The
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A forum for natural history

THE LINNEAN SOCIETY OF LONDON

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Edited by Brian G Gardiner

Editorial

It has recently been decided that there will be three editions of *The Linnean* this year, rather than the two that were originally planned. This is partly because we have plenty of material but also to take the pressure off those staff who will produce *Pulse* while Leonie is on maternity leave. The next issue is planned to be circulated in the middle of July and will include the Minutes of the Anniversary Meeting. The autumn issue will be a little later than planned and appear at the beginning of October.

The new cover is an attempt to illustrate that 2010 is the International Year of Biodiversity and, as usual, we are most grateful to John Stone of RBG, Kew for his skill in designing it.

This issue contains three articles, in addition to all the usual news items. The first article deals with the causes and functions of spirals, helices and vortices in nature. It notes both the helical nature of *Euglena* and of the glass sponge. It also deals with the shell of the pearly nautilus whose gas-filled chambers are arranged in a logarithmic spiral. On the other hand, ammonites differ from nautiloids in forming an Archimedes' spiral (cf the orb webs of araneid spiders). The article, additionally, discusses the Fibonaci series which is demonstratively shown in the giant sunflower (see Fig 8).

The second article concerns the discovery of the largest butterfly in the world, in Papua New Guinea, by Albert Stewart Meek in 1907. Through correspondence held in the Rothchild Museum at Tring, Meek discusses the rearing of both males and females from larvae. Meek also collected birds of paradise for Rothchild. The correspondence contains a wealth of general data concerning his travels in the southern Pacific.

The final article describes the level of botanical knowledge in 1815 in the British Isles as reported by Christen Smith. Smith was a Norwegian who had previously described the flora of the Canary Islands, which included *Pinus canariensis*. It was somewhat later that he visited the United Kingdom, making several botanical excursions, particularly in the Scottish Highlands and to Ireland. Eventually he was befriended by Joseph Banks who persuaded him to join the Congo expedition, where he collected many plant specimens. Sadly, he contracted a fever and died while in the Congo. Fortunately his collection was saved by David Lockhart who finally turned it over to Robert Brown.

We are also reporting on four Cambridge Exhibitions in an article entitled Darwin's Cambridge Summer. This includes a photograph of a bronze by Anthony Smith of the 22 year old Charles Darwin sitting on the arm of a wooden bench. Other pictures include "endless forms" and the announcement of the Darwin Festival itself.

BRIAN GARDINER
Editor

Society News

As I write, we are preparing for our first joint meeting of 2010. Co-ordinated with the Joint Nature Conservation Committee (JNCC) and entitled "Is biodiversity under pressure?" this meeting is fully-booked and is part of a series of day and evening meetings in 2010, which link to this year as the "International Year of Biodiversity". In January, Tony King FLS from the Scottish Wildlife Trust launched this series with an evening lecture entitled "Restoring British Biodiversity: Native Mammal Reintroductions and the Scottish Beaver Trial". It was good to welcome a full meeting-room of Fellows and guests joined by others in the library watching the lecture on the screen.

As a Society we greatly value the opportunity to collaborate with other organisations, and we ended 2009 with a number of very successful joint meetings. A programme of six evening lectures under the umbrella "What's in a name? – Taxonomy and Biodiversity: Saving our experts from extinction" were jointly hosted with the Ecology and Conservation Studies Society at Birkbeck University during October and November 2009. These were very well attended and helped to raise the profile of issues in, and the importance of, taxonomy today. We were delighted to host a day-meeting with the Galapagos Conservation Trust in November – "The Galapagos Archipelago: a living laboratory" and our inaugural Darwin lecture with the Royal Society of Medicine was given by Professor Steve Jones at the RSM's premises in December 2009.

Our programme of events for 2010 is now complete and we look forward to welcoming you to the Society during the year. If you have any suggestions for meeting topics and possible speakers for the 2011 programme please do send them to me so I can forward them to the Programmes Committee.

Since the publication of the last issue of *The Linnean* we have welcomed two new members of staff to the team. Gabrielle St John McAlister joined us in November 2009 as part-time Cataloguing Archivist and you will have read about her work on the correspondence of Sir James Edward Smith in the last issue of *PuLSe*. In January, we were pleased to welcome Tom Helps as Facilities Assistant, based in the main office.

We also look forward to welcoming a number of new Fellows for admission in the coming months following the election at the evening meeting in January. The Society's membership is increasing and its continued increase, without compromising standards, is one of the Society's strategic priorities. At it's meeting in October last year, Council committed to a target of recruiting 1000 additional Fellows to the Society over the next three years. I would like to encourage you to encourage others to join us in "*the cultivation of the Science of Natural History in all its branches"*

RUTH TEMPLE
Executive Secretary

Library

It was reported in the last issue that funding had been secured from the Wellcome Trust for the cataloguing of Sir James Edward Smith's correspondence. I am pleased to say that our part-time archivist, Gabrielle St John-McAlister, has now been in post since November. She initially spent time familiarising herself with the material and reading around the subject to understand the context of the letters. She then decided on the structure and hierarchy of the collection and configured the newly acquired CALM archival software to accommodate the arrangement. She is now pressing on with creating detailed catalogue records for the individual letters.

In October, the picture conservator returned the Darwin portrait to its rightful place in the Meeting Room. The work done on re-lining and cleaning the portrait has produced excellent results, with the colours being much warmer and more distinct than before. Shortly after Darwin's return, our portrait of Daniel Solander (pupil of Linnaeus and botanist on the *Endeavour* with Joseph Banks) spent 2 weeks on display at Bonhams as part of an exhibition to support the launch of Penelope Treadwell's book *Johann Zoffany, artist and adventurer.* There is some question over the attribution of our painting, but the author examined it closely during the course of her research for the book and she remains convinced that it is a Zoffany.

Early in the New Year, we received a Google alert for the sale of a Linnaean item on e-bay by a book dealer in New Jersey. The pictures online showed that it had a Linnean Society binding and Sir James Edward Smith's usual ownership signature and the note with which he marked all the items he purchased in 1784 as part of the Linnaean Collection. We are mystified as to how and when this volume was removed from the Collection and are still trawling sale catalogues for any reference to it. Through the good offices of a contact in the United States, we were able to secure the item and it will be personally couriered over to us on the next trip to London. We are impatient to examine the volume in detail to see if we can pick up any further clues to its history and solve the mystery. We have contacted the dealer to see if he is willing to share with us anything he knows about the volume's more recent provenance, but have heard nothing as yet.

This year's Linnaeus Link Partners' Meeting took place in Pittsburgh, hosted by the Hunt Institute for Botanical Documentation. The venue encouraged representatives from several US libraries to attend and we now have one full Partner there with two more in the pipeline. The Assistant Librarian, Ben Sherwood, the Collections Secretary, Susan Gove, and the Honorary Archivist, Gina Douglas, attended the meeting on behalf of the Society. Several proposed improvements to the system were discussed and these proposals will now be worked on and costed over the next few months.

Our dedicated team of volunteers continues to work on a wide range of tasks for the benefit of the Library; cataloguing monographs and portraits, sorting and listing Society archives and biographical reprints, adding to the Fellows' database, listing Smith material and transcribing scientific correspondence.

LYNDA BROOKS
Librarian

Donations

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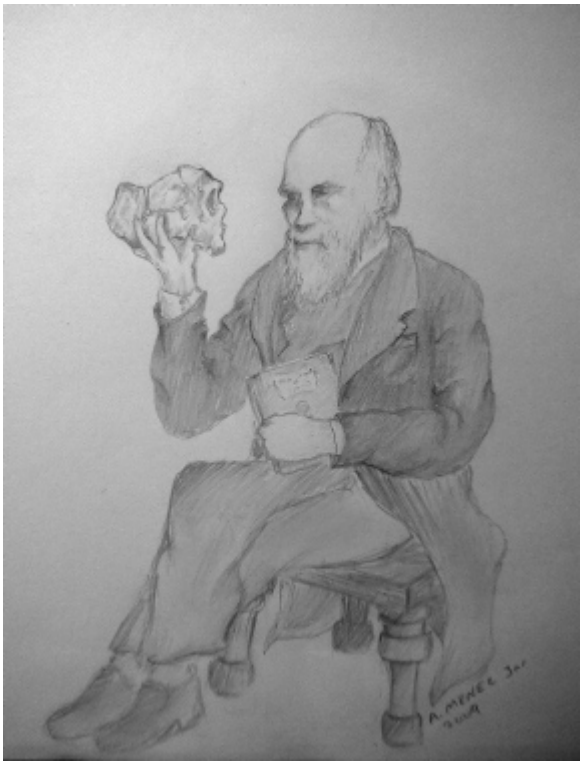
Correspondence

From: Dr Alex Menez The Gibralter Museum

The day Charles Darwin came face to face with a Neanderthal

Sir – My research into the history of natural history in Gibraltar has led to a discovery related to the famous Gibraltar skull and Charles Darwin that has not been reported by historians before. The first report of the skull is from the President of the Gibraltar Scientific Society, Dr Burrow, who recorded the following entry for 3rd March 1848 in the minute book of the Society: 'Presented a human skull from Forbe's Quarry. North Front by the Secretary'. The Secretary was Lieutenant Edmund Henry Réné Flint of the Royal Artillery. Details surrounding the skull's discovery are not known but the skull lingered in Gibraltar until it was brought to the attention of Dr Hodgkin who was in Gibraltar in 1863. It was Dr Hodgkin who arranged for it to be sent to George Busk in England in July 1864. The skull was exhibited by George Busk at the 34th Meeting of the British Association for the Advancement of Science, held in Bath in September 1864.

Prior to the exhibition Charles was feeling unwell and was resting from the 25th of August to the 1st of September with his cousin and sister-in-law Sarah Elizabeth Wedgwood at Chester Place in London. But before taking its place in the exhibition at the British Association, the Gibraltar skull would wind its way to Charles. In a letter of 1st September 1864 from Charles Darwin to Joseph Hooker (Letter 4605, Darwin Correspondence Project), Charles states that: '*F. brought me the wonderful Gibralter skull*'. And so, at that moment, two very distantly related humans, both with extraordinary roles to play in evolutionary theory, came face to face.



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Charles Darwin – Palaeomycologist?

Further to the account by Barry Thomas (2009) of Charles Darwin FLS as a collector of fossil plant material, it appears Darwin may also have obtained some fossil fungi whilst in South America. Andrews (1980 pp299-300), gave a brief biography of the Dresden palaeobotanist Hans Bruno Geinitz (1814-1900), including mention that "he [Geinitz] investigated some fossil plants *(sic)* collected by Charles Darwin in Argentina…". Andrews (1953 pp36, 171 & 260) also mentions the genus *Hylomites*, published posthumously in Geinitz (1925), as an apparently orthographic error for *Xylomites* Unger 1841, a genus of fungi from the Tertiary of Croatia. During the nineteenth century, of course, both extant and fossil fungi were commonly included in the plant kingdom. In spite of the best endeavours of Geoff West of the British Library, I have not yet succeeded in locating a copy of the paper by Geinitz (1925), so it is hard to judge the taxonomic affinity of the *"Hylomites"* that Darwin collected in the Triassic of Mendoza Province as either fungal or botanical *sensu stricto*. Perhaps another reader of *The Linnean* might help to answer this question.

Readers may be interested to know that some more of Darwin's fossil plant material has also been preserved at his former university in Cambridge (not Oxford, Thomas 2009). Keynes (2002) illustrates one of the fossilized stumps from "Darwin's Fossil Forest" at the Uspallata Pass in Argentina. The Sedgwick Museum Cambridge, holds two specimens of *Araucarioxylon protoaraucanum* Brea, silicified conifer wood from this Middle Triassic locality: the smaller collected by Darwin in the spring of 1835 and the larger resulting from dynamiting in the reconstruction of a road in the 1950's. As is often the case, destructive procedures can result in the advancement of science.

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Darwin's Cambridge Summer

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Two books lie before me as I write this. They record events, 27 years apart, which took place in Cambridge, Charles Darwin's *Alma Mater.* The first book, entitled *'Evolution from molecules to men'*, is the formal procedings of a conference, held in 1982, to mark the centenary of Darwin's death. The second, published last year, 2009, takes its main title from the last paragraph of the *Origin*, *'Endless forms'; Charles Darwin, Natural Science and the Visual Arts*, and was produced to accompany the exhibition at Cambridge's Fitzwilliam Museum in celebration of last year's double centenary. The two events and their written records are very different and represent a dramatic shift in attitude.

The 1982 conference, one of several held that year, was, essentially, a gathering of biologists asking the question 'where, post-synthesis, are we now?'. The event was organised, appropriately, by Darwin College and the formal sessions were held in the vast auditorium of the Cambridge Music School, but it was a private affair and the book to which it gave rise was a technical work. Not so the razamataz of very public events which marked the 2009 celebrations. Lectures, concerts, plays, debates, recitals, films and book signings, not to mention the tea-towels, coffee mugs and *Mrs Charles Darwin's Recipe Book.* In addition, The Alumni were treated to tours of the Herbarium and the Botanic Garden. All this combined to produce a veritable Darwinian Summer tidal wave which engulfed Cambridge and which was set against the backdrop of the University's own 800th anniversary celebrations; it all made one's head spin and *then* there were the exhibitions themselves!

So why this enormous shift from private to public celebration of Darwin's work? There is no single answer, but it may have something to do with C.P. Snow's 'Two Cultures' merging and becoming one again, as they were in Darwin's day. In 1982 we were only on the threshold of the mighty genomics revolution. The first volume of the Darwin Correspondence was not published until 1985 and Tim Berners-Lee's World Wide Web did not reduce the size of Planet Earth until 1991. Now we can all read Darwin's works on line and 'Genome Hackers' can sequence DNA in the garage. Moreover, the politics and the rekindling of religious controversy have all combined to bring Darwin's thinking into the domain of 'Popular Culture' once again. It is this passionate general interest that the events and exhibitions of last year so successfully exploited.

The first of the four Cambridge exhibitions was held at Christ's College, where Charles Darwin was an undergraduate from 1828 to 1831. The College had refurbished Darwin's (and Paley's) 'most snug and comfortable rooms' and, in the Old Library, had mounted an exhibition, *Charles Darwin On Land and Sea.* This latter included many never-before-seen manuscripts and memorabilia of the 'Beagle' voyage. Walking through to the new Sculpture Garden we see, relaxed and confident, sitting on the arm of a wooden bench, the 22 year-old Charles Darwin. This bronze is by Anthony Smith,

and is an image which presents a refreshing contrast to the long-received one of the venerable old man. Darwin's coat tails are draped over the three books which influenced his thinking: John Herschel's *Preliminary Discourse on the Study of Natural Philosophy*, Alexander von Humboldt's *Personal Narrative* and, of course, Paley's *Natural Theology*, are all there. A fourth book, resting on Darwin's right knee, is James Stephens' *Illustrations of British Entomology*. Thus, in small, both the philosophical and the field naturalist sides of Darwin's thinking are neatly illustrated.

Exiting Christ's College and turning left into St. Andrew's St. and then right into Downing St. brings us to the second exhibition in the Sedgwick Museum of Earth Sciences, unsurprisingly entitled *Darwin the Geologist* and, which again unsurprisingly, focuses on his first love, (if you exclude beetles!) viz. geology.

We now have to cross the River Cam, noting, in passing Charles Jencks' huge Double Helix sculpture in Clare Memorial Court, unveiled by James Watson in 2005; a structure which has generated its own artistic legacy. On to Sir Giles Gilbert Scott's New University library and exhibition number three, *A Voyage Round the World: Charles Darwin and the Beagle Collections in the University of Cambridge*. If you still had stamina enough, after all this, you could have recrossed the river and paid a visit to what *The Daily Telegraph* called 'the best show of the year', at the Fitzwilliam Museum on Trumpington Street. Between the Corinthian columns of George Basevi's giant portico flapped banners bearing a portrait of Charles Darwin, framed in a montage of 'Endless Forms' in the tropical setting that had so overwhelmed Darwin on his *Beagle* voyage. The exhibition itself was, however, staged in the new courtyard galleries west of the old building.

Indeed, apart from Christ's College itself, none of the buildings which housed the 2009 exhibitions existed in Darwin's undergraduate years. At that time Cambridge was a small town of some 16,000-20,000 plus c.400 undergraduates confined to the eastern banks of the River Cam, with green fields and farmland stretching westward where the University Library now stands. The foundation stone of the Fitzwilliam Museum was not laid until November 1837. Darwin had left Cambridge, for the last time, after sorting his Beagle collection, in the March of that year. Darwin was, however, able to visit Richard, 7th Viscount Fitzwilliam's art collection because, at that time, it was housed in the seventeenth century building which had been a boy's grammar school and was situated at the western boundary of the Old Botanic Garden where Darwin 'walked with Henslow'. This building is now home to the Whipple Museum wherein is displayed Robert Whipple's collection of antique scientific instruments. Robert Stuart Whipple was the sometime partner of Horace Darwin, one of Charles' sons, who founded the Cambridge Instrument Company and who was responsible for supplying instruments to the new science laboratories which, in the 1860's and '70's, were rising on the site of the Old Garden so as to leave the school building hemmed in by the Cavendish Laboratory (Founded 1874) and its various extensions. It was here, of course, that the atom was first dismantled and where Watson and Crick carried out their work on DNA. Perhaps Rutherford would have revised his opinion on 'stamp collecting' had he lived to have seen this.

So it was that, within a few yards of where the young Charles, with Sir Joshua Reynolds' *Discourses* under his arm, '...admired the best pictures, ...' in the Fitzwilliam

'A place among scientific men': the bronze by Anthony Smith in the Sculpture Garden of Christ's College, Cambridge.

collection, there it was that modern physics had its birth. Not far away, in the new Zoology laboratories, the young and brilliant Francis Maitland Balfour, realised that comparative embryology was one of the keys to the understanding of evolutionary relationships, a study which has now taken centre stage again under the name 'Evo-Devo' and has revolutionised our understanding of the genesis of '....endless forms'.

Leaving the Old Botanic Garden and crossing Downing St., young Charles would have seen spacious lawns framing Wilkins' neo-Grecian pavilions of Downing College. This vista is now blocked by the buildings of the 'Downing Site' among which is the Sedgwick Museum of the Earth Sciences, where many of Darwin's *Beagle* specimens are housed and named after Adam Sedgwick, one of Darwin's mentors and a friend of Henslow. Sedgwick started life as a mathematician, as, indeed, did Henslow, but was to become a leading geologist, occupying the Woodwardian Chair for 55 years from 1818. Across the courtyard from the Sedgwick is the new Botany School, a building in which another of Darwin's sons, Francis, was to spend much of his Cambridge career in botany at the turn of the century.

Charles Darwin's sons, George, (who became Plumian Professor of Astronomy), and Francis, were both gifted artists as was his sister, Caroline and his grand daughter, Gwen Raverat, George's daughter, who studied with Virginia Woolf and Agnes Arber. In fact there was artistic talent running through both the Darwin and the Wedgwood lines and yet, Charles himself, despite his student visits to the Fitzwilliam collection and his admiration for the work of Titian, Raphael and Sebastiano del Piombo, denied having any sort of proficiency in or taste for art. At the centenary celebration, on June 23rd 1909, held in the newly built Examination Hall, next to the Cavendish, yet another of Charles' sons, the banker, William, along with such luminaries as Lord Rayleigh, Arthur Balfour, a future Prime minister, and Svante Arrhenius delivered an oration. William dealt with, what he called, 'the very hackneyed subject of his [father's] loss of interest in poetry and art' saying that his father had much exaggerated this loss and

that he could not possibly have written the last paragragh of the 'Origin' '...without a deep sense of the beauty and poetry of the world and of life'. This assertion is supported by the close attention to the artistic detail which we know that Darwin paid to the illustrations of his works and particularly those of his *Expressions of Emotion in Man and Animals* (1872). This work forms one of the major themes of the Fitzwilliam exhibition. With this background we can, at last, enter and marvel at *Endless Forms*.

Fellows of the Linnaean Society would have immediately felt at home as, facing them, as they walked through the entrance door was the huge portrait of Darwin by John Collier. This full length painting was, however, not the one from the Linnaean Society but another, commissioned by the Darwin family a year after Charles' death and is therefore based on the 1881 Linnaean portrait *but* with subtle differences. The book of the exhibition states that 'the compositional echoes of Titian's patrician portraits and Rembrandtesque modelling of the head, confer on Darwin an aura of history, which implicitly counteracts the controversial aspects of his theories' (p.13). Whether or not the visitor agrees with that assessment, this theatrically lit image forms an arresting overture to the exhibition.

The exhibition's title, *Endless Forms Charles Darwin Natural Science and the Visual Arts*, neatly encapsulated both its theme and its argument, for the sequence of displays did indeed constitute, in true Darwinian fashion, 'One long argument' presented both beautifully and imaginatively but tempered, in the tradition of Baconian empiricism that Darwin himself favoured or, as he put it, '.....speculative men, with a curb on, make far the best observers'. Connections and influences can, of course, always be established using the 'For the want of a nail' formula and physicists assure us that the mass ratio of the neutron to the proton ultimately governs everything. This may be so, but it has little *prior, proximate* bearing on how to grow a prize-winning

'Endless Forms' in the portico of the Fitzwilliam Museum in Cambridge.

marrow or the evolution of the auditory ossicles. For these things we need a demonstrably closer connection, one with a lower 'Bacon number'(Kevin, not Francis), if that term is permissible in a diachronic sense. This exhibition, with its stunning 220 artefacts, convincingly argued for a very low 'Bacon number' connection between Natural Sciences and the Visual Arts with Darwin's work as pivotal. This connection was equally convincingly demonstrated to be reciprocal, shedding refreshingly new light on that '...hackneyed subject...' of Darwin's supposed loss of interest in the visual arts. There, on display, was a watercolour of the Fitzwilliam collection (1822-5) showing one of Darwin's favourites: Titian's *Venus and Cupid with* a *Lute Player.* Also, there was Darwin's own copy of Jan Swammerdam's 1758 English edition of *The Book of Nature* with its insect dissections. In addition were exhibited some of James Audubon's illustrations for his *Birds of America* which so impressed Darwin when, as a medical student in Edinburgh, Audubon showed these illustrations at a meeting of the Wernerian Society, of which Darwin was a member. All these were alongside Henslow's beautiful botanical teaching sheets. Illustrations such as these, it was argued, instilled in Darwin a profound appreciation of Nature's beauty and diversity.

The idea of an exhibition to explore the connections between Darwin, Natural Science and the Visual Arts was first proposed, appropriately enough by Charles' great-great-grandson, Randal Keynes and, yet again, highlights that artistic family heritage which Charles himself felt to have passed *him* by. However, the exhibition left us in no doubt that nature's beauty and diversity *did* play a key role in Darwin's thinking and, subsequently, his own interpretation of them influenced the art of the late nineteenth century.

The exhibition was divided into seven areas, starting with the young Darwin's exposure to various art forms and continuing by illustrating the changing attitudes to the 'History of the Earth', then on to 'The Struggle for Existence', 'Animal Kin', the 'Descent of Humankind', 'Darwin, Beauty and Sexual Selection' and *then* comes the stunning finale of 'Darwin and the Impressionists'. For Darwin, art was representational or nothing. To James Sowerby, one of the illustrators of his barnacle volumes, Darwin wrote that he 'did not care for artistic effect, but only for hard, rigid accuracy'. It is not suprising, therefore, that the pre-Raphaelites, with their 'Truth to Nature', which revelled in diversity, appealed to him. This was in sharp constrast to Sir Joshua Reynold's edict, as elaborated in his *Discourses*, that high art should transcend reality and reflect ideal essences. Ironically this attitude was more akin to that of the 'Philosophical Naturalists' whose heyday was the 1830's and 40's, and who condemned the pre-Raphaelites as nothing more than 'servile technicians'! This is just one of the complexities and contradictions of the proverbial 'Entangled Bank' which the exhibition managed to explore so adroitly without either patronising or simplifying.

In fact the exhibition opened up a hitherto hardly tapped seam of riches which could be profitably mined by such a multiplicity of disciplines as to quite overwhelm the visitor and to defy adequate summary in a short article; the book of the exhibition contains twelve long essays and runs to 344 pages! I will therefore, in order to convey a mere taste of this unique presentation, chose two of the linkages between 'Charles Darwin, Natural Sciences and the Visual Arts' which the exhibition reveals.

From an early stage in his career Charles Darwin thought of himself primarily as a geologist; and, indeed, his work with Adam Sedgwick and his South American experiences reinforced this predilection. Geology, at this time, posed more questions than answers and these uncertainties were reflected in the visual arts of the time. The official attitude of the geological community was that of Newton's *'hypothesis non fingo'*. 'Describe and catalogue' was their mantra while paying lip service to the account of the Creation story given in Genesis. Darwin looked back to this time by recalling a comment that, if one has no hypothesis to work on then '...a man might as well go into a gravel pit and count the pebbles and describe their colours'. 'Deluvian' geology, however, generated some sublime art. One of the first of the massive art works, depicting the Noahian flood, is the hauntingly beautiful *The Subsiding of the waters of the Deluge* by Thomas Cole (1829). For him, geological evidence gave clear support to the Mosaic account, as it initially did for William Mallord Turner whose breath-taking *The Evening of the Deluge* (1843) stops the visitors in their tracks. Times and attitudes were, however, changing. No amount of special pleading could easily reconcile the story, being told increasingly clearly by the strata, with the Biblical Creation story. However, the Almighty was not to be so easily air-brushed out of the picture and Georges Cuvier, in Paris, Adam Sedgwick, in Cambridge and William Buckland, in Oxford, all attempted a Tychonic compromise by postulating multiple castastrophes as part of God's overall strategy to 'save the phenomena' as it were. None of it worked. The accumulating anomalies were too many and too great. In any case, the 6000 years that Archbishop Ussher had allowed was clearly insufficient for the newly revealed geological processes. Those sedimentary strata and their entombed fossils were the trouble and pictures by several artists are dramatically used to illustrate the problem. Edward Cooke's *Cliffs at Blue Anchor, North Somerset* (1866) is one such. The canvas shows eroded and contorted strata as testimony of the action of powerful forces acting over inconceivable lengths of time. It was all too much for Mosaic geology to accommodate. Again the exhibition shows how the visual arts reflected these tensions, uncertainties and progressive changes in attitude, both individually and institutionally alongside the ever increasing fascination of the general public with the giant, extinct sea monsters, geologising and fossil collecting on the shore. To illustrate these movements Robert Farren's *Duria Antiquior (An Earlier Dorset.* c.1850) had been brought down the road from the Sedgwick. The canvas, based on a design by the geologist Henry De la Beche, shows assorted denizens of a 'prehistoric' tropical lake engaged in fierce battles. A gentler picture, but one with more of a philosophical agenda, is William Dyce's *Pegwell Bay, Kent – A recollection of October 5th 1858*. Ostensibly the picture shows the Dyce family indulging in the tranquil pastime of seaside natural history, but the real message, in those cretaceous cliffs and with Donati's comet in the sky above, is time, driving home James Hutton's unsettling message 'no vestige of a beginning, – no propect of an end'. The section concludes with studies of tumbled rocks and volcanic landscapes by John Ruskin, himself a frustrated geologist and friend of both Turner, Darwin and Thomas Moran. Moran was an artist with geological interests who, on a visit to Yellowstone Park, was inspired to paint *The Castle Geyser, Fire Hole Basin*, in which, with enormous artistic skill, he conveys the feeling of the awe-inspiring forces of Nature. Little did he know that his picture showed the source of Taq polymerase, which has caused another revolution!

One of the highlights of this section, at least to me, was Darwin's own watercolour of a geological section of South America rendered both sensitively, artistically and accurately, elegantly refuting his own denial of any artistic ability. According to William Broderip, Darwin ' ...was a first rate landscape painter with his pen' and both Darwin and Ruskin shared a 'vivid delight in scenery' which, for both men, was accentuated by a scientific understanding of its causes. The science of beauty is a recurring theme in the exhibition and is the second of the themes to be treated briefly here.

There have been and remain several schools of thought as to the nature and provenance of beauty. Sir Joshua Reynolds and William Paley held that perfect beauty was ideal, God-given and appreciable only through man's higher senses. This tradition was subscribed to by the Royal Academy and was reflected in the great narrative paintings. Darwin saw the beauty of nature quite differently and more prosaically. For him, the beauty of animals and plants was a result of Natural, more specifically, Sexual Selection and, therefore, was accessible to animals and *not* the preserve of mankind alone. This interpretation Darwin elaborated in his *The Descent of Man and Selection in Relation to Sex* (1871). Both the text and the illustrations scandalised moralists but had an immense impact on the visual arts. The sixth section of the exhibition explored this impact, its consequences and demanded three fascinating essays in the exhibition book. The section is sumptuous with exhibits ranging from studies of bird plumage, with particular attention paid to the Argus Pheasant, through cartoons of humanoid birds, the pre-Raphaelites, A.H. Thayer's studies of camouflage colouration to the work of Monet and Cezanne, all products of that creative tension generated by attitudes to man's place in and interrelationship with nature.

We were greeted, on entry, by Charles Darwin himself. Our exit from this incredible exhibition was followed by the gaze of Edgar Degas' *Little Dancer.* Oh Darwin, cher Monsieur, I wouldn't have missed your *Endless Forms* for worlds. They were, indeed, 'most beautiful', an opinion, I suspect, shared by the other 90,000 visitors who saw and marvelled at them. I came home with the book and memorabilia in a bag emblazoned with that spectacular Argus Pheasant's feather and with a new intellectual perspective.

Reference

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I wish to thank my wife for her valuable humanist input and for putting 'a curb on' my over enthusiastic purple prose.

The Causes and Functions of Spirals, Helices and Vortices in Nature

J L Cloudsley-Thompson Hon FLS

Introduction

From the Milky Way and the spiral nebula in the constellation Andromeda, to ungulate horns, molluscan shells, dextro- and laevo-rotatory moleules and DNA, what is the cause, if any, of a spiral or helical shape and does it confer any selective advantages? Again, what is the significance of clockwise or counter-clockwise rotation in anticyclones and cyclones, or of dextral and sinistral gastropod shells? These are the types of questions to which it is not easy to obtain answers. This article is an attempt to summarise those that are available in the literature.

Astronomical Examples

Only as recently as the 1920s was Edwin Hubble (1888-1955), using the method of 'cepheid variable' stars, able to show that what astronomers had thought to be clouds of gas were, in fact, galaxies far beyond the Milky Way. In 1850 William Parsons (1800-1867) 3rd Earl of Rosse with his famous 6 ft diameter reflecting telescope was able to resolve these gas clouds into 'stellar islands'. There are, in fact, several hundred billion others, with vast empty spaces between them. A few months ago, yet another of these open spaces, with dimensions in the order of billions of light years, was discovered. Each galaxy itself contains hundreds of billions of individual stars. Those of the Milky Way are clustered around a huge black hole to form the shape of a plate with a swollen centre. Outside this dense zone, the stars form four principal spiral arms which orbit the central black hole once every few hundred million years. The suggestion has been made that the movements of our solar system into and then away from the spiral arms might have caused the major post-Cambrian extinctions on Earth, possibly through consequential encounters with giant meteorites or the reduction of light due to dust. Alternatively, as our solar system moves into a spiral arm, it might possibly encounter large concentrated complexes of molecular gases, dust, and an increased stellar density. When one of the stars explodes producing supernovae, these cause changes in the interplanetary medium of the solar system which, in turn, engender a reduction in the levels of light at the Earth's surface. As the solar system moves away from the supernovae, there is an increase in the amount of sunlight that reaches the Earth. Moreover, supernovae reduce the amount of ozone in the Earth's atmosphere: consequently the ultraviolet light reaching the ground increases. It is believed that the sun has travelled round the galaxy 16 times since it was formed 5 billion years ago, and has travelled in and out of the four arms about 64 times. So the entries into each arm take place roughly every 100 million years. The spirals are waves of compression which cause young stars in the process of formation that pass through them to 'light up' (David Butt *in litt.* 7 July 2008).

In order to determine the direction in which an astronomical spiral is twisting it is necessary to make allowance for the position from which it is being observed. Nebulae are large heavenly bodies between the galaxes. They show evidence of gaseous material

and dust surrounding starry nuclei. Some reflect the birth of stars, some their extinction. Many, like the nebula in Andromeda, have spiral arms. The current 'density wave' theory explaining why this is so was first proposed by Chia Crias Lin and Frank Shu in the late 1960s. It envisages a solitary wave of density moving through the rarified gas and dust in the disk of a galaxy. As it does so, it triggers the formation of stars. The curvature results from the rotation of the galaxy – and the arms themselves are intitiated by gravitational interaction between different galaxies.

Vortices – Whirlwinds and Hurricanes

Descending 10^{14} or so orders of magnitude from galaxes to our own planetary system, whirlwinds and hurricanes (known as 'typhoons' in the western North Pacific and 'cyclones' in the Bay of Bengal) are frequently evident. These are intensive tropical storms that occur in vortices spiralling anticlockwise (as seen from above in the northern hemisphere) and low pressure systems. Their wind speeds are extremely high – often about 34m sec^{-1} (121 km h^{-1}) – while the centre or eye of the storm is characterised by calm weather. In contrast, anticyclones are high pressure systems with clear skies and stable weather. They appear especially in subtropical areas and may remain in position for several weeks. In the northern hemisphere, winds blow in a clockwise direction out of an anticyclone; in the southern hemisphere, the direction is counter-clockwise. These weather systems are of considerable ecological importance.

Hurricanes are not related to jet streams. The latter are narrow bands of high velocity wind blowing at the top of the troposphere (*c* 9,000-15,000m above sea level). They travel in a westerly direction in both hemispheres. Because they are caused by the conjunction of hot and cold air masses with the Earth's rotation, their speeds may reach 135m sec^{-1} (322 km h^{-1}) in winter (Ridley, 1979).

A 'vortex' is a rotational form of flow where stream lines are curved, and may even form closed loops in the case of hurricanes, whirlwinds, whirlpools and the eddies caused by obstructions in rivers. When water flows down a drain or plug-hole, a 'free vortex' is created, and the stream lines near the centre sweep out at a given angle faster than do the outer stream lines. The speed along the path of flow is constant or may even decrease away from the centre. Consequently, the outer flow is slower, in terms of the angle traversed, than is the inner. The direction of rotation of water running

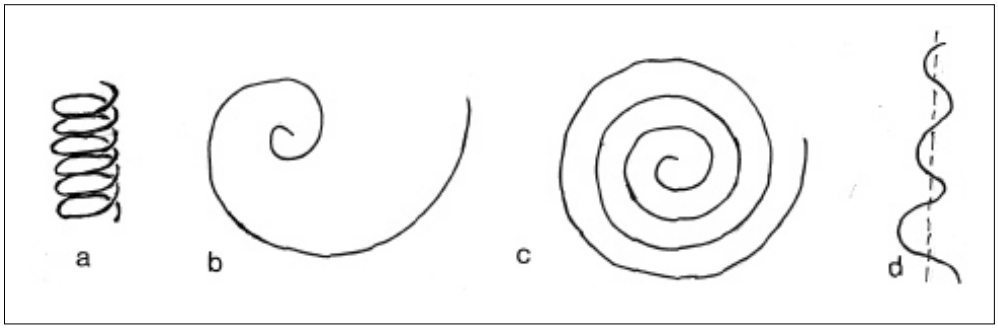

Figure 1. (a) Helix. (b) Equangular or logarithmic spiral (c) Archimedes' spiral (d) Extended equangular spiral.

down a plug-hole is random in the sense that it depends upon chance causes, such as the direction from which the plug has been pulled out. The direction may even change spontaneously at the very end of rotation for no apparent reason, while the water is still running away. The direction of rotation is in no way related to the Earth's rotation, to Coriolis Force, or to the latitude in which the plug-hole is situated. Vortices in astronomy include those in spiral galaxes, black holes, sunspots, the Great Red Spot on Jupiter and the intermittent dark spot on Neptune.

The Coriolis Force

Named after the French mathematician Gustave Gaspid Coriolis (1772-1843), the Coriolis Force results in part from the Earth's rotation – it can also occur in mechanical systems – and acts upon objects moving across its surface. It is distinct from centripedal force and its strength is usually comparatively insignificant. Nevertheless, it may affect the motion of ocean currents although it is so small in practice that it plays no part in the case of small systems such as water flowing down plug-holes. Nor does it assist in the navigation of migrating animals. In 1947, H.L. Yeagley suggested that a direction-finding grid might be set up between the vertical component of the Earth's magnetism and the Coriolis Force, but neither he nor anyone else has been able to find supporting evidence for the idea. The Coriolis Force is doubtless too weak to be detectable in the semi-circular canals of the inner ear, but it is evidently capable of engendering movements of large air masses, as mentioned above.

In the northern hemisphere, the Coriolis Force deflects the rotation of anticyclones clockwise to the right; in the southern hemisphere, to the left. It is applicable to rotating systems in general. Warm anticyclones are a semi-permanent feature of subtropical climates (eg. the Azores and Hawaiian high pressure zones): Coriolis Force not only deflects these but is also responsible to some extent for the patterns of the ocean currents below them. Climate is determined by the interplay of atmospheric winds and oceanic winds. Heated air rises and cools, water vapour condenses into clouds. The cooled air, being now dry, produces cloudless conditions. Cold polar air moves towards the Equator while warm tropical air, blowing towards the poles, produces the high-altitude jet streams referred to above (Ridley, 1979). The task of unravelling the interconnections which exist in the weather-making process is far too complex even for modern super-computers and is certainly not relevant to the present discussion.

Spirals and Helices in Animals

The terms 'spiral' and 'helix' are applied to different structures. Spirals are flat, like the ridges on a gramophone record or the arms of a spiral galaxy. In contrast, helices are three-dimensional coils shaped like screws. So-called spiral staircases are, in fact, not spirals at all, but helices! (Fig. 1a). Examples of helixes in nature are afforded by *Euglena spirogyra*, the skeleton of the glass sponge *Euplectella aspergillum* (Hexactinellida) especially abundant near the Philippine Islands, and DNA (deoxyribonucleic acid: see below).

When the shell of a pearly nautilus (*Nautilus pompilius*) (Cephalopoda) is cut away to reveal the gas-filled chambers which provide buoyancy (Fig. 2) it can be seen that these are arranged in an approximately 'equiangular' or 'logarithmic' spiral (Fig. 1b) first described by René Déscartes (1596-1650). As the nautilus grows, the coils

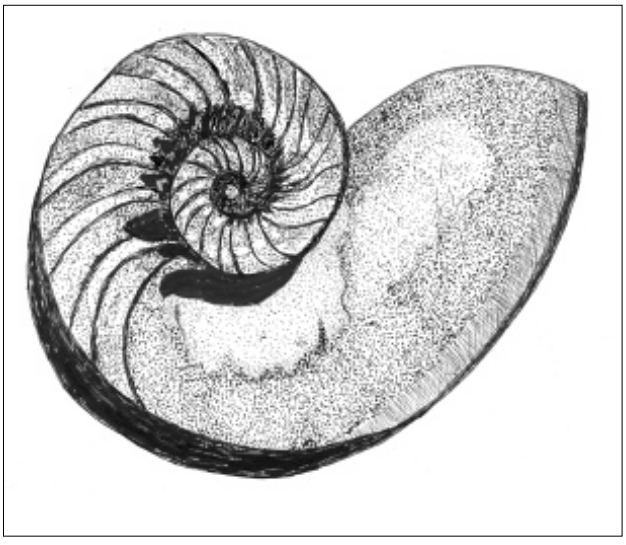

Figure 2. Shell of *Nautilus pompilius* cut away to reveal the chambers in an approximately logarithmic spiral.

become further and further apart. Extended equiangular spirals curve away from a central point which becomes progressively more distant as the spiral revolves around that point (Fig 1d). Extended equiangular spirals occur in many gastropod molluscs, artiodactyl horns, mammalian teeth, and so on (see below).

The ammonites, which arose from the nautiloids in the Upper Silurian, differ from the latter in that their coils are all approximately the same distance from one another (Fig 3). They form an 'Archimedes' spiral, so named after Archimedes (*c* 287-212 BCE) the Greek mathematician who first described it. Archimedes' spirals can be seen in the orb-webs of araneid spiders which are covered with drops of sticky liquid which traps the prey. They are attached to the radial threads of the webs. The proboscis of a butterfly is usually coiled in an Archimedes' spiral – except when feeding – and chameleons walk with their tails coiled in these spirals. The spirals presented by animals can be either temporary, or patterns of growth which are more or less permanent. The latter are usually equiangular (Fig 1b) or extended equiangular spirals (Fig 1d).

The study of spirals in nature has a long history. Sir Christopher Wren (1632-1723) noted that many molluscan shells take the form of logarithmic spirals, while his Dutch contemporary Jan Swammerdam (1637-80) observed the common mathematical characteristics of a range of shells from *Helix* to *Spirula*. Years later, Sir D'Arcy Thompson (1961) analysed several of them. He described how the shapes of mollusc shells could be created by rotating a closed curve around a fixed axis. The shape of the

Figure 3. Ammonite fossil, showing compartments forming an approximate Archimedian spiral (Photo J. H. Cloudsley).

curve remains fixed, but its size grows in a geometric progression. In nautiloids and ammonites the curve revolves in a plane perpendicular to the axis. In gastropod shells (see below), on the other hand, it follows a skewed path forming a helix-spiral pattern (http: // en wikipedia. org/wiki/spiral).

The pearly nautilus (*Nautilus pompilius*) is the only living cephalopod to possess an external shell. This can be delineated mathematically in terms of a sequence of 'Fibonacci numbers' – so named after Leonardo Pisano (*c*1170-1250), possibly the greatest mathematician of the Middle Ages. He is best known for his book *Liber quadraporium* ('The book of square numbers', 1225). Fibonacci numbers, first described in India consist of a sequence of integers in which each number is the sum of the preceding two. They begin as follows: 0,1,1,2,3,5,8,13,21, 34, 55, and 89… Fig 4 shows six squares whose sides are proportional to the lengths of successive Fibonacci numbers. If the squares were living cells each of which has divided the same number of times, an explanation would be provided for the proportional increases in the sizes of the shell chambers of nautiloids, ammonites, and some other molluscs. Furthermore, if arcs are drawn connecting the opposite corners of the squares – thus representing the outer walls of the spirals, a 'Golden' spiral will be created (Fig 5). This shows

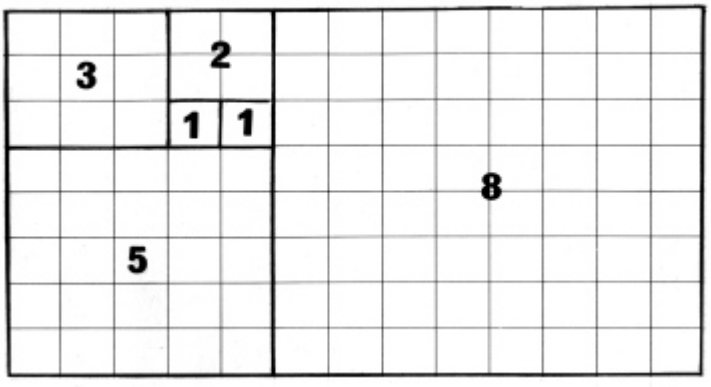

Figure 4. Six squares whose sides are proportional to the length of successive Fibonacci numbers.

striking resemblance to the spiral of a nautilus shell (Fig 1). It should be remembered, however, that the arithmetical ratio between two numbers on the same 'ladder' (eg 2,7,9,16,25,41……) rapidly approaches a 'Golden section' which for practical purposes may be approximated to 5:8 or to 13:21.

D'Arcy Thompson (1961) also showed that if a 'Golden' rectangle is made with two adjacent sides in the ratio 1:/2, a rectangle of half the size and having similar proportions is produced, for 1:/2::/2:2 and each half of the figure is now a gnomon to the other. As implied by Aristotle (384-322 BCE) a gnomon has been defined by Hero of Alexandria (1st century CE) as 'any figure which, being added to any figure whatsoever, leaves the resultant figure similar to the original'. If a sheet of A2 paper is folded through the middle, the resulting sheet is A3. If this is folded in a similar way, it results in a sheet of A4 which can then be folded to A5, and so on. The reverse occurs when the sheets are unfolded.

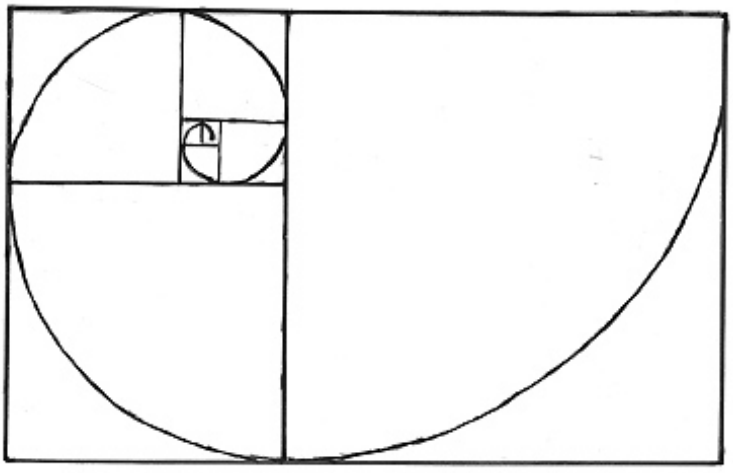

Figure 5. A Fibonacci or 'golden' spiral.

Whereas in the shells of nautiloids and ammonites the generating curve revolves in a plane perpendicular to the axis, gastropod shells grow by rotating a closed curve around a fixed axis, thereby forming a 'helico-spiral' or 'turbinate' pattern, as described below. The Rev Henry Mosely (1801-72), Canon of Bristol and Professor of Natural Philosophy at King's College London, gave a simple mathematical account of the spiral forms of gastropod or 'univalve' shells. Gastropods provide the best examples of helices among Mollusca.

Spiral Shells of Gastropod Molluscs

If the shell of a gastropod mollusc is held with the aperture on the right as this faces the observer, the shell is said to be 'dextral'. If, however, it is on the left of the shell when this is held towards the observer, the shell is 'sinistral'. In most genera of terrestrial gastropods the shell is dextral, as it is in the majority of marine genera also. A reversed specimen, whose whorls spiral anti-clockwise to the left, appears only very rarely. The sacred Chank shell (*Turbinella pyrum*) is indispensable to Hindus as a libation vessel on every occasion of prayer and worship. A 'reversed' specimen of this species is extremely rare and regarded with veneration, bringing blessings upon the fisherman who discovered it. Mounted in silver or gold, it is an emblem of purity and a fitting offering at the shrine of a god. The Lightning Whelk (*Busycon contrarium*) which is common in western Florida, is one of the very few naturally sinistral marine species. Large specimens, which may reach a length of 40.6 cm (16 ins) are often imported into India and can be seen in many Hindu shrines and temples along with sacred Chank shells. In Britain naturally sinistral snails include *Balea perversa*, *Vertigo pusilla* and members of the genus *Clausilia* (Saul, 1974).

Sinistral shells are of four kinds: (1) Those of species in a genus that is normally sinistral (e.g. *Busycon contrarium*); (2) those in which the genus is normally dextral but certain species are unusually sinisral (e.g. *Balea perversa*, *Vertigo pusilla* and members of the genus *Clausilia*); (3) species in which the shell is equally likely to be dextral or sinistral (e.g. *Ampullaria* spp.); (4) both genus and species are normally dextral, and sinistral forms are abnormal monstrosities (e.g. *Turbinella pyrum*). In some genera the shell is apparently sinistral but the animal within is dextral. In this case, the shell is ultra-dextral and the orifice sinistral, but this is most unusual (Cooke, 1895). These facts may be of genetic interest, but they give no indication whatsoever

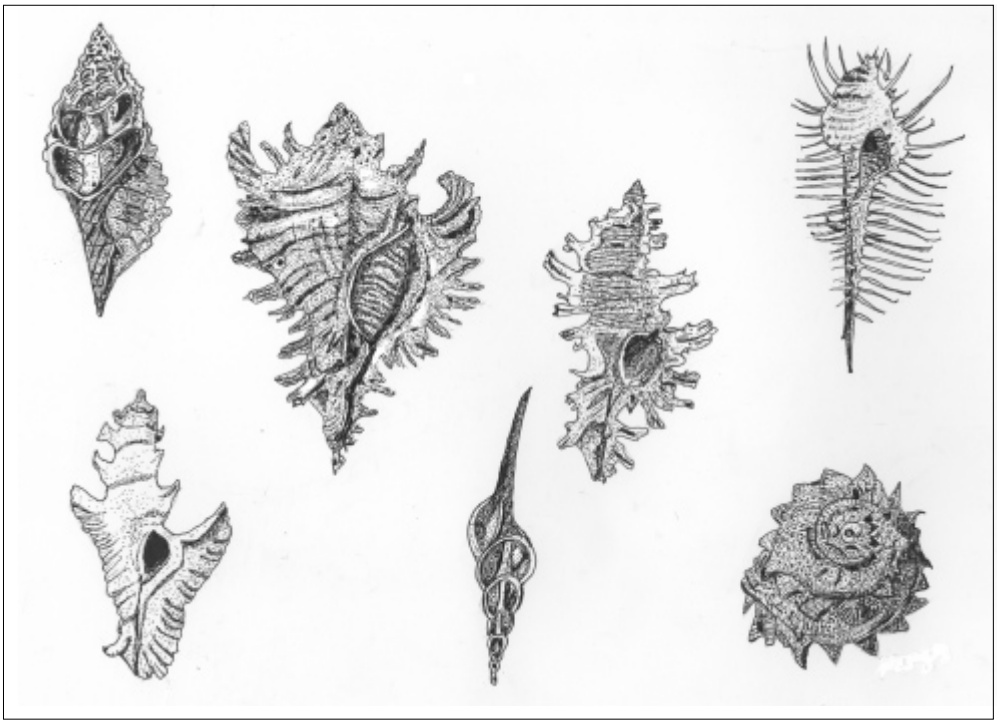

Figure 6. A variety of muricid gastropod mollusc shells showing their spiral form. Some in section. (Not to scale.)

as to why the vast majority of univalve spiral shells are dextral. Nor as to whether there is any selective advantage of dextral over sinistral shells.

The Spirals of Artiodactyl Horns

The spirals of artiodactyl horns (eg Kudu, *Strepsiceros* spp.) diversified explosively during the Pliocene epoch. Spirals enable all kinds of architectural ritualisation to evolve as well as adaptations to the habitat. Both visual and physical impact are of social importance. The tendency to ritualise the shapes of horns during phylogeny and ontogeny to less offensive and more defensive spirals is particularly obvious among bovids such as blackbuck (*Antilope cervicapra*) and bighorn sheep (*Ovis canadensis*) (Kitchener, 1988).

As D'Arcy Thompson (1961) pointed out, the distribution of forces which manifest themselves in the growth and configuration of a horn is not simple, and many different factors play a part. 'To suppose that this or that size or shape of horn has been produced or altered, acquired or lost, by natural selection…… is harder to define and to substantiate than some imagine it to be.' However large and heavy horns may be, they neither endanger poise nor encompass movement because the head and horns are perfectly balanced in such a way that no bending-movement tends to turn the head up or down, about its fulcrum in the atlas vertebra. Horns differ from mollusc shells in that they are always tubular. Their generating curves are closed and there is no 'involution' (wrapping one horn within another) or successive intersection of the generating curve.

Figure 7. Head of a male Argali sheep (*Ovis ammon*) showing spiral horns.

It is obvious that the horns of male Argali sheep (*Ovis ammon*) (Fig. 7) (which range from Bukhara and the northern slopes of the Himalayas to Kamchatka) and of North American bighorn sheep (*Ovis* spp.), for instance, must always grow from the skull in a clockwise direction away from the right side of the head, and anticlockwise from the left, because otherwise they would hamper their possessor from looking to the right or left. Considerably less conformity can be seen, however, in the directions of rotation of the spirals or helices of horns than those of mollusc shells.

In addition to his analysis of the shapes of horns, D'Arcy Thompson (1961) also discussed teeth or tusks. The most remarkable of these is that of the narwhal (*Monodon monoceros*). Thompson concluded however, beautiful as the spiral pattern of the tusk of the narwhal may be, it obviously falls short of that of a long, tapering gastropod shell. The grooves and ridges which constitute the 'thread' of the screw are 'the result of irregularities or inequalities within the alveolus, which "rifle" the tusk as it grows'. It would seem that in this case, once again, the direction in which the spiral or helix is twisted has no apparent adaptive function.

Spiral Cleavage

After another descent in size of several more orders of magnitude we come to the development of metazoan eggs. Those of Platyhelminthes, Nematoda, Annelida, Arthropoda and Mollusca develop by spiral cleavage, the eggs of other phyla by radical cleavage. The first group are known as Protostomia, the second as Deuterostomia. (In protostomes the blastopore becomes the mouth, while in deuterostomes it becomes the arms and the mouth in a new penetration.) Cell division occurs rhythmically, affecting the blastomeres simultaneously. As development proceeds, the micromeres lie in the upper or animal pole of the embryo and the larger macromeres form the vegetative pole. The micromeres are not directly over the macromeres from which they are formed but in one quartet are displaced to the right while in the next to the left

of the embryonic radius. In the following they are again displaced to the right. The cleavage is therefore said to be 'spiral' and spiral cleavage planes are at right angles. In pond snails (*Lymnea* spp.) the first quartet is budded off in an anticlockwise direction and the subsequent shells are sinistral. The mitotic spindles in spirally cleaving eggs are oriented vertically, but at an angle to the polar axis in the third and subsequent divisions. Furthermore, the inclination from the vertical is alternately to one side of this axis or to the other (Barrington, 1967). The above is of considerable phylogenetic significance, but the causes of the distinction between spiral and radial change is apparently not known at all. Nor is the adaptive function, if any, of each type yet understood.

Spirals in Plants

Flowering shoots or inflorescences show either 'racemose' (indefinite) or 'cymose' (definite) branching. The latter not infrequently takes the form of a logarithmic spiral, sometimes deformed by an helicoid influence. (The same is true of roots.) The florets of blossoms are also mathematically analogous to equiangular spirals found in the animal kingdom (D'Arcy Thompson, 1961).

In 1901 A.H. Church (*Relation of Phyllotaxis to Mechanical Forms*) pointed out that the fractions representing the screw-like arrangement of leaves around the stems of plants are often in numbers of the Fibonacci Series, but this appears to have attracted

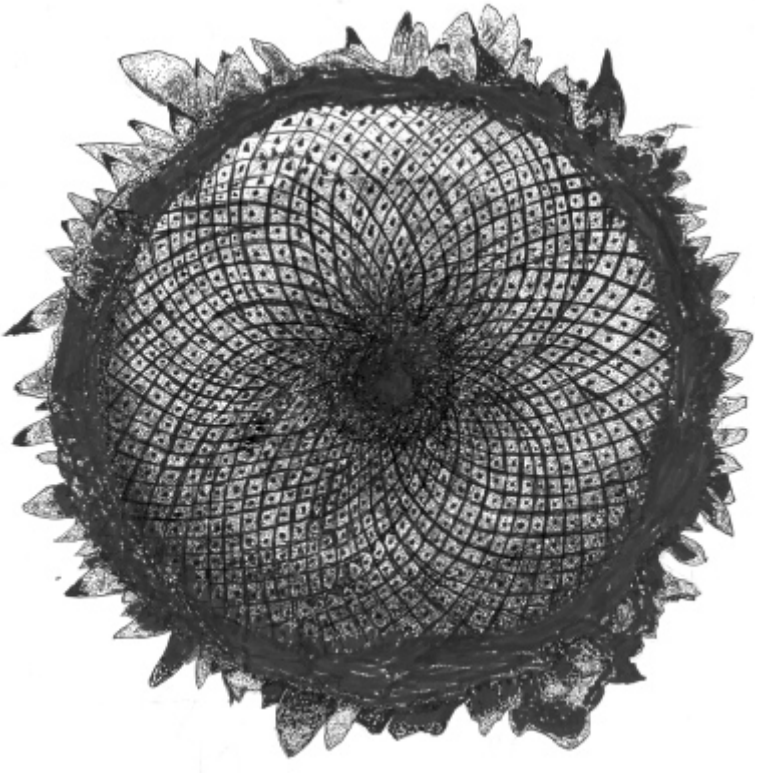

Figure 8. Seed head of the giant sunflower (*Helianthus maximus*) showing Fibonacci spirals.

little interest at the time – perhaps because Church referred to the phenomenon as an 'organic mystery'! Fibonacci numbers are also found in the pattern of florets of seed heads. In some species of sunflower the number of clockwise spirals is 34 and of counterclockwise spirals 55. Both are Fibonacci numbers, occurring consecutively in the series. The precise numbers depend upon the species of sunflower (Stewart 1995, 1998). The giant sunflower (*Helianthus maximus*) (Fig. 8) shows this clearly. Pineapples have 8 rows of scales sloping in an anticlockwise direction and 13 clockwise.

As the ratio of successive Fibonacci numbers gets larger, it approaches more and more closely to the 'Golden number', calculated mathematically (Stewart, 1998) and from this 137.5° to the 'Golden angle'. If the divergence angle is less than this, gaps appear in the seed head and only one family of spirals can be seen. On the other hand, if the angle is greater, gaps in the seed head also appear but only the other family of spirals can be observed. Efficient packing makes the most solid seed head possible, and this presumably has a relative advantage in attracting the attention of pollinating insects. (In his books, Ian Stewart gives full references to this work.)

Protozoa, Bacteria and Chromosomes

Protozoans and bacteria are not infrequently spiral shaped and rotate as they swim. *Euglena* and other flagellates move through the water in a spiral path. This recalls the different types of spirals in the animal kingdom – either temporary or patterns of growth – discussed earlier. *Spirella* bacteria are rod-shaped (eg *S. volutans* often found in stagnant water) but look like tightly coiled springs when highly magnified. Bacilli are rod-shaped while vibrios are shaped like commas. The flagella of bacteria use a hydrogen-ion gradient to rotate a helical shaft composed of flagellin.

Chromosomes consist of folding strands of DNA forming a double helix round a core of protein. Presumably the double helix must serve to condense the strand of DNA into a relatively small space. Alternatively, if the molecules cannot fit together in any other way, the condensing may be fortuitous. Like all natural amino acids, DNA is left-handed. That is to say, its molecules are laevo-rotatory and have the ability to rotate the plane of polarization of polarized light to the left. (Curiously, if amino acids are synthesised in the laboratory, equal amounts of laevo-rotatory and dextro-rotatory molecules are obtained in a so-called 'racemic' mixture.) The spiral coiling thus allows DNA to become contracted into the confined space of a cell nucleus and replication to take place as the DNA helix strands split into two.

Physicists have identified four basic forces in nature. Of these, gravity keeps the planets orbiting the sun, the stars within their galaxies and so on while electromagnetic forces hold atoms and molecules together. The remaining basic forces are nuclear and are known as the 'strong' and 'weak interaction' respectively. The strong interaction binds protons and neutrons together in the nucleus of an atom. It is the strongest force known. Both the strong and the weak interaction are of extremely short range. The latter is associated with radioactive ß-decay. The evolution of living matter depends in a very intimate way on the nature or all four fundamental forces.

The three-dimensional molecular structure of amino acids is, for instance, intrinsically asymmetrical. This explains their ability to rotate the plane of polarization

of polarized light to the left, as mentioned above. The suggestion has been made that selection may be associated with the lack of symmetry found in weak interactions: it is seen in radioactive ß-decay, the decay of mesons and other fundamental particles. If electrons from such processes are accelerated towards a target containing a racemic mixture, the right-handed molecules are destroyed preferentially. Once an initial selection of laevo-rotatory particles has been made, this would have been built into genetic structures and lead to the complete rejection of dextro-rotatory molecules as these would not have been the correct shape for them to fit into the complex cellular structure. This intriguing idea has been discussed by Ridley (1979). Alternatively, as David Butt (*in litt*., 13 June 2008) reminded me, it has been suggested that, at the commencement of life, the number might have been so small that, just by chance, laevo might have taken over and, once that choice had been made, life continued in this way (see also Marsden, 1998). Non-symmetrical shapes are said to possess *chirality* (from the Greek *khier*, a hand). Even when they are the same shape, they can only form 'mirror images' of one another. (The mirror images of a molecule are known as *enantionmires*.) As we have seen, all natural amino acids are left-handed (while sugars are right-handed) and rotate polarized light accordingly. The chirality of amino acids could even be due simply to the initial accidental choice of one original self-replicating molecule! Lewis Dartnell (2007) suggested that the enantiomires of amino acids were formed within interstellar clouds – before the birth of the solar system – and may have been affected by the polarization of UV light from nearby stars. 'If true, it is possible the enantiomer bias displayed by cells on Earth is an imprint of ancient starlight.' However, as David Butt (*in litt*., 19 August 2009) commented, light from main sequence and red giant stars is not polarized. So, if this suggestion is correct, the light in the space where the enantiomires were formed, must have come from a neutron star. This means that if biomolecules were formed elsewhere in the universe than in our own solar system, they would not necessarily be laevo-rotatory!

Discussion

Theoretical physicists have long sought to elucidate a unified theory of physics. When I began to ponder about spirals, helices and vortices, I thought that there just might be a simple comprehensive explanation for some of their adaptive functions, on all scales from the astronomical to the molecular. It soon became apparent, however, that this cannot be the case. Occasionally a cause for the direction of rotation of a spiral or helix, as in cyclones and anticyclones, reveals itself. But explanations such as this are rare. The most usual adaptive advantage of a spiral or helix lies in the fact that it packs a considerable amount of material into a relatively small space.

D'Arcy Thompson emphasised that equiangular spirals are implicit in a great many vertebrate structures in addition to artiodactyl horns. These, for instance, include teeth, beaks, nails and claws. In them, the logarithmic spiral invariably manifests itself, although it is most apparent in elongated structures such as horns and tusks. Conrad H. Waddington (1905-75), Professor of Animal Genetics in Edinburgh University, suggested that perhaps it may be developmental processes themselves which are the objects of selection rather than the final structures they produce.

Conclusion

The origins and adaptive significance of spirals, helices and vortices in the Universe has seldom been explained with the following exceptions: (1) The direction of rotation in anticyclones in the northern hemisphere, and of their equivalent in the southern, is determined by Coriolis Force; (2) Proportional increases in the sizes of ammonite, nautiloid and gastropod shells can often be interpreted biologically in the sequence of Fibonacci numbers; (3) The laevo-rotation of polarized light by amino acids could well be rotated to selection by weak nuclear interaction. Apart from these instances, there is little explanation for the direction of rotation of spirals, helices and vortices in nature.

Acknowledgements

My warmest thanks are due to Peter Cloudsley who, not for the first time, has helped me by researching on the internet. He also introduced me to the significance of Fibonacci numbers in biology. Dr David Butt kindly read a preliminary draft of the MS and I am most grateful to him for correcting my errors and for his numerous helpful comments. The MS was typed by Laura Tatham to whom I am most grateful as always.

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The "long-winged Troides": discovery of the largest butterfly in the world, in Papua New Guinea, by Albert Stewart Meek (1871-1943)

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Introduction

In transcribing letters written by English explorer/naturalist/collector Albert Stewart Meek (1871-1943) to the staff of Lord Rothschild's museum at Tring, Hertfordshire, between 1894 and 1931, several references were noted regarding Meek's capture of the largest known butterfly in the world: *Ornithoptera alexandrae* Rothschild, 1907, in the Oro Bay region of northeastern New Guinea. The circumstances of the capture of the holotype female (fig. 1) have been briefly reported previously (Rothschild, 1907; Jordan, 1908; Meek, 1913; Ackery, 1997), but the Meek correspondence contains some fascinating additional data, including a pencil drawing of the male (fig. 6) made by Meek in the field. Some details of Meek's association with *O. alexandrae* were also presented by Parsons (1998), who wrongly referred to Meek as "Alfred Stanley" Meek throughout his book.

The female holotype

In common with several other historically interesting "type" specimens of birdwing butterflies (Ackery, 1997; Tennent, 1997, 1999), the female holotype of *O. alexandrae* was shot. This is not such an extreme measure as it might first seem – birdwing

Figure 1: The holotype female of *Ornithoptera alexandrae.*

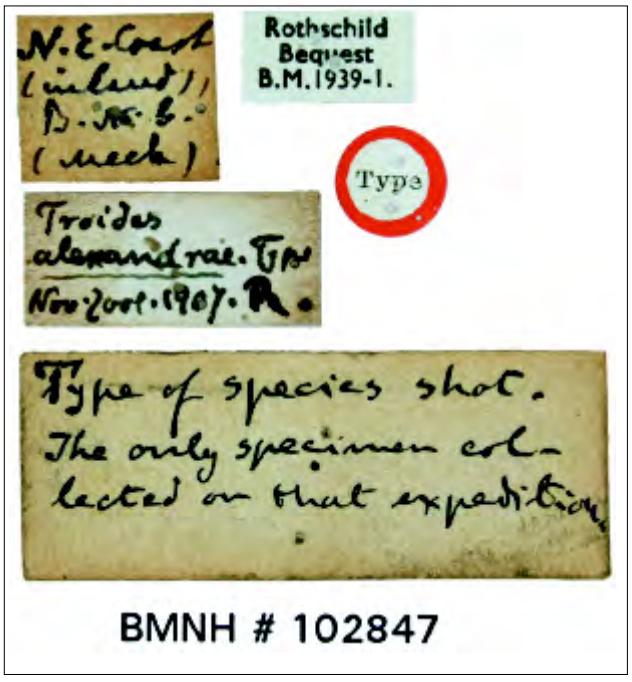


Figure 2: The holotype female of *Ornithoptera alexandrae* – accompanying specimen labels.

butterflies often fly high, and 'mustard seed' or 'dust shot' cartridges, designed primarily for shooting small birds at short range without causing damage to the plumage (Mearns & Mearns, 1998: 52) were sometimes used to shoot butterflies. This was especially so in Victorian and Edwardian times, when "collectors" were generalists, and routinely collected anything that moved – and many things that didn't. The holotype of *O. alexandrae* fared quite badly (fig. 1), with a large tear in the left forewing and many smaller holes and chips: it is interesting that Rothschild, who provided detailed information taken from Meek's letters regarding the collection of the specimen, made no mention at all of the fact that it had obviously been shot, or indeed that it was damaged. It clearly was shot (fig. 2), as Meek himself noted; Karl Jordan (1908: 13), Rothschild's Curator of entomology at Tring, also subsequently declared "the species was described from a ♀ killed by the collector with gun-shot".

With regard to its capture, Meek commented rather matter-of-factly in a postscript (fig. 3) to a letter to Karl Jordan in February 1906 (Meek, 1906a):

> Enclosed is a female of large Ornithoptera shot by me on way up only two days from coast. This one is a small [original emphasis] specimen, mostly running much larger. Females seemed to be not too uncommon, but were unable to see a male. All females are exactly like specimen I'm sending. Notice length of hind wings [original emphasis].

Meek appears to have had little inkling that he had discovered the largest butterfly in the world, and this measured account appears relatively tame – particularly when compared with the emotive and oft repeated account, including a thinly camouflaged version related to the entomologist Stein in Joseph Conrad's book *Lord Jim* (Tennent, 1990), of Alfred Russel Wallace's discovery of *Ornithoptera croesus* (Wallace, 1869: 257-8) on the Moluccan island of Bacan half a century earlier:

> …During my very first walk into the forest at Batchian, I had seen sitting on a leaf out of reach, an immense butterfly of a dark colour marked with white and yellow spots. I could not capture it as it flew away high up into the forest, but I at once saw that it was a female of a new species of Ornithoptera or "bird-winged butterfly" … during the two succeeding months I only saw it once again, and shortly afterwards I saw the male flying high in the air at the mining village … [later I] succeeded in catching a female, and the day after a fine male. I found it to be as I had expected, a perfectly new and most magnificent species, and one of the most gorgeously coloured butterflies in the world. Fine specimens of the male are more than seven inches across the wings, which are velvety black and fiery orange, the latter colour replacing the green of the allied species. The beauty and brilliancy of this insect are indescribable, and none but a naturalist can understand the intense excitement I experienced when I at length captured it. On taking it out of my net and opening the glorious wings, my heart began to beat violently, the blood rushed to my head, and I felt much more like fainting than I have done when in apprehension of immediate death. I had a headache the rest of the day, so great was the excitement produced by what will appear to most people a very inadequate cause …

However, Meek's own emphasis on "small" is quite correct; the female *O. alexandrae* holotype is unusually small, and is the smallest specimen in the BMNH series by a margin – its wingspan when "set" in the conventional style is approximately 19cm; the average wingspan of other females in the Museum's series is nearer 23cm. If the solitary female Meek obtained had been even an average sized female, or if he had collected the magnificently coloured male, he might have been a little more enthusiastic about his discovery.

In his book *A Naturalist in Cannibal Land* (Meek, 1913) – to which, strangely, Meek himself may have had limited input (research in progress) – Meek referred to the new butterfly as both *Ornithoptera alexandrae* and *Troides alexandrae*, using the generic names interchangeably, but in his correspondence, before the butterfly was formally described, he referred to it most often as "the long winged Troides", on account of the long, narrow wings of this species compared with most other described *Ornithoptera* species (*O. victoriae* Gray, 1856, was and is an obvious exception). Some months after sending the butterfly to Tring, Meek enquired (Meek, 1906b):

> I received your letter of 16th June. Was the Ornithoptera new I sent in letters? Male has long hind wings similar to victoriae, but have only seen it high up

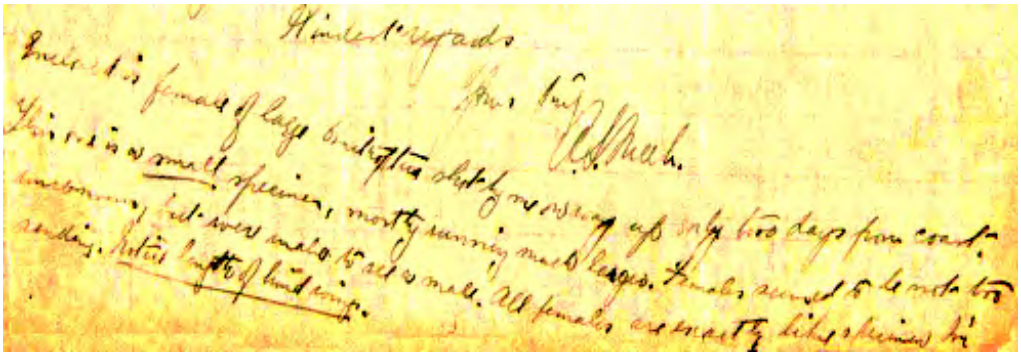


Figure 3: Postscript from Meek relating to capture of *alexandrae* holotype (Meek, 1906a).

A frustration with the early Meek correspondence is that it is one-sided; no copies were kept of outgoing correspondence from Tring at this time (the first copy of an outgoing letter to Meek is dated January 1911). However, Meek was informed that the *Ornithoptera* was indeed an undescribed species and, writing from Cape Nelson on the northeast coast of New Guinea (Meek, 1907c) he suggested it should be named after Lord Rothschild:

> I reached here yesterday evening and am proceeding to Oro Bay this evening, where I expect to get the new Troides. Should I not do so I shall have to proceed to the place where I got it last time, about twenty miles further on. I am intending to stay a fortnight at Oro Bay (in any case) to try for it. I'm almost certain it is as likely to be there as at the other place ... I do not expect to be able to send away letters for some while, but should I get the male of the Troides, I will try and get a letter away from here. Why don't you name the new Troides after Mr Rothschild! …

Rothschild was of the opinion that the new *Ornithoptera*, with its structural affinities to *O. victoriae*, named in 1856 for Queen Victoria, should be named in honour of Alexandra of Denmark, Queen Consort to the then British Monarch, Edward VII – another newly discovered birdwing species from the Arfak Mountains of Irian Jaya just a few years later, was named after Rothschild (*Ornithoptera rothschildi* Kenrick, 1911).

The first males

Having seen – but failed to capture because it was flying too high to collect – what he believed was the male of *O. alexandrae* on several occasions, Meek was anxious to tidy up this loose end, and declared in several letters to Tring his intention of returning to the Oro Bay area of northeast New Guinea (although there is some doubt about precisely where Meek was when he first collected *O. alexandrae* (Parsons, 1998: 232) with the express purpose of collecting it. The staff at Tring were keen for Meek to visit the Solomon Islands, but he was less than enthusiastic to go there "during hottest season (hurricane months)", and in April 1907 Meek mounted another expedition from his base at the island of Samarai to the area where he had shot the female *alexandrae* the previous year. He believed (wrongly as it turned out) there was a second large species of *Ornithoptera* to be discovered in the same locality (Meek, 1907a, b):

> The males of it are extremely rare I fancy, and whats more I believe there are two species of them, both exceedingly large. The one I sent you occurs at ten miles from coast, the other at fifty, [original emphasis] but still on flat land. I forgot to mention this before … . I intend collecting for a month at bottom of Collingwood Bay, until S E trade winds set in and then go along to Oro Bay or Mangrove Islands to try for the Troides of which I shot one specimen and forwarded to you. I am almost certain to get some females and hope to get the male of it. It is apparently like T. victoriae, the females appear very much the most numerous until one finds out how to get the male. I am taking up a great quantity of trade goods with the idea of getting local natives to work … I mentioned … there is yet another (I believe) large Ornithoptera on the flat, about sixty miles inland. I only saw the female, but it did not appear to have those peculiar white markings that the one I sent you had on hind wings, they are very striking when on the wing, and against the sky

The Meek correspondence is often duplicated, in that he was in the habit of writing at the same time – with similar content – both to Karl Jordan on the subject of insects,

Figure 4: *Ornithoptera alexandrae*, male reared by Meek (BMNH)

and to Ernst Hartert, Rothschild's curator of birds. There are few examples in the correspondence of Meek writing to Hartert on the subject of Lepidoptera, but the 'long winged Troides' provided an exception (Meek, 1907d, e):

> [Oro Bay] is only twenty miles or less from the place where I got the female Ornithoptera, so I anticipate getting it there also. It will be very much better should I get it at Oro Bay as natives there here have been very little touched there as yet, consequently will be more willing to work to enable them to procure trade goods. Of course the risk is slightly more, but that is more than compensated for by fact mentioned. I am trying to get all the birds possible, but am afraid you'll be disappointed … I hope I get a good series of the new Troides. I intend breeding them if possible. Its easy to get the food plant on the low lands … I went inland from there but saw nothing worth staying for as the country seemed to be all grass or undergrowth from old gardens. There was virgin forest on top of the hills but as there was no chance of getting the long winged Troides there I came on here to where I know it is. If I'm able to get the male of the Troides fairly quickly and do not see much opportunity of getting a good series, I shall probably go back there and work the hills … [I will not be able to write] for nearly a month perhaps. I hope with this will be later advice of the capture of male long winged Troides

A little over two weeks later, Meek had three females but still had not collected a male *alexandrae*. However, he had some remarkable luck in finding the larvae (Meek, 1907f):

> You will be pleased to hear I have three ♂ [he meant ♀: see later in paragraph] specimens of the long winged Troides. They measure eleven inches across wings and are I think longer than [Ornithoptera] Chimaera. I also have about two dozen Troides larvae which I take to be them. They cannot be the common one, they differ so much. These larvae vary considerably. The spines in some being all blood red with white saddle and one side each side white and tipped with red. Others have spines of orange colours tipped with black and lower two rows pure black. They have eight rows of spines which are

very long, very similar to T. victoriae from Solomons. The only thing that troubles me is that the pupae seem to be no longer than the common one. They feed on an entirely different vine. I found the first larvae by accident the first day here, and before camp was made. I've seen dozens of females but no male as yet. They fly very high.

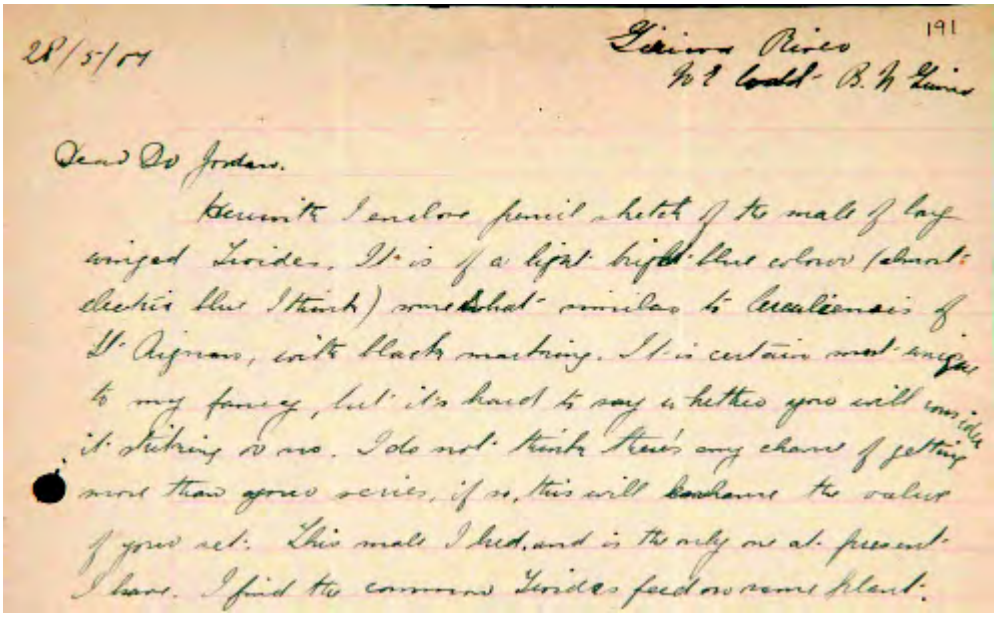
Towards the end of May 1907, Meek's fortuitous discovery of the early stages paid dividends, with the emergence of a male (Meek, 1907g: fig. 5):

Herewith I enclose pencil sketch of the male of long winged Troides. It is of a light bright blue colour (almost electric blue I think) somewhat similar to caelestis of St Aignan [*Ornithoptera priamus caelestis* Rothschild, 1898, also collected for the first time by Meek], with black marking. It is certain most unique to my fancy, but its hard to say whether you will consider it striking or no. I do not think there's any chance of getting more than your series, if so, this will enhance the value of your set. This male I bred, and is the only one at present I have. I find the common Troides feed on same plant … Apart from Troides, there is very little to be got. The country is <u>too flat</u> [original emphasis]… "

and on the 10th June (Meek, 1907j):

"I wrote you a few weeks ago about the male of the long winged Troides, sending sketch the outline of which I traced. Since then I have bred another female and have eleven pupae in hand, of which three may be males, or possibly small females … I ought to stand a chance of breeding a decent variety of the common Troides as I must have considerably over an hundred pupae. I have to buy these too, so as not to discourage the natives. The good men I pay looking glasses, knives, shirts etc. but they're hard to get. The larvae are much easier to get, but too delicate to rear excepting a small per centage

The traced sketch of the left side of a male *O. alexandrae* (fig. 6) is entirely accurate, and has been overlooked previously because although it accompanied a letter dated 28th of May 1907 (Meek, 1907g) it bears no date or indication of what it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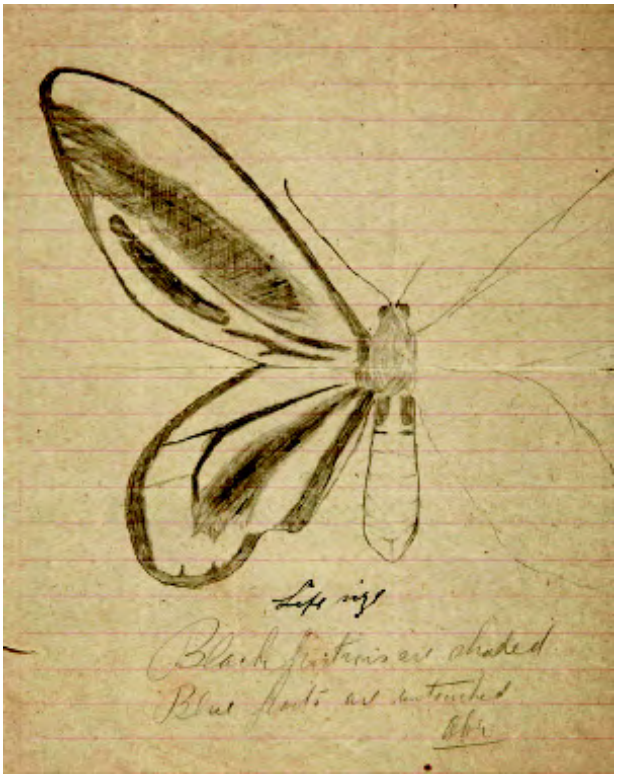
Dear Dr Jordan.

Herewith I enclose pencil sketch of the male of long winged Troides. It is of a light bright blue colour (almost electric blue I think) somewhat similar to caelestis of St Aignan, with black marking. It is certain most unique to my fancy, but its hard to say whether you will consider it striking or no. I do not think there's any chance of getting more than your series, if so, this will enhance the value of your set. This male I bred, and is the only one at present I have. I find the common Troides feed on same plant.

Figure 5: Extract from Meek (1907g) with brief description of the first male.

Figure 6: Meek's pencil sketch (Meek, 1907h)



represents, and was filed in the BMNH archive some years out of sequence, between typed letters from Tring to Meek dated 5th and 25th of February 1911. Towards the end of June 1907, Meek had reared a short series of *alexandrae* (Meek, 1907k):

> You will be pleased to hear I have this morning bred the fourth male specimen of the long winged Troides. I also have bred eight females, and captured perhaps twenty indifferent female specimens. I hope you will be pleased with this collection. One of the males measures eight and a half inches across wings and the hind wing of same specimen measures three inches in length. The old specimen of female which I shot (last trip) and sent you in envelope was a small specimen. Some of these measure eleven inches across wings, and majority go ten and a half, quite as large as T. chimaera, probably larger … I have over two hundred pupae of common Troides, besides over a hundred which have emerged and put in papers. I think there's a fair prospect of getting a fair number of the long winged Troides duplicates. Why do you not name some of my discoveries after Mr Rothschild? If this Troides is not already named I should be pleased for you to do so in this case. This insect is in my opinion most decidedly the most novel and handsome of any of my discoveries … I measured a larvae of the long winged Troides yesterday and it measured five inches, when lying along vine of food plant. This is larger than any larvae of Attacus Hercules [the saturniid moth Coscinocera hercules Miskin, 1876 – one of the largest moths in the world] that I've seen. They are very beautiful in colour. The jet velvetty black with straight ruby spines and broad cream coloured band across the middle of body forming such a pleasing and striking contrast. I have them in all stages from the egg to butterfly. Wasn't it a fortunate thing I discovered the larvae so early, entirely by accident too. I was out looking for suitable place for camp, and sat down on a log (after going about two miles to the creek intended) when my eye was arrested by seeing a Troides larvae [sic] on a leaf, just about to change skin. After that of course things came very easy for I was able to show natives what I wanted

This last section was reproduced almost verbatim in Meek's account of his expeditions to Papua New Guinea and the Solomon Islands (Meek, 1913). Meek's

contractual arrangement with Rothschild was that the Tring Museum accepted eight specimens of each insect species, and six bird skins taken in each locality from where a "collection" was to be made, all at a previously agreed price of 6 shillings and 6 pence [32.5 new pence] per bird skin, and two shillings [10 new pence] each for Lepidoptera. Birds of Paradise and Birdwing butterflies were valued separately, and specimens in excess of these numbers were forwarded by Tring to London natural history dealers Edward Gerrard in the case of birds and Oliver Janson (1850-1925) in the case of insects. Meek's rearing programme was successful (Meek, 1907l, m):

> I think I told you in a previous letter that I had completed your series of the new Ornithoptera, and will now [original emphasis] be able to pick out eight of the best and have a quantity over for Janson … I have picked out eight specimens of the best of the new Troides, which I think you will be pleased with, the only drawback is that in all the largest male specimens the bodies go greasy, but no doubt you can remedy this. I note what you say about Mr Rothschild naming it Alexandrae. The name is certainly very appropriate as you will say when you see it, for it certainly is a near relative of T. victoriae and perhaps even more beautiful and I think larger"

and later (Meek, 1907n):

> I am sending the Giriwa collection in a few days and have enclosed four pair of the very best specimens of Alexandrae and am also sending one special pair by parcels post for Mr Rothschilds acceptance. This is in case collection should get lost and because I'd like him to see what it is like quickly, and firstly … Alexandrae does not occur further inland than about twenty miles … Enclosed with your collection is a small parcel for Mr Janson in which are thirty nine pairs of T. Alexandrae

A proportion of the material Meek sent to Tring was set in the field – a remarkable thing to do in view of the time taken to do so, extremely difficult rain forest conditions, and added difficulty in transporting and looking after set specimens. But this was presumably part of his contractual obligation with Tring. A disadvantage in transporting set material was that – predictably perhaps – a certain amount of damage was unavoidable in sending a collection back to the UK, however carefully packed, and this was the case with *O. alexandrae*. Although a 'papered' pair was sent by letter post (Meek, 1907p), the bulk of the collection, sent by sea, arrived with some damage:

> For your acceptance and in case of possible delay in collections reaching Tring I am sending by letter post one pair of Troides Alexandrae. The male is rather a light blue specimen and was bred on "Shamrock" [Meek's own boat] on the way down along N. E. Coast …and later (Meek, 1908a) … The reason I did not pack them separately was because they seemed to fit so nicely into the box and I thought it impossible for them to move. Mr Hartert writes me that the Troides in collection are slightly damaged. If you

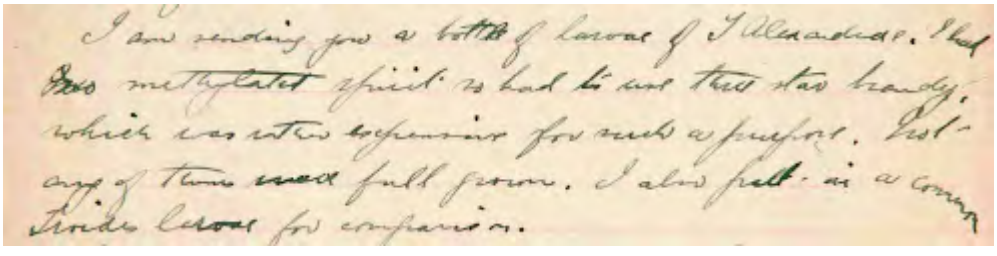


Figure 7: Extract from Meek (1908b) regarding the larvae of *O. alexandrae*.

Figure 8: Preserved larva of *O. alexandrae* (ex Meek) (BMNH)

> will tell me what loss there is I will try and remedy it, as I have kept three pair here and will make good the damage out of them

It was not only adult butterflies that Meek sent to Tring: he also sent O. alexandrae larvae, preserved in rather expensive alcohol (Meek, 1908b: fig. 7):

> I am sending you a bottle of larvae of T Alexandrae. I had no methylated spirit so had to use three star brandy, which was rather expensive for such a purpose. Not any of them were full grown. I also put in a common Troides larvae [sic] for comparison

and later (Meek, 1908c):

> I am sending a parcel, [word removed by hole punch] some larvae of the T Alexandrae [word partly removed by hole punch] and three or four bird skins

In the *Ornithoptera* collection at the BMNH, there are five preserved larvae of *O. alexandrae*, each labelled "larvae from Kumusi R[iver]. A. S. Meek. The rather bedraggled condition of these specimens (fig. 8), and the fact that no mention is made by Meek of ever having sent any dried specimens, suggests that these were the larvae sent by Meek in brandy, subsequently dried out and mounted by the staff at Tring. At least one has been "stuffed" with wadding, in the manner of a bird skin. The larval host-plant, *Aristolochia* sp. (Aristolochiaceae), was also sent to Tring (Meek, 1908d):

> I also sent you for Dr Jordan, the food plant of Troides Alexandrae. The vine grows very much larger almost as thick as a mans leg and bear a fruit somewhat like a thick vanilla bean which grows from the main vine in bunches of two or three. I tried to dry some but they rotted and fell to pieces.

The plant was confirmed at the Royal Botanic Gardens, Kew, as an "unidentified" species of *Aristolochia* (Meek, 1913: 174 [footnote added by Karl Jordan]). This was presumably *Pararistolochia schlechteri* (Aristolochiaceae) the primary larval host-plant of *T. alexandrae* on which the butterfly was thought for many years to be monophagous, although it is now believed that the species also utilises other similar species of *Pararistolochia* (Parsons, 1998: 234). Meek's 1907 expedition was very successful, but a return visit to the same locality in June 1908 (Meek, 1908c) was less so:

> After discharging cargo I got carriers and went inland to where I got the T Alexandrae. I did not succeed in getting any quantity but got a lot of fever and sickness instead

Troides alexandrae remains the only butterfly species afforded full protection under CITES Schedule One, due to its restricted distribution in eastern New Guinea and its undoubted commercial value. Whilst it is known that insects and birds in excess of Tring's "requirements" were forwarded to London natural history dealers for sale, the number of *O. alexandrae* (at least 49 pairs) sent by Meek directly to Janson as a result of his field rearing programme suggests that many specimens of these magnificent insects remain in private hands.

The Meek correspondence contains a wealth of specific and general data concerning Meek's travels in the southwest Pacific and the very real difficulties he and his contemporaries encountered travelling in the region at that time. A biography of A.S. Meek, largely based on this correspondence, is in preparation.

Acknowledgements

Polly Tucker, BMNH Archivist, facilitated examination of Meek archive material; the extracts from correspondence were kindly provided by the BMNH Photographic Unit. Phil Ackery was most helpful in discussing the BMNH collection of Ornithoptera butterflies.

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The state of botany in the British Isles about 1815 as reported by Christen Smith

Per M. Jørgensen, FMLS

Introduction

While writing a book about the history of botany in Norway (Jørgensen 2007), I had to go through much archive material including many letters from Norwegian botanists, and not all of them related to Norway. I shall here quote in translation a letter written by Christen Smith from London in March 1815 to his friend and colleague the professor of botany in Copenhagen, Jens W. Horneman (1770-1841), since it describes the level of botanical knowledge at that time in the British Isles, as well as giving personal impressions of the botanists he met and of the British landscape and its gardens.

Who was Christen Smith

I guess that most botanists connect Christen Smith (Fig. 1) with the Canary Islands where he did pioneering work and described many plants, including the well-known *Pinus canariensis*. It may therefore come as a surprise that he was Norwegian and that he made botanical excursions also in the Scottish Highlands during a trip to the British Isles just as he had become professor of botany in Christiania (Oslo). Christen Smith was born into a wealthy merchant family near Drammen in Norway in 1785 (Munthe 2006, from which much of the data in this chapter originates). Already as a boy he took an interest in plants and after having finished school started to study medicine at the University in Copenhagen, and at the same time followed lectures in Natur-historieselskapet (i.e. The Natural History Society, a private organization) by the botanist Martin Vahl (1749-1804) (Jørgensen 1999). He finished his medical training in 1808 and started practising medicine at the Royal Frederic Hospital there, though in the years 1810-12 he made noteworthy plant-collecting trips in the montainous regions of Norway, proving himself to be a most able botanist. He participated among other things in the work of the prestigious 'Flora danica' of which Hornemann had become the editor after Vahl's premature death. In 1814 Smith became the first professor of botany at the new Norwegian university in Christiania (Oslo), a position he declined to accept before having finished a European tour (see note 15) to study the state of botany abroad for up to $1^{1}/_{2}$ years. This was granted, and he started with a visit to Great Britain (probably due to the unrest on the continent in the Napoleonic period) where he became involved in expeditions to exotic countries, but before that he managed a short visit to Scotland and Ireland on which he reported back to Copenhagen in the letter below. Later he was invited on a trip to the Canary Islands by his friend L. von Buch who happened to be in London. They sailed early in April 1815, shortly after this letter was written, and collected for half a year with great success. On his return to London in December 1815, Smith planned to return to Christiania through the continent, visiting Paris and other major continental botanical centers. However, Sir Joseph Banks (1743-1820) who had befriended Smith, had other plans for this gifted botanist. He

Figure l. Christen Smith, the only existing portrait, by Heinrich Gross.

more or less ordered him to join the Congo expedition. “It is your duty!” he wrote in a letter, offering Smith the job as naturalist on the expedition with the right to decide which trees should be cut down to feed the steam-engine of the ship (that project was eventually abandoned, and they used a sailing ship). They sailed on the 16th of February in 1816, and made a short stop at the Cape Verde Islands where Smith took the opportunity to collect while the ship was overhauled and resupplied with food etc. They continued on the 29th of April only to find that it was not possible to sail up the Congo river for more than a few miles. They then had to continue on foot which proved disastrous. Under these conditions it is a miracle that Smith managed to collect any plants at all. Smith was one of the few who managed to return to the ship at the coast (Fig. 2), but he was very ill and as they set sail and turned North to return, on the 22th of September, Smith died. His body was lowered into the sea at a place called ‘Tall trees’. Fortunately his collections were well taken care of by the gardener from Kew, David Lockhart (d.1846), and were carefully studied by Robert Brown who published a full account of them (Brown, 1818). He named one new tree genus after Christen Smith, *Christiana* (Fig. 3), as he believed his name was Christian.

Smith’s letter

This is cited in full as translated by me from a printed version (Dahl, 1894), double checked with the original which still exists in the archives in Copenhagen (Fig. 4). The latter proved necessary since Smith’s handwriting is notoriously difficult and some misunderstandings, particularly concerning names, occur. I have added some explanations in brackets or as separate notes to facilitate the understanding of the text:

Dear Mr. Professor London 28th March, 1815

I have for a long time hoped to find a direct possibility to reach you in Copenhagen with my written account and greetings, and I must now, as I am about to leave English soil, leave these lines in my friends’ best care. As you most probably have heard from Siebke [i.e. Johan Siebke, 1781-1857, the head-gardener of the newly established botanical garden in Christiania], I left Norway in June last year. Unfortunately I had to spend most

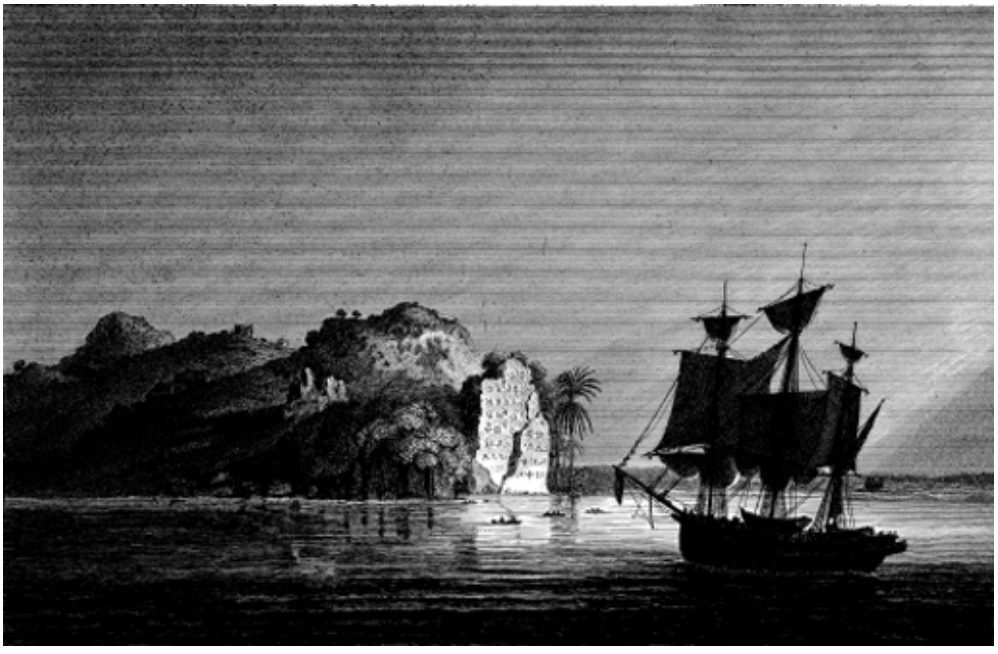

Figure 2. 'The Congo' at the Fetiche Rock at the outlet of the Congo river not far from where Smith found his final resting place. From Captain Tucker's report (1818).

of the summer in Norwegian outports and on the North Sea, and I landed finally on the east coast of England in August. In spite of this, I was unable to give up my plan to visit the Highlands of Scotland, though I made a hurried visit to London, Kew and Hammersmith. On the 5th of September I wandered from Edinburgh along the east side of the country, passed Inverness to the middle of Rosshire, and criss-crossed the mountainous regions as well as climbing every mountain of some importance, until the snow forced me down to the lowlands towards the end of October. It would be too much to expect to be able to discover any new plants for a country which is so often and carefully studied. I had to be content with a couple of mosses and a *Draba.* The country is anyway poor in plants as is evident from its isolated position and the influence of the ocean as well as the low altitude of the mountains which hardly exceed 4400 feet [= c.1300 m] and accordingly do not reach the nival region with its specialities. I do not regret, however, that I spent six weeks there in constant rough weather and hardship. No one has as yet offered any attention to the geographical and physical aspects of the vegetation, which in comparison to that of Nordic countries was of particular interest to me (1). As the season left much to desire, and the records in 'Flora Britannica' [by J.E.Smith, 1800-1804] as well as 'English Botany' [by Sowerby and Smith, 1790-1814] leave much to be desired (2), I called upon Scottish botanists to go through their herbaria. The industrious and famous Don [must be George Don senior, 1764-1814] from Forfar whose interesting discoveries are well-known, had to my sorrow unfortunately become a victim of his own zeal for botany (3). His herbarium was in great disorder and left me with much doubt. In the eastern parts of the Grampians and particularly around the valley of Clova, a remote part, from where he had most of his rarities, which have not been examined before or after him, I refound some for Scotland strange plants, although not all of the ones he had recorded. I had particularly wanted to see the Canadian *Potentilla tridentata* (perhaps the same as *Potentilla retusa* of 'Flora danica') (4). There is every reason to believe that Don's records are more reliable than those of Smith [i.e. J.E.

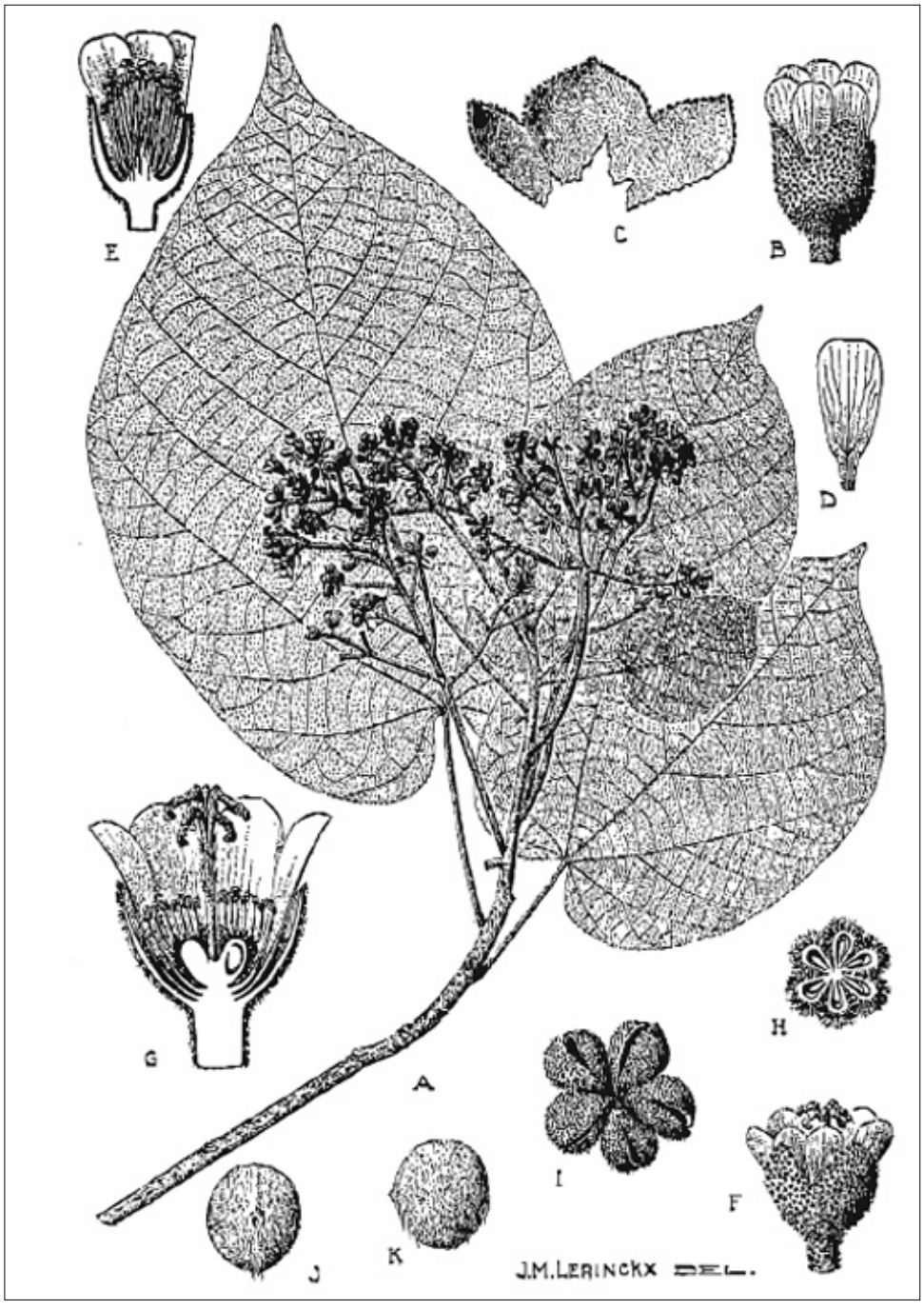

Figure 3. *Christiana africana* as depicted in Flore du Congo (1896).

Smith] who claims to have discovered *Rubus arcticus* and *Cardamine bellidiflora* (5), a regrettable expression of his desire to expand the catalogue of British plants. This inclination has prevailed in his work rather than adopting a real scientific approach, as is also obvious from his perpetual species-making. I found a complete representation of British plants in the collection of the most forthcoming nobleman Brodie [i.e. James

Brodie, 1744-1827, of Brodie House] (*Fucus brodiei* is named after him) and in many places collections of living native plants. On the northern, eastern and central peaks of the Grampian Mountains, there are many hints of Nordic vegetation, even *Phyllodoce coerulea* (6) has been found here. The southern mountains and the lowlands have many plants in common with southern parts of Europe and on the western isles one meets with the North-American *Eriocaulon septangulare* in quantity, but of plants exclusively known from Scotland I know only of *Stellaria scapigera, Alopecurus alpinus* and a new *Veronica* called *hirta* (7). Dickson's [obviously in his *Fasciculus Plantarum Cryptogamicarum Britanniae*, 1783-1801] many strange mosses are for the most part imperfect descriptions and false drawings of old, well-known species.

The Scottish mountains are in no way attractive. The grace and variation in the scenery which has repeatedly, close to boredom, been referred to, is in my mind restricted to a few parts by the large lakes. The tree-limit occurs already at 1200 feet [about 350m]. All mountains, even the lowest, are accordingly bare, and the plains between them perpetual heaths or bogs. On the western side of the country, like in Norway, the mountains are steeper and higher, but also totally treeless as a result of the temperate climate which is constantly wet all year around, favouring grass- and moss-vegetation which covers the mountains and gives them a characteristic, pleasant look.

Nor has the famous Scottish farming been able to spread into the Highlands. Vast territories belong to noble families who recently have found it beneficial to use the land for sheep-grazing rather than to claim the small tax they might have received if they had rented the land to their subjects, the ancient Celtic farmers, who have been forced to emigrate in thousands to the big industrial cities or to America.

I spent some quite interesting weeks in the lowlands and Edinburgh. Among natural history scientists in the latter place, I particularly remember the amiable Professor Jamesson [most probably Robert Jameson, 1773-1854], Mr. Maughan [most probably Robert Maughan 1769-1844] and Neil [i.e. Patrick Neill, 1776-1851] secretary of the Wernerian Society (8). There are on the whole very few persons in Scotland who take an interest in botany, while mineralogy is studied even by ladies.

I left Scotland in December and travelled through the northwestern part of England and made a few excursions from Holyhead to Ireland. I made the acquaintance of many interesting, most obliging persons, particularly Prof. Gieseke [i.e. Georg K. Gieseke, professor of geology], in Dublin who made my fortnight long stay there most pleasant. In Dr. Taylor [i.e. Thomas Taylor, 1786-1848]. I found the best bryologist I have ever come across, a man to whom this branch of botany will have much to thank for. We made numerous excursions in the vicinity of the city, and I was particularly struck by the wealth of rare mosses which is present in this country as a result of the mild climate which does not leave any rock or treebole uncovered, and makes excursions in the winter as enjoyable as in the middle of the summer. I did not manage to see the admirable Miss Hutchins [i.e. Ellen Hutchins, 1785-1815]. She had been attacked by a serious illness [tuberculosis according to Wikipedia] which recently has robbed science of one of its best cryptogamologists. Moreover, the time of the year was not suitable for a visit to Bantry Bay where she lived, and which has become so famous for the many aquatic algae she has discovered. There they are well at home and are said to be luxuriant.

Neither did I manage to reach the delightful region of the lakes near Killarney where shrubberies of *Arbutus unedo* are found.

I had to return to England and arrived in London in January.

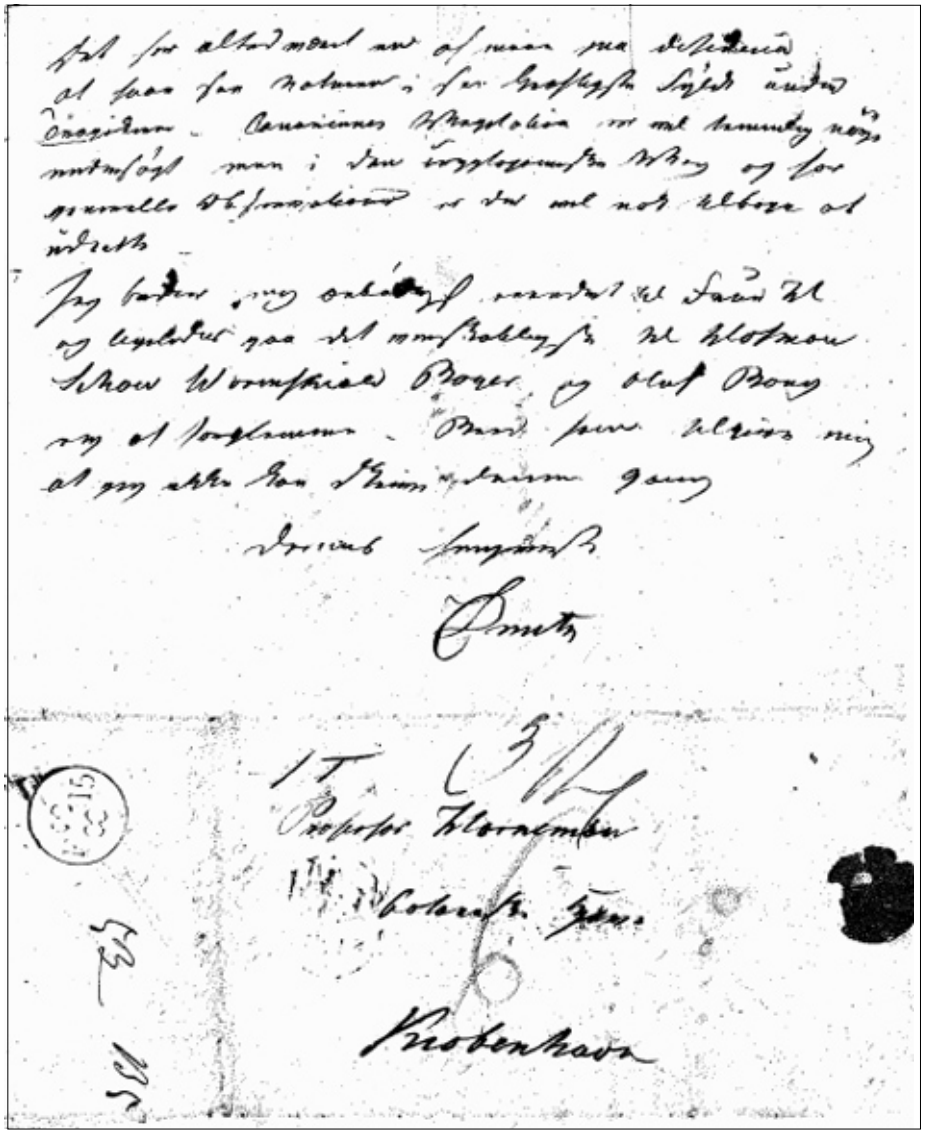

Figure 4. The envelope and last page of the letter with Smith's signature. Original in Botanisk Centralbibliotek, Copenhagen.

During my journey I took special care in visiting botanical gardens of good standing to become known with and by them in order to establish connections to the new garden in Christiania and to increase the exchange of plants with the garden in Copenhagen. As you know they are not so willing to communicate with continental gardens, possibly since we as poor beginners have little to offer in specimens and/or money (9). We need to draw on their kindness and give promises for the future. I received, however, many assurances that we could expect their assistance in the best possible way, and furthermore that they would start communication with Copenhagen at the first possible hint.

I believe this should be of mutual benefit since the English gardens are as poor in European herbaceous plants as they are rich in exotic trees and bushes. This is quite evident in the garden in Edinburgh. The professor [i.e. Daniel Rutherford, 1749-1819] is generally

called “the old wise”. The head-gardener, however, Macnab [i.e. William Macnab, 1780-1848] is very industrious (10), and eager to develop contacts on the continent. In Liverpool there is a new, elegant and in many ways excellent garden which has been founded by private funds, through subscription. It might soon have surpassed any in the country, including Kew, if the interest for further investments had not cooled in later years, and they have been forced to turn it into a commercial nursery. The curator and head-gardener Mr. Shepard [i.e. John Shepard 1764-1836] is, however, most anxious to expand the collection and is willing to provide others with surplus material. With more money it would have been possible to achieve more than did the Jews of Hammersmith. I have nowhere seen a better collection of bulbous plants and succulents.

In Dublin there are two gardens. One belongs to the Dublin Society and is of considerable size with many merits, but more shortcomings. On the whole one would expect more for a yearly income of £1400. Both the professor and the gardener are in the same league as those in Edinburgh. – The garden of the university was established a few years ago and is totally run by Mr. Mackay [i.e. James T. Mackay 1775-1862], a man whose zeal British botany owes as much to as that of his work in the garden and his friendship to me. You will find him a worthy correspondent for the garden. In spite of the restrictions of the terrain and money, the collections are considerable and already surpass the garden of the Dublin Society.

In Hull there is also a newly established garden, which is still in its infancy. The garden in Oxford is at the moment just for the amusement of the professors, and that in Cambridge, which I have not seen, is reported to be in decline after Don’s death, and Chelsea has nothing left of its former glory except some proud, old specimens but there is hope that this may change under the energetic manager Mr. Anderson [? George Anderson, d.1817].

About Kew and Hammersmith I have little to report which you do not know already. As you know, Kew is too proud to be involved in trade with other gardens. They lose yearly many rarities which they accordingly have to replace. Still it is particularly the English gardens which are anxious not to communicate or to send presents to the continent. Aiton [i.e. W. T. Aiton, 1766-1849] has, however, given very galant promises. – He has recently again published ‘Hortus Kewensis’ . He has saved many plants which are said to have been lost in the gardens and some which have never been planted there. A most noteworthy example is *Primula finmarkica.* The garden has at the moment one gardener in Australia, another in Brazil, as well as one in South Africa. – I spent some time at Kew and in Hammersmith. Lee [i.e. James Lee, 1754-1824, at Vineyard Nursery at Hammersmith] was particularly sympathetic towards me. For the small sum of money which the University had assigned to me to buy seeds, I got hold of some from the Cape and Australia which I have forwarded to Siebke. I presume that he learnt how to raise *Proteae* and *Banksiae,* etc, when he was at Hammersmith. They are so rare in cultivation on the continent, though they grow like salad here, and I hope that next year he may send them some which they do not have. – I have with gratitude noted your generous contribution to our new development, as communicated by Siebke. Your kindness for Norway and our cause is remarkable as our paths departed (11). – Back in London, I have been staying close to the focus of scientific botany in this country – Soho Square – and have daily visited the Banksian library and have profitted from the praiseworthy liberality of Sir Joseph Banks. Dryander’s [i.e. Jonas C. Dryander, 1748-1810] place has been taken by a young talented man Mr. Brown [i.e. Robert Brown, 1774-1858] who will soon most probably be mentioned as one of the leading persons within our science. You have possibly heard that he followed captain Flinders [i.e. Mathew Flinders,

1774-1819] on an expedition to Australia [in 1801-05], but you have hardly yet seen his excellent work on Australian plants, the first part of which was issued in 1810 [i.e *Prodromus Florae Novae Hollandiae et Insulae van Diemen*], as he keeps this edition until the second part is finally printed (12). As well as in these works as in his monographs on Proteaceae and Asclepidaceae he has discovered the ways of nature and has enriched our understanding by his many interesting observations, so that even the French, including old Richard [i.e. Louis C.M. Richard, 1754-1821], mention him with deep respect.

Among the foreigners I have met at Sir Joseph's, I remember a certain Mr. Siez (?), pupil and successor of Mutis [Jose C.B. Mutis, 1760-1817] in Santa Fe de Bogota (in Colombia) who asked much about you. – Humbolt [i.e Alexander von Humbolt, 1769-1859] had been here just before I arrived in England. They say he is determined to travel to the high plateau of Asia when he had finished with the publication of his works. Bonpland [i.e. A. Bonpland, 1773-1858] was also here.

After the death of Empress Josephine [he described the plants of her gardens at Malmaison], his patroness, he has chosen to settle in South America. I have still to make a tour in the eastern parts of England, to Sir Edward Smith [i.e. James Edward Smith, 1759-1828] in Norwich, Dawson Turner [1775-1858, banker in Yarmouth, cryptogamologist and Hooker's father-in-law] and Hooker [i.e. William J. Hooker, 1785-1865] in Yarmouth. The latter has repeatedly invited me for a visit. I presume you are aware of his recollections of Iceland [in 1809] and the accident that lead to the loss of his collections. Last summer he travelled in Switzerland and among other things, he brought with him Humboldt's South American mosses to describe and publish on.

He has recently published an excellent, but according to the prevailing trend, costly opus on '*Jungermanniae Britannicae'* and he is together with Taylor working on a *Muscologia Britannica.From* Turner and Borrer, a very good lichenologist [i.e. William Borrer, 1781-1862] a '*Lichenographia Britannica'* is soon to be expected. Sowerby and Smith have sent me English botany. Some parts and the illustrations of certain families can be purchased separately. I have ordered Lichenes and Confervae which are regarded as the best parts of the work. Musci on the other hand are poor with both extremely incorrect descriptions and drawings. (13). – Among the physiologists a Mr. Knight [i.e. Andrew Knight, 1758-1838] is particularly distinguished by his many sharp observations. A mistress Ibetson [i.e. Agnes Ibetson, 1757-1823] also appears with many new observations, but as she only makes use of a solar microscope, so she must in her reflections only be classified among Mirbel's [i.e. Charles F. Mirbel, 1776-1854] discoveries (14).

It was my original plan to leave England in March and to travel to France to spend some time in Paris and in southern parts, with the rest of the summer in Switzerland and northern Italy, and to spend the winter in Germany, finally to reappear in old Copenhagen. (15). Just as the war broke out again [i.e. the Napoleonic wars] on the continent, I luckily got other ideas, and it may sound a bit eccentric to you that I am now about to leave the bloodstained soil of Europe for the peaceful gardens of the Hesperids – The Canarian Islands. The well-known Baron Buch [i.e. Leopold von Buch, 1774-1853] who had heard me mention how interesting it would be for me with such an excursion, proposed that we should join forces and soon my cursory wish had become a reality. Tomorrow we leave for Portsmouth where the ship is ready to sail at the first favourable wind. On the route we shall call at Madeira for a few days.

It has always been one of my desires to be able to observe Nature at its greatest abundance under the tropics. – The vegetation of the Canaries is fairly well-researched, but in the

studies of cryptogams and in general there is certainly much to be discovered.

I ask you to give my regards to Mrs. Horneman and also friendly greetings to Hofman, Schouw, Wormskiold, Bayer and not to forget Oluf Bang (15). Ask him to forgive that I cannot write to him this time.

Yours sincerely C. Smith

I believe I shall return in August. [as a matter of fact he returned on the 8th of December].

Concluding remarks

A general and very distinctive feature of this letter, is Smith's direct style and analytic argument, a feature I hope my translation has managed to retain. He is as sharp in his comments on botany as in that on persons, and I have often found him to be correct though his distrust of some British botanists and trust in others sometimes leads him astray. He appears to have inherited his teacher's, Martin Vahl's, general suspicion of British botanists. Vahl particularly loathed Sir Joseph Banks whom he accused of wanting to take an undeserved leading position in botany (that is to take over the role of Linnaeus) (Jorgensen 2000). Interestingly, Smith like many of his contemporaries became fond of the open house of Sir Joseph who included him in his inner circles, a friendship that proved to be fatal for Smith as Banks was the man who picked him for the ill-fated Congo-expedition on which Smith died.

It is also interesting to note the tendency for British botanists already then to claim that they had found rare, very Arctic plants in the mountains of Scotland, something that made Smith, the great explorer of the much higher Norwegian mountains very suspicious. He wanted to see the specimens, or even better, the plants in the field.

The claim of unwillingness on the British side to co-operate with continental botanists, particularly in exchange of seeds between botanical gardens is also noteworthy, particularly his comments about the Kew policy.

Notes

1. This proves that Smith was thinking of making contributions in the field of plant geography and vegetation both in Norway and elsewhere, but his premature death unfortunately prevented this. In Scotland such studies started modestly with W. MacGillivray's (1796-1828) account in 1855 of the landscape of Dee and Braemar, and in Norway the first vegetation survey was published in 1841 by the Swede W. Hisinger (1766-1852) (Jorgensen, 2007). Both were published privately, indicating that the establishment was doubtful about their value. Only at the turn of the century did vegetation studies become more standard (the turning point, at least in Scandinavia, being the publication of Warming's pioneering book in 1897), so Smith was certainly far ahead of his time.
2. This is a surprisingly restricted selection of available floras of the region, done perhaps since these were the most recent ones. Lightfoot's *Flora scotica* would be a more relevant work for the region, but was probably outdated, as it was published in 1777.
3. George Don Sr. died in January 1814 after having neglected both his business and his health due to his botanical activities. In 1813 he faced bankruptcy and still

went on a collecting trip during which he caught a heavy cold which he had no time to nurse on his return due to his economic circumstances, so he died prematurely in January of 1814.

4. *Potentilla tridentata* does not occur in Europe including Scotland, and the record was surely one of Don's mistakes (see e.g. Raven & Walters, 1956). The nearest locality is in Greenland from where the cited plate in *Flora Danica* originates, though its identity is obscure (Lange, 1897).

5. *Cardamine bellidiflora* has until this day not been reliably recorded from the British Isles. However, there are several independent records of *Rubus arcticus,* which according to Stace (1991) was reliably collected for the last time in 1841 and is probably extinct at the moment, but presumably present when Smith visited.

6. This species had just been discovered in Scotland in 1812 by Robert Brown near, Aviemore (Clarke, 1900).

7. None of these are endemic, but the grass *Alopecurus alpinus* has a most isolated occurrence in Scotland, and it had just been described (in 1803) from there by J.E. Smith on material collected by Robert Brown in the mountains of Lochnagar. It was not known to occur elsewhere, while it actually has a wide distribution in Arctic regions of Europe and Asia (but is not known from Scandinavia). The *Veronica* is in all probability the plant that had recently (1813) been named *V. hirsuta* by Hopkirk in his flora of the Glasgow-region *(Flora glottiana),* a plant which Smith had not seen, but heard about. It is just a synonym of the widespread *Veronica officinalis.* I have been unable to trace the *Stellaria,* the identity of this name thus remains obscure.

8. The Wernerian Natural History Society was named after the German Abraham Gotlob Werner (1750-1817), the founder of scientific geology and of the "neptunic" school which claimed that the rocks originate in the ocean by sedimentation, as opposed to the "volcanic" school. The society also had an interest in botany and both Robert Maughan and William McNab contributed botanical papers to their memoirs (Fletcher & Brown, 1970). Neill was later instrumental in the establishment of the Botanical Society of Edinburgh (1836).

9. While this certainly was the case for the garden in Christiania, it can hardly have been the main reason, as the garden in Copenhagen had been established about 200 years earlier, and many continental gardens are older than any of the British. Probably political reasons were of greater importance, at least for Kew where Sir Joseph Banks, the man who tried to build a botanical empire according to Vahl, resided.

10. Smith obviously did not meet the Regius Keeper, Prof. Rutherford, who was old and in poor health. He was mainly known to work with chemical experiments and had little interest in plants as such, but was lucky to have got William Macnab as his latest (of five) head gardener (Fletcher & Brown, 1970). Macnab had also become the curator of the garden from 1810.

11. Norway had just separated from Denmark after a union for about 400 years, just as the Danish king after much hesitation was about to establish a new university in Christiania (Oslo) to which Smith was appointed the first professor of botany (by

the new Norwegian King Christian Frederik). Smith was very eager, as is obvious from the letter, to get plants to the new garden. Interestingly the political separation of the countries did not have a negative influence on the academic contact between Norway and Denmark, and particularly those men who had studied with Martin Vahl, kept in close contact throughout their lives.

12. It is comforting to see that Smith actually met Robert Brown and thought well of him since Brown was the man who took care of the publication of Smith's collections from the Congo, something of which none of them had the slightest idea in 1815. The second volume of his Australian plants was never published (Stafleu & Cowan, 1976).
13. In this part of the letter Smith gives important clues to the publication history and dates of several standard works of British botany.
14. Mirbel was known as a sharp observer in the microscope who, however, was said to pay too little attention to plants in nature.
15. Here we find Smith's original plan, proving that he, to begin with, had planned a grand tour in Europe before he was tempted into his exotic adventures which cost him his life. He never saw Copenhagen again.
16. These are all Danish naturalists and friends that Smith knew from his student days in Copenhagen.

Acknowledgements

I am primarily indebted to the libraries of the University in Bergen and Copenhagen for their assistance, particularly Asta Lunde Nord for providing me with the original letter and rare old literature. Prof. John Birks, Bergen has been my constant reference to the British literature and flora, and Prof. John McNeill, Edinburgh provided me with interesting information on old Scottish botanists and also read a draft of it, commenting on the text. Beate Helle as always, kindly assisted in preparing the illustrations. Above all, thanks go to my wife, Gerd, who assisted in the translation and who also googled very much to find data about old botanists.

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Book Reviews

Darwin's Universe – Evolution from A to Z, by Richard Milner
University of California Press, Hard back, 488pages, ISBN 978-0-520-24376-7.

No-one could have been left in any doubt that 2009 had special importance in relation to Darwin. The Darwin book industry, always a healthy business, went into over-drive, often publishing more than one volume a week, rising to three or four around significant anniversary dates. Any excuse seems to have been used to add Darwin's name to the title of any book in order to capitalise on the bicentenary of his birth.

It was relatively easy to pick out the worthwhile titles released by the Darwin 'specialists', who added to our knowledge by their detailed studies. However, there was one outstanding publication that gave me so much pleasure that I was most happy when I was asked to provide this review. Each week I scanned the Amazon website to see what new titles had appeared and in February up popped *Darwin's Universe – Evolution from A to Z* by Richard Milner. I knew he had been asked, by the Programmes Committee, to come and 'perform' at an evening meeting in November, so with the added incentive of a pre-publication discount offer I ordered this volume!

What a great and pleasant surprise it was when it arrived! The extraordinary dust jacket with its myriad of subtle vignettes indicated something special and different may well be inside the covers. I was not disappointed – Richard Milner, building on his earlier work the *Encyclopaedia of Evolution*, has produced an outstanding reference volume. Based on an overview of Darwin's life and works it is supplemented with hundreds of articles on all those individuals that have carried on the development of his concepts, developing whole new research programmes, whilst ensuring the cartoonists and public battles waged down the years are all given space. As the book's flier says, 'it illuminates the ways in which ideas of evolutionary biology have leapt the boundaries of science to influence philosophy, law, religion, literature, cinema, art and popular culture'. Every imaginable link to Darwin's work from his contemporaries to present-day researchers has been itemised with essays prepared by Milner in an alphabetical compendium. His essays are written smoothly and with flair and clarity, often with humour and personality that gave me a great deal of pleasure. Written for the layperson, but at all times supported by clear and appropriate science throughout. I feel this is a 'must buy' for any biologist to have in easy reach of his/her desk. Here is a reference source to all the individuals and activities surrounding the world of evolutionary science from Darwin to today. Milner's personal approach adds flesh to all the subjects he tackles but the 'problem' is whilst looking for a particular reference, one is seduced into reading the adjacent article by the title or an image that one has not seen before.

Richard Milner duly arrived at the Society to give his 10th November presentation, 'Charles Darwin Live at the Linnean', needless to say it was a bravura performance, with music, songs and science. Although I had dipped pretty extensively into his book in the intervening period I now understood the skill and care this author had put into his magnum opus to ensure the world at large can see and understand what Darwin's legacy is for all elements of life and society today.

Richard Milner's in depth research has uncovered and presented hundreds of images of people, animals and fossil drawings, cartoons, posters and much else, in a style that is reminiscent of the publications in Darwin's time. The University of California Press is to be congratulated on producing this fine volume to the highest standards. If I am ever asked what single book I would take if marooned on a desert island it would be this one. It is a compendium of stories to entertain, stimulate and enjoy that will give pleasure over many years. Certainly my best buy in Darwin's Bicentennial Year.

GREN LUCAS

Footnote: Richard Milner read a little too much into the history of the birth of the Linnean Society which of course was started by Smith in 1788, not when the collections were purchased by the Society in 1829. They were bought directly from Lady Smith who had offered them, in their entirety, to the Society first! As Treasurer I am only to well aware how long it took the Society to pay off the loan! Gren Lucas.

Scientific expeditions to the Arab World 1761-1881, by Jan Marten Ivo Klaver. 256 pp., illus., 2009. The Arcadian Library, in association with Oxford University Press. ISBN 978-0-10-056889-5. Price £95.

It is a rare event for such a lavishly illustrated book to appear on the theme of European exploration of Arabia, or to use the title's phrase 'Arab World' since this encompasses a wider swathe of North Africa and S.W. Asia. Based on works held in a private library in Switzerland, this account is not only about pioneering expeditions but also about the books, and notebooks, in which the explorers' discoveries were recorded. The Society's involvement in supplying images is acknowledged in the preface, along with assistance by several Fellows.

The introductory chapter sets the scene by outlining early investigations of the fauna and flora of the region, ranging from Herodotus' rather fanciful accounts of winged serpents to the more sober recollections of the Dean of Mainz, Bernhard von Breydenbach who made a pilgrimage to the Holy Land in 1483. His *Pereginatio in Terram Sanctam* (1486), one of the first travel books ever to be printed, contains the first western illustration of a giraffe. Other early explorers included Pierre Belon du Mans, Leonhart Rauwolff, John Chardin (whose inclusion is welcome but surprising, since his journeys focussed on Iran) and the Revd. Thomas Shaw, discoverer of Shaw's Jird. The book also touches on the travels of Joseph Pitton de Tournefort, though I would question the author's statement that the mission was to Georgia; the destination was in fact Armenia, and Tournefort's plant collections from Turkey, including East-Central Anatolia (then populated mainly by Armenians) laid the basis for much of Linnaeus' knowledge of the Near Eastern flora.

The four main chapters of the book each describe a phase of exploration of a different part of Arabia, particularly Yemen. The first describes Forsskål and Niebuhr's journey to Egypt and Yemen, the second involves the French military invasion of Egypt in 1798-1801, the third covers the Prussian expedition of Ehrenberg & Hemprich of 1820-25, and the fourth combines accounts of Balfour's and Schweinfurth's all-too-brief visits to the remote island of Socotra (with apologies to those who spell it Soqotra; I prefer the traditional English version). These chapters are well illustrated with plates taken from the published accounts of the expeditions, mostly reproduced full-sized thanks to the lavish foolscap format of the book. A concluding chapter headed 'high hopes, disillusionment and final achievements' mentions some of the obstacles encountered by the explorers not only during their travels but also in publishing their results. I was surprised to find no reference whatsoever to the travels of Pierre Martin Rémy Aucher-Eloy, the French pharmacist and botanist whose travels in Greece, Cyprus, Syria, Turkey, Iran and Oman were extremely productive of new plant species even though Aucher himself died, probably of malaria, in Isfahan in 1838. This omission may be explained by the fact that a later title in the Arcadia Library series, *An Arabian Utopia: the western discovery of Oman* by Alastair Hamilton is to be published early in 2010. Alastair Hamilton is thanked by the present author for his help and encouragement. It is a pity, however, that Dr Marten's manuscript was evidently not checked by a botanist or zoologist with relevant experience, as there are a number of minor errors and misinterpretations which could easily have been eliminated and which detract somewhat from the otherwise exemplary production standards of the book: to give but one trivial example, *Hortus Cliffortianus* is spelled 'Cliffortiana'. Due to the cut-off point of the book, no mention is made of Henry Ogg Forbes' very productive visit to Socotra in 1898-9. But the detailed accounts of the selected naturalists' travels make fascinating reading, often revealing aspects of their work which are unfamiliar to those who have only consulted their floristic and faunistic publications.

JOHN EDMONDSON

The Linnean Society
Programme

2010

17th Mar	Wed 6 pm	Eerie Silence Paul Davies	Burlington House Lecture at the Geological Society
18th Mar*	Thurs 6 pm	Siphonophores: tangled tentacles or ocean predators? Gill Mapstone FLS	Evening Meeting
19th Mar	Fri 1 pm	London Freshwater Group	
15th April	Thurs 6 pm	The obvious solution to biodiversity loss: a bigger planet. Dr Martin Sharman	Evening Meeting
20-22nd April	9.30 am	Early Events in Monocot Evolution ** † Dr Paul Wilkin FLS	Joint Meeting of Royal Botanic Gardens, Kew and The Linnean Society
29th April	Thurs 6 pm	Anders Sparman - an enigmatic figure between Enlightenment and Romanticism Per Wästberg	Evening Meeting and Book Launch
24th May*	Mon 4pm	Anniversary Meeting ** Schistosomiasis and environmental change Dr Vaughan Southgate PLS	
10th June	Thurs 4.30pm	Sequencing the Red and the Dead David Rollinson	Afternoon Meeting

* Election of new Fellows † organiser(s) ** Registration required

Unless stated otherwise, all meetings are held in the Society's Rooms. Evening meetings start at 6.00pm 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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