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Professor G. David Price, UCL

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Cliffs beyond Ecclesbourne Glen with fallen block of ripple-marked sandstone in the foreground

Volume 21 December 2015

Cover picture: Cliffs beyond Ecclesbourne Glen with fallen block of ripple-marked sandstone in the foreground - photo: Peter Austen

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

Contributions for next year's Journal would be appreciated and should be submitted by the October 2016 meeting.
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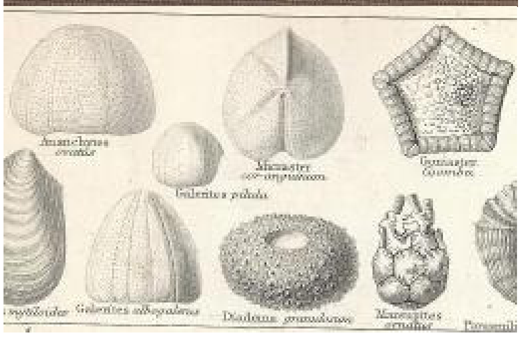
In Conversation with the Past

by Siân Evans

As a small child I was often drawn to a chest of drawers hidden behind the stack of spare timber in my father's shed in the garden. Within this treasure chest lay The Fossil Collection – **always** referred to by its full title. I loved The Fossil Collection and cherished the times I was allowed to pick through the dilapidated boxes and fading notes.

Our family – my sisters, father, grandfather and uncles – were avid beachcombers with a special affection for the shepherds' crowns or sea urchin fossils we would find beneath the chalk cliffs in Sussex. I had always thought that The Fossil Collection was the sum of these finds and it was not until my teens that I realised the original collection had been rescued from a rubbish bin by my great uncle some years before. He had been working at the Surrey home of a bereaved family whose father had been an amateur geologist. The family had no interest in this collection of rocks but were keen to free up the nice cabinet in which they were housed. Fortunately my great uncle offered to bring the fossils home and later he gave them to my father.



Twenty years ago it was my turn to look after The Fossil Collection and I carefully brought the treasure home and saw it with adult eyes for the first time.

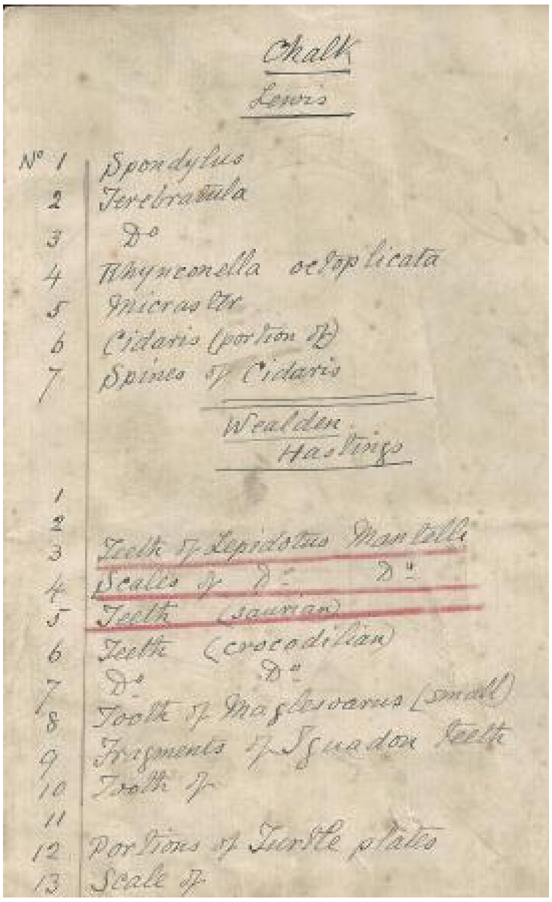
A large number of ammonites had oxidised beyond recognition and had to be discarded. The shells and sea urchins were gently cleaned and sorted into display boxes. Bone fragments and teeth were placed into another container.

Finally I picked up the faded leather folder at the bottom of the box and realised that it was a guide to British fossils, published by the *Society for Promoting Christian Knowledge* in August 1853.

The drawings were by C. R. Bone and within the cover one E. J. White (or was it E.I. White?) had crossed out the name of the previous owner before signing his or her name along with the words *Pemb Coll, Camb. Oct 1868* (presumably Pembroke College, Cambridge).

This writing appeared to match the assorted torn notes found underneath another of the boxes. They showed that the collection had been arranged in sections, drawer by drawer, and gave a small insight into the pieces that must originally have been there.

According to the notes, some of the lost ammonites had been found in "Upper Greensand Cambridge", whilst others had been found in "Oxford Clay, St Ives Huntingdon". Other specimens had "Lower Greensand, Potton" noted in the margin, whilst tantalisingly missing specimens from a coral bed at Upware near Cambridge were described.



Chalk
Lewes

No 1 Spondylus
2 Terebratula
3 Do
4 Rhynconella octoplicata
5 Micraster
6 Cidaris (portion of)
7 Spines of Cidaris

Wealden
Hastings

1
2
3 Teeth of Lepidotus Mantelli
4 Scales of Do Do
5 Teeth (saurian)
6 Teeth (crocodilian)
7 Do Do
8 Tooth of Megalosaurus (small)
9 Fragments of Iguadon teeth
10 Tooth of
11
12 Portions of Turtle plates
13 Scale of

One particular page delighted me though, when I saw the words "Wealden. Hastings" handwritten there and I felt a sudden connection to this stranger who had written his name in his fossil guide a century before my birth. Although the exact location was not described, I couldn't help wondering if I had traced the footsteps of E.J. White on my own foraging trips for fossils.

Among the surviving specimens of the collection were a number of plants including this Bennettitale frond – consistent with finds from the Ashdown Beds at Hastings. Since being uncovered a century or so earlier, it had travelled all round the country before finding its way "home".

These little fossils have two concurrent histories. The first is the ancient story of the life and death of the organism that left these beautiful traces, whilst the second is the social history of whoever amassed them. I can still have a conversation with the person who found all these small treasures as I have such empathy for his passion. When reading his notes and seeing his tiny numbered labels on the specimens I can identify with his excitement and delight at each new find. I imagine him referring to his identification chart and smiling as he plans his next expedition.

And I fondly imagine future owners of The Fossil Collection doing exactly the same.

Réunion Island

by Margaret A. Dale

This article briefly explains the events involved in the formation of the Island of Réunion, which is part of the Mascarene Archipelago. The Archipelago of Mauritius, Rodrigues and Réunion is located in the south-west of the Indian Ocean. A glossary has been included for the words that appear in bold.

Réunion Island is about 440 miles east of Madagascar and 125 miles west of its nearest neighbouring island Mauritius (21.11°S, 55.53°E). It is approximately 39 miles long and 29 miles wide.

The island has a tropical climate with a dry season (May to November) and a rainy monsoon season (November to April). The temperature moderates and the rainfall increases with elevation. The annual rainfall is approximately 2,200mm. By contrast Hastings has an annual rainfall of approximately 580mm. The island holds several world records for the most rainfall in given periods of time, the most notable being 1,087mm in 9 hours. Most of Réunion Island's rain falls in the east and on the peaks. Incredibly deep gorges and river beds and some of the world's tallest waterfalls testify to the ferocity of these rainfalls (Fig. 1). The total height of the tallest waterfall, the Bras de Caverne Falls (Cave Arms), is 2,379 ft. It falls in three steps of 689 ft, 590 ft and 984 ft with a few smaller steps in between.

Réunion Island is entirely volcanic and was produced by a **hotspot** of rising magma, upon which it still rests and which is still active.

It is believed that the same hotspot erupted 66 million years ago (mya) under the Indian plate as it drifted northwards producing the Deccan Traps. This is one of the largest volcanic features on earth. The multiple layers of solidified basalt of the Deccan Traps are more than 1.23 miles thick in places and cover an area of almost 200,000 square miles of India, which is more than twice the area of England's 95,000 square miles.

Over the following 6 to 21 million years, as the Indian Plate continued northwards, the hotspot repeatedly punctured it creating volcanic plateaus and volcanoes. The **atolls** of Lakshadweep (Laccadive Islands), the Maldives and the Chagos Archipelago currently sit atop the rims of some of these now extinct and submerged volcanoes.

About 45 mya the **mid-ocean rift** crossed over the hotspot, after which the hotspot appears to have remained quietly under the African Plate until 35 mya when it started erupting to create the Mascarene Archipelago. The three earliest islands to form have since submerged under the sea and a fourth remains as an atoll. The only remaining islands are the younger ones of Mauritius, which appeared 8-10 mya followed by Rodrigues and Réunion 2 mya.

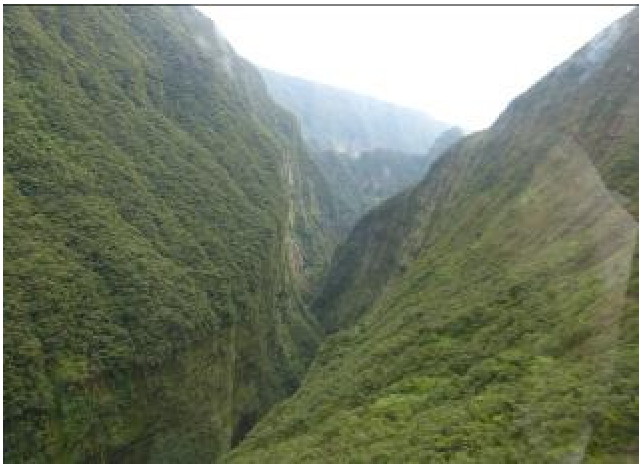


Fig. 1. A moderately deep ravine that has been gouged out by water.

Fig. 2. The Cirque de Cilaos. The steep flanks and erosion on the western edge (left) are clearly visible. The Piton des Neiges rises above the clouds in the centre.

Réunion Island was initially formed by the eruptions of two adjacent volcanoes, the Piton des Neiges (Snow Peak) and Les Alizés (The Trade Winds). Both volcanoes remained active until approximately 530 thousand years ago (kya), when a third volcano, the Piton de la Fournaise (Furnace Peak), started to erupt to the west of and almost on top of Les Alizés causing its volcanic activity to stop.

The Piton des Neiges, an **Hawaiian-style shield volcano**, remained active until 12 kya (Fig. 2). It occupies the northwestern two thirds of the island and at 10,069 ft is the highest peak in the Mascarenes and the Indian Ocean. By comparison Ben Nevis is 4,410 ft. Intense erosion by water from heavy rainfalls together with landslips and rockfalls of the high, steep flanks of the volcano around the central peak has resulted in the formation of three enormous, deeply ravined, rugged depressions, the Cirques de Cilaos (Fig. 2), Salazie and Mafate. The interiors of the Cirques de Cilaos and Salazie can be reached by road, the former on a road of "400 bends", whilst the Cirque de Mafate can only be accessed on foot.

The Piton de la Fournaise, also an Hawaiian-style shield volcano, has erupted since it first appeared and is one of the most active volcanoes in the world along with Kīlauea in the Hawaiian Islands (Pacific Ocean), Stromboli, Etna (Italy) and Mount Erebus in Antarctica. It is 8,635 ft high (Fig. 3).

Three successive and now separated **calderas** formed around the Piton de la Fournaise as it slumped towards the east. Each of these and their outer flanks are dotted with volcanic **pyroclastic** cones. The youngest caldera, Enclos (enclosure) Fouqué, was formed less than 5 kya (Figs 4, 5). It is 5 miles wide and is breached to the south-east into the sea. It is unstable and will eventually collapse into the ocean. There is speculation as to whether this may cause a mega-tsunami.

The highest volcano within the Enclos Fouqué, is the 1,315 ft tall Dolomieu (Fig. 3). It has been responsible for most of the historical eruptions which have emanated from its summit and flanks and which have usually presented no danger to the island.

Fig. 3. The Piton de la Fournaise topped with the volcano Dolomieu, from which there is evidence of numerous lava flows. Smoke and steam rising vertically from Dolomieu's latest eruption (2015) is visible at the bottom of the steeper flank on the right hand side. The horizontal white is clouds.

Fig. 4. Enclos Fouqué, the youngest caldera on the top of Piton de la Fournaise. Lava flows from Dolomieu can be seen on the caldera floor. The Piton de Neiges is the tallest peak in the background.

Fig. 5. A close view of the caldera walls of Enclos Fouqué.

Fig. 6. Evidence of the 2007 eruption looking up towards the Piton de la Fournaise.

Fig. 7. The active cone on Dolomieu. In addition to smoke and lava, steam from ground water and volcanic bombs are being thrown upwards.

Fig. 8. An aerial view of the active cone on Dolomieu. A small vent has appeared to the top left hand side of it.

However, since the beginning of the 17th century, six eruptions (including the three more recent ones of 1977, 1986 and 2007) fed from the magma chamber under Dolomieu originated on the outer flanks of the Enclos Fouqué. The 1977 eruption flowed through a village destroying property and fields. In the 1986 eruption, two lava flows crossed the main coast road whilst a third flowed into the sea increasing the island's area by 62 acres. The 2007 eruption, which appeared 5 miles from Dolomieu, remains one of the largest eruptions at the volcano in the last 100 years. Some of its lava fountains reached unprecedented heights of 656 ft. Two of its several-tens of lava flows crossed the main coast road, one of which reached the sea, increasing the island by 111 acres (Fig. 6). In addition, the eruption caused a 6,562 ft high column of rock, which the pressurised magma chamber under the Dolomieu crater had previously supported, to collapse into the magma chamber. This lowered the floor of the Dolomieu crater by 1,090 ft.

To date in 2015 there have been four separate eruptions of varying length and intensity from the flanks of Dolomieu. The last eruption, which started in August, is still active at the time of writing this article in October 2015 (Figs 7, 8). Over the last fifty years, there has been a mean time between eruptions of eight months. Seventy-five percent of the eruptions last less than one month.

Apart from the amazing geology and beautiful scenery, the island has some interesting and unique flora, fauna, sea life and food. The island is an overseas department of France and the southern-most point of the EU. Despite it being their late winter when my husband and I visited, the coastal temperature was usually in the mid 20s. There was always a pleasant coastal breeze and the humidity was low. The currency used is the Euro and the cost of living is lower than that of France. A really beautiful holiday destination and perfect for geologists!

Glossary

Atoll — a roughly circular coral reef that surrounds a lagoon in oceanic waters. The coral sits on the top of the rim of an extinct volcano or seamount, which has eroded and/or submerged beneath the sea.

Caldera — a cauldron-like feature which has been formed by the collapse of the roof of an emptied magma chamber to form the floor of a large crater.

Hawaiian-style volcano — an eruption of fluid basaltic lava flowing out with fire-fountaining at the vent. The steady production of lava builds up the form of a shield volcano. The volcanoes are not related to plate boundaries and are typical in ocean island settings.

Hotspot — a volcanic region fed by its underlying mantle that is hotter than its surrounding mantle. They may be on, near to, or far from tectonic plate boundaries but remain stationary in respect to the mantle.

Mid-ocean rift — where the lithosphere (crust and uppermost part of the mantle) is being pulled apart to produce new oceanic crust.

Pyroclastic — a concentrated eruption of hot volcanic rock fragments.

Shield volcano — a broad volcano built up from repeated eruptions of basalt and pyroclastic rocks to form a dome or shield, usually having a large caldera at the summit.

William Smith and the Castle Hill Section – Part 2

by Anthony Brook

In last year's issue of this Journal I presented the 'historical mystery' surrounding William Smith and the Castle Hill Section (1808) that was cited in the literature, and asked for your assistance in tracking down this historically-significant artefact. I am very pleased to report that this matter has been successfully resolved and the Section located, with the additional benefit of another important Smithian document.

The Archivist at the Geological Society informed me that the Castle Hill Section was not amongst their material relating to 'The Father of English Geology', and suggested that I contact the Archivist at Oxford University Museum of Natural History (OUMNH), where the vast collection of Smith's papers, etc. is held, more and more of which is being posted online in the 'William Smith Archive', and therefore easily accessible. It was still there, amongst his 'Sections', but not yet digitally scanned for the computerised archive. In due course I was sent a copy, which is herewith published for the first time (Fig. 1), with the permission of OUMNH.

This Section of Castle Hill Cliff, Newhaven, was surveyed by Smith in November 1808, and drawn very carefully on to a page of a Surveyor's Field Book; the strata were later water-coloured, and the page torn out. He must have had the help of an assistant or two during the day, to hold the other end of the measuring rod/tape, at the least, and thereby obtain such accurate dimensions of the different strata in the cliff face, such as the 'black incrustations'. Because Smith's handwriting is difficult to interpret, I have provided a Transcription (Fig. 2).

A little later I was asked whether I would like a copy of William Smith's 'Field Notes' to accompany the Castle Hill Section; unsurprisingly, I agreed, and they, too, are published herewith for the first time (Fig. 3), again with the permission of OUMNH. They sprawl over 2 pages of his Field Book, in his lamentable calligraphy, and were clearly written on the day of the survey, which is specified as Monday November 28, 1808 – which must have been a fine-weather day that year! I have deciphered Smith's handwriting as best I could and provided a Transcription (Fig. 4), which shows what an excellent field geologist he was, particularly for his day and age: observations of care, detail and accuracy. There are also some interesting comparisons with similar strata/features elsewhere in the country, which he had noticed on his many travels associated with his survey work.

Because William Smith surveyed Castle Hill Cliff in his own way, for his own purposes, his frontal survey is a little difficult to interpret after this length of time. Probably the best way to consider it is in 4 parts: part 1 consists of 'Gravel and Soil' and strata 1 and 2, with a total thickness of 16 feet, shown in square brackets on the transcript; part 2 is strata 3–14, indicated by the extended dotted bracket down the right-hand side, that were measured in detail, sometimes to 6 inches or less, to a total thickness of 36ft 5ins. Parts 1 and 2, taken together, total 52ft 5ins, shown in square brackets on the transcript, and were those strata subject to careful measurement and close scrutiny. Part 3 is 35 feet of undifferentiated 'Sand', and part 4 is 40 feet of 'Chalk, down to Low Water', producing a total stratal thickness and vertical height of 127ft 5ins for the cliff profile. For some reason, strata 9–11 were separately specified but not separately measured, being lumped together as 15 feet: perhaps they were too difficult or dangerous to access and measure on the cliff face.

A few other comments are tenable. At the top of strata 4 (3 feet of laminated clay), Smith has noted 'expect to be 1st spring', which is where water, percolating downwards, would reach this impermeable layer and issue forth as a spring line in the cliff face. In fact, there are 4 successive layers of 'laminated clay' – nos 4, 6, 9 and 11, each of which would produce its own issuance of percolated waters. Stratum 8 (black incrustation) and stratum 14 (black laminated shale) suggest periods of anaerobic depositional conditions. Indeed, all the strata of the top 50 feet of the cliff, those so carefully surveyed by William Smith, suggest a repeated sequence of placid-to-stagnant environments in post-Cretaceous times. The dotted lines above stratum 3 could be Smith's representation of the coastal topography, but his phrase 'Form the great Plains', opposite stratum 8, the very thin black incrustation, but encompassing measured strata 3–14, remains enigmatic: what did he mean by that?

These two documents, both by the hand of William Smith, the Section and the Field Notes, form a marvellous complementary pair, of immense value to the history of geology in Sussex. More than likely William Smith produced them for his own interest, having been told, during the preceding summer, that Castle Hill Cliff, just to the west of Newhaven, by the mouth of the river Ouse, had a series of unusual strata well worth a visit. He never envisaged publication, and they joined all the similar geological material in his personal collection; they remained completely unknown. That is important, because William Buckland, in 1817, and Gideon Mantell, in 1822, believed that they were the first to describe the Section of Strata at Castle Hill (Fig. 5), which does not differ all that much from Smith's of 1808! Indeed, in many ways, the first drawing of Strata of Castle Hill, Newhaven, by Mary Ann Mantell in 1818 which forms the Frontispiece of Mantell's volume of 1822 (Fig. 6) can be interpreted using Smith's Section and Field Notes of 1808. Modern visual interpretations of this stratigraphically-significant cliff profile, by Castleden (1997) (Fig. 7) and Mortimore (1999) (Fig. 8), only serve to reinforce the quality of Smith's workmanship of two centuries ago.

Fig. 1. 'Castle Hill Cliff, Newhaven' as drawn by William Smith

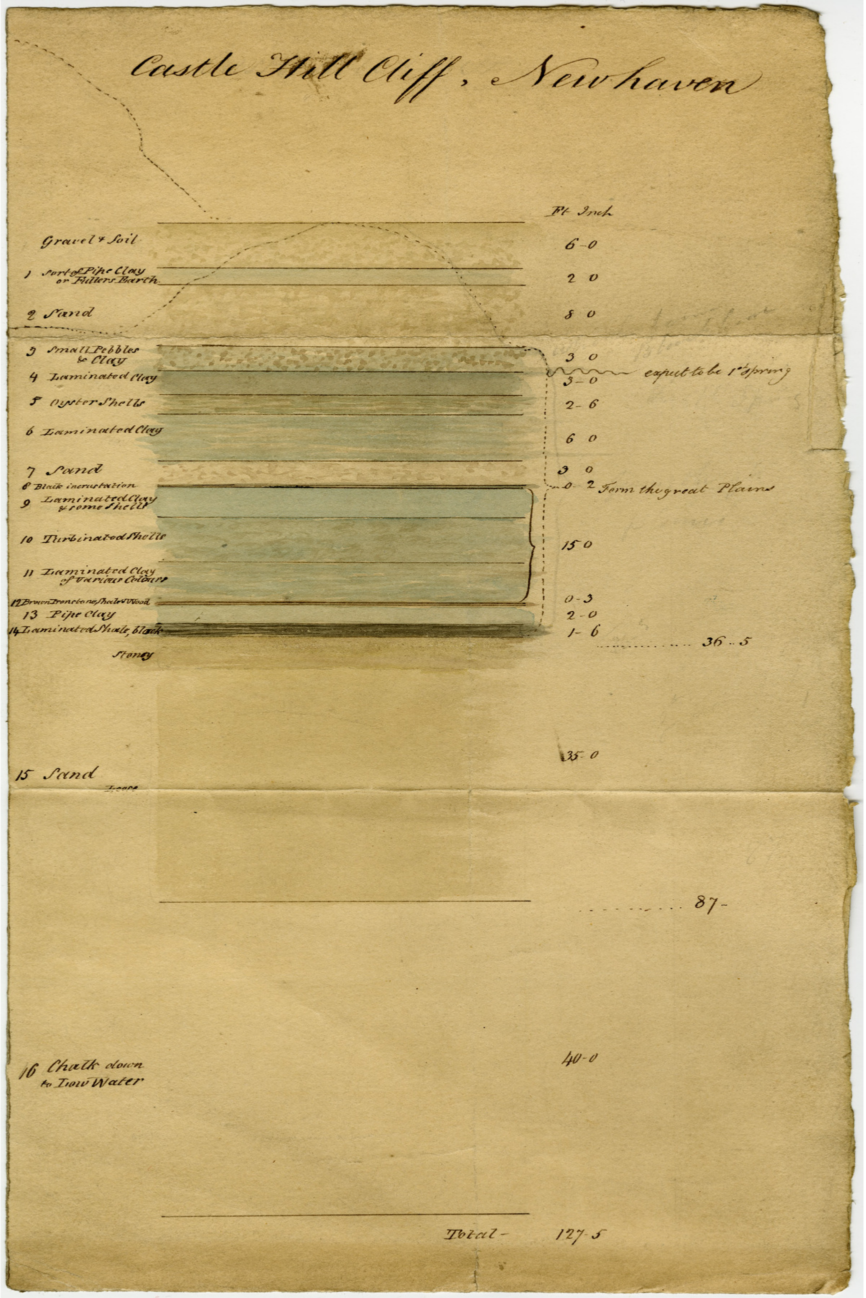


Fig. 2. Transcript of William Smith's Section of Castle Hill Cliff, Newhaven

Castle Hill Cliff, Newhaven

		Ft Inch		
	Gravel & Soil	*6-0*		
1.	*Sort of Pipe Clay or Fullers Earth*	*2-0*		
2.	*Sand*	*8-0*		[16-0]
3.	*Small Pebbles & Clay*	*3-0*	*. . . . . expect to be 1st spring*	
4.	*Laminated Clay*	*3-0*		
5.	*Oyster Shells*	*2-6*		
6.	*Laminated Clay*	*6-0*		
7.	*Sand*	*3-0*		
8.	*Black incrustation*	*0-2*	*. . . . . Form the great Plains*	
9.	*Laminated Clay & some Shells*			
10.	*Turbinated Shells*	*15-0*		
11.	*Laminated Clay of Various Colours*			
12.	*Brown Ironstone, Shale & Wood*	*0-3*		
13.	*Pipe Clay*	*2-0*		
14.	*Laminated Shale, black*	*1-6*	*. 36-5*	[52-5]
	Stoney			
15.	*Sand*	*35-0*		
			87-	[87-5]
16.	*Chalk, down to Low Water*	*40-0*		
	Total -	*127-5*		[127-5]

Fig. 3. William Smith's Field Notes.

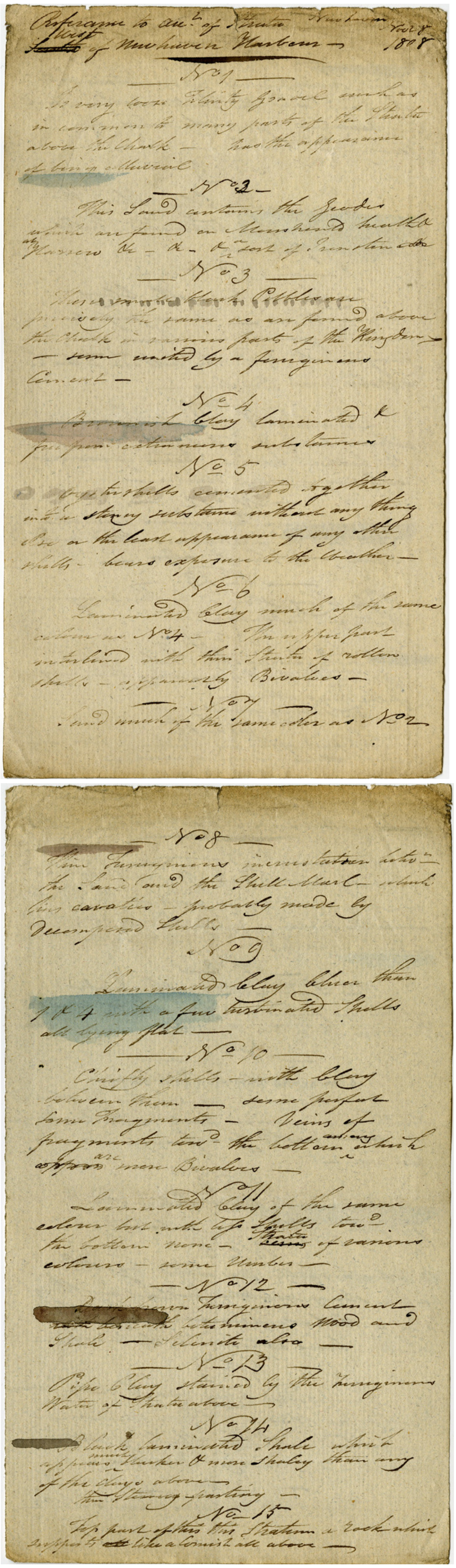


Fig. 4. Transcript of William Smith's Field Notes.

Reference to account of Strata   Newhaven   Nov 28 1808

West of Newhaven Harbour

No. 1

Is very loose Flinty Gravel such as is common to many parts of the Strata above the Chalk – has the appearance of being alluvial.

No. 2

This Sand contains the Geodes which are found on Hampstead [?] *heath and at Harrow etc. – etc. – and are sort of Ironstone.*

No. 3

These smooth black Pebbles are precisely the same as are found above the Chalk in various parts of the [United] *Kingdom – some united by a ferruginous Cement.*

No. 4

Brownish Clay laminated and free from extraneous substances.

No. 5

Oyster shells cemented together into a stoney substance without anything else, or the least appearance of any other shells – bears exposure to the weather.

No. 6

Laminated Clay much of the same colour as No. 4. The upper part interlined with thin Strata of rotten shells – apparently Bivalves.

No. 7

Sand much of the same order as No. 2.

No. 8.

Thin Ferruginous incrustation between the Sand and the Shell Marl which lines cavities – probably made by decomposed Shells.

No. 9

Laminated Clay bluer than [Nos] *1 and 4, with a few turbinated Shells all lying flat.*

No. 10

Chiefly shells – with clay between them – some perfect, some fragments. Veins of fragments towards the bottom among which are more Bivalves.

No. 11

Laminated Clay of the same colour but with less Shells towards the bottom none – Strata of various colours, some Umber.

No. 12

Dark brown Ferruginous Cement beneath bituminous Wood and Shale – Selenite also.

No. 13

Pipe Clay stained by the Ferruginous Water of Strata above.

No. 14

Black laminated Shale which appears much thicker and more shaley than any of the clays above.

thin stoney parting.

No. 15.

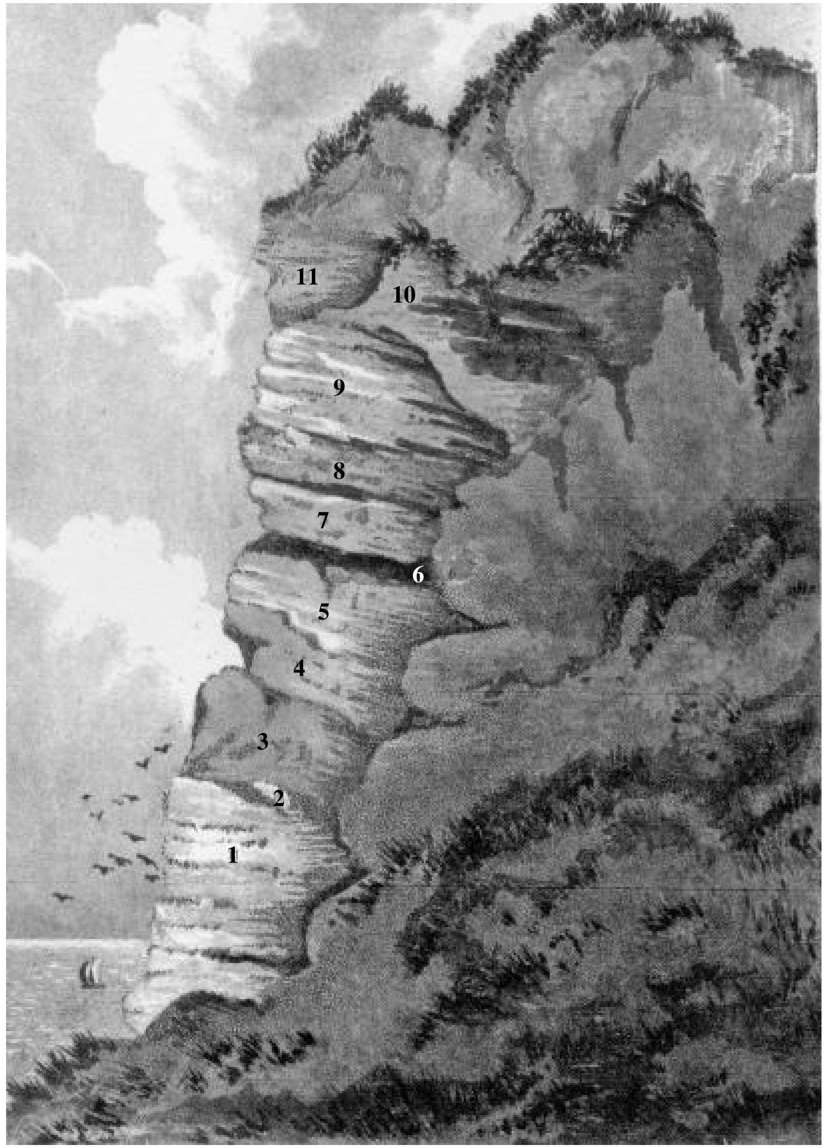
Top part of this thin Stratum a rock which supports like a Cornish [cornice] *all above.*

Fig. 5. William Buckland (1817) versus Gideon Mantell (1822)

Modified from William Buckland 'Description of a series of Specimens from the Plastic Clay near Reading, Berks., etc' *Transactions of Geological Society* Vol. 4, Part 2 (1817) 296-97			Modified from Gideon Mantell *Fossils of the South Downs* 1822, 257-258		
Section of the Strata at Castle Hill, near Newhaven (beds inverted from original text to match plate, right)					
No.	BUCKLAND	Thickness (ft)	No.	MANTELL	Thickness (ft)
7.	Alluvium full of broken chalk flints mixed with sand	10	11.	Diluvium, consisting of yellow and fawn coloured sand, with pebbles: the latter evidently formed of broken chalk flints rounded by attrition	10-15
6.	Consolidated argillaceous rock full of oysters, with a few cyclades and cerithia	5	10.	A bed composed almost entirely of oyster shells held together by an argillaceous cement	*c.* 5
5.	Foliated blue clay containing cerithia, and cyclades, and a few oysters. In this clay is a seam of iron pyrites about an inch thick with pyritical casts of cyclades and cerithia	10	9.	Blue clay with broken bivalve shells, apparently of genera *cytherea* and *cyrene*	10
			8.	Blue clay, containing an immense number of shells, chiefly of the genus *cerithium*; teeth of a species of *squalus*, etc. This bed is traversed by a seam of *pyrites*, a few inches thick, containing casts of *cerithia*	
			7.	Indurated reddish brown marl, the lower part slaty, containing *impressions of leaves*, and casts of *cerithia*, *cyclades*, etc.	a few inches
	[possibly below as 'coaly matter']		6.	A seam of *surturbrand*, or *coal*	*c.* ½
4.	Series of clay beds containing coaly matter, selenites and fibrous gypsum, also leaves of plants, and sulphur-coloured clay	20	5.	Blue clay with *marl of a sulphur yellow colour*; including large crystals of *sulphate of lime*, with *fibrous* and *foliated* gypsum	20
3.	Sand, varying from yellow to green and ash colour	20	4.	Sand, of various shades of yellow, green, and ash colour	20
2.	Breccia of green sand and chalk flints, the latter covered with a ferruginous crust	1	3.	*Breccia* of green sand and chalk flints, the latter covered with a *green* and *ferruginous* crust	1
1.	Chalk, containing alumine in hollows on its surface	50	2.	Ochraceous clay, containing *hydrate* and *subsulphate* of *alumine*, and *crystallized sulphate of lime*	*c.* 1½
			1.	Chalk with flints	50
	Total	116		Total	118-123

Fig. 6. Strata at Castle Hill, Newhaven - Mantell (1822/1818)

Frontispiece, drawn by Mary Ann Mantell, 1818



STRATA AT CASTLE HILL NEAR NEWHAVEN

Fig. 7. Strata at Castle Hill, Newhaven - Rodney Castleden (1996, p.22, fig. 6)

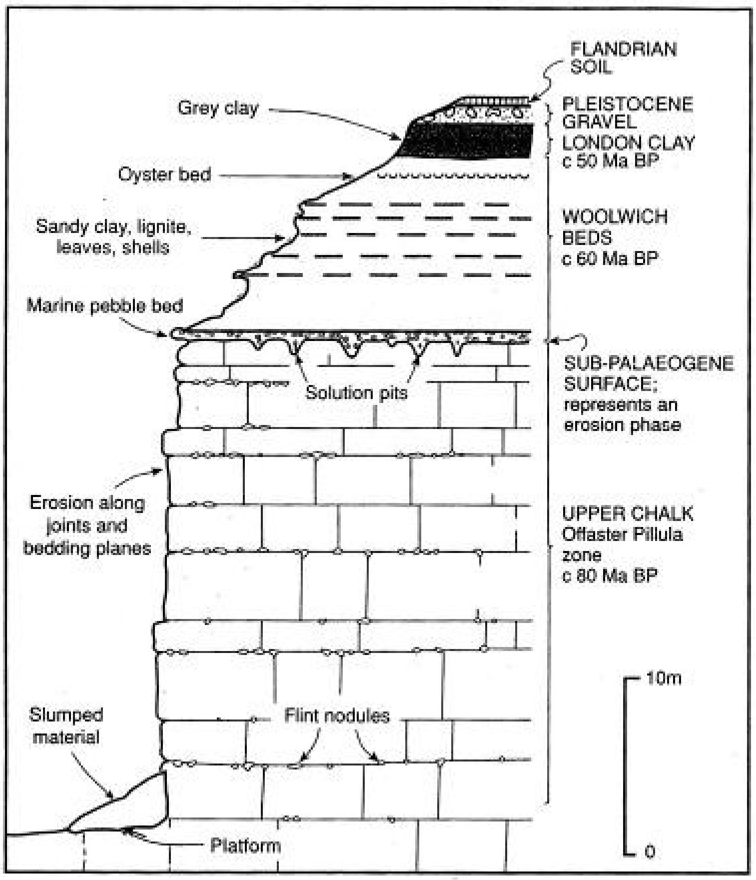


Figure 6. Profile of cliff at Castle Hill, Newhaven

The shape of the cliff is closely related to its geology. This is the only natural exposure of the basal bed of the Sussex Palaeogene, the 'Reading Bottom Bed', made of cemented green-coated flint pebbles. The solution pits in the Chalk were made by acidified groundwater passing through the overlying Woolwich Beds.

From "CASTLEDEN, R. 1996. *Classic Landforms of the Sussex Coast*. Revised Edition. The Geographical Association, Sheffield, 56 pp."

Fig. 8. Strata at Castle Hill, Newhaven - Rory Mortimore (1997, p.76, fig. 38)

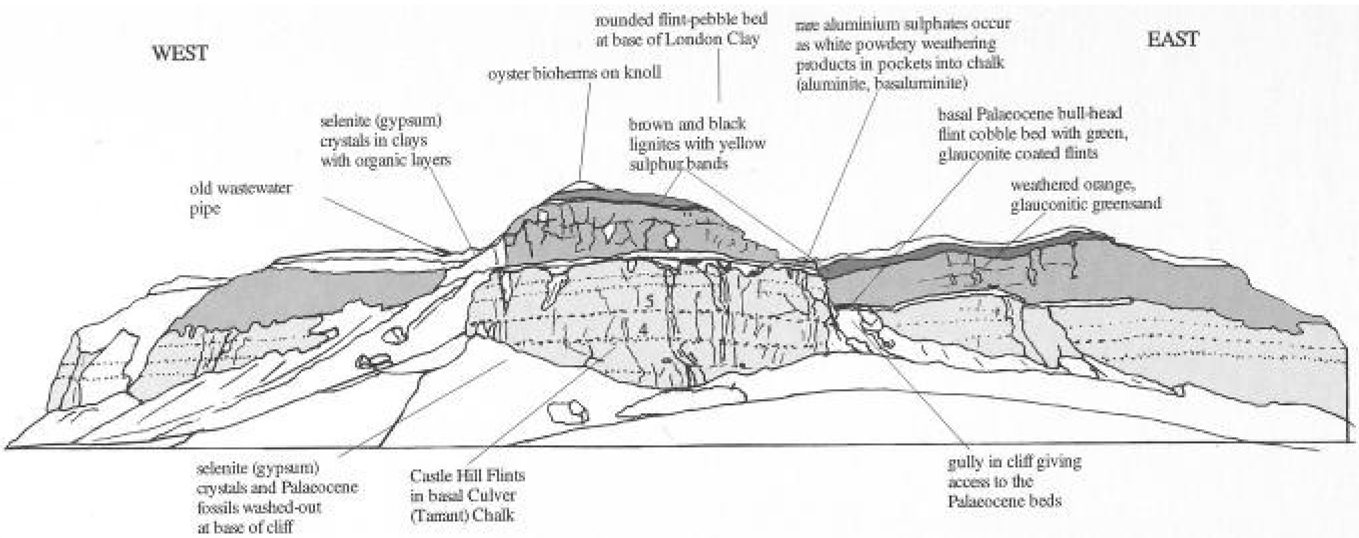


Figure 38. Castle Hill, Newhaven, showing Palaeocene deposits resting on Cretaceous (Lower Campanian Culver Chalk).

From "MORTIMORE, R. N. 1997. *The chalk of Sussex and Kent*. Geologists' Association Guide, **57**, iii + 139 pp."

How Britain became an island – by Professor Sanjeev Gupta

HDGS lecture meeting – Sunday, 17th May 2015

Reported by Peter Austen

At our May meeting we were fortunate to have Professor Sanjeev Gupta talk to us on the formation of the English Channel. Professor Gupta is Professor of Earth Sciences at Imperial College London, and he uses his understanding of rocks and physical processes such as plate tectonics, mountain building, deposition of sediment and erosion by water to understand how particular landscapes were formed – in remote deserts, under the sea in the English Channel and on Mars! He is a lead scientist on NASA's Mars Curiosity Rover Mission, using his understanding of rocks and physical processes to plan where the Curiosity Rover should go next. In 2007 he published a landmark paper in *Nature*, proposing a compelling explanation for the formation of the English Channel by megafloods (Gupta *et al*. 2007). This was the subject of Professor Gupta's talk.

Professor Gupta showed high-resolution sonar data revealing the detailed morphology of the Channel floor. It showed that the Channel seabed is transected by a huge east-west-trending valley cut into bedrock that contains a distinct assemblage of landforms characteristic of erosion by catastrophic floods.

Britain and France are joined by a relatively shallow continental shelf, and over the past million years or so, at times of peak glaciation, sea levels have been as much as 120 m below their present levels, leading to the shelf being emergent, connecting Britain directly to France via the dry English Channel. Previous geophysical investigations had identified a 400-km-long network of submerged and partially infilled valleys carved into the bedrock floor of the continental shelf, some with a valley floor width of up to 15 km (Fig. 1). These dimensions were not consistent with being carved by rivers during glacial periods of low sea level, particularly when allowing for the volumes of water available from the feeder rivers. During interglacial periods higher sea levels flooded the English Channel, cutting Britain off from France, but a structural chalk ridge, the Weald-Artois anticline, connecting the white cliffs of Dover to the chalk cliffs of Calais remained, separating the North Sea from the English Channel, and forming a land bridge between Britain and France. Professor Gupta proposed that this bridge suffered a catastrophic breach carving the features that we see in the bedrock of the English Channel today. To the north of the chalk bridge was a large pro-glacial lake contained by an ice sheet in what is now the North Sea. Various forms of these ideas had been proposed previously by John Wallis (1616–1703), who suggested a land bridge between Britain and France; Alfred John Jukes-Browne (1851–1914) and Laurence Dudley Stamp (1898–1966), who both proposed early drainage models; and more recently Alec J. Smith, who, building on the work of Dudley Stamp, proposed a model very similar to that which is now accepted (Smith 1985); but with no supporting evidence these ideas were not taken seriously.

Using details of seafloor mapping undertaken in the 1960s and 70s, multi-beam sonar data of the seafloor collected by Professor Gupta and his colleagues, and single-beam sonar data of the seafloor from other sources including the United Kingdom Hydrographic Office, Professor Gupta explained how he was able to build up a detailed picture of the topography of the floor of the English Channel and identify particular features that could only be explained by a catastrophic megaflood.

These features included longitudinal erosional grooves cut into the channel bedrock over tens of kilometres, and large islands protruding from the bedrock forming elongate streamlined islands corresponding to the direction of flow of the megaflood (Figs 1, 2). Also, at the points where the land bridge between Calais and Dover had been breached, there was evidence of large plunge pools carved into the bedrock by the force of the initial stages of the breach and overspill. All of these features bore a striking resemblance to those found in the Cheney–Palouse terrain of the Channeled Scabland of Washington, USA. The formation of this terrain by catastrophic floods from the Pleistocene glacial lake Missoula was first proposed in the 1920s and 30s by the American geologist J Harlen Bretz (1882–1981), and although the bedrock in the Washington deposits was basalt as opposed to Lower Cretaceous clays and Upper Cretaceous chalk in the English Channel, they still showed the same longitudinal grooves, elongate streamlined islands and plunge pools seen in the English Channel.

Professor Gupta used detailed maps of the seafloor to support this explanation, as well as a 3D interactive visualisation system, which also allowed cross-sections of the topography to be seen. There is thought to have been two separate breaches of the land bridge, the last one being around 180,000 years ago, finally cutting off Britain from France. The loss of the land bridge would also have had implications for human migration patterns, helping to explain some of the gaps in the movement of people into Britain.

Professor Gupta also showed aerial views of Mars where similar features could be seen, particularly the elongate islands in wide valleys, possibly caused by huge megafloods in the distant past.

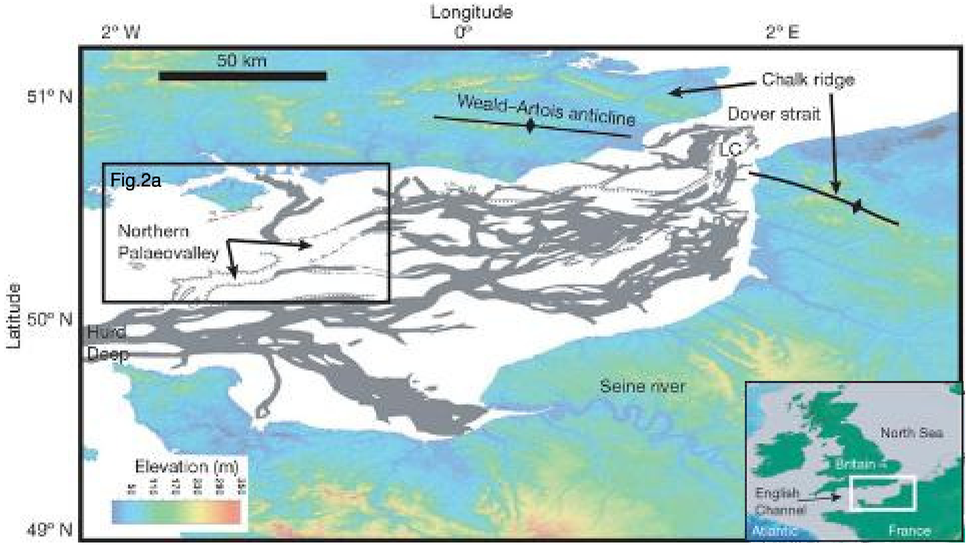


Figure 1. Distribution of palaeovalleys on the English Channel shelf. *Grey indicates valleys filled with sediment; white and hatched, unfilled valleys. The box shows the segment of the Northern Palaeovalley studied (fig. 2 below). There is a prominent topographic escarpment formed by the Weald–Artois anticline that extends from southeastern England into northwestern France. The Lobourg Channel (LC) in the Dover Strait extends westward into the Northern Palaeovalley.*

Figure 2. Sonar map (a) and profile (b) of the north-central English Channel shelf (box in figure 1 above).

a. *Coloured and shaded relief map.*

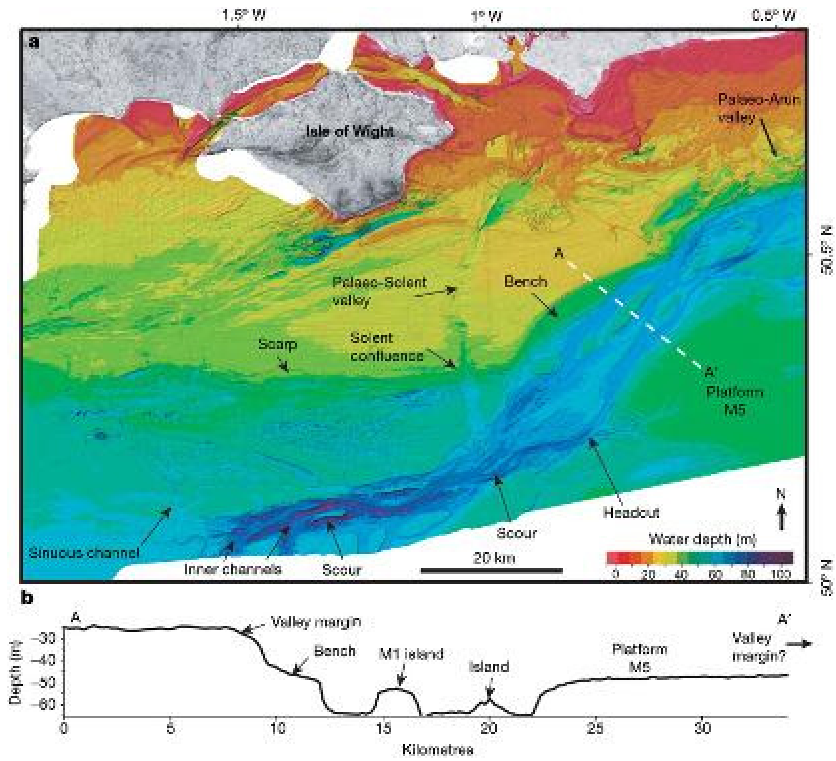
A headcut is a small cataract at the upstream termination of inner channels.

Scours are elongate hollows eroded into the channel floor.

The scarp is an east–west-trending escarpment defining the northern limit of the palaeovalley.

The white dashed line shows the location of the profile A–A'.

b. *Profile across the Northern Palaeovalley showing valley margin, bedrock bench and streamlined islands.*



Figures 1 and 2 reprinted by permission from Macmillan Publishers Ltd: NATURE (Gupta et al. *2007), copyright (2007).*

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The Cretaceous Greenhouse World and its Impact on the Evolution of Land Vertebrates

by Paul Upchurch, Professor of Palaeobiology, University College London

Summary of a talk presented to the Society on 13th September 2015

Today, animals and plants are typically most diverse (i.e. have their highest number of species) located in the tropics. This means that a graph of species diversity plotted against latitude tends to peak near the equator and decrease in height towards the poles (Fig. 1). This is not particularly surprising given that the tropics provide an abundance of important advantages for life (e.g. increased insolation, higher temperatures, reduced seasonal variation) compared to harsh polar conditions. For a long time, palaeontologists have believed that this same basic pattern can be detected throughout much of Earth history, perhaps as far back as 400 or even 500 million years ago. However, one serious problem with most palaeontological studies is that they have not taken into account the uneven sampling of the fossil record – were ancient organisms really most diverse in tropical zones, or is this pattern an artefact created by larger amounts of sedimentary rock laid down in these regions? Increasingly large data sets on the distributions of fossil organisms, combined with new analytical methods, mean that we can now examine the latitudinal biodiversity patterns of extinct organisms in a way that removes the worst effects of uneven sampling.

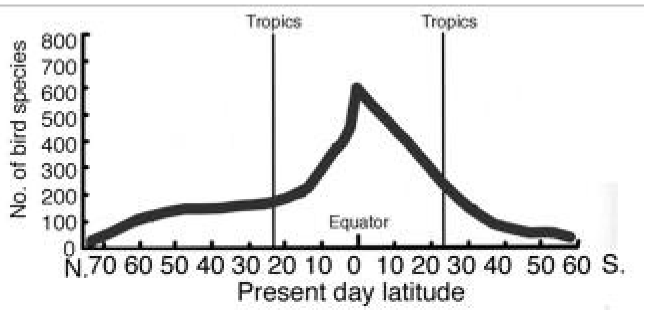

Fig. 1. The diversity of living birds plotted against latitude (modified from Turner & Hawkins 2004).

The Cretaceous Period (145–66 million years ago), provides an interesting time to look at ancient latitudinal biodiversity patterns. There were many important geological, environmental and evolutionary changes that occurred during the Cretaceous. In particular, the single supercontinent, Pangaea, had already split into Laurasia in the north and Gondwana in the south in the Jurassic, but during the Cretaceous there was further fragmentation. This resulted in the formation of the Atlantic Ocean and the break-up of Gondwana into South America, Africa, India, Madagascar, Antarctica and Australia. Such a profound reorganisation of the continents had knock-on effects in terms of changes in sea level and climate. It seems that CO_2 levels rose during the Cretaceous, reaching a peak at about 90 million years ago. This is associated with elevated average global temperatures (perhaps as much as 16°C higher than today), creating a 'Greenhouse world'. Consequently, there were no permanent ice caps at the poles. In terms of the organisms that dominated Cretaceous ecosystems, many new groups of dinosaur appeared, replacing forms that had been previously important during the Jurassic. For example, the long-necked gigantic herbivorous sauropods, known as titanosaurs (Fig. 2), replaced other types of sauropod, and the bipedal carnivorous tyrannosaurs replaced allosaurs. Mammals continued to diversify, so that forms very closely related to true placental mammals were present by the end of the Cretaceous. Snakes evolved during the Cretaceous, with the earliest ones still retaining the legs they had inherited from their lizard-like ancestors. Perhaps one of the most important evolutionary events during the Cretaceous is the rise of flowering plants and their associated pollinating insects such as wasps, bees etc. But how did this great diversity of life respond to the warm 'Greenhouse' conditions of the Cretaceous?

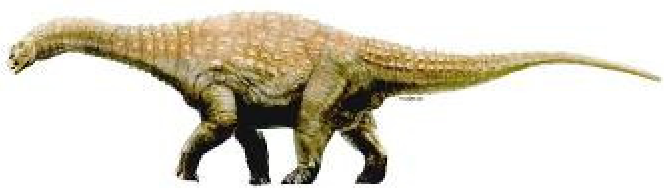

Fig.2. Restoration of the ~90 million year old titanosaur sauropod Diamantinasaurus *from Queensland, Australia (modified from https://commons.wikimedia.org/wiki/File:Diamantinasaurus.png).*

Our analyses show that vertebrates (including dinosaurs, birds, pterosaurs, crocodiles, lizards, snakes, turtles and mammals) and at least some invertebrates, were most diverse in the temperate zones, and were less diverse in the tropics (Fig. 3). This is a very different pattern from that observed today. There were even crocodile-like animals (known as champsosaurs) that lived at close to 80° north of the equator. Clearly these latitudinal patterns are related to the warmer conditions of the Cretaceous, with temperate and even Polar Regions being more amenable to life. However, why was diversity lower in the tropics than at temperate latitudes? There are several possible factors, which might have acted singly or in combination. One possibility is that, under warmer global conditions, the tropics became so hot that many organisms were unable to survive there – they either became extinct or were forced to move to the cooler temperate zones. Another possibility is that many of the organisms in our analyses were terrestrial and so could only live on land. Continental movements meant that there was actually relatively little dry land available in the tropics compared to the temperate zones. Finally, the diversity of plants seems to play a key role in controlling where the animals were living in the Cretaceous. Thus, it might be that Greenhouse climatic conditions promoted the richest floras to occur in temperate zones, and that this in turn meant that this is where the most diverse faunas occurred.

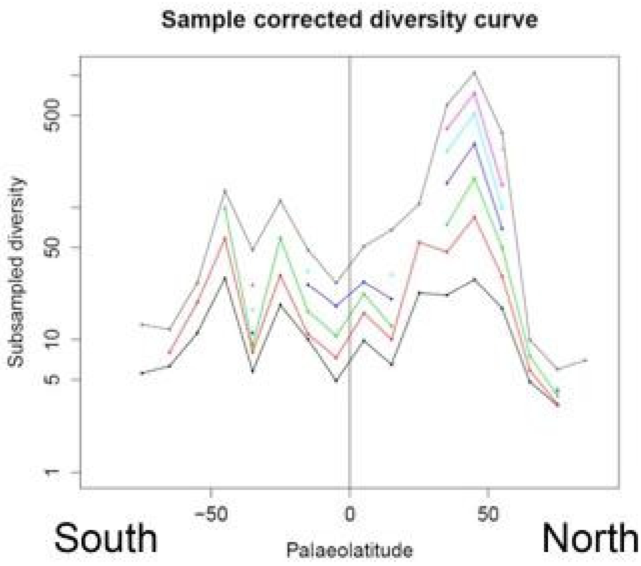

Fig. 3. Reconstructed latitudinal diversity pattern for Cretaceous land vertebrates (based on analyses that account for uneven sampling of the fossil record, carried out by Paul Upchurch and colleagues). Each of the different lines represents a result produced by sampling the data in a different way. The lower graphs are based on using a larger proportion of the total data set, but this includes poorer quality samples. The higher graphs use a smaller amount of data, but focus on the better quality samples only. Although the magnitudes vary, the basic pattern of temperate peaks and tropical lows in diversity can be seen in most of the results.

Current evidence (which is admittedly rather limited) suggests that temperate peaks in diversity persisted beyond the end of the Cretaceous into the first part of the Cenozoic Era. However, around 35 million years ago, Antarctica lost contact with South America as a result of the opening of the Drake Passage. This allowed the formation of a circumpolar current, which, in turn, resulted in substantial cooling of the southern polar region. These changes sent global climates into a spiral of increasingly low temperatures – so-called Icehouse conditions. As polar, and even temperate, regions developed harsher climates, many groups of organism were forced to move towards the tropical zones or face extinction. Thus, diversity near the equator increased, eventually creating the modern latitudinal pattern (Fig. 1).

What does this mean for the near future as global temperatures rise? Essentially the fossil record suggests that diversity generally increases with higher temperatures. However, this does not mean that global warming is 'good news' for either us or other organisms. In the past, organisms have had the freedom to move across latitudes in response to climate change, but this might not be so easy in the future because of human activity. Destruction of habitats, reduced population sizes for many species, and the much faster rates of temperature rise compared to past climatic events, mean that extant organisms will have less time to adapt and will find it more difficult to move to suitable locations. Thus, human activities might break the long-term positive relationship between temperature and diversity.

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News from the Weald

by Peter Austen

Over the past year HDGS members have been involved in a number of field meetings looking at the geology and palaeontology of various Wealden localities. These have included field trips to Smokejacks Brickworks (p. 18), the Hastings coastal section from Rock-a-Nore to just past Ecclesbourne Glen (p. 21) and Langhurstwood Quarry (p. 24), as well as the ongoing rescue dig of the Bexhill dinosaurs (p. 27). A number of interesting finds have also been made, including a new pterosaur (p. 30), and a previously unrecognised shark skull (p. 32), both from the Bexhill/Cooden area. There are photos from our members of various finds and trace fossils from the Hastings coastal section (p. 33), a 190 year old drawing of the Hastings coastline from White Rock to Cliff End, Pett (p. 34), and an article looking at the use of Wealden sandstones in Medieval Sussex churches (p. 38). Finally we have an article explaining why the Weald that we've known for the past 150 years or so is not quite what it seems.... (p. 43). Below is a brief introduction to the Wealden environment and succession, together with a stratigraphical column (Fig. 2) hopefully putting all these articles into context. Thanks to all our members who have contributed both to the Wealden fieldwork over the past year, and to the following articles.

Introduction to the Weald

The geological unit known as the Wealden Supergroup dates from the early Cretaceous between 125 and 140 million years ago, and in south-east England we have rocks covering almost the whole of the Wealden succession, from the older rocks of the Hastings Group along the Hastings coastal section, to the younger rocks of the Weald Clay Group in quarries around the Horsham area. These Wealden deposits extend over parts of the counties of Surrey, Sussex and Kent between the Chalk escarpments of the North and South Downs (Fig. 1). It generally represents a freshwater wetland environment of rivers, lakes and floodplains, with occasional brackish marine incursions. Global temperatures were higher and Britain was nearer the Equator, so it would have been generally warmer than today. Present day analogues of the Wealden landscape include the Okavango Delta in Botswana and the Maracaibo Basin, Venezuela.

The Wealden succession is divided into two main groups, the older Hastings Group and the younger Weald Clay Group.

The older beds of the **Hastings Group** display a succession of intermittently faulted sandstones, siltstones and mudstones that extend from the Ashdown Formation up through the Wadhurst Clay Formation to the Tunbridge Wells Sand Formation, which also includes the Grinstead Clay Formation. These beds were deposited in fresh-brackish water and originated as great quantities of sand, silt and mud carried down by rivers into the Wealden lowland area from the London massif to the north (Londinia) and, to a lesser extent, from the Armorican massif to the south (Normandy) and Cornubia to the west (Cornwall). The cycles of sandstones and clay sedimentation reflect the tectonics of the London massif to the north. The London area was bounded by active faults causing uplift of the London platform; at times of high relief sands would have been deposited, followed by clays as the London area was eroded to a lower relief, followed again by sands after renewed uplift, and corresponding freshwater and brackish interludes in the basin.

The younger **Weald Clay Group** is dominated by clays interspersed with relatively thin beds of sandstone and limestone, indicating that the earlier tectonic cycles were losing their energy. The various thick clay, mudstone and fine-grained siltstone deposits were mostly derived from the low-lying, eroded London massif to the north

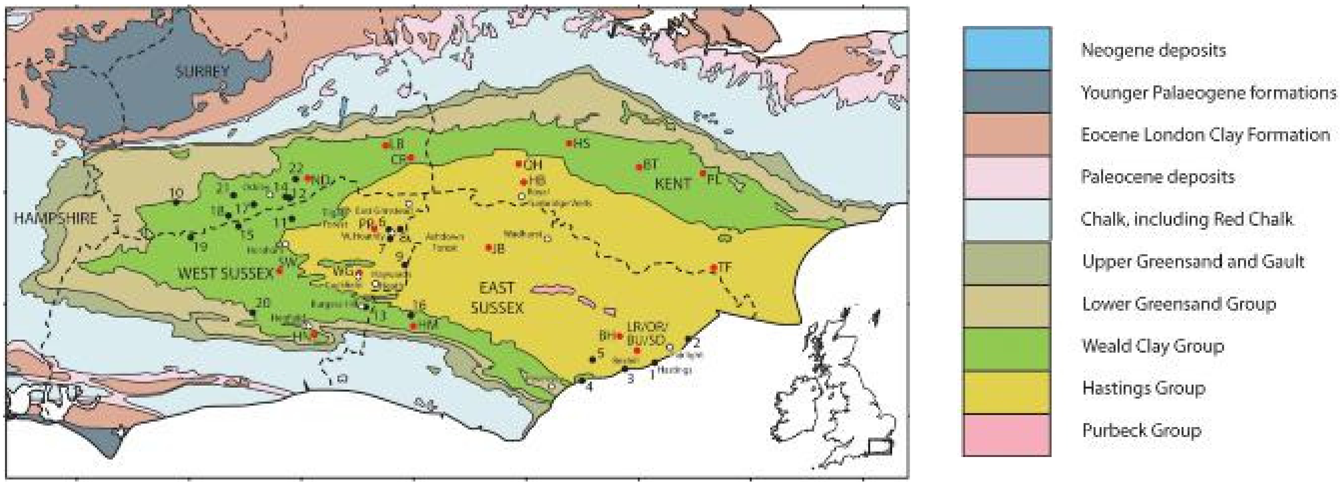

Fig. 1. Geological map of south-east England showing Wealden Supergoup. *Adapted from Batten and Austen (2011).*

(Londinia), whereas the source of the sediments feeding the sandstone units was the Cornubian Massif (Cornwall) to the west, indicating periodic uplift of this massif. The sandstone and limestone units of the Weald Clay Group are numbered and labelled following the procedure adopted by the British Geological Survey (see fig. 2 for beds), although the validity of the upper bed numbers has recently been called into question (p. 43).

Information sourced from:

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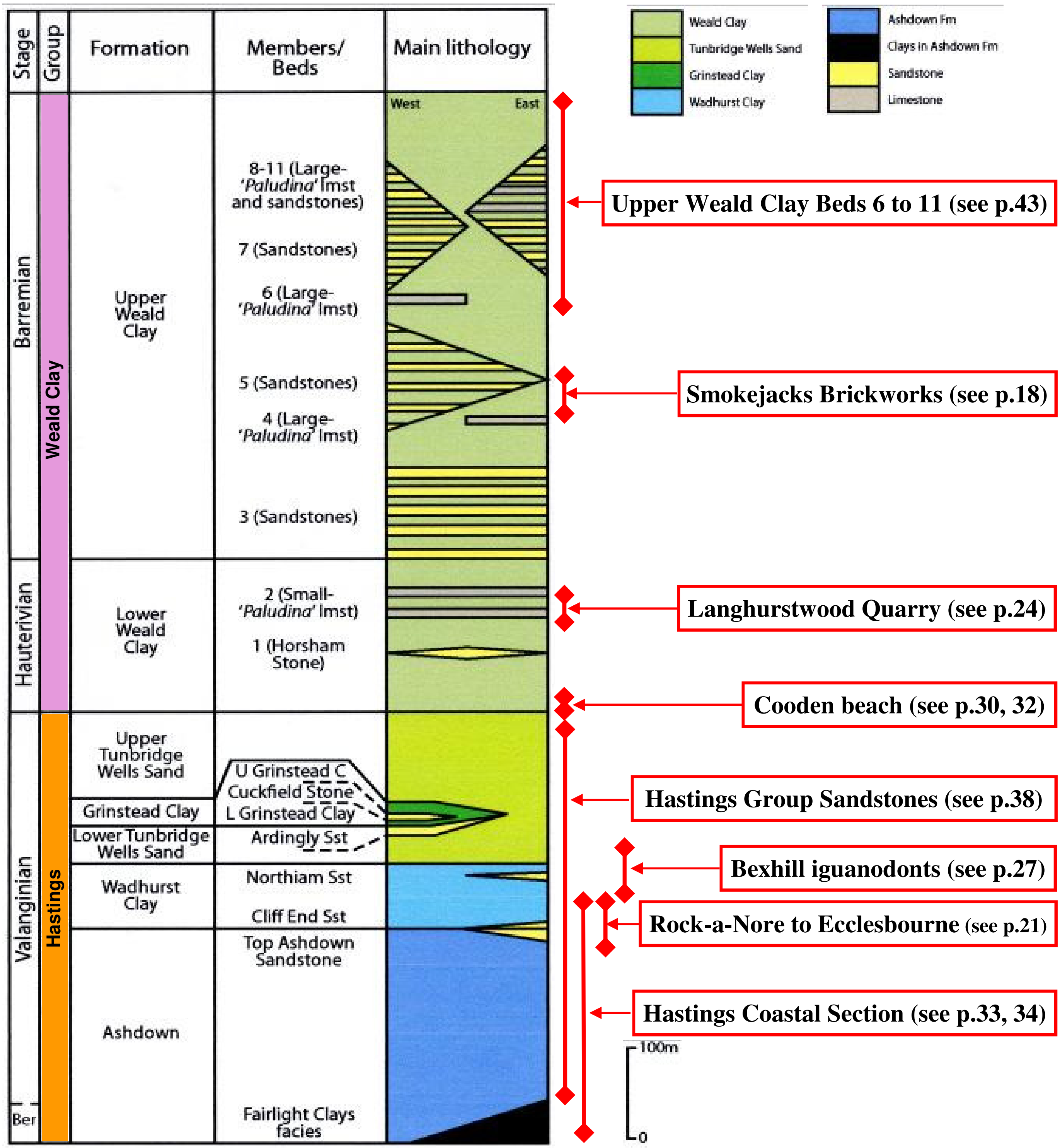

Fig. 2. Stratigraphical column for the Wealden Supergroup in south-east England. Adapted from Batten and Austen (2011).

Smokejacks Brickworks

by Peter Austen

During 2015, the Hastings & District Geological Society (HDGS) held a joint field meeting with the Horsham Geological Field Club (HGFC) at Smokejacks Brickworks, Walliswood, near Ockley, in Surrey (21st June). A number of members also attended the two open field meetings held on the 12th April and the 6th September. Smokejacks only returned to full operation at the end of 2014 following a six-year partial closure brought about by the 2008 economic recession. At that time, the brick-making plant was mothballed, and only a small number of staff were retained for the making of hand-made 'specials' (specially shaped bricks and other specialist clay products) which meant there were no fresh scrapes of the quarry faces for several years, leaving them to degrade and become overgrown.

The Smokejacks pit is in the Upper Weald Clay Formation (Barremian) and exposes BGS Bed 5c (Alfold Sandstone) near the top. Of the 23 m of section exposed, the lower 13 m consist of mudstones and shaley mudstones with sporadic lenses of sideritic mudstones and siltstones, within which insects, spinicaudatans (clam shrimps), ostracods (seed shrimps), fish and plants are preserved. These deposits are thought to indicate sedimentation in a shallow lake or lagoon in which the salinity fluctuated. The upper 10 m include laterally variable beds of mudstone and sandstone that have yielded the remains of crocodiles, dinosaurs and land plants. They are considered to reflect deposition on mudflats and in sluggish river channels (Batten & Austen 2011). A study of the stratigraphy, sedimentology and palaeontology of the pit was reported by Ross and Cook (1995), who included a species list of the non-marine fauna and flora found there: insects, crustaceans, bivalves, bony fish, sharks, turtles, crocodiles, pterosaurs, dinosaurs, clubmosses, horsetails, ferns, conifers and the early flowering plant *Bevhalstia*.

The pit has yielded a number of important fossils. In 1983 Bill Walker, an amateur collector, discovered the remains of a new theropod dinosaur, *Baryonyx walkeri*, which proved to be an important discovery in our understanding of the spinosaurids, and on a Geologists' Association field trip to the site in 2001, a well-preserved partial skeleton of a juvenile '*Iguanodon*' (referred to *Iguanodon atherfieldensis*, but later renamed as *Mantellisaurus atherfieldensis*), was discovered by Geoff Toye of the HGFC, and subsequently excavated by the Natural History Museum (NHM). The *Mantellisaurus* skeleton was from the same bed as *Baryonyx*, and two *Baryonyx* teeth were also recovered from the excavation, suggesting that the carcass may have been scavenged by one of these dinosaurs. As part of the excavation, a detailed micropalaeontological analysis of the sediments surrounding the *Mantellisaurus* find was undertaken, and a new section drawn up for the south-east face (Nye *et al*. 2008). A '*Titanosaurus*'-like sauropod is also known from the pit (Jarzembowski 1991).

Remains of *Bevhalstia* (Hill 1996) are abundant at the site, and continue to be found in the siltstone and mudstone nodules. The concretions of sideritic ironstone and fine-grained calcareous sandstone have

Fig.1. Roadway into pit leading to north-east face.

Photo: PA

Fig.2. Hunting for amber on north-east face.

Photo: PA

also yielded numerous insect remains (ten orders), including cockroaches, beetles, true flies, bugs, wasps, termites, scorpionflies, lacewings, dragonflies, crickets and grasshoppers, with several new species being identified over the past few years. Other discoveries have included an arthropod trackway, the first to be found in the Wealden succession; a small cone similar to that of present-day *Sequoia*; shark egg cases; and a well-preserved death assemblage of teleost fish, including an articulated pycnodont fish not known previously from the Wealden succession. Samples taken from a vertebrate-bearing, plant-debris horizon near the top of the south-east face and processed for microvertebrate remains have yielded a partial frog maxilla (S. C. Sweetman, pers. comm. 2011), the first such discovery from the Upper Weald Clay Formation. Further references and details of previous finds at Smokejacks can be found in Batten & Austen (2011).

The field meetings began with a display of fossils found at Smokejacks and an introductory talk with photos of some of the specimens mentioned above. After entering the pit most members headed towards the freshly-scraped north-east face (Fig. 1) and the cutting alongside the pit roadway, while others explored the water-cut gullies where reptilian bones can sometimes be found washed out. The south-east face has not been scraped for more than 10 years, but some members continued to explore a plant-debris horizon near the top of this face for reptilian bones and teeth. Both the 1983 *Baryonyx* and the 2001 *Mantellisaurus* were found in this area, and dinosaur footcasts can sometimes be found on the underside of a sandstone ledge exposed in the northern corner of the face.

The newly worked north-east face had previously proved to be the most productive area, even during the six-year period when no scraping was taking place. This is where most of the insects, arthropods and plants have been found recently, mainly in the mudstone and siltstone concretions from the bottom 13 m of the face. The top 10 m has yielded occasional reptilian bones; however, on the April visit Kai Bailey, who came with the Isle of Wight group, found pieces of amber here (Fig. 3), the first from Smokejacks, and following this initial discovery, Terry Liddiard (HDGS) managed to trace a scatter of broken pieces which was collected up (Fig. 2) and given to Ed Jarzembowski. Ed has since sent the amber for infrared analysis, and details have been passed on to Professor Barbara Kosmowska-Ceranowicz at the Museum of the Earth, Polish Academy of Sciences in Warsaw, who is currently preparing a world catalogue of amber spectra. Ed has also had some of the fossil wood associated with the amber examined by scanning electron microscopy (Fig. 4), the results suggesting that it came from *Pseudofrenelopsis*, a common Wealden conifer from the Cheirolepidiaceae family (E. A. Jarzembowski, personal communications from Chris Hill).

The fresh workings on the north-east face have exposed numerous mudstone and siltstone lenses, which have yielded a number of interesting finds. In one of the lenses, Joyce Austen found a new spinicaudatan (clam shrimp), and further excavation revealed many more specimens. The unusual find is currently being compared with Asian species at the Nanjing Institute of Geology and Palaeontology.

The lenses also yielded several new beetles to Ed & Biddy Jarzembowski and Terry & Barbara Keenan. These included a schizophorid water beetle (Fig. 5) new to the Weald (Jarzembowski *et al.*, 2015).

Fig. 3. Smokejacks amber.

Photo: Ed Jarzembowski/Fred Clouter

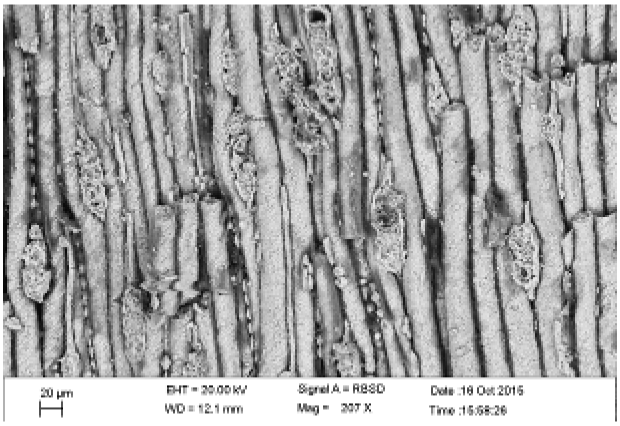

Fig. 4. Wood SEM.

Photo: Ed Jarzembowski/Yan Fang

Relatives of some of the Smokejacks beetles, such as the primitive ommatins (Fig. 6), are now turning up in younger Cretaceous amber from Burma (Fig. 7). Also found in the lenses were the remains of small plant bugs (Fig. 8) and a flying beetle with outstretched elytra (Fig. 9). Other finds from the visits included reptilian bones, a nest of bivalves, trace fossils, pterosaur bones and teeth, a string of fish vertebrae, and a partial aeschnidiid dragonfly hindwing, possibly *Angloaeschnidium toyei* or *Lleidoaeschnidium maculatum* (Jarzembowski 2011, p.143, text-figs 13.3A, D).

We are grateful to the quarry manager for allowing continued access to the site.

Fig. 5. Water beetle: 17.2 mm-long elytron or wing case.

Photo: Terry Keenan

Fig. 6. Ommatin beetle, Cionocoleus elizabethae, *from Smokejacks. Scale bar mm (Jarzembowski* et al.*, 2013).*

Fig.7. Typical ommatin beetle, 6 mm long, Burmese amber (Xia et al.*, 2015).*

Fig. 8. 'Whitefly' nymph (larva).

Photo: EJ/Qingqing Zhang/FC

Fig. 9. First flying beetle from the Wealden with 11.5 mm wingspan.

Photo: Terry Keenan

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HDGS/GA field meeting: Rock-a-Nore to past Ecclesbourne Glen

Sunday, 26th July 2015

by Ken Brooks, Peter Austen and Ed Jarzembowski

In the last of three field trips covering the 8 km Hastings coastal section, some 14 hardy members and guests assembled at 10.30 on a wet morning at the Hastings Country Park car park. Once again, the Hastings & District Geological Society (HDGS) hosted the Geologists' Association (GA) on a joint field meeting. (For discoveries on the previous two visits and the background geology of the Hastings coastal section see Austen *et al*. 2013 and Jarzembowski *et al*. 2014).

The planned descent down Fairlight Glen had to be abandoned due to adverse weather conditions – instead the party drove to Rock-a-Nore for a brief introductory talk (Fig. 1) and began the trip from there. Descending to the beach at East Cliff, the sandstone rocks exposed at the base of the cliff form the upper part of the Ashdown Formation. Near the top of the cliff is the start of the Wadhurst Clay Formation, a sequence which includes the Cliff End Sandstone (Cliff End Sand Member) and shales and thin siltstones (Fig. 2). The beds from Rock-a-Nore to Ecclesbourne Glen rise gently towards the north-east, with the Foul Ness Fault crossing the cliff top around 150 m before Ecclesbourne Glen with a downthrow of about 17 m to the north-east (Lake & Shephard-Thorn 1987, p. 63–64). The continuous rain enhanced the appearance of various sedimentary structures and some fossils on fallen blocks in the lower part of the cliff. The former included large channels in the upper Ashdown Formation, floodplain deposits (Fig. 3), and on a smaller scale, slump structures showing convolute bedding (Fig. 4); ripple marks (wave and current) (Fig. 5), as well as secondary iron deposition (Fig. 13); concretionary

Fig. 1. A hardy group of HDGS and GA members congregate at the start of the field meeting!

Photo: PA

Fig. 2. Cliffs at Rock-a-Nore showing the Ashdown Sandstone overlain by the massive Cliff End Sandstone, topped by Wadhurst Clay shales. *Photo: Linda Burnham*

Fig. 3. Large channel fill in the upper Ashdown Formation.

Photo: PA

Fig. 4. Slump structures (convolute bedding). Height of scale bar c.*1m.* *Photo: Linda Burnham*

developments, which included numerous fallen blocks of the mammillated Tilgate Stone (Fig. 6), a hard concretionionary sandstone widely used in the 19th century as roadstone; dewatering structures, and the occasional conglomerate with rolled bones (Figs 7, 8) perhaps from the overlying Wadhurst Clay Formation. Fossils found in the Ashdown blocks included bedding planes packed with bivalves (*Neomiodon*), a few caddis cases (*Conchindusia* (Fig. 11), *Folindusia*), clam shrimps (*Liograpta*), a large unionoid bivalve found in a fallen block by Alistair Wallis (HDGS) (Figs 9, 10), a dinosaur footcast, and plants including a horsetail (*Equisetites*), tree fern (*Tempskya*), possible lycopod stems (*Lycopodites*), bennettitalean bark (*Monanthesia*) (Fig. 12), wood fragments and other plant debris. Two enigmatic trace fossils were also seen (Figs 13, 14).

The first trace, brought to our attention by Terry Liddiard (HDGS), was near the start of the section where a large fallen (upright) block of Ashdown Sandstone showed what appeared at first glance to be a quillwort, similar to those found at Cliff End with a 'corm' and 'leaves', although closer inspection suggested that it could be a root trace enhanced by iron mineral precipitation (Fig. 13). The 'corm' was perhaps a nodule/tuber formed by nitrogen-fixing bacteria (a widespread occurrence in the Cretaceous), and the filamentous and branched 'leaves' are very likely the result of iron-staining of the rock (leaves of quillworts being linear and unbranched) – nevertheless an interesting and unusual structure.

The second enigmatic trace fossil, shown in figure 14, could be cross-cutting crustacean burrows of *Beaconites barretti*, or possibly of inorganic origin (a pseudofossil), originating as a gas or water escape structure, expanded upwards through cross-bedded sandstone (Pollard & Radley 2011, p. 667, text-fig. 34.7G), and we are seeing the two-dimensional expression of a three-dimensional structure – this is supported by it tapering to a broad point where it terminates (top of fig. 14).

At Ecclesbourne Glen, metal and other artefacts amongst the ironstone on the foreshore revealed the loss of land due to cliff erosion. Ecclesbourne Glen (Fig. 15) is an ancient river valley formed during the last ice age – it has since been eroded to form a hanging valley with a small waterfall where the footcasts of

Fig. 5. Ripple marks in sandstone, formed by wave action. 2 lb geological hammer for scale. Photo: PA

Fig. 6. Fallen block of mammillated Tilgate Stone. Photo: PA

Fig. 7. Group examining conglomerate containing rolled bones. Photo: PA

Fig. 8. Rolled reptilian vertebra in conglomerate. Scale bar in cm. Photo: PA

Fig. 9. Large unionoid bivalve. Width 10 cm. Photo: Alistair Wallis

Fig. 10. Alistair Wallis showing location of large unionoid bivalve. Photo: PA

large three-toed iguanodontids may occasionally be seen on the undersides of the sandstones. After reaching a large-scale cross-stratification feature in the cliffs 0.5 km past the glen (Fig. 16), the rain-soaked party turned back, retracing their steps to Rock-a-Nore and a welcome respite from the rain.

This is the last of the Hastings field trips for now - but enthusiasts may wish to complete the section by visiting Covehurst Wood via Fairlight Glen in drier weather.

Acknowledgements
Thanks to Prof. Robert Spicer (Department of Earth Sciences, The Open University) and Dr. John Pollard (University of Manchester) for comments on figures 13 and 14, Prof. Shigeyuki Suzuki (Department of Earth Sciences, Okayama University, Japan) for comments on figures 3, 4 and 16 and to Dr. Martin Munt (Natural History Museum) for comments on figure 9.

*Fig. 11. Caddis case. (*Conchindusia rasnitsyni *Jarzembowski). Scale bar 1 mm.* *Photo: EJ*

Fig.12. Worn bark of the bennettitalean tree Monanthesia*. Scale bar cm.*

Photo: PA

Fig. 13. Enigmatic trace fossil 1 - possible root trace enhanced by iron mineral precipitation. Scale bar 10 cm.

Photo: PA

Fig. 14. Enigmatic trace fossil 2 - cross-cutting crustacean burrows or gas/water escape structures? 2 lb geological hammer for scale. *Photo: PA*

Fig. 15. Ecclesbourne Glen – iguanodontid footcasts may occasionally be seen on the underside of the sandstones.

Photo: PA

Fig. 16. Large-scale cross-stratification feature in the foot of the cliffs 0.5 km past Ecclesbourne Glen.

Photo: PA

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An abridged version of this report will appear in the December 2015 issue of the Magazine of the Geologists' Association *which has also published abridged versions of the previous reports.*

Langhurstwood Quarry, Warnham

by Peter Austen

On 31st May, despite the very wet weather, a small group of hardy HDGS members attended a field meeting at Langhurstwood Quarry, Warnham in West Sussex. An edited extract from Batten & Austen (2011) giving a summary of the geology and palaeontology of the site is given below:

> Langhurstwood Quarry, Warnham, is situated near the top of the Lower Weald Clay Formation (Hauterivian), and exposes around 30 m of grey-brown mudstone, siltstone, fine sandstone and shelly limestone. Siltstone and fine sandstone lenses contain a range of trace fossils and the mudstones yield various bivalves (*Filosina*) and gastropods (*Paraglauconia*). Limestones with concentrations of shell debris along bedding planes occur mainly near the base of the pit as part of BGS Bed 2a. This unit consists of two prominent limestones, about 50 mm thick, separated stratigraphically by 2 m of mudstone. The lower of the two is a '*Cyrena*' limestone in which calcite-cemented bivalves (*Filosina gregaria*) are abundant; the upper bed is a Small-'*Paludina*' limestone containing the gastropod *Viviparus infracretacicus* (Toye *et al*. 2005). Abundant blocks of these limestones can be found on the northern spoil heap.
>
> Often occurring in association within these blocks, particularly in the Small-'*Paludina*' limestone, are the remains of fish [bones, scales and teeth of *Scheenstia* (previously known as *Lepidotes*)], teeth and fin spines of hybodont sharks, and spiral coprolites (Jarzembowski *et al*. 2009). Partial fish palates of *Scheenstia* and pycnodonts can also be found in the Small-'*Paludina*' limestone. Ostracod limestones containing abundant, well-preserved *Cypridea* occur at several levels within the pit. Lithified siltstone lenses have yielded insect remains including cockroaches, beetles, dragonflies and bugs, as well as ostracods, teleost scales, plant fragments and small burrows

Fig. 1. Wing of an aeschnidiid dragonfly. Length 35mm.

Photo: Terry Keenan

Fig. 2. 'Paludina' *limestone containing the gastropod* Viviparus infracretacicus.

Photo: PA

(Toye *et al*. 2005). Also in 2009 the wing of an aeschnidiid dragonfly was found (Jarzembowski *et al*. 2009) (Fig. 1). Near the top of the south-east face a bone-bearing unit yielding various reptilian remains, including those of '*Iguanodon*' and possibly *Valdosaurus*, has been reported (Styles 2000). Confirmed '*Iguanodon*' bones have since been recovered from the same face (Toye *et al*. 2005). Plant remains have been found in the top sandstones: these include *Equisetites*, *Onychiopsis* and conifer shoots (Toye *et al*. 2005).

This site is also important for the first record of fish otoliths (ear stones) from the Wealden succession (Austen 2011). They occur in both the shelly limestones and the ostracod-limestone beds. In 2010, more than 100 scattered specimens were recovered from a thin band of well-cemented calcareous sandstone just below the Small-'*Paludina*' limestone that marks the top of BGS Bed 2a.

Further references can be found in Batten & Austen (2011).

The field meeting started with a brief introduction to the Weald with some examples of what can be found at Langhurstwood Quarry. Hand specimens of '*Paludina*' limestone (Fig. 2) and '*Cyrena*' limestone (Fig. 3) were passed around, as well as examples of palates from the pycnodont fish *Ocloedus* (previously known as '*Coelodus mantelli*') (Figs 4, 5). Before we entered the quarry proper we walked over the northern spoil heap, where blocks of the '*Paludina*' limestone and '*Cyrena*' limestone could be found. These are normally removed and discarded where possible before the clay goes through the brick-making process. After looking over the spoil heap we moved into the quarry. The wet weather made it quite difficult to explore the quarry fully, but Alistair Wallis found two worn fish palates, possibly from *Scheenstia* (Figs 6, 7). As mentioned above, the quarry is an important site for otoliths (fish ear stones) (Fig. 9), but on the day only one example was found, more a result of the bad weather than a paucity of

*Fig. 3. '*Cyrena*' limestone containing calcite-cemented bivalves (*Filosina gregaria*).*

Photo: PA

Fig. 4. Palate (vomer) from the pycnodont fish Ocloedus *(from the roof of the mouth).*

Photo: Mike Webster

Fig. 5. Palate (right splenial) from the pycnodont fish Ocloedus *(from side of the lower jaw).* *Photo: Mike Webster*

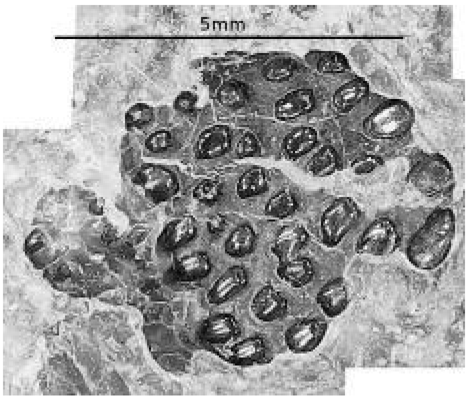

Fig. 6. Worn palate, possibly from the Wealden fish Scheenstia.

Photo: Alistair Wallis

Fig. 7. Worn palate, possibly from the Wealden fish Scheenstia.

Photo: Alistair Wallis

Fig. 8. Hybodont shark tooth.

Photo: Mike Webster

Fig. 9. Otolith (fish ear stone). Scale bar 1mm.

Photo: PA

Fig. 10. Abundant otoliths (fish ear stones) on grey shaley mudstone.

Photo: PA

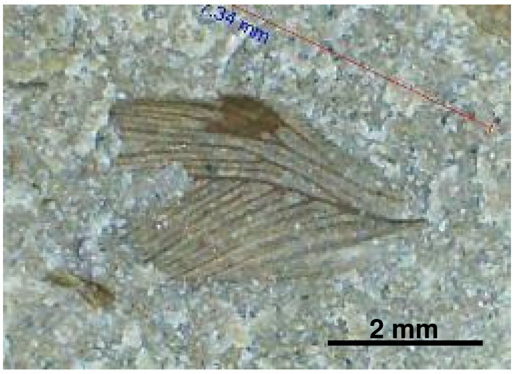

Fig. 11. Part of a cockroach wing, possibly Elisama molossa.

Photo: Mike Webster

Fig. 12. String of vertebrae, most likely from a teleost fish. Length of specimen c. *4cm.*

Photo: Mike Webster

specimens. However, on a follow up visit with the Horsham Geological Field Club on the 19th July several hundred otoliths were collected (Fig. 10). Unfortunately, they were not *in situ*, but were found in blocks of mudstone at the side of the roadway into the quarry, pushed aside by the heavy site machinery. Most of the otoliths normally found at Langhurstwood Quarry are quite robust (as in fig. 9), but many of these specimens were partially decalcified. The Wealden otoliths are still to be formally published and at the moment we are uncertain of their true affinities, although they do bear similarities to *Teleostus*, a species from the German Mesozoic (Nolf 2013, plates 4–5) (E. A. Jarzembowski, pers. comm.). Also found were insect remains including a cockroach wing, possibly *Elisama molossa* (Fig. 11) (Ross 2011, p.175, text-fig. 14.1A); a hybodont shark tooth (Fig. 8); and assorted fish remains, mainly scales, but also a string of vertebrae (Fig. 12).

We are grateful to the quarry manager for allowing continued access to the site.

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TOYE, G., AGAR, R., AUSTEN, P. A. and JARZEMBOWSKI, E. A. 2005. Wealden field meeting – Warnham & Clockhouse – 23rd July 2005. *GA (Magazine of the Geologists' Association)*, **4** (4), 14–15.

Bexhill dinosaurs – latest news

by Peter and Joyce Austen

In the last two journals we reported on the discovery and excavation by Society members of two dinosaurs at a quarry in Bexhill (see 'Dinosaur found at Bexhill', *HDGS Journal*, Dec 2013, Vol. 19, p.36–37, and 'Bexhill dinosaur – an update', *HDGS Journal*, Dec 2014, Vol. 20, p.8–9). Little did we realize at the time that more than two years after its discovery we'd still be digging, although the bones are not as prolific now as in the early days. They are being prepared by Dave Brockhurst, who is co-ordinating the dig, and Andy Ottaway, who has previously worked as a volunteer curator in fossil reptiles at the Natural History Museum. To date around 170 bones have been prepared with as many still to be done. Unfortunately, a lot of the bones are covered in a very hard matrix, so this is a long and arduous task.

As mentioned previously, we believe the bones come from two animals, a juvenile and a sub-adult, most likely of the iguanodont species *Hypselospinus fittoni*. Dr David Norman of the University of Cambridge (one of the world's leading authorities on iguanodonts) intends to include them in a forthcoming monograph on iguanodonts. Members may be interested in accessing Dr Norman's recently published 98 page paper on the history of this particular species, which is freely available online (http://onlinelibrary.wiley.com/doi/10.1111/zoj.12193/pdf). Unfortunately, the discovery of the two Bexhill *Hypselospinus* specimens was too late to be included in this paper.

Many of the prepared bones are already on display in Bexhill Museum, so many in fact that the Museum's curator, Julian Porter, has had to set up another display case, as reported in the *Bexhill-on-Sea Observer* on the 14th August (see photo right). (Unfortunately, the species name was spelt incorrectly in the article, *Hypsecospinus* instead of *Hypselospinus*.)

Julian Porter, Curator, Bexhill Museum

Dave Brockhurst has been mapping the major finds as they are excavated (page 28). As you can see, the bones are very jumbled, implying that the carcasses were subject to predation and decomposition before the bones were washed together and finally buried.

Once again, we are grateful to the quarry manager for allowing continued access to the site.

Reference

NORMAN, D. B. 2015. On the history, osteology, and systematic position of the Wealden (Hastings group) dinosaur *Hypselospinus fittoni* (Iguanodontia: Styracosterna). *Zoological Journal of the Linnean Society*, **173**, 92–189.

Terry Liddiard, Andy Ottaway, Anton Hack and Dave Brockhurst working at the face, April 2015. Photo: PA

Dave shifting overburden with Terry, Alan Prowse and Siân Evans, Aug. 2015. Photo: PA

Bexhill iguanodonts - Major finds - Sketch by Dave Brockhurst

VERTEBRAE

AP = Axis Process
C = Chevron
CAV = Caudal Vertebra
CV = Cervical Vertebra
NP = Neural Process
SV = Sacral Vertebra

LIMBS

AS = Astragalus
F = Femur
FIB = Fibula
HU = Humerus
M = Metatarsal
P = Phalanx
TIB = Tibia
UL = Ulna
UNG = Ungual Phalanx

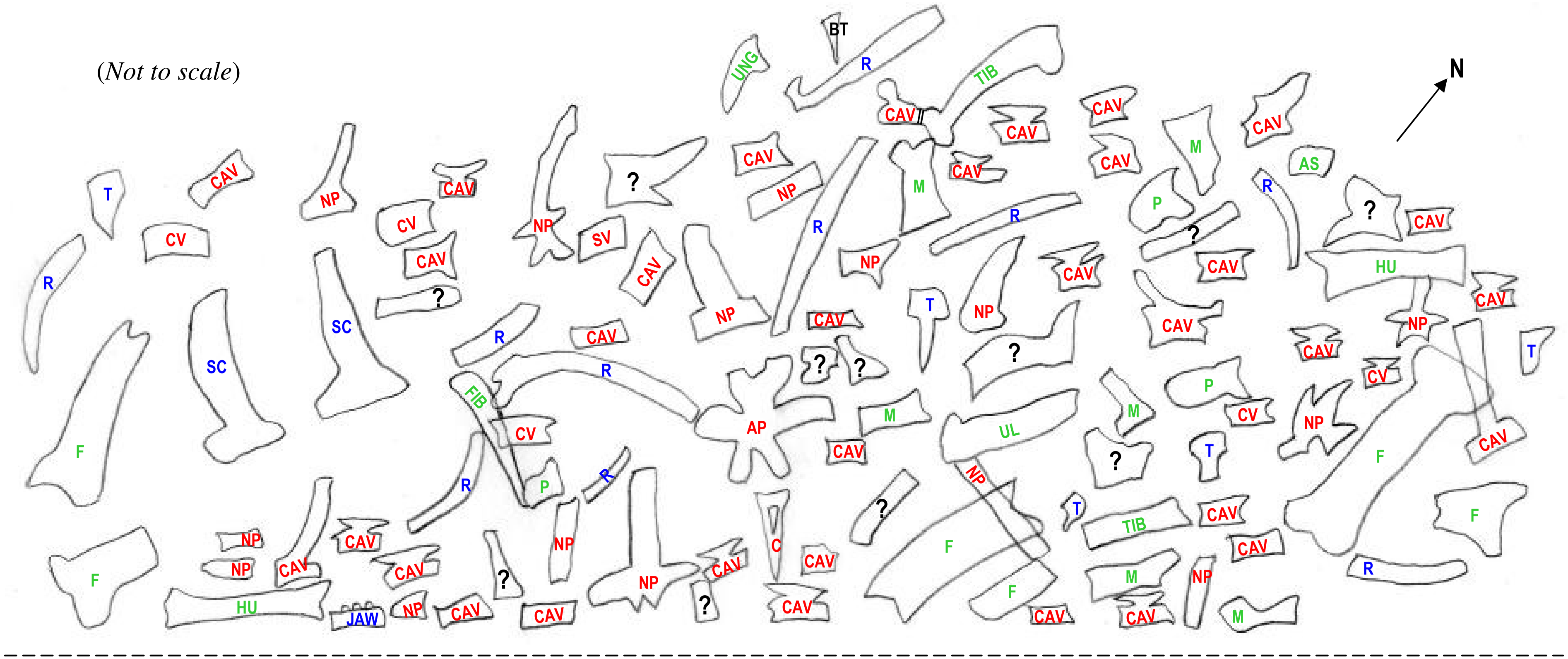
HEAD and BODY

JAW = Jaw with Teeth
R = Rib
SC = Scapula
T = Tooth

MISCELLANEOUS

? = Unidentified
BT = *Bernissartia* tooth (crocodile)

(*Not to scale*)



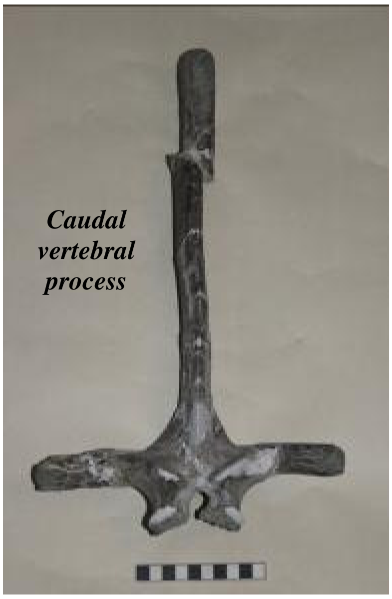
Original quarry face

Aug. 2015 *HDGS members working at the excavation face.* *Photos: PA* *Oct. 2015*

Caudal vertebra

Fused sacral vertebrae

Dorsal vertebral process



Caudal vertebral process

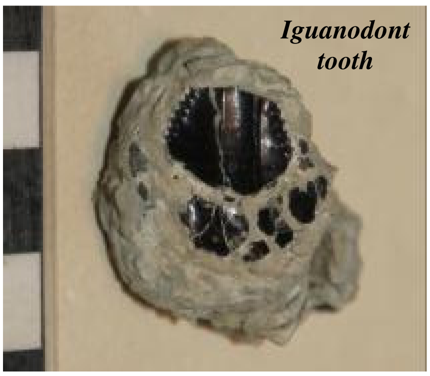
Iguanodont bones

All scales in cm.

Photographs by Dave Brockhurst.

Cervical rib

Ulna



Iguanodont tooth

Ungual phalanx

Phalanx

Bexhill pterosaur discovery

by Ken Brooks

In August 2011 Jon Molton and his family were enjoying a trip to the beach at Bexhill. (Jon later described the location as almost opposite the clock tower, near Bexhill Museum). His wife, Jane, and their two boys, Max (2) and Herbie (3), were throwing stones into the sea. Then, just as one particular rock was thrown, Jane noticed that there was something unusual about it. The family waited for the tide to go out a little and then searched the shingle until they found the rock.

Fig. 1. String of seven articulated vertebrae. (cm scale bar)

Photo: Ken Brooks

At home it was placed on a window sill where it remained for about three years. Eventually, the boys took the rock to school (Little Common Primary) for a fossil topic and it was put on display. By this time Jon felt that they should try to have it identified. On 21st February 2015, he contacted me through the HDGS website and we arranged to meet at the Shipwreck Museum, Hastings. As soon as I saw the rock, which contained seven articulated vertebrae, three teeth and a bone fragment (Figs 1–3), I realised that it was very special. Diana and I emailed photos of the fossil to Peter and Joyce Austen, and they immediately sent them on to Dr. Steve Sweetman at the University of Portsmouth.

Fig. 2. Three teeth and partial jaw. (cm scale bar)

Photo: Ken Brooks

Looking at the photos, Steve realised the bones were from a pterosaur and therefore a very rare find indeed. After contacting his colleague at Portsmouth, Dr Dave Martill, Steve emailed me to say he believed it was a potentially important and unusual specimen and that he and Dr Martill would very much like to study it. If it belonged to the pterosaur family he suspected, it would shed unique light on the anatomy of, and relationships within the group concerned. All members of this group, with one possible exception, are otherwise known only from scraps from places as far afield as China and Brazil. He suggested having the fossil professionally prepared by a technician familiar with pterosaurian osteology, as pterosaur bones are very fragile and a specialist technician would be required if unintentional damage was to be avoided. He was in no doubt that a detailed account should be published in the scientific literature, but for that to be possible the specimen would have to be donated to a registered museum, possibly Bexhill or the Natural History Museum. He said full recognition of the collectors would be provided in the paper, and if a new species was described it could be named after them.

Fig. 3. Partial limb bone. (cm scale bar)

Photo: Ken Brooks

I then contacted Jon Molton and during our discussion he agreed to donate the fossil to Bexhill Museum. I also offered to make a cast of the specimen for his family to keep.

Fig. 4. Max Molton presenting the pterosaur fossil to Julian Porter, curator at Bexhill Museum.

Photo: Jon Molton

Fig. 5. Left to right, Stanislav Rigal, Dave Martill, Steve Sweetman, Ken Brooks and Julian Porter, studying the pterosaur fossil at Bexhill Museum in June 2015.

Photo: Peter Austen

The fossil was presented to Bexhill Museum by the Molton family on Saturday 25th April (Fig. 4), and two months later Steve Sweetman, Dave Martill and their visiting researcher Stanislav Rigal from the University of Lyon, France, travelled from Portsmouth to collect it for study (Fig. 5).

In August–September Steve, Dave and Stan gave a poster presentation on the new pterosaur at an international pterosaur conference, Flugsauria 2015, hosted this year by the University of Portsmouth. The specimen had been professionally prepared to expose further details (Figs 6, 7).

Fig. 6. Articulated vertebrae after preparation showing neural spines.

Fig. 7. Teeth and jaw fragment after preparation.

The pterosaur is thought to be related to a specimen found west of St. Leonards-on-Sea in the 19th century by Samuel H. Beckles (1814–1890). That specimen was included in *English Wealden fossils* (Martill *et al*., 2011, p. 386, text-fig. 25.12) referred to the species *Lonchodectes sagittirostris*, although the authors acknowledged that the validity of this generic attribution is controversial.

The paper describing this new pterosaur specimen from Bexhill is still in preparation and should be published late in 2016 in a *Geological Society Special Publication*. We will carry a more detailed report in the next *HDGS Journal* after the paper has been published.

Reference

MARTILL, D. M., SWEETMAN, S. C. and WITTON, M. P. 2011. Pterosaurs. 370–390. *In* BATTEN, D. J. (ed.). *English Wealden fossils.* Palaeontological Association, London, Field Guides to Fossils, **14**, ix + 769 pp.

Shark skull from Cooden

by Peter Austen

In the 2012 edition of the *Journal*, we reported on our Society's field trip to Cooden beach (see 'HDGS field trip to Cooden, near Bexhill, East Sussex – Sunday 1st July 2012', *HDGS Journal*, Dec 2012, Vol. 18, p.33–37). The article included a photo of what was then thought to be shark skin in a water-worn ironstone nodule (p.36, fig. 3) which was found in the Weald Clay deposits opposite the Cooden Beach Hotel, in an area renowned for its well-preserved three dimensional shark fossils in ironstone. As the ironstone nodule was a similar matrix to that of the new pterosaur discovery in the previous article, I took it along to Bexhill Museum to show Drs Steve Sweetman and Dave Martill when they came to pick up the pterosaur, the intention being to discuss the possible source locality of the nodule. (These ironstone nodules are normally found in the Weald Clay deposits which outcrop on the shoreline along a 2 km stretch in the vicinity of the Cooden Beach Hotel, so the pterosaur could have come from there and been washed along by longshore drift.) As soon as I showed the specimen to Dave Martill he immediately recognized it as the remains of a shark skull and braincase – the skull roof can be seen arrowed in figure 1 (white arrows), the diagnostic feature being the V-shape (yellow arrows) – this feature has been circled on the restoration (Fig. 3). The braincase is circled in figure 2. It's most likely from the hybodont shark *Egertonodus basanus* (previously known as *Hybodus basanus*). One of our members, John Evans, has found more than 100 shark skulls along that section over a number of years, most of which have been donated to the Natural History Museum. This specimen is now in Bexhill Museum (BEHM: 2015.69).

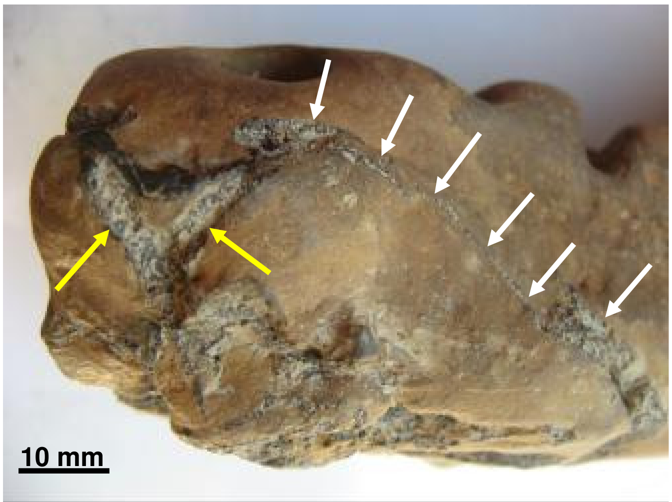


Fig. 1. Shark skull (arrowed) in water-worn ironstone nodule. Cooden beach. *Photo: PA*

Fig. 2. Shark braincase (circled) in water-worn ironstone nodule. Cooden beach. (cm ruler for scale). *Photo: PA*

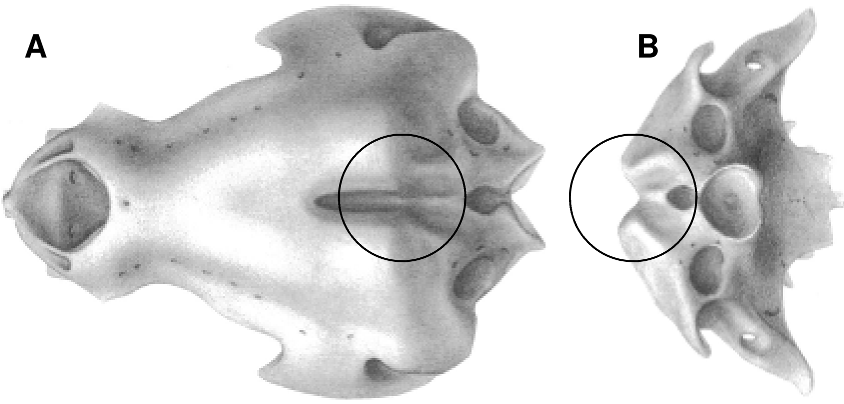


Fig. 3. Restoration of skull and braincase of Egertonodus basanus *in dorsal (A) and posterior (B) view. Diagnostic feature circled (arrowed in yellow in figure 1).*

Adapted from Maisey 1983, p. 20, fig. 8.

Reference

MAISEY, J. G. 1983. Cranial anatomy of *Hybodus basanus* Egerton from the Lower Cretaceous of England. *American Museum Novitates*, **2758**, 1–64.

HDGS members' finds from the Hastings coastal section (Rock-a-Nore to Cliff End, Pett)


Iguanodont footcast - Terry Liddiard


Theropod footcast - Ivan Constable


Sauropod tooth - Terry Liddiard


Theropod footprint - Jerry Burchett


Baby iguanodont footcast - Terry Liddiard


Liesegang rings - Terry Liddiard


Ripple marks - Terry Liddiard


Iguanodont footcast - Siân Evans


Worn iguanodont footprint/cast - Siân Evans


'Hanging' iguanodont footcasts - Ivan Constable


Iguanodont footcast - Ivan Constable

Coastal section from White Rock, Hastings to Cliff End, Pett - 1826

In 1826 the recently formed Geological Society of London published a paper by Thomas Webster, Esq. (Secretary to the Society) entitled “Observations on the Strata at Hastings in Sussex.” (*Transactions of the Geological Society of London, Second Series*, Volume II, p.31–36, plates V–VI). The paper attempts to describe the types of rock seen along the Hastings coastline from White Rock to Cliff End, particularly the mammillated Tilgate Stone (Fig. 1), which at that time was used for “paving and mending the roads, for which purposes they prove an excellent material”. However, what is remarkable about the paper and may be of interest to our members is that it includes a detailed drawing of the entire coastline from White Rock at the western end of Hastings, through to Cliff End at Pett, and this historical drawing (with added colour) is reproduced in nine sections over the next three pages. Although published in 1826, Webster’s paper was first read to the Geological Society on the 4th June 1824, which implies the drawing was made before that date and is more than 190 years old, as does the fact that Pelham Crescent, which was built just below the Castle at West Cliff in 1825, is not shown in the drawing.

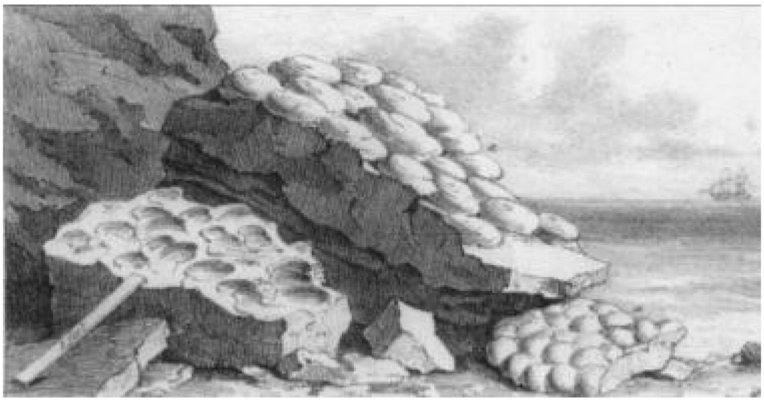


Fig. 1. Fallen blocks of Tilgate Stone along the Hastings coastal section. (Image from Webster’s 1826 paper)

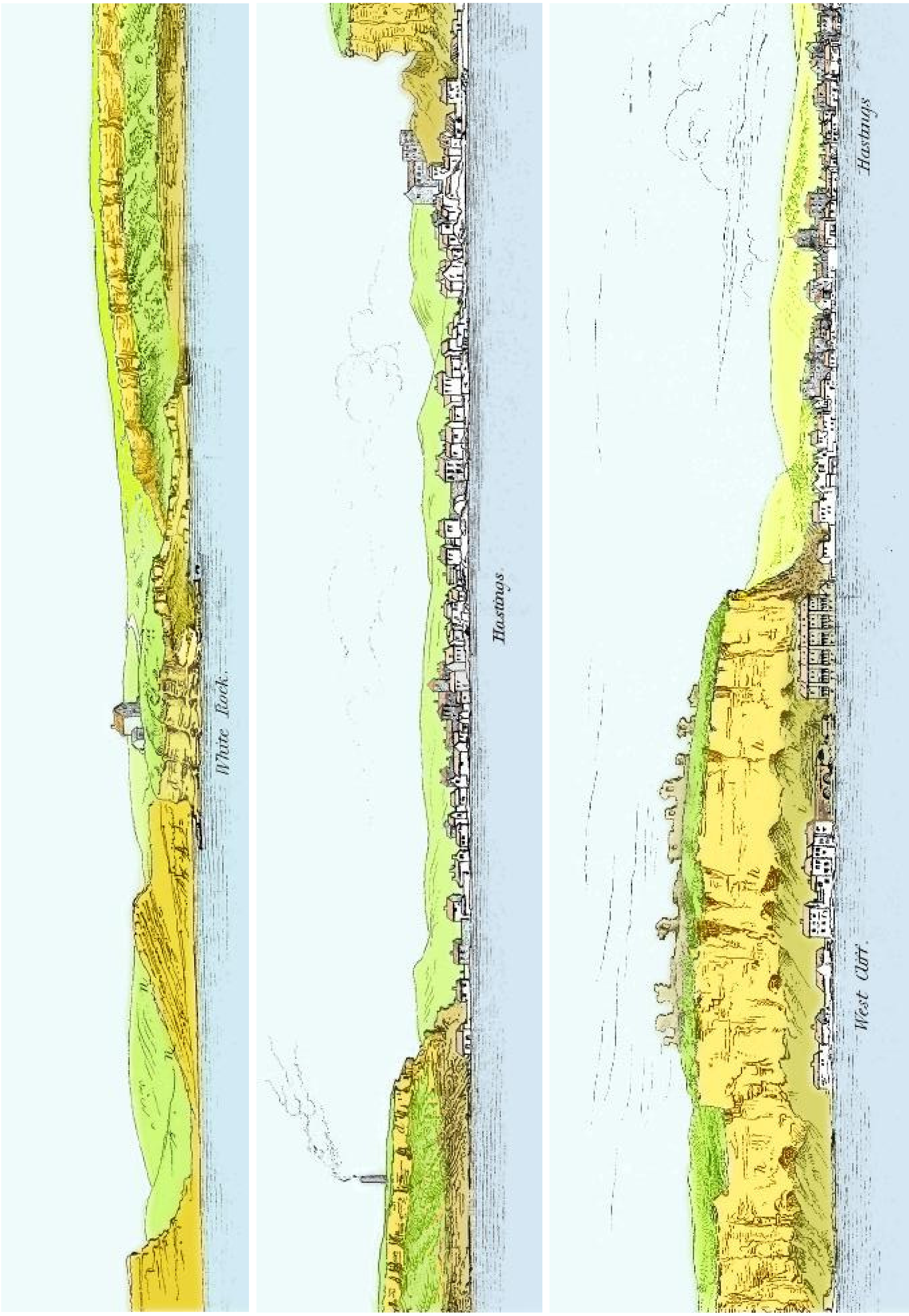
The first section shows the **White Rock** headland, which was removed in 1835 after the carriage carrying the young Princess Victoria and her mother on their visit to St Leonards and Hastings in 1834 became stuck in the mud on the hill at White Rock. Local officials were so embarrassed by this incident that they had the headland blown up with gunpowder to build a new seafront road to connect the two towns. Other named features include: **Eaglesbourne** (now known as Ecclesbourne Glen), where Webster notes that the stream called Eaglesbourne forms the well-known fish-ponds; **Govers**, now known as Covehurst Bay; and **Fairlee**, now known as Fairlight. On the section illustrating Eaglesbourne, a house can be seen on the beach just east of the glen, its inhabitants possibly taking advantage of the “fish-ponds” mentioned above. Figure 2 is a photo of a house at the same precarious location taken much later, near the end of the 19th Century – all evidence of that house has long since disappeared!

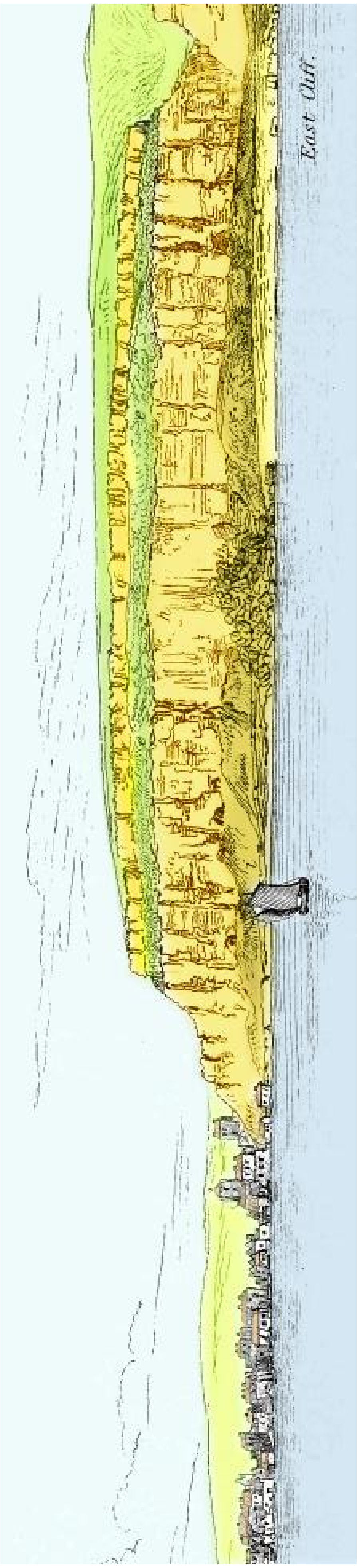
Acknowledgements

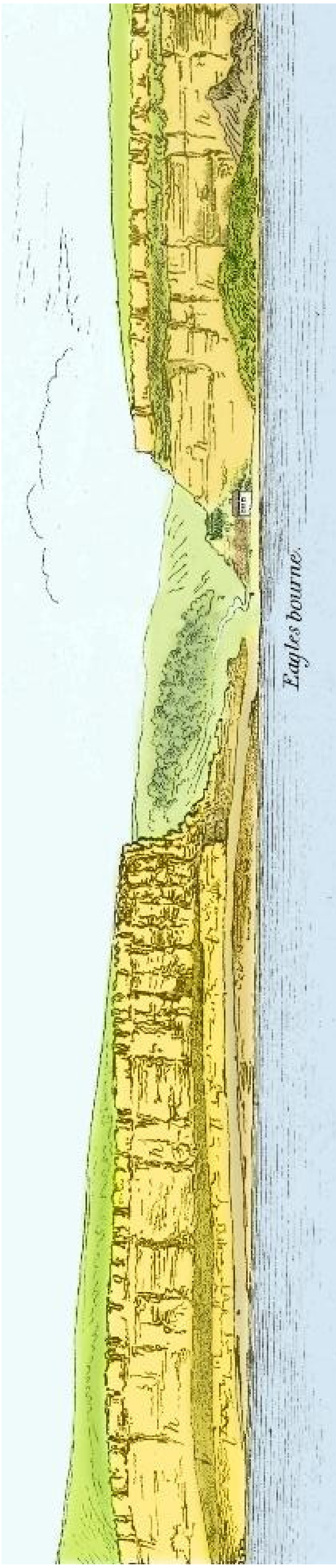
I’d like to thank Anthony Brook for bringing this paper to my attention, and Ken Brooks for historical information, figure 2, and colour artwork on the section.

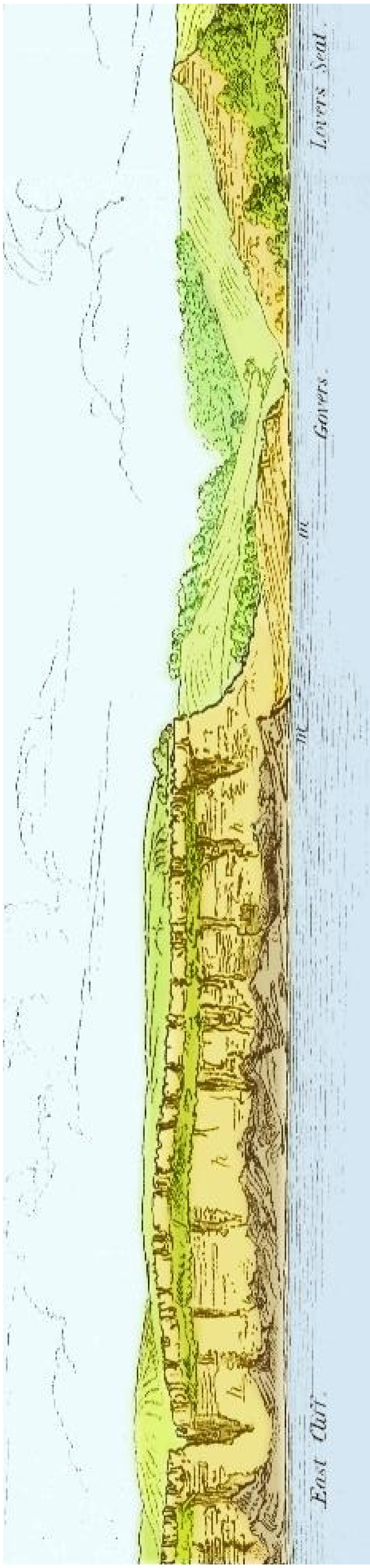
Peter Austen

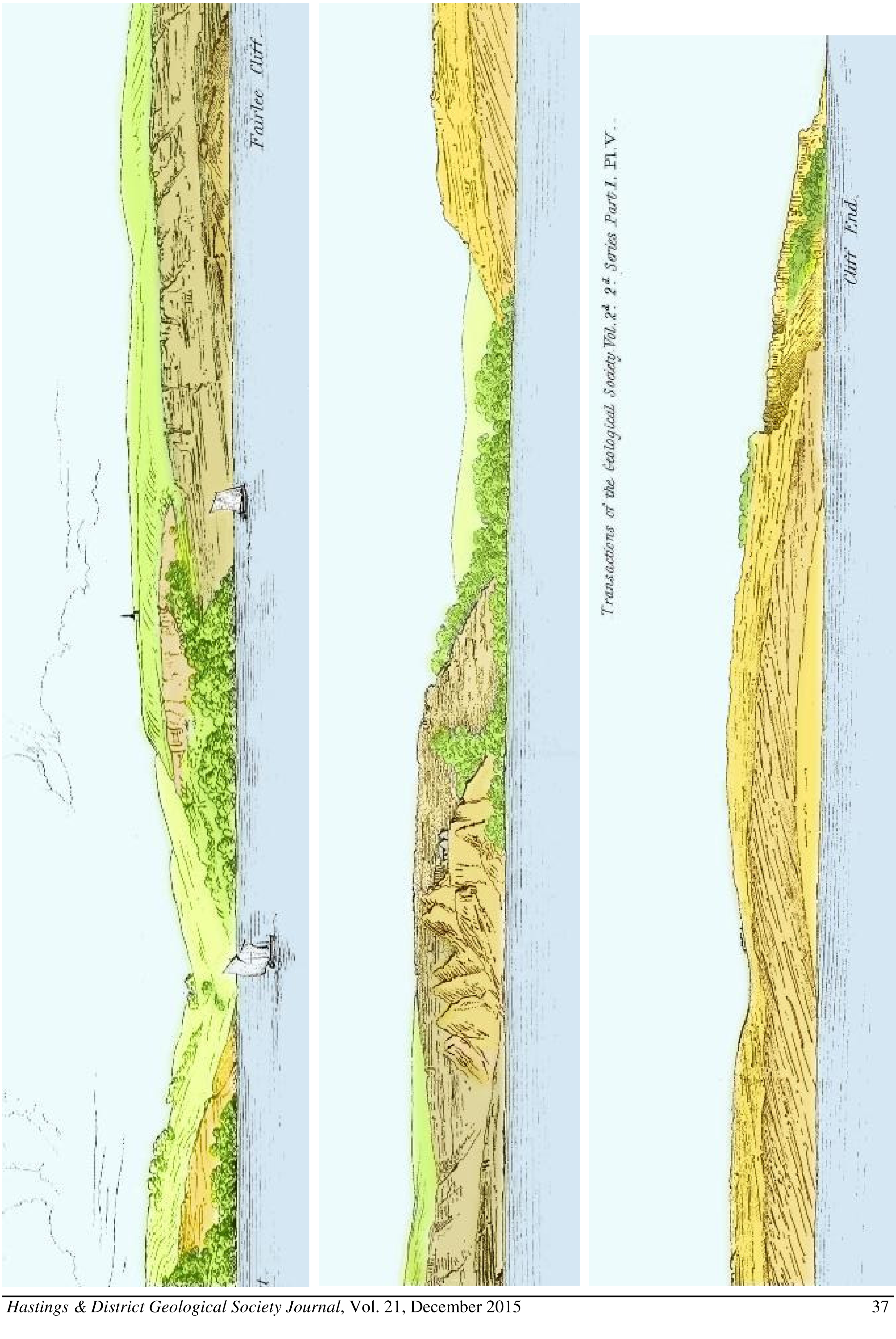
Fig. 2. House on the beach at Eaglesbourne (Ecclesbourne Glen), in the late 19th Century.


White Rock.
Hastings
West Cliff.
Hastings


East Cliff.


Eaglesbourne.


Lovers Seat.
Govers.
East Cliff.


Fairlee Cliff
Transactions of the Geological Society Vol. 2d. 2d. Series Part I. Pl. V.
Cliff End

Hastings Group Sandstones
Varieties used in the Walls of the Medieval Churches of Sussex

by Roger Cordiner

"*The first (collection) contained specimens of the various rocks of the Wealden Series, from the milk-white sandrock composed of transparent quartz grains, at the base of the Ashdown, through all the varieties and bandings of yellows, browns, and brilliant carmines. These sandstones in themselves offer an object of interesting study, showing every description of false-bedding, faulting, and zonal banding, and change of colours from dark browns to brilliant carmines and even blood reds.*"

W. J. Lewis Abbott. Excursion to Hastings. 1907
Proceedings of the Geologists' Association, **20**, 169–174. (page 170)

Over the past 18 months Anthony Brook and I have surveyed the building stones present in all the medieval churches, as well as many other ancient buildings of East Sussex. This complements the survey of West Sussex, which I started originally in 2001 and then continued with Roger Birch, a former geology teacher at Collyer's College, Horsham. The survey of the medieval churches of West Sussex was carried out as time permitted, and was eventually completed in 2012. The results of the research can be seen in the recently published book (Birch and Cordiner 2014).

The basic survey of Sussex has now been completed and distribution maps have been compiled for each building stone type. Further visits to ancient buildings, however, usually reveal more information, and a number of building stones, particularly those seen in coastal areas, have yet to be identified. An atlas of Sussex building stones is now being prepared and due to be published in 2016.

The building stone records have been input onto Excel spreadsheets listing 322 ancient churches surveyed, together with the occurrence or otherwise of 30 indigenous, and 20 imported building stones used in Sussex. The number of building stone types varies, however, depending on how they are defined. If all the varieties are included there would be nearer 100. Each building stone type may occur in a number of different varieties reflecting the various quarries and different beds from which they were obtained.

On starting the building stone survey of East Sussex it soon became clear that there were far more types of building stone present in the ancient buildings of West Sussex than in East Sussex. This is due to the dominance of the city of Chichester as a major centre during Roman and Medieval times. The coastal plain of West Sussex is poorly provided with local building stone except for flint, so considerable amounts of stone had to be imported for the numerous medieval stone buildings.

The stratigraphy of the Hastings Group together with the main sandstone beds is shown below:

Tunbridge Wells Sand Formation
- Upper Tunbridge Wells Sandstone
  - Grinstead Clay Member
    - Cuckfield Sandstone Bed (includes Tilgate Stone at Cuckfield)
- Lower Tunbridge Wells Sandstone
  - Ardingly Sandstone Member (at top of LTWS)

Wadhurst Clay Formation
- Northiam Sandstone
- Hog Hill Sandstone
- Cliff End Sandstone (includes Tilgate Stone, a hard calcareous sandstone)

Ashdown Formation
- Top Ashdown Sandstone (at top)
- Lee Ness Sandstone
- Fairlight Clay (Hastings area only)

The Hastings Group strata are fluviatile, lacustrine and terrestrial, being deposited on an extensive braidplain and land-surface during Lower Cretaceous times. Fine grained sands and silts make up a high proportion of the succession but beds of harder more resistant sandstone occur usually towards the top of the arenaceous formations. Some sandstone beds such as Sandrock contain a small percentage of calcite cement making them more resistant to weathering and therefore good building stones. The Hastings Group sandstones have been extensively quarried in the past throughout the High Weald. They are mainly fine grained, but thin layers of quartz grit and conglomerate occur at specific horizons. The sandstone beds are fluviatile in origin and vary from massive varieties (Fig. 2) to those showing a wide variety of sedimentary structures, such as fine laminar bedding, cross bedding, channel structures and slump and flame structures (Fig. 3).

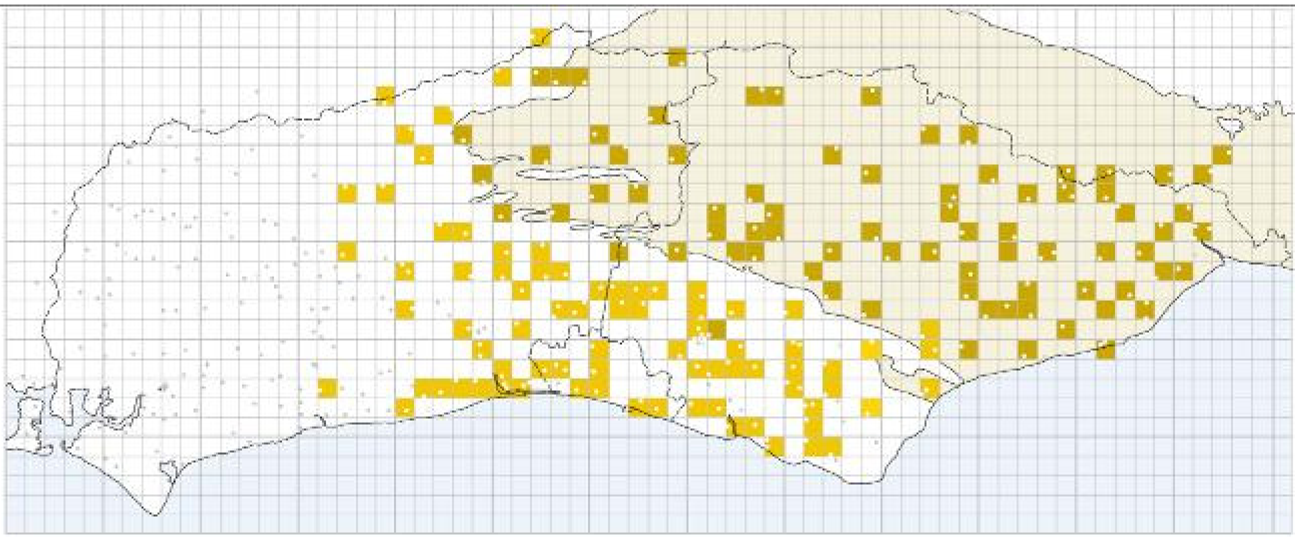
Large numbers of sandstone quarries once dotted the High Weald landscape, but now only one is still working the Wealden Sandstone, Philpots Quarry at West Hoathly in West Sussex, where Ardingly Sandstone is quarried. Many of the settlements such as Hastings, Battle and Uckfield had their own stone quarries, but apart from important buildings of high value and status Hastings Group sandstone was never used extensively in the villages; brick was used in post medieval times for cottages on a much larger scale, and was no doubt cheaper than stone.

The best quality sandstone for building is massive, tough, silver-grey sandstone known as Sandrock. It was commonly used for quoins and higher quality stonework in medieval times throughout the High Weald area. The most commonly used sandstone for both ashlar and rubble comes in various hues of grey, ochre, buff and brown. Massive sandstone (Fig. 2) was more commonly used in the western part of the Hastings Group outcrop, while bedded and laminar sandstones (Fig. 3) are more abundant in the east. Ferruginous sandstones have been widely used, and many are stained with repeated bands, often in striking patterns caused by iron oxide rich water, which has percolated through the rock. These are known as Liesegang Bands and give added architectural interest to some churches such as Withyham (south entrance) and Etchingham (pillars). Iron-rich sandstone has commonly been used as rubble including spherulitic siderite and even siderite iron ore from fractured concretions.

Careful examination of some of the sandstone in the walls of medieval churches reveals fossils (Fig. 4) such as layers of bivalve shell casts (*Neomiodon* and *Unio*), and less commonly gastropods (*Viviparus*), but are not always easy to spot as the stone is normally placed showing a section through the bedding. Vertical ferruginous rods run through some of the sandstone and may represent *Equisetites* stems. Occasionally dark shale rubble has been used, packed with fossil *Neomiodon* and ostracod shells.

Figure 1 shows the distribution of Hastings Group sandstone in medieval churches of Sussex based on 2km grid squares. Darker colour indicates the main use of this building stone in a church. The outcrop

Fig. 1. HASTINGS GROUP SANDSTONE DISTRIBUTION IN THE MEDIEVAL CHURCHES OF SUSSEX



Map shows 2 km grid squares, position of Medieval churches (dots) and outcrop of Hastings Group sandstone (large shaded area). Coloured squares indicate building stone use. Darker colour squares indicate Hastings Group sandstone as the dominant building stone.

of the Hastings Group is also shown. It is notable how closely the main use of the sandstone is confined to the outcrop, indicating the stone was never transported in large amounts far from the quarry. The outcrop of the Hastings Group can in fact be quite accurately mapped from the distribution of its use in ancient churches!

An important result of the survey has been the recognition that the sandstones used as building stone in medieval churches are not diagnostic of any particular Formation, Member or Bed within the Hastings Group. There are a wide variety of fluviatile sandstones, which appear to occur within each of the separate Formations (Figs 2, 3 and 4). Sandrock for instance tends to occur at the top of major sand units. It comprises the upper part of the Ardingly Sandstone Member and also forms the Top Ashdown Sandstone.

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Reference

BIRCH, R. and CORDINER, R. 2014. *Building Stones of West Sussex*. Published by R. Cordiner and R. Birch, 349 pp.

Glossary

arenaceous rocks or sediments composed of sand-sized particles, or having a sandy texture

ashlar finely-shaped and smoothly-finished stonework, usually laid to course

quoins external cornerstones, which are usually large blocks of high-quality ashlar

Hastings Group Sandstone types present in the walls of Medieval churches of Sussex

Fig. 2. Massive Sandstones

Brown, roughly-shaped rubble sandstone, Wadhurst.

Sandrock ashlar, Frant.

Tilgate Stone paving sets, Lewes.

Siderite sandstone, Brede.

Ferruginous sandstone, Westfield.

Siderite (iron ore), Hailsham.

Grey, rock-faced ashlar sandstone weathering brown, Hollington.

Sphaerosiderite, Herstmonceux.

Quartz Grit, Hooe.

Single Liesegang Bands, Battle.

Multiple Liesegang Bands, Withyham.

Grey sandstone block, Christ Church, St Leonards.

Fig. 3. Bedded Sandstones

Flaser Bedding (infilled scours), Lancing College.

Banded, crazy-paving style, sandstone, Bolney.

Alternating hard and soft sandstone quoin, Ashburnham.

Flaggy sandstone, Icklesham.

Finely laminated shale, Playden.

Sand volcanoes (fluid escape structures), Peasmarsh.

Cross bedding, Peasmarsh.

Channel scour, Fletching.

Flame structures, Catsfield.

Fig. 4. Fossil Sandstones

Burrow structures, Beaconites, *Heathfield.*

Sandstone with fossil wood, Northiam.

Lignitic sandstone, Wivelsfield.

Neomiodon, *Ninfield.*

Unio, *Kingston, nr Lewes.*

Viviparus *sandstone, Ripe.*

Equisetites *stems, Catsfield.*

Equisetites *stems, East Hoathly.*

A sting in the tail for the Weald Clay

by Roger Cordiner

You may be surprised to learn that the Weald Clay has shrunk. That is, however, the belief of Dr. Andrew Ross of the National Museum of Scotland, Edinburgh (formerly of the Natural History Museum, London). In a single paragraph in a paper on the wasps of the Purbeck Limestone Group and Wealden Supergroup of southern England, Dr. Ross put forward evidence that only about the lower two-thirds of the Weald Clay Group actually exists [Ross in Rasnitsyn *et al*. (1998, p. 333)]. He believes that what is thought to be the upper third is probably a repetition of the lower part.

The Weald Clay Group, the upper part of the Wealden Supergroup, consists of up to 500m of clay with thinner intervening beds of sand, sandstone, limestone and occasional beds of siderite concretions. The strata are mainly freshwater and terrestrial in origin, and were deposited on extensive braidplains of meandering rivers, in lakes and across a low lying landscape, which extended across SE England during the early Cretaceous Period. Much of the sediment was derived from the then mountainous ridge of the London Platform to the north.

William Topley (1875) in his classic memoir on the geology of the Weald for the Geological Survey recognised seven main beds or marker horizons of sandstone and limestone in the Weald Clay. These bed numbers are still used today by the British Geological Survey (BGS) in their geological maps of the Wealden area (Fig. 1). The sandstones include the well-known Horsham Stone (Bed 1), and the limestones include the famous Petworth, Laughton or Bethersden Marbles (Bed 6), which are generally known as the Sussex Marble or '*Paludina*' Limestone. The strata of the Weald Clay are displaced by numerous faults, which together with lateral variation in the stratigraphy from place to place and poor exposure make them very difficult to map. Topley's sequence of seven marker beds forms the main basis for mapping the Weald Clay today, although Topley's Bed 2 now refers to the Small '*Paludina*' Limestone (Charlwood Marble) rather than a sandstone bed, which is no longer thought to be present. This sequence has been mapped on the 1:50,000 and 1:63,360 scale BGS geological maps of West

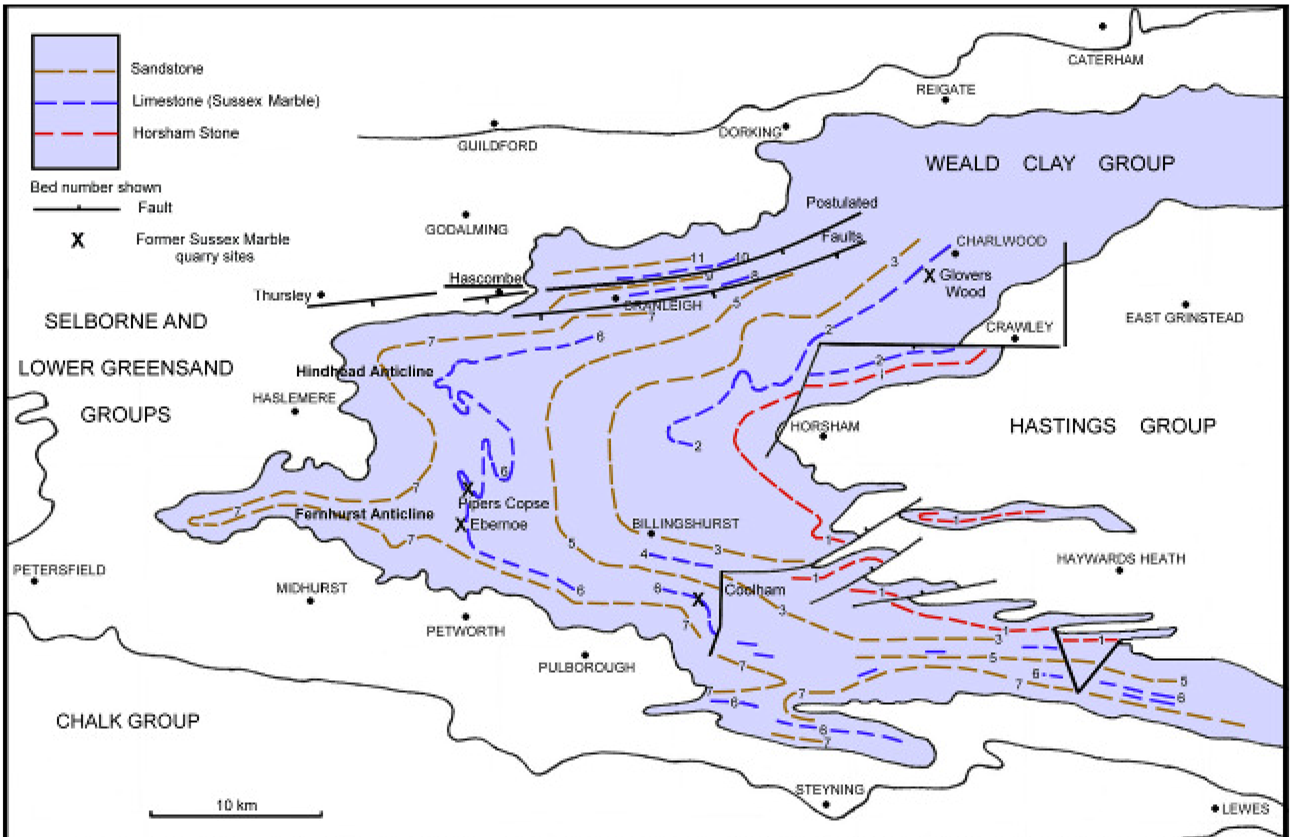


Fig. 1 OUTCROP OF THE WEALD CLAY GROUP SHOWING THE POSITION OF THE TWO PROPOSED FAULTS

Sussex (301 Haslemere, 302 Horsham, 317/332 Chichester and Bognor Regis and 318/333 Brighton and Worthing), but is more obscure when traced eastwards into East Sussex and Kent.

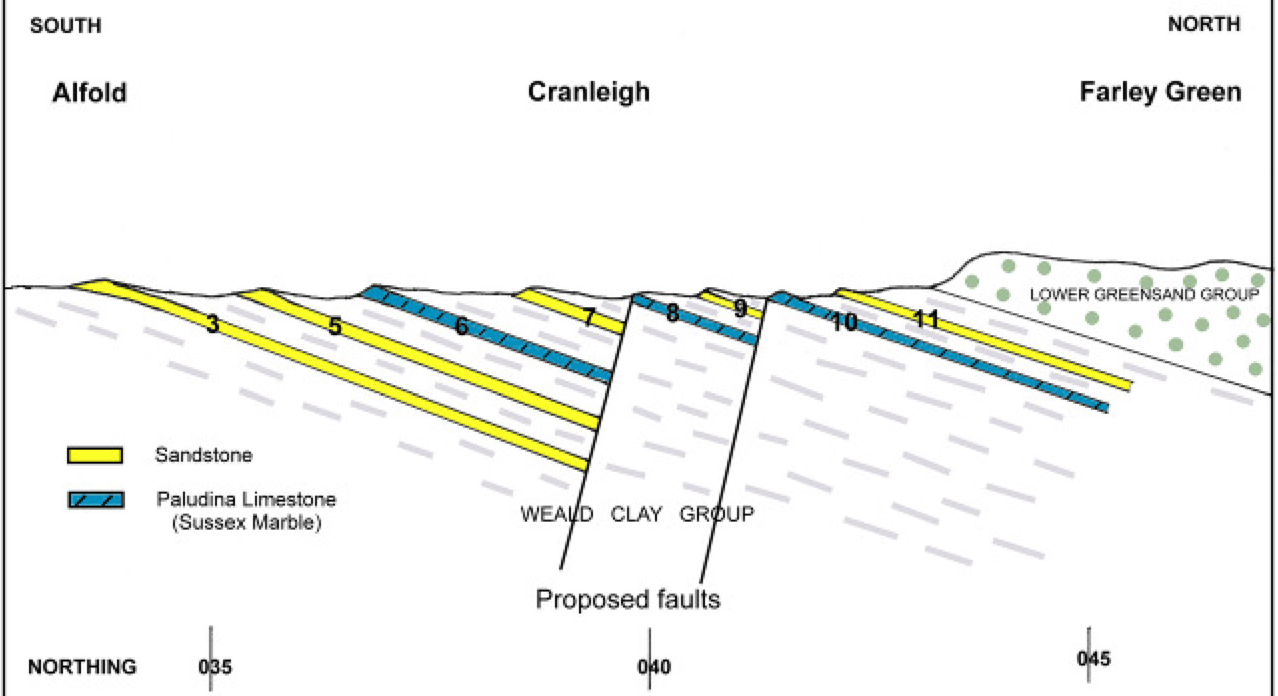
The BGS Haslemere map sheet (301), however, shows further beds numbered from 8 to 11 along the northern margin of the Wealden Anticline. The Chichester/Bognor and the Brighton/Worthing map sheets to the south only show Topley's original seven beds. A possible reason for fewer beds being present along the north flank of the Weald Anticline might be that the overlying Hythe Formation lies unconformably upon the Weald Clay, so it may have cut down into the Weald Clay in the southern part of the outcrop, removing the upper beds. Another explanation might be that the upper Beds 8 to 11 were never even deposited in the south.

The axis of the Weald Anticline trends roughly west to east across the north of West Sussex and then bends towards the east-south-east when traced across East Sussex. The Weald Anticline forms a dome-like structure or pericline, where the fold closes to both the east (across the Channel near Boulogne) and to the west (in the Petersfield/Haslemere area). The detailed structure of the dome is complex as the Wealden strata revealed along its core are cut by numerous faults.

Along the southern margin of the Weald Anticline the junction between the Weald Clay and the overlying Hythe Formation is shown on the geological maps as a relatively smooth east to west line, except where it is diverted by the Thakeham – Pycombe Anticline to the north of Worthing. However this boundary, when traced eastwards along the north side of the Weald Anticline, is displaced northwards from 5 to 8km in each of three main steps. These displacements occur at Haslemere, Hascombe and Dorking (Fig. 1). This outcrop pattern could be the result of topography, faulting or minor anticlines situated along the northern limb of the main Weald Anticline.

To the west the dome-like structure of the Weald Anticline dissipates in the area of the Hampshire border where it is known as the Fernhurst Anticline (Fig. 1). A wide embayment, defined by the base of the Lower Greensand (LGS) to the north, is caused by gently dipping strata across the Hindhead Anticline (Thurrell *et al*. 1968). Further northeast at Hascombe the base of the LGS is again deflected north-to-south. In this case the underlying beds in the Weald Clay (BGS Haslemere map sheet (301),

GEOLOGICAL SECTION FROM ALFOLD TO FARLEY GREEN SHOWING THE 2 PROPOSED FAULTS



Beds 8 and 9 and Beds 10 and 11 are probably Beds 6 and 7 repeated by two normal faults which downthrow to the south.

FIG. 2

1997) continue east-to-west and are not shown to be deflected around a fold. BGS Bed 7 strikes to the east apparently unaffected by this diversion of the boundary between the Weald Clay and the overlying LGS to the north. In this area BGS Beds 8 to 11 are shown in stratigraphic continuity to the north. The BGS mapping suggests that the overlying LGS has cut down through the Weald Clay to the south, revealing higher beds in the Weald Clay to the north. However, it appears more likely that the lower beds of the Weald Clay in this area have been repeated by two east-to-west trending faults. Further evidence for these faults is that they continue the line of a series of faults to the west running between Thursley and Hascombe. Therefore it appears that the Thursley – Hascombe Fault, which is shown to downthrow to the south, continues eastwards towards Cranleigh as two separate faults. These faults cause Beds 6 and 7 to be repeated in outcrop to the north as Beds 8 and 9 and again as Beds 10 and 11. Measurements taken from the BGS Haslemere map sheet indicate a throw of about 75m to the south for the southern fault and 25m to the south for the northern fault (Fig. 2).

Ross in Rasnitsyn *et al*. (1998, p. 333) puts forward evidence that Beds 8 to 11 are most likely Beds 6 and 7, which have been repeated by faulting. He shows that the base of the ostracod zone, *Cypridea valdensis*, is just above Bed 8 at Bookhurst Tileworks, Surrey. However, Bed 7 at Northchapel is within this zone. Obviously something is wrong, as the older Bed 7 could not have been deposited after Bed 8. The answer appears to be that Beds 8 to 11 are repetitions of Beds 6 and 7.

It can now be seen that the Weald Clay Group is not lopsided with more beds preserved along the northern flank of the Weald Anticline. Beds 8 to 11 appear to be repetitions of Beds 6 and 7 caused by two major faults, which run through the Cranleigh area. These faults are a continuation of the fault between Thursley and Hascombe as shown on the BGS Haslemere map sheet (301). It looks like the Haslemere geological map sheet may be in need of a little revision.

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TOPLEY, W. 1875. *The geology of the Weald (parts of the counties of Kent, Surrey, Sussex and Hants.)*. Memoirs of the Geological Survey, England and Wales. HMSO, London, xiv + 503 pp., 7 pls.

HDGS Barbecue

The HDGS barbecue in August was once again hosted by Trevor and Fiona Devon. Despite the inclement weather, members enjoyed a pleasant afternoon in the comfort of our hosts' conservatory. Thank you again to Trevor and Fiona for all their hard work and for welcoming us into their home.

Palaeontology in the News

A review of recent research and discoveries

Edited by Peter and Joyce Austen

Introduction

The following is a summary of recent research and discoveries in or associated with 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. Another increasingly useful site is *ResearchGate* – if you enter the author's name alongside *ResearchGate* in your computer's search engine you will normally gain access to the author's papers or abstracts. 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. Once again special thanks to Christine Wagner for bringing to my attention several of the news items included below.

Brontosaurus is back

Many of us are familiar with the name of the giant Jurassic dinosaur *Brontosaurus*, but as any child older than three will tell you "it's not called *Brontosaurus*, it's *Apatosaurus*".

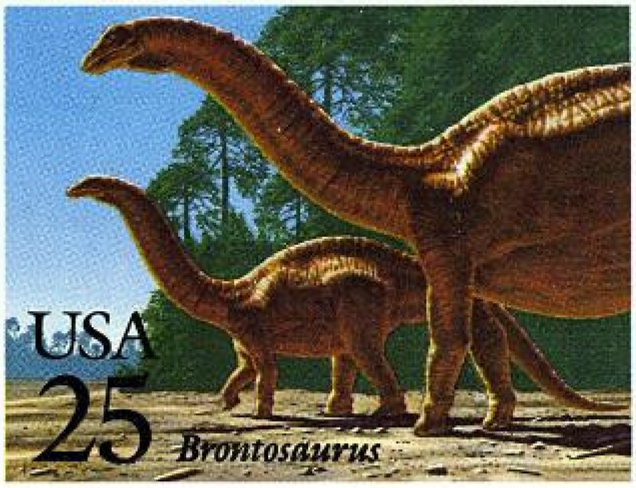

Fig. 1. The Brontosaurus *stamp issued by the US Postal Service in 1989 greeted by a chorus of criticism.*
Image: US Postal Service

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Palaeontologist Othniel Charles Marsh (1831–1899) first gave the name *Brontosaurus* to the giant bones he unearthed from Colorado's Morrison formation in 1879. However, two years earlier, in 1877, his arch-rival, Edward Drinker Cope (1840–1897), had already named a similarly gargantuan dinosaur from the same rock formation *Apatosaurus*. The rivalry between the two palaeontologists, often referred to as the 'bone wars', was legendary, sometimes leading to gunfights over fossil sites. None-the-less, the two names remained until 1903 when, following further discoveries, a new study of the two dinosaurs revealed they were one and the same genus, but as *Apatosaurus* had been named first it had priority over Marsh's discovery and thus, sadly, the name *Brontosaurus* was consigned to history. Or was it? For some strange reason, the name *Brontosaurus* endured in the public imagination, with the US Postal Service even issuing a much criticized *Brontosaurus* stamp in 1989 (Fig. 1), but now, after more than 100 years, *Brontosaurus* is back! A detailed 5-year study conducted by Emanuel Tschopp, a palaeontologist at the Nova University of Lisbon, Portugal, with Octávio Mateus and Roger B.J. Benson, comparing dozens of sauropod specimens at 20 museums across Europe and the United States has now found that *Apatosaurus* and *Brontosaurus* are different enough to each warrant their own genera (*PeerJ* 3:e857; DOI 10.7717/peerj.857 (2015)), which means *Brontosaurus* can once again hold its head up high!

However, if you're still unsure about this and would like some bedtime reading to clarify matters, the monumental 298 page paper (as enormous as its subjects!) can be downloaded from the internet at https://peerj.com/articles/857/.

Reference

CALLAWAY, E. 2015. Beloved *Brontosaurus* makes a comeback. *Nature News*, doi: 10.1038/nature.2015.17257.

Climate fluctuations slowed the rise of the dinosaurs

Despite dinosaurs being around for 160 million years until their demise 65 million years ago, for the first 30 million years of their existence most of the planet was dominated by more archaic reptiles, such as the archosaurs and primitive crocodiles. Large dinosaurs were confined to the poles, with only the smaller ostrich sized ones managing to gain a foothold in the hotter lower latitudes. Jessica Whiteside of the University of Southampton, UK, and colleagues tracked ancient plant growth from that early period by analysing carbon isotopes in petrified soil from New Mexico, and found that the climate in the hotter lower latitudes swung violently between wet and dry periods causing major ecological disruption (*Proceedings of the National Academy of Sciences*, 2015, Vol. 112, No. 26, p.7909–7913). This was not a problem for the smaller more archaic reptiles which needed less food, but could not have supported the big herbivorous dinosaurs, which would have needed a constant supply of food as they grew from hatchlings to as large as 4,000 kilograms over 10–20 years. It was only as the climate stabilized that the larger dinosaurs were able to move into the hotter lower latitudes.

Discovery of a four-legged fossil snake from Brazil

A four-legged fossil snake has been described from the Early Cretaceous (Aptian) Crato Formation of Brazil (Figs 2, 3). The snake was spotted in a private collection in a museum in Solnhofen, Germany, and was described by David Martill, a palaeobiologist at the University of Portsmouth, UK and colleagues (*Science*, 2015, Vol. 349, No. 6246, p.416–419). The discovery means that scientists will have to rethink how snakes evolved from lizards. Previously, the discovery of snakes with two legs had shed some light on the transition from lizards to snakes, but no snake had been described with four limbs, although researchers say the creature's limbs were probably not used for locomotion, but rather for grasping prey, or perhaps for holding on to mating partners. The snake, named *Tetrapodophis amplectus*, shows clearly the early transitional stages from a lizard-like body plan to the smooth legless snakes we know today, and although scientists have long argued over whether snakes evolved from land or marine animals, *Tetrapodophis* lacks adaptations for marine life, such as a tail useful for swimming. Its skull and body proportions, however, are consistent with adaptations for terrestrial burrowing. Martin Cohn, an evolutionary developmental biologist at the University of Florida, Gainesville, USA, thinks that from a developmental perspective, it's one of the most important fossils ever found, calling it "a snake version of *Archaeopteryx*."

Shortly after the paper was published, the Brazilian authorities launched an enquiry into whether the snake had been removed from their country illegally – it has been illegal to sell or export fossils from Brazil since 1942 without governmental permission (*Nature News*, doi:10.1038/nature.2015.18116).

Reference

CHRISTAKOU, A. 2015. Four-legged fossil snake is a world first. *Nature News*, doi:10.1038/nature.2015.18050.

Fig. 2. Four-legged snake Tetrapodophis amplectus *from the Early Cretaceous (Aptian) Crato Formation of Brazil.*
Image: Dave Martill, University of Portsmouth

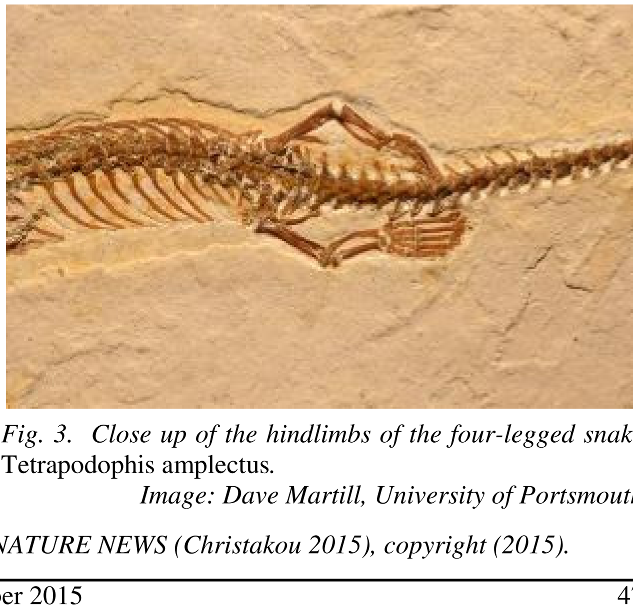

Fig. 3. Close up of the hindlimbs of the four-legged snake Tetrapodophis amplectus.
Image: Dave Martill, University of Portsmouth

Cambrian jellyfish had skeletal structures

All 150 known species of modern comb jellies (known as ctenophores) lack skeletons and use eight rows (or combs) of hair-like structures to swim. An analysis of fossil comb jellies, including three newly identified species from 520 million year old Cambrian deposits in south China, has found that the fossils had combs and a similar basic body plan to living comb jellies, but that they also had radiating spokes and rigid plates (Fig. 4), which probably provided support or served as armour (*Science Advances*, 2015, Vol. 1, No. 6, e1500092). The authors, Qiang Ou of the China University of Geosciences in Beijing and his colleagues, suggest that these strengthened body types in the Cambrian period may have evolved as a result of the intense interactions of ancient comb jellies with their predators and prey in the Cambrian seas.

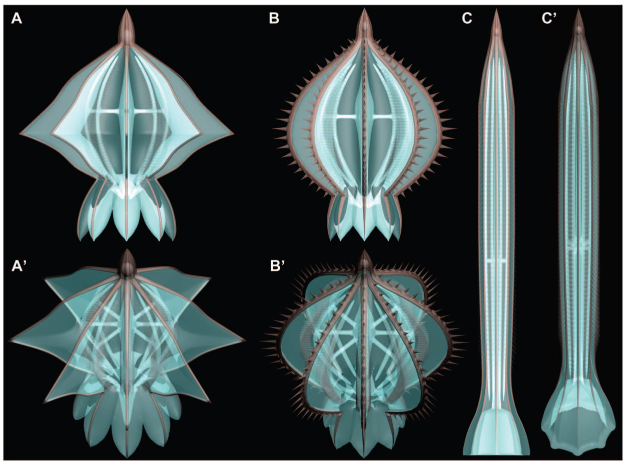

Fig. 4. Idealized models of the three Cambrian jellyfish with radiating spokes and rigid plates: A. Gemmactena actinala*, B.* Batofasciculus ramificans*, C.* Thaumactena ensis.

Image: Ou et al.*, 2015, Science Advances*

Reference

OU QIANG, XIAO SHUHAI, HAN JIAN, SUN, GE, ZHANG FANG, ZHANG ZHIFEI and SHU DEGAN. 2015. A vanished history of skeletonization in Cambrian comb jellies. *Science Advances*, **1** (6), e1500092 (2015).

Exceptional fossil preservation caused by gut microbes

Exceptionally preserved fossils provide major insights into the evolutionary history of life, and it had been suspected that this exceptional preservation was due to microbial activity. A recent study by Philip Donoghue at the University of Bristol, UK and his colleagues of the present-day brine shrimp, *Artemi*a, found that soon after death, the shrimp's gut wall breaks open and bacteria spills out into the body cavity (*Proceedings of the Royal Society B: Biological Sciences*, 2015, Vol. 282, No. 1808, doi: 10.1098/ rspb.2015.0476). These bacteria form sticky aggregates, or biofilms, which contain mineral deposits (calcium/phosphates) that gradually replace the shrimp's soft tissue. These observations help explain the exceptional preservation of animals like the Cambrian Burgess Shale fossil arthropods, as the guts of these animals are preserved relatively frequently, while preservation of other internal anatomy is rare.

Waco mammoths get monument status

In July 2015 Waco Mammoth palaeontological site in Texas was designated a national monument (Fig. 5). The site features the 65,000 year old well-preserved remains of 24 Columbian mammoths (*Mammuthus columbi*), and includes the only preserved nursery herd of mammoths in the United States. The site will now be protected under the United States Antiquities Act (*Nature*, 2015, Vol. 523, No. 7560, p.260).

Reference

ANON. 2015. Waco mammoths get monument status. *Nature*, vol. **523**, no. 7560, 260.

Fig. 5. Newly designated WACO Mammoth National Monument, Texas, USA.

Image: Kye R. Lee/AP/Press Association Image

Hallucigenia's head

A new study by Martin Smith of the University of Cambridge and Jean-Bernard Caron of the University of Toronto, Canada, has clarified the anatomy and evolutionary significance of the bizarre Cambrian arthropod *Hallucigenia* (Fig. 6), which when first discovered was mistakenly described upside down. Work in recent years has shown it to be an ancestor of the velvet worms (onychophorans), and the new study shows that *Hallucigenia* had pharyngeal teeth* and circumoral mouthparts* – which settles the uncertainty as to which end was the head or rear of the animal! The discovery of these characters is also thought to unite the two groups of 'moulting arthropods', the worm-like organisms with a non-segmented body (e.g. nematodes) and the segmented organisms with paired legs (e.g. velvet worms, tardigrades), and improves our understanding of the evolutionary links between moulting animals. Their work also shows that *Hallucigenia* had an elongated head with a pair of simple eyes (*Nature*, 2015, Vol. 523, No. 7558, p.75–78).

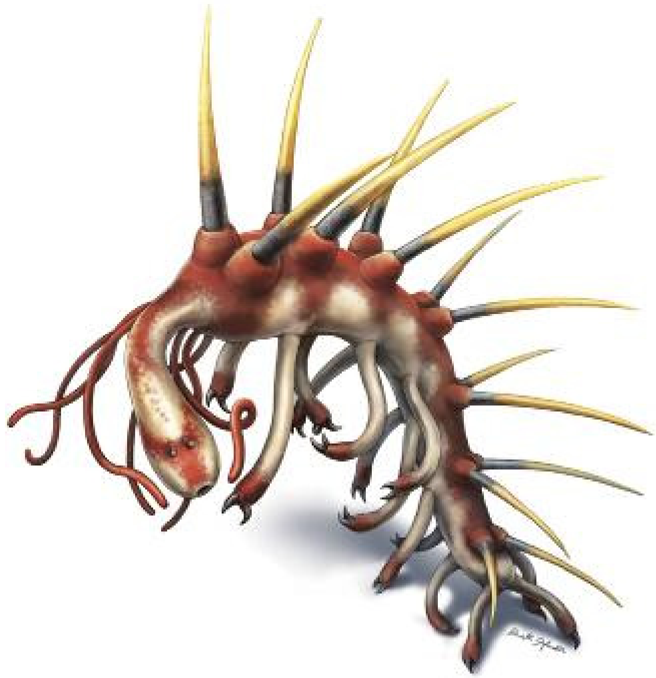

Fig. 6. Reconstruction of the Cambrian arthropod Hallucigenia.

Image: Danielle Dufault

* pharyngeal teeth = teeth in the throat
* circumoral mouthparts = plates surrounding a circular mouth

Reference

SMITH, M. R. and CARON, J-B. 2015. *Hallucigenia*'s head and the pharyngeal armature of early ecdysozoans. *Nature*, vol. **523**, no. 7558, 75–78.

Early vertebrate relative

A bizarre Cambrian group of 500 million year old sea creatures called vetulicolians are one of the most problematic and controversial Cambrian fossil groups, having been considered as arthropods, chordates, and even placed in their own phylum. A team led by Diego García-Bellido at the University of Adelaide and John Paterson at the University of New England, Armidale, Australia analysed a fossil vetulicolian, *Nesonektris aldridgei* (Fig. 7), from Emu Bay Shale Konservat-Lagerstätte in South Australia (*BMC Evolutionary Biology*, 2014 14:214). The fossil shows the outline of a notochord, a rod-like structure that develops into the backbone in vertebrates, as well as distinct anterior and posterior body regions, clearly making it a relative of the vertebrates. The authors believe it was probably a free-swimming filter-feeder.

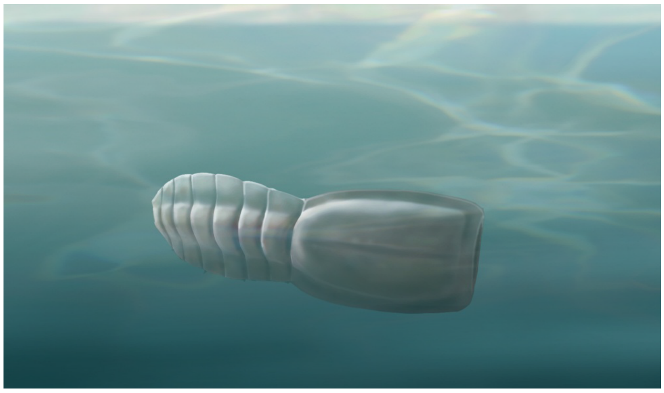

Fig. 7. A relative of the vertebrates Nesonektris aldridgei *from South Australia.*

Image: Katrina Kenny

Reference

GARCÍA-BELLIDO, D. C., LEE, M. S. Y., EDGECOMBE, G. D., JAGO, J. B., GEHLING, J. G. and PATERSON, J. R. 2014. A new vetulicolian from Australia and its bearing on the chordate affinities of an enigmatic Cambrian group. *BMC Evolutionary Biology*, 2014 **14**:214.

‘Bizarre’ triceratops relative discovered

A new triceratops-type dinosaur with a strange halo of bony spikes (Fig. 8) has been described by Caleb Brown from the Royal Tyrrell Museum in Drumheller, Canada and colleagues (*Current Biology*, 2015, Vol. 25, No. 12, p.1641–1648). It was discovered near the Oldman River in southeastern Alberta, Canada, and took scientists two summers to excavate and a further 18 months to remove from its rock matrix. The horned dinosaur, which lived 68 million years ago, was named *Regaliceratops peterhewsi* after the regal crown of spikes at the back of its skull, and after Peter Hews, the man who discovered its fossilized remains.

Fig. 8. Triceratops-type dinosaur Regaliceratops peterhewsi *from the late Cretaceous of Alberta, Canada.*
Image: Julius T. Csotonyi/Royal Tyrrell

Reference

DENG, B. 2015. ‘Bizarre’ triceratops relative unearthed. *Nature News*, doi:10.1038/nature.2015.17699.

Caimans ruled the Miocene wetlands

A remarkable fossil find has revealed that a vast diversity of specialized crocodilians dominated the wetlands of South America before the Amazon River formed. Rodolfo Salas-Gismondi at the University of Montpellier in France and his colleagues found two bone beds in Peru containing remains of seven species of crocodilian, the largest diversity of such species ever found in one place (*Proceedings of the Royal Society B: Biological Sciences*, 2015, Vol. 282, No. 1804, doi: 10.1098/rspb.2014.2490). As well as two known large-bodied species, they found five animals that are new to science, including several caimans with teeth specialized for crushing shellfish. The numbers of these animals declined as the Amazon River systems began forming around 10.5 million years ago, draining the wetlands and allowing more-generalist caiman predators to dominate.

Oldest relative of modern birds found in China

The oldest relative of modern birds has been found in China. The fossils were found in the Sichakou Basin, Fengning County, Hebei Province, northeastern China, and date back to the Lower Cretaceous, 130.7 million years ago. The new species, *Archaeornithura meemannae* (Fig. 9), which was described by Min Wang at the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing, China and colleagues (*Nature Communications*, 2015, Vol. 6, No. 6987, doi: 10.1038/ncomms7987), had already lost key dinosaur traits, and had elaborate plumage, including a fan-shaped tail, and other modern features such as a wishbone. It belonged to a family of wading birds, strengthening the theory that modern birds originated near water.

Reference

ANON. 2015. Early modern bird. *Nature*, vol.**521**, no.7551, 128.

Fig. 9. The early bird Archaeornithura meemannae *from China.*
Image: Wang et al.*, 2015, Nature Commun.*

Bat-winged dinosaur discovered in China

A small feathered dinosaur the size of a magpie with bat-like wings has been discovered in the Tiaojishan Formation of Hebei Province, north-eastern China (Middle–Upper Jurassic) (160 mya) (Fig. 10). The new species, *Yi qi*, meaning "strange wing" described by Xing Xu, at the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing, China and colleagues (*Nature*, 2015, Vol. 521, No. 7550, p.70–73), has a 13 cm long, rod-like bone that extends from each wrist, and may have helped to support wing membranes. It is the first time such a bone structure has been seen in dinosaurs. Although it is difficult to tell whether the creature glided, flapped its wings or alternated between the two, features on the forelimb bones suggest that the dinosaur's flight muscles were relatively small and weak, implying that it was more likely to glide rather than flap its wings. Also the creature's feathers were more like stiff, frayed bristles rather than the aerodynamic feathers of today's birds.

Fig. 10. The bat-like dinosaur Yi qi *from China.*
Image: Dinostar Co. Ltd

Reference

PERKINS, S. 2015. Bat-winged dinosaur discovery poses flight puzzle. *Nature News*, doi: 10.1038/ nature.2015.17434.

Dinosaurs shake a tail feather! - How to sex dinosaurs

Researchers have proposed a new method for telling whether dinosaurs are male or female, at least for some small feathered species. The team led by Scott Persons of the University of Alberta in Edmonton, Canada and colleagues looked at two turkey-sized oviraptors unearthed in Mongolia in the mid-1990s (*Scientific Reports*, 2015, Vol. 5, doi: 10.1038/srep09472). The fossils were found centimetres apart in a 75 million year old rock layer, and were nicknamed 'Romeo and Juliet' (Fig. 11). The authors suggest that differences in the length and shape of blade-like bones called chevrons, which jut down from the vertebrae near the base of the tail, can be used to tell the difference between the sexes. They believe the chevrons were shorter in females to ease the process of laying eggs and that the specimen where the chevrons were longer and had broader tips was male. They suggest males needed larger chevrons to anchor the muscles that controlled their flexible, feather-tipped tails, and they suspect that male oviraptors shook their tail feathers in mating displays, similar to the behaviour of modern-day peacocks.

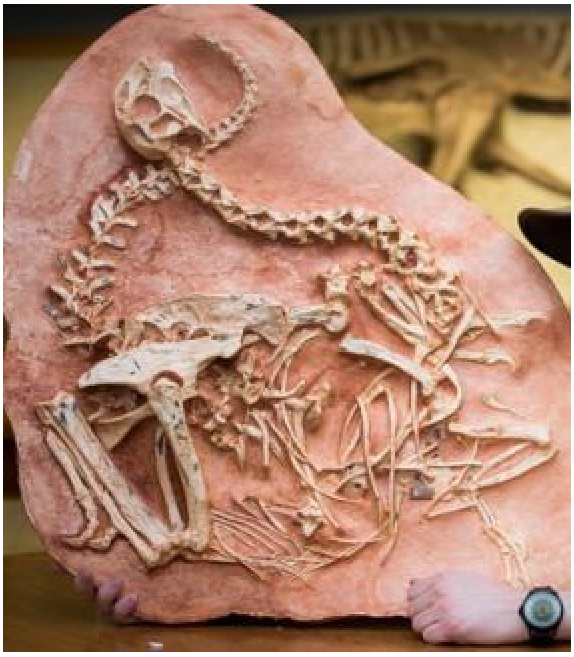

Fig. 11. The fossil remains of two oviraptors – nicknamed 'Romeo and Juliet'.
Image: Amanda Kelly

In 2005, researchers found that some *Tyrannosaurus rex* fossils contain bone tissue similar to the medullary bone of modern female birds, where it provides a short-term reservoir of calcium to produce eggshells, although this is only evident in sexually mature females.

Reference

PERKINS, S. 2015. Tails tell the tale of dinosaur sex. *Nature News*, doi: 10.1038/nature.2015.17299.

Acidic oceans linked to Permo-Triassic extinction

One of the Earth's greatest extinction events known as the Permo-Triassic extinction (or the 'Great Dying') happened in two phases 252 million years ago. Scientists are unsure what caused the first phase, which lasted around 50,000 years, but believe the second shorter (10,000 years), much more intense phase, was caused by huge volcanic eruptions in Siberia that spewed out vast quantities of carbon dioxide and made the oceans more acidic, wiping out around 95% of marine species. The team led by Matthew Clarkson at the University of Otago in Dunedin, New Zealand used chemical evidence in rocks from that period to calculate how quickly the ocean chemistry shifted, and their study suggested that the Siberian volcanoes belched so much CO_2 in such a short period of time that the acidity of the oceans was increased to lethal levels (*Science*, 2015, Vol. 348, No. 6231, p.229–232).

Unusual plant-eating theropod discovered in Chile

We think of the theropods as the dominant carnivorous predators of the Mesozoic, but the discovery of an unusual plant-eating theropod in Chile challenges this idea. The fossils, which include an articulated almost complete skeleton and the skull of a juvenile, were found in rocks from the 145 million year old Upper Jurassic Toqui Formation in the Aysén Region of southern Chile, and were described by Fernando Emilio Novas of the Museo Argentino de Ciencias Naturales ''Bernardino Rivadavia'', Buenos Aires, Argentina and colleagues (*Nature*, 2015, Vol. 522, No. 7556, p.331–334). The new species, named *Chilesaurus diegosuarezi* (Fig. 13), was just over three metres from nose to tail, and had spatula-shaped elongated teeth, obliquely pointing forwards (Fig. 12), a feature unique in the theropods, but typical for a herbivore. Another adaptation for a plant eater is the backward-pointing pubic bone in the pelvis, making room for a large gut. This pelvic arrangement is typical for the ornithopod dinosaurs (e.g. the plant-eating iguanodonts), but not for theropods.

Reference

NOVAS, F. E., SALGADO, L., SUÁREZ, M., AGNOLÍN, F. L., EZCURRA, M. D., CHIMENTO, N. R., DE LA CRUZ, R., ISASI, M. P., VARGAS, A. O. and RUBILAR-ROGERS, D. 2015. An enigmatic plant-eating theropod from the Late Jurassic period of Chile. *Nature*, vol. **522**, no. 7556, 331–334.

Fig. 12. Elongate spatula-shaped teeth of the plant-eating theropod Chilesaurus diegosuarezi.

Image: Novas et al.*, 2015, Nature*

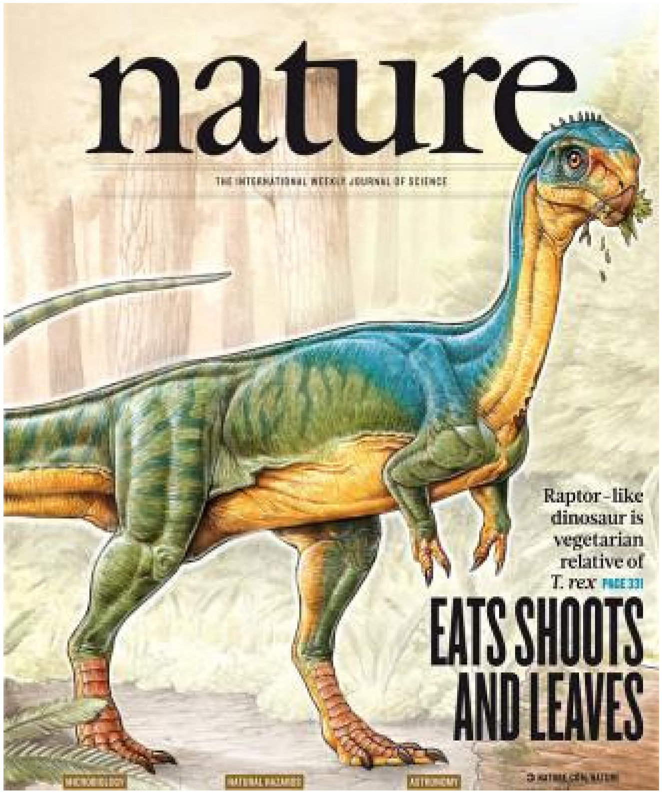

Fig. 13. Reconstruction of Chilesaurus diegosuarezi *from the cover of Nature.*

Image: Novas et al.*, 2015, Nature*

Diversity of early mammals

A study of two species of early Chinese mammals has shown that these animals had a more varied anatomy and behaviour than previously thought. A team led by Zhe-Xi Luo at the University of Chicago, Illinois, and Qing-Jin Meng at the Beijing Museum of Natural History, China, analysed the 160 million year old fossil mammal, *Docofossor brachydactylu*, and found that it had short, wide digits for burrowing underground, similar to those seen in moles (*Science*, 2015, Vol. 347, No. 6223, p.760–764). Some of the team also studied another fossil mammal, the 165 million year old *Agilodocon scansorius* (Fig. 14), and discovered it was adapted to tree-climbing, with its teeth bearing the hallmarks of a diet of tree gum and sap (*Science*, 2015, Vol. 347, No. 6223, p.764–768). The two species, which belong to an extinct group called docodonts, show that early mammals lived in diverse habitats.

Fig. 14. Fossil mammal Agilodocon scansorius *from China (US cent shown for scale).*
Image: Zhe-Xi Luo, Univ. Chicago

Reference

ANON. 2015. Ancient mammals displayed diversity. *Nature*, vol. **518**, no. 7539, 276.

World's oldest fossil snake

A study conducted by Michael Caldwell at the University of Alberta in Canada and colleagues has re-described the remains of four early snakes previously masquerading in the scientific literature as lizards, and the study has thrown new light on how snakes evolved (*Nature Communications*, 2015, Vol. 6, No. 5996, doi: 10.1038/ncomms6996). The oldest of the snakes is *Eophis underwoodi* from the Kirtlington Cement Works Quarry in Oxfordshire, England [Bathonian stage of the Middle Jurassic, about 167 million years old (mya)]. The next oldest is *Portugalophis lignites* from coal deposits near Guimarota, Portugal (Kimmeridgian stage of the Upper Jurassic, between 157 and 152 mya), followed by *Diablophis gilmorei* from the Morrison Formation, in Fruita, Colorado, USA (Kimmeridgian stage of the Upper Jurassic). The youngest of the snake fossils is *Parviraptor estesi* from Durlston Bay, Dorset, England (Berriasian stage of the Early Cretaceous, between 145 and 140 mya) (Fig. 15). The previous oldest known fossil snakes date from the Upper Cretaceous (100 mya), and it had been thought that the long, thin skull structure that is characteristic of snakes evolved after the animals became legless and developed their elongate bodies, but this new study shows that the skull evolved first, and they lost their legs later.

Fig. 15. Reconstruction of the Purbeck snake Parviraptor estesi *from Durlston Bay, Dorset, England.*
Image: Julius T. Csotonyi

Reference

CRESSEY, D. 2015. Hiss-toric record. *Nature News*, doi: 10.1038/nature.2015.16829.

Insect evolution

The early evolution of the insects and the evolutionary relationships between the major lineages has always been contentious. Now a study by Bernhard Misof at the Alexander Koenig Zoological Research Museum in Bonn, Germany and his colleagues has given a more reliable framework for use in future analyses (*Science*, 2014, Vol. 346, No. 6210, p.763–767). By analysing fossil and molecular data, the team were able to determine the evolutionary relationships of all 30 orders of insects. Their work showed that the first insects evolved in marine or coastal habitats in the Early Ordovician [~479 million years ago (mya)], and moved on to land at around the same time as plants appeared, some 440 mya. Insect flight developed in the Early Devonian (~406 mya), major present-day lineages appeared in the Lower Carboniferous (~345 mya), and the major diversification of the more advanced insects took place in the Early Cretaceous.

A new 'beer-bellied' dinosaur from Mongolia

A large hump-backed, big-bellied bipedal dinosaur the size of *Tyrannosaurus rex*, has been discovered in the Gobi Desert in southern Mongolia. Previously the dinosaur, named *Deinocheirus mirificus*, was known only from fossils of its long arms and a few isolated bone fragments originally found in 1965, but in expeditions to the Gobi Desert over the past decade a team led by Yuong-Nam Lee, a vertebrate palaeontologist at the Korea Institute of Geoscience and Mineral Resources in Daejeon, South Korea has recovered the remains of two more individuals of the species, giving them around 95% of the creature's skeleton (*Nature*, 2014, Vol. 515, No. 7526, p.257–260). *Deinocheirus* weighed in at around 6 tonnes and was about 11 metres long (Fig. 16). Most of the spinal vertebrae have blade-like projections that extended upward and served as anchors for a network of ligaments that probably helped to support the immense weight of the creature's abdomen. The skull of *Deinocheirus* was more than a metre long, and although it lacked teeth, it had a keratinous beak that could be used to nip off vegetation. The researchers suggest that a deep lower jaw probably housed a large tongue that could have helped suck up plants from the bottoms of rivers and lakes. Its stomach contents included fish vertebrae and scales, suggesting that *Deinocheirus* consumed aquatic animals as well as vegetation. Along with its humped back and large belly, it also had wide hips, big feet and broad toes, which helped to prevent it sinking into soft sediments while foraging.

Fig. 16. Reconstruction of the large-bellied dinosaur Deinocheirus mirificus *from Mongolia.*

Image: Michael Skrepnick

Reference

PERKINS, S. 2014. Fossils reveal 'beer-bellied' dinosaur. *Nature News*, doi: 10.1038/nature.2014.16203.

Large mammal from the late Cretaceous

A team led by David Krause of Stony Brook University, New York, USA has discovered an unusually large mammal that lived in what is now Madagascar during the Late Cretaceous (70–66 mya) (*Nature*, 2014, Vol. 515, No. 7528, p.512–517). The new fossil mammal, named *Vintana sertichi*, belongs to a group known as the Gondwanatheria (or gondwanatherians), a group of early mammals that lived in the Southern Hemisphere from the Cretaceous through to the Miocene. The discovery was of a complete, well-preserved cranium, the first skull material of a gondwanatherian to be found. The animal was unusually large, weighing around 9 kg, with a skull length of 13 cm (Fig. 17), twice the size of the previously largest known mammal skull from the Mesozoic of the southern continent of Gondwana - at that time the vast majority of mammals were mouse-sized. Detailed study of the skull indicated the animal was herbivorous, large-eyed and agile, with well-developed high-frequency hearing and a keen sense of smell. It also showed it to be a close relative of the multituberculates, a successful group of Mesozoic mammals known almost exclusively from the Northern Hemisphere, but which became extinct at the end of the Cretaceous.

Teeth from multituberculate mammals can be found in the Cliff End Bone Bed at Pett, east of Hastings.

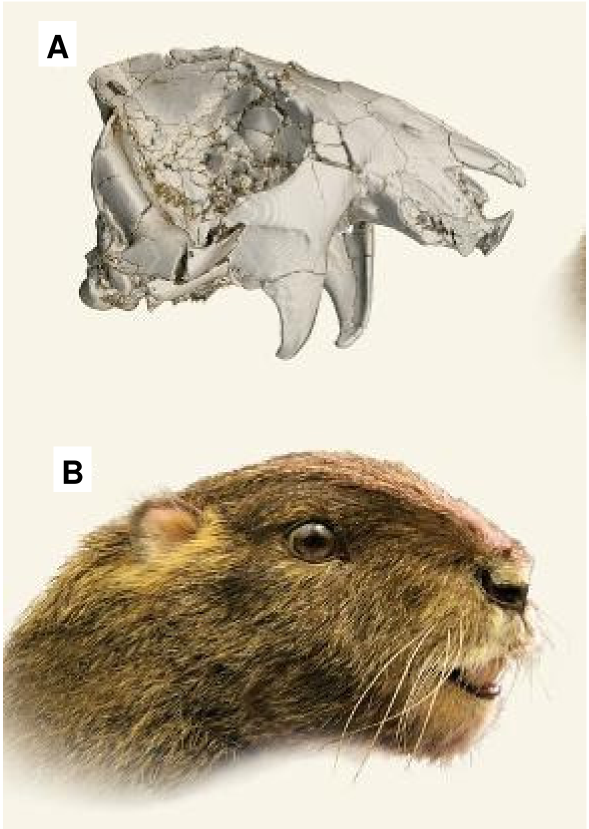

Fig. 17. Skull (A) and reconstruction (B) of the unusually large Late Cretaceous mammal Vintana sertichi *from Madagascar.*
Image: A, Joseph Groenke; B, Gary Staab

Reference

WEIL, A. 2014. A beast of the southern wild. *Nature*, vol. **515** no. 7528, 495–496.

Amphibians could regenerate limbs 300 million years ago

The oldest evidence for limb regeneration has been found in fossils of a 300 million year old amphibian (*Proceedings of the Royal Society B: Biological Sciences*, 2014, Vol. 281, No. 1794, doi: 10.1098/rspb.2014.1550). The amphibian, called *Micromelerpeton credneri* (Fig. 18), from the fossil lake deposits of Lake Odernheim, Saar-Nahe Basin, Germany (latest Pennsylvanian–earliest Permian) shows a unique pattern and combination of abnormalities in its limbs that is distinctive of irregular regenerative growth in modern salamanders. Usually, the re-growths are indistinguishable from those limbs they replace, but occasionally they have distinctive abnormalities such as fused or missing digits. Nadia Fröbisch and her colleagues at the Natural History Museum, Leibniz Institute for Evolution and Biodiversity Science in Berlin found similar abnormalities in fossils of *Micromelerpeton*, a distant relative of modern amphibians. This is the first fossil evidence for limb regeneration.

Reference

ANON. 2014. Amphibian regrew limbs long ago. *Nature*, vol. **514**, no. 7520, 8.

Fig. 18. Fossil amphibian Micromelerpeton credneri *from Germany.*
Image: Carola Radke/MFN

Dominican lizards in the slow lane

A study led by Emma Sherratt at the University of New England in Armidale, NSW, Australia has shown that lizards of the Caribbean islands have changed little over millions of years. Sherratt and her colleagues looked at 20 fossil anole lizards entombed in 15 to 20 million year old Dominican amber (Miocene) (Fig. 19) and found that they were made up of the same types of habitat specialists present in the group today (*Proceedings of the National Academy of Sciences*, 2015, Vol. 112, No. 32, p. 9961–9966). It has long been an unresolved question in ecology as to whether the structure of ecological communities can be stable over very long timescales, and the Dominican amber fossils have shown that this can be the case, certainly for the anole lizards.

Reference

ANON. 2015. Lizards evolved at snail's pace. *Nature*, vol. **524**, no. 7563, 9.

Fig. 19. Fossil anole lizard preserved in Dominican amber. Image: Ettore Morone

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Origin of the ichthyosaurs

Ryosuke Motani of the Department of Earth and Planetary Sciences, University of California, Davis, California, USA and colleagues have described a new basal ichthyosaur from the upper Lower Triassic (about 248 mya) of China (Majiashan Quarry, Anhui Province, China) (*Nature*, 2015, Vol. 517, No. 7535, p.485–488). The creature, named *Cartorhynchus lenticarpus* (Fig. 20), had a primitive skeleton indicating possible amphibious habits. It was smaller than later ichthyosaurs and had unusually large flippers which probably allowed limited terrestrial locomotion. It also retained some features of early terrestrial reptiles, including a short snout and body trunk, and is thought to have been a suction feeder. Basal ichthyosaurs are only known from south China suggesting that the group originated in that region which was a warm and humid tropical archipelago in the Early Triassic.

Reference

MOTANI, R., JIANG DA-YONG, CHEN GUAN-BAO, TINTORI, A., RIEPPEL, O., JI CHENG and HUANG JIAN-DONG. 2015. A basal ichthyosauriform with a short snout from the Lower Triassic of China. *Nature*, vol. **517** no. 7535, 485–488.

Fig. 20. Fossil of the early ichthyosaur Cartorhynchus lenticarpus *from China.*
Image: Motani et al.*, 2015, Nature*

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News update

Dr. Marcelle K. BouDagher-Fadel (UCL) - Planktonic foraminifera

In Jim Simpson's article on our 2013 visit to UCL (see 'Report on the visit by a group of HDGS members to UCL', *HDGS Journal*, Dec 2013, Vol. 19, p.24–31) he reported that Dr. Marcelle BouDagher-Fadel's most recent volume on the planktonic foraminifera was freely available on the UCL website. Our president, Professor David Price, has recently informed us that this remarkable volume has been updated and published by UCL Press, and is free online at: http://discovery.ucl.ac.uk/1404017/. The book is also available from Amazon in hardback (£40), softback (£20) and Kindle edition (£7.37).

Dr. Susannah Maidment (Imperial College, London) - Soft Tissue Preservation in Dinosaurs

Earlier this year (15th February 2015) Dr. Susannah Maidment (Imperial College) gave a fascinating talk to our Society entitled 'Soft Tissue Preservation in Dinosaurs'. Since Susannah's talk the article around which her presentation was based has been published and is freely available online at: http://www.nature.com/ncomms/2015/150609/ncomms8352/full/ncomms8352.html
As well as the actual paper, you can also download further supplementary information which includes two short movies that show the 3-dimensional structure of the dinosaur cells.

GEOLOGISTS' ASSOCIATION FIELD MEETINGS – 2016

The HDGS 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 2016 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*.

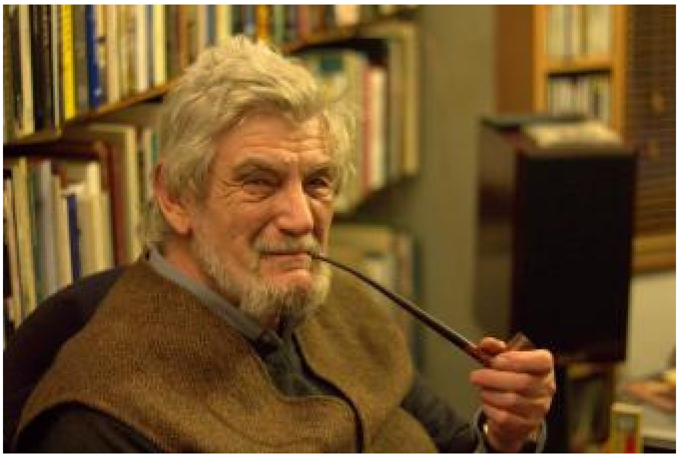
FIELD MEETINGS IN 2016

February (*date to be confirmed*)	Sheppey	Fred Clouter
Sun 13th March	Lincolnshire geology	Paul Hildreth
Sun 3rd April	Bardon Hill Quarry	Eddie Bailey
Sat 7th May to Sun 8th May	South Wales	Steve Howe
Sun 22nd May	Charnwood Forest	Keith Ambrose
Sat 11th June	Goring Gap	Peter Worsley
Sat 18th June	Wrens Nest	Colin Prosser
Tues 21st June	Canary Wharf Building Stones	Ruth Siddall
Sun 10th July	Mimms Valley	Mike Howgate
July (*date to be confirmed*)	Wealden	Peter Austen and Ed Jarzembowski
Sun 7th August	Canterbury Building Stones	Geoff Downer
Sun 25th September	Fossil Hunting in the City walk	Mike Howgate
Sat 8th October	Selsey	David Bone
Sat 5th November	GA Festival of Geology (UCL, London)	Geologists' Association

Roger Blaker - a tribute

Roger Frederick Blaker

8th July 1944 - 4th January 2015



Roger was born and grew up in Worthing. Although he was a very shy and quiet boy, living most of the time in a dream world, his childhood with his younger brother Malcolm was happy and busy. In September 1955 he started at West Tarring County Secondary School for Boys, a place that was in some ways quite a rough school for the more sensitive pupils, but he made friends with boys who shared his interests and would often lead expeditions of 'intrepid explorers' into the wilds of the South Downs on his bike. By this time he had started to develop a lifelong interest in history, books and art, but his chief hobby was prehistoric animals and this was the beginning of a great enthusiasm for collecting fossils which he carried with him into his later years when he would go hunting for specimens in the abandoned chalk quarries of the Lewes area. There was also painting and drawing and the beginnings of collector-fever for books - a passion that remained with him throughout his life.

Roger made it through to complete his 'O' levels, managing to overcome his dyslexia, a problem which would always frustrate him. He then embarked on four years of study at West Sussex College of Art and Craft to gain his National Diploma in Design, specialising in ceramics. This was followed by a place at Brighton College of Art and Craft to qualify for an Art Teacher's Certificate, and in 1965 he took up his first teaching post at Brighton Grammar School.

Roger met Judith Papenhuijzen in Holland and they were married there in April 1966. Their first child, Andrew, was born at the end of the year. The family moved to Emsworth where Roger took a post at Oak Park County Secondary School for Girls, Havant. Unfortunately this wasn't quite the job he had anticipated (he later heard that the school was known as 'Hell's Kitchen'!), and in the Spring of 1968 he was accepted as an art teacher at the Mary Sheafe Secondary School for Girls, Cranbrook, where he was a popular member of staff. Roger and Judith moved to Robertsbridge where their second child, Antony, was born in 1969. They moved to Hawkhurst in 1970 and in September that year Roger was appointed as the Art and Pottery teacher at Angley High School. While working there he became friends with the artist Alan Reynolds who became his mentor, and it was during this time that he painted and constructed most of the work that formed his first solo exhibition, the opening event that he described as 'the best day of my life'. Over the next few years two daughters were added to the family; Saskia in October 1977 and Laura in August 1981.

Following his divorce from Judith in 1987, Roger moved to St Leonards becoming part of, and greatly enjoying, the colourful life around him.

He met Heather in 1990 and re-married. They moved to Hastings and Roger took early retirement from his position as the Head of the Art Department. With his new-found freedom they had plenty of time to enjoy travelling - Crete, Tunisia, Spain, Australia and all over the British Isles. Their daughter, Alice, was born in June 1996.

Roger joined the Hastings & District Geological Society in May 1996. He was an active member, regularly attending monthly field trips and lectures. He also volunteered to become the Society's librarian, and with his wide knowledge in this area gradually expanded the club's collection by recommending and acquiring suitable geological reference books.

Roger wasn't always in the best of health, but he maintained his enthusiasm for getting out and about, walking for miles even after acquiring a new knee. He also enjoyed eating cakes, smoking his pipe, the occasional tipple, visiting galleries and concerts, and combing bookshops and book fairs looking for that rare first edition.

Given his large family - five children, six grand-children and six great grand-children - it's not surprising Roger was interested in researching his family tree, spending hundreds of hours visiting archive offices, libraries, graveyards and, as a last resort, the internet in search of his origins. He discovered that the Cuckfield Giant - Henry Blaker, born in 1721 at Bolney - was his Great, Great, Great, Great, Great, Great Uncle. "His height was seven feet four inches and his figure was well proportioned - not sure where those genes ended up...."

Roger was always ready to laugh at himself and was a persistent practical joker. He had a large collection of comedy recordings, which probably explains the choice of music and Goon Show excerpt played at his funeral!

Over the years Roger produced many paintings, drawings and 'constructions' which were recently exhibited at the Fleet Gallery in St Leonards, where a number successfully sold. When he was told of his illness in November 2014 he was undeterred, still planning to visit Scandinavia on the proceeds from his paintings and also to attend the 200th anniversary of Waterloo this Summer.

Roger died on 4th January 2015. He was buried at Clayton Wood in the heart of Sussex, close to the Downs he loved and where he spent so much time. He was an intelligent, kind, sensitive and determined man who contributed so much value to those who knew him through his teaching and friendship. He will be sadly missed by his family and many friends.

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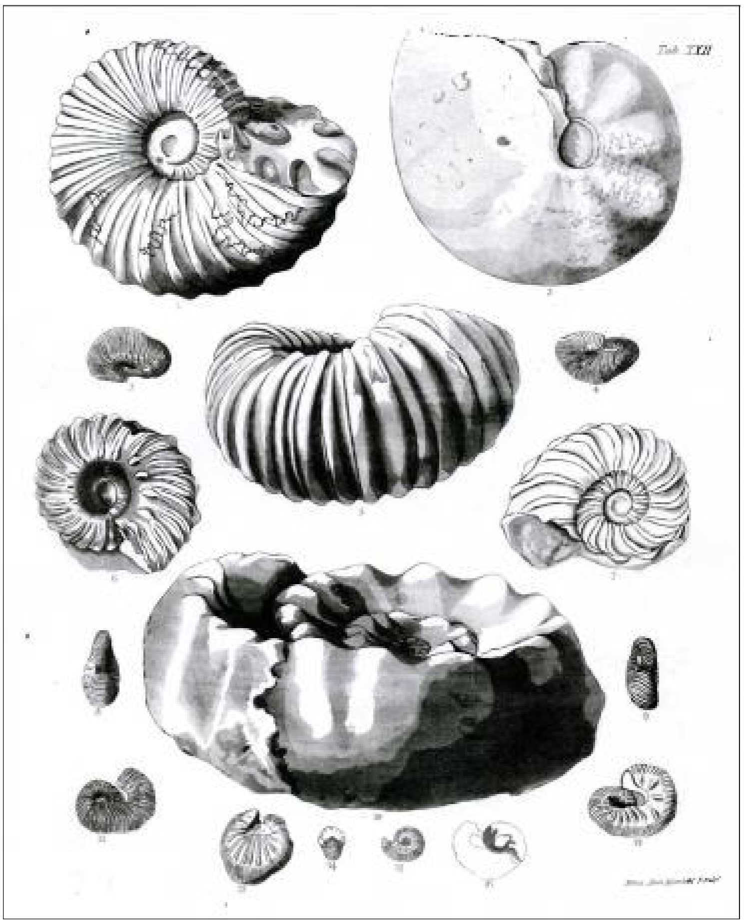
TABLET XXII.

Ammonites, and Scaphites, from the chalk and chalk marl, near Lewes.



A plate from Gideon Mantell's 1822 book 'Fossils of the South Downs' showing chalk ammonites and scaphites from the chalk quarries near Lewes.

The plate reflects two of Roger's passions - antiquarian books, particularly on the geology of Sussex, and chalk fossils, especially ammonites from the abandoned chalk quarries around Lewes.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Minutes of the A.G.M. - 7th December 2014

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

1) **Apologies:** Were received from:
Stuart Barnes, John Boryer, Richard Crespin, Margaret Dale, Clare Mitchell, Derek Payne, Jim Priestley, John Shirlaw, Diana Simpson.

2) **Minutes of the last A.G.M.:** These had been printed in the *H.D.G.S. Journal* which had been handed out to members. Their acceptance was proposed by Geoff Bennett, seconded by Tony Standen, and unanimously approved.

3) **Chairman's report:** Ken welcomed two new members to the A.G.M., Kenneth and Dominie Wilson. He said that the overall attendance to meetings during the year had been up yet again on the previous year's figures, with forty-two members on two occasions.

a) 2014 Programme: Ken summarised the year's activities:

Lectures:

'Fossil Folklore' by Ken Brooks

'Arthur Woodward & the NHM Fossil Fish Collection' by Mike Smith

'Diamonds' by *Dr.* Chris Duffin

'Micro Minerals' by *Dr.* Trevor Devon

'The Rock-a-Nore Story' by Ken Brooks

'Dinosaurs of Bexhill' by Julian Porter

'Flint' by Diana Smith

'Mineral Physics and the Structure of the Earth' by *Prof.* G. David Price

Field Trips:

Natural History Museum (Behind the scenes visit)

***Covehurst Bay to Fairlight Cove*:** Leaders *Prof.* Ed Jarzembowski, Peter Austen & Ken Brooks

***Bexhill to Hastings Link Road*:** Leaders Bob Pape and Casper Johnson

Ken said that twenty members had gone to the Natural History Museum, and it had been a great success, apart from a rather slow and tortuous coach journey. The second Fairlight trip (combined with members of the Geologists' Association) had been very well attended and everyone was looking forward to the third trip in the series, which would be from Fairlight to Rock-a-Nore, in 2015. The Link Road visit had been fascinating and very informative. Unfortunately, numbers had had to be restricted to ten members, but the interest had been so great that the County Archaeologist, Casper Johnson, had been asked to give us a talk on the geology and archaeology of the link road next year. Ken said that Jim Simpson had written a comprehensive account of this trip for the current *H.D.G.S. Journal*.

Barbecue:

Ken said that as Trevor and Fiona Devon had been unable to host this year's barbecue at their home, a beach barbecue had been suggested as an alternative. However, on the day, the weather had taken a turn for the worse and only five hardy members had braved the elements. However, a good time had been had by all.

Geologists' Association Southeast Regional Conference:

Ken mentioned that five of our members had managed to get to this year's conference on '*Geology and History in Southeast England*' held at Worthing College, and that nine very interesting lectures had been given throughout the day.

b) *H.D.G.S. Journal*: Ken thanked Peter & Joyce Austen for yet another superb *Journal*, and for all their work in producing it. He said that David Price was so impressed with its high standard that he would like to put it, and the past editions, on to the UCL publications website. Ken also thanked all the members who had contributed articles.

c) Other thanks: Ken thanked all the members of the committee as well as everyone who had helped to keep the meetings running smoothly by setting up and putting away tables and chairs, making tea and coffee and doing the washing up, etc. He also thanked those people who had brought fossils and geological specimens for display during the year.

4) Treasurer's report for the year ending 31st December 2014:

Statements of income and expenditure had been given out to members with the *H.D.G.S. Journal*. Norman went through each item and said that the balance was twice as much as it had been a few years ago. He also mentioned that we had had two generous donations this year. The first, of £450, had been a bequest from Nancy Wagner, and the money had been used to purchase a radio microphone for use by guest speakers. The second, £99, had been money collected from donations to the memory of Martin Bluhm, and donated by his niece, Sophie Jordan. Acceptance of the statement was proposed by Trevor Devon, seconded by Christine Wagner, and unanimously accepted.

5) Election of the Committee:

All members were willing to remain in office and it was proposed that the re-election of the Committee should be *en bloc*. This was proposed by Barbara Young, seconded by John Fowler and unanimously accepted. Ken said that there was again a vacancy for the post of Librarian as Douglas Macmillan, who had taken the job on a year earlier, had now moved to Ireland. (During the meeting Alison Cook very kindly agreed to become librarian.) He also asked if anyone would like to become Publicity Officer for the Society - there were no takers. Trevor said that if anyone would like to make any improvements to the website, he would be happy to help them.

Therefore the Committee was said to be as follows:

	2014	2015
Chairman	Ken Brooks	Ken Brooks
Treasurer	Norman Farmer	Norman Farmer
Secretary	Diana Brooks	Diana Brooks
Journal editors	Peter & Joyce Austen	Peter & Joyce Austen
Librarian	Douglas Macmillan	Alison Cook
Website manager	Trevor Devon	Trevor Devon
Other Officers	Colin Parsons John Boryer Pat Dowling	Colin Parsons John Boryer Pat Dowling

6) **2015 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 he listed the talks for the coming year:

- ***'Archaeology & Geology of the Link Road'*** by Casper Johnson
- ***'Soft Tissue Preservation in Dinosaurs'*** by *Dr.* Susannah Maidment
- ***'Ice Age Sussex'*** by *Dr.* Colin Whiteman
- ***'Mineralogy at the Natural History Museum'*** by *Prof.* Andy Fleet
- ***'How Britain Became an Island'*** by *Dr.* Sanjeev Gupta
- ***'The Cretaceous Greenhouse World & its Impact on the Evolution of Land Vertebrates'*** by *Prof.* Paul Upchurch
- ***'Wildlife of Sussex 140 Million Years Ago'*** by Peter Austen
- **Presidential Lecture** by *Prof.* David Price

He said that there would be the third joint field trip in the series with the Geologists' Association, this time to Rock-a-Nore, and probably approaching the beach area from the eastern end, going down through Fairlight Glen.
He also said that the New Year's Day walk would coincide with a low tide, so there would be a walk along the beach after lunch at The Smuggler Inn, and asked members to let him know if they wanted to attend as he would have to book tables in advance.
Pat Dowling thanked the committee for the 2015 programme and said it looked good.

7) **Any Other Business:**

- Ken then thanked everyone who had brought food and drink for the party and prizes for the raffle, and the Committee and members for their help at meetings. He also thanked Diana and Joyce for getting the teas, and Peter and Joyce for their continued work on the Journal.
He reminded members that the 2015 subscriptions were now due.
He said that Roger Blaker had brought along some items for auction, and that half of the resulting money from this would go to a local teenagers' charity.

- Ken said that during the year, articles by various members, including himself, Margaret Dale, Trevor Devon, Colin Parsons and Jim Priestley had been sent to UKGE and included in their *Deposits* magazine.

- Referring to his article in the *H.D.G.S. Journal* on the Sussex Mineral & Lapidary Society's 2014 visit to Maine, where he had seen Leopold and Rudolf Blaschka's glass botanical and zoological specimens, Trevor said that he had brought in a book of their glass models for members to look at. Details of the book were: *The Glass Flowers at Harvard* by Richard Evans Schultes & William A. Davis.

- Colin said that he had downloaded the free EarthViewer app (as recommended by Alison Cook) on to his tablet, and that it was quite remarkable and well worth a look.

- John Fowler asked if we could have a discussion on what is or isn't being done to house the archaeological finds from the Bexhill to Hastings Link Road. Ken suggested that we leave this until after Casper Johnson's talk on the Link Road, in January, when we will know a bit more about what is being proposed. He pointed out that there were quite a lot of artefacts already on display at Bexhill Museum. He said that the same problem was happening with the lack of fossil and mineral displays in the Hastings Museum, but that this was a national problem where museums were short of curators with palaeontological knowledge. He said he was going to see Cathy Walling to see if Teilhard de Chardin's collection could be put on display.

- Peter Austen said that Ken would be interviewed on *Countryfile* that evening, so everyone should switch their televisions on at 6.15 p.m.!

The meeting was declared closed at 3.20 p.m.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Statement of Income & Expenditure for the Year Ending 31st December 2014

INCOME	£	EXPENDITURE	£
Subscriptions		**G.A. Affiliation fees**	40.00
Single: 48 @ £15.00	720.00	**Hire of hall**	160.00
Family: 15 @ £20.00	300.00	**Society *Journal* production**	237.41
	1,020.00	**Insurance premium**	164.34
		Stationery, copying, postage	68.20
Donations	614.00	**Lecture fees and expenses**	162.38
Visit to Natural History Museum	475.00	**Purchase of radio microphone**	464.99
Raffle receipts	57.00	**Refreshments**	50.00
Sale of books and magazines	81.70	**Purchase of books and magazines**	22.00
	2,247.70	**Donation towards new printer**	100.00
		Visit to Natural History Museum	420.00
		Raffle prizes	35.55
			1,924.87
		Surplus being excess of income over expenditure	322.83
	2,247.70		2,247.70

Bank Account and Monies in Hand

Balances as at 31st December 2013	£	Balances as at 31st December 2014	£
NatWest Bank	874.89	NatWest Bank	1,001.22
Monies in hand	42.59	Monies in hand	239.09
	917.48		1,240.31
Increase in Balances 2014	322.83		
	1,240.31		1,240.31

December 2014