Hastings & District Geological Society Journal

Hastings and District Geological Society
affiliated to the Geologists' Association

President
Professor G. David Price, UCL

Founded 1992

Cliffs at Rock-a-Nore, Hastings - 2012

Volume 18 December 2012

Cover picture: Cliffs at Rock-a-Nore, Hastings - 2012 - photo: Ken Brooks

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Hastings & District Geological Society Website - http://hastingsgeology.btck.co.uk/

Geologists' Association Website - http://www.geologistsassociation.org.uk/

Contributions for next year's Journal would be appreciated and should be submitted by the October 2013 meeting.
Please contact Peter Austen on: tel: 01323 899237 or e-mail: p.austen26@btinternet.com

This Journal is issued free to members of the Hastings & District Geological Society (HDGS) and is also freely available on the HDGS website.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Minutes of the A.G.M. - 11th December 2011

The Meeting was declared open at 2.40 p.m. by the Chairman, Ken Brooks. There were twenty-seven members present.

1) Apologies: Were received from:
John Boryer, Richard Crespin, Chris Edwards, Val Grist, Marilyn Hadley, Colin Parsons, Nancy Wagner and Kay Wilks.

2) Minutes of the last A.G.M.: These were printed in the *H.D.G.S. Journal* which had been handed out to members. Their acceptance was proposed by Diana Nichols and seconded by Geoff Bennett, and a show of hands indicated that they were unanimously accepted.

3) Chairman's report:

a) 2011 Programme: Ken summarised the year's activities:

Lectures by visiting speakers:

'Darwin as a Geologist' by Chris Duffin
'New Techniques in Conservation' by Chris Collins
'The Polacanthus Story' by *Dr.* William Blows
'Triassic Extinction, Jurassic Recovery' by *Dr.* Peter Forey
'Seismic Surveying' by David Howe
'Earth, Life & Evolution' by *Prof.* David Price

Members' Day talks:

'Pierre Teilhard de Chardin' by Ken Brooks
'Recent Discoveries in the Weald' by Peter Austen

Field Trips:

***Bracklesham Bay*:** Leaders Peter & Joyce Austen
***Beachy Head*:** Leader *Prof.* Rory Mortimore

b) Ken said that the attendances had been good again this year, the average being 31.6 (!) per meeting. He said that he was also very pleased again with the wide range of subjects that had been covered in the programme. The number of members on field trips had been mixed, with only 11 going to Bracklesham Bay, but a magnificent 31 going to Beachy Head.

c) Ken thanked everyone for their help with various duties during the year, such as preparing the hall by putting out chairs and tables and managing to negotiate the blackout curtains, providing refreshments, washing up, running the library and organising the raffle, etc. He thanked all the members of the Committee and gave special thanks to Peter & Joyce Austen for all their work on producing the *H.D.G.S. Journal*.

4) Treasurer's report:

Diana had typed up Norman Farmer's *Statement of Income & Expenditure for the Year Ending 31st December 2011* which was handed out to members. Norman briefly discussed the items, saying that again little had changed since last year, except that we had gained one more member. He said that there had been a slight deficit (being excess of expenditure over income), and that this had been due to the purchase of a microphone for lectures. He said that, despite the deficit, there would not be any need to increase subscriptions this year. The acceptance of the report was proposed by Trevor Devon and seconded by Dale Smith.

5) Election of the Committee:

Ken said that, over the next year, he and Diana would like to step back and pass on some of their work to other people. The main area concerned would be Diana's involvement with the Society. He said that the main jobs to be taken over were:

- Taking and typing the minutes for the Committee Meetings and the A.G.M.s.
- Typing the Treasurer's report for the A.G.M. and the interim reports for the Committee.
- Arranging lectures and field trips for the following year, including writing to guest speakers.
- Liaising with the guest speakers and hosting their meals.
- Arranging transport etc. for field trips.
- Sending out membership forms, details and programmes to new members.
- Sending out renewal forms each year and receiving the annual subscriptions.
- Maintaining up-to-date membership records and producing address lists for the Committee.
- Writing letters to members every two months with details of the next couple of meetings.

Trevor Devon suggested that these jobs could be divided up between several people, and said that he would be happy to host the speaker John Pearce in October.

In the meantime it was suggested that the Committee again be re-elected *en bloc*. This motion was proposed by Tony Standen, seconded by Ron Elverson and unanimously carried.

Therefore the Committee was said to be as follows:

2011	**2012**
Chairman	
Ken Brooks	Ken Brooks
Treasurer	
Norman Farmer	Norman Farmer
Secretary	
Diana Williams	Diana Williams
Journal editors	
Peter & Joyce Austen	Peter & Joyce Austen
Librarian & Education Officer	
Gordon Elder	Gordon Elder
Website manager	
Trevor Devon	Trevor Devon
Other Officers	
1. Colin Parsons	Colin Parsons
2. John Boryer	John Boryer
3. Pat Dowling	Pat Dowling

Ron Elverson gave a vote of thanks to the Committee for all the work they had done during the year and for the excellent programme they had produced.

Gordon Elder asked that, as Siân was now 16, her name be added as Librarian. This was then proposed by Joyce Austen and seconded by Norman Farmer.

6) 2012 Programme: Copies were handed out to all members present. Those unable to attend would be receiving their copies with the next letter to members. Ken thanked Diana for her work in preparing the Programme and gave a brief résumé of next year's lectures:

- ***'William Buckland: First Professor of Geology'*** by *Dr.* Chris Duffin
- ***'New Fossils from a Classic Area'*** by Tess Ormrod
- ***'Basic Geology'*** by Ken Brooks
- ***'Thirty Years of Mineral Collecting'*** by John Pearce
- ***'Wealden Dinosaurs'*** by *Dr.* Paul Barrett

Ken said that the 'Basic Geology' lecture would primarily be for new members (but everyone was welcome), and he emphasised that one of the main reasons for the existence of the Society was to help with the understanding of geology.

He said that the annual lecture by *Prof.* David Price would be omitted next year as we occasionally give him a break from his Presidential duties. However, we would instead (by popular demand) be having a behind-the-scenes visit to UCL, where David would be our host.

So the 'outings' for 2012 would be:

- New Year's Day walk at Fairlight
- Field trip to Smokejacks with Peter & Joyce Austen
- Field trip to Pett/Fairlight with Ken Brooks & Peter Austen
- Barbecue Party with Trevor Devon
- Field trip to Cooden with Peter & Joyce Austen
- Visit to UCL with *Prof.* David Price

Ken said that he hoped he would be able to arrange a visit to the Aldershaw quarry near Sedlescombe where they produce handmade tiles from the local Wadhurst Clay.

7) Any Other Business

- Ken thanked everyone who had brought prizes for the raffle (£46 already taken).
- Peter Austen said that he was already looking for articles for next year's Journal. He also mentioned that the Geological Society's History of Geology Group (HOGG) would be holding an open meeting on 20th March next year at Burlington House.
- Ken mentioned that Peter had been very involved in the production of the Palaeontological Association's English Wealden Fossils (Field Guide to Fossils series No. 14) - a monumental work of 769 pages (every one of which had been proof read by Joyce). Peter said that the book was not available locally, but could be purchased for £24 (plus £8 p+p). Trevor suggested that if the next Chairman's letter had a tear-off strip to be filled in by people wanting a copy of the book, Peter could perhaps obtain copies to be brought to the next meeting.
- Ken reminded everyone about the New Year's Day walk which would begin with an optional lunch at the Smuggler Pub at Pett at 12 o'clock. The walk itself would start at 2 p.m. from the Visitors' Centre and go through the old quarry in the Country Park as the tides that day would not be suitable for a beach walk. He asked members to let us know if they would like to have lunch first as tables had to be booked in advance. Anne Hancock asked how level the ground would be, and Ken said that the steps into the quarry could be a bit dodgy, but that there was another way round if necessary.
- Ken also reminded members that their annual subscriptions were now due.
- Ken finished by saying that, as a special treat, Dale Smith had organised a live performance by his Fiddle Choir as entertainment during the Christmas party. The band would consist of violins, violas, a 'cello and a mandolin, this last played by Dale himself.

Ken declared the Meeting closed at 3.21 p.m.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Statement of Income & Expenditure for the Year Ending 31st December 2011

INCOME	**£**	**EXPENDITURE**	**£**
Subscriptions		**G.A. Affiliation fees**	33.00
Single 40 @ £15.00	600.00	**Hire of hall**	144.00
Family 17 @ £20.00	340.00	**Society *Journal* production**	212.28
	940.00	**Insurance premium**	153.70
		Stationery, copying, postage	66.85
		Lecture fees and expenses	186.81
		Purchase of microphone	154.73
		Refreshments	40.00
Sale of books and magazines	26.62	**Purchase of books & magazines**	27.00
	966.62		1,018.37
Deficit being excess of expenditure over income	51.75		
	1,018.37		1,018.37

Bank Account and Monies in Hand

Balances as at 31st December 2010	**£**	**Balances as at 31st December 2011**	**£**
NatWest Bank	481.26	NatWest Bank	452.89
Monies in hand	68.99	Monies in hand	45.61
	550.25		498.50
Decrease in Balances 2011	51.75		
	498.50		498.50

December 2011

New fossils from a classic area: the Builth Inlier

by Tess Ormrod

A talk given to the HDGS on 19th February 2012

Introduction

One hundred and fifty years ago, Roderick Murchison and his entourages and colleagues swept across Wales and the Marches surveying and describing what he believed to be the very earliest rocks and fossils. The outcome of these activities was the publication of *Siluria* (Murchison 1854; 3rd ed. 1859), one of the seminal works of geology, although, at that time the term Silurian encompassed what we today refer to as Ordovician. Many now classic sites were described and became almost places of pilgrimage for generations of field geologists.

I am lucky enough to live right on the Welsh border, in the heart of Siluria, and when my interest in fossils developed, naturally I went to see some of these sites for myself. About seven years ago I got round to Llandrindod Wells where there are some of the best known quarries. So I did a spot of collecting and saw that there were the trilobites and graptolites as expected, but there were also lots of other small blobs and stripes that I did not recognise. By sheer good fortune, the Radnorshire Museum in Llandrindod was at that time holding an exhibition called “As Old As The Hills” which looked at these very fossils and much more. I was able to get in touch with the palaeontologists who had set up the exhibition and who, for some fifteen years now, have been doing ground-breaking research in the area. These two young people, Joe Botting and Lucy Muir, welcomed me, explained things, taught me about the area and encouraged me to be part of the field team – which I have been ever since and will continue to do so as long as I am able, as there are many lifetimes’ worth of new knowledge waiting to be revealed. And from these experiences, this talk arose.

Location

The area with which we are concerned is known as the Builth–Llandrindod Inlier in Radnorshire, Mid-Wales (Fig. 1). An inlier is an area of relatively old rock exposed at the surface and surrounded by younger rocks. This particular Ordovician inlier, surrounded by Silurian rocks, forms a rough triangle bounded by Llandrindod Wells, Builth Wells and Llandegley Rocks.

So, let us locate ourselves in place and time. Llandrindod Wells is a small Victorian spa town in Radnorshire (Powys). It was for some decades during the later 19th and early 20th centuries a very popular watering place with baths, pump rooms and entertainment. Llandrindod is easy to get to: it still has a railway station with a decent regular service and is easily accessible from the A44. All the sites I shall mention are in this quite small area, although, with the exception of the Llanfawr Quarries, you would need local guidance to locate them.

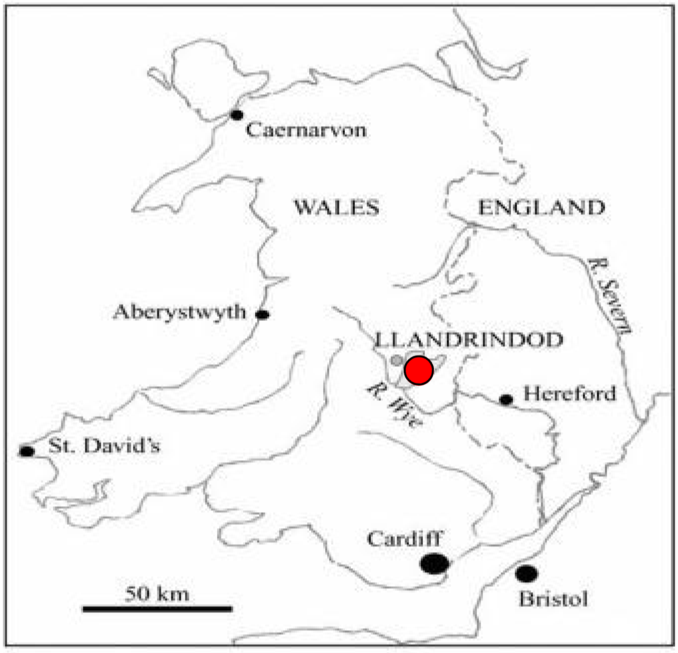

Fig. 1. Builth–Llandrindod Inlier in Radnorshire, Mid-Wales.

Palaeogeography

In time we are looking at the middle of the Ordovician period, approximately 465–455 million years ago, when this part of the world formed part of the landmass of Avalonia (Fig. 2), a small continent deep in the southern hemisphere. Sea levels were very high then and the global temperatures were probably

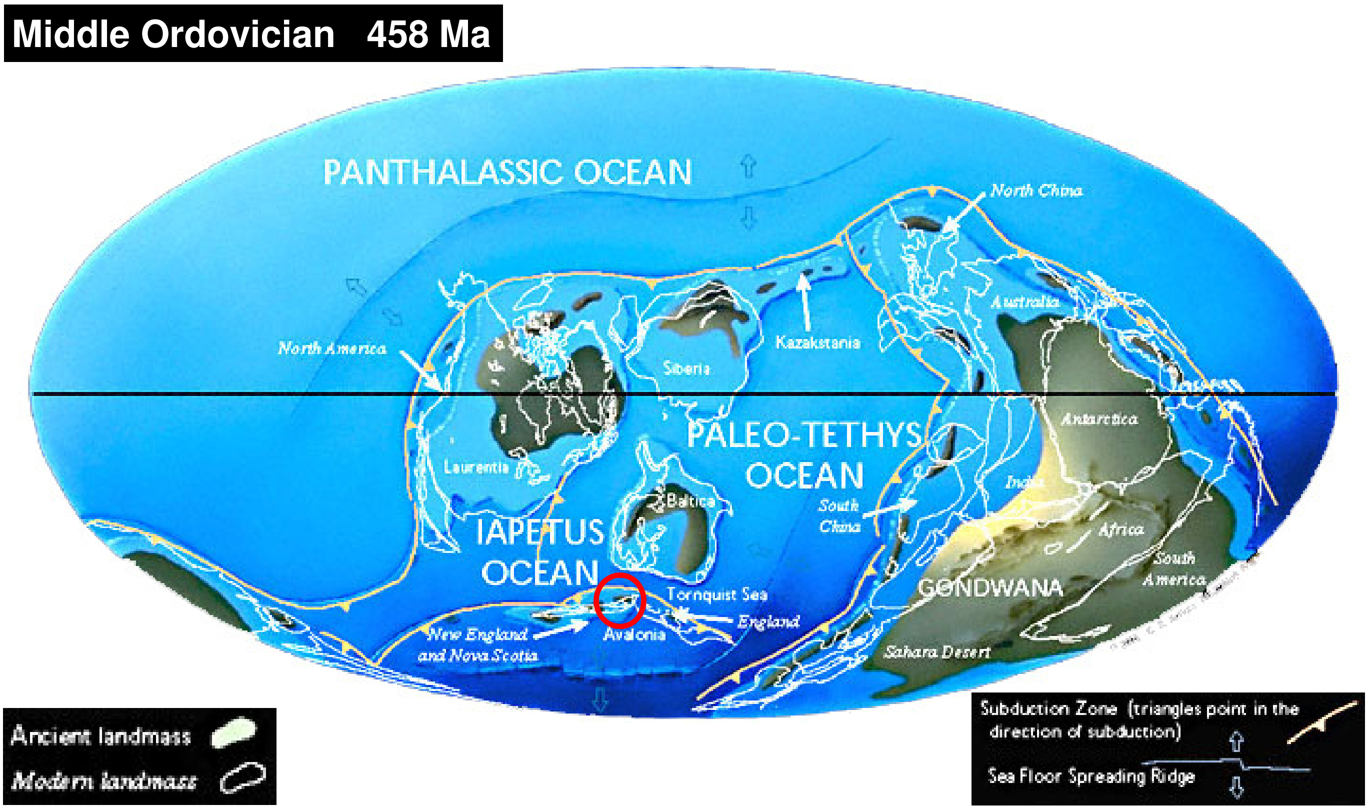

Fig. 2. Position of the Builth–Llandrindod Inlier in the Middle Ordovician (circled red).

the highest known in the last 500 million years. Wales was a marine basin with shallow water to the east and dotted with actively volcanic islands.

Ordovician radiation

Before we look at the fossils themselves, I would like to say something about the 'Ordovician Radiation' (Fig. 3). Animal life during the Ordovician was going through an extraordinary phase of diversification unparalleled before or since. The preceding Cambrian period is famous for its 'Cambrian Explosion', made widely familiar by the fossils of the Burgess Shale and by Stephen J. Gould's book *Wonderful Life* (1990), and during this time most of the modern phyla appeared. (N.B. working down from the greatest to the smallest categories, we divide life into: kingdoms; phyla; classes; orders; families; genera and species). Even among the nearly unpreservable organisms that lacked mineralised skeletons, most groups are now known from the Early to Middle Cambrian, and it is likely that the real diversification may have begun even earlier. The timing, speed and extent of diversification are among the great arguing points among palaeontologists who find scope for endless discussion, argument and downright disagreement: fortunately it rarely degenerates as far as fisticuffs or pistols at dawn, but feelings can run high.

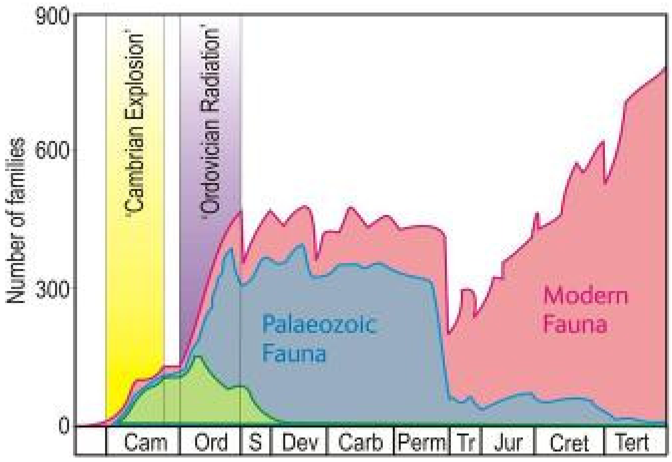

Fig. 3. Chart showing the increase in families during the 'Cambrian Explosion' and the 'Ordovician Radiation'.

So, at the beginning of the Ordovician, *c*. 490 million years ago, although the major groups of animals were present, the total diversity at species and genus level was still low and although predator/prey and relatively complex food chains were established, ecosystems were still fairly simple and the same type of fossils are found in virtually every environment. But by the end of the Ordovician, *c*. 430 million years ago, global diversity at genus level had tripled and at species level quadrupled. Most of the now living classes and orders, as well as phyla, had appeared and ecosystems had become much more specialised where different localities were dominated by different types of organism in a manner similar to that seen at the present day. The cause of the Ordovician Radiation is not understood although numerous hypotheses including continental break up, large areas of shallow seas, changes in sediment types, tectonic instability, etc., have been proposed.

So why is the Builth Inlier special? It illustrates a region at the centre of diversification, with a unique range of environments that yield a remarkable variety of superbly preserved fossils. This allows us to piece together a detailed historical narrative of the changing ecology of the Ordovician Radiation, which in its turn provides insight into the origin of modern types of ecosystem and how they are structured and maintained.

The fossils

Collecting fossils around the Builth Inlier is very different from coastal collecting or collecting from large brick pits and quarries. Most of the sites (Figs 4–5) are small, unobtrusive, often very beautiful and botanically rich. They are small quarries, stream beds and banks, small land slips, field banks or even sheep scrapes and with a few exceptions, such as the trilobites and graptolites, the fossils are of a very different kind and preservation from most of those found in younger environments. No dinosaur bones or tracks; you won't see sea monsters and great fish (although there were early fish around during the Ordovician), nor are there lots of large shells or chunky ammonites. To find the important fossils it is necessary to learn a different technique. You sit down on a rock, frequently wet, with a bag full of dark shale or mudstone fragments (if there are any larger bits you will probably need to reduce them to fragments). Then with a hand lens painstakingly examine every piece often looking for tiny black or orange blobs on bits of very dark stone. It is a refined and exquisite pleasure which takes some acquiring. For many of the finds, their beauty and potential can only be revealed under high, often very high, magnification, X-ray or even CT scanning. At some sites, particularly Llandegley

Figs 4–5. Examples of exposures within the Builth Inlier.

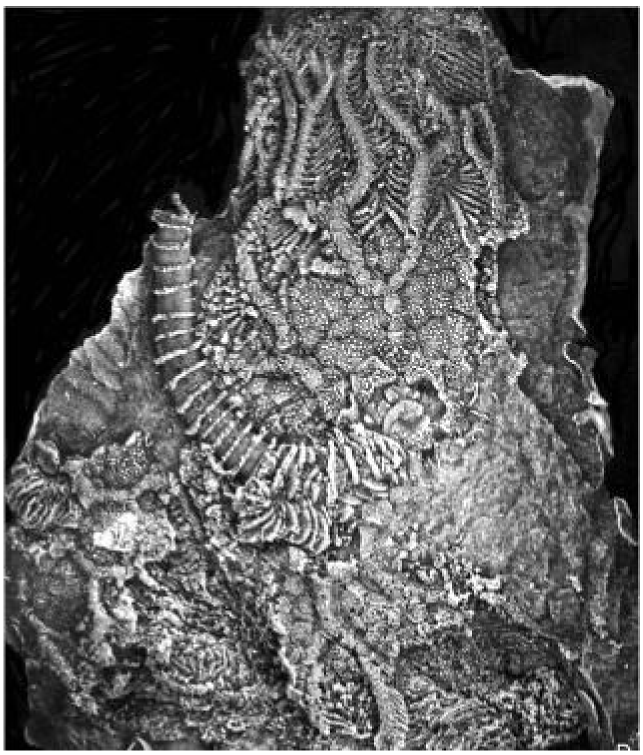

Fig. 6. Early crinoid, Cefnocrinus samgilmouri*, from Llandegley Rocks, revealed by taking a latex cast of the original fossil.*

Rocks where magnificent very early crinoids have been found, the fossils look like a crumbly mess of very decomposed rock and it takes a latex cast to reveal the order and structure (Fig. 6).

Although the various localities within the Inlier demonstrate the fauna of different biozones within our timescale, rather than deal with each site individually, I am going to try to give an overview of some of the major fossil groups and provide some examples of the wonderful things we have found.

Trilobites

The trilobites are the most obvious and best known fossils of the area. They have been recognised as curiosities for centuries; the first one described from the Builth area dates from 1698 and some of the larger trilobites in Wales were described a little later by the Rev. Llhwyd who identified them as flatfishes. Trilobites are arthropods, segmented creatures with a hard carapace. They appear in the Lower Cambrian and the last lonely representative vanishes at the time of the 'Great Dying' – the end-Permian Extinction, 250 million years later. There are literally thousands of species known throughout the world, from the tiny simple agnostids through every possible permutation of size and variation in spikes and spines. Some of the later trilobites are positively baroque, if not rococo in their extravagance of ornament. Within the Inlier the most famous site for trilobites is the Llanfawr Quarries just outside Llandrindod, although numerous other localities yield many fine specimens and a number of major studies have been done on these, notably Gertrude Elles in the early 20th century and Peter Sheldon at the other end of the century.

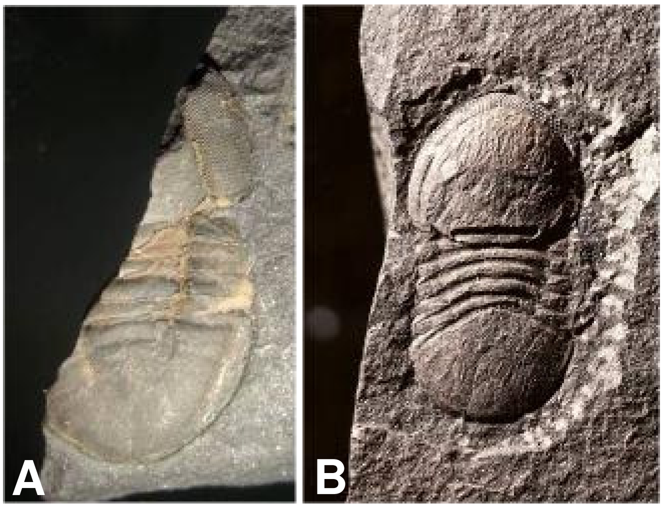

Fig. 7A–B. Cyclopygid trilobites displaying hypertrophic eyes covering most of the head.
A, Sagavia *sp. B,* Microparia lusca.

Photo (B): Terry Keenan

Fig. 8. Spiny trilobite, Bohemilla.

Fig. 9. Trilobite with long forward-pointing spike, Cnemidopyge.

Fig. 10. Large, abundant trilobite, Ogygiacarella angustissima.

Fig. 11. Trinucleid trilobite, Trinucleus fimbriatus.

Even within the limited area and timespan of the Inlier there is a superb variety of species. Some were deep water species with streamlined bodies and hypertrophic eyes covering most of the head. These are the cyclopygids (Fig. 7A–B). A completely new spiny species has also been found, *Bohemilla* (Fig. 8). Another species had long fragile spines and a long forward-pointing spike protruding from the front of its head – *Cnemidopyge* (Fig. 9). *Ogygiacarella angustissima* is a large and very abundant trilobite (Fig. 10). But the most famous, locally abundant and beautiful of the trilobites is the trinucleid *Trinucleus fimbriatus* (Fig. 11) which is found at very few other sites. Trinucleids are unusual as they do not have eyes but have a fringe-like structure around the front of the head containing neat rows of tiny pits. These pits probably had a sensory function but whether it was chemical light or motion related is not known. Most trilobite fossils are incomplete, being moulds deposited when the creatures moulted – as crabs do today – and consequently have been split along various bodily divisions, but here complete or almost complete specimens are not uncommon. Sadly the trilobites of Llanfawr have been too beautiful and too plentiful for their own good.

Commercial collecting

It is important to remember that the quarries at Llanfawr are not just of interest to professional palaeontologists. Amateur geological groups go there on field trips to see the exquisite trinucleids and splendid graptolites, and many local people collected their first fossils there as children. However, commercial collectors have stripped out most of the trilobites from the most productive bed and specimens from Llanfawr can be seen for sale on the internet or at fossil fairs as far away as New York or Hong Kong. Ten years ago it was easy to find complete trilobites within half an hour of searching; two years later a whole day's collecting may yield only fragments. The quarries are legally protected as a SSSI meaning that permission to collect must be sought not only from the landowner but from the Countryside Council for Wales, but this is impossible to enforce. In practice no one begrudges a few specimens and genuine interest is to be encouraged. The problems come with the completely unprincipled commercial collectors when hundreds of specimens are gathered not just from scree but by smashing into pristine bedrock. In the process everything else is trashed; all the rare, delicate and important fossils which won't bring in a quick buck. And in addition the context of the remaining fossils is lost. This type of invasive commercial collecting is just as much an outrage and a crime as pillaging archaeological sites or tomb robbing for the gold or jewels and destroying everything else. So please, think hard and try to establish the provenance of any fossils you might wish to buy for your own collections.

Graptolites

Most of you will recognise graptolites as fossils which resemble miniature hacksaws either with a single blade or linked together in the shape of a tuning fork (Fig. 12). They are strange creatures; a fine study of the graptolites of the Inlier was done by Elles in the early 20th century, but it is since then that they have started to be properly understood. They are colonial animals distantly related to a few obscure modern organisms including acorn worms. Each little serration acted like a cup (Fig. 13) in which the individual animal, the zooid, lived. There are two particularly interesting features relating to graptolites; firstly, hard though it may be to believe, they are hemichordates; that is they are distantly related to the vertebrates and ultimately, if very remotely,

Fig. 12. Graptolite, Dicellograptus cambriensis, *from the LLanfawr Quarries.*

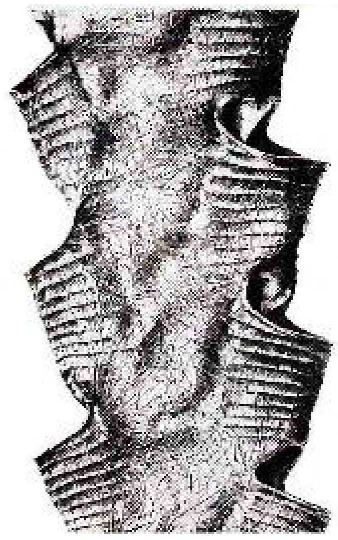

Fig. 13. Reconstruction of graptolite cups (from Andres 1976, 1977).

Fig. 14. Graptolite, Nemagraptus gracilis, *displaying spiralling pattern.*

Fig. 15. Dendroid graptolites from the Cefnllys area.

to us. Secondly, the planktonic or free drifting ones in particular evolved and changed very rapidly in geological terms, so they are extremely valuable as an aid to dating and correlating fauna from different areas. Graptolites can be extremely abundant and very variable in size from a few millimetres to 10 cm or more, and with branches (called stipes) numbering from a single one to complex or spiralling patterns (Fig. 14). These graptolites were mostly planktonic, but there is another group, the dendroids (Fig. 15) which were sessile, attaching themselves by a holdfast to a fixed surface. These grew into branching bush-like formations up to 20 cm high.

Brachiopods

Brachiopods in the Ordovician tend rather to be overlooked. After all they are mostly small, insignificant, frankly rather dull shells and we can see plenty like this and much better on practically any seashore. But of course, what we see today are almost invariably bivalve molluscs, e.g. clams, mussels etc., which are fundamentally different from brachiopods. The bivalves are today among the most prolific and diverse sea and seashore creatures with a rich fossil record especially from the Jurassic onwards. But if you go back deep into the Palaeozoic there are as many shells, equally diverse but very different from the bivalves; these are the brachiopods which today still lurk in deep water or in shallower tropical seas, largely ignored. After hundreds of millions of years the brachiopods are still with us but they are now sad remnants of a glorious past.

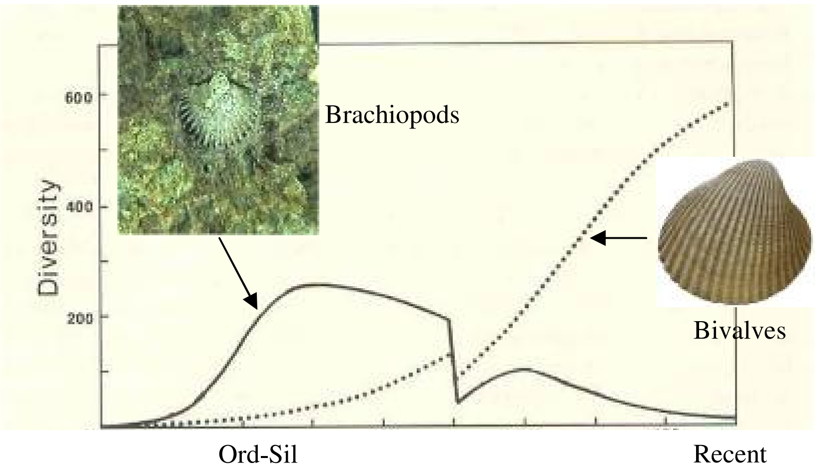

Fig. 16. Diversity of brachiopods and bivalves over time.

Brachiopods do share a relationship with molluscs and annelid worms but they have been going their separate ways for at least 530 million years (Fig. 16). The common ancestor was probably something like an armour-plated slug, an approximation to which is a strange Early Cambrian creature called a halkiierid. Brachiopods and bivalves are completely different inside and the rule of thumb distinction from outside is that brachiopods have front and back shells and bivalves have left and right ones. There are a fair number of different brachiopods to be found

Fig. 17. Brachio-pod, Apatobolus micula.

Fig. 18. Brachiopod, Palaeoglossa attenuata.

Fig. 19. Brachiopod, Hesperorthis dynevorensis.

within the Inlier and although by no stretch of the imagination are they spectacular, I feel it would be rather mean to exclude them. Of three of the more common ones, the most prolific is *Apatobolus micula* a small (3–5 mm) saucer-shaped phosphatic shell (Fig. 17). Another small, quite common species is *Palaeoglossa attenuata* (Fig. 18). *Hesperorthis dynevorensis* (Fig. 19) sometimes occurs in huge numbers creating almost a monospecific fauna in some sites. Curiously where there are large numbers of *H. dynevorensis*, no sponges are found, a phenomenon reflected in modern Antarctic seas.

Sponges

Sponges (Fig. 20A–C) are where it starts to get really interesting. You will all know the familiar bath sponge and most of you will have found sponges among the chalk and flint, but sponges have been going strong since the Early Palaeozoic (or even before) and have played a vital role in the evolution of diverse ecosystems despite being in themselves very simple organisms. Indeed it was long debated whether sponges were animals at all. The sponges of the Middle Ordovician had a silicious skeleton formed of spicules of various sizes in a variety of conformations. The sponge fauna of the Builth Inlier, particularly at three localities including Llandegley Rocks and Llanfawr Quarries, demonstrate by far the richest fossil fauna known from the Palaeozoic of Britain (Fig. 21) and is now being recognised as one of the more important areas for fossil sponges on the planet. The most delicate sponge spicules were abruptly buried by volcanic ash and the spicules were replaced by pyrite, now mostly weathered to iron oxide. This type of taphonomy is in itself unusual. It would seem that at Llanfawr and nearby, generations of palaeontologists have suffered from Inexplicable Sponge Blindness. Admittedly they are often obscure in the field, but some are spectacular. Before the current work in the area began there were only three recognisable species of sponge from the Ordovician of Wales. Now in the Builth Inlier alone the number of species is well in the 20s and rising (Fig. 22). Just imagine a field location where you are distinctly disappointed if you do not come away with at least a couple of completely new species after each visit. To find the sponges it is necessary to find recently exposed and unweathered rock as the oxidised spicules disappear very rapidly when exposed to wind and weather.

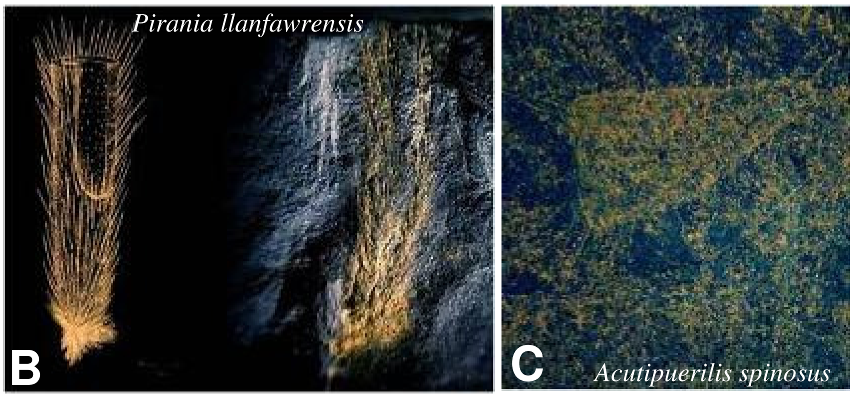

Fig. 20A–C. Sponges from the Builth Inlier.

Fig. 21. Undescribed sponge.

Fig. 22. Sponge, Pyritonema.

Crinoids

Crinoids (Sea lilies) are relatives of starfish and sea urchins, and although all that is usually found are disarticulated stem ossicles, many of which look more like tiny flowers (Fig. 23) or more prosaically washers, occasionally wonderful branching fronds are found (Fig. 6). The full flowering glory of crinoids is most evident in the Mesozoic but some of the very earliest known crinoids have been found in the Inlier and over 11 different species have been described (Fig. 24).

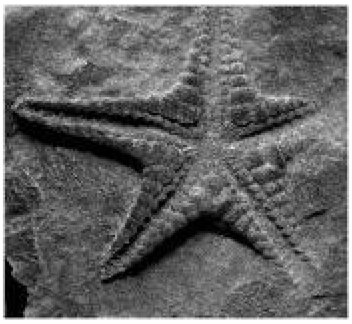

Fig. 23. Crinoid ossicle from the Late Ordovician, Berwyn.

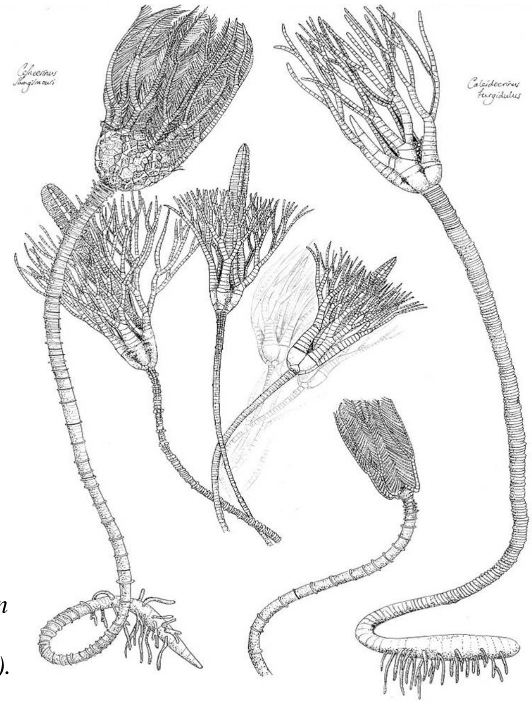

Fig. 24. Crinoid reconstruction
Cefnocrinus samgilmouri *(left)*
Caleidocrinus turgidulus *(right).*

Also occurring in considerable profusion throughout the Inlier are a number of strange early relatives or precursors of the crinoids: carpoids, cystoids, mitrates (Figs 25–26) and the enigmatic cornutes (Fig. 27A–B). These last oddities are also known as calcichordates as they were believed by some to be related to the ancestors of the vertebrates. Two each equally convinced schools of thought argued the issue for years but the general opinion is now that they are related to or a form of echinoderm. They are so weird and asymmetrical that the morphology is by no means fully understood. I remember finding a slab with some particularly fine specimens looking rather like demented daddy-longlegs and when I passed it over for expert assessment it provoked the response "Come off it Tess, you've just scratched these on to fool us" – but I hadn't, and the specimens turned out to be of real value and are now with a French palaeontologist who is specialising in the study of these creatures.

Fig. 25. Mitrate, possibly Anatifopsis.

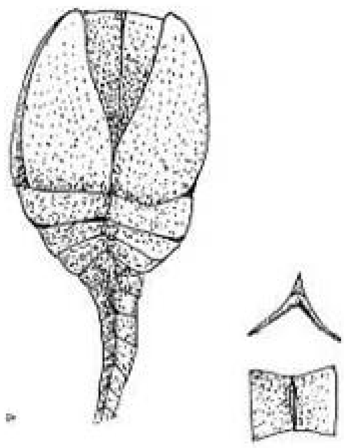

Fig. 26. Reconstruction of mitrate.

Fig. 27A–B. Cornutes.

Other unusual discoveries

The Inlier contains representatives of many fossil groups, including nautiloids, bryozoans, conodonts, arthropods, chitinozoans and ostracodes, and more than 300 different species have been collected from the area. Below are some of the more important discoveries.

Hydroids. These are cnidarians, related to corals, jellyfish and sea anemones. They are colonial animals and nowadays are often abundant in rock pools where they form brittle, thin-branched seaweed-like structures made of a substance similar to chitin. Rather like graptolites, each branch has lots of little pores from which tiny anemone-like polyps emerge. Usually the skeleton does not mineralise, but a number have been found within the Inlier, although usually they are very difficult to see and identify (Fig. 28). But take a piece of black shale with faint pyritised curving streaks on it and X-ray it and see what is revealed (Fig. 29). Figure 30 shows a reconstruction of the Llanfawr hydroid shown in figures 28–29.

Fig. 28. Crinoid or hydroid? See figure 29.

Fig. 29. X-ray of figure 28 clearly shows a hydroid.

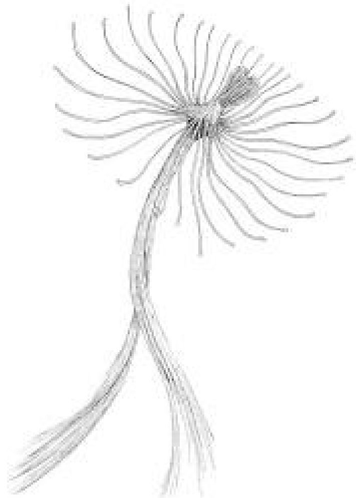

Fig. 30. Reconstruction of Llanfawr hydroid.

Holothurians. Holothurians or sea-cucumbers (Fig. 31) are prolific today and many are beautifully florid and colourful. They are echinoderms and have no hard parts except for a ring of plates around the mouth aperture so another unlikely fossil, but figure 32 shows the world's oldest holothurian from the Builth Inlier.

Fig. 31. Present-day sea-cucumber (holothurian).

Fig. 32. World's oldest sea-cucumber (holothurian).

Palaeoscolecids. If worms make you shudder, these may help to change your mind. Palaeoscolecids are very small armoured worms (Fig. 33A–D) and are related to modern priapulid worms. The skin is covered with an exquisite array of minute and amazingly ornate phosphatic plates which can only properly be seen under the SEM (Figs 34A–B, 35). All you see with the naked eye of faith is a tiny black or orange blobby line. Truly, small is beautiful. Fossils of palaeoscolecids are, as you would imagine, extremely rare, yet at least three sites from the Inlier have produced several different species.

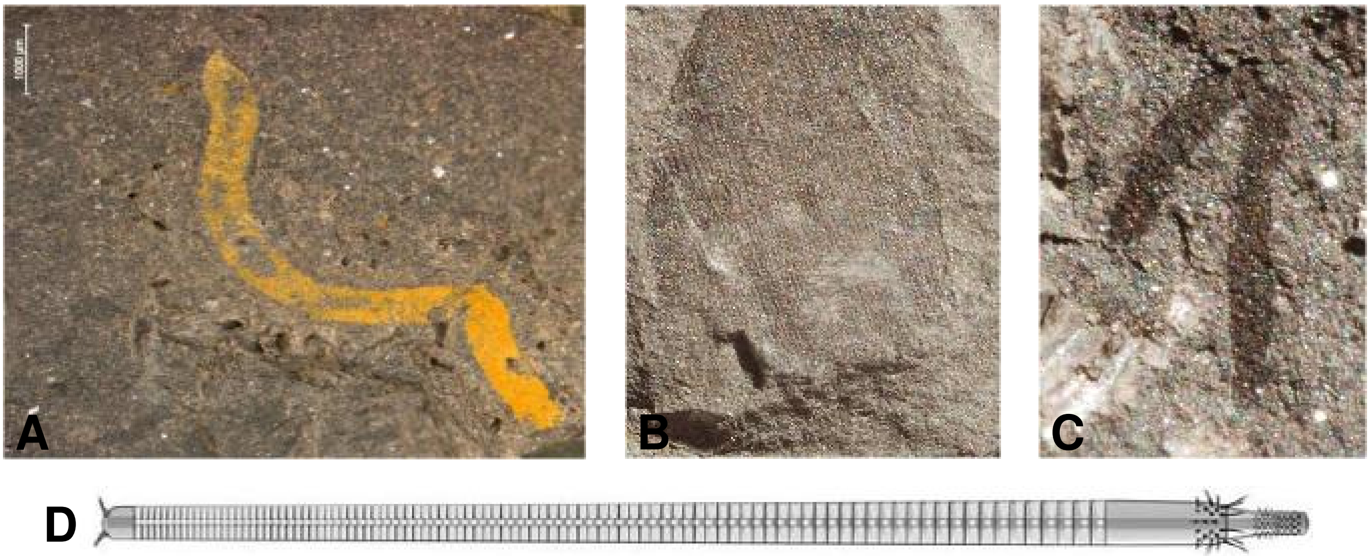

Fig. 33A–D. Palaeoscolecids, or armoured worms (A–C), together with reconstruction (D) from Han et al. *2007.*

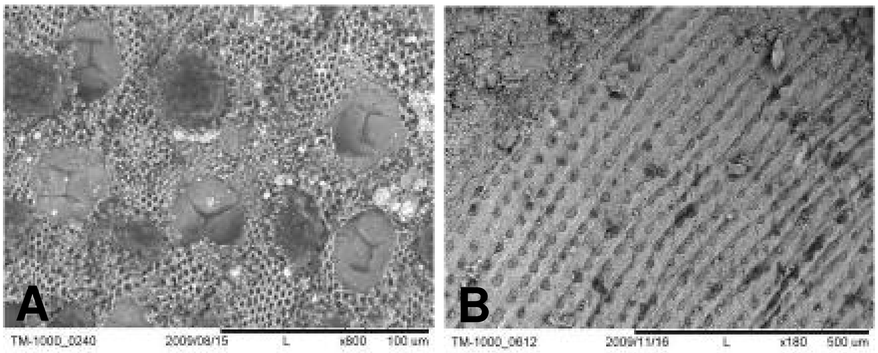

Fig. 34A–B. SEM of palaeoscolecid phosphatic plates.

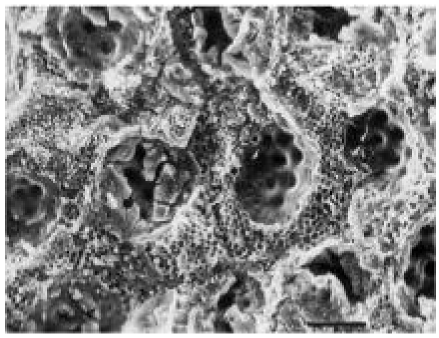

Fig. 35. SEM of palaeoscolecid cuticle.

Problematicum. And finally, what is known as a WHIT or 'what the heck is that?', or more professionally, a problematicum (Fig. 36). Here are two scans of an unidentified organism from Llanfawr Quarries. Its identity? - your guess is as good as mine.

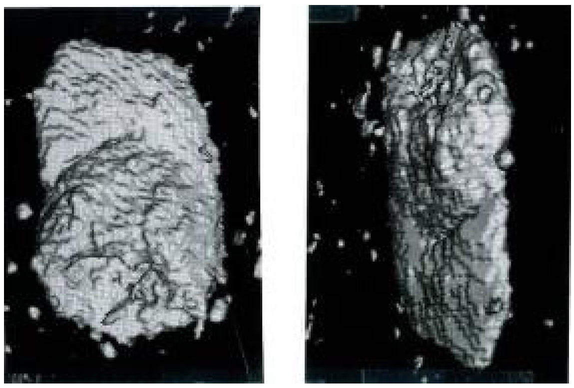

Fig. 36. Unidentified organism from Llanfawr Quarries.

Summary

I have tried to give you a brief peep at some of the most wonderful fossil sites around. I know I'm prejudiced but they are. The Builth Inlier (Fig. 37) is receiving international recognition of its importance which lies in a number of aspects: the completeness of the sequence, the range of environments, the ecological history together with the truly exceptional faunas (the Llanfawr Quarries are now recognised as the Llanfawr Lagerstätte, a term used to describe a site of truly exceptional preservation); these provide a detailed view of the evolutionary and ecological processes operating during one of the most critical intervals in the history of life, which makes the Inlier a research area of genuinely global significance.

I hope that some of you at least will be encouraged to come and visit the area for yourselves; no one objects to responsible collecting and it is a lovely part of the country, and there is always the possibility of a brand new species lurking under the next piece of rock.

Visit the website www.asoldasthehills.org for lots of information and a forum open to all.

Finally if you come to the area do visit the Radnorshire Museum in Llandrindod which has a very fine and up-to-date display of the palaeontology of the area.

Fig. 37. A section in the Builth Inlier.

Acknowledgements

The material for this talk is taken from the recent and on-going research into the palaeontology of the Builth Inlier by Dr Joe Botting and Dr Lucy Muir. They were not only generous enough to allow me to use many of their superb images, but also took an ageing amateur under their wing and let me join in the fun.

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A 'Society' Wedding

Congratulations to our Chairman and Secretary, Ken Brooks and Diana Williams, who were married at The PowderMills Hotel, Battle, on Saturday 5th May 2012.

Photo: Matthew Brooks

Dinosaur Quarries of Hastings
Shornden Quarry – an update

by Ken Brooks

Since the publication of 'Dinosaur quarries of Hastings' (see *HDGS Journal*, Dec 2011, Vol. 17, pp. 7–13), further research into the location of the Shornden Quarry has revealed that the site was not, as stated, at TQ 802105, i.e. next to Shornden Reservoir. In fact, it appears that the clay was extracted from pits within the nearby brickworks site itself (TQ 801106) (Fig. 1). This occupied a triangle of land with a path leading through it (Fig. 3) from Beaufort Road into Alexandra Park (Fig. 4) and the reservoir.

During the 19th century Wadhurst Clay and Tunbridge Wells Sand were quarried here for making tiles, chimney pots and bricks in two large kilns, which are shown on the local OS map of 1873 (Fig. 1). However, the site appears too small to have provided enough clay to sustain a working brickworks for any length of time, so clay must also have been obtained from other quarries or pits in the Silverhill area (e.g. Vale Road).

In the 1880s dinosaur bones were excavated from the Wadhurst Clay, and Shornden Quarry is one of the locations named in The Natural History Museum's collection of fossils from Hastings. Specimens found here by Charles Dawson include various pelvic bones and vertebrae from *Iguanodon* (= *Hypselospinus*) *fittoni* (NHMUK R1635 a-d) and *I.* (= *Barilium*) *dawsoni*, which still have their original 'Dawson Collection' labels (Fig. 5). Other fossils from these dinosaurs include an almost complete ilium and incomplete sections of pelvis, leg and foot bones (Lydekker 1888, 1890; Woodward and Sherborn 1890; Norman 2010, 2011 *a*, *b*).

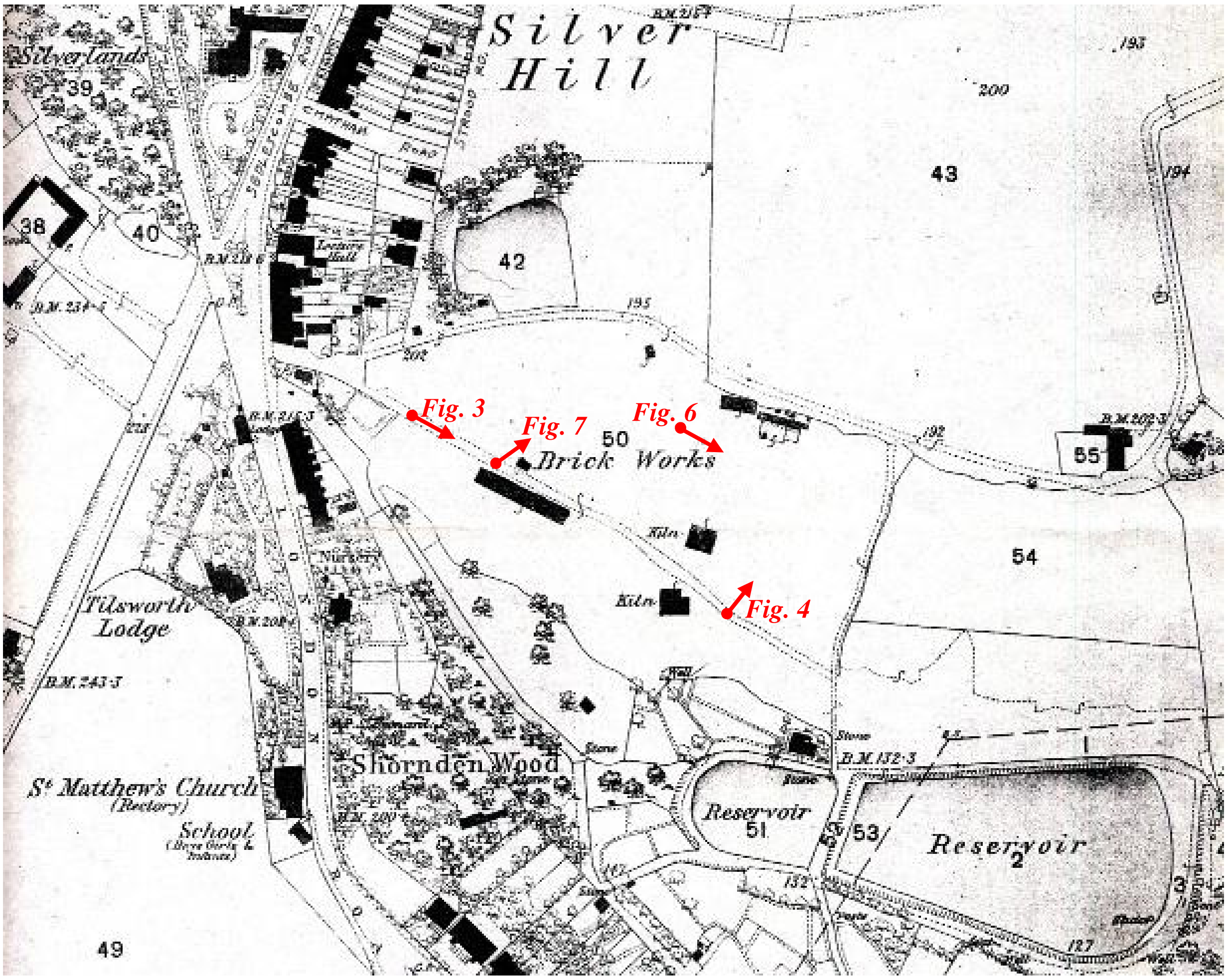

Fig. 1. Shornden Quarry brickworks showing two kilns, from 1873 OS map. Red arrows indicate direction of view in figures 3–4 and 6–7.

By 1861 the brickyard was already established here (Kelly's Directory of Sussex 1862). Records show that between 1878 and 1887 the owner/manager was Henry Hughes, and that his Builders and Brickmakers business continued until its closure in around 1890 (Beswick 2001). At some time after this the site was in use as a nursery (see 1929 OS map) (Fig. 2B). Local residents recall that during the 1950s watercress was grown there (commercially?) in small ponds (Fig. 6). These 'ponds' appear in the same locations on all OS maps dating back to 1899 (Fig. 2A). Could it be that they are the hollows left by the excavation of clay for bricks and pottery during the 19th century? They might also be the holes left by fossil hunters, such as Dawson, who were collecting during the late 19th and early 20th centuries. We know that the British Museum bought some of his collection in 1909.

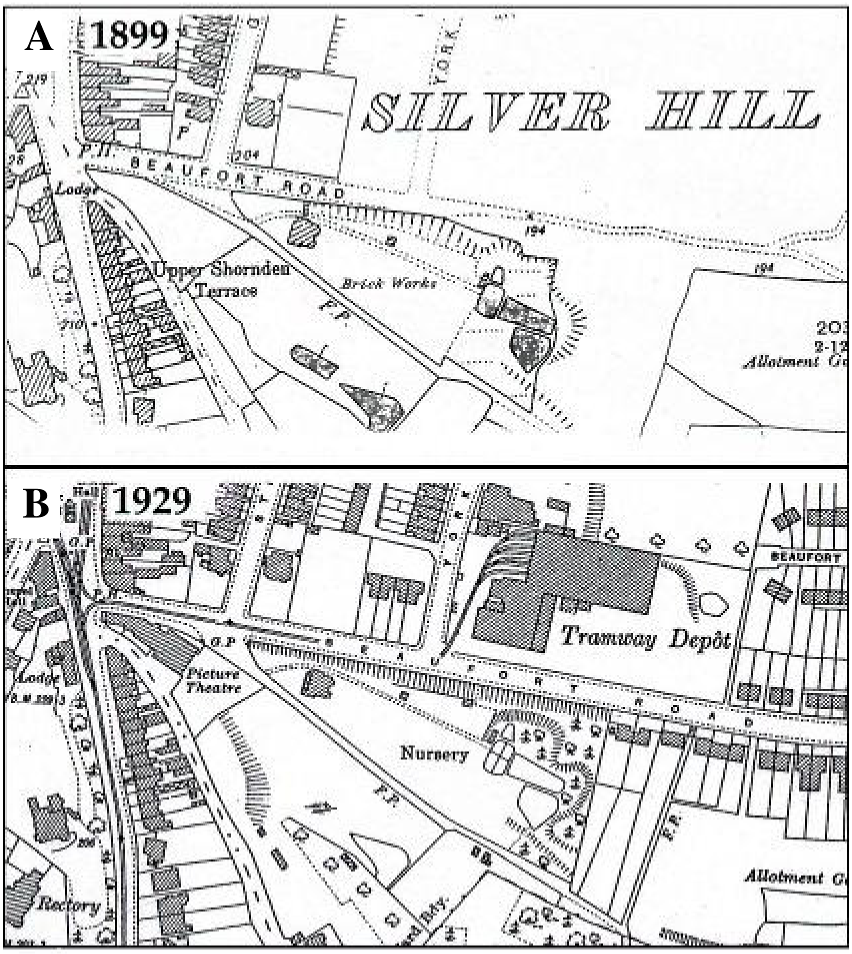

Fig. 2A–B. OS maps from 1899 (A) and 1929 (B). The 1899 map still shows the brickworks, and the 1929 map shows the area taken over by a nursery. Both maps show ponds on the east side of the brickworks site.

The nursery site later became a private garden belonging to the corner house – now the Silver Springs Medical Practice. Eventually, the land was sold for development and a block of retirement flats, Beaufort Court (Fig. 7), was built here in 1985 by the James Butcher Housing Association.

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Fig. 3. Footpath through the brickworks site from Beaufort Road into Alexandra Park.

Fig. 5. Iguanodon *vertebrae from Shornden Quarry.*

Fig. 4. View from footpath looking towards the ponds shown on the two maps in figure 2A–B.

Fig. 6. View from Beaufort Court of the ponds shown on the two maps in figure 2A–B.

Fig. 7. Beaufort Court, built on Shornden Quarry brick-works site.

Collecting minerals in the Eifel Mountains

by Trevor Devon

I have now been on collecting trips to the Eifel region of Germany for the past two years, in 2011 with the Norfolk Mineral & Lapidary Society and in 2012 with a joint party drawn from both the Norfolk and Sussex mineral societies. On each occasion we timed the trips in June to fit in with one of Europe's premier mineral and gem shows at St. Marie-aux-Mines in the Vosges Mountains of Alsace, eastern France. We also stopped off for a half-day visit to nearby Idar-Oberstein in Germany. This report for the Hastings & District Geological Society Journal combines my experiences from both trips.

The Eifel is a scenically attractive area of Germany located west of the Rhine, north of the Moselle and south of Aachen and is notable for its volcanic origins and features resort areas like the Laacher See as well as many basalt quarries for building stone. It is also the home of the Nurburgring motor racing circuit.

The basalt hosts a wealth of minerals, ranging from the usual igneous species quartz, nepheline, sanidine, pyroxenes (Fig. 1), amphiboles, titanite, spinel, haematite, magnetite, perovskite and micas, as well as a number of zeolites (eg. thomsonite, phillipsite, gismondine and chabazite) and many rarer species, several unique to the Eifel. One such mineral, schullerite, was named after one of our hosts, Willi Schuller. Of particular fame here is the attractively bright blue silicate hauyne, found easily in several quarries, but rarely as complete crystals: this semi-precious stone is used in jewellery. A relative rarity is jeremejevite, also blue, but extremely hard to find as the crystals are mostly in the <1mm range!

Fig. 1. Pyroxene crystals in basalt.

Photo: Martin Stolworthy

The base for our visits on each occasion was the lovely country village of Weibern, about 25 kilometres west of Koblenz, where some 16 quarries are anywhere from 15 minutes to an hour's drive away. On our first day we met our hosts Manfred and Willi at the hotel and after dinner they gave us a video introduction to the geology and mineralogy of the Eifel. The photography of the microminerals was truly stunning and wetted our appetite for the collecting to come. And we were not to be disappointed. Over the two trips we visited many of the major quarries, and on the occasion of one afternoon where the rain was too heavy, Willi invited us all to his home "to collect from his garage" as he put it. There we were not only able to see his magnificently displayed mineral collection (accumulated over 40 years), but Willi showered us with gifts of material from some of the quarries we were unable to get to (including the famous Bellerberg, now closed to collecting).

The quarries we did get to explore over the two visits were Nickenicher Weibern, Emmelberg, Lohley, Rotherkopf, Graulai, Hannebacher Ley and In Den Dellen. It was notable that while they were all basaltic lava quarries, the basalts were different in density, from lightweight "cinder" at In den Dellen through to "rock hard" at Rotherkopf. The mineral suites similarly varied, although pyroxenes and amphiboles were commonly found in most specimens. A number of the minerals were relatively easy to spot with the hand lens (particularly nepheline and the zeolites) but it soon became clear that some serious time with the microscope was ahead of us when we got the specimens home!

One location, called Perler Kopf, turned out to be a ploughed field at the top of a hill. Collecting was undertaken by crawling on hands and knees with a hand lens looking for tiny (1-2mm) dark red andradite garnets in the soil (Fig. 2). And after a few minutes "to get your eyes in" we were finding them quite readily and within 30 minutes could collect a small handful. It was also possible to find the garnets embedded in the matrix rock from which they get weathered out.

One notable feature of the minerals from the Eifel is the minute size of the crystals, which made identification in the field quite difficult – especially when looking for the rarer species. Coupled with this is the richness of the crystalline rock – masses of silicates (Fig. 3) which must have crystallised relatively quickly from the lava. So in general it was very easy to find crystalline specimens, and after cursory examination with a hand lens, identify the more common crystals such as glassy hexagonal prisms of nepheline, tabular glassy plates of sanidine or dark bladed crystals of amphibole. The zeolites were also fairly easy to find with a hand lens and were mostly glassy prismatic crystals displaying the characteristic morphologies of phillipsite, gismondine, thomsonite and chabazite.

Fig. 2. Looking for tiny andradite garnets at Perler Kopf.

Photo: Martin Stolworthy

For our tourist bit we visited the Laacher See (a lake formed in a volcanic caldera) and had a relaxing walk around the historic Maria Laach Abbey, a Benedictine monastery. Nearby we strolled through a spa park and paddled in the rather cold medicinal spa waters. We also visited one of the geological museums in the area, the Maarmuseum in Manderscheid where we were treated to an illustrated introduction to the geology of the Eifel by the curator: we were all surprised to learn that the area comprised over 600 volcanoes! Many of the volcanic calderas are now scenic lakes that are referred to as "maars". And of course when in Germany you have to visit a brewery! This one had the original brewery underneath in a cellar mined out of the basalt. By descending what seemed like hundreds of steps it was possible to see the original brewery equipment, tanks and plumbing in the basalt "cave".

On both our trips we visited Idar Oberstein, the "gem capital" of Germany, for a few hours. There are at least two museums related to minerals, gems, jewellery and lapidary and we enjoyed a visit to the Oberstein museum. A modest walk above the town, we visited the Church in the Rock and the remains of two castles perched even higher up. In the town it seemed that just about every second shop was devoted to rocks, minerals, gems and jewellery.

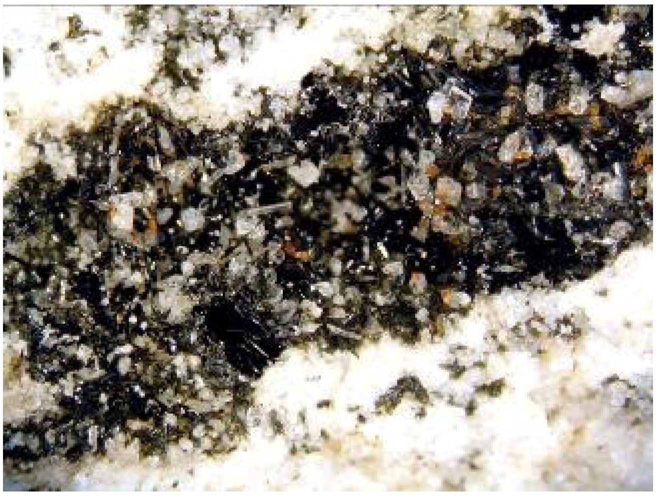

Fig. 3. Silicate crystals galore!

Photo: Martin Stolworthy

The third component of our itinerary was the St. Marie-aux-Mines Mineral & Gem show which takes over the whole of the centre of this attractive former mining town in the Vosges Mountains of Alsace. Open for four days from Thursday to Sunday, it attracts some 900 dealers from all over the world and more than 20,000 visitors over the four days. There are always some stunning exhibits and displays in both the Euro Mineral and Euro Gem shows. Although I have now been to this show four times in six years, I remain quite overwhelmed by the whole experience. The dealers cover the complete range from the "cheap & cheerful" from North Africa and Eastern Europe to the "rich and extravagant" from the USA.

This year, 21 members from the two Societies attended the Show and we all stayed together in a beautiful hotel just over the Rhine in Germany. The evenings were predictably sociable – enjoying the local food, wine and the company into the night. Driving home it was noticeable how low the cars were on the road, laden as they were with all the goodies from our collecting in the Eifel quarries and the St. Marie Show!

The stunning Glacier Gardens of Lucerne

by Geoff Bennett

No holiday in Switzerland could fail to appreciate the grandeur of the mountain scenery and the great lakes. I spent a week holidaying on the shores of Lake Lucerne, one of the only lakes not to freeze during the Swiss winters. It is sheltered from the northern winds by the range of Alps and remains above freezing. It is warm for swimming during the summer months, unlike many of the Alpine Lakes.

Twenty million years ago Lucerne was on the edge of a coastal plain. There are ripple marks in the Lucerne Sandstone, and numerous shells of *Paphia* which lived in shallow coastal areas buried under sand, surviving by two breathing tubes going from their shells to the surface where they could absorb oxygen and nutrients. This Alpine Ocean was about 500 miles wide and 700 miles long. The northwards drift of the African Plate and its subsequent collision with the European Plate (Fig. 1) brought the compression, uplift and folding of the present day Alps.

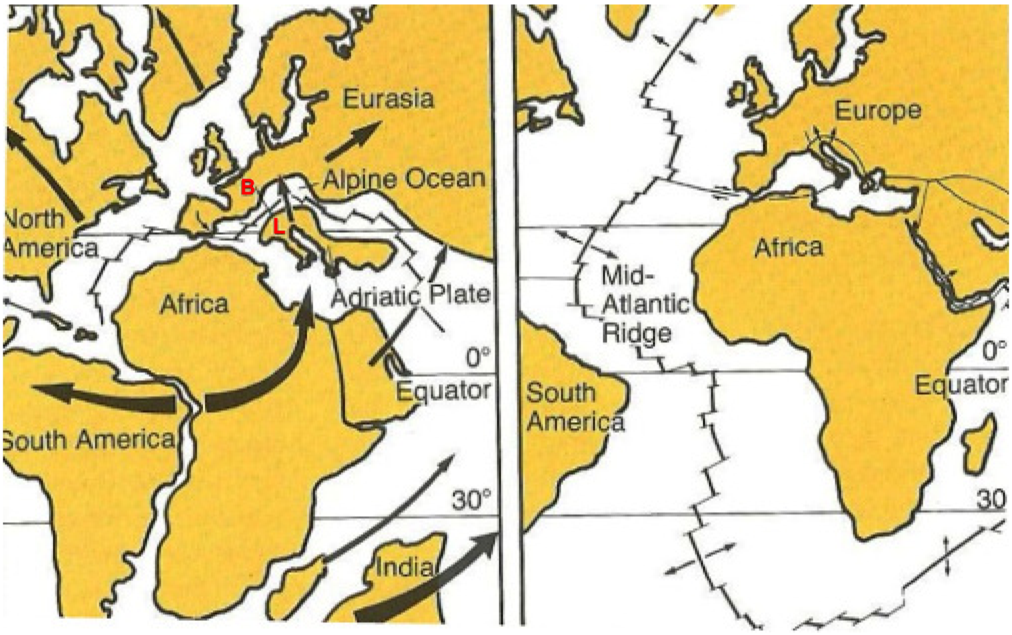

Fig. 1. Part of the African Plate forcing itself into the European Plate.

*The "**B**" and "**L**" on the left sketch show the positions of Basle and Lugano. Lucerne would be between the two.*

The right hand sketch shows present position and the direction of movement.

My primary interest, however, was not just in the Alps despite numerous trips up local mountain passes, but especially in the fascinating Glacier Garden in Lucerne itself. While at the beginning of the Tertiary period, the Lucerne area was a subtropical bay surrounded by palm trees, this whole area was covered with vast glaciers during the Ice Age 10–20 thousand years ago. And the Glacier Garden which reveals an amazing amount of evidence of these past events was discovered only in 1872.

Attempting to excavate a wine cellar, a young bank clerk, J.W. Amrein-Troller, discovered the first pothole. Geologist and doctor, F.J. Kaufmann, a teacher of natural history at the local junior college, recognized the basin shaped depression in the rock and the scrapings on the surface (Fig. 2) as traces of the Ice Age. During the next three and a half years (1872–1876) the Glacier Garden was excavated (one original photograph of the period shows the removal from the largest pothole of a

Fig. 2. A photograph of ice marks from 1890, many of which have now weathered and almost disappeared. Some further ice marks were newly discovered in 1980 in a still unweathered state.

huge block weighing over six tons). A number of these potholes were uncovered in the Garden.

Many similar potholes have been discovered throughout the Alps and especially in Switzerland. During the Middle Ages these strangely scoured hollows and basins were thought to be the work of giants and witches. Those at Lucerne were formed at the bottom of the glacier (itself estimated to be almost 1000 metres thick) by the sheer force of water melting below. Vortices were formed by the water pressure, travelling over 125 miles an hour to produce within a short time (a few years) potholes that were eroded out of the rock (Fig. 3). Most of the erosion was brought about by sand and gravel transported with the muddied melt water. The largest pothole in the Glacier Garden is almost 30 feet deep and five feet in diameter.

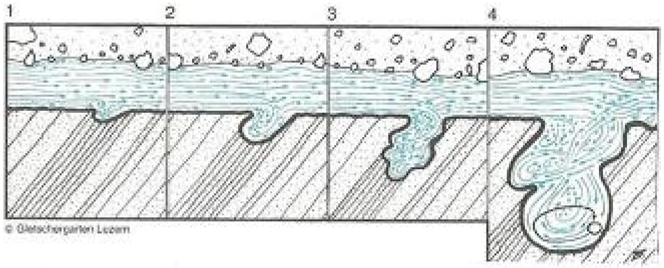

Fig. 3. Different stages in forming potholes at the bottom of the ice. Water flowing under enormous pressure and great speeds over irregular bedrock cause turbulence with complicated vortex motion.

An example of the erosive power of water vortices today can be shown by the effect of a drainage gallery of an artificial lake near Zermatt which has a slope of 6% embedded in very hard ophiolite rock. In just over two years, a whirlpool almost seven feet across and six and a half feet deep has been gouged out by the vortex formation of the water current!

Any irregularity, no matter how small, will result in vortex motion of the sub-glacial water jet and the formation of cavities of various sizes (Fig. 4). Different hardness of rocks will result in different levels of erosion, with soft sandstones being far more susceptible to scouring. Most of the scouring is done by coarse sand particles and small pebbles. Large rocks whirl as grindstones in the water. Eventually they will be smashed into tiny fragments and finally washed away. Huge blocks may outlast the enormous stress.

Why was the sandstone so hidden in Lucerne? Almost all the Swiss Plain is covered with moraine debris or gravel deposited by the Ice Age and its glacial rivers. Because of this cover, the Lucerne Sandstone rock and scoured holes were hidden until their discovery between 1872 and 1876.

I enjoyed my exploration of the Glacier Garden, and seeing the numerous glaciers and ice high up in the huge mountain passes.

Fig. 4. A small pothole composed of two cavities. Within a short time, the turbulent melt water mixed with sands, pebbles and such from the ground moraine has eroded complicated formations in the hard sandstone rock.

Life and death in Cretaceous seas

by Andy Ottaway

I visited Hope Gap, Seaford, one evening in June 2009 and headed west along the base of the cliffs not expecting to find more than a sea-urchin, but on this occasion I found something very much rarer and more interesting than a mere echinoid! After scrambling over a large rock-fall my eye caught something about 20 cm long on the upper surface of a large fallen block. On closer examination I could see that it was a bone of some sort, but the surface was very badly weathered, presumably by the sea, or at least that is what I thought.

Fig. 1. Dramatic scene showing a marine reptile being attacked by a ginsu shark in the Cretaceous oceans of Kansas. (from Everhart 2005)

I spent about 45 minutes carefully extracting the specimen, wary of its extreme fragility having been preserved in chalk. Eventually I could remove the fossil, but when turning it over I was surprised to discover the other side was just as badly weathered and pitted as the exposed surface. I was rather disappointed at the time, thinking my new fossil had been damaged by exposure to the elements or was simply poorly preserved, without realising the significance of this surface damage. After preparing the fossil further at home, I knew by its overall shape that it was the humerus or femur of a marine reptile, most likely a plesiosaur or mosasaur (Fig. 2).

By chance at this time, I had started to read a book entitled *Oceans of Kansas* by Mike Everhart (Everhart 2005) of the Sternberg Museum (www.oceansofkansas.com), about the fossil fauna of the Smoky Hill Chalk of western Kansas. On the cover of this fascinating book is a wonderful image of a large shark attacking a mosasaur, witnessed by a sky full of soaring pterosaurs (Fig. 1). In the book is a chapter on the fossil evidence for predation in the Upper Cretaceous seas of Kansas, which were inhabited by marine reptiles and huge fish, including sharks.

Looking at these photographs of the munched remains of several unfortunate plesiosaurs and mosasaurs,

Fig. 2. Plesiosaur or mosasaur bone from Hope Gap, Seaford, showing evidence of bite marks and etching by stomach acid. Shark tooth fragment (arrowed) was found embedded in the bone. Scale in inches.

Fig. 3. Plesiosaur limb bones from the Upper Cretaceous of Kansas showing stomach acid wear and bite marks. Scale bar in cm. (from Everhart 2005)

I noticed an astonishing similarity to the condition of these fossils and that of the bone I had found at Seaford (Fig. 3). I then realised that the worn condition of my bone, which I had taken as poor preservation or caused by exposure to the elements, was in fact caused by stomach acid – it had been partly-digested! Furthermore, all the pits and grooves on the surface of the bone were actually bite marks!

So cause of death established perhaps, but what might have attacked and eaten my unfortunate Seaford beast? I didn't think I would ever know the answer to that question. However, on re-examining my find I made the most grisly discovery of all: embedded in the bone was the broken tip of a shark tooth! So instead of finding what I thought was a rather poorly preserved or weathered lump of bone has in fact turned out to be forensic and rather dramatic evidence of a ferocious assault that took place over 80 million years ago, when a plesiosaur or mosasaur was attacked by a shark!

We'll never know if the reptile was alive or dead when it was bitten, or indeed whether it survived the attack minus a limb, but my Seaford discovery does reveal a brutal story of life and death way back in the Upper Cretaceous Seas of around 85 million years ago. That picture on the cover of *Oceans of Kansas* could just as well have depicted the Oceans of Seaford all that time ago.

Reference

EVERHART, M. J. 2005. *Oceans of Kansas: a natural history of the western interior sea*. Indiana University Press, 322 pp.

Editor: Andy's spectacular find was featured on the BBC regional news programme, South East Today, in August 2009 and a short video of the report can be found at:
http://news.bbc.co.uk/local/sussex/hi/people_and_places/history/newsid_8209000/8209581.stm

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GEOLOGISTS' ASSOCIATION FIELD MEETINGS – 2013

The Hastings & District Geological Society is affiliated to the Geologists' Association (GA), and as such members are entitled to attend GA lectures, normally held at Burlington House, Piccadilly, London, W1, or attend any of the GA field trips. Below is the 2013 GA field programme, although some of these dates may change. Details of these trips and also GA lectures appear in the *Magazine of the Geologists' Association*, which is available at HDGS meetings. Details can also be found on the GA website http://www.geologistsassociation.org.uk/. All bookings must be made through the Geologists' Association office – details in the *Magazine of the Geologists' Association.*

FIELD MEETINGS IN 2013

Sun 17th March	Barton - fossils and geo-engineering	Peter Reading
Sat 23rd March	Somerset quarry	Simon Carpenter
Sun 14th April	Buckinghamshire geology	Jill Eyers
Sun 5th May	Brookwood Necropolis, Surrey	Di Smith
Sat 18th May	Tottenhoe and Kensworth, Dunstable, Beds.	Heydon Bailey
Sat 1st June	Newark, Nottinghamshire	Andy Swift
Mon 10th Jun. to Thurs 13th Jun.	Pembroke geology and churches	John Potter
Sat 20th July	Cliff End to Fairlight (Joint GA/HDGS trip)	Ken Brooks/Peter Austen
Sat 21st Sep. to Sun 22nd Sep.	Durham conference	Geologists' Association
October/November (date t.b.c.)	Fossil Fest IX	Neville Hollingworth
Sat 2nd November	GA Festival of Geology, UCL, London	Geologists' Association

Sussex Mineral & Lapidary Society celebrates 40th Anniversary

by Trevor Devon

Following the recent talk to HDGS "Mineral collecting around the world with SMLS" that was presented by John Pearce, I thought HDGS members might like to hear a bit more about this relatively local society that has now been active for 40 years. It is also perhaps pertinent that this July I started my three year term as the Chairman of SMLS!

Members of SMLS recently gathered for a dinner to celebrate the 40th anniversary of the founding of the Society in 1972. At the dinner were 11 members who had been members for more than 20 years and one, Don Ford, who was a founding member. Don was presented on this occasion with a Ruby plaque in honour of his unique status. Although based in West Sussex at Haywards Heath, the Society not only attracts members from all the Home Counties, but throughout the country from Cornwall to Norfolk, and from Wales to Northern Scotland – and even the South of France!

During these forty years SMLS has grown into an active, well-respected club which ranks among the premier amateur mineral societies in the country. This has been achieved through a combination of activities such as regular meetings, field trips, an annual show, a Journal and website; but equally important has been the quality of the people who have built the Society through their individual contributions and a rare camaraderie. At the dinner, guest speaker Bob Symes OBE, formerly Keeper of Minerals at the Natural History Museum, reflected on the achievements of SMLS and remarked especially on this camaraderie. Bob also noted that the Sussex Show in November at Haywards Heath is such a highly regarded event that it has become the premier mineral show in the country.

A distinguishing feature of SMLS has always been its range of field trips, particularly overseas. John Pearce noted that 26 such trips had been undertaken over the 40 years, visiting places as far afield as India (twice), Namibia (twice), USA and Canada, Russia, Poland, Faroes, Bulgaria, France, Lanzarote, Spain, Germany and Slovakia. Next year a trip is planned for Morocco. In the British Isles pretty well all the major collecting areas have been visited, including some of the more unusual and challenging sites on the Isle of Skye.

In common with HDGS, SMLS attracts a good range of speakers for its monthly meetings with a variety of topics drawn from the Earth Sciences – geology, mineralogy, gemmology, palaeontology and vulcanology. Ken Brooks and Peter Austen from HDGS have featured as speakers at SMLS and reciprocally, Peter Hay and John Pearce from SMLS have given talks at HDGS. We have also shared some other well-known speakers such as Professor David Price, Chris Duffin and several members of the Natural History Museum professional staff.

Most members are collectors or practise lapidary, and one feature of the Society is the sharing of our know-how, finds and expertise. One meeting a year is devoted to an internal SMLS competition featuring members' own fossil, mineral and lapidary displays with a focus on self-collected material. This provides members with the opportunity of seeing a wider range of specimens that are generally secreted away in private collections at members' homes. We also have occasional "at home" visits to those members whose collections are on display or accessible. At each of our meetings a "mineral of the month" is featured where members are invited to bring along their favourite specimens to display. Twice a year a number of members with micromount collections assemble at Haywards Heath with their microscopes to spend an evening studying specific aspects of microminerals, often exploring minerals from the British Micromount Society collection.

Many of the SMLS activities are duly recorded in our bimonthly journal which has been produced without a break for nearly the whole forty years and is eagerly read throughout the country. Of great interest are the field trip reports by members sharing their experiences and various finds with a wider audience.

Finally, a word about the SMLS Show at Haywards Heath in November each year: attracting as many as a thousand visitors at its peak, the show is much more than a shop window to 40 mineral, lapidary and fossil dealers. There are always several special displays, including the finest display of UV fluorescent minerals in the country; talks by accomplished speakers (with one of the three talks aimed at juniors) and a workshop for children to try their hand at gold-panning, lapidary, hunting for rocks or fossils. In recent years we added a themed mineral display competition (yours truly has won this twice with one display on calcites and another on iron minerals!). We provide something for all the family to enjoy on a day out.

So after forty years we feel we do have something special in SMLS to be proud of here in Sussex. If you are interested in current activities of SMLS do have a look at our website www.smls.org.uk

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HDGS visit to the Sussex Mineral Show, Haywards Heath

Saturday, 10th November 2012

Several HDGS members attended the Sussex Mineral Show at Haywards Heath. The show is organised by the Sussex Mineral & Lapidary Society, and the photo shows dealers and exhibitors in one of the halls. See below for next year's show - well worth a visit. *Photo: Peter Austen*

SUSSEX MINERAL SHOW

Saturday 16th November 2013

10.00 am to 4.30 pm

Clair Hall, Perrymount Road, Haywards Heath

(Close to Haywards Heath Station)

Minerals, gems, fossils, meteorites, flints, books and accessories on display and for sale

Illustrated Talks

Organised by the **Sussex Mineral & Lapidary Society**

Details and map available from Trevor Devon at HDGS meetings closer to the date of the Show

Fairlight Cove field meeting, 6th May 2012

by Alison Nicholls (Oxford Geology Group)

This field trip was a joint venture with members of Oxford Geology Group and Hastings and District Geological Society (HDGS) attending.

The Oxford Group left Oxford at around 10.30 and arrived at The Smuggler Inn at Pett Level shortly after 13.00 where we met the Hastings Society. The weather was dry but overcast, cool and with light airs. The field trip was timed to allow the group to examine the foreshore at an exceptionally low tide. Following a good carvery lunch we were introduced to our guides from the Hastings Society, Ken Brooks and Peter Austen prior to our site visit.

Siderite ($FeCO_3$) nodules in sandstone, located above the littoral zone.

Lower Cretaceous

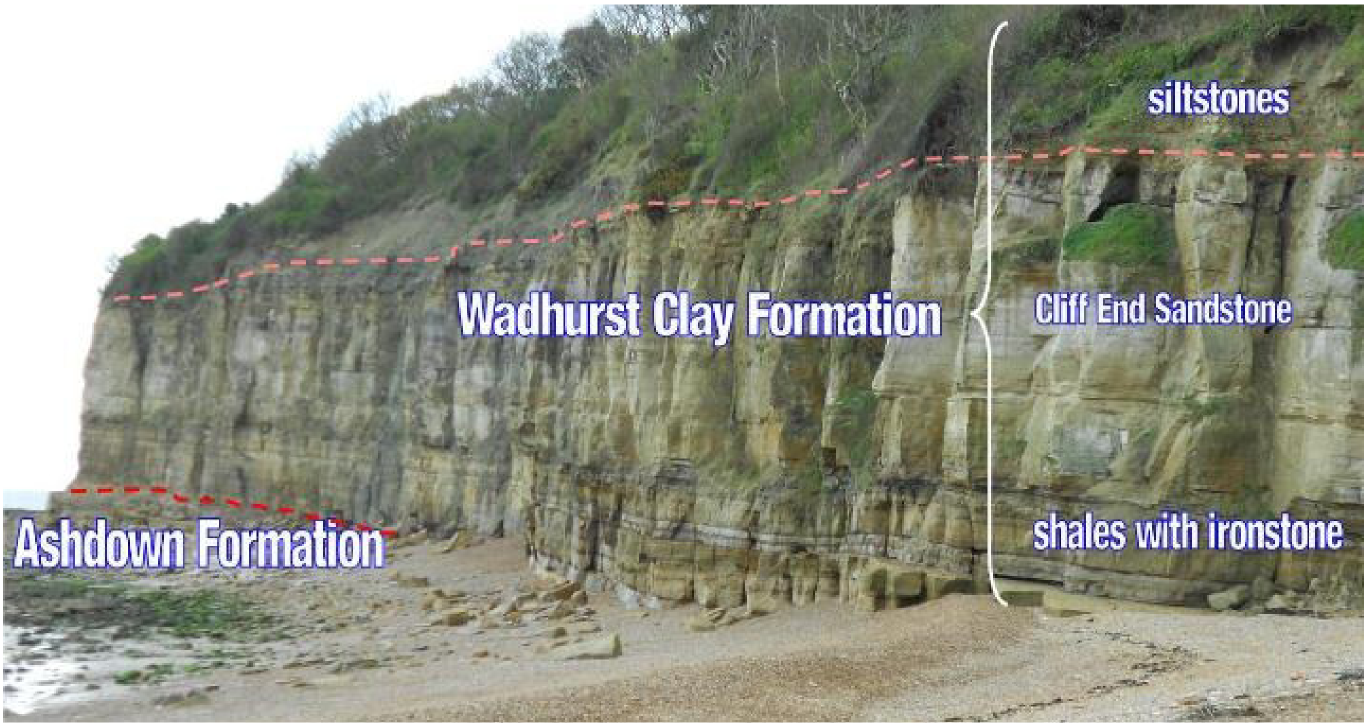
Ken, fresh from his wedding the day before, showed us an artistic impression of the palaeoenvironment of this Lower Cretaceous Period. He explained that at that time 120–140 Mya south-east England was part of a land mass sitting 40° N with a hot humid climate. The illustration showed a landscape set in an area of meandering rivers, flood plains and lakes. The dinosaurs *Iguanodon*, *Polacanthus* and *Baryonyx* could be seen eating lush vegetation and each other.

The Cretaceous rivers flowing down into this lowland area, from the London Uplands and the west, deposited great quantities of sand, silt and mud. This was subsequently consolidated to form the Hastings Group comprising of the Ashdown Formation, overlain by the Wadhurst Clay Formation, which includes at its base the Cliff End Sandstone. The aforementioned rock units are all exposed in the cliffs and foreshore between Pett Level and Fairlight Cove. During the Alpine Orogeny the rock units at Fairlight Cove were compressed laterally causing one side to slip upwards over the other. The beds are therefore faulted by sets of reverse thrust faults. Two sets were shown to us by our guides, (Haddock's & Fairlight Cove reversed faults). These beds are now tilting very gently southwards and are uplifted to form the southern part of the Wealden Anticline.

The cliffs between Fairlight Cove and Pett Level.

Ken showed us examples of various fossils found in these beds. These included a fine specimen of fish scales *c*. 25 cm by 15 cm. Each scale was about 15 mm square and formed part of a *Lepidotes* fish which was probably 1 m long at its demise. Casts of dinosaur bones included a metatarsal, two vertebrae with dorsal bony prominences, probably from the tail of the armoured ankylosaur *Polacanthus*, along with a photo of the braincase and partial skull of an Ankylosaur. We were also shown a cast of the snout of a large Wealden crocodile *Goniopholis*, found by a child on the beach. These specimens were disarticulated suggesting that they had been washed down into the rivers and lakes. Fibreglass moulds of the footprints of several different species of three-toed theropod dinosaurs were handed round;

Larvikite revetment protecting the cliffs at Fairlight Cove.



The cliffs between Pett Level and Fairlight Cove showing Hastings Group strata.

these footprints are often found in the once soft muds now visible on the foreshore, and in fallen blocks of sandstone. Unusual parallel ridges in the mudstones were formed by slow trickling water across the once soft muds; an example of these 'gutter casts' was shown. A polished block of the attractive banded buff coloured sandstone showing the effects of iron staining with iron mineral haematite (red), and siderite (dark brown) and the hydrated iron oxide minerals, known as limonite (yellow), was passed around.

The Cliff End normal fault.

Peter explained that a variety of Cretaceous molluscs, fish and sharks lived in the brackish to freshwater environments of this area. The land was dominated by crocodiles, turtles and dinosaurs. Carbonated plants found here such as horsetails, ferns, cycads, conifers and tree ferns indicate that the summers were hot and dry, followed by wet and humid conditions in the winters. The group was shown samples and drawings of these plants.

The group then set off, walking along the sea wall promenade at Pett Level. Tree stumps are visible on the foreshore. These are a 'fossilised forest', remnants of a drowned wooded area used as a hunting ground in the Mesolithic. Hand axes have been found in a cave in the cliffs overlooking this foreshore. It was suggested that this cave was used as a vantage point for Mesolithic hunters.

Faults

The cliffs that rise-up from Pett Level are promptly punctuated by the Cliff End faults. These normal faults form a graben type depression with the Cliff End Sandstone visibly off-set.

Ken explained that he had witnessed a significant cliff fall last year. Cracks and fissures extend up the full face of the cliff, rendering it very unstable. The group was therefore advised not to approach the foot of the cliffs and search instead for fossils

Haddock's Reversed Fault, Fairlight Cove.

Theropod dinosaur footprint.

mainly in the littoral zone.

A rock sample containing fish scales, fish teeth and a turtle scute was found by a member of the group searching in fallen blocks from the Cliff End Bone Bed, part of the Wadhurst Clay Formation. The stems of quillworts (clubmosses) were visible as 5-cm raised circular discs on blocks of sandstone from the top of the Ashdown Formation. Some blocks of mudstone in this area were pitted with small *Neomiodon* bivalve fossils, iron-stained brown. On the shallowly dipping mudstones of the foreshore, dinosaur footprints were seen, some more convincing than others. Two sets of three-toed footprints about 50 cm across indicated 2 dinosaurs moving in opposite directions across the then soft estuarine muds.

Tectonic activity associated with the Alpine Orogeny formed Haddock's Reversed Fault. The rocks on the south-west side (Ashdown Formation) were thrust upwards forming the cliff to the south-west of the fault, which has latterly slipped backwards (in the direction of its natural position), resulting in a visible slip-plane across the exposed Wadhurst Clay to the north-east of the fault.

Fairlight Cove

The Ashdown beds have been eroded to form Fairlight Cove. With the rate of cliff erosion accelerating since the mid 20th century with property lost in cliff falls, a cottage now sits abandoned on the cliff edge. Efforts have been made to protect the village of Fairlight on the cliff top from further losses. Two revetments have been placed in the vicinity of the cove. The easterly one is made of blocks of dark grey Norwegian larvikite, a form of monzonite containing ternary feldspar, and its purpose is to stabilise the cliff slopes at an angle of 40 degrees. The lagoon that was initially created behind the berm has now been filled in by storm thrown flint pebbles. The lower slopes are now starting to stabilise with gorse, brambles and grasses growing on them. The top of the slopes still have fractured strata. Further cliff falls will presumably occur before the 40° angle of stability is reached but these efforts appear to be having some success. The westerly berm is made of massive blocks of white Carboniferous coralliferous limestone from the Bordeaux region.

Mary Edginton's find: Gleichenites *sp.*

Joyce Austen's find: Gleichenites *sp. (mm scale)*

On the western side of the cove Peter showed us a second reverse fault (Fairlight Cove Reversed Fault). This had thrust up the reddish-purple Fairlight Clays facies; foundering of these soft clays, rocks and recent midden deposits had resulted in huge landslips down onto the beach. Butchered cattle bones were found in the clays but alas none from dinosaurs.

On the foreshore we were shown a small localised deposit of mudstone containing abundant plant material. This deposit is part of the Fairlight Clays facies which shows a unique Lower Cretaceous flora. The plant material was not *in situ* but appeared to have floated in from elsewhere at the time of deposition. The group collected samples of carbonised conifer wood, bennettitalean leaves and fern pinnules, including one species (possibly *Gleichenites* sp.) rarely found.

The group then walked back along the foreshore to The Smuggler Inn and following a much needed drink returned home.

The above is an edited version of an article that first appeared online
on the Oxford Geology Group website
http://oxgg.org.uk/wp-content/uploads/2012/05/Fairlight-Cove-Report-May-2012.pdf
on 8th May 2012, and was reproduced by kind permission of
Alison Nicholls and the Oxford Geology Group.

A five minute video of the trip can be found at http://www.youtube.com/user/OxfordGeology

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Geologists' Association Festival of Geology, UCL, London

Saturday, 10th November 2012

One of the halls at the GA's Festival of Geology, featuring displays by local geological societies from all over the country, and exhibits by other organizations including the Natural History Museum, Natural England and the British Geological Survey. There were also fossil and mineral displays, and books, maps and geological equipment for sale. The 'Discovery Room' featured activities for budding young geologists including an area for making fossil plaster casts, a microscope area for studying micro-fossils, and radio-controlled racing trilobites!

Photo: Peter Austen

The Natural History Museum stand at the GA. Peta Hayes (left) is curator of Invertebrates and Plants at the NHM, and Christine Strullu-Derrien (right) is studying the Museum's collections of Coal Measure and Devonian plants, looking for associations between the plants and fungal-like micro-organisms.   Their stand included examples of Coal Measure plants and photos of plant/fungal associations from the Devonian Rhynie Chert.

Photo: Peter Austen

HDGS Barbecue

Sunday, 19th August 2012

The HDGS Barbecue in August was once again hosted by Trevor and Fiona Devon at their home in Sedlescombe. We were blessed with a fine, sunny afternoon – a rarity in this wet summer!

Thirty members gathered in Trevor and Fiona's garden to enjoy the magnificent spread of barbecued treats, salads and desserts provided by our hosts. We were also able to browse Trevor's extensive displays of rocks and minerals from around the world, many of which he has collected himself during field trips at home and abroad.

A superb selection of goodies was provided by Norman Farmer for the raffle – so many, in fact, that no-one had to miss out on a prize!

We all had a very enjoyable afternoon – thank you again to Trevor and Fiona for all their hard work and for welcoming us into their home.

Photos: Peter Austen

HDGS field trip to Cooden, near Bexhill, East Sussex
Sunday 1st July 2012

by Peter & Joyce Austen

The coastal exposures in the vicinity of Cooden cover both the Hastings Group and the Weald Clay Group. Immediately adjacent to the Cooden Beach Hotel (TQ 710 064) is an exposure of Weald Clay which stretches for around 2 km from TQ 716 065 (½ km east of the Cooden Beach Hotel) to TQ 700 062 (west of Cooden towards Norman's Bay), although the section is complicated by faulting and folding (Anon. 1999). These Weald Clay deposits are bounded on each side by the Tunbridge Wells Sand, which extends eastwards for 5 km to the Old Town Fault (TQ 763 078) east of Bexhill, and westwards for a short distance before being obscured by clay, silt, sand and gravel. Figure 1 shows the stratigraphy of the Weald in south-east England, and places Cooden in context with other Wealden localities.

Unlike the coastal succession to the east of Hastings which exposes extensive cliff sections, most of the exposures along the Bexhill–Cooden section are shoreline deposits, access to which varies depending on the amount of drifted sand and shingle, and also tidal and weather conditions – a storm or rough seas can easily obscure or reveal the exposures.

On Sunday 1st July 2012, twenty-one HDGS members and guests gathered on the beach at 2 pm opposite the Cooden Beach Hotel, Cooden, East Sussex. Low tide was due at 4.11 pm, but unfortunately, it was a very windy day with the wind (force 6) coming off the sea from the south-west, preventing the tide from fully retreating. This meant that upon our arrival no foreshore exposures were visible at the foot of the shingle. However, after a brief explanation of the geology and palaeontology of this section of coast, the receding tide started to expose areas of the foreshore, and the party proceeded westwards.

The section to the west of Cooden to Norman's Bay is well known for rolled dinosaur bones (Fig. 8), which are found as 'float' (i.e. they are not *in situ*), and are probably derived from the Tunbridge Wells Sand Formation to the west, having been transported by long-shore drift (Batten and Austen 2011). The section also yields the remains of sharks, mainly in ironstone nodules, some *in situ* buried head downwards in the mudstone (Mitchell 2000) and some loose on the foreshore. The nodules formed preferentially over the skull and the parts of the trunk which bear the fin spines, and very rarely over the tail (Evans 1999). Historically many important shark specimens have been recovered from this section, and even in recent years more than 100 specimens have been found. However, on the day of our visit all the exposures in this area were obscured by sand so it was decided to return eastwards to examine the Weald Clay platform on the foreshore which was now being exposed by the falling tide. On the way, John Fowler picked up a promising piece of rock which when split revealed the tail end of an arthropod body (Fig. 2A), since identified by Prof. Ed Jarzembowski as the abdomen of a polyphagan beetle. The polyphaga are the largest and most diverse sub-order of beetles with over 300,000 present-day species described, representing around 90% of all known beetles. In the Cooden specimen the leg impressions are visible on the front of the abdomen, and a reconstruction of a present-day polyphagan abdomen with legs has been included from Chinery (1976) for comparison (Fig. 2B). Several groups of insects have previously been recovered from sideritic mudstones within the Weald Clay exposures, including caddisflies, cockroaches, grasshoppers (Fig. 5) and crickets, leafhoppers, planthoppers and a species of cicada (Fig. 7) (Anon. 1999; Gorochov *et al*. 2006; Wang Bo *et al*. 2008). On the foreshore adjacent to the Cooden Beach Hotel, Joyce Austen found a shark's tooth, *Polyacrodus parvidens* (formerly *Hybodus parvidens*) (Fig. 4), in a loose block of Weald Clay, and shortly after picked up a water-worn nodule containing shark skin (Fig. 3).

Other finds known to have come from Cooden include dinosaur trackways to the east of the Cooden Beach Hotel (Fig. 9) (Baldwin 2000) and, as 'float' (hence not unequivocally of Weald Clay origin), shark egg cases, *Spirangium* sp. (Fig. 6), the teleost fish *Leptolepis brodiei* (Fig. 10), the finger-bone of a large sauropod dinosaur (Fig. 12A) (Anon. 2005), the partial jaw and teeth of an '*Iguanodon*' (Fig. 13) (Anon. 2005) and a new species of crayfish (Fig. 14) (Anon. 1999; Jarzembowski 2011). A hybodont shark fin-spine has also been recovered *in situ* from the Weald Clay (Fig. 11) (Anon. 2001). Plants have also been found along the Cooden-Bexhill section, including the bennettitalean stem *Bucklandia* sp. (Fig. 16) and shoots of the cheirolepidiacean conifer *Pseudofrenelopsis* sp. (Fig. 15) (Austen and Batten 2011).

Unfortunately, due to the poor exposures on the day, very few fossils were found during the HDGS visit. However, there is always the potential for interesting finds along this section of coast.

Further information about the geology and palaeontology of Cooden may be found in Lake and Shephard-Thorn (1987), Ruffell, *et al*. (1996) and Batten (2011), and further information on fossil sharks can be found in Woodward (1916), Patterson (1966) and Maisey (1983).

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* *Wealden News* can be found at: http://geoconservationkent.org.uk/ (click on 'Resources')

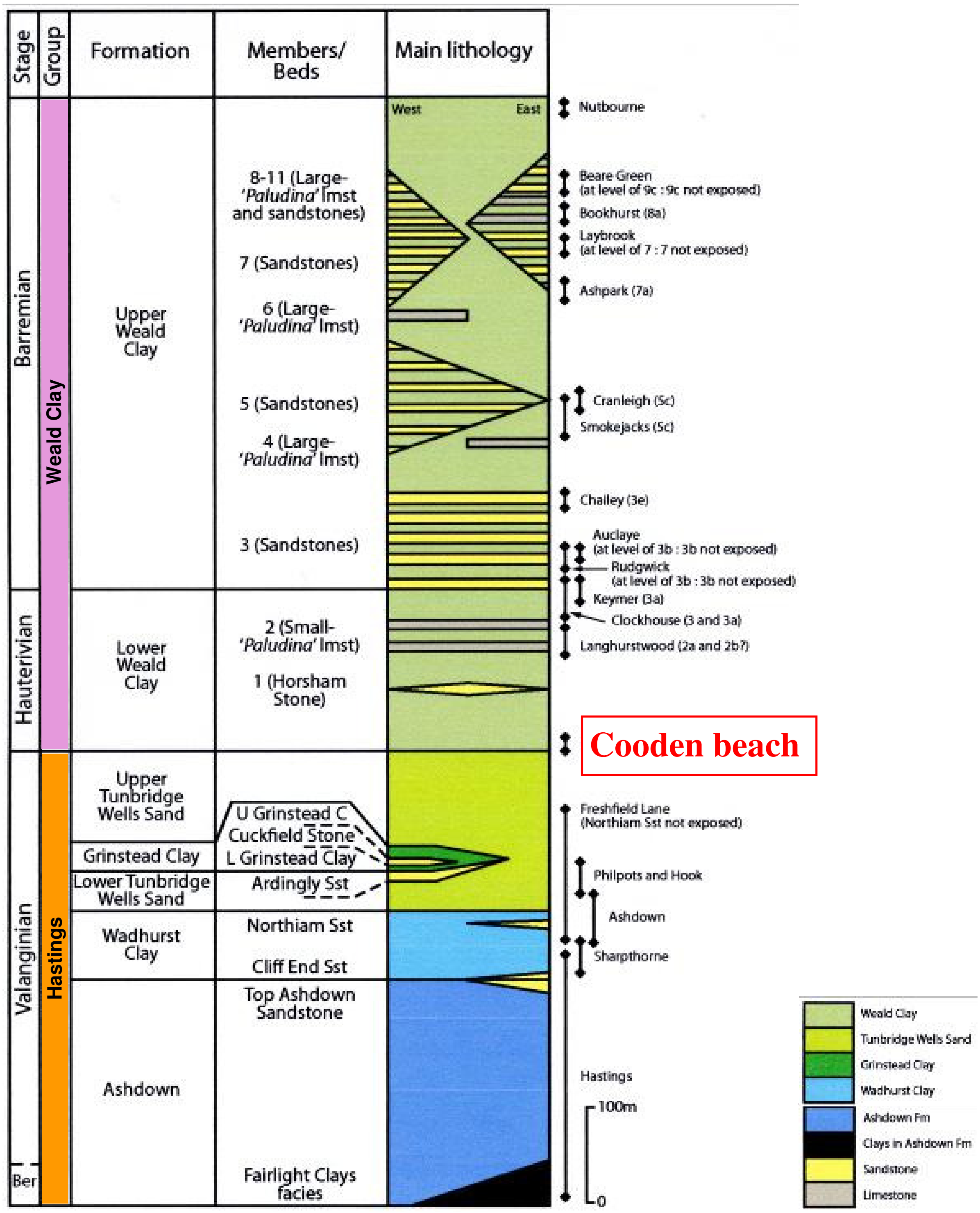

Fig. 1. Stratigraphical column for the Wealden Supergroup in south-east England. Adapted from Batten and Austen (2011).

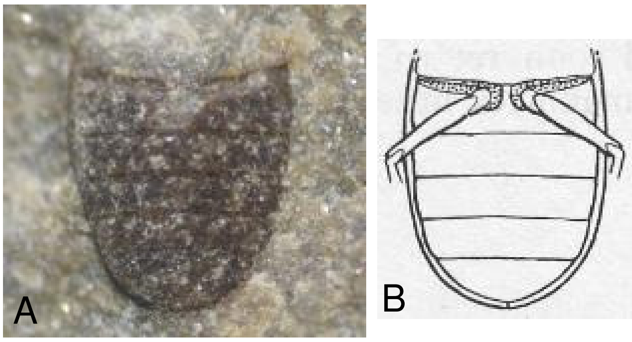

Fig. 2A–B. A, beetle abdomen. Cooden beach. Length of section shown 2 mm. B, present-day reconstruction for comparison. (from Chinery 1976, page 293)

Fig. 4. Shark tooth, Polyacrodus parvidens. *Cooden beach. (Scale in mm.)*

Fig. 6. Shark egg case, Spirangium *sp. Cooden beach. Length of section shown 45 mm.*

Fig. 8. Fused caudal vertebrae, possibly 'Iguanodon'. *Cooden beach. Found in 2011. 30 cm ruler for scale.*

Fig. 3. Water-worn nodule containing shark skin. Cooden beach. cm ruler for scale.

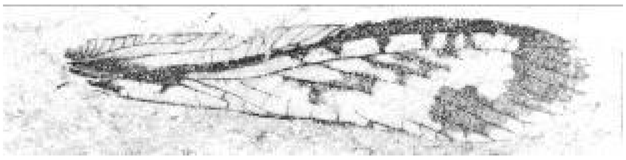

Fig. 5. Forewing of long-horned grasshopper (Orthoptera: Panorpidium *sp.). Cooden beach. Length 15 mm. (from Anon. 1999, page 3)*

Fig. 7. Hindwing of cicada, Valdicossus chesteri *(Hemiptera: Palaeontinidae). Cooden beach. Length 14 mm. (from Wang Bo* et al. *2008, page 67)*

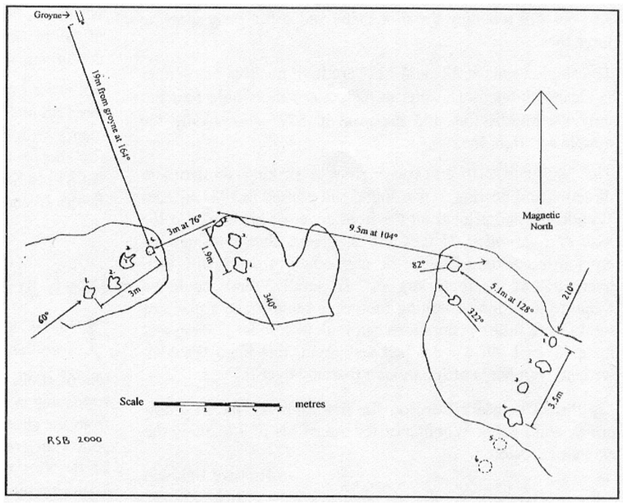

Fig. 9. Dinosaur trackways to the east of Cooden Beach Hotel. (from Baldwin 2000, page 1)

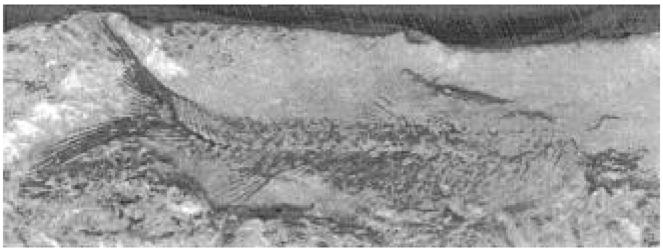

Fig. 10. Fossil fish, Leptolepis brodiei. *Cooden beach. Length 28 mm. (from Anon. 1999, page 2)*

Fig. 11. Hybodont shark fin spine found in situ. *Cooden beach. Found by Richard Baldwin. Length 15 cm. (from Anon. 2001, page 2)*

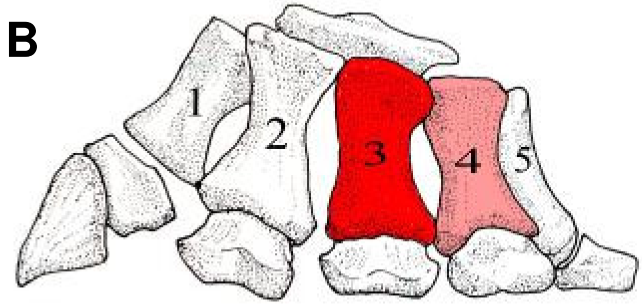

Fig. 12A–B. A, sauropod metacarpal (finger bone), possibly diplodocid. Cooden beach. B, reconstruction of diplodocid hand. Third and fourth metacarpals highlighted (adapted from Norman, 1999). Cooden beach. Found by Frank Hamill. On display in Bexhill Museum. Scale bar in cm. (from Anon. 2005, page 2)

Fig. 13. Water-worn jaw and teeth of Iguanodon. *Cooden beach. Found by Frank Hamill. On display in Bexhill Museum. Length of section at maximum 17.5 cm.*

Fig. 14. Unnamed crayfish. Cooden beach. Found by Dave Brockhurst. Length of concretion at maximum 8 cm. (specimen figured in Jarzembowski 2011).

Photo: Peter Holloway

Fig. 15. Shoots of the Wealden conifer Pseudofrenelopsis *sp. (Cheirolepidiaceae). Cooden beach. Scale bar 20 mm. (specimen figured in Austen and Batten 2011)*

Fig. 16. Bennettitalean stem, Bucklandia *sp. Bexhill beach. Length 16 cm. (specimen figured in Austen and Batten 2011)*

Charles Dawson and his List of Wealden Fossils

by Anthony Brook and Peter Austen

Part 1 Charles Dawson as Wealden Fossilist by Anthony Brook

We are rapidly approaching a rather unfortunate anniversary. December 18, 2012 will mark the centenary of that infamous Meeting of the Geological Society when Arthur Smith Woodward and Charles Dawson announced "*to a great and expectant scientific audience the epoch-making discovery of a remote ancestral form of man*", which became known, in common parlance, as Piltdown Man, and, more scientifically, as *Eoanthropus dawsoni*. This was the apex of Dawson's scientific career, bringing him international celebrity status, particularly after publication, at length, in the next issue of the *Quarterly Journal of the Geological Society* (Vol. 69, 1913, 117–151), under the banner headline 'On the discovery of a Palaeolithic Human Skull'.

It is not Dawson's dubious archaeological practices that concern us here, but rather the foundation of his scientific career, which was grounded in the rocks and fossils of the Wealden Beds which outcrop either side of his hometown of Hastings, in East Sussex, where the High Weald meets the sea. Dawson was in the long tradition of excellent amateur fossil collectors; after decades of fossil hunting in the Wealden strata, he published what he considered to be a definitive List of Wealden Fossils (see pages 42–45), which is subject to examination here. My contribution is twofold: to provide an assessment of his geological record, and to delve into aspects of this publication bar the fossils themselves.

One of several obituaries to Charles Dawson appeared in the *Geological Magazine* (New Series, Decade 6, Vol. 3, 1916, 477–479) with the initials A.S.W., which can only stand for his long-time friend and scientific associate, Arthur Smith Woodward, of the British Museum (Natural History), who wrote that:

> "*Charles Dawson was born at Fulkeith Hall, Lancs. on 11 July 1864, the son of Mr Hugh Dawson, barrister. Most of his early life was spent at St. Leonards-on-Sea, and he was educated at the Royal Academy, Gosport. He began to study law in 1880, and from 1890 until his death practised as a solicitor in Uckfield, where he held several public appointments and won the highest esteem of all those who knew him. His duties were many and arduous, and science was the recreation of his leisure hours.*
>
> *From early boyhood he had been interested in natural history and antiquities, and began to collect Wealden fossils from the quarries and cliffs around Hastings. He soon attracted the notice of Mr Samuel Beckles, F.R.S., who was then spending his last years in St. Leonards. He was thus helped and encouraged to collect dinosaurian remains in a systematic manner; and he met with so much success that by 1884 he had made a valuable collection which was gladly accepted by the British Museum. From then until almost the end of his life he made continual additions to the Dawson Collection, as it was named by the Museum, where it now occupies a prominent position. The last noteworthy accession was the finest known specimen of the Wealden ganoid fish,* Lepidotus mantelli. *On the death of Mr Beckles in 1890, Mr Dawson gave much help to the Museum in labelling the collection of Wealden fossils acquired from Mr Beckles' executors.*
>
> *Among the Wealden dinosaurian remains discovered by Mr Dawson, Mr Lydekker recognised 3 new species of* Iguanodon*, one of which he named* Iguanodon dawsoni. *Among his later discoveries was the first tooth of a Wealden mammal,* Plagiaulax dawsoni*, which he obtained from one of the fine pebbly bone-beds, which occur in different horizons of the Wealden series. He subsequently encouraged two French students at Hastings Jesuit College to examine these bone-beds more thoroughly, and they succeeded in finding a second form of mammalian tooth,* Dipriodon valdensis*, besides numerous rare teeth of reptiles and fishes. Mr Dawson was also the stimulating friend of Mr Philip Rufford, who made the great collection of Wealden flora now in the British Museum.*
>
> *While interested chiefly in the fossils of the Wealden formation, Mr Dawson also paid much attention to its purely geological features: he made one important investigation of the natural gas at Heathfield, which he described to the Geological Society in 1898. He also exhibited zincblende from the Wealden and Purbeck beds to the same Society in 1913……….*

Mr Dawson made few contributions to geological literature, preferring to hand over his specimens to experts for examination. He published only one paper in the Geological Magazine*, on 'Dene Holes, Ancient and Modern' (Vol. 5, 1898, 293–302), concluding that they were all mines; and his only geological contribution to the* Quarterly Journal of the Geological Society *was 'On the Discovery of Natural Gas in East Sussex' (Vol. 54, 1898, 564–574).*"

After the Piltdown skull was shown to be fraudulent, on 21 November 1953, one of the scientists involved, Joseph Weiner wrote his account of the whole affair in a book entitled *The Piltdown Forgery* (O.U.P., Feb. 1955), which was reissued, as a 50th anniversary edition, with a new introduction and afterword by Chris Stringer, in 2003. On pages 74–76, Weiner has this to say about Dawson's early life and geological activities:

"*From his schooldays onwards his interest on geology and archaeology had been unremitting. While still a schoolboy at the Royal Academy, Gosport, he had begun to search the Weald for fossil reptiles under the tutelage of S. H. Beckles. F.R.S., then in his last years at St Leonards-on-Sea. So successful was he that he was able to present to the British Museum an impressive collection of Wealden fossils, which, along with those of his old friend, Beckles, he put in order and catalogued. By the early age of 21 his work in Geology brought him election as a Fellow of the Geological Society, to which he was admitted on the same day as Arthur Smith Woodward in 1885.*

[On his Election Form Charles Dawson is described as 'Gentleman', and his qualification as 'Wealden Geologist'; his sponsors were Samuel Beckles, Richard Owen, Henry Woodward, John Peyton, William Topley, E. T. Newton, Thomas Evans and Arthur Stokes; he was elected as Fellow No. 3468 on 2nd December 1885, only 4 months after his 21st birthday, one of the youngest Fellows in the Society's history. This was a remarkable achievement for an ambitious young man, without any academic or professional qualifications, from a small, provincial seaside town.]

He was accepted as an Honorary Collector for the British Museum for over 30 years. The Dawson Collection, to which he constantly added, contains some highly important specimens. He was responsible for finding 3 new species of Iguanodon*, one of which was named after him, as well as other dinosaurs and the Wealden mammal,* Plagiaulax dawsoni.

Dawson's father was a barrister living at St Leonards-on-Sea, and, after leaving the Royal Academy, Gosport, Charles was articled to Langhams, a firm of solicitors in Hastings, in 1880. He spent some years in London at Head Office, then went in 1890 to a branch at Uckfield, 8 miles from Lewes, and became a partner in the practice. His professional career was successful, and he played a prominent part in the civic affairs of the town, as Clerk to the Magistrates and to the Urban District Council for many years……….

In 1911, on the occasion of Woodward's report to the Geological Society of the finding of further specimens of these very early mammals, Dr Henry Woodward paid Dawson high praise for the acumen, which underlay these particular discoveries. His initial success in 1891 came through intense searchings for these minute teeth in thin strata near Hastings, which he had rightly recognised, from the pioneer work of Mantell and of Marsh, as a likely formation. Before then there had been no trace of these particular Mesozoic mammals, despite the extent of the Cretaceous formation in southeast England and western Europe. To this key problem of mammalian origins Dawson had, by persistent and successful searching, made a contribution to add to the accomplishments of men like Owen, Boyd Dawkins, Marsh and Cope.

That Dawson's geological abilities were of a high order is clear, and not only from his Wealden palaeontology. He wrote on 'Dene Holes', which he diagnosed as ancient mines. He recognised and exhibited to the Geological Society zincblende from the Wealden and Purbeck beds; and, in 1898, made an important discovery of natural gas at Heathfield, used to light the hotel and station for many years."

Moving forward to this side of the millennium brings us, first of all, to the book by Miles Russell entitled *Piltdown Man: The Secret Life of Charles Dawson*, published by Tempus in 2003, in which there are three paragraphs of relevance:

"*From his earliest days Charles Dawson possessed a keen interest in the natural world, collecting a variety of fossils from the coast, cliffs and quarries around Hastings. In much of these searches he was encouraged by Samuel Beckles, F. R. S., a distinguished geologist then in his twilight years. Together with Beckles, Dawson amassed a considerable collection of reptilian and mammalian fossils, the prize piece being the 'finest extant example' of ganoid fish,* Lepitodus mantelli*, all of which he donated to the British Museum (Natural History) in 1884. The Museum conferred upon him the title 'honorary collector', and in 1885, in recognition of his many discoveries, he was elected a Fellow of the Geological Society, quite an achievement for a man still only then aged 21.*

He continued to add fossil discoveries to the 'Dawson Collection' at the British Museum throughout the late 1880s, 1890s and early 1900s. Amongst the material forwarded were 3 new species of dinosaur, one of which was named in his honour by the palaeontologist Richard Lydekker. Later discoveries included the finding, in 1891, of teeth from a previously unknown species of Wealden mammal, later named Plagiaulax dawsoni. *Dawson periodically continued his fossil-hunting activities up until 1911, discovering more unique remains, including a new species of mammal* Dipriodon valdensis*, and two new forms of fossil plant,* Lycopidites teilhardi *and* Salaginella dawsoni." [pp. 13–14]

The opening paragraph of Chapter 2 Monsters in the Weald reads as follows:

"*Charles Dawson was an avid collector of fossils from a very early age. His friendship with Samuel Beckles, then one of the country's most distinguished geologists, is well documented, the two men amassing an important collection of fossil remains, most of which were donated to the British Museum (Natural History). Dawson's prize discoveries during his many years searching the quarries and cliffs of the Hastings area were the ganoid fish* Lepidotus mantelli*, a new form of fossil plant* Salaginella dawsoni*, 3 new species of dinosaur, one of which was named* I. dawsoni*, and a new form of mammal known as* Plagiaulax dawsoni. *There is nothing overtly suspicious about most of Dawson's early discoveries: in fact, specimens such as Lepidotus,* Salaginella *and* Iguanodon *are exactly the sort of fossils that a determined amateur palaeontologist, feverishly searching the quarries of this area, would, in the latter years of the 19th century, be expected to find. One discovery,* Plagiaulax dawsoni*, has caused concern, especially as it presents a worryingly-familiar prelude to the discoveries later made at Piltdown.*" [p. 28]

Having published a masterful survey of the whole Piltdown hoax in 1990 (*Piltdown: A Scientific Forgery*), with a short section on Dawson's early career, Frank Spencer proceeded to write the entry on Charles Dawson in the *Oxford Dictionary of National Biography* (2004, Vol. 15, 550–51), and summarised the issue most succinctly:

"*His primary avocation was palaeontology, an interest he had lovingly nurtured since childhood. Indeed, it was a precocious interest in Wealden fossils that led to the assembly of a large and valuable collection that was donated to the newly-opened Natural History Museum in 1884, which gained him not only the title of Hon. Collector for the Museum, but also brought him the coveted F.G.S. at the age of only 21. During his lifetime he was responsible for finding several new species of Iguanodon as well as new species of Mesozoic mammal,* Plagiaulax."

The geological credentials of Charles Dawson are reinforced by brief entries in two major works of reference: in William Sarjeant's monumental *Geologists and the History of Geology* 1980, Vol. 2. A–K, p.866; and also in Ron Cleevely's *World Palaeontological Collections* 1983, p.99, although the entry is inaccurate in places.

Turning now to this 8-page pamphlet, it is intriguing to see what can be established by a careful scrutiny of the publication itself, without considering the fossils per se. First of all, it was published under the imprimatur of the *Brighton and Hove Natural History and Philosophical Society*, which was founded in 1852, in the same decade as the Brighton Museum and Art Gallery, at a time when Brighton was earnestly striving to establish a stronger cultural and intellectual base. It continued in mid/late Victorian times as a small but thriving society, with just an annual publication, Abstracts of Papers read before the Society, together with the Annual Report. Ladies could join and attend meetings, and even present papers to the Society, as shown by Agnes Crane, the Brighton brachiopod specialist. Otherwise, geology is notable for its absence, except for this supplementary publication by Charles Dawson in 1898.

In the circumstances this seems to be a curious place to publish such a specialised list. Membership of this Natural History and Philosophical Society would have been constrained, in two ways: to the rapidly-expanding towns of Brighton and Hove; and, moreover, to that small group of people in the area with a particular interest in the natural world, with limited interest in rocks and fossils. It would, therefore, have had limited readership and restricted circulation, probably only in what is now the Brighton and Hove conurbation. For the sake of posterity, Dawson donated a signed copy to the Geological Society, where it resides in the Archives, under Tracts and Pamphlets.

Two other points of interest. This publication gives the impression that it was specially compiled for the Society, in response to a request; and Dawson clearly announces his Fellowship of two national learned societies, and his place of residence, Uckfield, which is well beyond the normal spatial range of the Society. Also, he was an Honorary Member of the Society: was it because he lived beyond the pale, or acknowledgement of his scientific achievements? It was published by the Southern Publishing Co., North St., Brighton, in June 1898, which, again, is significant, in two different ways: the late 1890s saw the climax of the British Empire and Pax Britannica; and 1898 was the year of all of Dawson's geological publications.

Further relevant information can be derived from the concluding paragraphs. First, he reports that "*the following Collections in the British Museum contain almost all the type specimens, many of which are exhibited in the drawers of the Museum: others can be viewed upon application.*" He then lists six personal Collections, which, apart from his own and Beckles, included those of Sir Philip de Malpas Grey Egerton and Gideon Mantell, of earlier decades of the century, and Philip Rufford, of his own time. The significance of this collection of Collections is that they were still held as Personal Named Collections at this time, pre-1900, rather than by geological strata or period. Dawson then provides a list of Museums with useful specimens of Wealden fossils: two are in Sussex – at Brighton, under the geologists Thomas Davidson and Edward Crane, and, not surprisingly, at Hastings; only one in London, the Geological Museum in Jermyn St.; and three in the provinces, at Cambridge, York and at Manchester, where Owen's College was the precursor of Manchester University.

As is so often the case, the footnote provides more relevant information. Dawson states that this List of Wealden Fossils has been compiled from specimens preserved in the Geological Museum (under the superintendence of E. T. Newton F.R.S. – one of his F.G.S. sponsors!), and from lists of fossils in works by James and James de Carle Sowerby, William Topley, John Morris, Thomas Rupert Jones, Edward Forbes, Robert Etheridge, etc – all prominent palaeontologists and geological authorities of the 19th century. And finally, he directs our attention to the list of fossils from the Sub-Wealden borings, organised and led by Henry Willett between 1872 and 1876, which could be found, as a separate section, in the middle of *The Geology of Sussex*, which was Frederick Dixon's masterful volume of 1850, thoroughly revised, greatly enlarged and edited by T. Rupert Jones, and published in Brighton in 1878.

Charles Dawson's List of Wealden Fossils was a very good attempt to collate all known fossils from the Wealden strata, from an exhaustive repertoire of established and reputable sources. Nevertheless, it is very much a product of its time – the late 19th century, in particular the mid/late 1890s, and, therefore, a significant historical document in the history of geology. It is, also, very much a personal compilation. During the last decade of the century Dawson's interests gradually switched from palaeontology to archaeology, and particularly, to palaeoarchaeology, so this List of Wealden Fossils can be seen as a swansong, the culmination of his fossil-hunting career. It was meant to be an authoritative reference work, and so gain him further social and scientific status, as a Geologist.

All the publications of the *Brighton and Hove Natural History and Philosophical Society*, including Charles Dawson's List of Wealden Fossils (reproduced on pages 42-45) can be found at the Booth Museum of Natural History in Hove.

Part 2 The Fossils by Peter Austen follows on page 46.

Brighton and Hove Natural History and Philosophical Society.

LIST OF

WEALDEN AND PURBECK-WEALDEN FOSSILS.

COMPILED FOR THE SOCIETY BY ITS HONORARY MEMBER,

CHARLES DAWSON, F.G.S., F.S.A., UCKFIELD.

Brighton:
THE SOUTHERN PUBLISHING COMPANY, LIMITED, 130, NORTH STREET.
1898.

THE FOLLOWING VALUABLE

LIST OF WEALDEN AND PURBECK-WEALDEN FOSSILS,

HAS BEEN COMPILED FOR THE SOCIETY

BY ITS HONORARY MEMBER,

CHARLES DAWSON, F.G.S., F.S.A., UCKFIELD,
JUNE, 1898.

ABBREVIATIONS.*

H.......	Hastings—Wadhurst clay; Ashdown; Fairlight clay.
Ck. ...	Cuckfield—Upper Wealden Beds.
I. of W.	Isle of Wight— ,, ,,
Br. ...	Brightling }—Purbecks.
P.......	Pounceford }—Purbecks.
Cw. ...	Cowden; Upper Wealden Beds.
H.W.	Heathfield Railway Station Well (Purbecks reached 353 feet).

* The Fossils from the Cuckfield and Cowden districts belong to the Upper Wealden Beds.

Those from the Hastings district are from the Tunbridge Wells sands, Wadhurst clays and Ashdown sands, and Fairlight clays).

The Brightling and Pounceford specimens are from the "Sussex Purbecks" (or rocks which underlie the Fairlight clays).

The Isle of Wight specimens are nearly all from the Weald clay of Brook Point.

MAMMALIA.—MULTITUBERCULATA.

Plagiaulax Dawsoni (A.S.W.) H.
Bolodon sp., Lyd, H.

REPTILIA.—SAUROPTERYGIA.

Cimoliosaurus valdensis, Lyd, H.
Limnophilus, Koken, Ck.

CROCODILIA.

Goniopholis crassidens, Owen, H., Ck., Br., I. of W.
Heterosuchus valdensis, Owen, H., Ck., I. of W.
Suchosaurus cultridens, Owen, H., Ck., I. of W.

Hylæochampsa vectiana, Owen, I. of W. (H. ?).
,, sp., I. of W. (H. ?).
Pholidosaurus Meyeri, Dunker, I. of W.

DINOSAURIA.

Hylæosaurus armatus, Mantell, Ck. (I. of W. ?) (H. Teeth ?)
Iguanodon Bernissartensis Blgr., I. of W., Ck.
,, Dawsoni, Lyd, H.
,, Fittoni, Lyd, H.
,, Hollingtoniensis Lyd, H.
,, Mantelli, Meyer, Ck., I. of W.
Hypsilophodon Foxi, Huxley, I. of W., Ck.
Vectisaurus valdensis, Hulke, I. of W.
Pleurocœlus valdensis, Lyd, H.
Megalosaurus Oweni, Lyd, H., Ck.
,, Dunkeri, Koken, H., Ck., I. of W.
Aristosuchus pusillus, Owen, I. of W.
Calamospondylus Foxi, Lyd, I. of W.
Morosaurus brevis, Owen, Cw.
Polacanthus Foxii, Hulke, I. of W.
Polacanthus sp., Lyd, H.
Titanosaurus sp., I. of W.
Ornithopsis Hulkei, Seeley, Cw., I. of W. (H. ?)
Thecospondylus Daviesi, Seeley, I. of W.
,, Horneri, Seeley, Tunbridge.

ORNITHOSAURIA.

Ornithochirus Clavirostris, Owen, Cw., I. of W. (H. ?).
,, ? Clifti, Mant, Ck.
Ornithochirus Nobilus, Owen, I. of W.
,, ? sp., Lyd, I. of W.
,, ? sp., Owen, Ck.

CHELONIA.

Plesiochelys Brodiei, Lyd, I. of W.
,, valdensis, Lyd, I. of W.
Tretosternum sp., Lyd, Ck., I. of W.
Hylæochelys latiscutata, Owen, Br., I. of W.
,, emarginata, Owen, I. of W.
,, Belli, Mantell, I. of W.
Archæochelys valdensis, Lyd, Ck.

PISCES—ELASMOBRANCHII.

Hybodus basanus, Egerton, H.
,, striatulus, Agassiz, Ck.

Hybodus, subcarinatus, Agassiz, Ck.
Acrodus ornatus (A.S.W.) H.
Asteracanthus granulosus, Egerton, Ck., H.

GANOIDEI.

Lepidotus, Mantelli, Agassiz, H.
Cœlodus Mantelli, Agassiz, Ck.
,, hirudo, Agassiz, H., Ck.
Caturus sp. (A.S.W.) H.
Neorhombolepis valdensis (A.S.W.) H.
Belonostomus sp., (A.S.W.) I. of W.
Oligopleurus vectensis (A.S.W.) I. of W.
? Thrissops sp., H.

INSECTA.

*Coleoptera (elytra of), Tunbridge, Weald clay of Wateringbury, H. (Fairlight clay and Ashdown).
Neuroptera (elytra of) H. (Ashdown and Fairlight clay).
(Borings in fossil wood).

CRUSTACEA.

*Estheria elliptica, Dunker, H., T. Wells.
* ,, v. subquadrata, Jones, H.
*Cyprione Bristowi, R. J., H., Lindfield.
*Cythere faba, Reuss, H.
* ,, sp.
*Metacypris, Fittoni, Mant., Atherfield.
Cypridea Austeni, R. J., Peasemarsh and Shotover.
,, Phillipsiana, R. J. (Neocomian), Shotover.
,, verrucosa (var. crassa), R. J. (Neocomian), Shotover.
,, bispinousa, R. J. (Neocomian), Shotover.
,, ? leguminella, Upper Purbeck.
,, fasciculata, E. F., Mid Purbeck.
,, Purbeckensis, E. F. ,,
,, punctata, E. F. ,,
,, cornigera, R. J., I. of W.
,, candona Mantelli, R. J., I. of W.
,, Dunkeri, R. J., I. of W.
* ,, Fittoni, S., Hythe.
,, Granulosa (Granulata; Forbes), S., Hythe and Haslemere, and Sub-Wealden Boring.
* ,, gyripunctata, R. Jones, Sevenoaks.
* ,, tuberculata, E, Forbes, H.; I. of W., Hythe and Haslemere.

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*Cypridea Spinigera, S., R. J., Uckfield, Hythe and Haslemere
  ,, striatopunctata, R. J., Hythe.
* ,, valdensis (C. Faba), S., I. of W., Burwash and Lindfield.
Darwinula leguminella, F., I. of W.

ANNELIDA.

Arenenicola, general (worm castings).

MOLLUSCA.—LAMELLIBRANCHIATA.

Cardium, H.W.
*Corbula sp., Br., Atherfield, Haslemere and Teston.
  ,, oblata, H.W.
Cyrena, H.W.
  ,, angulata, Sowerby, S. (and generally)
* ,, dorsata, Ck.
* ,, elongata, S., H. (and generally).
  ,, gibbosa (variety of C. Media), generally in Weald.
  ,, major, S., generally in Weald.
* ,, media, S., ,, ,,
  ,, membranacea, S. ,,
* ,, parva, S., ,, ,,
* ,, subquadrata, H. and Atherfield.
*Exogyra Bousingaulti, d'Orb, Atherfield.
Ostrea, H.W.
* ,, distorta, S., Hythe and Atherfield.
*Unio antiquus, S., Ck., H., Tunbridge.
  ,, compressus, S., H.
* ,, cordiformus, S., Ck., H., Wheatley and Oxford.
* ,, gualteri, Mantell, T. Wells.
  ,, Mantelli, S., Ck.
  ,, Martini, S., Ck.
* ,, porrectus, S., H., Ck.
* ,, Stricklandi, Phil, Shotover Kill.
* ,, subsimiatus, H. & D., H.
* ,, substruncatus, S., H., T. Wells.
* ,, valdensis, Mant., I. of W., H., Ck.
  ,, sp., H., Ck.
*Potamomya.

GASTEROPODA.

Actœon, near T. Wells (Fitton).
Bulla Mantelliana, S., Ck., and near T. Wells (Fitton).
Hydrobia ? H.W.

5

Melania sp., H.W., and near T. Wells (Fitton).
  ,, attenuata, S., H.
  ,, tricarinata, S., Haslemere.
Mylitus sp ? Haslemere.
Neritina, Fittoni, Mant., Ck.
Paludina carinifera, S., H.
* ,, (vivipara) elongata, S., Outwood and generally.
* ,, ,, fluviorum, S., H. and generally.
  ,, sp. ? S., Hythe, Wheatley and Compton Bay.
*Tornatella, H., Southboro'.
*Vicarya (melania) strombiformis Schl., Shipborne, Tunbridge and Atherfield.

PLANTÆ.—THALLOPHYTA.

Algites valdensis, Sew, H.
  ,, catenelloides, Sew, H.

CHAROPHYTA.

Chara Knowltoni, Sew, H.

BRYOPHYTA.

Marchantites, Zeilleri Sew, H.

PTERIDOPHYTA.

Equisetites Lyelli, Mant, H.P.
  ,, Burchardti, Dunk, H.
  ,, Yokoyamæ, Sew, H.
Onychiopsis Mantelli, Brong, H., Ck.
  ,, elongata, Geyl, H.
Acrostichopteris Ruffordi, Sew, H.
Mantonidium Göpperti, Ett., H., Ck.
Protopteris Witteana, Schenk, H.
Ruffordia Göpperti, Dunk, H.
  ,, latifolia, Sew, H.
Cladophlebis longipennis, Sew, H.
  ,, Albertsii, Dunk, H.
  ,, Browniana, Dunk, H.
  ,, Dunkeri, Schimp, H.
Sphenopteris Fontainei, Sew, H.
  ,, Fittoni, Sew, H.
Weichselia Mantelli, Brong, H.
Tæniopteris Beyrichii, Schenk, H.
  ,, superba, Sew, H.
  ,, Dawsoni, Sew, H.

Sagenopteris Mantelli, Dunk, H.
" acutifolia, Sew, H.
Microdictyon Dunkeri, Schenk, H.
Dictyophllum Römeri, Schenk, H.
Leckenbya valdensis, Sew, H.
Tempskya Schimperi, Cord, H., Ck.

GYMNOSPERMÆ.

Cycadites Römeri, Schenk, H.
" Saportæ, Sew, H.
Dioonites Dunkerianus, Göpp, H.
" Brongniarti, Mant, H.
Nilssonia Schaumburgensis. Dunk, H.
Otozamites Klipsteinii, Dunk, H.
" superbus, Sew, H.
" longifolius, Sew, H.
" ? Reiberioanus, Heer.
" Göppertianus, Dunk, H.
Zamites Buchianus, Ett., H.
" Carruthersi, Sew, H.
" latifolius, Sew.
Anomozamites Lyellianus, Dunk, H.
Cycodolepis Dory—H.
" Eury—H.
Carpolithes, sp., H.
Androstrobus Nathorsti, Sew, H.
Bucklandia anomala, (S. and W.) H., Ck.
Fittonia Ruffordia, Sew, H.
Bennettites Saxbyanus, Brown, I. of W., H.
" Gibsonianus, Carr, I. of W.
" sp., H.
" Carruthersi, Sew, H.
" latifolius, Sew, H.
Yatesia ? Morrisii, Carr.
Sphenolepideum Kurrianum, Dunk, H.
" Sternbergianum, Dunk, H.
" ? subulatum, Heer.
Pagiophyllum crassifolium, Schenk, H.
" sp., H.
Brachyphyllum spinosum, Sew, H.
" obesum, Herr, H.
Pinites Dunkeri, Carr, I. of W.
" Carruthersi, Gard, H.
" Solmsi, Sew, H.

Pinites Ruffordi, Sew, H.
Nageiopsis heterophylla, Font, H.
Thuites valdensis, Sew, H.
Conites (Araucarites), sp., H.
" armatus, Sew, H.

PLANTÆ INCERTÆ SEDIS.

Withamia Saportæ, Sew, H.
Becklesia anomala, Sew, H.
Dichopteris ? lævigata, Phill, H.

There are also two unnamed specimens from Hastings, figured in the British Museum catalogue—by Mr. A. C. Heward, Vol. I., p. xxxv., pl. 1, fig. 7, and p. xxxv., pl. 1., figs. 8 and 9. The latter is probably one of the Lycopodiaceæ.

The following collections in the British Museum contain almost all the type specimens above mentioned; many of these are exhibited in the drawers of the Museum, and others may be studied on application to the keeper.

"The Beckles Collection,"
"The Dawson Collection,"
"The Egerton Collection,"
"The Fox Collection,"
"The Mantell Collection,"
"The Rufford Collection."

The following other Museums contain useful specimens for the study of the Wealden fossils :—

The Brighton Museum,
The Cambridge Museum,
The Geological Museum, Jermyn Street, W.,
The Hastings Museum,
The Owen's College Museum,
The York Museum.

Reference should be made to the excellent catalogues now published by the Trustees of the British Museum.

NOTE.—The above list of Mollusca, Crustacea, etc., has been made up from the specimens preserved in the Geological Museum (under the superintendence of E. T. NEWTON, ESQ., F.R.S.), and from the lists of fossils given by SOWERBY, TOPLEY, MORRIS, RUPERT JONES, FORBES, ETHERIDGE, and others.

It is right to say that the Molluscs have not yet been properly described, and the large collection in the British Museum is not yet arranged or catalogued. The specimens above named and marked with an *asterisk* can be seen at the Geological Museum, Jermyn Street, London, W.

A list of the Fossils discovered in the Sub-Wealden, 1872-6 boring, is given in *Dixon and Jones' Geology of Sussex*, p. 160.

Part 2 The Fossils by Peter Austen

Needless to say, although Charles Dawson's listing provides a snapshot of what was known at the time about Wealden and Purbeck–Wealden fossils, much has changed since the list was compiled in 1898. The most up-to-date summary of these changes, at least for the Wealden fossils, can be found in the recently published Palaeontological Association Guide to English Wealden fossils (Batten 2011). In summarising the changes within the various groups of fossils, only selected references are given; more extensive references can be found in the Guide, which contains more than 1,400 references covering all the Wealden fossil groups, including several not considered in Dawson's listings.

Mammalia (Multituberculata)

Of the two fossils listed under Mammalia, neither are now recognised from the English Wealden. The tooth of the 'mammal' *Plagiaulax Dawsoni* was 'found' by Charles Dawson in 1891 and named in his honour by Arthur Smith Woodward (Woodward 1891). Clemens (1963, p.56) was doubtful of the tooth's mammalian affinities, and a study conducted by Miles Russell in 2003 into a number of Dawson's 'discoveries', found that the tooth had been filed down in the same way as the teeth of Piltdown man several years later (Russell 2003). *Bolodon* sp. is still a valid taxon, but although it is known from the Purbeck Beds of Dorset, it is no longer recognised as being present in the English Wealden. Only limited work was carried out on mammal teeth in the first part of the 20th century until the late Kenneth A. Kermack and William Clemens re-examined previously collected material, and took bulk samples from the Cliff End Bone Bed at Hastings and two other localities (Clemens 1963; Kermack *et al*. 1965; Clemens and Lees 1971). More recently Steve Sweetman has undertaken extensive sampling of the Isle of Wight Wealden plant-debris beds looking for micro-vertebrates, including remains of Wealden mammals (Sweetman and Hooker 2011). A comprehensive summary on the history of collecting and this more recent work, together with references, can be found in Sweetman and Hooker (2011).

Reptilia

Sauropterygia (Marine reptiles) – Of the two plesiosaur species listed, *Cimoliasaurus* (*Cimoli**o**saurus*) and *Limnophilus*, the combined name '*Cimoliasaurus limnophilus*' is often used, but Ketchum (2011) notes that several authors regard it as invalid. Ketchum (2011) gives an up-to-date summary of the marine reptiles.

Crocodilia (Crocodiles) – Salisbury and Naish (2011) undertook an extensive revision of the crocodilians, both revising existing species and creating new ones, thus affecting several of the species listed in Dawson's report. In the case of *Suchosaurus* this has been found to be an indeterminate baryonychine theropod (Salisbury and Naish 2011, p.308).

Dinosauria (Dinosaurs) – Considerable work has been undertaken on the dinosauria since the publication of Dawson's list, a summary of which, together with references, can be found in the Palaeontological Association guide to dinosaurs of the Isle of Wight (Martill and Naish 2001) and the four chapters on dinosaurs in the Wealden Guide (Barrett and Maidment 2011; Norman 2011; Upchurch *et al*. 2011; Naish 2011). One of the most abundant dinosaurs to be found in the Wealden is *Iguanodon*, of which Dawson lists five species. However, following a number of revisions (e.g. Paul 2008; Carpenter and Ishida 2010; see Norman 2011 for discussion) only one species remains, *Iguanodon bernissartensis*. It is worth noting that following the discovery of the theropod dinosaur *Baryonyx walkeri* in 1983, it was subsequently found that around 10% of crocodile teeth in some national collections dating back to the 19th century were actually *Baryonyx* teeth (see *Suchosaurus* in crocodiles above).
Ornithosauria (Flying reptiles) – Since the publication of Dawson's list many more pterosaurs have been described from the English Wealden, and the only genus listed by Dawson, *Ornithocheirus* (*Ornithoch**i**rus*) is now thought to be an indeterminate pterosaur. Martill *et al*. (2011) gives an up-to-date summary of the pterosaurs, together with references.

Chelonia (Turtles) – Of the four turtle genera listed by Dawson, the two species of *Plesiochelys* have been reclassified as *Brodiechelys*; *Tretosternon* (*Tretostern**um***) has been reclassified as *Helochelydra*;

Hylaeochelys is still valid, although with a reduced number of species, and it also now includes the final genus *Archaeochelys*. Milner (2011) gives an up-to-date summary of the turtles, together with references.

Pisces (Fish)

Elasmobranchii (Sharks) – The most recent summary of the sharks is Duffin and Sweetman (2011). The three *Hybodus* species listed have been reclassified as *Egertonodus*, *Planohybodus* and *Polyacrodus*, as have subsequent species of *Hybodus*. *Acrodus* has been reclassified as *Hylaeobatis*, and *Asteracanthus granulosus* remains unchanged. Further taxa have been erected since the publication of Dawson's list, including *Lonchidion* and *Parvodus* (Patterson 1966).

Ganoidei (Bony fish) – The most recent summary of the bony fish is Forey and Sweetman (2011). The list produced by Dawson remains largely unchanged. The spelling of *Lepidotu*s has been corrected to *Lepidotes*. With regards to *Coelodus* the dentition is so variable that most Wealden pycnodont remains are referred to '*Coelodus mantelli*'. *Caturus* sp. still stands and includes two species, as does *Belonostomus* sp. with one species. *Neorhombolepis valdensis* remains unchanged, and *Oligopleurus* is no longer recognised as a Wealden species. *Thrissops* has been reclassified as *Pachythrissops*.

Woodward (1916-1919) still remains an excellent guide to Wealden fish.

Insecta (Insects)

Dawson only records two groups from the Wealden, Coleoptera (Beetles) and Neuroptera (includes Alder flies, Snake flies, Lacewing flies). Only limited work had been carried out on Wealden insects until the early 1970s when Ed Jarzembowski commenced research in this area. Since then 13 orders (major divisions of the Class Insecta) have been recognised from the Wealden and more than 100 species described, with new species being discovered all the time. Although the two groups recorded by Dawson were present in the lower part of the Wealden (Hastings Group), most of the new species since that time have come from the upper part of the Wealden (Weald Clay Group). A comprehensive guide to Wealden insects can be found in the Palaeontological Association Guide (Jarzembowski 2011; Ross 2011*b*).

Crustacea (Crustaceans)

Dawson's list of crustaceans contains two groups of bivalve crustaceans, the clam shrimps (spinicaudatans, previously referred to as conchcostracans), and the ostracods (seed shrimps). The only clam shrimp listed is *Estheria*, but this name had already been assigned to a fly, so it has since been renamed *Liograpta*, and is the only recognised species in the Wealden. There is one other species known from the Wealden, but this has still to be described. See Ross (2011*a*) for further information and an up-to-date summary of the spinicaudatans, together with references. The abundance and diversity of ostracods in the Wealden has made them one of the most useful groups of Wealden fossils in the interpretation of stratigraphy and palaeoenvironment. Although a number of the species listed still stand they have been greatly expanded since then, particularly by the classic works of the late F. W. Anderson (e.g. Anderson 1985), and more recently by the work of David Horne (e.g. Horne 1995). Horne (2011) gives an up-to-date summary of the ostracods, together with references.

Annelida (Segmented worms)

Dawson only refers to one species of worm, *Arenenicola*, based on worm casts. This is a present-day species and is no longer recognised as Wealden. The study of worm casts or worm tracks/burrows now falls under the heading of trace fossils. Goldring *et al*. (2005) produced a comprehensive list of Wealden trace fossils (including also, crustacean burrows, dinosaur tracks, coprolites, etc.), and this was further summarised, together with references, by Pollard and Radley (2011).

Mollusca (Molluscs)

Lamellibranchiata (Bivalves) – A number of the bivalves are no longer valid as Wealden species and some have undergone a change of name, *Cardium* is now *Nemocardium* and *Corbula* is now

Cuneocorbula. *Cyrena* is still recognised, but only in the name of the formation '*Cyrena*' limestone. *Cyrena* itself is no longer a valid genus name and is now known as *Filosina*. A number of the *Unio* species are still recognised, with others added since 1898, however, because of the difficulties in identifying exact species (see Munt *et al*. 2011, p.92, last paragraph, for detailed explanation) most taxa are provisionally assigned to '*Unio*' *sensu lato* (i.e. *Unio* in the broad sense, e.g. '*Unio*' *antiquus*).

Gasteropoda (Gastropods) – Of the gastropods in Dawson's listing only *Paludina* is still recognised, but only in the name of the formations "Large-'*Paludina*' limestone" and "Small-'*Paludina*' limestone". *Paludina* itself is no longer a valid genus name and is now known as *Viviparus*.

Munt *et al*. (2011) gives an up-to-date summary of the molluscs, together with references.

Plantae

Thallophyta (fungus, algae and lichens) – Charophyta (division of green algae) – Bryophyta (mosses, hornworts and liverworts) – Pteridophyta (ferns, horsetails and clubmosses) – Gymnospermae (naked seed plant) – Plantae *incertae sedis* (plant of uncertain affinity).

Publication of this plant species list in 1898 benefited greatly from the then recently published volumes by Albert Seward on the English Wealden flora (Seward 1894, 1895). Since this time much work has been undertaken on the Wealden flora, most notably by Joan Watson and her colleagues, and also the late Kenneth Alvin. Many of the species have been revised and new species erected, bringing the number of Wealden plant species to around 140. When studying Wealden pteridophytes (ferns), Seward (1894) is still referred to alongside the more recent Watson (1969), and the pteridophytes remain the last group that requires re-examination using modern techniques. Watson and Alvin (1996) produced a floral list for the English Wealden, and Austen and Batten (2011) summarise the current position, together with references.

At the end of the listing Dawson notes "Reference should be made to the excellent catalogues now published by the Trustees of the British Museum." Many of these catalogues are now freely available on the Internet Archive (http://archive.org/index.php), as are most of the 19th century publications included in the following list of references.

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Geology and Palaeontology in the News

A review of recent research and discoveries

Edited by Peter Austen

Introduction

The following is a summary of recent research and discoveries in or associated with geology and palaeontology. Where possible I have included enough detail (i.e. species name, author, etc.) to allow for a search of the internet for further information. In most cases more information is available, including an abstract of the paper and press releases, and quite often if you go to the author's own website or the museum/university website to which the author is affiliated you may be able to obtain a copy of the original paper. Many authors now make their papers available on their own Facebook sites. If you do not have a computer at home, all libraries in the UK are now equipped with computers with internet access for use by the general public.

Whale-bone-eating worm

The present-day whale-bone-eating worm, *Osedax mucofloris* (Fig. 1), affectionately known by researchers as the bone-eating snot-flower worm, lacks guts and relies on bacterial symbionts to eat its food. Evidence of a fossil whale-bone-eating worm has been found in 3-million-year-old fossil whale bones from Italy. The find was reported by Nicholas Higgs at the University of Leeds, UK, and his team – the bones were thought to be those of a beaked whale (*Historical Biology*, 2011, Vol. 24, p.269–277). A previous similar discovery was reported from a 30-million-year-old fossil whale from the northwestern United States, but this is the first such find from the Mediterranean area, past or present.

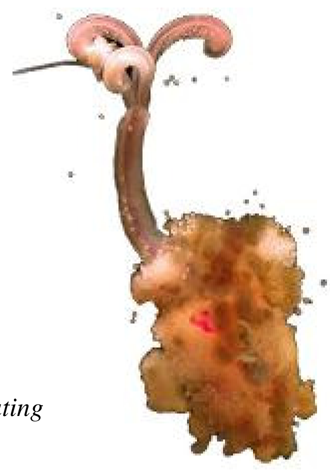

Fig. 1. Present-day whale-bone-eating worm, Osedax mucofloris.

Triassic–Jurassic mass extinctions

A doubling of carbon dioxide levels around 200 million years ago may have reduced plants' uptake and release of water, dramatically altering local water cycles and leading to a decrease in animal biodiversity. A team led by Margret Steinthorsdottir, at Stockholm University, Sweden, examined 91 fossil plants from eastern Greenland, spanning the transition between the Triassic and Jurassic periods (*Geology*, 2012, Vol. 40, No. 9, p.815–818). They measured the fossils' stomata (tiny holes through which plants vent water) and found that their density and size decreased over the Triassic–Jurassic transition. This suggests that the volume of water released by plants (a process called transpiration) fell by 50–60% during this period of mass extinctions and high levels of atmospheric carbon dioxide. Analysis of the sediments revealed that the drop in transpiration coincided with increased water run-off and erosion, suggesting that the change may have reduced soil quality and contributed to a decline in biodiversity.

Dwarf mammoth on Crete

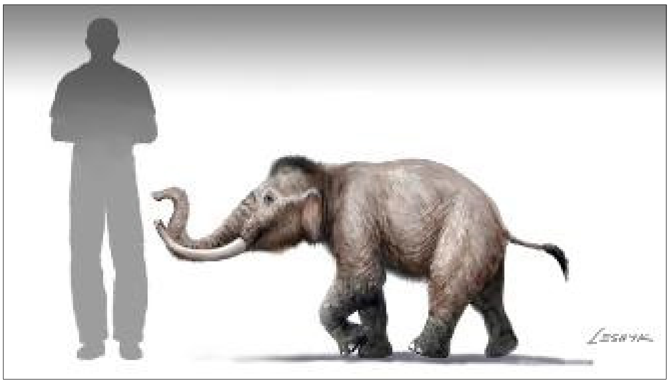

Fig. 2. Reconstruction of Pleistocene dwarf mammoth. Illustration by Victor Leshyk

Scientists have discovered the smallest mammoth known to have existed on the Mediterranean island of Crete (Fig. 2). Small pachyderm teeth, dating from the Pleistocene, found on the island were originally attributed to a diminutive elephant when first described early in the twentieth century. However, the discovery of more teeth and an upper forelimb bone (or humerus) last year has allowed Victoria Herridge, a vertebrate palaeontologist at the Natural History Museum in London and Adrian Lister to re-classify it as a dwarf mammoth (*Proceedings of the Royal Society B: Biological Sciences*, 2012, Vol. 279, No. 1741, p.3193–3200). As an adult, the tiny mammoth would have been no taller than a modern newborn elephant – it would have stood about 1.13 metres tall at the shoulder and weighed around 310 kilograms. Islands scattered across the Mediterranean once played host to dwarf versions of deer, hippos and elephants, and it is now widely accepted that species that get stranded on islands can be affected by dwarfism. The most popular explanation for island dwarfism suggests that in a small, isolated ecosystem, natural selection favours smaller individuals that can get by with fewer resources.

Reference

PERKINS, S. 2012. Mini mammoth once roamed Crete. *Nature News*, doi:10.1038/nature.2012.10605.

Brain tissue in Cambrian arthropods

The discovery of the brain and partial nervous system preserved in a Cambrian arthropod, *Fuxianhuia protensa*, is set to shed new light on the development of the arthropod nervous system. The discovery of the exceptionally preserved fossil from the 520-million-year-old Chengjiang biota (Cambrian Series 2, Stage 3), Yunnan Province, southwest China, was reported by Xiaoya Ma, a palaeontologist from Yunnan University, Kunming, China, and colleagues (*Nature*, 2012, Vol. 490, No. 7419, p.258–261). *Fuxianhuia protensa* is thought to lie close to the most recent common ancestor of present-day arthropods, and is the oldest and most convincing nervous-system tissue found so far in a fossil arthropod. The fossil shows two large, faceted eyes on stalks and within the stalks are dark, iron-rich traces of what Ma and colleagues interpret to be concentrations of nervous tissue. Optic nerves lead from this nervous tissue towards the brain where the material is divided into three regions corresponding to the brain ganglia (mass of nerve cells) found in most present day arthropods, including most crustaceans and insects, (the exceptions to this are the branchiopods [water flea, fairy shrimp, etc.], spiders and scorpions, which have much simpler brains). If *Fuxianhuia* is close to the ancestral arthropod it can be argued that this complex brain organisation evolved early within this group, and that those arthropods with less complex brains (branchiopods, spiders and scorpions) must at some stage have reverted to a simpler arrangement. There are, however, two alternatives to this interpretation: one is that the brain arrangement in *Fuxianhuia* is convergent to that in modern crustaceans or insects, i.e. similar brain assemblies to that seen in *Fuxianhuia* evolved again in later arthropods; the other is that the position of *Fuxianhuia* in the arthropod family tree is incorrect. Whichever is right, it has prompted the re-examination of many old specimens for further evidence of brain tissue.

Ocean acidification

It is hoped that rare finds of intact fossils of prehistoric plankton will allow scientists to get a better insight into the effects of ocean acidification on present-day plankton. Intact specimens of coccolithophores (calcified single-celled organisms) are extremely rare in the fossil record – normally only skeletal bits (fragments of the actual coccolithophore) are found. The coccolithophores (Fig. 3), from sites in California, New Jersey and Tanzania cover a period of rapid ocean warming and acidification at the Palaeocene-Eocene Thermal Maximum, around 55 million years ago, a period thought to be a natural analogue for the current acidification of the oceans. A growing concern among scientists is that present-day ocean acidification will reduce the abundance of calcium carbonate in the oceans, making it more difficult for algae to form their microscopic plating. Now researchers will be able to compare the sizes, shapes, thickness and growth rates of ancient and modern coccolithophores. Preliminary results suggest that the growth rates of these ancient coccolithophores were sensitive to changes in ocean acidity. Paul Bown, a palaeoceanographer at University College London, and his colleague Samantha Gibbs, a palaeoceanographer at the University of Southampton, presented their results at the "Third International Symposium on the Ocean in a High CO_2 World" in Monterey, California, USA.

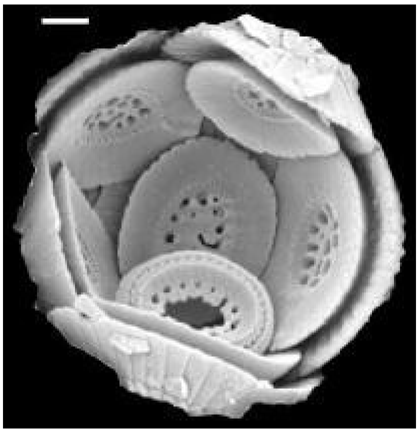

Fig. 3. Coccolithophore, Toweius pertusus, *from the Palaeocene-Eocene Thermal Maximum. Scale bar = 1 micron.*

Reference

GEWIN, V. 2012. Tiny fossils hint at effects of ocean acidification. *Nature News*, doi:10.1038/nature.2012.11500.

Cambrian mollusc

Martin Smith, a researcher from the University of Toronto, Canada, has analysed the mouthparts of more than 300 specimens of the Cambrian invertebrates *Odontogriphus* and *Wiwaxia*. The fossils are from British Columbia's 505-million-year-old Burgess Shale, which is home to a diverse assemblage of Cambrian fossils, providing a record of an explosion in new body forms that occurred during the Cambrian era (542 million to 488.3 million years ago). Previously it had been uncertain whether *Odontogriphus* and *Wiwaxia* belonged within the molluscs or the annelids (segmented worms), but the study (*Proceedings of the Royal Society B: Biological Sciences*, 2012, Vol. 279, No. 1745, p.4287–4295) found that the mouthparts contained rows of jagged teeth resting on a grooved tongue, and resembled those of modern-day molluscs, making them among the world's earliest molluscs.

Transitional snake from North America

Snakes are the most diverse group of lizards, but their origins and early evolution remain poorly understood owing to a lack of transitional forms. *Coniophis precedens*, a Late Cretaceous snake from North America, was among the first Mesozoic snakes to be described, although until now it has only been known from an isolated vertebra. Nicholas Longrich from the Department of Geology and Geophysics, Yale University, Connecticut, USA, and colleagues, have now described additional

Coniophis material, including the maxilla, dentary and additional vertebrae (*Nature*, 2012, Vol. 488, No. 7410, p.205–208). *Coniophis* occurs in a continental floodplain environment, consistent with a terrestrial rather than a marine origin, and the newly described material from the upper Maastrichtian Lance Formation of eastern Wyoming, USA (the same strata as the original vertebra), suggests that snakes evolved from burrowing lizards. The skull is intermediate between that of lizards and snakes, suggesting that *Coniophis* represents a transitional snake, combining a snake-like body and a lizard-like head.

The Great Unconformity and the Cambrian Explosion

During the early part of the Palaeozoic between 540–480 Myr ago there was an expansion of shallow seas with sedimentation that was indicative of increased oceanic alkalinity and extensive chemical weathering of the continental crust. These conditions were caused by a long period of continental denudation during the Neoproterozoic (1,000–542 Myr ago) followed by extensive erosion of soils and basement rock during the first large-scale marine transgression of the Phanerozoic (542 Myr ago to date). The resultant globally occurring stratigraphic surface resulted in a crystalline basement rock overlain by much younger Cambrian shallow marine sedimentary deposits – this is known as the Great Unconformity. This transition between the Proterozoic (2,500–542 Myr ago) and Phanerozoic (542 Myr ago to date), is distinguished by the diversification of multicellular animals and by their acquisition of mineralized skeletons during the Cambrian period. Shanan Peters of the Department of Geoscience, University of Wisconsin, Madison, Wisconsin, USA, and Robert Gaines of the Geology Department, Pomona College, Claremont, California, USA, argue that the formation of the Great Unconformity may have been the trigger for the evolution of biomineralization and hence the diversification of animal life known as the 'Cambrian explosion' (*Nature*, 2012, Vol. 484, No. 7394, p.363–366).

Late Devonian insect

Although insects were thought to have originated around 425 million years ago, their early fossil record is almost non-existent, and the first winged insect only appeared in the fossil record around 325 million years ago. Romain Garrouste of the Muséum national d'Histoire naturelle, Paris, France, and colleagues, now report the discovery of an insect from the 370-million-year-old Strud Quarry (Upper Famennian, Late Devonian), Namur province, Belgium, a site normally renowned for its early tetrapods (*Nature*, 2012, Vol. 488, No. 7409, p.82–85). The fossil (Fig. 4), found in freshwater deposits, shows a six-legged thorax, long single-branched antennae, triangular jaws and a 10-segmented abdomen, and although it has no wings, insects are the only known arthropods to possess all these features. It is the oldest complete insect fossil yet found, and will help fill the gap in the fossil record between their origins in the Silurian, and the first appearance of winged insects in the fossil record in the Lower Carboniferous.

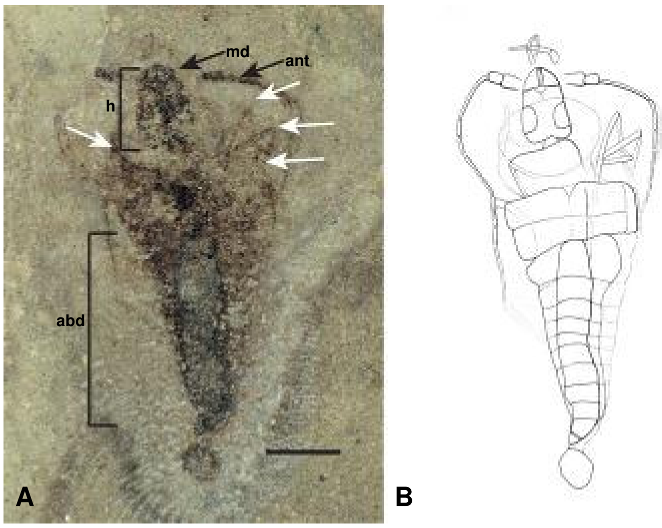

Fig. 4. A, Late Devonian insect, Strudiella devonica*. B, reconstruction. White arrows indicate legs. abd, abdomen; ant, antenna; h, head; md, mandible. Scale bar = 1 mm.*

Reference

GARROUSTE, R., CLÉMENT, G., NEL, P., ENGEL, M. S., GRANDCOLAS, P., D'HAESE, C., LAGEBRO, L., DENAYER, J., GUERIAU, P., LAFAITE, P., OLIVE, S., PRESTIANNI, C. and NEL, A. 2012. A complete insect from the Late Devonian period . *Nature*, **488**, 82–85.

Feathers in the earliest theropods

The discovery of an exceptionally preserved skeleton of a juvenile megalosauroid, *Sciurumimus albersdoerferi*, from the Late Jurassic of Germany, has thrown new light on the widespread possession of feathers or proto-feathers in the dinosaurs. The 150-million-year-old dinosaur, reported by Oliver Rauhut, a palaeontologist at the Ludwig Maximilian University in Munich, Germany, and colleagues, preserved a filamentous plumage at the tail base and on parts of the body (*Proceedings of the National Academy of Sciences*, 2012, Vol. 109, No. 29, p. 11746–11751). Since the first discovery of feathered dinosaurs in 1996, more than 30 types have been recognised, mainly coelurosaurs (a group of theropods that includes the tyrannosaurs), but also birds. What makes this discovery so exceptional is that *Sciurumimus albersdoerferi* was a megalosauroid, a group of archaic sharp-toothed dinosaurs near the base of the theropod family tree, far removed from the various types of feathered dinosaur and early birds, suggesting that simple feathers were a very ancient dinosaur trait. The lead author, Rauhut, suggests that proto-feathers are probably as old as the Dinosauria itself.

Early fleas fed on dinosaurs

A discovery in China has extended the history of the flea back a further 60 million years. The discovery of nine flea specimens from two sites – the 165-million-year-old Jurassic deposits in Daohugou and the 125-million-year-old Cretaceous strata at Huangbanjigou, both in China – was reported by Michael Engel, a palaeoentomologist at the University of Kansas in Lawrence, USA, and his colleagues (*Nature*, 2012, Vol. 483, No. 7388, p.201–204) (Fig. 5). Previously, fleas have only been recorded from the last 65 million years (Caenozoic), and as with present day fleas fed on mammals and birds, but the fleas from China were between 8 and 21 millimetres long, larger than the present-day flea, they lacked the spring-legged, jumping adaptations of modern fleas, and their siphoning mouthparts were armoured structures with saw-like projections, unlike the smooth jaws of modern fleas. The authors suggest that they could have fed on the hides of dinosaurs.

Fig. 5. Jurassic flea. Scale bar = 5 mm.

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Reference

SWITEK, B. 2012. Super-sized fleas adapted to feed off dinosaurs. *Nature News*, doi:10.1038/nature.2012.10135.

Credit: Article supplied by Christine Wagner.

Unusual Precambrian fossils

An unusually complex group of 570-million-year-old fossils from Doushantuo, China, has sparked debate among palaeontologists. Researchers cannot agree whether the fossils are those of animals, bacteria or close relatives of animals. Philip Donoghue, a palaeontologist at the University of Bristol, UK, and Stefan Bengtson, a palaeontologist at the Swedish Museum of Natural History in Stockholm, used X-ray microscopic tomography to produce three-dimensional images of the interiors of the fossils, and found that they were none of the above (*Science*, 2011, Vol. 334, No. 6063, p.1696–1699) (*Proceedings of the Royal Society B: Biological Sciences*, 2012, Vol. 279, No. 1737, p.2369–2376). They noticed that the specimens which seemed to be in later stages of development contained hundreds of thousands of tiny cells, and that the outer envelopes of these specimens had partly burst open. Donoghue and Bengtson suggest that the creatures are similar to modern mesomycetozoeans, single-celled micro-organisms that are neither animals nor bacteria. Mesomycetozoeans reproduce by creating thousands of spore cells inside a protective envelope that bursts when it is time for them to spread into the environment. Once these cells settle, they create a new envelope and begin replicating again.

Gigantic feathered tyrannosaur

Numerous feathered dinosaur specimens have recently been recovered from the Middle–Upper Jurassic and Lower Cretaceous deposits of northeastern China, but most of them represent small animals. Xing Xu of the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China, and colleagues, report the discovery of three nearly complete skeletons of a gigantic new basal tyrannosauroid, *Yutyrannus huali* (*Nature*, 2012, Vol. 482, No. 7392, p.92–95). It is hoped that the new dinosaur from the Lower Cretaceous Yixian Formation of Liaoning Province, China, which bears long filamentous feathers, will offer new insights into the early evolution of feathers.

Acute vision in Cambrian predator

In the last issue of the HDGS Journal (see *HDGS Journal*, Dec 2011, Vol. 17, p.43) we reported on the exceptionally well-preserved fossil eyes of arthropods from the Early Cambrian (around 515 million years ago) Emu Bay Shale of South Australia. New research on the fearsome Cambrian predator, *Anomalocaris* (Fig. 6), from the same locality, has shown that its sight was better than most present-day arthropods. *Anomalocaris* had compound eyes, and in a study of these fossils, palaeontologist John Paterson at the University of New England, Australia, and his colleagues, counted about 16,000 lenses on each eye (*Nature*, 2011, Vol. 480, No. 7376, p.237–240). In fact it is possible there were many more because in life the eyes would have been bulbous, but as fossils they are flattened in the rock, and it is likely that many more lenses would be discovered on the other side. As a comparison, the common housefly has only 3,200 lenses and most ants have fewer than 1,000. Dragonflies have extraordinary eyesight with up to 28,000 lenses in each eye, but they are exceptional amongst the arthropods.

Fig. 6. The sharp-eyed, metre-long Anomalocaris.
Illustration: Katrina Kenny & University of Adelaide

Reference

KAPLAN, M. 2011. An eye-opening fossil. *Nature News*, doi:10.1038/nature.2011.9586.

Mammoth extinction

The reason for the extinction of the woolly mammoths has long been a subject of debate, with the cause being attributed to one or a combination of factors including over-hunting by humans, loss of habitat during the transition from the Last Glacial Maximum to the warm and stable Holocene, or impact by an extraterrestrial object. A new study by palaeoecologist Glen MacDonald at the University of California, Los Angeles, USA, and his colleagues has looked at the pattern of mammoth extinction in Beringia (the bridge of land that connects eastern Russia and western Alaska) during the past 45,000 years (*Nature Communications*, 2012, Vol. 3, No. 893). They found that mammoth populations fluctuated in concert with fluctuations in climate, reducing as cold climates gave way to warmer, wetter ones. These changes drastically altered the mammoths' habitats, causing their populations to shrink. Prehistoric humans who were moving through Beringia at the time may also have played a part by hunting the remaining mammoths. These findings support previous studies, showing that human predators could have hastened the extinction of the slow-breeding mammoths which were already weakened by environmental change, the last mammoths finally disappearing 4,000 years ago after a long, slow decline in numbers.

Mammals diversify before the end of the Cretaceous

The mass extinction at the end of the Cretaceous (65 million years ago), which saw the end of the dinosaurs, is conventionally thought to have been a turning point in mammalian evolution, when mammals were able to diversify into wider ecosystems after previously being mostly confined to roles as generalised, small-bodied, nocturnal insectivores. Although recent individual fossil discoveries have shown that some mammalian lineages diversified well before the mass extinction event, until now there have been no detailed ecological analyses of this. A study conducted by Gregory Wilson of the Department of Biology, University of Washington, Seattle, Washington, USA, and colleagues, has shown that a group of mammals called the multituberculates started to diversify at least 20 million years before the end-Cretaceous extinctions (*Nature*, 2012, Vol. 483, No. 7390, p.457–460). Changes in body size and dental complexity indicate a shift towards increased herbivory, this change tracking the rise of angiosperms. These mammals had taken advantage of new ecological opportunities in the Mesozoic, and these opportunities were relatively unaffected by the end-Cretaceous mass extinction.

Ancient forest ecosystem reconstructed

Scientists have uncovered a 300-million-year-old early Permian swampy forest in Inner Mongolia, northern China, buried under a layer of ash, preserving a wealth of detail about the region's flora (Fig. 7). The researchers, Jun Wang at the Chinese Academy of Sciences in Nanjing, and Hermann Pfefferkorn at the University of Pennsylvania in Philadelphia, USA, and colleagues, reconstructed the ancient ecosystem by analysing the positions of individual plants across three sites that together cover more than 1,000 square metres (*Proceedings of the National Academy of Sciences*, 2012, Vol. 109, No. 13, p.4927–4932). Species from six plant groups were present, and besides sporting a broad, low canopy of tree ferns, the peat forest contained trees that looked like feather dusters, with trunks twice the height of telephone poles. Also present were small spore-bearing trees, possibly relatives of the earliest ferns.

Fig. 7. 300-million-year-old peat forest in northern China. Reconstruction by Ren Yugao

Reference

PERKINS, S. 2012. Ash-covered forest is 'Permian Pompeii'. *Nature News*, doi:10.1038/nature.2012.10061.

DNA half-life

A team of researchers have calculated the half-life of DNA. The team led by Morten Allentoft at the University of Copenhagen, Denmark, and Michael Bunce at Murdoch University in Perth, Australia, examined 158 leg bones from three extinct species of New Zealand moa, from three sites within 5 km of each other. The bones ranged from 600 to 8,000 years old, and the preservation conditions were nearly identical (*Proceedings of the Royal Society B: Biological Sciences*, 2012, Vol. 279, No. 1748, p.4724–4733). The team compared the specimens' ages and the degree of DNA degradation, and calculated the half-life to be 521 years. This means that after 521 years, half of the bonds between nucleotides in the DNA would have broken; after another 521 years half of the remaining bonds would have gone; and so on. Although the bones were preserved at a burial temperature of 13.1°C, the team predicted that even at an ideal preservation temperature of -5°C every bond in the DNA would be destroyed after 6.8 million years, and that the DNA would be unreadable much earlier, around 1.5 million years. Their findings cast doubt on claims of DNA in dinosaur bones (65 million years and older) and in ancient insects in amber.

Archaeopteryx back on its perch?

In the last issue of the HDGS Journal (see *HDGS Journal*, Dec 2011, Vol. 17, p.43) we reported that a study had questioned whether the 150-million-year-old *Archaeopteryx* was a bird at all. It concluded that *Archaeopteryx* was more closely related to dinosaurs such as *Velociraptor* than to early birds. Now a study by Michael Lee at the South Australian Museum in Adelaide and Trevor Worthy at the University of New South Wales in Sydney, Australia, has placed *Archaeopteryx* back on its perch as the first known bird (*Biology Letters*, 2012, Vol. 5, No. 2, p.299–303). Lee and Worthy re-analysed the data used in the original study with methods that are often used to draw evolutionary relationships from genetic information. Their work placed *Archaeopteryx* closest to birds, making it distinct from feathered and other related dinosaurs. However, because transitional forms between birds and dinosaurs can differ very subtly, future fossil discoveries could well change *Archaeopteryx*'s relationship with birds and dinosaurs yet again. Watch this space!

Mating turtles from Messel

Numerous pairs of mating turtles have been described from the 47-million-year-old Messel Shale, Germany, the first known example in the fossil record (Fig. 8). The report by Walter Joyce of the University of Tübingen, Germany, suggests that the turtles, *Allaeochelys crassesculpta*, like their living cousins, probably stopped swimming when they started mating – the pairs then began to sink through the water column (*Biology Letters*, 2012, Vol. 8, No. 5, p.846–848). The authors suggest that below the surface waters of the Messel lake was a layer poisoned by volcanic gases or rotting organic material. As the skin of some turtles can act as a respiratory membrane, the turtles were killed as the poisons accumulated in their bodies, and these same conditions kept their bodies safe from scavengers as sediment accumulated on top of them.

Fig. 8. Mating turtles from Messel. Scale bar = 5 cm. Courtesy of Senckenberg Naturmuseum Frankfurt

Reference

SWITEK, B. 2012. Sex locked in stone. *Nature News*, doi:10.1038/nature.2012.10850.

Websites

Only one website this time - but if you want an updated list of the websites included in the Journal over the last six years, drop me an e-mail at p.austen26@btinternet.com. If you do not have access to a computer at home, all libraries in the UK are now equipped with computers with internet access for use by the general public.

Google Translate
http://translate.google.com/#
An excellent site for translating documents from virtually any language, even Chinese characters. You can either copy and paste the text from any document (e.g. Word Document or PDF), or scan a document using Optical Character Recognition (OCR) and then copy and paste the result directly into Google Translate. The translation, including grammar, is fairly good for most European languages. Languages like Chinese can be a bit more difficult, but you still get a good idea of what is being written - better results will be obtained with shorter sections of text.