter finding was received with incredulity. One wag asked whether the microfilariae had watches to tell the time!

Towards the end of the 19^{th} century, much parasitology was being reported in medical journals. This was true of Manson's output, as was Paget's discovery of trichini, above. As the science of parasitology developed, and its importance to human and animal health was appreciated, so did the numbers of those working in the field. This inevitably led to the setting up of journals and societies devoted to the discipline. *Archives de Parasitologie* first appeared in France in 1898, in Britain *Parasitology* followed in 1908 (and is now published by Cambridge University Press), whilst in 1914 in the USA the *Journal of Parasitology* carried on the expansion of specialist journals devoted to the new discipline.

As part of the Linnaean Tercentenary, we share a meeting with the Royal Society of Tropical Medicine and Hygiene, during its centenary – *The Natural History of*

Host-pathogen Evolution & Co-evolution – on 27/28 September, followed by Lord May's presentation *Parasites, People and Poverty* on 18 October.

JOHN MARSDEN

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Obituary

Henry Arthur Osmaston
Forester and Geographer (1920-2006)

Fellow of the Linnean Society 1955 - 2006

Henry Osmaston, who led such a full and productive life, first as a forester in the Uganda Forest Department, then from Bristol University as a geographer who studied climatology and floras in the high mountains of Africa and in the Himalayas, died suddenly of a heart attack near his Lake District home on 27 June 2006 aged 85. His death came as a great blow to all of us who had so much enjoyed the stimulating company of this most energetic and good-humoured scientist. Life-long friends, we first met in Uganda in 1949 on early explorations to the Rwenzori when we both lived in Jinja, where the River Nile leaves Lake Victoria. Thankfully, just before he died Henry had managed to complete his last big project, the definitive '*Guide to Rwenzori Mountains of the Moon*' (published by The Rwenzori Trust 2006, ISBN 0-9518039-6-4). It was characteristic of Henry to push himself (and sometimes his companions) to the limits of human endurance in his pursuit of knowledge. But he enjoyed life to the full when in the field and sharing his knowledge.

This meticulously researched guide to the long-fabled Rwenzori equatorial mountain range, a horst in the western Rift Valley on the Uganda- Congo boundary, reflects Henry's very wide interests in all aspects of natural history, with chapters on geology and climate, flora and fauna, comments on the local place names and history of the local peoples, also of organizations concerned in the development of the Rwenzori Mountains National Park, and tales told by the porters.

The war had interrupted Henry's initial studies at Worcester College, Oxford, but wartime service in REMA (Royal Electrical & Mechanical Engineers) in the Middle East gave him other skills of use when travelling in remote places. After Henry left Uganda in 1963 he completed an Oxford University D.Phil. thesis on '*The Past and Present Climate and Vegetation of Ruwenzori and its Neighbourhood*' which included analyses of pollen samples collected from Rwenzori's many bogs. In1952 he returned to Uganda as a member of the Anglo-Belgian Scientific Expedition which explored the geology and flora of the Rwenzori. These studies led on to a lectureship in the Geography Department of Bristol University, near which he also ran a farm.

At Bristol Henry was invited by John Crook to join the University's Indian/ British study of farming systems in relation to the prevailing Buddhist religious practices in Ladakh, 'Little Tibet', in the Himalayas. From 1980 this long-term study with several colleagues culminated in Crook & Osmaston's 1994 book on *Himalayan Buddhist Villages: environment, resources, society and religious life in Zangskar, Ladahk* (1,029 pages long). Henry had been born at the Himalayan hill station of Dehra Dun where his father, a distinguished member of the IFA (Indian Forest Service), had published a book on the birds of the area and collected numerous botanical specimens, so Henry was delighted at this chance to return to the Himalayas. He took students with him on strenuous mountain climbs to collect geomorphological and botanical data.

After his retirement from Bristol University to his Lake District home, Henry's life was as full as ever with annual field excursions and conferences in Africa: to Uganda for the revived Forest Department and to assist the Rwenzori Mountain Park to become listed as a World Heritage Site, also to Ladakh for many meetings and elsewhere. In his main interest in the effects of changing climates and glaciation on tropical mountain floras, he collaborated with Georg Kaser from the University of Innsbruck who had worked in the Andes (Osmaston & Kaser 2001, Rwenzori Mountains National Park & Parc National des Virungas, DRC. *Glaciers and Glaciations*, with maps; Kaser & Osmaston 2001. *Tropical Glaciers*. Cambridge University Press). Their maps, which show how fast many tropical glaciers are now shrinking, provide valuable evidence of climate change. Henry's other interests included participation in the Freshwater Biological Association's survey of the Lake District tarns (published by Haworth *et al* 2003). In 2006 in a letter to the *Linnean,* commenting on Christopher Zeeman's catastrophy theory applied to Darwinian evolution, Henry cited his observations on evolution associated with altitudinal changes in Rwenzori's giant *Lobelia* species as an example of 'punctuated equilibrium with a physical basis.

Henry edited and published over a hundred papers, maps, working plans and contributions to many books. He also took time to publish an annotated version of '*Wild Life and Adventures in Indian Forests'* (and in the Anderman and Nicobar Islands) from the 1868-1961 diaries of his uncle B.B.Osmaston of the IFS (Indian Forest Service, 1888 to 1923), with appendices on plants and birds. This book also included extracts from memoirs of another uncle - Gordan Osmaston, a founder member of the Himalayan Club and formerly a director of the Survey of India, who had employed the young sherpa Tenzing, later to make the historic climb to the summit of Mount Everest with Edmund Hilary.

We have a delightful first-hand picture of life on field trips with Henry in East Africa in '*Uganda before Amin'* (1991) written by his wife Anna, who throughout his life was a stalwart support to Henry, their three daughters and a son. Henry was a rare human spirit with a keen analytical mind, well described as 'kind, humorous, sympathetic with a prodigious appetite for hard work'. Held in great affection by people in many parts of the world, he will be most sadly missed.

RO LOWE MCCONNELL
October 2006

The Linnean Society
Programme

12th July*	Thurs.	ECOLOGY AND BIOGEOGRAPHY OF THE SMALLER INDIAN OCEAN ISLANDS Presenting the results of the Percey Sladen Trust Centenary Expedition. Robert Prys-Jones and Julian Hume
14th Sept.	Fri.	BOTANICAL ART IN THE AGE OF LINNEAUS † Brent Elliott FLS and David Cutler PLS Joint afternoon meeting with the RHS at Vincent Square
15th Sept.	Sat.	LONDON OPEN HOUSE
20th Sept.	Thurs.	PROFILING ENDANGERED SPECIES: HOW MOLECULAR GENETICS CAN HELP US MANAGE OUR VANISHING SPECIES Mike Bruford
27-28th Sept.		THE NATURAL HISTORY OF HOST-PATHOGEN EVOLUTION AND CO-EVOLUTION † David Rollinson FLS and Joanne Webster Two-day meeting at the Linnean Society with the Royal Society of Tropical Medicine and Hygiene
29th Sept.	Sat.	CONVERSAZIONE at Oxford Botanic Garden and Oxford Natural History Museum † Jenny Edmonds FLS
11th Oct.*	Thurs.	LINNEAUS'S MICROSCOPES Brian Ford FLS Book Sale Election of new Fellows
18th Oct.*	Thurs.	PARASITES, PEOPLE AND POVERTY Lord May PPRS FLS
24th Oct.	Wed.	Palaeobotany Specialist Group (day meeting) † Peta Hayes FLS
25th Oct.	Thurs.	Palynology Specialist Group (day meeting) † Carol Furness FLS
31st Oct. – 1st Nov.	Wed. Thurs.	ORCHID EVOLUTIONARY BIOLOGY AND CONSERVATION – FROM LINNAEUS TO THE 21st CENTURY † Mark Chase FRS FLS and Michael Fay FLS Two day conference with one day at Royal Botanic Gardens, Kew

† organiser * Admission of Fellows

Unless stated otherwise, all meetings are held in the Society's Rooms. Evening meetings start at 6 pm with tea available in the library from 5.30. For further details please contact the Society office or consult the website – address inside the front cover.

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